Length – Weight Relationship of the Great seahorse, *Hippocampus kelloggi* (Jordan and Snyder 1902), inhabiting Coromandel Coast, Southeast coast of India

Balasubramanian R & A. Murugan*

Faculty of Marine Sciences, Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai – 608 502, Tamil Nadu, India

*[E.Mail: arumugam.murugan@gmail.com]*

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In this paper we report the Length-Weight Relationship (LWR) of *Hippocampus kelloggi* inhabiting Coromandel Coast. Sampling period was from October, 2000 to September, 2001. Overall 537 individuals were sampled and all of them were caught from the bottom trawl nets. Sample size ranged from 55mm to 302 mm and the estimated $b$ value was 2.7, 2.5 and 2 for males, females and juveniles respectively. The results indicate a negative allometric growth rate. Analysis of co-variance suggest that between the regression equation obtained for males and females no significant difference ($P < 0.01$) was observed. The results presented in this study provides a baseline information on the LWR of *H. kelloggi*, a biological data deficient fish from Indian waters. The biological information obtained will help policy makers to prepare the much important management plan and conservation strategies for *H. kelloggi* or seahorses for Indian waters in near future.

[Keyword: Length- weight, Seahorse, *H. kelloggi]*

**Introduction**

Growth in fishes is manifested as an increase in the size (length and weight). Length-Weight Relationship (LWR) has been mathematically proven to have a constant relationship between total length and weight of the individuals. Length-Weight Relationship (LWR) is of great importance in fishery biology for the calculation of a fish’s average weight at a certain length and the conversion of an equation of growth in terms of length and weight. Furthermore LWR allows *inter alia*: i) estimation of average weight of the fish of a given length group; ii) conversion of length-growth equation to weight-growth equivalent; iii) inter-specific and inter-population morphometric comparison of fish species; and iv) assessment of the relative wellbeing of fish populations. The growth in terms of weight can be calculated through LWR and is extremely useful in studying fish maturity and to develop analytical models.

Among the seahorse recorded *H. kelloggi* is the largest species found in Indian waters, with a maximum recorded Standard length of 302 mm from Cuddalore waters. Globally available scientific information’s on the biology of *H. kelloggi* is limited. The most recent survey on the incidental catch in India include reports on catch decline of seahorses, including *H. kelloggi*. It has been categorized as Data Deficient in the IUCN Red List despite the high trade demand for *H. kelloggi* although absolute numbers of representative populations in trade are unknown since it is illegal in most Asian countries.

Only few research studies have been conducted thus far on the LWR of wild populations from Indian waters for the fishes belonging to the family Syngnathidae viz., *H. trimaculatus*, *H. kuda*, *Syngnathoides biaculeatus*. Studies on, biological aspects of these species are not extremely cumbersome since the species has been listed on schedule I of the Indian Wildlife Protection Act, (1972) by the then Ministry of Environment and Forests as an active
conservation strategy. The procedures of this law, in turn make it nearly impossible for studies to be conducted on such species, and severely restricts researchers accessing samples or even handling individuals of the species. The same scenario persists in other regions of the world also when it comes to obtaining LWR records of wild populations of seahorses.\textsuperscript{12} The present attempts to provide basic information about its growth condition of \textit{H. kelloggi} under ex – situ conditions, which will be valuable for the fishery biologists and managers interested in developing conservation protocols for this unique endangered species with a restricted global distribution pattern.\textsuperscript{8,12}

Materials and Methods

For studying LWR, data from 537 individuals of \textit{H. kelloggi} were gathered during the study period (October 2000 to September 2001) from Cuddalore, Pazhayar and Nagapattinam region whereas the fishing depth varied from 5 to 75m (Fig.1). Among the collected samples 176 males, 198 females and 163 juveniles were categorized and examined. Standard length (mm) of the fish was measured from the tip of the snout to the end of the tail\textsuperscript{10}, and the fish was weighed (g) after draining and blotting it with a tissue paper to remove the excess water.

The LWR were estimated from the allometric formula, $W = a L^b$, where \( W \) is total body weight (g), \( L \) the Standard length (cm), ‘\( a \)’ is the intercept and ‘\( b \)’ is the slope\textsuperscript{17}. Degree of association between the variables was computed by the determination coefficient (\( r^2 \))\textsuperscript{10}. Parameters ‘\( a \)’ and ‘\( b \)’ were estimated by linear regression on the $\log$ - transformed (\( \log_{10} \)) equation $\log(W) = \log \,(a) + b \log \,(L)$. In order to confirm whether \( b \) values obtained in the linear regressions were significantly different from the isometric value (\( b=3 \)), t-tests with appropriate degrees of freedom were used\textsuperscript{19}. The comparison between obtained values of ‘\( r \)’ statistics and respective tabled critical values allowed for the determination of (statistical significance) the ‘\( b \)’ values, and their inclusion in the isometric range (\( b=3 \)) or allometric ranges (negative allometric: \( b<3 \) or positive allometric: \( b>3 \)). ANCOVA was used to determine if there were significant differences in the LWR between the sexes\textsuperscript{20}.

Results

The Standard Length (SL) for males ranged between 148 and 302mm with a mean length of 224 ± 78mm, whereas the wet weight ranged from 20.3 to 86.8 mg with a mean of 65.3 ±18.5 mg. In the case of females, the SL observed was between 155 and 296mm with a mean length of 244 ±52mm.

However, the wet weight observed was between 19.6 to 72.4mg with a mean weight of 48.4 ± 19.3 mg. However, in the case of juveniles the SL ranged between 55 and 147 mm with a mean length of 112± 20 mm, whereas the wet weight ranged from 2.9 to 23.7 mg with a mean of 8.36 ± 10.44mg.

The present study suggests that the values of the slope ‘\( b \)’ were 2.7, 2.5 and 2.0 for male, female and juvenile seahorses (Fig: 2 to 4). Negative allometric growth for males, females and juveniles was observed for the population occurring along the Coromandel coast for \textit{H. kelloggi}. However, there were no significant differences in the slope or intercept between males and females (\( P>0.005 \)). Study species shows negative allometric growth rates (\( b<3 \)), suggesting that they are moderate growing fishes. The co-efficient of determination (\( r^2 \)) was 0.993, 0.968 and 0.914 for males, females and juveniles. Linear regressions drawn for males, females and, juveniles were statistically significant (\( P < 0.05 \)). Linear equations obtained for \textit{H. kelloggi} is:

- **Males:** $\log W = -4.87417 + 2.7088 \log L$
- **Females:** $\log W = -4.5921 + 2.5681 \log L$
- **Juveniles:** $\log W = -3.1160 + 2.0110 \log L$

The regression co-efficient (\( b \)) obtained for males and females were 2.7, 2.56 and 2.01 respectively. This co-efficient were compared between males, females and juveniles using ANCOVA and presented in tables 1 and 2. No significant difference was observed between males and females (\( F = 10.13 \)) at the 5% level.
Fig. 2 – Length – weight relationship of male *H. kelloggi*

Fig. 3 – Length – weight relationship of female *H. kelloggi*

Fig. 4 – Length-weight relationship of juvenile *H. kelloggi*

Table: 1. Corrected sum of squares and products of the length – weight data of *H. kelloggi* males, females and juveniles, regression coefficient and deviation from regression (df = degrees of freedom, $x^2$, $y^2$, $xy$=corrected sum of squares and products, $b$ = regression coefficient, SS = sum of squares)

<table>
<thead>
<tr>
<th>Groups</th>
<th>df</th>
<th>Sum of squares and products</th>
<th>b</th>
<th>Error Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>175</td>
<td>$1.92$ 14.29 5.21</td>
<td>2.7</td>
<td>174 0.17</td>
</tr>
<tr>
<td>Female</td>
<td>197</td>
<td>$2.45$ 17.28 6.31</td>
<td>2.56</td>
<td>196 1.07</td>
</tr>
<tr>
<td>Juvenile</td>
<td>162</td>
<td>$2.54$ 12.30 5.12</td>
<td>2.01</td>
<td>161 2.00</td>
</tr>
<tr>
<td>Total</td>
<td>534</td>
<td>$7.03$ 43.88 16.64</td>
<td>531 3.25</td>
<td></td>
</tr>
</tbody>
</table>

Table: 2. Analysis of covariance of *H. kelloggi* males, females and juveniles

<table>
<thead>
<tr>
<th>Sources of variation</th>
<th>df</th>
<th>Sum of squares</th>
<th>Mean squares</th>
<th>Observed F</th>
<th>5 % F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviation from individual regression</td>
<td>531</td>
<td>3.25</td>
<td>6.13</td>
<td>10.13</td>
<td>3.0</td>
</tr>
<tr>
<td>Difference between regression</td>
<td>2</td>
<td>1.21</td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Discussion**

Fishes continue to grow until the maximum growth is obtained. Rapid growth indicates abundant food and other favorable conditions, whereas slow growth indicates just the opposite. The LWR in fishes can be affected by a number of factors including season, habitat, gonad maturity, sex, diet and stomach fullness, health and preservation techniques and differences in the length sizes of the specimens caught\(^{21-22}\). Although the fishes of the family Syngnathidae are not economically important, they are significant from the aspect of ichthyofauna conservation and are considered as flagship species\(^{24-26}\).

Studies on LWR have indicated that one might find wide variability in parameter estimates for a single species\(^{27}\), whereas it varies within different species among the family, which might depend on sex, stage of maturity and food habits\(^{28-29}\). Our results report that ‘$b$’ value for males, females and juveniles were 2.7, 2.5 and 2 respectively. The LWR of *H. kelloggi* was not compared based on temporal and spatial variation due to limited studies. Recent studies of LWR of *H. kuda* from the Gulf of Mannar waters revealed a negative allometric isometric growth pattern and the exponent values varied spatially\(^{15}\), and similar observations are recorded for *H. trimaculatus* inhabiting Gulf of Mannar waters\(^{10}\) and *H. kuda* inhabiting Palk Bay region\(^{15}\). The LWR for *H. hippocampus* revealed that weight increases isometrically with length for populations inhabiting the Aegean Seas, whereas in the case of *H. guttulatus* negative allometric growth was observed from specimens collected in similar habitat\(^{18}\). Isometric growth was observed for seahorse species like *H. hippocampus* and *H. guttulatus* inhabiting the temperate lagoon from the south coast of Portugal and Mar Menor coastal lagoon of the Western Mediterranean Sea\(^{31-32}\), whereas negative allometric growth was
observed for \textit{H. guttulatus} and \textit{H. hippocampus} collected from the Arade estuary, southern Portugal\textsuperscript{33}. From the existing literature, it may be concluded that the LWR for seahorses varies spatially and temporally as well as based on biological characteristics.

At present LWR studies are available for many coral reef and marine commercial fishes\textsuperscript{34,36} whereas similar studies on Syngnathid fishes are indeed limited\textsuperscript{12}. This might be attributable to its low density in the ecosystem but also to the restricted of researchers to study this species within the current policy framework. Information provided in this paper serves a reference for LWR data necessary fisheries and stock management planning for \textit{H. kelloggi} of the Coromandel Coast, whose population is considerable in comparison to other parts of Indian waters\textsuperscript{9}. Consequently, the data presented here can be compared to data from other studies of \textit{H. kelloggi} found in other waters or for comparative work on similarly sized seahorse species from India.

**Conclusion**

Sound knowledge of the life history of species is essential for their conservation and Management\textsuperscript{12}. The scientific information on LWR relationship is very much important for a species which is highly exploited\textsuperscript{10}, and for species where its life-history characteristics makes them more vulnerable to overexploitation and trade\textsuperscript{37,38}. The present study suggest that the LWR for \textit{H.kelloggi} inhabiting Coromandel coast showed negative allometric in growth rate, which might be attributed to fishing pressure especially from bottom trawlers operated in this region. The present study is first of its kind for \textit{H.kelloggi} from Indian waters and this base line information will serve as a yardstick for comparison for other seahorse species or for the same species studied from Indian waters in future.

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