LENGTH-WEIGHT RELATIONSHIP IN *SAURIDA TUMBIL* AND *S. UNDOSQUAMIS* AND RELATIVE CONDITION IN *S. TUMBIL**

K. VENKATA SUBBA RAO**

Waltair Research Centre of CMFR Institute, Waltair.

ABSTRACT

The length-weight relationship of *S. tumbil* was estimated and given by the equation: Males: $W = 0.003642\ L^{3.2018}$; and Females: $W = 0.002614\ L^{3.2957}$. As there was no significant difference observed in the regressions between the sexes in *S. undosquamis*, an equation for the two sexes combined was found to be: $W = 0.005811\ L^{3.0308}$.

The relative condition factor, Kn, given by the formula, $Kn = \frac{W}{\bar{W}}$, where W and $\bar{W}$ are the observed and expected weights, respectively, was employed for studying the condition in *S. tumbil*. The seasonal variations in the Kn value of mature fish were observed to be related to the sexual cycle and feeding intensity while the variations in the value in the case of immature fish could not be related either to the sexual cycle or feeding intensity. The inflexion at 260 mm in the curve for Kn values in females as well as males may indicate the minimum size at first maturity.

INTRODUCTION

The length-weight relationship is useful for understanding the mathematical relationship between length and weight so that one may be converted into another. It is also useful to measure the 'Condition,' i.e., the variation from expected weight for length of individual fish or groups of individuals as indications of fatness, general 'well being,' gonad development, etc. (Le Cren, 1951). Changes in condition have usually been analysed by means of a "Condition factor" or "Coefficient of condition" or "Ponderal index" (Hile 1936; Thompson, 1943) which is given by the formula $K = \frac{100\,W}{L^3}$, where K represents the condition factor, W the weight and L the length of fish respectively. The seasonal changes in the condition factor have been shown to be correlated with gonad cycles, rates of freeding, etc. (Hickling 1930, Hart 1946, Menon 1950, Le Cren 1951, Rao 1963).

* Formed part of the author's thesis for Ph.D. of the Banaras Hindu University.

** *Present address*: National Academy of Agricultural Research Management, Rajendranagar, Hyderabad 500030.

Le Cren (*op. cit*) has shown that the 'K' values will be affected if the fish does not obey the cube law in its length-weight relationship, and he proposed the 'Relative condition factor' K_n, given by the formula $K_n = \frac{W}{\overline{W}}$, where W represents the observed weight and $\overline{W}$, the calculated weight of fish. Since the values of 'B' in male as well as female *S. tumbil* differed from 3, it was felt that the use of relative condition factor K_n in this study would be more appropriate.

Material and Methods

The material was obtained from the catches of the Government of India trawlers M. T. Ashok, M. F. V. Champa and M. V. Sea Horse, based at Visakhapatnam during the period 1964-1966. Total length (correct to 1 mm) was measured from the tip of the snout to the tip of the longest caudal ray in the upper lobe and weight was taken in grams (correct to 0.5 g) for each specimen. A total of 1297 specimens of *S. tumbil* (807 males, 490 males) ranging in size from 14.0 cm to 45.0 cm were used in this study. Relative condition factor (K_n) was calculated by employing the formula, $K_n = \frac{W}{\overline{W}}$ where W represents the observed weight and $\overline{W}$ the calculated weight. The individual K_n values were grouped according to the size, sex of the fish and the month.

In the case of *S. tumbil* and *S. undosquamis* a general parabolic equation of the form $W = AL^B$ was fitted, where W = weight, L = Length, A is a constant and B an exponent (Hile 1936, Martin 1949).

Length-Weight Relationship

S. tumbil

By using logarithms, the general parabolic equation $W = AL^B$ can be expressed by the linear equation:

$$\log W = \log A + B \log L.$$

The linear equation was fitted separately for the two sexes. The estimates of the parameters 'A' and 'B' were obtained by the method of least squares. The equations for the two sexes were found to be:

Males: $W = 0.003642\ L^{3.2018}$

Females: $W = 0.002614\ L^{3.2957}$

The corresponding logarithmic equations may be represented as:

Males: $\text{Log } W = -2.4386 + 3.2018 \log L$

Females: $\text{Log } W = -2.5826 + 3.2957 \log L$

To test if the regressions of Y on X are significantly different for the two sexes, Analysis of covariance was employed.

It was observed that there was significant difference at 5% level in the regression of Y on X between sexes, but not at 1% level.

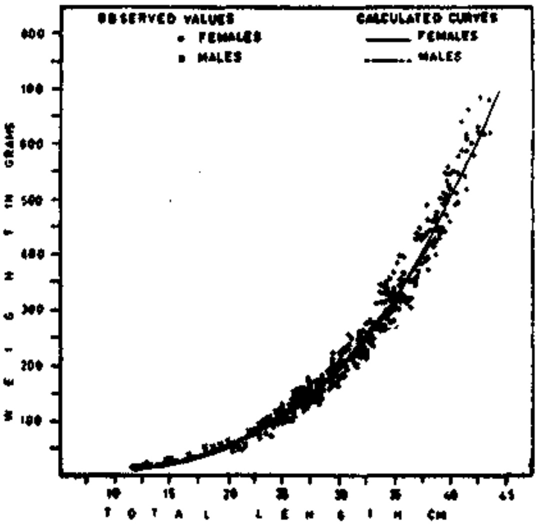

FIG. 1. Parabolic relationship between length and weight of *S. tumbil.*

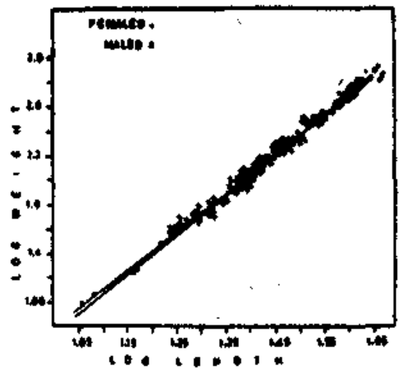

FIG. 2. Logarithmic relationship between length and weight of *S. tumbil.*

The regressions of the length-weight relationship of the two sexes were tested to see whether they differed in elevation. F-test showed that the two regressions differed significantly in elevation ($F = 26.21$; d.f. = 1,1294) both at 5% and 1% levels. Tiews et al (1972) fitted roughly the length-weight curves for male and female *S. tumbil* from the Philippine waters and did not find any difference between the sexes.

The observed values of length and weight of *S. tumbil* were plotted (Fig. 1) and the calculated length-weight curve fitted to the data. A close agreement between the two sets of data may be seen from the figure. Similarly, the logarithmic values of lengths and observed weights were plotted (Fig. 2) and the regression line fitted to the data indicates a straight line relationship.

The significance of the variation in the estimate of 'B' for *S. tumbil* from the expected value for ideal fish (3.0) was tested by the 't' test, as given by the formula, $t = \frac{b-B}{Sb}$. The values of 't' for males ($t = 7.761$; d.f. = 479) as well as females (t = 21.96; d.f. = 816) showed significant difference both at 5% and 1% levels. Hence the cubic formula $W = AL^3$ will not be a proper representation of the length-weight relationship of *S. tumbil*. The exponent is greater than 3 and the best estimates of 'B' for males and females would be 3.2018 and 3.2957 respectively.

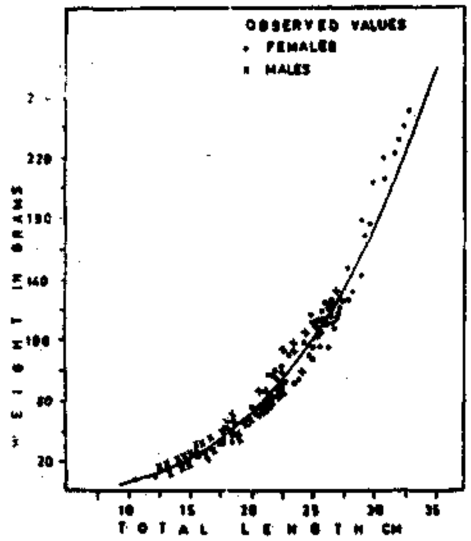

FIG. 3. Parabolic relationship between length and weight of *S. undosquamis*.

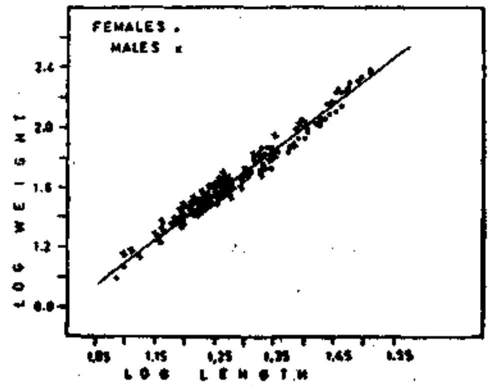

FIG. 4. Logarithmic relationship between length and weight of *S. undosquamis*.

S. undosquamis

For calculating the length-weight relationship 312 specimens (172 females and 140 males) ranging in size from 12.1 to 32.5 cm were used. The equations for the length-weight relationship for the two sexes were found to be:

Males: $W = 0.005128\ L^{3.0753}$

Females: $W = 0.005852\ L^{3.0271}$

The corresponding logarithmic equations may be written as:

Males: $\log W = -2.2901 + 3.0753 \log L$
Females: $\log W = -2.2327 + 3.0271 \log L$

Analysis of covariance showed that there was no significant difference in the regressions between the sexes. There was no significant difference in the elevation of the regressions between the sexes either at 5% or 1% level (F =

0.49; d.f. = 1,309). Hence the length-weight data of males and females were pooled and the equation for the length-weight relationship for the two sexes combined was calculated and found to be:

$$W = 0.005811 \; L^{3.0308}$$

The corresponding logarithmic equation may be written as:

$$\log W = -2.2358 = 3.0308 \log L$$

The observed values of length and weight of *S. undosquamis* were plotted and the calculated length-weight curve fitted to the data (Fig. 3). The logarithmic values of lengths and observed weights were plotted (Fig. 4) and the regression line fitted to the data indicates a straight line relationship.

The significance of the variation in the estimate of 'B' for *S. undosquamis* from the expected value for ideal fish (3.0) was tested by the 't' test as given by the formula, $t = \frac{b-B}{Sb}$. The values of 't' for females (t = 0.6062; d.f. = 171) did not show significant difference at 5% or 1% level while the value of 't' for males (t = 2.5268; d.f. = 139) showed significant difference at 5% level but not at 1% level.

Relative Condition Factor in *Saurida tumbil*

For studying the condition cycle in *S. tumbil* and its relation to gonad cycle and feeding, the immature and mature fish were treated separately. Fish above 280 mm were considered as mature and those below 280 mm as immature amongst females, since nearly 50% of the females are mature in the size group 280-300 mm. In the case of males, fish above 250 mm were considered as mature and those below 250 mm as immature. The monthly average values of the relative condition factor for the years 1964-65 and 1965-66 of the females and males are represented in Fig. 5.

Mature fish

Females (Fig. 5): The K_n value was high in June but suddenly declined in July and again gradually increased till September. From October there was a gradual decline in the values till February followed by an increase in March-April and a slight fall in May. The trend in both the years was similar except that in January 1965 the value was high and in January 1966 the value was low. The values were in general low from October to February.

Males (Fig. 6): In 1964-65, the K_n value gradually declined from June to September but increased in October. From November to March the values were low except for a minor peak in January. The K_n value again increased in April followed by a fall in May. These variations were similar to those observed for mature females.

The graph for 1965-66 appears different and this may be due to the small number of fish contributing for the mean K_n values in many months and, hence, great reliance cannot be placed on these values. A steep fall in July 1965 and three peaks, one each in November, February, and April, were observed in the K_n values.

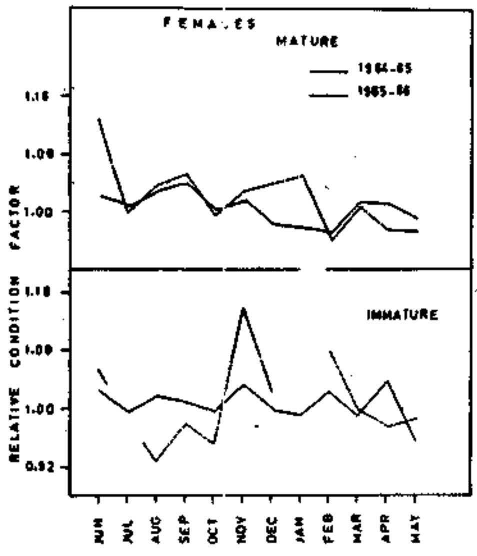

FIG. 5. Seasonal variations in the relative condition factor of *S. tumbil* females.

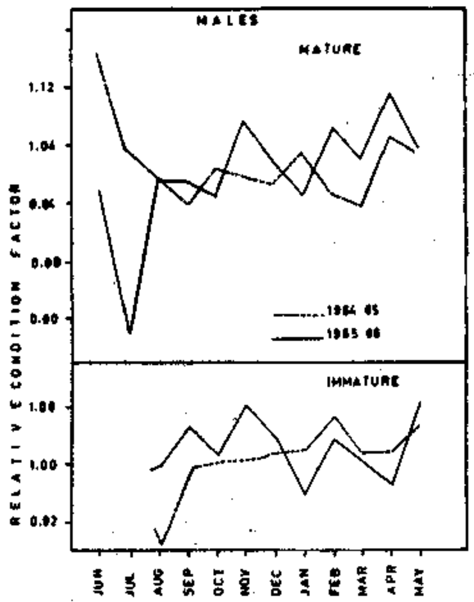

FIG. 6. Seasonal variations in the relative condition factor of *S. tumbil* males.

Immature fish

Famales (Fig. 5): In 1964-65, the Kn value declined from June to August but increased slightly in September. There was a slight fall in the value in October, a sudden increase in November and another fall in December. From February to May there was a gradual decline. The trend in 1965-66 was similar except in the months of August and April when the values were low in 1964-65 but high in 1965-66.

Males (Fig. 6): In 1964-65, the K_n value was high in June, suddenly dropped in August and again increased in September. From September to January there was not much fluctuation in the values. In February the K_n value shot up but declined in March and April followed by another rise in May.

In 1965-66, the Kn values gradually increased from June to September, declined in October followed by another rise in November. The values dropped in December and January but again increased in February. There was again a decrease in the value in March and April followed by a rise in May. From January to May the trend in both the years was almost the same.

In the case of immature fish, the declining trend in the K_n values from October to February or March, which was evident in mature fish, was not observed.

Relative condition factor according to length

For studying the variations in the relative condition according to the length of the fish K_n values for 609 females and 327 males of *S. tumbil* were calculated. The data were split up into 20-mm size groups and the average Kn value for each size group was determined. The average K_n values for different size groups are plotted in Fig. 7.

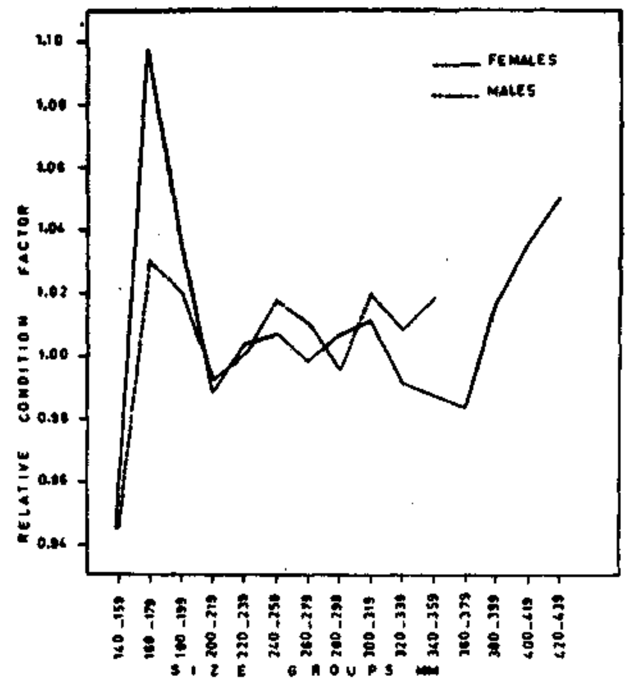

FIG. 7. Relative condition factor in various size groups of *S. tumbil*.

It can be seen from Fig. 7 that the K_n values for males as well as females dropped at 200 mm followed by an increase up to 240 mm. The values again declined at 260 mm in both the sexes. In females the K_n values increased from 260 mm up to 300 mm, but declined gradually thereafter reaching the minimum at 360 mm. From 380 mm onwards the K_n values gradually increased. The values for males showed an increase from 280 to 300 mm and a fall at 320 mm followed by another rise at 340 mm.

DISCUSSION

S. tumbil has a protracted spawning season (Rao, MS) extending from October to March. In the present study it has been observed that in mature fish the K_n has low values from October to February, whereas in immature fish the values do not show such a decline. The fall in the K_n values of mature fish in October and the downward trend thereafter till February or March may be attributed to the poor condition of the fish due to the strain of spawning. This is further supported by the fact that, in the females, the K_n values of immature fish were high and those of mature fish low during the period November to February. In the case of males also, the values of immature fish were high and those of mature fish low from from November to March in 1964-65 and from September to December in 1965-66.

The peaks in the K_n values of mature females in June and September may be due to the high feeding intensity and the prespawning increase in the weights of gonads due to maturation. The seasonal variations in the feeding intensity of mature fish (31-45 cm) showed peaks in June, September and December-January (Rao 1981). The peak in the value observed in January 1965 may be due to the recovery of some fish from the strain of spawning and their high feeding intensity. The rise in the values in April and May may denote the recovery of the spent fish from the strain of spawning.

The seasonal variations of the K_n values in mature males during 1964-65 was similar to those of mature females. The lower values from November to March may be related to the strain of spawning while the minor peak in January may be due to the recovery of some fish and also higher feeding intensity. This trend was not clear in the seasonal values for mature males in 1965-66.

The peak K_n values in September and May observed in the case of immature males can be attributed to the higher feeding intensity observed in immature fish of the size range 16-30 cm while the peaks in November and February may be due to other factors. The seasonal variations in the values for immature females in both the years cannot be related to feeding intensity.

A sudden fall in the K_n value in the month of July was observed for immature and mature fish in both the years. The fall in the value in July for mature fish may be due to the fall in the feeding intensity as observed for mature fish (31-45 cm). The feeding intensity for immature fish in July was observed to be high though the relative condition factor was low.

The peaks in the K_n values observed in June, November, February and April for immature fish and also the decline in the values in April or May observed, in the case of both immature and mature fish, cannot be related to the feeding intensity.

It therefore appears that, besides the sexual cycle and food intake, other factors also may be responsible for the variations in the relative condition factor values. Blackburn (1960) in the Australian barracouta *Thyrsites atun*, and James (1967) in the ribbon fish *Eupleurogrammus intermedius* from Indian waters, could not correlate the changes in condition either to the gonad cycle or feeding habits; and these authors feel that changes in condition may be due to factors other than the reproductive cycle and feeding habits.

Hart (1946), in the report on the trawling surveys on the Patagonian continental sehlf, observes "...... apart from the seasonal variation in condition, there is a secondary variation related to the length of the fish. With the increase in age, there is a lower level of condition throughout the seasonal cycle consequent upon the increased metabolic strain of spawning. The point of inflexion on the curve showing the diminution of 'K' with increasing length is thus a good indication of the length at which sexual maturity is attained".

The variations in the K_n values according to length in *S. tumbil* appear to be related to maturation. The maturing and mature fish start appearing from 220 mm onwards (Rao, MS). The minimum size at maturity and the size at 50% maturity were found to be 260 mm and 300 mm, respectively. The sudden fall in K_n values at 200 mm may be indicative of the commencement of maturation and the inflexion at 260 mm in both sexes (Fig. 7) may indicate the minimum size at first maturity.

The peak at 300 mm in the K_n values probably indicates the recovery of fish from the first spawning and the fall in the values from 320 to 360 mm may be due to the second spawning. The steep rise in the values from 380 to 440 mm in the case of females may be due to the fish getting ready for the subsequent spawning.

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