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# A COMPARISON OF THE DIFFERENCES IN SOME CRANIAL BONES OF TWO SPECIES COMMON CARP *CYPRINUS CARPIO* AND THE COMMON TILAPIA *COPTODON ZILLII*

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**ABSTRACT**

This study attempts to identify some of the differences between two species Common Carp, *Cyprinus carpio*, and Common Tilapia, *Coptodon zillii*, by studying some of the characteristics of their cranial bones as an analytical and taxonomic study of two types of species that belong to two different types of fish, which are most common in the Iraqi aquatic environment.

***Keywords***: Cranial Bones, Common Carp, *Cyprinus Carpio*, Common Tilapia, *Coptodon Zillii*

## Introduction

There is a considerable extent of convergence between fish species and sexes in terms of the general structure of the skeleton, especially the bones of the skull that differ from one type to another and between males and females. Bones of the skull and cranial bones of the same family fish are similar in somewhat different races and differ between fish families in terms of the shape and division of the cranial bones (Akmal *et al*., 2020). The study of the bone characteristics of fish gives valuable information for the classification of fish and the study of genetic relations between fish as agreed upon by researchers in their most significant studies (Keivany, & Nelson, 1998, 2004, 2006; Diogo, & Bills, 2006; Keivany 2014a, b, c, d).

The skeleton in fish is very complex and has a highly efficient articular kinetics (Ferry-Graham and Lauder, 2001), and the study of bones in general and the study of the bones of the skull in particular provides a great impression of the formation of the fish body and the characteristic of this formation. The skeletal system is needed for one type rather than the other type, and the vertebrate skeleton in general attracted many specialists in the study of comparative anatomy as indicated by Goethe (1824) and confirmed by H. Hiawa and S. Kuratani (2015); in order to understand Taxonomic relationships of fish, the physiological characteristics of fish must be understood, including the study of bone and comparative anatomy between species in a single family, and species between different fish families (Ramaswami, 1951; Howes, 1982; Bogutskaya, 1994; Mafakheri, *et al*., 2014).

It was shown that the development of the skull in fish is closely related to the development and growth of fish bones (Bogutskaya *et al*., 2008), and many research studies and morphological studies of many fish families that researchers have been interested in diagnosing and studying such as the Cyprinidae family (Takeuchi and Hosoya. 2011; Nasri *et al*., 2016), and the Cichlidae family had a share of interest and studies related to morphology of its skeletal structure (Dierickx *et al*., 2017).

Hilton (2011) indicates that skulls among the vertebrates have the function of protecting the brain and the delicate sensory organs, as the skull is divided into two parts: the nerve skull, which includes the brain, nerves, and sensory organs, and the second section, facial and venereal bones (Jalili and Nasri, 2015). The shape of the skull in fish is influenced by genetics first, type and nature of food, in addition to the quality and nature of water secondly (Cooper and Westneat, 2009).

Studies concerning fish bones are still rare and scarce compared to the study of the bones of some mammals and birds (Leprevost and Sire, 2014). Despite the availability of a few previous studies on the skeleton and the bones of the type Tor tambroides (Akmal *et al*., 2020), detailed studies of the skull bones of this species were not studied, and detailed studies on the bones of the species *Coptodon zillii* and *Cyprinus carpio* and the study of the skull and cranial bones of these two species were not available in detail (Akmal *et al*. 2018a; 2018b; Zulfahmi *et al*., 2018); therefore, this study attempts to identify some of the bones of the skulls of these two types and make a comparison between them in terms of the shape as the two families are characterized by differences within their families and sexes, while also aiming to identify some of the characteristics of these bones for these two types.

## Materials and Methods

Ten heads were collected from both species. *C. carpio* and *C. zillii* were isolated. Then, the heads were cooked to a boiling level for only five minutes and placed in cold water immediately after cooking to stop the cooking process, as they were soaked for 15 minutes in cold water. The tissues, muscles, gills, and other tissues and organs, which are not included in the study, were removed using forceps and scalpel, then the skulls were washed carefully with running water and the skulls were kept in diluted formaldehyde with a concentration of 10% for one week only.

The bones were taken from the 10% diluted formaldehyde solution and the skulls washed with clean running water for five minutes; then, they were stored in a diluted ethyl alcohol solution at a concentration of 70% for a week to get rid of the fat and the remaining water in the bones. After that, it was left to dry at room temperature on blotting paper for a week as a preparation to photograph it and perform the rest of the required biometrics. This method of preparing the bones is close to what Taylor and Dyke (1985) prepared.

## Results and Discussion

Although there are some phenotypic differences, such as a phenotypic sex-related difference, which came in line with the findings of the researchers (SL HOR and KS Misra, 1936) between male and female *Cyprinus carpio* fish. We notice from figures (1) and (2), the difference in the shape of the mouth and its size, the shape of the pectoral fins and their thickness, the location of the eye at the front of the head has a distinct difference in the two images, in addition to the depth of the female body, which is significantly evident from that in the male's. The same case of a phenotypic sex-related differentiation of *Coptodon zillii* fish, as in figures (3) and ( 4), show that the male was more distinctive in the distribution of colors, especially the area under the head towards the abdomen with a red color, and an olive color evident in the male with a sort of sharpness in the distribution of black lines in the male, which may reach up to six color packages, unlike with the female whose colors were somewhat dull, not to mention the clear presence of colors in the eye of the male in comparison to that in the female.

**Fig. 1 :** Male *C. carpio*

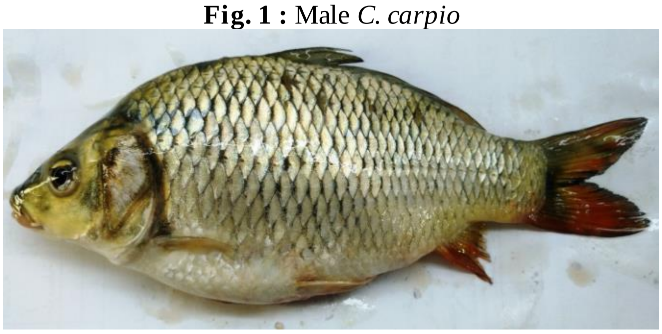

**Fig. 2 :** Female *C. carpio*

**Fig. 3 :** Male *C. zillii*

**Fig. 4 :** Female *C. zilli*

There was no effect of the sex of fish on all studied characteristics, and there were no significant differences between males and females and all of the characteristics studied with both species: *C. carpio* and *C. zillii* except with regards to the length of the mouth, which was significant at the level ($p < 0.05$), as in Figure (5); a detailed graphical analysis of all the characteristics and relationships studied was conducted.

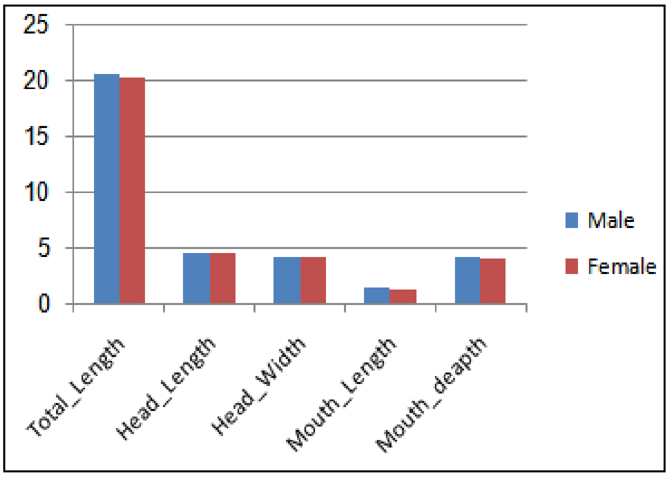


**Fig. 5 :** There were no significant differences between male and female for all studied vital characteristics between the two types C. carpio and C. zillii ($p < 0.05$)....

It was found from the analysis of variance, there were significant differences at the level ($p < 0.05$) between the two species *C. carpio* and *C. zillii* in terms of total length, head length, mouth depth, and weight (Common carp have outperformed Common tilapia in the aforementioned traits), while no significant differences were observed in relation to head width and mouth length, as Figure 6 shows below.

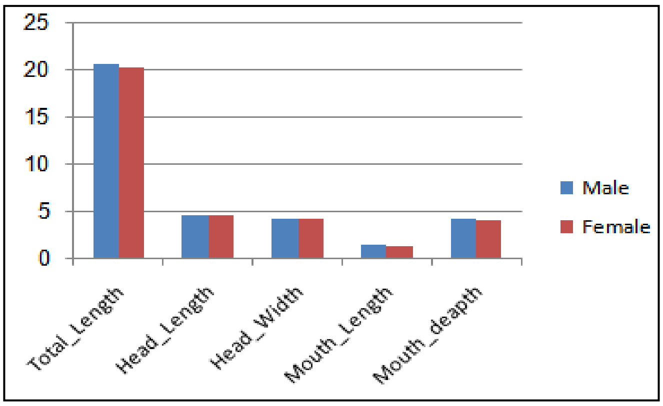


**Fig. 6 :** Shows significant differences in some biometrics between C. zillii and C. carpio at a level level ($p < 0.05$).

There are no studies that show the relationship between both sexes differentiation between the *C. carpio* and *C. zillii*, and the effect of this differentiation between the two sexes on the shape of the bones of the skull, and the possibility of differences between those bones for these two species. We note in figures (7), (8) (9) the skull bones of the Common tilapia, *C. zillii*, with some measurements indicated on it, as the symbol (SL.) Indicates the total length of the skull, (SW.) Denotes the width of the skull, while (EHL) refers to the length of the eye socket from the outside and ( EHW) refers to the depth of the eye socket, as well as in Figures (10), (11) and (12), showing the skull bones of *C. carpio* fish, using the same symbols that were used above to explain the details of this study.

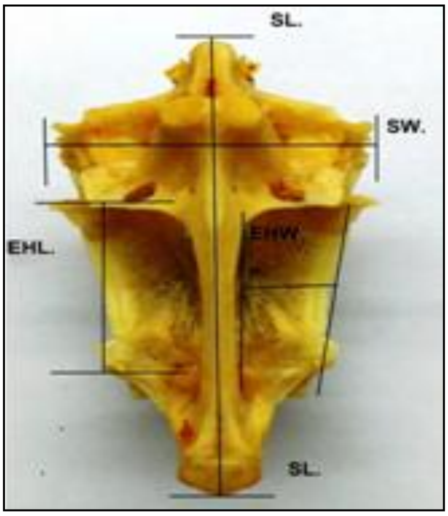


**Fig. 7 :** C. zillii skull from below

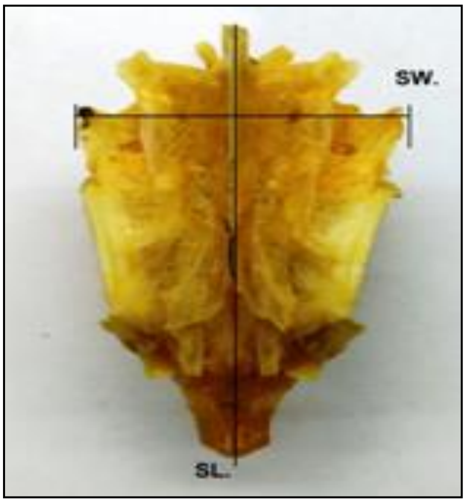


**Fig. 8 :** C. zillii skull from above

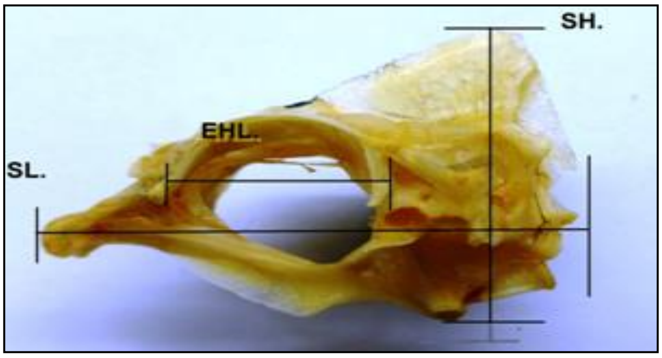


**Fig. 9 :** C. zillii skull from the side

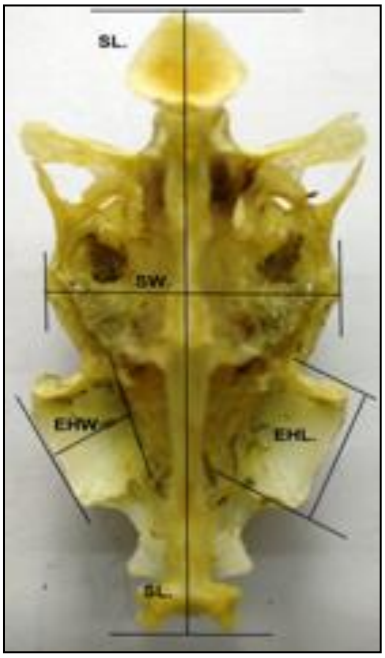


**Fig. 10 :** C. Carpio skull from below

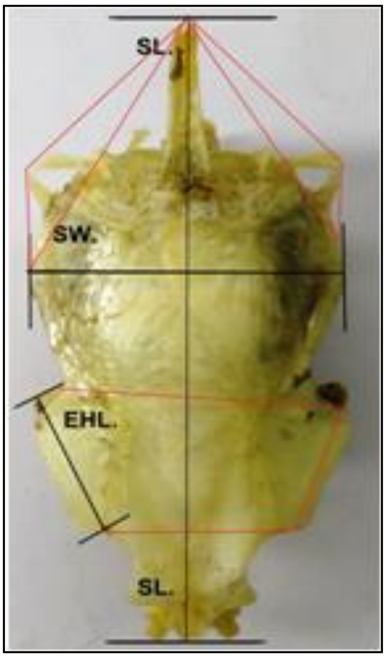


**Fig. 11 :** C. Carpio skull from above

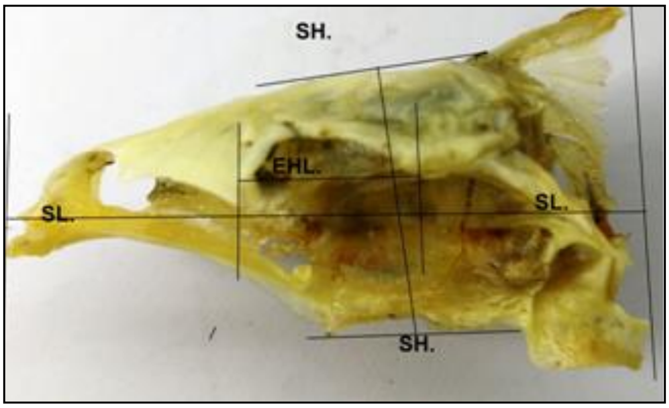


**Fig. 12 :** C. Carpio skull from the side

After cleaning and preparing the bones according to the method mentioned above, biological measurements were taken for each species and a comparison was made between these two species, as the total length of the skull (SL.) of *C. carpio* was bigger with a total length of the bones from the ten models estimated at 4.17 cm, while the average total length of the bones of the *C. zillii's* ten models reached 3,14 cm. The total length of the bones and these differences can be clearly seen from the two figures (9) and (12), which show the profile of the bones between the *C. carpio* and *C. zillii*. The average bone width of the skull (SW.) of *C. carpio* was 2 cm, while it was 1.6 cm in *C. zillii*. These differences in the total length and width of the skull bones, which differ between the species, may be due to the origins of the species and its family, the behavior of this type and the type of food that it feeds on, as well as the depth of water in which this type exists and the extent of pressure of water applied to fish according to different areas of the depths of water that affect the behavior and feeding of the species. The biological changes that one type of fish acquires differ from the other type, but it can be similar within the same family, especially in the behavior, type of food, the way they feed and the presence or absence of teeth on both the jaw and Pharyngeal levels (Akmal *et al*.2020). From here, to clarify the comparative studies between the bones of fish species, we must first understand the stages of evolution of these species and their environment (Hilton, 2011). The shape of the skull and the head bones, especially the jaws, is related to the diet of each type of fish, the method of feeding, and the type of presence of the species in the water column, such as the difference in the shape of the skull, jaws, and the front of the head in the fish that feeds from the surface from those that feed from the bottom or middle (Fugi *et al*., 2001). This explains the differences between *C. carpio* and *C. zillii*, and their method of feeding, which varies between one species and another.

In this study, we find some biological characteristics such as the length of the eye socket (EHL.), the depth of the eye socket (EHW.), and the height of the skull (SH.), between the *C. carpio* and *C. zillii* in this study. The differences, if any, aren't remarkable, but here the *C. zillii* outperformed *C. carpio* in these traits: the average depth of the eye socket for the *C. carpio* was 0.64 cm, while in *C. zillii* 0,84 cm, and the average height of the skull bones was 1,67 cm in the *C. carpio*, unlike the *C. zillii* (1,84 cm). While there were no differences in the characteristic of the eye socket length between *C. carpio* and *C. zillii*, the average total length of the eye socket in *C. carpio* was 1.22 cm while it reached 1.1 cm for the *C. zillii*. Despite the appearance of the thin skull bones in fish, it is one of the strongest bones in terms of formation and cohesion, as is the case of the skull bones in all other vertebrates. The bones of the fish skull provide great protection for the brain and the delicate sensory organs as well as play a key role in both breathing and nutrition (Herbing *et al*., 1996; Koumoundouros *et al*., 2000; Löffler *et al*., 2008).

In this study, it was suggested that the weight of the skull bones between the two species be compared, as the physiological and morphological studies did not address the weight of the bones between species and compare their results to identify the features and composition of the bones of fish species that differ, especially that bone tissues may differ between one type and another, depending on the genetic genes in the formation of the bones of that type, the environmental elements affecting development and the nature of body formation in water. In addition to the species and nature of food that provides the bodies of different types with many elements that may be missing in a second species, and the effect of the presence of heavy elements in the water and the extent of the sedimentation of these elements in the bodies of fish, it was concluded that great differences between the weight of the bones of the skull of both species, as the average weight of the ten skull bones of the *C. carpio* was 2,080 g, while the average weight of the skull bones of *C. zillii* amounted to 0,780 g. We note here that the Carp's skull bones are heavier than those of the Common Tilapia bones. This explains the reason why the skull bone is heavier in one type rather than the other. This also confirms importance of knowing the environment for each species, the type of nutrition followed by that type and the amount of metabolism as well. This is consistent with what Jogeir and others (2007) put forth when he showed that active fish with a low fat content in the nature of their body composition had low levels of concentrations of Calcium (Ca) and Phosphorous (P) elements, unlike less active fish which are characterized by high fat content in their, which bodies increases the concentrations of these two elements, therefore, gives weight to the bones of these fish. This is evident in this study between the species *C. carpio* and *C. zillii*, as the first species is characterized by being one of the types that are kept in somewhat "fish farms", as it has limited movement and has rising levels of fat, in contrast to the common Tilapia species, which is more active, mobile and free-floating in Iraqi internal waters.

## Conclusion

*C. carpio* and *C. zillii* are similar in relation to traditional biological measurements, as there was a strong positive correlation between the total length of individuals with the head length, head width, mouth length, mouth depth and weight of both species. There was also a strong positive correlation relationship between head length with head width, mouth length, mouth depth and weight, as well as a strong and positive minor correlation between head width with mouth length, mouth depth and weight, and a strong and positive minor correlation between mouth length with mouth depth and weight. There is also a strong positive correlation relationship between the depth of the mouth and weight. However, with regard to the shape of the skull bones, the Common Carp exceeded most of the results of bone measurements of the Common Tilapia species, *C. zillii*, especially with the average length of the total bone of the skull and the weight of those bones.

## Recommendations

It is possible to delve deeper into conducting research studies related to the nature of bone formation of fish species in order to find diagnostic and taxonomic indicators especially among the species within the same family, and between species from different families. It is the basis for the phenotypic diversity of fish. The origin of brain development remains somewhat difficult, as the development of the skull in vertebrates generally depends on the presence of an embryonic nerve top whose cells migrate to induce the formation of various elements of the cranial skeleton, teeth and some soft tissues. Much progress has been achieved in understanding vertebrate skull since pioneering anatomical descriptions were conducted in the past century, and in the past few decades, studies that include precise anatomy, gene evolution, molecular biology, and gene expression have shown the main growth processes that appear to be common to Wide vertebrate range. However, molecular biology and genetic studies have been limited to a small number of fish species. There is still a lot of need for investigation and studies on the exact parallels between parts of the skull bones of different types of fish, due to the fact that the skull of vertebrates exhibits remarkable morphological and anatomical elasticity (M. Richter and C. Underwood, 2018).

## References

Richter, M. and Underwood, C. (2018). Origin, Development and Evolution of the Fish Skull, Natural History Museum, London, Publisher: Cambridge University Press, 144-159.

Hora, S.L. and Misra, K.S. (1933). Sexual Dimorphism in the carp Labeo dero (HAM.), Zoological Survey of India, Oalcutta, Records of the Indian Museum, pp 341-342.

Akmal, Y.; Zulfahm, I.; Dhamayanti, Y. and Paujiah, E. (2020). Osteocranium of Tor tambroides (Cypriniformes: Cyprinidae) from Tangse River, Aceh, Indonesia. BIODIVERSITAS. 21(2): 442-450.

Goethe, J.W.: Schädelgrüst aus sechs Wirbelknochen aufgebaut. Zur Morphologie, Band 2, Heft 2. Stuttgart: J. G. Cotta; 1824.

Tatsuya, H. and Shigeru, K. (2015). Evolution of the vertebrate skeleton: morphology, embryology, and development, Hirasawa and Kuratani Zoological Letters 1:2

Ferry-Graham, L.A. and Lauder, G.V. (2001). Aquatic prey capture in ray-finned fishes: a century of progress and new directions. J Morphol, 248(2): 99-119.

Bogutskaya, N.G.; Naseka, A.M.; Golovanova, I.V. (2008). Descriptive osteology of Gymnocorymbus ternetzi (Teleostei: Characiformes: Characidae). *Zoosystematica Rossica*, 17(2): 111-128.

Takeuchi, H. and Hosoya, K. (2011). Osteology of Ischikauia steenackeri (Teleostei: Cypriniformes) with comments on its systematic position. Ichthyol Res 58 (1): 10-18.

Nasri, M.; Eagderi, S. and Farahmand, H. (2016). Descriptive and comparative osteology of Bighead Lotak, Cyprinion milesi (Cyprinidae: Cypriniformes) from southeastern Iran. Vertebr Zool, 66(3): 251-260.

Dierickx, K.; Wouters, W.; Van Neer, W. (2017). Comparative osteological study of three species of distinct genera of Haplotilapiini (Cichlidae). Cybium, 41(3): 223-235.

Hilton, E.J. (2011). The Skeleton Bony Fish Skeleton. Elsevier Inc., USA.

Jalili, P.; Eagderi, S.; Nasri, M. and Mousavi-Sabet, H. (2015a). Descriptive osteology study of Alburnus amirkabiri (Cypriniformes: Cyprinidae), a newly described species from namak lake basin, central of Iran. Bull Iraq Nat Hist Mus, 13(4): 51-62.

Cooper, W.J. and Westneat, M.W. (2009). Form and function of damselfish skulls: rapid and repeated evolution into a limited number of trophic niches. BMC Evol Biol., 9(1): 9-24.

Taylor, W.R.; Van Dyke, C.C. (1985). Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. Cybium 9: 107-119.

Fugi, R.; Agostinho, A.A. and Hahn, N.S. (2001). Trophic morphology of five benthic-feeding fish species of a tropical floodplain. Revista Brasileira de Biologia, 61(1): 27-33.

Leprevost, A. and Sire, J.Y. (2014). Architecture, mineralization and development of the axial skeleton in Acipenseriformes, and occurrences of axial anomalies in rearing conditions; can current knowledge in teleost fish help? J Appl Ichthyol., 30(4): 767-776.

Akmal, Y.; Zulfahmi, I. and Saifuddin, F. (2018a). Karakteristik Morfometrik dan Skeleton Ikan Keureling (Tor tambroides Bleeker 1854). Jurnal Ilmiah Samudra Akuatika 2(1): 35-44.

Akmal, Y.; Zulfahmi, I. and Rahardjo, M.F. (2018b). Morphology of appendicular skeleton of the Thai mahseer’s Tor tambroides (Bleeker, 1854). Jurnal Iktiologi Indonesia, 18(3): 261-274.

Zulfahmi, I.; Akmal, Y. and Batubara, A.S. (2018). The morphology of Thai mahseer's Tor tambroides (Bleeker, 1854) axial skeleton (ossa vertebrae). Jurnal Iktiologi Indonesia, 8(1): 35-44.

Ramaswami, L.S. (1951). Skeleton of cyprinoid fishes in relation to phylogenetic studies. Proceedings of the National Institute of Science, India, 18(2): 125-140.

Howes, G.J. (1982). Anatomy and evolution of the jaws in the semiplotine carps with a review of the genus Cyprinion Heckel, 1843 (Teleostei: Cyprinidae). Bulletin of the British Museum (Natural History: Zoology), 42 (4): 299-335.

Mafakheri, P.; Eagderi, S.; Farahmand, H. and Mousavi-Sabet, H. (2014). Osteological structure of Kiabi loach, Oxynoemacheilus kiabii (Actinopterygii: Nemacheilidae). Iranian Journal of Ichthyology, 1(3): 197-205.

Bogutskaya, N.G. (1994). A description of Leuciscus Lepidus (Heckel, 1843) with comments on Leuciscus and leuciscinea spinine relationships (Pisces: Cyprinidae). Annalen des Naturhistorischen Museums in Wien, 96(B): 599-620.

Keivany, Y. and Nelson, J.S. (1998). Comparative osteology of the Greek ninespine stickleback, Pungitius hellenicus (Teleostei, Gasterosteidae). Journal of Ichthyology 38(6): 430-440.

Keivany, Y. and Nelson, J.S. (2004). Phylogenetic relationships of sticklebacks (Gasterosteidae), with emphasis on ninespine sticklebacks (Pungitius spp.). Behaviour 141(11/12): 1485-1497.

Keivany, Y. and Nelson, J.S. (2006). Interrelationships of Gasterosteiformes (Actinopterygii, Percomorpha). Journal of Ichthyology 46(suppl. 1): S84-S96.

Diogo, R. and Bills, R. (2006). Osteology and myology of the cephalic region and pectoral girdle of the South African Catfish Austroglanis gilli, with comments on the Autapomorphies and phylogenetic relationships of the Austroglanididae (Teleostei: Siluriformes). Animal Biology, 56: 39-62.

Keivany, Y. (2014a). Comparative osteology of the suspensorial and opercular series in representatives of the eurypterygian fishes. Iranian Journal of Ichthyology 1(2): 73-90.

Keivany, Y. (2014b). Osteology of hyobranchial arches in eurypterygian fishes. Iranian Journal of Ichthyology, 1(3): 129-151.

Keivany, Y. (2014c). Pectoral girdle bones in eurypterygian fishes. International Journal of Aquatic Biology, 2(5): 253-274.

Keivany, Y. (2014d). Comparative osteology of the jaws in representatives of the eurypterygian fishes. Research in Zoology 4(2):29-42.

Herbing, I.H.V.; Miyake, T.; Hall, B.K. and Boutilier, R.G. (1996). Ontogeny of feeding and respiration in larval Atlantic cod Gadus morhua (Teleostei, Gadiformes): I. Morphology. J Morphol, 227(1): 15-35.

Koumoundouros, G.; Divanach, P. and Kentouri, M. (2000). Development of the skull in Dentex dentex (Osteichthyes: Sparidae). Mar Biol., 136(1): 175-184.

Löffler, J.; Ott, A.; Ahnelt, H.; Keckeis, H. (2008). Early development of the skull of *Sander lucioperca* (L.) (Teleostei: Percidae) relating to growth and mortality. J Fish Biol 72(1): 233-258.

Jogeir, T.; Sissel, A.; Britt, H. and Anders, A. (2007). Chemical composition, mineral content and amino acid and lipid profiles in bones from various fish species. Comparative Biochemistry and Physiology Part B Biochemistry and Molecular Biology 146(3):395-401.