Bulletin of Pure and Applied Sciences
Zoology (Animal Science), Vol.43A, No.1,
January-June 2024: P.29-37

Print version ISSN 0970 0765
Online version ISSN 2320 3188
DOI: https://doi.org/10.52710/bpas-zoo.22

Original Research Article
Content Available online at: https://www.bpasjournals.com/

Length-Weight Relationship and Condition Factor of *Ompok bimaculatus* from the Commercial Fish Market of Krishnagar, Nadia, West Bengal, India Amid Monsoon

[1]R. Garai# and [2]S. Sanyal*

Author's Affiliation:
[1]Post Graduate student at Krishnagar Govt. College, Post Graduate Department of Zoology, Krishnagar, Nadia, West Bengal 741101, India
E-mail: garairumpa0@gmail.com
[2]Associate Professor at Krishnagar Govt. College, Post Graduate Department of Zoology, Krishnagar, Nadia, West Bengal 741101, India
E-mail: sutapa2007.sanyal@gmail.com

***Corresponding author:**
S. Sanyal,
Associate Professor at Krishnagar Govt. College, Post Graduate Department of Zoology, Krishnagar, Nadia, West Bengal 741101, India
E-mail: sutapa2007.sanyal@gmail.com

Received on 04.12.2023
Revised on 25.03.2023
Accepted on 04.04.2024

ABSTRACT:
The length-weight interrelation and the condition factor of *Ompok bimaculatus* collected during monsoon period from Krishnagar, Nadia, West Bengal of India was investigated. Linear regression was significant ($p < 0.05$) with R^2 values 0.73. The intercept (a) of LWR was 0.0002, while the slope (b) was 4.14. The exponent 'b' value was significantly higher than 3 ($b > 3$). Values of condition factor (k) varied between 0.41 to 0.88. High proportion of energy exertion for gonad and unpredictable feeding during spawning season may be culpable for these retarded values of condition factor in *Ompok bimaculatus*. Further, high value of body relative weight condition (Wr) like 109.471 demonstrated that fish caught from balanced aquatic environment hold satisfactory amount of prey for their good growth.

Keywords:
Condition factor, length-weight relationship, Monsoon, Nadia, *Ompok bimaculatus*

How to cite this article: Garai R. and Sanyal S. (2024). Length-Weight Relationship and Condition Factor of *Ompok bimaculatus* from the Commercial Fish Market of Krishnagar, Nadia, West Bengal, India Amid Monsoon. *Bulletin of Pure and Applied Sciences-Zoology*, 43A (1), 29-37.

INTRODUCTION

Ompok bimaculatus (Bloch) a native freshwater catfish belonging to the Order Siluriformes and Family Siluridae is a delectable food and highly priced catfish (Gupta et al, 2011). The fish with its distinctive lipo-protein texture and soft bones is highly useful as diet for speedy development of health and prevails over illness (Demska & Dlugosz, 1995). Moreover, magnificent source of iron, omega-3 fatty acids, omega-6 fatty acids, vitamin, mineral etc. makes it more popular and approves as high-value catfish (Mishra et al, 2013; Rawat et al, 2018). *Ompok bimaculatus* being quite shy and calm in nature unlike other catfish is favoured in polyculture system and reinforces maximum standing crop exploiting all ecological zones of the pond environment (Rawat et al, 2018). This peaceful and quite carp has a notable feature of survival without food or water for a long time which makes it more remarkable (Pawar et al, 2023). *Ompok bimaculatus* can grow to a bigger size among *Ompok pabda* and *Ompok pabo* which is another cause of attraction of buyer fondness (Debnath et al, 2020). This two-spot glass catfish gets very prosperous

favouritism as an ornamental fish in the international ornamental fish trade due to presence of two round black blotch above and behind the base of the pectoral fin and another at the base of the tail (Debnath et al, 2020).

Fondness for catfishes like *Clarias magur* (Magur), *Heteropneustes fossilis* (Singhi) and *Ompok bimaculatus* (Butter catfish) is high in India following carps (Biswas et al, 2023). Pabda does not pick up sufficient attention in aquaculture despite its greater economic value (Banik et al, 2011) due to inadequate live samples in nature and poor survival of the larvae (Chakrabarti et al, 2009). *Ompok bimaculatus* has been designated as near threatened by International Union for the Conservation of nature (IUCN) (Halim and Nahar, 2019). The species is facing high risk of annihilation due to restrained distribution, deficient gravid stock for experimentation, inadequacy of details regarding its breeding capability, larval rearing and culture technology (Dawson et al, 2003; Bhattacharjee & Pal, 2020). Over the last few decades distribution of the species among wild population become delimited by various human influenced factors like habitat spiling, unplanned fishing during breeding season, catching of fry and fingerlings, pollution, adoption of damaging fishing methods, banned fishing gear application and rampancy of pesticide etc. (Gupta, 2018). Further, the species is at threat due to insufficiency of proper climatic conditions and topography, deficiency of adequate freshwater, limited physical admittance to the site, disrupted power supply etc. (Rawat et al, 2018; Pawar et al, 2023). This catfish has been acknowledged special priority by the National Bureau of Fish Genetic Resources (NBFGR) being highly valued fish. Fruitful Captive culture of *Ompok bimaculatus* has been executed newly by the Regional Aquaculture Research Centre of the Central Institute of Freshwater Aquaculture, Kalyani, West Bengal, India after assimilating required details regarding its breeding and culture (Chakrabarti et al, 2009). However, catfish culture has been favoured only in states such as West Bengal and Tripura (Biswas et al, 2023). Recently *Ompok bimaculatus* is contemplated as a modern species for production of a good quality brood stock in breeding programs by conservation with restocking programs (Halim & Nahar, 2019). Detail scientific studies with different biological attributes are of absolute priority for management, conservation and extension of aquaculture practice of *Ompok bimaculatus*. Moreover, different biological facets must be realized to elucidate the diversity in the level of populations and to strengthen stock in the wild.

Length-weight relationship (LWR) of fish is considered as an important biological marker to generate information about the growth condition of fish species living in both natural and culture environment (Mehmood et al, 2021). LWR is investigated for setting up of a relationship between length and weight which is needed to evaluate the production and biomass of a fish population and condition indices. LWR is also useful for correlating life history and morphology of population belonging to different regions for ontogenic allometric studies. LWRs furnished valuable details for stock analysis, population dynamics (Kampouris et al, 2020; Erzini, 1994), growth model, general health, habitat conditions, life history, fish condition and morphological attributes of the fish (Tesch, 1968; Ricker, 1975; Froese, 2006; Geraci et al, 2018). Additionally, morphometric analysis is an efficient and powerful technique which is carried out to determine differences between fish populations, mainly short-term and environmentally induced variations (Başusta et al, 2014; Kalhoro et al, 2015; Özcan & Altun, 2015). Further, determination of morphological relationships between the population of a species, identification of fish stocks along with their spatial distributions has been widely done by morphometric measurements (Turan, 2004; Mustač & Sinovčić, 2010; Ivanković et al, 2011).

Regardless of their significance, morphometric analysis including LWRs are often insufficient and scanty to the most common or commercial species. Most of the studies are mainly focused on morphometry with LWRs of *Ompok pabda* than in *Ompok bimaculatus*. Further, many times *Ompok bimaculatus* is wrongly identified as *Ompok pabda* because of very little difference between these two species under the same genus Ompok. Currently there is no knowledge of

endangered butter catfish, *Ompok bimaculatus* biology among fishing areas of Nadia. Length-weight relationships can deviate between species, between stocks of different fishing areas (Kuriakose, 2014). Moreover, different stock structure can be used as a powerful technique of management policies for conserving the biodiversity allied with different species, subspecies, stocks and races (Turan et al., 2005; Nahar et al., 2015). Considering the paucity of data about LWRs and morphometry of *Ompok bimaculatus* in the published literature, present study assessed and described LWRs and morphometric characters of *Ompok bimaculatus* from Krishnagar of Nadia district, West Bengal, India.

METHODS

During the study, a total of 60 fish specimens of *Ompok bimaculatus* were studied for morphometric characters and length weight relationship. Total period of analysis was June 2022 to September 2022. Fishes were collected from the Patra Bazar fish market and Goary Bazar fish market of Krishnagar, Nadia, West Bengal, India. The collected fish were carried to the fishery laboratory of the Department of Zoology, Krishnagar Govt. College in aseptic condition.

The morphometric characters of specimens were measured with a Varnier caliper up to the nearest 0.1 cm and weighted with a sensitive electrical analytical up to the nearest 0.01 g (Gupta et al, 2011). Different morphometric characters like Total length [TL] (From head to tail), Standard length [SL] (From head to just before caudal length), Head length [HL] (total length of the head), Snout length [SL] (front part of the head including jaws), Eye diameter [ED] (the diameter of total eye), Inter orbital length [IOL] (diameter of the orbit in the eye), Body depth [BD] (Length of the body at the middle portion), Caudal depth [CD] (length of the body at the caudal side or end of the body) and Antenna or barble length[AL](total length of antenna) were measured.

The length weight relationship was estimated using the linear form of formula $W=aL^b$ (Le Cren, 1951). Where, W= weight of the fish in gram, L= length of the fish in cm and a and b are constant. The equation has been transformed into the following logarithmic form:
Log W = log a + b log L
the values of 'a' and 'b' are the coefficients of the functional regression between W and L (Beckman, 1948; Ricker, 1973). The values of constants a and b were estimated by the least-square linear regression from the log-transformed values of length and weight:
log W = log a + b log L (Zar, 1984; Stergiou & Politou, 1995; Sivashanthini et al, 2009).

To confirm whether the values of b obtained in the linear regressions were significantly different from the isometric value (b = 3), the confidence interval (CI) at 95% was estimated (isometric if b equal or very close to 3 and allometric if b significantly different from 3; negative allometric if b < 3 and positive allometric if b > 3) (Bagenal & Tesch, 1978). In addition, Student's *t*-test (Zar, 1984) was used to see if parameter b is significantly different from 3 and to identify the type of growth.

The condition factor K (Fulton, 1904) was evaluated from the relationship: $K = 100\ W/L^3$
where: W = weight of the fish in grams, L = total length of the fish in centimeters.

The relative weight condition Wr (Rypel & Richter, 2011) refers to $Wr= (W / aL^b) \times 100$
Where: Wr is a factor of relative weight conditions, W is the weight of fish (g), aL^b (g) is the calculated weight from the combined length-weight regression.

All the statistical analysis including descriptive statistics, students's t-test and linear regression analysis were done in Excel 2003 (Microsoft Seattle, WA, USA) with the add-in software Statcel 2 (Yanai 2004).

RESULTS AND DISCUSSION

In the present study, ten morphometric characters were measured (Table 1) in total of 60 samples of *Ompok bimaculatus*. High phenotypic plasticity within-population is described in fish (Carvalho, 1993; Sajina et al, 2011). Morphological variations between population of a fish species arise due to man-made or natural

environmental factors (Wimberger, 1992; Stearns, 1983). Documentation of morphological variations is necessary for identification and conservation of different stocks, species, subspecies and races of fish (Turan, 2004; Turan et al, 2005; Mustač & Sinovčić, 2010; Ivanković et al, 2011; Nahar et al, 2015).

The LWR was subsequently determined using the equation log W = log a + b log L (Pauly, 1984). The LWR in the form of a regression equation was estimated as Log W_t = 4.14Log L – 3.67 (Table 2, Fig 1). Exponent of the arithmetic form and the slope of the regression line in the logarithmic form, 'b' is the most important parameter in a LWR. The significance deviated from the expected value b = 3 for *Ompok bimaculatus* by using the *t*-test, which revealed positive allometric growth (t_{cal} 3.450 at df 58, p< 0.05). As 'b > 3', so large specimens increased in height or width more than in length, either as the result of a notable ontogenetic change in body shape with size, which is rare, or because most large specimens in the sample were thicker than small specimens, which is common. Differences in 'b' values and its variations from the ideal '3' can also arise due to variations in habitat and gonadal maturity (Tesch, 1971; Froese, 2006).

Table 1: Descriptive statistics of different morphometric measurements of *Ompok bimaculatus* specimens*

Body Measurements	Minimum	Maximum	Mean ± SD
Body weight(gm)	18.25	76.15	37.48±12.36
Total length(cm)	15.5	20.5	18.25 ± 1.13
Standard length(cm)	12.9	18.5	15.78 ±1.05
Head length(cm)	1.8	3.1	2.5 ±0.30
Snout length(cm)	0.9	2.9	1.78 ±0.42
Eye diameter(cm)	0.3	0.5	0.38±0.05
Interorbital length(cm)	0.1	0.3	0.22±0.04
Highest Body depth(cm)	2.7	4.9	3.79±0.54
Caudal depth(cm)	1	2	1.21±0.23
Antenna length(cm)	4.5	10.2	6.37±1.36

* (N=60, **body weight [g] and various morphometric length parameters are expressed in [cm])**

Table 2: Statistics of Total length-Body weight and Total length-Standard length relationships for wild *Ompok bimaculatus* of Nadia District

Equation	a	95% CL of a	b	95% CL of b	R^2
W=bTL-a	-3.67	-2.80 - -4.50	4.14	4.8-3.4	0.73
TL = a + bSL	0.26	0.40-0.11	0.83	0.95-0.71	0.76

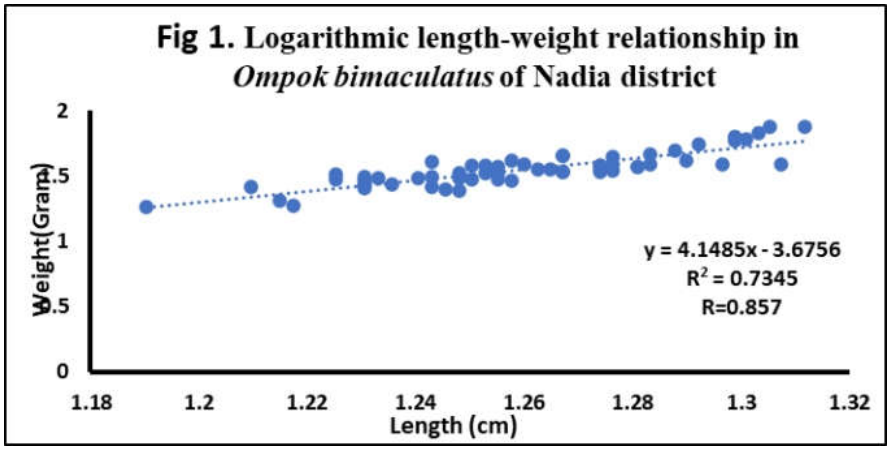

Figure 1: Logarithmic length-weight relationship in *Ompok bimaculatus* of Nadia district

Recent evidence also indicates that LWR is also subjected to evolutionary selection (Wooton, 1990). The reported b value of 4.14 higher than 3 declared positive allometric growth (b>3) in *Ompok bimaculatus*. Similar studies on the length-weight relationship in wild populations of *Ompok bimaculatus* described by several researchers and explained as positive allometric growth pattern (Malakar et al, 2013; Mishra et al, 2013; Malla & Banik, 2015; Muhammad et al., 2017). On contrary, an isometric growth with b = 3.0 purported by Sivakami (1987) and Sani et al. (2010) for *Ompok bimaculatus*. However, a variation of 'b' value may be observed due to different seasonal variations. Related research with monsoonal samples showed general growth pattern of wild populations as allometric growth (Mishra et al, 2013; Malla & Banik, 2015). The differences in the values of 'b' may be due to the environmental differences, differences in the utilized types and length ranges or differences in the number of specimens examined. The exponential value of LWR varies in response to temperature, food availability, spawning status and biological aspects such as dissolved oxygen contents in water, sex, and age of the fish (Zakeyudin et al. 2012).

The coefficient of determination (r^2) acquired from the regression was appraised at 0.73 for *Ompok bimaculatus* (Table 2, Fig. 1). This means that 73% of fish body weight achieved due to hike of fish length, while 27% of fish body weight rise was generated by other factors such as environmental and age factors. The value of body relative weight condition (Wr) was 109.471. The value of relative weight (Wr) was above 100, indicates the excess availability of prey or low density of a predator.

The condition factor (K) is an index reflecting interactions between biotic and abiotic factors in the physiological condition of the fishes. It shows the well-being of the population during various life cycle stages (Angelescu et al, 1958). Average value of Fultons condition factor (K) for this species during studied period was 0.60 with a range from 0.41 to 0.88. Similar value of Fultons condition factor (K) for this species in different season ranged from 0.62 to 0.75 was outlined by Mishra et al, (2013). Recent studies documented late June to August as the spawning season of butter catfish in wild populations (Mishra et al. 2018) as well as in captivity (Chakrabarti et al, 2012; Debnath et al, 2013; Biswas et al, 2018) in India respectively. Thus, low K values of the present study may be attributed to the high percentage of energy utilization for the development of gonads of maturing and mature *Ompok bimaculatus* (Mishra et al, 2013). However, the low values of K factor during breeding season are more credited to the restrained and inconsistent feeding habits (Sarkar et al., 2008; Mir et al., 2012). Low value

of K during spawning season of fish was also recorded by Sarkar et al, 2005; Hossain et al, 2006; Chakrabarti et al, 2009).

CONCLUSION

The present study communicates an important base line information on the length-weight association and K factor for *Ompok bimaculatus* captured from Nadia district of West Bengal, India during monsoonal season. The determination coefficient was significant, and the condition factor may often be modulated by spawning. The basic information of the present study assists research, management and conservation of stock of threatened species *Ompok bimaculatus* in the Nadia district.

Acknowledgement
The authors would like to thank Officer-in-Charge, Krishnagar Govt. College, Krishnagar, Nadia, for providing necessary laboratory facilities.

Conflict of Interest
There is no conflict of interest

REFERENCES

1. Angelescu, V. Gneri, F.S. & Nani, A. (1958). La merluza del mar argentino(Biologia y Taxonomia).Servicio de Hidrografia Naval,Secretaria de Marina,Publico, H1004,1-224.
2. Bagenal, T.B. & Tesch, F.W. (1978). Age and growth. In: T. Begenal (Ed.). Methods for assessment of fish production in fresh waters, (3rd ed., pp. 101–136). IBP Handbook No. 3, Oxford, Blackwell Science Publications.
3. Banik, S. Goswami, P. & Malla,S.O. (2011). Ex situ studies of captive breeding of *Ompok bimaculatus* (Bloch, 1794) in Tripura. Journal of Advanced Laboratory Research in Biology, 2, 133-137.
4. Başusta, A. Özer, E. Girgin, H. Serdar, O. & Başusta, N. (2014). Length-Weight Relationship and Condition Factor of *Hippocampus hippocampus* and *Hippocampus guttulatus* Inhabiting Eastern Black Sea. Pakistan Journal of Zoology, 46(2), 447-450. https://www.researchgate.net/publication/261360488
5. Beckman,W.C. (1948).The weight length relationship, factors of conversion between standard and total lengths coefficient of condition for seven Michigan fishes. Transaction of the American Fisheries Society, 75, 237–256.
6. Bhattacharjee, P. & Pal, P. (2020). Study on length weight relationship and feeding habits of a threaten fish *Ompok pabda* from Tripura. Indian Journal of Entomology and Zoology Studies, 8(6), 1971-1975. DOI: https://doi.org/10.22271/j.ento.2020.v8.i6aa.8110
7. Biswas, P. Jena, A.K. Saha, H. & Chowdhury, T.G. (2018).Induced breeding and seed production of pabda: A species with potential for aquaculture diversification in northeast India. World Aquaculture, 49, 41–45.
8. Biswas, P. Jena, A.K. & Singh S.K. (2023).Conservation aquaculture of *Ompok bimaculatus* (Butter catfish), a near threatened catfish in India.Aquaculture and Fisheries, 8, 1–17.
9. Carvalho, G.R. (1993).Evolutionary aspects of fish distribution: genetic variability and adaptation. Journal of Fish Biology, 43, 53-73.
10. Chakrabarti, N.M. Chakrabarti, P.P. & Mondal, S.C. (2009). *Ompok bimaculatus* and *Ompok pabda* Comparative, morphometric and meristic study of embryonic larval development. Fishing Chimes, 29(6), 8-9.
11. Chakrabarti, P.P. Mandal, S.C. Chattopadhaya, D.N. Mandal, R.N. Paul, B.N. & Jayasankar, P. (2012).Pabda-seed production and culture. Central Institute of Freshwater Aquaculture, Bhubaneswar, PP-44, India.
12. Dawson,T.P. Berry, P.M. & Kampa, E. (2003). Climate change impacts on freshwater wetland habitat. Journal for Nature Conservation, 11, 25 –30.
13. Debnath, C. Sahoo, L. Datta, M. & Ngachan, S.V. (2013). *Ompok bimaculatus* (Bloch, 1794), an emerging species for diversification of aquaculture in Tripura, NorthEastern India. Aquaculture Asia, XVIII, 33–35.
14. Debnath, C. Dube, K. Saharan, N. Tiwari, V.K. Datta, M. & Sahoo, L. (2020).

Assessment of growth and production potential of Indian butter catfish *Ompok bimaculatus* as a substitute for mrigal *Cirrhinus mrigala* in polyculture of Indian major carps. Indian Journal Fisheries, 67(4), 48-55. DOI: 10.21077/ijf.2020.67.4.65052-06

15. Demska, Z.K. & Dlugosz, M. (1995). Fecundity of Vendace from Two Lakes of Mazurian District. Archives of polish fisheries, 3, 37-50.

16. Erzini, K. (1994).An empirical study of variability in length-at age of marine fishes. Journal of Applied Ichthyology, 10, 17–41.

17. Froese, R. (2006). Cube law, condition factor and weight–length relationships: history,meta-analysis and recommendations. Journal of Applied Ichthyology, 22, 241–253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

18. Fulton, T.W. (1904). The rate of growth of fishes. 22nd Annual Report, Part III. Fisheries Board of Scotland, Edinburgh, 141–241.

19. Geraci, M.L. Scannella, D. Falsone, F. Colloca, F. Vitale, S. Rizzo, P. & Fiorentino, F. (2018).Preliminary study on the biological traits of the Por's goatfish *Upeneus pori* (Chordata: Actinopterygii) off the southern coast of Lampedusa Island (Central Mediterranean). The European Zoological Journal,85, 231–241.

20. Gupta, B.K. Sarkar, U.K. Bhardwaj, S. K. & Pal, A. (2011). Condition factor, length–weight and length–length relationships of an endangered fish *Ompok pabda* (Hamilton 1822) (Siluriformes: Siluridae) from the river Gomti, a tributary of the River Ganga, India. Journal of Applied Ichthyology, 27, 962–964.

21. Gupta, S. (2018). A Review on Feeding and Reproductive Biology of *Ompok pabda* with an Emphasis on its Conservation. Journal of Aquaculture Research and Development, 9(2), 1-5. doi: 10.4172/2155-9546.1000525

22. Halim,M.A. & Nahar, S. (2019). Study the growth performance of *Ompok pabda* (Hamilton 1822) in cemented dewatering canal at Bapard campus, Gopalgonj. Journal of Entomology and Zoology Studies, 7(4), 935-939.

23. Hossain, M.Y. Ahmed, Z.F. Leunda, P.M. Islam, A.K.M.R. Jasmine,S. Oscoz, J. Miranda, R. & Ohtomi, J. (2006). Length–weight and length–length relationships of some small indigenous fish species from the Mathabhanga River, southwestern Bangladesh. Journal of Applied Ichthyology, 22, 301–303.https://doi.org/10.1111/j.1439-0426.2006.00801.x

24. Ivancovic, P. Treer, T. Knezovic, Z. & Piria, M. (2011).Meristic and morphometric characteristics of endemic Neretva chub, *Squalius svallize* from the Neretva River area, Bosnia and Herzegovina. Journal of applied Ichthyology, 27, 1031–1032. DOI:10.1111/j.1439-0426. 2011.01741.x

25. Kalhoro, M.A. Liu, Q. Valinassab, T. Waryani, B. Abbasi, A.R. & Memon, K.H. (2015). Population Dynamics of Greater Lizardfish, *Saurida tumbil* From Pakistani Waters. Pakistan Journal of Zoology, 47(4), 921-931. https://www.researchgate.net/publication/280558237

26. Kampouris, T.E. Kouroupakis, E. & Batjakas, I.E. (2020). Morphometric Relationships of the Global Invader *Callinectes sapidus* Rathbun, 1896 (Decapoda, Brachyura, Portunidae) from Papapouli Lagoon, NW Aegean Sea, Greece. With notes on its ecological preferences. Fishes, 5, 5.

27. Kuriakose, S. (2014).Estimation of length weight relationship in fishes. In: Training Manual on Fish Stock Assessment and Management. (India: ICAR-Central Marine Fisheries Research Institute, P 220).

28. Le Cren, E.D. (1951). The length weight relationship and seasonal cycle in gonad-weight relationship and condition in the perch (*Perca Fluviatilis*). Journal of Animal Ecology, 20: 201-209.

29. Malakar, A.K. Lakra, W.S. & Mishra, R.M. (2013).Length-weight relationships of butter catfish, *Ompok bimaculatus* in Betwa River, India. International Journal of Bioinformatics and Biological Sciences, 1, 251, 155.

30. Malla, S. Banik, S. (2015). Reproductive biology of an endangered catfish, *Ompok bimaculatus* (Bloch, 1794) in the lotic water bodies of Tripura, North-East India. International Journal Fish Aquatic Study, 2, 251–260.

31. Mehmood, S. Ahmed, I. & Ali N. (2021). Length-weight relationship, morphometric and meristic controlling elements of three freshwater fish species inhabiting North Western Himalaya. Egyptian Journal of Aquatic Biology & Fisheries, 25(6), 243 – 257.

32. Mir, J.I. Sarkar, U.K. Dwivedi, A.K. Gusain,O.P. Pal A. & Jena, J.K. (2012).Pattern of Intra basin Variation in Condition Factor, Relative Condition Factor and Form Factor of an Indian Major Carp, *Labeo rohita*(Hamilton-Buchanan, 1822) in the Ganges Basin, India. European Journal of Biological Sciences, 4, 126-135.

33. Mishra, S.K. Sarkar, U.K. Trivedi, S.P. Mir, J.I. & Pal, A. (2013). Biological parameters of a silurid catfish *Ompok bimaculatus* (Bloch, 1794) from River Ghaghara, India. Journal of Environmental Biology, 34(6), 1013-7.

34. Mishra, A. Sarkar, U.K. Kumar, R. Rawat, A. & Verma, S. (2018). Gonadal maturity assessment of butter catfish (*Ompok bimaculatus*) from major rivers and tributaries of India during spawning season. Iranian Journal of Fisheries Sciences, 17, 458–470. https://doi.org/10.22092/IJFS.2018.116612

35. Muhammad, H. Iqbal, Z. Bashir, Q. & Hanif, M.A. (2017).Length-weight relationship and condition factor of catfish species from Indus River Pakistan. Punjab University Journal of Zoology, 32, 35-38.

36. Mustač, B. & Sinovčić, G. (2010). Morphometric and meristic parameters of Sardine (*Sardina pilchardus*, walbaum, 1792) in the Zadar fishing area.Croatian Journal of Fisheries, 68, 43- 48.

37. Nahar, A. Siddik, S. Alam, Md. A. & Chaklader, Md R. (2015). Population Genetic Structure of Paradise Threadfin *Polynemus paradiseus* (Linnaeus, 1758) Revealed by Allozyme Marker. International Journal of Zoological Research, 11, 48-56.

38. Özcan, G. & Altun, A. (2015). Length-Weight Relationship and Condition Factor of Three Endemic and Threatened Freshwater Fishes from Orontes River. Pakistan Journal of Zoology, 47(6), 1637-1643.https://www.researchgate.net/publication/285186720

39. Pauly, D. (1984). Fish Population Dynamics in Tropical Waters: A Manual for Use with Programmable Calculator. ICLARM Studies and Reviews, Manila, Philippines, 8, 325.

40. Pawar, I.L. Das, T. Yadav, K.K. & Nag, M. (2023). Culture and breeding of *Ompok bimaculatus*, Pabda (Indian Butter catfish), seed production in North-East. International Journal of Fisheries and Aquatic Studies, 11(1), 116-122.DOI: https://doi.org/10.22271/fish.2023.v11.i1b.2771

41. Rawat, P. Singh, S.M. Bharti, R.K. Verma, N. & Chirwatkar, B. (2018). *Ompok bimaculatus* Rearing Potential with Feed Attractants Used in Aquaculture.International Journal of Pure and Applied Bioscience, 6(6), 621-634. doi: http://dx.doi.org/10.18782/2320-7051.7194

42. Ricker, W.E. (1973). Linear regressions in fisheries research. International Journal of Fisheries and Applied Research Board of Canada, 30, 409–434. doi: 10.1139/f73-072

43. Ricker, W.E. (1975).Computation and interpretation of biological statistics of fish populations. Bulletin -Fisheries Research Board of Canada, 191, 382.

44. Rypel, A.L. & Richter,T.J. (2011). Empirical Percentile Standard Weight Equation for the Blacktail Redhorse. North American Journal of Fisheries Management, 28, 1843-1846.

45. Sajina, A.M. Jaiswar, S.K. Pazhayamadam, A.K. & Sudheesan, D.G. (2011).Stock structure analysis of *Megalaspis cordyla* (Linnaeus, 1758) along the Indian coast based on truss network analysis. Fisheries Research, 108, 100-105.

46. Sani, R. Gupta, B.K. Sarkar, U.K. Pandey, A. Dubey, V.K. & Singh, 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, 456–459.https://doi.org/10.1111/j.1439-0426.2009.01388.x

47. Sarkar, U.K. Deepak, P.K. Kapoor, D. Negi, R.S. Paul, S.K. & Singh, S. (2005). Captive breeding of climbing perch *Anabas testudineus* (Bloch, 1792) with Wova-FH for conservation and aquaculture. Aquaculture Research, 36(10): 941-945.https://doi.org/10.1111/j.1365-2109.2005.01281.x

48. Sarkar, U.K. Negi, P.K. Deepak, W.S. & Lakra, S.K. (2008). Biological parameters of endangered fish *Chitala chitala*(Osteoglossiformes: Notopteridae) from some Indian rivers. Fisheries Reseaech, 90, 170-177.

49. Sivakami, S. (1987). Length-weight relationship and relative condition in *Ompok bimaculatus* (bloch) from bhavanisagar reservoir (Tamil Nadu). Indian Journal of Fisheries, 34 (2), 202–207.

50. Sivashanthini, K. Gayathri, G. & Gajapathy, K. (2009).Length-weight relationship of *Sphyraena obtusata* cuvier, 1829 (Pisces: perciformes) from the Jaffna Lagoon. Sri Lanka Journal of Aquatic Sciences, 4, 111–116. doi: 10.3923/jfas.2009. 111.116

51. Stearns, S.C. (1983). A natural experiment in life-history evolution: field data on the introduction of mosquito fish (*Gambusia affinis*) to Hawaii. Evolution, 37, 601-617.

52. Stergiou, K.I. & Politou, C.Y. (1995). Biological parameters, body length-weight and length-height relationship for various species in Greek waters. NAGA, 18, 42–45.

53. Tesch, F.W. (1968). Age and growth. In: Ricker, W.E. (ed). Methods for Assessment of Fish Production in Freshwaters (93–123). Oxford, UK, Blackwell Scientific Publications.

54. Tesch, F.W. (1971). Age and growth. In: W.E. Ricker, (ed.). Methods for Assessment of Fish Production in Fresh Waters (98-130). Oxford, Blackwell Scientific Publications.

55. Turan, C. (2004). Stock identification of Mediterranean horse mackerel (*Trachurus mediterraneus*) using morphometric and meristic characters. Journal of Marine Science and Technology, 61, 774-781. https://www.researchgate.net/publication/238728155

56. Turan, C. Yalçin, F. Turan, E. Okur, N. & Akyurt, I. (2005). Morphometric comparisons of African catfish, *Clarias gariepinus*, populations in Turkey. Folia Zoologica, 54(1-2), 165-172.

57. Wimberger, P.H. (1992).Plasticity of fish body shape,the effects of diet, development, family and age in two species of *Geophagus* (Pisces: Cichlidae). Biological Journal of the Linnean Society, 45, 197-218.

58. Wooton R.J. (Ed.). (1990). Ecology of Teleost Fishes, Chapman and Hall, London, 404.

59. Yanai H.S. (Ed.). (2004). Referencing: Statcel: The Useful Addin Forms on Excel (2nd ed.). OMS Publishing Company, Tokyo, Japan.

60. Zakeyudin, M.S. Isa, M.M. Rawi, C.S. & Shah, A.S. (2012).Assessment of Suitability of Kerian River Tributaries Using Length-Weight Relationship and Relative Condition Factor of Six Freshwater Fish Species. Journal of Environment and Earth Science, 2, 52–60.

61. Zar, J.H. (Ed.). (1984). Referencing: Biostatistical Analysis. (2nd ed). Englewood Cliffs, Prentice Hall, Inc.

****