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LENGTH-WEIGHT AND VOLUME RELATIONSHIP IN THE THREAD-FIN BREAM, *NEMIPTERUS JAPONICUS* FROM THE PAKISTAN COAST

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ABSTRACT

The single equations for describing length-weight and length-volume relationships of indeterminate, males and females of *Nemipterus japonicus* (Bloch) have been justified. A comparison of the regression coefficients for the Andhra-Orissa and Kerala Coasts with the Pakistani Coast shows differences from the former and the resemblances with the latter, which suggests that the *N. japonicus* of the Pakistan Coast may belong to the same stock as the Kerala Coast. The distribution of condition factor 'K' for indeterminate, males and females has been tabulated.

INTRODUCTION

NEMIPTERUS JAPONICUS (Bloch) (Family : Nemipteridae) is the most widely distributed fish in the Indo-Pacific region from South Japan to East Africa and Red Sea (immigrant to Mediterranean). They are bottom living and are caught from the Pakistan Coast in all the seasons of the year from the shore to about 290 m depth (Fig. 1).

Length-weight relationship provides a means of converting measurements of length and weight. It can be an indication of some important events in the life-history of fishes such as metamorphosis, maturity and condition.

Usually the specific gravity of the fish is maintained as that of the surrounding water by the swim bladder and therefore changes in weight for a given length are due to changes in form or volume (LeCren, 1950). The length-volume relationship gives an idea of the seasonal changes in the specific gravity (Tester, 1940). Dhulkhed (1963) studied the length-volume relationship of the Indian Oil Sardine *Sardinella longiceps* Val.

References on some biological aspects of *N. japonicus* from India (Rao, 1964 ; Kuthalingam, 1965 ; Krishnamoorthi, 1971 ; Vinci and Nair, 1974) and Hong Kong (Eggleston, 1972) are available but no work has been reported from Pakistan. In the present report a detailed analysis of the length-weight and volume relationships and 'condition' has been given.

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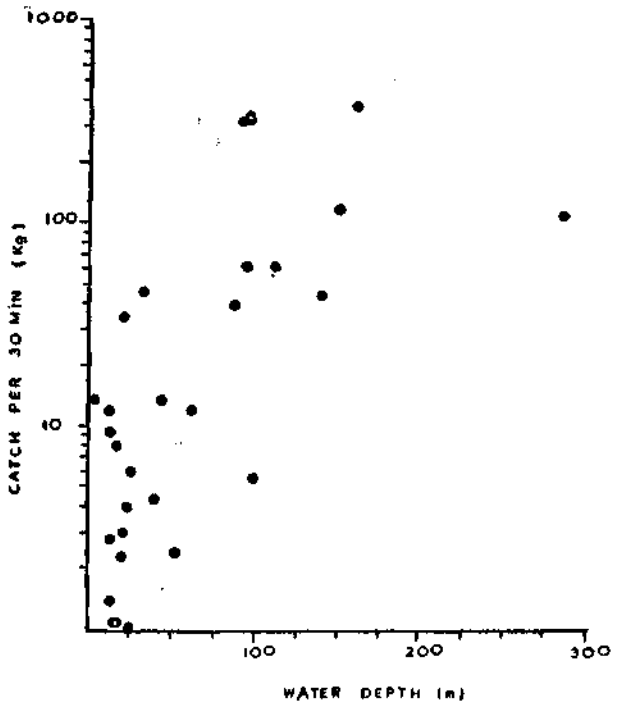

Fig. 1. Relation between catch and depth in *Nemipterus japonicus* along the Pakistan Coast. Data based on the collections made by R/V 'Dr. Fridtjof Nansen' cruising under NORAD/PAK/FAO Fisheries Research Programme from January to June, 1977.

Material and Methods

The fish were caught by bottom and pelagic trawls operated from R/V 'Dr. Fridtjof Nansen' of the NORAD/PAK/FAO Fisheries Research Programme along the Pakistan Coast between N 23° 34′ E 67° 41′ and N 25° 03′ E 61° 35′ (Fig. 2) from January to June, 1977. Samples of the fish were deep frozen at −20°C and brought to the Institute of Marine Biology, University of Karachi. The randomly sampled fish ranged from 74 to 250 mm in total length and were separated into three groups *viz.* indeterminate, females and males, their number being 45, 83 and 88 respectively.

The logarithmic form of allometric equation has been used to derive the length-weight and volume relationships :

W or $V = a L^b$ Where W = weight (gm)
V = volume (ml)
and 'a' and 'b' are constants

The constants ' a ' and 'b', the former measuring the initial growth index and the latter representing the slope of the regression line are estimated by ' least square method '. Weight and volume are determined by means of physical balance and water displacement respectively.

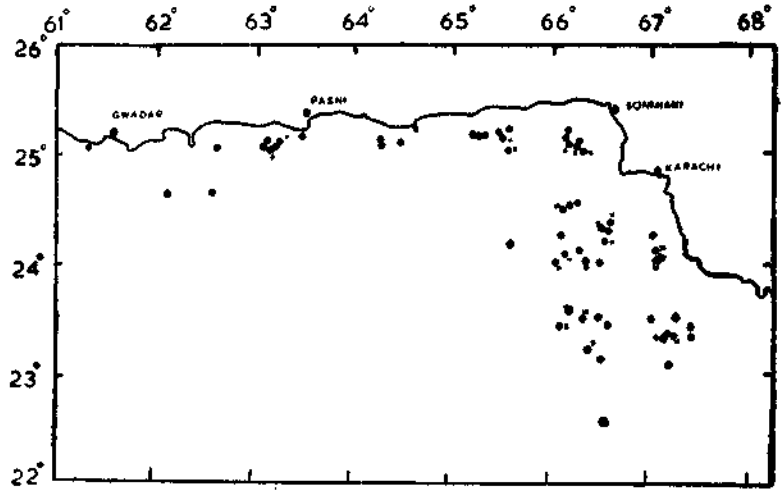

Fig. 2. Location of catches of *Nemipterus japonicus* along the Pakistan Coast. Data based on trawling by R/V ' Dr. Fridtjof Nansen ' along the Pakistan Coast between January and June, 1977 under NORAD/PAK/FAO FISHERIES RESEARCH PROGRAMME. Uncrossed circles indicate the locations for sampling only. Circles indicate the locations for catches of *N. japonicus*.

DISCUSSION AND CONCLUSIONS

The regression equations for length-weight relationships are given in Table 1.

TABLE 1. *Regression equations for length-weight relationships for indeterminate, females, males and combined*

Group	Linear equation	r	S. E. of reg. coeff.
Indeterminate	Log W = $\bar{6}$.947794 + 3.042351 Log L	0.9845889	0.0824049
Female	Log W = $\bar{5}$.259687 + 2.924475 Log L	0.9377865	0.1203085
Male	Log W = $\bar{6}$.915203 + 3.072529 Log L	0.9751321	0.0328121
Combined	Log W = $\bar{6}$.875413 + 3.090598 Log L	0.9870639	0.0343188

TABLE 2. *Analysis of covariance for testing the differences in the regression lines of the length-weight relationships in indeterminate, females and males*

		d.f.	Reg. coeff.	Deviation from regression d.f.	SS	MS	F
Within							
1.	Indeterminate	44	3.042351	43	0.095119	0.00221206	
2.	Female	82	2.924475	81	0.922300	0.01138642	
3.	Male	87	3.072529	86	0.069156	0.00084140	
4.				210	1.086575	0.00517417	
5.	Pooled within	213	1.85933	212	1.095535	0.00516762	
	Difference between slopes			2	0.00896	0.0044800	0.866
	Comparison of slopes : F = 0.00448/0.00516762 = 0.866 (d.f. 2, 210)						

The standard error in the regression coefficient of length-weight relationship is relatively lower in males than in females, which indicates that for females weights vary more frequently for a given length than for males. This is in agreement with the observations made by Vinci and Nair (1974). This is also true for volumes (Table 3).

TABLE 3. *Regression equations for length-volume relationships for indeterminate, females, males and combined*

Group	Linear equation	r	S.E. of reg. coeff.
Indeterminate	Log V = $\bar{5}$.308061 + 2.858422 Log L	0.9766162	0.0959911
Female	Log V = $\bar{6}$.967018 + 3.040255 Log L	0.9923402	0.0421215
Male	Log V = $\bar{6}$.821164 + 3.114348 Log L	0.9958261	0.0307797
Combined	Log V = $\bar{6}$.923095 + 3.072275 Log L	0.9901259	0.0185696

Krishnamoorthi (1971) calculated the length-weight relationship of males and females of this species from Andhra-Orissa Coast :

Males .. Log W = $\bar{3}$.2435 + 2.0769 Log L

Female .. Log W = $\bar{5}$.2625 + 2.9423 Log L

Vinci and Nair (1974) determined the length-weight relationship of the species from the Kerala Coast :

Males .. Log W = $\bar{5}$.503 + 2.8376 Log L

Females .. Log W = $\bar{5}$.4352 + 2.8689 Log L

The calculations on the same species from the Pakistan Coast show the relationship to be :

Males .. $\text{Log } W = \bar{6}.9152 + 3.0725 \text{ Log } L$

Females .. $\text{Log } W = \bar{5}.2597 + 2.9245 \text{ Log } L$

Krishnamoorthi (1971) tested the significance of the difference between the ' b ' values for males and females and found the difference highly significant at 5% level and hence he justified separate equations to describe the length-weight relationship for the males and females. Vinci and Nair (1974) tested the difference and found it to be statistically non-significant and obtained a general relationship : $\text{Log } W = \bar{5}.4795 + 2.8487 \text{ Log } L$ (S.E. of reg. coeff. 0.0152). In the present study the test of the difference in the regression lines revealed ' F ' value not significant, thus it is in conformity with the results of Vinci and Nair (1974) but differs from Krishnamoorthi (1971). The ' F ' test for length-volume relationship shows non-significant values (Table 4) at 0.01% level.

TABLE 4. *Analysis of covariance for testing the difference in the regression lines of the length-volume relationships of indeterminate, females and males*

	d.f.	Reg. coeff.	Deviation from regression d.f.	SS	MS
Within					
1. Indeterminate	44	2.858422	43	0.128964	0.00299163
2. Female	82	3.045210	81	0.111370	0.00140370
3. Male	87	3.114348	86	0.060856	0.00070763
4.			210	0.301190	0.00143424
5. Pooled, within	213	3.040412	212	0.316081	0.00149095
Difference between slopes			2	0.014891	0.0074455

Comparison of slopes : $F = 0.0074455/0.00143424 = 5.191$ (d.f. 2,210)

The value of ' a ' depends upon the obesity of the fish (LeCren, 1951). General fatness in the two sexes is different in Krishnamoorthi's (1971) sample from Andhra-Orissa Coast. This is in conformity with the present observation. The regression coefficients for the Kerala and Andhra-Orissa Coast seem to show differences especially in males (Vinci and Nair, 1974). The differences between males and females of the Kerala and Pakistan Coast are statistically non-significant and hence *N. japonicus* from the Pakistan Coast appears to belong to the same stock as that of the Kerala Coast but differs from the Andhra-Orissa Coast.

Generally the value of ' b ' is 3 in the length-weight relationship of fishes, but due to changing specific gravity and shape of the body contour the cube law need not always hold good (Rounsefell and Everhart, 1953). This departure has been tested by applying ' t ' test, and has been found non-significant showing that the

cube law holds good in case of *N. japonicus*. This observation tallies with the result of Krishnamoorthi (1971) but differs from Vinci and Nair (1974). The cube law also holds good for length-volume relationship.

The 95% confidence interval for predicted weight and volume ($\hat{Y}$) for a given length (X) is calculated as follows :

$$\text{Statistic} \pm (t)\ (\text{S.E. of statistic})$$

(i) $\hat{Y} \pm (t) \sqrt{s^2 \left[\frac{1}{n} + \frac{(X-\bar{X})^2}{\Sigma x^2}\right]}$ for mean value

(ii) $Y \pm (t) \sqrt{s^2 \left[1 + \frac{1}{n} + \frac{(X-\bar{X})^2}{\Sigma x^2}\right]}$ for a single value

A wider confidence interval in length-weight relationship in females prove the already said fact that the females vary much in their weight. Rarely a point lies outside the confidence interval (continuous lines, Figs. 2-7) suggesting that the samples were taken from a homogeneous population.

Condition Factor

Condition factor has been calculated by using the formula $K = \frac{W.\ 100}{L^3}$, where 'W' is the weight of the fish in gram, 'L' the length in centimeter (Hile, 1936). The 'K' is in fact a proportionality factor between weight and length since $W = 0.01\ K.\ L^3$. The value of 'K' thus obtained is a quantitative measure of relative heaviness and in this sense is directly comparable between the fish of any length. The distribution of the values of 'K' is summarised in Table 5.

Table 5. *Distribution of the values of condition factor 'K'*

		Indeterminate	Female	Male
Number of fish	..	45	83	88
Range of 'K'	..	0.0967-0.3150	0.9984-1.6027	1.0388-1.4088
Range of concentration	..	0.96-1.24	1.11-1.35	1.11-1.31
Percentage in the range of concentration	..	71.10	81.93	81.82
Mean 'K'	..	1.100	1.235	1.207
S.D. of 'K'	..	0.118359	0.1071355	0.012366
β_1	..	0.000954	0.616806	0.012366
β_2	..	2.062215	4.710906	2.942173

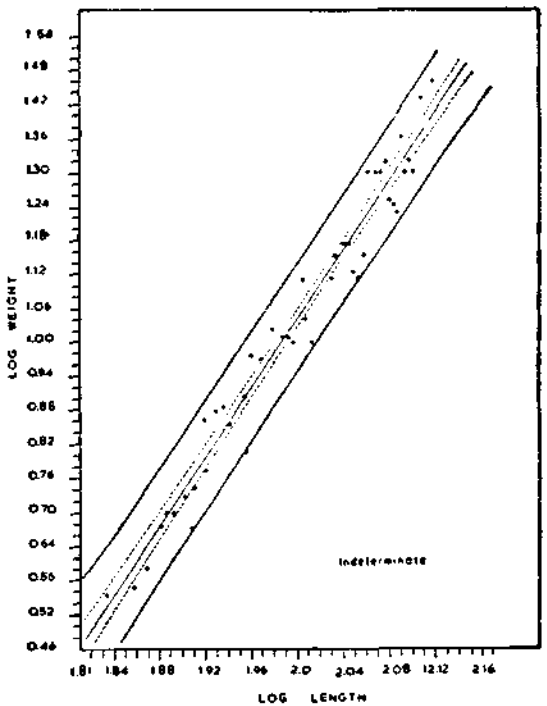

Fig. 3. Length-weight relationship of indeterminate. Broken and continuous lines indicate 95% C.I. for average and single values of weight respectively.

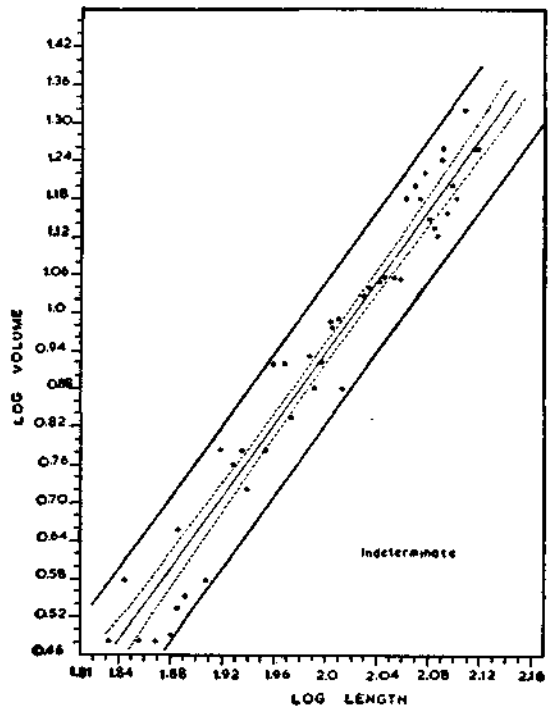

Fig. 4. Length-volume relationship of indeterminate. Broken and continuous lines indicate 95% C.I. for average and single values of volume respectively.

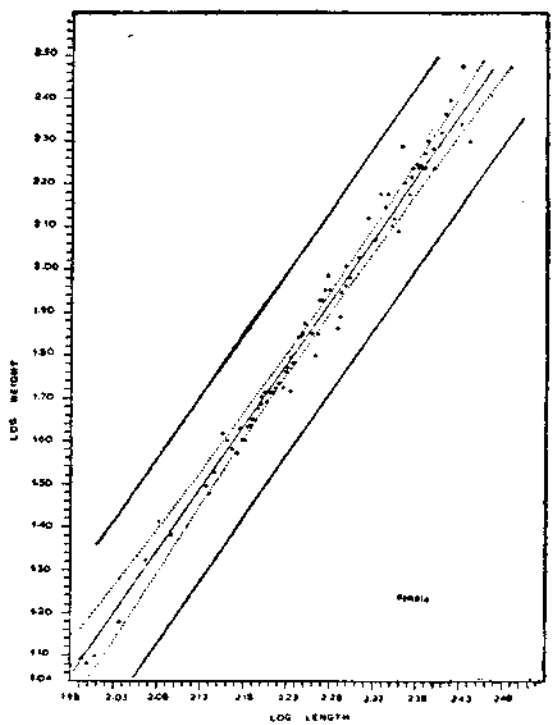

Fig. 5. Length-weight relationship of females. Broken and continuous lines indicate 95% C.I. for average and single values of weight respectively.

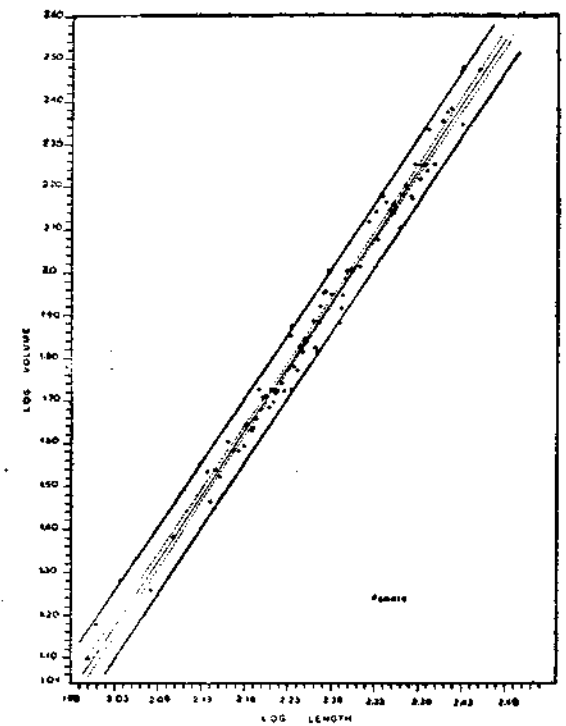

Fig. 6. Length-volume relationship of females. Broken and continuous lines indicate 95% C.I. for average and single values of volume respectively

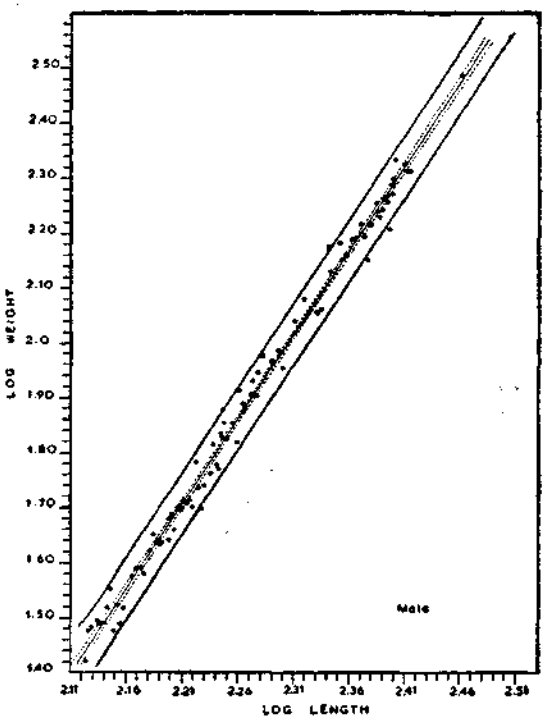

Fig. 7. Length-weight relationship of males. Broken and continuous lines indicate 95% C.I. for average and single values of weight respectively.

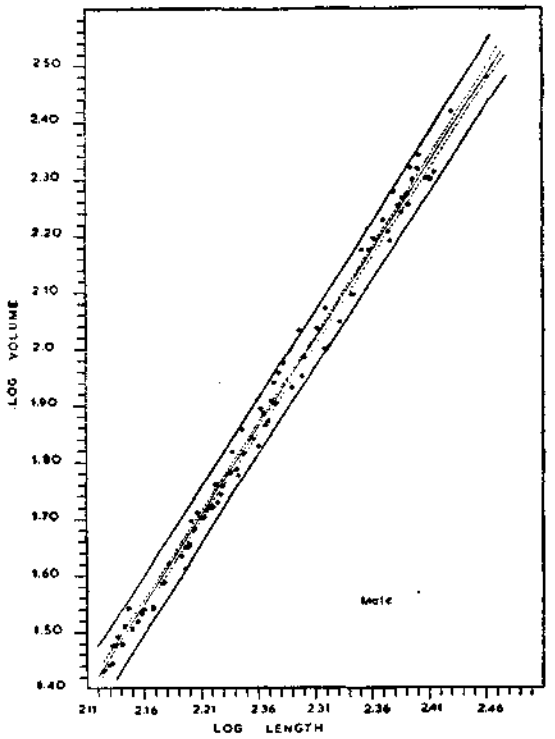

Fig. 8. Length-volume relationship of males. Broken and continuous lines indicate 95% C.I. for average and single values of volumes respectively.

References

DHULKHED, M. H. 1963. The length-weight and volume relationship of the Indian Oil sardine, *Sardinella longiceps* Val. *Indian J. Fish.*, **10** (1) : 40-47.

EGGLESTON, D. 1972. Pattern of the biology in the Nemipteridae. *J. mar. biol. Ass. India*, **14** (1) : 357-362.

HILE, R. 1936. Age and growth of Cisco *Leucichthys artedi* (Le Sueur) in the lakes of the north-eastern highlands, Wisconsin. *Bull. Bur. Fish.*, **48** : 211-317.

KRISHNAMOORTHI, B. 1971. Biology of the thread-fin bream *Nemipterus japonicus*. *Indian J. Fish.*, **18** (1 & 2) : 1-21.

KUTHALINGAM, M. D. K. 1965. Notes on some aspects of *Nemipterus japonicus* (Bloch) with special reference to feeding behaviour. *Ibid.*, **12** (2) : 500-507.

LECREN, E. D. 1951. The length-weight relationship and seasonal cycle in the gonad weight and condition in perch (*Perca fluviatilis*). *J. Anim. Ecol.*, **20** : 201-219.

RAO, K. S. 1964. Food and feeding habits of fishes from trawl catches in the Bay of Bengal with observations on diurnal variations in the nature of food. *Indian J. Fish.*, **11** : 277-314.

ROUNSEFELL, G. A. AND W. H. EVERHART 1953. *Fishery Science : its method and application.* John Wiley & Sons. Inc., N.Y.

TESTER, A. L. 1940. A specific gravity method for determining fatness (condition) in the herring (*Clupea pallasii*). *J. Fish. Res. Bd. Canada*, 4 : 461-471.

VINCI, C. K. AND A. K. KESAVAN NAIR 1974. Length-weight relationship in the thread-fin bream, *Nemipterus japonicus* along the Kerala Coast. *Indian J. Fish.*, **21** : 299-302.