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Morphological characters and morphometric relationship of gold fish, *Carassius auratus* (Linnaeus, 1758)

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Abstract
Morphometric characters of gold fish *Carassius auratus* (Linnaeus, 1758) have been studied and the relationships of morphometric characters with standard length were established. The fishes ranged between 9.5 cm to 16.2 cm. in Total length (TL.) The morphometric equations for the samples collected were SL = -0.4273 + 1.2593 TL., FL = -0.2750 + 1.1855 TL., UO = -1.9424 + 1.6837 TL., UG = -0.7930 + 1.1256 TL., OO = -1.8607 + 1.5805 TL., UD = -0.5927 + 1.1415 TL., UPh = -0.7813 + 1.1007 TL., UVh = -0.6053 + 1.1515 TL., -1.5771 + 1.9847 TL. In the present study the various morphometric ratios of the fishes were studied and ratios are observed such as, Fork length is 117.2 times in standard length, Snout length 9.31 times in standard length, Head length is 30.5 times in standard length, Orbital diameter 8.52 times in standard length, Pre dorsal length is 50.47 times in standard length, Pre pectoral length is 50.32 times in standard length, Pre pelvic length is 29.6 times in standard length, Body depth is 46.99 times in standard length.

Keywords: Total length, fork length, standard length, snout length, head length, orbital diameter, pre dorsal length, pre pectoral length, pre pelvic length, body depth

1. Introduction
Ornamental fishes are often called as 'living jewels' due to their colour, shape, behavior & origin. They are peaceful, generally tiny, available in attractive colours & capable of living in confined spaces. During the last four decades, there has been considerable growth & diversification in the international trade in ornamental fishes, which is valued at about US $ 5 billion. Considering the relatively simple techniques involved, this activity has the potential to create substantial employment opportunities, besides earning foreign exchange (Sudha 2014) [7]. Goldfish were mostly short, deep, with a thickened body, had a gold coloration, and a wide short head with a terminal mouth. The body of fish was covered by large cycloid scales, with a tapered body from the anterior region to the tip of the caudal fin, the caudal fin was forked. The fins were mostly firm and the edge of the dorsal fin slightly concave. The caudal peduncle was thick and short, without any spines. The head of the fish is without scales, broadly triangular, with a broad interorbital space, a snout longer than the eye diameter, and an overreaching maxillary. The lateral line was complete. The dorsal and anal fins were serrated. Specimen of *Carassius auratus auratus*, (Linnaeus, 1758) [4] commonly known as Gold fish. The taxonomic position of *C. auratus auratus*, (Linnaeus, 1758) [4] is given below.

Kingdom: Animalia
   Phylum: Chordata
      Sub phylum: Vertebrata
         Super class: Gnathostomata
            Class: Actinopterygii
               Division: Teleostei
                  Order: Cypriniformes,
                     Family: Cyprinidae
                        Genus: Carassius
                           Species: *C. auratus auratus* (Linnaeus, 1758) [4]

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There are more than 100 varieties of gold fish that appeal to a wide range of aquarium fish lovers. In the biology of fish the morphometric study has its own importance, as it helps to understand the relative growth of different body parts with compare to the total length of the fish. These morphometric studies also help to determine the degree of association of various morphometric characters and to establish an equation for conservation of one measurement into the others. The statistical relationship between total length of the fish and various body parts is very useful to confirm their ratios commonly used in taxonomic and growth studies. The most important characteristics to identify fish species are provided from these morphometric studies. No reference work is available on the reproductive biology of goldfish, in Marathwada region considering different climatic conditions, relationship between morphometric parameters and reproduction (Jagtap & Kulkarni 2013) [3]. In Common Goldfish (*Carassius auratus* L.) after that very less work had been done in terms of biology of gold fish varieties, numerous varieties with different colours, varied fin patterns and unbelievable shape and forms such as Common (Metallic group), Calico, Fantail, Oranda, Pyukin, Lion head, Pearl scale, Bubble eye, Telescope, etc., are available in the markets and has great demand both in domestic well as international markets. In the present paper an attempt has been made to define identification characteristic of Gold fish (*C. auratus*) through morphometric characters.

2. Materials and Methods

The present study is based on the total of 130 fish specimens in the size range of 9.5 to 16.2 cm. Total length (TL.) Samples were procured from local Ornamental fish shop at Nanded, Maharashtra fork nightly, during period of February 2017 to January 2018. The specimens of the different size groups were randomly collected from the stock in local Ornamental fish shop. The experiment was conducted in Laboratory of Fisheries department of N.E.S. Science College, Nanded. The total length (TL.) of each fish was measured from the tip of snout to the tip of the caudal fin to the nearest 1 mm using a divider and Linear measurements like total length, fork length and standard length were recorded with the help of standard fish measuring board to accuracy of 0.5 mm. Ten morphometric characters were studied and relationships between the various body measurements to the standard length have been calculated. In order to know the relationship between any two morphometric measurement, the statistical methods are proposed by Snedecor (1961) [6], was used in the present investigation to correlate the variables viz.1) Total length (TL), 2. Fork length (FL), 3. Standard length (SL), 4. Snout length (UO), 5. Head length (UG'), 6.Orbital diameter (OO), 7.Pre dorsal length (UD), 8.Pre pectoral length (UPh), 9.Pre pelvic length (UVh), 10.Body depth (h) compared with the Total length, the liner regression was to be used.

$$Y = a + b (X)$$

Where,
Y=Variable,
X= Total length
a= Constant
b= Regression coefficient.
Data collected on all length measurements of fishes were pooled together for morphometric analysis. Morphometric characters of all the fish as collected during present investigation have been worked out and compared. The various body part ratio of the fish are calculated.

3. Results

Morphometric characters of all the fish collected during present investigation have been recorded and compared. The various body part measurements of the fish are as given in Figure 1.

Table 1: Linear regression equations coefficients for the relationship of total length (TL) and various body parts for *C. auratus*

| Characteristics		Regression parameters		
Sr. no.	Compared with Total length	a	b	r
1	Fork length (FL)	-0.2750	1.1855	0.9164
2	Standard length (SL)	-0.4273	1.2593	0.9205
3	Snout length (UO)	-1.9424	1.6837	0.7173
4	Head length (UG')	-0.7930	1.1256	0.7795
5	Orbital diameter (OO)	-1.8607	1.5805	0.8529
6	Pre dorsal length (UD)	-0.5927	1.1415	0.7730
7	Pre pectoral length (UPh)	-0.7813	1.1007	0.5431
8	Pre pelvic length (UVh)	-0.6053	1.1515	0.7759
9	Body depth (h)	-1.5771	1.9847	0.9543

Keys: 1. Total length (TL), 2. Fork length (FL), 3. Standard length (SL),4. Snout length (UO), 5. Head length (UG'), 6. Orbital diameter (OO), 7. Pre dorsal length (UD), 8. Pre pectoral length (UPh), 9. Pre pelvic length (UVh), 10. Body depth (h).
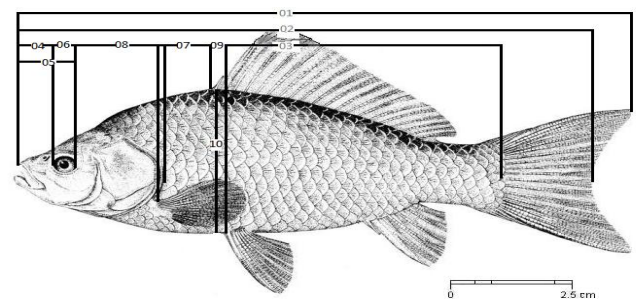

Fig 1: Morphometric characters of *Carassius auratus* (Linnaeus, 1758) [4]

In the present study the various morphometric ratios of the fishes are studied and ratios are observed such as, Fork length is 117.2 times in standard length, Snout length 9.31 times in standard length, Head length is 30.5 times in standard length, Orbital diameter 8.52 times in standard length, Pre dorsal length is 50.47 times in standard length, Pre pectoral length is 50.32 times in standard length, Pre pelvic length is 29.6 times in standard length, Body depth is 46.99 times in standard length. The morphometric relationships from the collected data have been analyzed using regression analysis. The regression parameters of the fish were computed and are given in Table 01. Relationships of various morphometric characters were compared with total length to find out the degree of correlation. The comparison of various relationships between different morphometric measurements have been depicted in (Fig. 02 to 10). The regression relationships between the various morphological characters with the standard length were studied. The SL" was directly proportional to the TL. The significant relationship was observed between SL and TL with r' value of 0.9205 (P < 0.05). The estimated equation for SL on TL was SL = -0.4273 + 1.2593 TL., The FL" was directly proportional to the TL. The significant relationship was observed between FL and TL with r' value of 0.9164 (P < 0.05). The estimated equation for FL on TL was FL = -0.2750 + 1.1855 TL., The UO" was directly proportional to the TL. The significant relationship

was observed between UO and TL with r' value of 0.7173 ($P < 0.05$). The estimated equation for UO on TL was UO = -1.9424 + 1.6837 TL., The UG" was directly proportional to the TL. The significant relationship was observed between UG and TL with r' value of 0.7795 ($P < 0.05$). The estimated equation for UG" on TL was UG = -0.7930 + 1.1256 TL., The OO" was directly proportional to the TL. The significant relationship was observed between OO and TL with r' value of 0.8529 ($P < 0.05$). The estimated equation for OO" on TL was OO = -1.8607 + 1.5805 TL., The significant relationship was observed between UD and TL with r' value of 0.7730 ($P < 0.05$). The estimated equation for UD on TL was UD = -0.5927 + 1.1415 TL., the UPh was directly proportional to the TL. The significant relationship was observed between UPh and TL with r' value of 0.5431 ($P < 0.05$). The estimated equation for UPh on TL was UPh = -0.7813 + 1.1007 TL., The UVh" was directly proportional to the TL. The significant relationship was observed between UVh and TL with r' value of 0.7759 ($P < 0.05$). The estimated equation for UVh on TL was UVh = -0.6053 + 1.1515 TL., The h" was directly proportional to the TL. The significant relationship was observed between h and TL with r' value of 0.9543 ($P < 0.05$). The estimated equation for h on TL was h = -1.5771 + 1.9847 TL. The morphometric relationships from the collected data have been analyzed using regression analysis. The high values of correlation coefficient ('r' 0.5431- 0.9543) obtained for various morphometric characters compared with Total length indicate high degree of interdependence of these compared characters. The regression parameters of the fish were computed and are given in Table1. Relationship of various morphometric characters were compared with standard length to find out the degree of correlation. The comparative account of various relationships between different morphometric measurements have been indicated by Figures against Total length and Table 1. Indicate values of their constants (a and b) and coefficient of correlation (r).
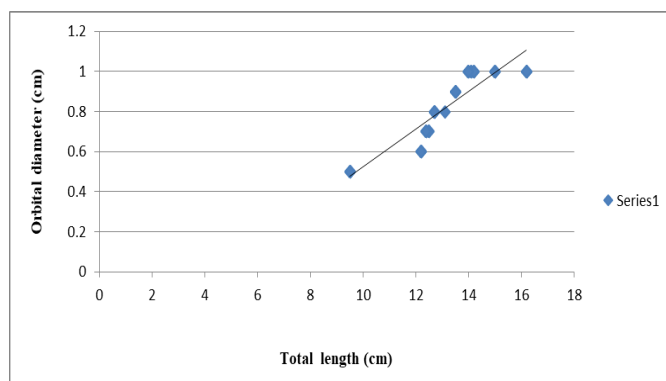

SL = -0.4273 + 1.2593 TL.
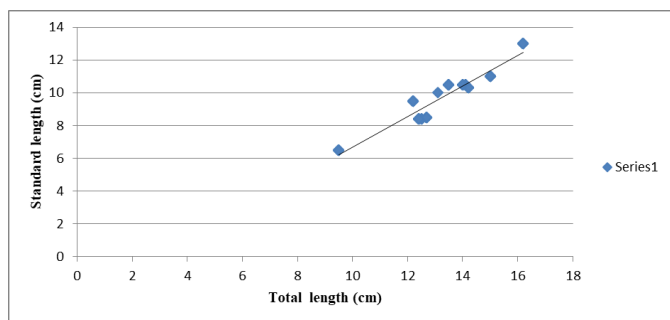
Fig 2: Relationship between total length and standard length (SL) in *C. auratus*

FL = -0.2750 + 1.1855 TL.
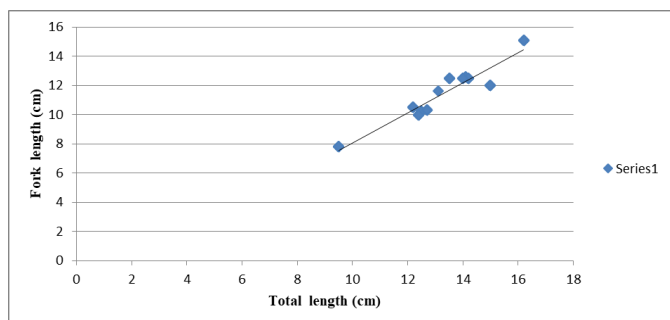
Fig 3: Relationship between total length and fork length (FL) in *C. auratus*

UO = -1.9424 + 1.6837 TL
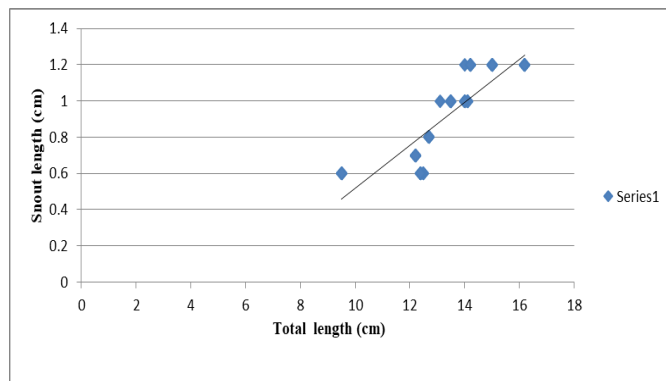
Fig 4: Relationship between total length and snout length (UO) in *C. auratus*

OO = -1.8607 + 1.5805 TL.

Fig 5: Relationship between total length and orbital diameter (OO) in *C. auratus*

UG = -0.7930 + 1.1256 TL.
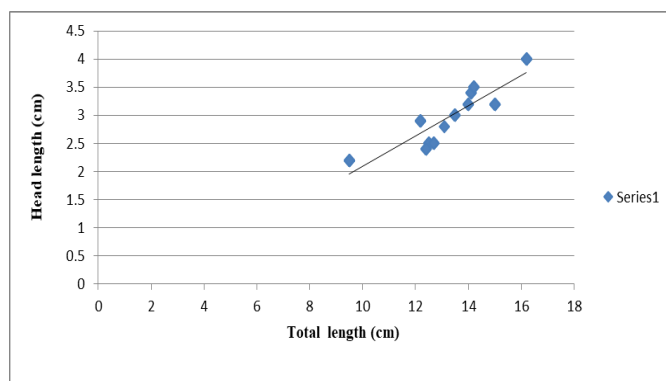
Fig 6: Relationship between total length and head length (UG) in *C. auratus*
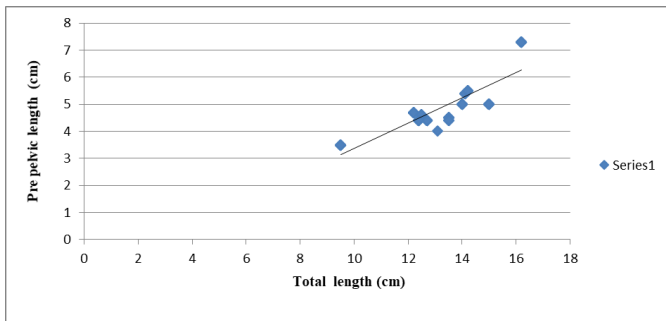

UD = -0.5927 + 1.1415 TL.
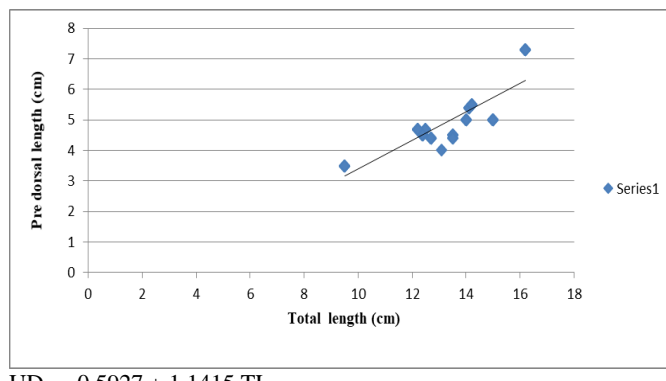
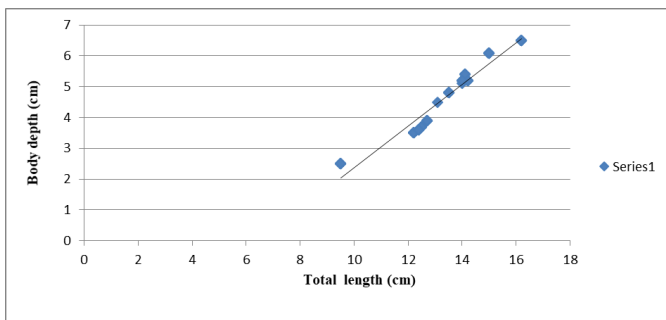**Fig 7:** Relationship between total length and pre dorsal length (UD) in *C. auratus*
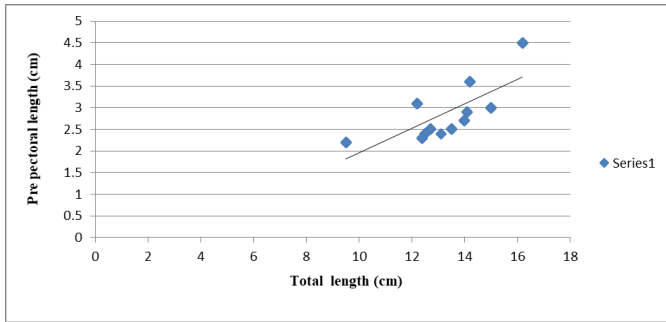
UPh = -0.7813 + 1.1007 TL.

Fig 8: Relationship between total length and pre pectoral length (UPh) in *C. auratus*

UVh = -0.6053 + 1.1515 TL.

Fig 9: Relationship between total length and pre pelvic length (UVh) in *C. auratus*

h = -1.5771 + 1.9847 TL.

Fig 10: Relationship between total length and body depth (h) in *C. auratus*

4. Discussion

In the present study, the total length of fish specimens in the size range of 9.5 to 16.2 cm. Total length (TL.) The morphometric equations for the samples collected were SL = -0.4273 + 1.2593 TL., FL = -0.2750 + 1.1855 TL., OO = -1.8607 + 1.5805 TL., UD = -0.5927 + 1.1415 TL., UPh = -0.7813 + 1.1007 TL., UVh = -0.6053 + 1.1515 TL., -1.5771 + 1.9847 TL. In the present study the various morphometric ratios of the fishes are studied and ratios are observed such as, Fork length is 117.2 times in standard length, Snout length 9.31 times in standard length, Head length is 30.5 times in standard length, Orbital diameter 8.52 times in standard length, Pre dorsal length is 50.47 times in standard length, Pre pectoral length is 50.32 times in standard length, Pre pelvic length is 29.6 times in standard length, Body depth is 46.99 times in standard length. In the present work, the morphometric study of *C. auratus* showed that, the Pre dorsal length (UD) and Pre pelvic length (UVh) in these species falls approximately within the same range of regression parameters. Morphological characters are one of the very important tools in fish taxonomical studies. Various morphological characters such as snout length, snout-vent length, orbital diameter, head length, dorsal fin base length, pectoral fin length, body depth, length of lower jaw, have been used in the taxonomical identification of Gold fish by various authors. Habbeb (2014) [2] recorded Morphometric of characteristics Gold fish, total and standard length ranged between 90-150 mm and between 70-110 mm, respectively. Habbeb (2014) [2] assessed that, Total length (TL) ranged from 90 to 150 mm, and the standard length (SL) from 50 to 110 mm. Mohamed *et al.*, (2017) [5] assessed during the study of the gold fish was W=0.0009L$^{1.936}$ and the R^2 value is 0.6318. In the present study the growth of the species was found to be satisfactory due to the nature of isometric growth which is suitable for fish.

5. Conclusion

In the present study, the total length of fish specimens in the size range of 9.5 to 16.2 cm. Total length (TL.) The morphometric equations for the samples collected were SL = -0.4273 + 1.2593 TL., FL = -0.2750 + 1.1855 TL., UO = -1.9424 + 1.6837 TL., UG = -0.7930 + 1.1256 TL., OO = -1.8607 + 1.5805 TL., UD = -0.5927 + 1.1415 TL., UPh = -0.7813 + 1.1007 TL., UVh = -0.6053 + 1.1515 TL., -1.5771 + 1.9847 TL. In the present work, the morphometric study of *C. auratus* showed that, The Pre dorsal length (UD) and Pre pelvic length (UVh) in these species falls approximately within the same range and no allometric growth was seen with increase in total length.

7. Conflicts of interest

The authors stated that no conflicts of interest.

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