Journal of Aquatic Biology & Fisheries | 2023 | 11(1) | pp. 193-197
ISSN 2321–340X
OPEN ACCESS
http://www.jabf.in/
University of Kerala, INDIA

Length–weight relationship, sex ratio, condition and relative condition factor of Giant trevally (*Caranx ignobilis*)

Elezabeth Tomy[1, 2*], Abdussamad E.M.[1, 2], Toji Thomas[1] and Ashly Gopinath[1, 2]

[1]ICAR- Central Marine Fisheries Research Institute, Ernakulam North P.O, Kochi-682018, Kerala, India
[2]Cochin University of Science and Technology, South Kalamassery, Kochi, Kerala 682022
*E.mail: micahpraveen@gmail.com

ABSTRACT

The study describes the main biological characteristics such as length-weight relationship, sex ratio, Fulton condition factor 'F' and relative condition factor 'Kn' for *Caranx ignobilis* along the southwest coast of India during 2018-2020. The length-weight relationship for *C.ignobilis* was analyzed by the cube law and was found to be 0.0219, 2.86, and 0.9534 respectively for a, b, and r values. The value of r obtained from the relation W=a L^b holds a strong relationship with the length and weight. The sex ratio of *C.ignobilis* was found to be 1:0.7 which was slightly biased towards males with Chi-square showing a significant difference ($p<0.05$) from the expected ratio of 1:1.Fulton condition factor studied for the species at different months varied from 1-1.9 with an average of 1.3 implies an overall biological condition of the fish in good health. The observed result of the relative condition factor of *C.ignobilis* is also found to be > 1 which signifies the good health condition of the species in its present habitat.

ARTICLE HISTORY

Received on: 29-06-2023
Revised on: 27-10-2023
Accepted on: 04-12-2023

KEYWORDS

Length-weigh relationship,
Sex ratio, *Caranx ignobilis*,
Condition factor,
Relative condition factor

1. Introduction

In fisheries, effective management and conservation strategy need the utmost knowledge of several aspects like length-weight relationship, sex ratio, and condition factors of the species. These factors should be studied in detail, as they provide much important information such as growth, well-being, fitness, and overall health of the selected species. The length-weight relationship is one of the most important parameters to be concerned in fishery management, whenever a stock has been selected for scientific studies. Length-weight regression has been used mainly for stock assessment models and also to predict the present and future possibilities of fish stock. This relationship is important in fishery science to raise the length frequency data to the total catch. The relation of length to weight can be expressed mathematically by the equation $W=aL^b$ (Le Cren,1951). Length-weight variables may differ between sexes and between stocks or those belonging to different geographical regions. LWR parameters a and b are used to evaluate the weight of individual fish from its length, to calculate condition indices, and to compare the life history and morphology of populations belonging to various regions (Sani et al., 2010). The morphometric relationships between length and weight can be used for the assessment of the well-being of individuals and to determine possible variation between separate unit stocks of the same species. Variable a is used as the scaling coefficient for the weight at length of the fish and variable b is used as the shape parameter for the body form of the fish (Kuriakose Somy ,2017).The value of b may change during various time phases which shows the fullness of the stomach, general condition of appetite, and stages of gonadal development (Zaher et al., 2015). The sex ratio provides basic information to assess the reproductive potential and to estimate the stock size of fish populations. The study on sex ratio gives an idea about sex viability, segregation, and aggregation of sexes according to their feeding, breeding, or migratory behavior. The condition factor which shows the biological condition or well-being of the fish in its present habitat is also an important parameter whenever a fish population is considered for stock studies. It is also called the 'coefficient of condition' or length–weight factor- K which is a measure of various ecological and biological factors like the degree of fitness, gonad development, and the fitness of the environment concerning the feeding condition (Mac Gregoer, 1959). The condition factor is used to compare the condition fatness or well-being of fish and it is based on the supposition that heavier fish of a given length are in better condition. The condition factor is a useful index for growth and feeding measure (Oribhabor et al., 2011). We can also compare the growth condition of the fish by studying the relative condition factor of the species (Kn). A good condition of the fish will be represented when Kn >1 and when Kn is less than 1, it indicates poor growth condition. The value of Kn varies based on many factors like feeding intensity, spawning periodicity, breeding pattern, and numerous factors like stress, sex, season, water quality parameters, and other environmental factors (Khalaf et al., 2003). The present work is on *C. ignobilis* which is a highly prized marine carangid fish that grows up to a length (TL) of 170cm and 80 kg by weight. This is regarded as a species of high mariculture potential (E.M Abdussamad., et al 2007*)* and economic importance, and there have been no other studies regarding the length-weight relationship, sex ratio, and condition factor of these species. So, the study on length-weight relationship, sex ratio & condition factors of *C. ignobilis* can greatly aid the fishery sector and scientific researchers who have been working in this field.

2. Materials and Methods

546 Samples of the species *C. ignobilis* were collected from the southwest coast of India mainly from Kanyakumari coast (8° 14' 13.09172 N , 77° 9' 50.17102 E) of Tamil Nadu and Vizhijam coast (8° 23'N,8.2388 E) of Kerala. The samples were collected from a depth of 30m with different types of gears mainly hook and line and trawl net.

Fig. 1. Site map of south west coast of India (Vizinjam and Kanyakumari)

The species of *C.ignobilis* was identified using the key for the carangid family. Measurements were taken The total length (TL) of the fish in cm was taken from the tip of the snout to the end of the caudal fin using a measuring tape in cm, and the weight of the fish in g was taken using a digital weighing balance.

2.1 Length-weight estimation

The estimation of the length-weight relationship of the fish under study was calculated using the equation $W= a L^b$ (Le Cren, 1951) where W = body weight of the fish (g), L= total length of the fish (cm); and 'a' and 'b' are the intercept and the slope respectively. This equation can be linearized by logarithmic transformation to give W = log a + b log (L). The statistical analysis, and the linear regression for estimating the b and coefficient of determination i.e. R^2 values were done using MS Excel software. In computing linear regression between the length and weight of the collected fish samples, the confidence limit was set to 95 %. To compare the pattern of growth, the value of b was confirmed by the equation $t_= b\text{-}3/S_b$ (Sokal and Rohlf 1987), where t_S is the test value, b = mean parameter of all the LWR, and $S_{b=}$standard error. Comparison of the t-test value with the critical table value in the t-table will allow the determination of the b value from the ideal value of 3.

2.2 Sex ratio

Males were distinguished from females by examining the gonad structure. The sex ratio was determined by dividing the number of females by the number of males. The chi-square test was used to analyze whether the proportion of females possesses any difference from the proportion of males. The null hypothesis was tested for the results at p (0.05) and the degree of freedom as 1. Chi-square (χ^2) verifies the existence of any significant differences between the sex ratio of the species which is commonly expected to be 1:1.

$$\chi^2 = \sum (O-E)^2/E$$

χ^2 : Chi-square test, O : observed values, E : expected values

2.3 Fulton's condition factor

The condition factor which shows the relative fatness and well-being of the fish was determined by Fulton's formulae $K = 100^* W/L^3$, Froese (2006) where W = weight (g), L = length (cm) and 100 is a factor to bring the value of k near unity.

2.4 Relative condition factor

The relative condition factor of the fish is studied to assess the health of the species. It is defined using the formula $Kn = W_o/W_c$, where W_o is the observed weight of the fish, and W_c is the calculated weight of the fish (Le Cren,1951).

3. Results and Discussion

The statistical analysis of the length-weight relationship for *Caranx ignobilis* was found to be in positive correlation with the linear equation expressed as Log W=0.021+ 2.86 Log X. The value of intercept (a) = 0.021 and the slope (b) =2.86 and the value of r^2 was found to be 0.953 which implies a strong relationship between the length and weight of the fish. For a fish to be in isometric growth the b value should be 3. The b value for *C.ignobilis* was statistically confirmed using a t-test and was found to be significant. The growth pattern of *C.ignobilis* shows negative allometric ie, b=-2.86. This decrease in the value of slope (b) may be due to many reasons as the value of b is dependent on biological, geographical, temporal, and sampling factors (Bagenal & Tesch 1978; Froese 2006). Wetherbee et al, 2004 found a similar b value for *C.ignobilis* in Hawaiian water which is -2.76, likewise supporting the negative allometric growth pattern of these species. The result of the present study also supports the views of Le Cren (1951) and Chauhan (1987) that a fish normally does not retain the same shape or body outline throughout their lifespan, and the specific gravity of tissue may not remain constant and so the actual relationship may depart significantly from the cube law. This variation in the value of slope or b value may be due to sampling size variation, life stages, geographical differences, and environmental factors.

The values of the sex ratio obtained for each month during the two years for the pooled data of corresponding months are shown in table 1. Analysis of the sex ratio of males to females was found to be 1:0.7, and chi-square analysis revealed that there is significant variation from the expected ratio of 1:1with $\chi 2$ =7.7, which is greater than the critical value of 3.8. In the month of May also the ratio was significant with a sex ratio 1:0.4 and $\chi 2$ value 5.142. In all other months except July (sex ratio 1:1) and May, the sex ratio was found to be fluctuating around 1:1 but not deviated significantly when chi-square values were observed. It seems to have male dominance in all the months (except in July and September) signifying the male preponderance in this species during the study. September is the only month that shows female dominance. But the chi-square value in September was 0.125 which is less than the critical p-value and hence found to be non-significant. In the month of May, only the sex ratio was found to deviate significantly from the expected ratio of 1:1 with a chi-

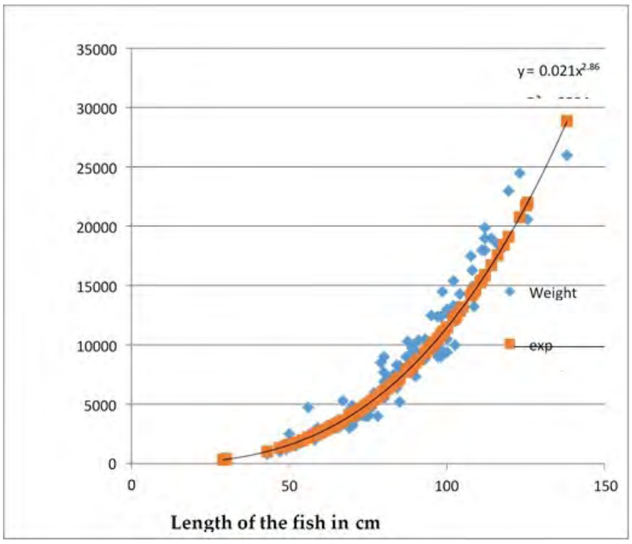

Fig. 2. Graph showing pooled data of length-weight relation for *Caranx ignobilis*

square value of 5.14. The pooled data also showed to be deviating from the normal (1:1 ratio) indicating an overall male preponderance in this species. William, F., 1965 also found similar results from Hawaii islands(USA) showing significant male dominance in *C.ignobilis*.

This difference in sex ratio during this month from the normally expected ratio of 1:1 may be due to many factors like reproductive behavior, food availability, and environmental conditions. Since the month of May is a peak spawning period for this species, a large number of males may get aggregated during this time. Similar findings in the variation of sex ratio have been explained by Reynolds J D, 1974 in which deviation in sex-ratio could also be due to partial segregation of mature forms through habitat preferences, due to migration (Collignon J1960) or behavioral differences between sexes (Polonsky A S & Tormosova I D, 1969) thus causing one sex being caught easily than the other. However, the overall significant difference

observed in the pooled data between the sexes indicates the existence of seasonality in the sex distribution of this population.

Condition factor is also a standard practice in fishery science, indicating the changes that occurred to the growth coefficient in fish. Fulton condition factor studied for *C.ignobilis* at different months for a period of consecutive two years (shown graphically in figure 3) revealed that the K value lies between 1- 1.9 with an average k value of 1.32 The K value was found to be highest in the month of May (K=1.9) and lowest in the month of February (K=1.05) Fig(3). The K value shows a steep increase during the months of March, May, and December which shows a conspicuous positive correlation between K and the spawning season of these species. As the condition factor is a representation of the overall health of the species, we can say that there is increased gonadal development during the breeding season, and hence it will impart to the total weight of the fish and thus by increasing the K value naturally.

There are similar findings that support our observations that the K value is highly dependent on the maturity cycle or the spawning periodicity of the fish. (Le Cren, 1951) explains that the fluctuation in the gonad weight is attributed to the condition factor of a fish. Here the average condition factor K for *C.ignobilis* is 1.3 which indicates the overall condition of the fish is in good condition. Observation on the relative condition factor of *C.ignobilis* for each month revealed that the Kn values vary in each month ranging from 0.92-1.4. The relative condition factor Kn for *C.ignobilis* in January was 1.056 and it gradually increases and reaches a peak in February. Kn value then goes down in March, and then it increases in April. In the month of May, Kn value again declines and in June, Kn value shows an upward trend. Kn reaches 1.41 in the month of July which is the highest Kn value observed during the entire period of study. In the month of August, the Kn value again declines. In September, Kn gradually tends to increase with a slight peak and then shoots to a steep peak of 1.2 in October. In November and December, Kn values declined. The high level of Kn value in the month of July may be attributed to high feeding and a high abundance of food since monsoon is available on the southwest coast during these months. The declining value of the relative condition factor for *C.ignobilis* in the months of March, May, August & November and in December can be correlated with their spawning period since many

Table 1. Monthly distribution of sex ratio and chi-square values of *C. ignobilis*

Months	Male	Female	Total	Sex Ratio	$\chi 2$	Significant or not at 5% level
JANUARY	19	13	32	1:0.6	1.19	NS
FEBRUARY	17	10	27	1:0.5	3.14	NS
MARCH	27	17	44	1:0.6	2.27	NS
APRIL	23	21	44	1:0.9	0.09	NS
MAY	20	8	28	1:0.4	5.14	S
JUNE	21	14	35	1:0.6	1.40	NS
JULY	21	21	42	1:1	0	NS
AUGUST	18	16	34	1:0.8	0.11	NS
SEPTEMBER	15	17	32	1:1.1	0.12	NS
OCTOBER	28	22	50	1:0.7	0.72	NS
NOVEMBER	26	24	50	1:0.9	0.08	NS
DECEMBER	19	12	31	1:0.6	1.58	NS
Total	**254**	**195**	**449**	**1:0.7**	**7.7**	**S**

Fig. 3. Graph showing Fulton condition factor for *C. ignobilis* during different months

studies report that feeding intensity will be very less in fish during breeding. This decline in Kn value was supported by the study conducted by Lizama and Ambrósio, 2002, who observed similar findings that the fish usually decrease their feeding activity and use their lipid reserves during spawning which results in a decrease in the condition of the fish. Even though *C.ignobilis* is a continuous spawner, it will show small breeding peaks during the months of March, May, August, November & December, and hence, a drop in feeding activity during these months may be the reason for the low Kn value at these times.

The findings of Venkataraman, 1979 suggest that the Kn value of carangids are exclusively based on spawning periodicity. But as long as the fish is living in a flexible environment, the wellness of a species cannot be correlated and explained only on certain limited factors. According to Morato et al., 2001 several factors determine the growth of fish such as food availability, habitat, environmental changes, etc. Le cren ,1951 also explains that the deviation of the Kn value from 1 is due to the consequence of physiochemical features on the life cycle of fish species. Furthermore, Vazzoler (1996) confirmed that the lowest Kn values during the more developed gonadal stages signify resource transfer to the gonads during the reproductive period. So the changes in relative condition factors for *C.ignobilis* at different months in this study cannot be correlated only to the spawning periodicity but also by the influence of other environmental factors. In the present study, the species is said to be in good health since the average Kn value of all months is 1.

4. Conclusion

From the present study on the LWR of *C.ignobilis*, we can conclude that C.ignobilis is having a negative allometric pattern of growth since the b value observed is found to be slightly deviating from the normal isometric value of b=3. The r^2 value was found to be good with a value of 0.953. which implies a strong relationship between length to weight. The sex ratio was found to be biased towards males and was significant, indicating a male preponderance in the population when analyzed through chi-square. Fulton condition factor, as well as the relative condition factor for *C.ignobilis*, was found to be in the good range which indicates that the overall condition of the fish is good in its natural habitat. It was also found that there is conspicuous positive relation exists between gonadal development and co-efficient (K), and the relative condition factor(Kn) was

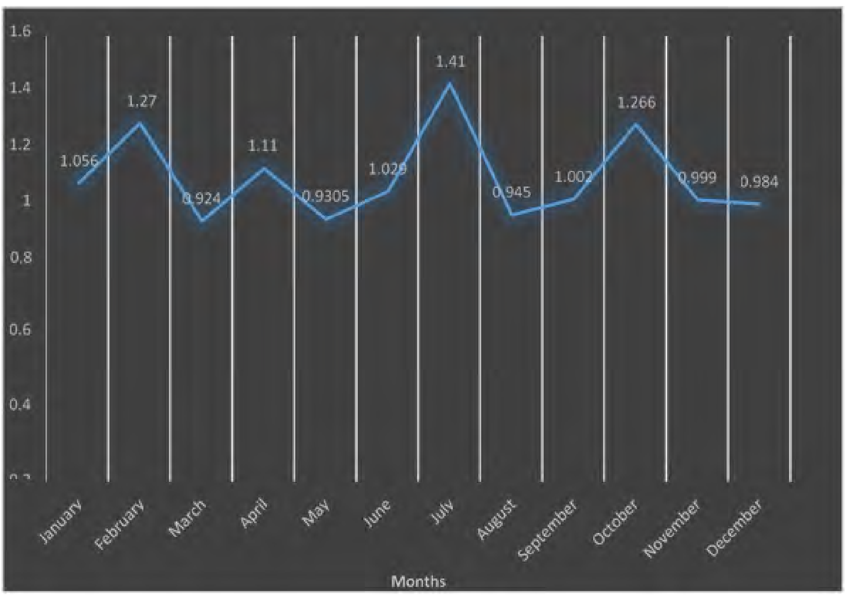

Fig. 4. Graph showing relative condition Kn factor of *C. ignobilis* at different months

influenced by many other unknown factors apart from the spawning cycle and feeding behavior. Being candidate species for economic as well as mariculture potential, studies on the length-weight relationship, sex ratio as well as condition parameters of these species will be useful for other researchers working in this field and also the data presented may further contribute in establishing future biometric studies of this species.

Acknowledgement

First author like to express gratitude to Dr. E.M. Abdussamed (Principal scientist, HOD in charge FFD-CMFRI) who has been a great support and help present work, also thank UGC and CUSAT for aiding financial and academic support. First author also grateful to the Director Dr. A. Gopalakrishnan for granting the opportunity to do the research work in CMFRI.

5. References

Abdussamad, E.M., Rohit, P. and Mohamed, O.M.M.J., 2007. A field identification key for 20 genera of Family Carangidae. *Journal of the Marine Biological Association of India*, *49*(2), pp.141-147.

Bagenal, T.B. and Tesch, F.W., 1978. Age and growth (In: Methods for Assessment of Fish Production in Fresh Waters. Ed. T. Bagenal)– Blackwell Scientific Publications.

Bakare, O., 1970. Bottom deposits as food of inland freshwater fish. *A Nigerian man made lake. Kainji Lake studies*, *1*.Barnham ,C &Baxter,A,1998.Condition factor K,for Salmanoid fish.Fisheries Note,pp:1-3

Collignon, J., 1960. Contribution à la connaissance des Otolithus des côtes d'Afrique Equatoriale. *Bull. Inst. Etudes. Centrafracaines Brazzaville. NS*, *1920*, pp.

Fagade, S.O., 1979. Observations on the biology of two species of Tilapia from the Lagos lagoon, Nigeria.

Flura, M.Z., Rahman, B.S., Rahman, M.A., Ashraful, M., Alam, M. and Pramanik, M.H., 2015. Length-weight relationship and GSI of hilsa, Tenualosa ilisha (hamilton, 1822) fishes in Meghna river, Bangladesh. *Int. J. Nat. Soc. Sci*, *2*(3), pp.82-88

Froese, R., 2006. Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. *Journal of applied ichthyology*, *22*(4), pp.241-253.

Fulton,T.W 1904. The rate of growth oh fishes. Twenty-second Annual Report, PartIII. Fisheries Board of Scotland, Edinburgh, pp.141-241.

Khallaf, E.A., Galal, M. and Authman, M., 2003. The biology of Oreochromis niloticus in a polluted canal. *Ecotoxicology*, *12*, pp.405-416.

Kleanthidis, P.K., Sinis, A.I. and Stergiou, K.I., 1999. Length-weight relationships of freshwater fishes in Greece. *Naga*, *22*(4), pp.37-40.

Kund, G.C., Mishra, G. & Sathapathy, D. 2011. Length-weight relationship and relative condition factor of Mugil cephalus in Chilika lagoon, east coast of India. Journal of Applied Zoological Researches, 22(2), 153-*156.*

Kuriakose, Somy, *2017.* Estimation of length weight relationship in fishes*.* In: CourseManual Summer School on Advanced Methods for Fish Stock Assessment and Fisheries Management. Lecture Note Series No. 2/2017. CMFRI; Kochi, Kochi, pp. 215-220

Le Cren, E.D., 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis). *The Journal of Animal Ecology*, pp.201-219

Leis, J.M., 2010. Ontogeny of behaviour in larvae of marine demersal fishes. *Ichthyological Research*, *57*(4), pp.325-342.

Lizama, M.D.A.P. and A.M.Ambrosio. 2002. Condition factor in nine species of fish of the characidea family in the upper Parana river floodplain, Brazil. Brazilan. Journal of Biology, 62 (1)

Mac Gregor, J.S., 1959. *Relation between fish condition and population size in the sardine (Sardinops caerulea)*. US Government Printing Office.

Morato, T., Afonso, P., Loirinho, P., Barreiros, J.P., Sanstos, R.S. and Nash, R.D.M. 2001. Length-weight relationships for 21 costal fish species of the Azores, North- eastern Atlantic. Fisheries Research, 50: 297- 302.

Oribhabor, B.J., Ogbeibu, A.E. and Udo, M.T., 2011. The length-weight relationships of brackish water/marine fish species assemblage in a Niger Delta Mangrove Creek, Nigeria. *Current Research Journal of Biological Sciences*, *3*(6), pp.616-621.

Polonsky, A.S. and Tormosova, I.D., 1969. The spawning of the horse mackerel of the North-east Atlantic and the distribution of its eggs and larvae. *Trudy Atlant. NIRO*, *23*, pp.27-48.

Reynolds J D, 1794. Biology of small pelagic fishes in the new Volta Lake in Ghana. Part 3 sex and reproduction. Hydrobiologia, 45: 498-508..

Sangita R. Kudale ,Jadhav, and J. L. Rathod, 2014.Length Frequency, Length-Weight and Relative Condition Factor of Ribbonfish, Lepturacanthus savala from Karwar Waters, Karnataka State IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) pp 25-31.

Sani, R., Gupta, B.K., Sarkar, U.K., Pandey, A., Dubey, V.K. and Singh Lakra, W., 2010. Length–weight relationships of 14 Indian freshwater fish species from the Betwa (Yamuna River tributary) and Gomti (Ganga River tributary) rivers. *Journal of Applied Ichthyology*, *26*(3), pp.456-459.

Vazzoler, A.E.A., 1996. *Biologia da reprodução de peixes teleósteos: teoria e prática*. Eduem.

Wetherbee, B.M., Holland, K.N., Meyer, C.G. and Lowe, C.G., 2004. Use of a marine reserve in Kaneohe Bay, Hawaii by the giant trevally, *Caranx ignobilis*. *Fisheries Research*, *67*(3), pp.253-263.

Williams, F., 1965. Further notes on the biology of East African pelagic fishes of the families Carangidae and Sphyraenidae. *East African Agricultural and Forestry Journal*, *31*(2), pp.141-168.