REPUBLIC OF TURKEY

FIRAT UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCE

DETERMİNATİON OF MOST RELİABLE BONY STRUCTURE FOR AGEİNG OF *Carassius carassius* (LİNNE, 1758) INHABİTNG İN DUHOK RİVER (IRAQ)

JIHAD SALEEM MOHAMMED

Master Thesis

DEPARTMENT OF FISHERIES BASIC SCIENCES

Supervisor: Prof. Dr. Serap SALER

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ELAZIĞ

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DETERMINATION OF MOST RELIABLE BONY STRUCTURE FOR AGEING OF *Carassius carassius* (LINNE, 1758) INHABITING IN DUHOK RIVER (IRAQ)

MASTER THESIS

JIHAD SALEEM MOHAMMED

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STATEMENT

All the information in the [Select Thesis Type from the List] title titled "The First Letter of Each Word Should Be Written Here," in accordance with the Fırat University Institute of Science thesis writing rules is correct, I am acting in accordance with scientific ethical rules in producing and presenting the information. I hereby declare that I have mentioned it, that I have stated all the institutions / organizations and persons who have financial and moral support, and that I have not used the data and information I have presented here in any way before.

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Jihad Saleem MOHAMMED

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Sincerely

Jihad Saleem MOHAMMED

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ABSTRACT

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In this study, it was aimed to make a comparative age determination in the population of *Carassius carassius* (Linne, 1758) living in Duhok River. For this purpose, 71 fish samples (57 male and 14 female) were obtained. The study was conducted in the fish anatomy laboratory of the Fisheries Faculty of Firat University. The length and weight of the fish samples were determined. The bony structures of the vertebrae, scales, otoliths and operculums used in the age determination were removed, cleaned and labeled. The bony structures were photographed using Leica S8APO brand microscope with Leica Application Suit (Ver.4.8.0) software. The age rings of each bony structure were counted three times and one day apart.

The age groups determined for each bony structure, the number and percentage distributions of individuals in these groups were expressed with tables, and the comparison of age matching between bony structures was expressed by figures and the most reliable bony structures were vertebra, otolith, scales and operculum respectively.The highest consistency was observed in the vertebrae (70.42%). The ages changed between I and IX age in *Carassius carassius* in this study.

Key Words: Age Determination, *Carassius carassius,* Bony Structures

ÖZET

Duhok (Irak)'ta Yaşayan *Carassius carassius* (Linne, 1758) Yaş Tespitinde En Güvenilir Kemiksi Yapının Belirlenmesi

Jihad Saleem MOHAMMED

Yüksek Lisans Semineri

FIRAT ÜNIVERSITESI

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Bu çalışmada, Duhok Nehri'nde yaşayan *Carassius carassius* (Linne, 1758) populasyonunda karşılaştırmalı yaş tayini yapılması amaçlanmıştır. Bu amaçla 71 balık örneği (57 erkek ve 14 dişi) elde edildi. Çalışma Fırat Üniversitesi Su Ürünleri Fakültesi balık anatomisi laboratuvarında gerçekleştirildi. Balık örneklerinin uzunluğu ve ağırlığı belirlendi. Yaş tayininde kullanılan omurlar, pullar, otolitler, ve operkulumlar çıkarılarak, temizlenmiş ve etiketlenmiştir. Daha sonra, kemik yapıları Leica S8APO marka mikroskopla incelendi (Ver.4.8.0) software altında incelendi. Her kemik yapısının yaş halkaları üç kez ve bir gün arayla sayıldı.

Her kemik yapısı için belirlenen yaş grupları, bu gruplardaki bireylerin sayı ve yüzde dağılımları tablolarla, kemik yapısı arasındaki yaş eşleşmesi rakamlarla ifade edilmiştir. En güvenilir kemik yapıları sırasıyla omur, otolit, pul, ve operculum olarak tespit edilmiştir. Omur okumalarında en yüksek tutarlılık gözlendi (% 70.42). Bu çalışmada *Carassius carassius* da yaş I ve IX yaşları arasında değişmiştir.

Anahtar Kelimeler: Yaş tayini, *Carassius carassius*, kemiksi yapılar

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1. INTRODUCTION

Growth in fish is expressed as a calendar year in terms of duration. During this period, the growth of fish occurs as a result of duplication of muscle and bone cells and the growth rate varies according to the seasons. Growth is fast in summer and slows down in winter. This is because fish take food, evaluate the food as growth and growth rate is directly proportional to the water temperature in which they live. These fast and slow growth events occur in fish, like trees, in the form of ring-like zones or light and dark bands and reflect on other bony structures such as scales, otoliths, operculum, vertebrae, fin beam etc. Age determination is made by reading these structures (Geldiay and Balık, 2007).

Age determination in fish is the most important step of fisheries biology studies and the studies on this issue date back to 300 years and the historical development of age determination in fish has been examined by many researchers (Türkmen et al., 2005). In order to find the appropriate method for the studies on fish and the development of fisheries, it is necessary to know the specific age structure and development rates of the populations. Annual growth lines on bone structures have allowed fish biologists to determine age. Age data, height and weight measurements related to the age values, stock composition, maturity of the first sex, reproduction life, growth, death and yield information about the amount (Türkmen et al., 2005).

A myriad of fish species is aged based on the discontinuities prevalent within their skeletal structures. Such discontinuities may derive from environmental condition alterations such as the temperature of the habitat, or relevant fish physiology changes including spawning. Even so, a majority of fish may live under similar environmental conditions which are void of discontinuities relating to their skeletal structures. In such contexts, fish ageing can only be achieved through indirect approaches, and often becomes an impossible process, as opined by (Shepherd and Cushing 1980).

For the purpose of reliable fish stock state evaluation, it is critical that information regarding the stock's age structure is available. A stock's age profile offers a reliable indicator regarding the health of such stock. In the event that a wide age range is obtained, it implies a good shape of the stock. Absence of young fish could imply failure at past attempts at spawning or recruitment which is a potential indicator of a disastrous future. On the other hand, if the stock justifies absence of old fish, then the underlying implication is stock overfishing practices. The data on age offers significant insight into the fish stock state, and often forms very crucial data in the process of assessment of the fish stock. As (Berkeley et.al. 2004) argue, information regarding the age of fish is essential for effective management and monitoring of the available fishery resources.

When numerous fish individuals are aged across the full size ranges within a specified fish population, it becomes viable to derive a growth curve of the average fish length for individual ages for the fish population. Derivation of the growth curve is essential in the determination of the productivity of the given species as well as the identification of the differences in the rates of fish growth over time.

In research studies handling topics ranging from reproduction rate, age composition, mortality, growth, survival rates, as well as age and length keys of fish stock, the process of fish age determination cannot be underestimated, as opined by Beamish and McFarlane (1983). Studies on growth and age of fish stock have become an important element of the resolution of challenges faced by the fisheries management. With accurate information on the age of fish, it becomes possible to determine the first maturity age of fish, enhances population dynamics studies, promotes growth estimation as well as optimizes harvest periods. There are different approaches to fish age determination. Of these, the mark-release-recapture approach is regarded as the most accurate of fish age determination methods. Additionally, it is worth noting that the application of the method is limited owing to challenges involving the massive constraint tally, including but not limited to finances and time resources (Das, 1994). Length-frequency data analysis is another viable method, as stipulated by (Horn, 1993). This approach is deemed appropriate and effective for use when determining the age of fish whose breeding occurs once every year, and it is impossible to utilize the method to determine individual fish age (Das, 1994). The anatomical method is other feasible approach to determining fish age. In this approach, an analyst determines the age of fish through thorough assessment of the fish growth rings evident on the fish bony structures including its pectoral or dorsal fin ray cross sections, the vertebra, opercular bone, scales, and otoliths. To derive fish age, it is critical to undertake comparisons of different reader scores of various fish bony structures (Barber and McFarlane; Barnes and Power, 1984; Casselman,1987). Even with all these methods, it is noteworthy that the most appropriate approach to fish age determination is species dependent. Consequently, bony structure precision assessment by readers needs critical comprehension (Baker and Timmons, 1991; Kamura and Lyons, 1991; Chiltonand Beamish, 1982; Polat and Gümüş 1996; Maceina et al., 2007). In addition, any errors committed in ageing calculation are subject to consideration ahead of identification of the most viable bony structure to be analyzed for reliable fish age outcomes (Kamura and Lyons, 1991; Gümüş and Polat, 1998; Becer et at., 1997). Conscious attempts have been made to determine the *Pleuronectes flesus luscus* age owing to no record of past fish age calculations in the past.

To understand the biology of fish, it is important that the age of fish is derived. Studies seeking to argue out elements of fish biology have been found to detail information about the stock mortality, age composition, survival rate, reproduction rate, and age-length keys. Studies on age grown have offered avenues for fisheries management problem resolution. Das (1994) is in agreement that with fish age information, it is possible to derive first fish age maturity, growth estimation, population dynamics comprehension, and harvesting time optimization. In view of

Kothari's (2004) suppositions, fish age knowledge is a valuable asset in the study of the fish population defining features, and it may be a necessity in the process of undertaking detailed research in the ecology and life history strategies.

As earlier noted, among the common fish age determination methods are anatomical assessment, length-frequency data evaluation, and mark-release-recapture approach. Owing to the complexities associated with the latter two approaches, the anatomical research method is the most widely utilized approach to fish age determination. The anatomical research approach uses evaluative processes which seek to analyze the fish bony structures including otoliths. Pectoral and dorsal fin ray cross sections, vertebrae, and scales. The type of bony structure to be used in the determination of the fish age is variant from one fish species to another. This implies that a bony structure may be appropriate for the calculation of the age of fish in a single fish species, the same structure may be inappropriate for the same calculation in another fish species since different species of fish do not necessarily achieve similar growth thus lack distinctly equal markings. Arguably, the bony structures employed in age calculation are not subject to generalization across distinct species (Das, 1994).

Age calculation should not be confused for a process of bonny structure ring tallying. Inspection of a bony structure under a microscope reveals that different rings concentrically run around the centre. Some rings may exhibit growth on a yearly interval, while others exhibit periods or stress of migration, starvation, or spawning, as held by Das (1994).

In the determination of age of fish, one must rely on annual rings as the valid age indicators. Of significance is the differentiation between true rings and other ring types including the spawning rings, larval rings, false rings, and stock rings. An analyst can derive this distinction by undertaking repetitive evaluation of the collected samples for the purpose of avoidance of inaccuracy and confusion in the process of age calculation. Conventionally, the scale method was the most common approach to age determination for a stock of population. However, validation of the determination outcomes has blown a major setback to the acceptability of the accuracy of the method (Beamish and McFarlane, 1983).

Investigators noted that scales would potentially underscore the age of older fish in the study population, thereby making the revelation that some fish species could have been way older than the scale method had shown (Beamish and McFarlane, 1983). Equally, Turkish analysts have been utilizing the scale method to calculate the age of fish. Particularly, estimations have been made based on the otolith surfaces and scales have been the routine bony structures under scrutiny. Occasional assessments have also relied on assessments made on broken otoliths, vertebrae, and fin rays. Worth noting is conventionally, otoliths and scales have been regarded as bony structures with accurate and valid rings, thereby justifying the absence of effort to utilize any other bony structures. Even so, the investigators have deciphered discontinued scale growth upon aging of fish

(Beamish, and McFarlane, 1987). Additionally, there are fish species in which otolith growth gains allometry owing to inner surface predominant deposition, such as in *Solea lascaris* (Polat et al., 2004). Thus, reliance on otolith readings for age calculation, there is the possibility of under-estimation of the fish ages as a result of loss of edge annuli or loss of central thickness rings. Pioneering work on burnt and broken otoliths offers a summative view that the scale method is bound to yield greater age estimates as compared to other age calculation approaches (McFarlane and Beamish, 1983; Fargo and Chilton, 1987). Consequently, the burnt-broken otolith can only be validly accepted as a reliable age determination bony structure of the *Solea lascaris* species (Polat et al., 2004), or the *Merlangius merlangius exunus* and *Salvelinus alpinus* species (Barber, and McFarlane, 1987).

To derive valid data, fish age estimation is conducted through comparisons of different bony structure readings by different investigators (Chilton and Beamish, 1982). It is possible for the age determination approaches to vary based on fish species, it is critical for bony structure precision assessment to be carried out for individual species (Baker and Timmons, 1991).

In addition, the errors obtained ought to be subjected to critical consideration before settling on any bony structure as the most appropriate for age determination for fish (Kimura and Lyons, 1991). If the ageing error and agreement rate are established, bony structures with the least ageing error against highest agreement rate can be identified. Consequently, the most reliable bony structures for age calculation for individual species can be identified.

Indirect fish age estimation is possible through length-frequency distribution analysis which provides the mean length for individual fish age groups. It also can be estimate directly for every age through counting of the annual growth rings on calcified specimen structures including opercular bones, otoliths, scales, and fin rays. The direct estimation approach is accepted as more accurate as it offers extra information regarding the dynamics of fish populations. However, there are regions which carry out age determination solely on otoliths and scale approaches, such as Tunisia, without any attempt to validate age values and ageing procedures.

Knowledge about age is the foundation of all mortality, productivity, and growth rate calculations; thereby making it a crucial biological variable. Biological history calculations need age knowledge.

This research is important in terms of which bony structure can best be determined from the age determination of the population of *Carassius carassius* (Linne, 1758), which is economically important in the Duhok River and in terms of leading the way for other biological studies.

To date, a study on the comparative age determination of *Carassius carassius* has not been found. Age determination study was needed and it was aimed to make comparative age determination from bony structures.

2. MATERIAL AND METHODS

2.1. Research area

In total, 71 *Carassius carassius* samples were captured from Duhok River, 36°45'38.88" N, 42°48'11.12" E (in Northern Part of Iraq) (Figure 2.1) between November 2017 and March 2018.

Figure 2.1. Sampling stations in Duhok River, Northern Iraq

2.2. Catching Fish Samples and Observations

The sample were caught using gill nets of multiple sizes (36, 40, 44, 50, 60, 70, 80 and 90 mm). The mesh sizes of the trammel nets were 100, 120, 140 and 160 mm. The measurement of Weight (W) and length (L) was rounded off to the nearest 1cm and 1g respectively. These were caught and recorded separately.

2.3. Carassius carassius

2.3.1. Biological Features

Body laterally compressed and thick, round abdomen; standard length 2.1-2.8 times body height and 3.1-4.1 times head length; length of head larger than body height; small and short head; short snout; terminal mouth and arch shaped; lower jaw slanting upwards slightly; thick lip; no palpus; 37-54 gill rakes on the first outer gill arch, gill rake long; one row of pharyngeal teeth on each side, laterally compressed, formula 4--4; 27-30 scales in lateral line. Tip of pectoral fin can reach the base of ventral fin; dorsal fin ray: 3, 15-19; pectoral fin ray: 1, 16-17; ventral fin ray: 1, 8; anal fin ray: 3, 5; body colour: silvery grey, deeper colour in dorsal portion, lighter colour in abdomen; colour of fins: greyish (Figure 2.2) (URL 1, 2019).

Figure 2.2. *Carassius carassius*

2.3.2. Historical Background

The culture of crucian carp was initiated in China. The earliest activity can be traced back to the East Han Dynasty (25-189 A.D.), according to archaeological studies, to the Song Dynasty (960-1279 A.D.) and according to written records. However, production was limited to a rather small scale. Aquaculture of this species was limited to China and Japan until the mid-1960s. Since then it has gradually expanded to many other countries and regions, including Taiwan Province of China, Belarus, Republic of Korea, and Uzbekistan. The major producer has always been China, whose production has expanded from less than 2000 tonnes in 1950 to nearly 1.7 million tonnes in 2002 (99.6 % of the global total).

2.3.3. Habitat and Biology

Crucian carp is a freshwater fish that inhabits lakes, rivers and reservoirs in various countries in Asia and Europe. They normally dwell in the bottom layer of the water column. Comparatively, they can tolerate a wide range of environmental conditions. They are sedentary fish, which can propagate naturally in various types of water bodies, such as rivers and lakes. Crucian carp is basically an omnivore that naturally feeds on organic detritus, filamentous algae, small benthic animals, and pieces and seeds of aquatic weeds. However, the fry/larvae feed on zooplankton. In addition, in aquaculture, they will accept artificial feed, such as by-products from grain processing and oil extraction, and pelleted feed. Rainfall, water level and temperature changes are the stimuli for reproduction. The presence of aquatic weeds is also important for spawning; they serve as the substrata for the eggs, which are adhesive. Crucian carp is a medium-size fish with a moderate growth rate that can reach 1.25 kg (Xianwen1964).

2.4. Methods

The fork length, total weight, standard length and total length, of each sample have been taken and otoliths, opercular bone (left and right side), scales and vertebrae were obtained from each of fish and prepared for processing of age determination in *C. carassius* (Figure 2.4, 2.5). From the 71 samples taken from comparative analysis were evenly distributed among the sexes (57 males, 14 females) and in all size ranging (30.5 cm - 70 cm for females and 22.2cm to 63.5 cm for males). Almost all bones structure has been immersed in alcohol, and some of them when we worked, they remained so fatty surrounding of them and then we putted into 3- 4 % solution of sodium hydroxide. To remove the extra attached fatty.

Figure 2.3. Weight measurement of *C. carassius.*

Figure 2.4. Length measurement of *C. carassius.*

As well as whole the structure after process of washing, cleaning and drying it has been preserved in a referenced packet then recorded some note on this packet about date, number and name of the structure till reading under microscopic.

2.4.1. Scale preparation

This part of the report discusses the process of scale preparation. The scales in this study were drawn from the dorsal side of the fish, inside of the mid-line between the lateral line and the dorsal fin. Forceps were by used to remove scales from the part right above the near tip of the pectoral fin (Figure 2.5). Once they were removed, they were then cleaned for study. They were studied as dry mounts once mucous was washed through running water, and extraneous matter removed by rubbing them between the finger tips. In order to make the scales soft and clearer, they were dipped in weak solution of potassium hydroxide for approximately five minutes and then washed by running water and dried (Khan and Khan 2009). Given that the scales are translucent with a fairly large size, a magnifying glass was used to read them. The scales from smaller fish were observed under a microscope (Khan and Siddiqui 1973).

Figure 2.5. Removing scales from *C. carassius.*

2.4.2. Operculum

A scalpel was used to detach the opercular bones and they were then dipped in water for a couple of minutes to get rid of extraneous matter (Figure 2.6, 2.7). To remove the tissue, a bristle brush was used. Initially, they had been dipped in boiling water to remove the tissue. The now cleaned opercular bones were out in transmitted fluorescent light and observed with the naked eye (Phelps et al. 2007). Opercular bones were immersed alcohol. On the other hand, otoliths were studied by immersing them in glycerol. Sand was used to rub against unclear Otoliths to make the annuli clear for age reading (Khan and Khan, 2009).

Figure 2.6. Cutting the operculum from *C. carassius.*

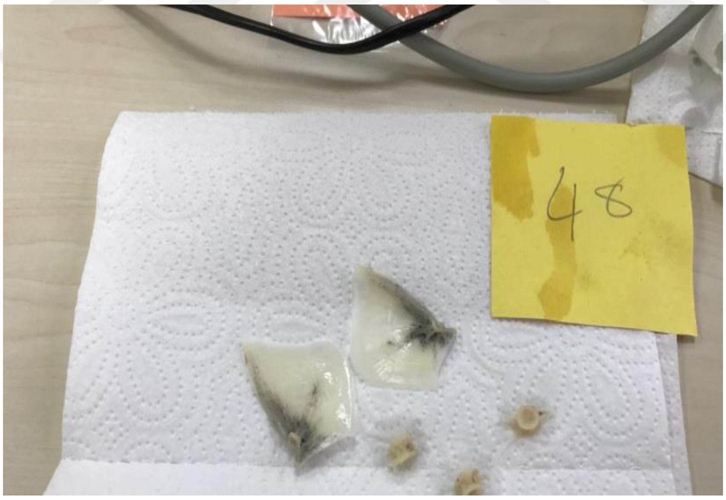


Figure 2.7. Cleaned operculums.

2.4.3. Otolith

The other bones used for ageing fish are the otolith bones (sagittae). These are found in the head of the fish (Figure 2.8). These are small calcareous particles found in sacs filled with fluid in the middle ear of the fish. The purpose of these structures is to give the fish its position in relation to gravity, allow to balancing. Otoliths have white center which is surrounded by alternating opaque and clear rings. In the study, sagittal otoliths came from otic capsules. The otoliths were studied by immersing them in glycerol. Sand was used to rub against unclear Otoliths to make the annuli clear for age reading.

Figure 2.8. Otolith receiving into left side of *C. carassius.*

Otoliths of older, slow-growing fish become thick and the yearly growth zones do not form equally on all surfaces. To detect annuli on otoliths from older fish, cross sections must be examined. The otolith can be broken in cross section through the nucleus and one of the broken surfaces carefully burned in an alcohol flame. The greater concentration of organic material in the translucent zones produces distinct dark bands that contrast with the light bands of the opaque zones when viewed with reflected light. The burnt otolith is held in Plasticine or a similar (Chilton and Beamish 1982).

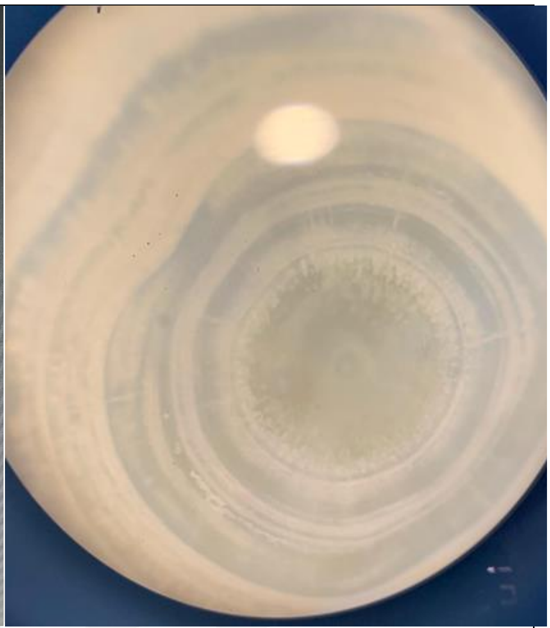
2.4.4. Vertebrae

After removal, vertebrae were put in boiling water for between 10 and 15 min. This was done to make them clear and remove the attached muscles (Figure 2.9). After this, the vertebrae that was processed was dried for a period of around 2 weeks so that the annul rings can be counted under a microscope (Phelps et al. 2007). To ensure accuracy, they were then placed an oven at very high temperatures of around 103°C for a period of around 15 min. They were then cleaned for the second time and studied in xylol using the microscope (Chugunova, 1963).

Figure 2.9. Boiling and washing of vertebrae of *C. carassius.*

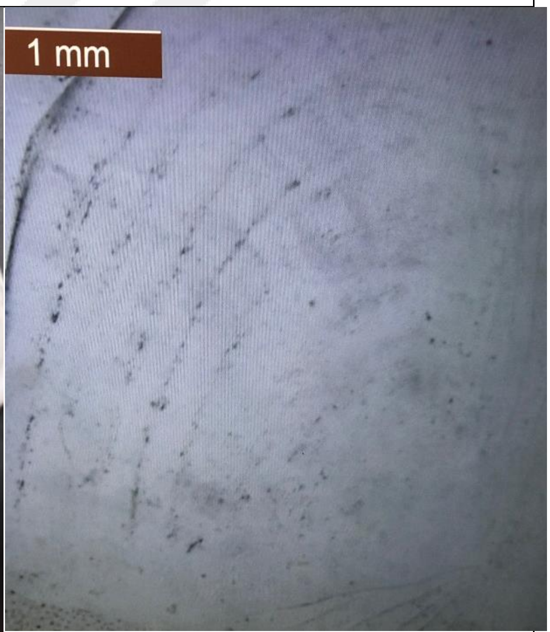
All the scales, vertebrae, dorsal fin rays got aged 3 different periods three times by the same reader without the knowledge of fish weight, length, date of collection. In the event where the 3 readers disagreed, re-examination was done to reach consensus and record (Khan and Khan 2009). The bony structures were photographed using Leica S8APO brand microscope with Leica Application Suit (Ver.4.8.0) software. The view of bony structures was given in Figure 2.10.

otolith 4 years old



Vertebrae 7years old

Operculum 8 years old



Scale 8 years old

Figure 2.10. The view of bony structures of *C. carassius.*

3. RESULTS

In this study, a total of 71 *Carassius carassius* samples from Duhok River were determined. Age determination was made from 4 bony structures of these obtained fish. The dorsal fin bone was thin and fractured and was not used for age determination. Each bony structure was read three times and one day apart on different days. The relationship of each bony structure with the other bony structure have been observed and given in graphics (Figure 3.1-3.16).

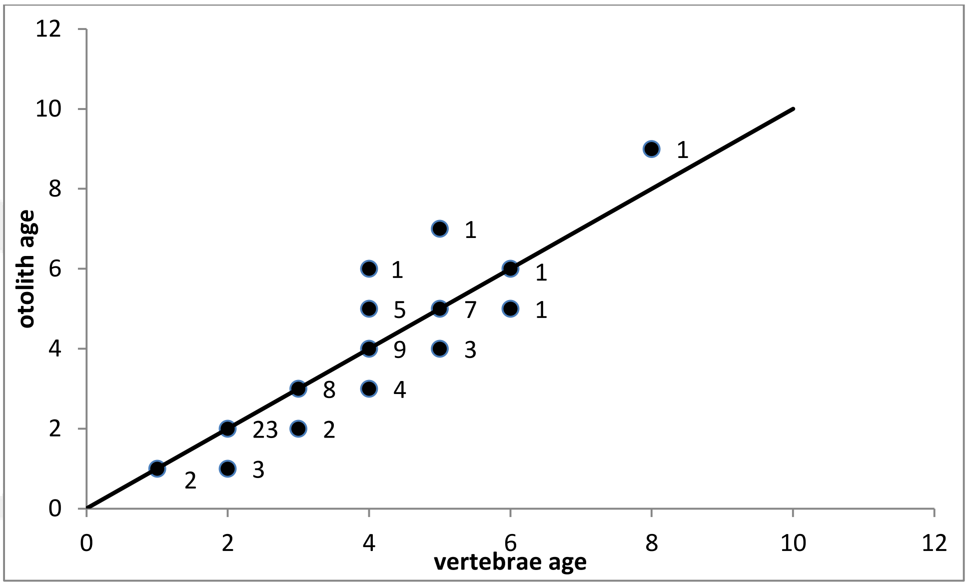


Figure 3.1. Otolith age – vertebrae age relationship of in *C. carassius* in Duhok.

Figure 11 shows that for *C. carassius*, the age relationship between the otolith and the vertebrate was; It is seen that the number of samples without age difference is 50, the number of samples with 1 age difference is 19, and the number of samples with 2 age difference is 2.

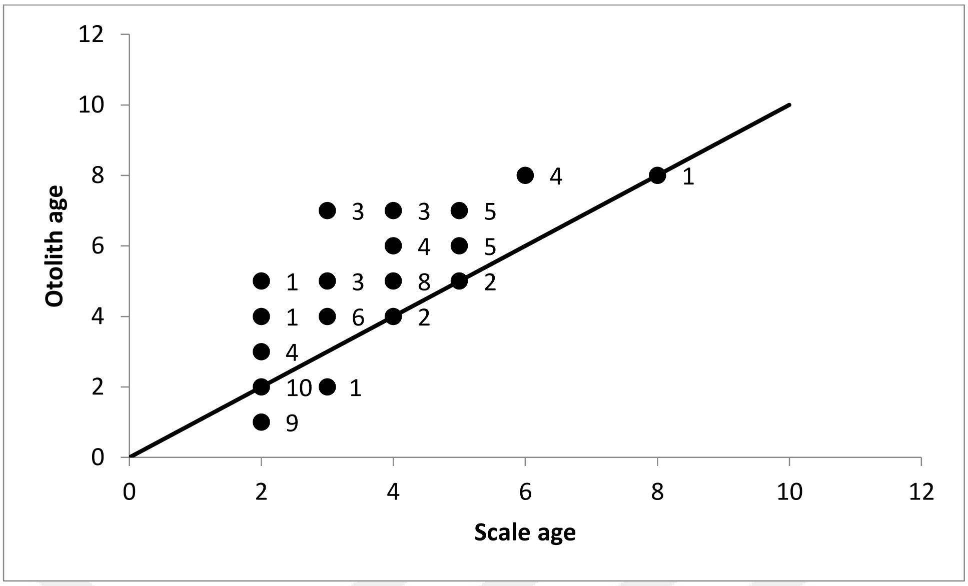


Figure 3.2. Otolith age – scale age relationship of in *C. carassius* in Duhok.

Figure 3.2. shows that for *C. carassius*, the age relationship between the otolith and the scale was; It is seen that the number of samples without age difference is 15, the number of samples with 1 age difference is 33, and the number of samples with 2 age difference is 17, 3 age difference is 3, 4 age difference is 3.

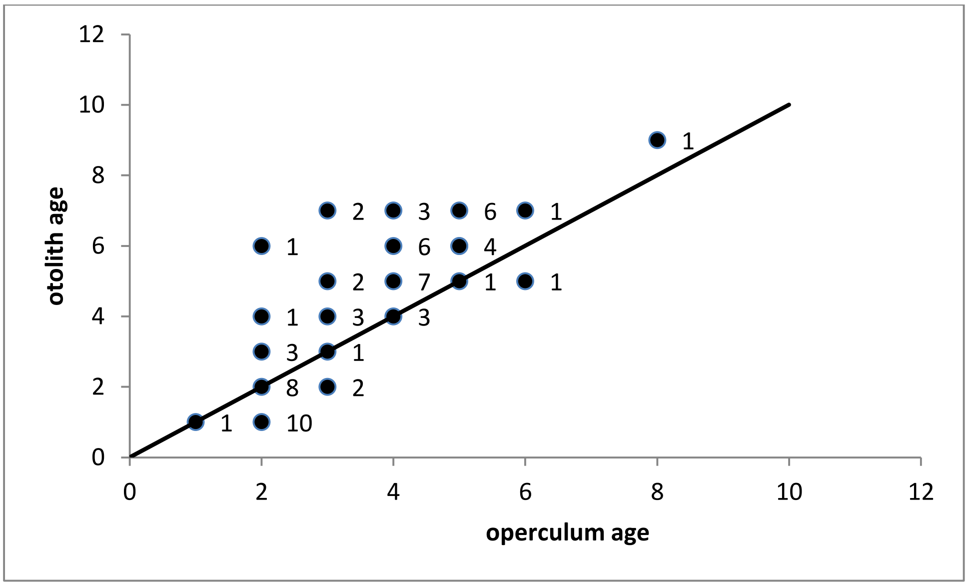


Figure 2. Otolith age – operculum age relationship of in *C. carassius* in Duhok.

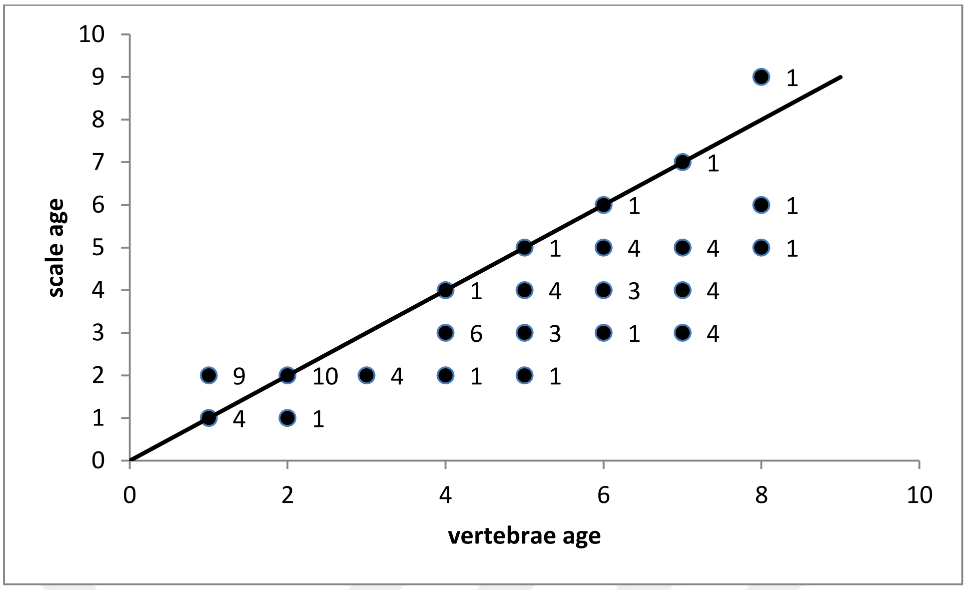


Figure 3. Scale age – vertebrae age relationship of in *C. carassius* in Duhok.

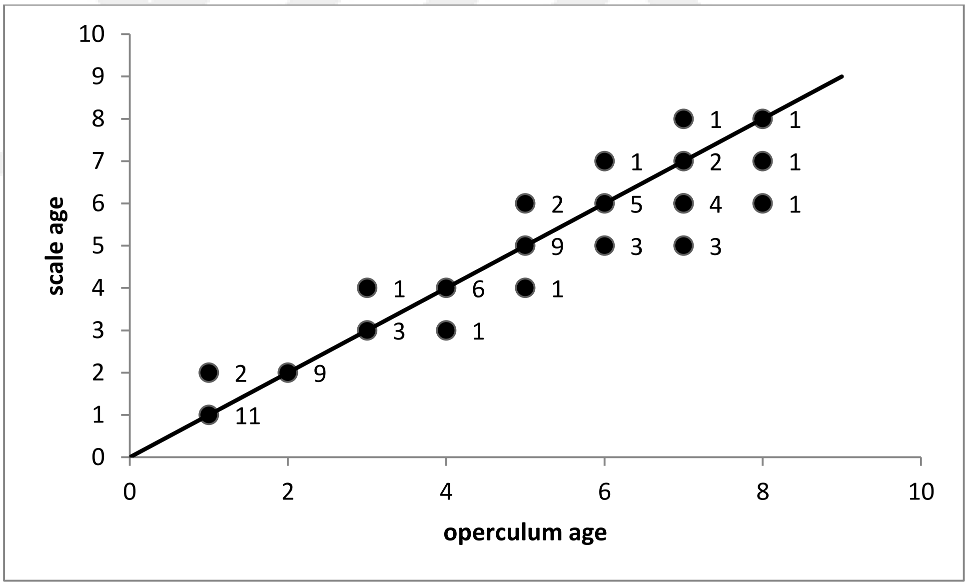


Figure 4. Scale age – operculum age relationship of in *C. carassius* in Duhok.

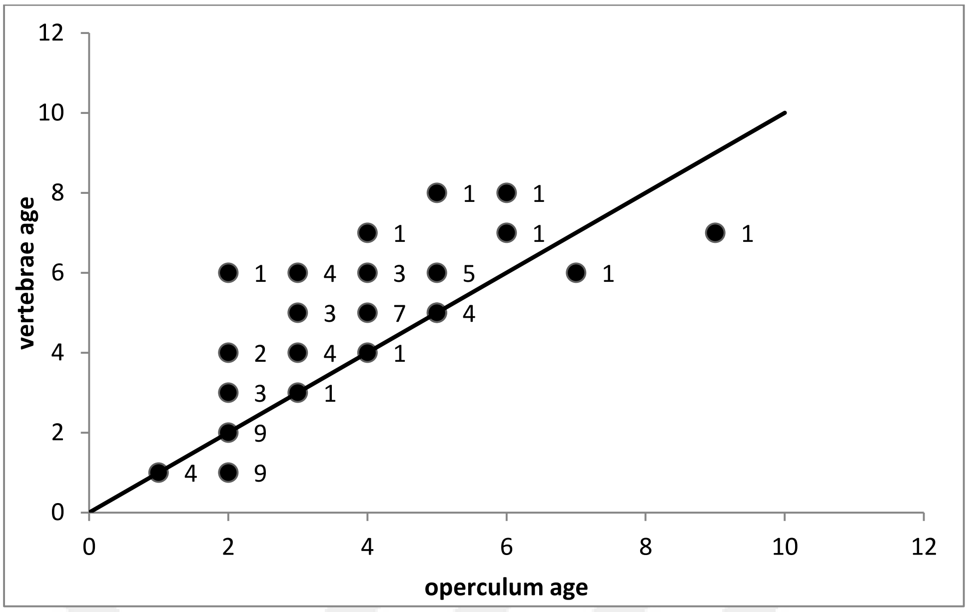


Figure 5. Vertebrae age – operculum age relationship of in *C. carassius* in Duhok.

The distribution of bone structures according to age groups in *C. carassius* also determined and given in Table 3.1.

Table 3.1. Distribution of bony structures ages according to age groups in *C. carassius* in Duhok.

	Age groups																		
	I		II		III		IV		V		VI		VII		VIII		IX		
Bony structures	**N**	**N%**	**N**	**N%**	**N**	**N%**	**N**	**N%**	**N**	**N%**	**N**	**N%**	**N**	**N%**	**N**	**N%**	**N**	**N%**	**N**
Operculum	3	4.21	11	15.50	9	12.67	11	15.50	16	**22.53**	15	21.12	4	5.64	2	2.82	0	0	71
Otolith	2	2.81	17	**23.94**	10	14.08	13	18.31	14	19.72	12	16.91	1	1.41	2	2.82	0	0	71
Scale	3	4.21	12	16.90	9	12.67	11	15.50	15	21.12	14	**19.73**	4	5.64	2	2.82	1	1.41	71
Vertebrae	5	7.10	18	**23.58**	12	16.91	12	16.91	13	18.60	9	12.67	1	1.41	1	1.41	1	1.41	71

In Table 3.1. The distribution of bony structures according to age groups in *C. carassius* has been given. In operculum the highest age group was determined with 16 samples as 22.53% in V age group, in otolith in 17 samples with 23.94% in II age group, in scale14 samples with 19.73% in VI age group and in vertebrae in 18 samples with 23.58% II age group.

Table 3.1. Age adjustment of the bony structures of *C. carassius* living in Duhok.

Bony structures compared	**Compliance groups**			
	3/3	2/3	1/3	Total
Operculum	43.66	56.34	-	100
Otolith	66.19	33.81	-	100
Scale	50.70	49.30	-	100
Vertebrae	**70.42**	29.58	-	100

When the age adjustment of *C. carassius* bony structures was examined, it was found that the highest adaptation of the reader was in the vertebrae with 70.42% and then in the otolith with 66.19 %. The lowest adjustment was recorded in operculum with 43.66% (Table 3.2).

Table 2.3. Minimum, maximum and average values of total length and weight of *C. carassius* living in Duhok.

	Total length (cm)	**Fork length (cm)**	**Standart length (cm)**	**Weight (gr)**
average	37.42	33.91	31.53	1141.33
minimum	22.20	26.00	24.00	176
maximum	70.00	65.00	58.60	6870
N	**71**	**71**	**71**	**71**

In *C. carassius* the average total length was determined as37.42 cm. Its minimum and maximum values were changed between 22.20- 70.00 cm. The highest weight of fish sample was recorded as 6870 g, minimum value as 176 g (Table 3).

4. DISCUSSON

Variations in the age estimates in diverse aging structures were examined. In this study, variations were observed in the age estimates from different aging structures. For example, an analysis of the vertebrae indicated sharper and clearer rings when compared with other structures. A number of researchers have raised doubt about the accuracy of using scales to estimate the age of fish (Maceina and Sammons 2006). This is because of reabsorption and deposition of false annuli as a result of stress. Also, the clarity of the annuli can be affected when the fish gets older. In *C. carassius* scales are very big. But a problem occurs during the age reading because of false and half ring age rings on the scale. In this study 71 *C. carassius* bony structures determined. Among the bony structures the highest adjustment was recorded in vertebrae with 70.42% followed by otolith with 66.19%. The lowest adjustment was observed in operculum with 43.66%.

In this research the age of fish samples were recorded between I and IX age groups. The highest age distribution has been determined between II and VI age groups. The highest age was as IX age in scales and vertebrae. The highest number of age group was recorded in 17 samples as II age. In Eğirdir Lake the highest age of. *Carassius auratus* has been determined as V age (Kuşat et all. 2006). They measured the highest length as 3.9 cm and highest weight as 1079 g. In this study the highest length was recorded as 70cm and highest weight as 6870 g. In Irak, All Norr (2010), studied the population status of gold fish *Carassius auratus*. He determined the highest age as X age. In this study the highest age value was IX age. Şası (2008), found *Carassius gibelio* age between III- VI ages in Topçam Dam Lake. In Keban Dam Lake, Duman and Şen (2002), studied the comparative age determination of *C. auratus*. They stated that the age changes between I and VII. He observed the most reliable bony structures in *C. auratus* as scale. He recommended otolith and vertebrae after scale as the most reliable bony structure.

In this study due to the large size of the scales in *C. carassius*, the samples which were not observed as a whole in the field of view of the microscope were determined with the help of a magnifying glass. In addition, deterioration was observed in the center. However, a large number of false rings were found.

The evaluation of age and growth of fish using opercular bones is well-researched in fishes drawn from temperate waters. According to Nargis (2006), the use of opercular bones is more accurate compared to other methods. In fish ageing structures, scales continue to be the most popular for moronid, esocids and centrarchids. The main reason for this popularity is because it is easy to remove them and such removal has little damage on the fish (Hogman 1968, Maceina et al. 2007).

It was concluded that the operculum was not suitable for age determination due to the abundant number of pseudo-rings and the fact that age rings were not easily distinguished.

However, age rings were sometimes not seen due to thickening with advancing age. It is also necessary to pay attention to the residence time of the boiling water when making it suitable for wet determination. If left too long, the age ring will deteriorate, if left too little, it is difficult to clean and time consuming.

In this study; Although similar results were obtained in the age readings of the vertebrae and otolith, the most clear age rings were observed in the vertebrae. The risk of taking fish from the ring structures; it was concluded that bony formation was the vertebrae in age determination readings because it was clear, homogeneous, clear and homogeneous, and showed the most confirmation at the end of three readings.

Nevertheless, ageing with fish scales has many disadvantages. Many types of fish can re-absorb scales. This is called “Crichton effect”. On the other hand, regenerate the scales when they are damaged, removed, which leads to growth patterns which can’t accurately tell the life span of the given fish (Schram and Fabrizio 1998). In other studies, examining the use of scales to tell the age of fish, it was noted that scales of long-lived salmonid species like Bull Trout *Salvelinus confluentus* (Zymonas and McMahon 2009), lake trout *Salvelinus namaycush* (Schram and Fabrizio 1998) and inconnu *Stenodus leucichthys* (Howland et al. 2004) are quite hard to interpret. This makes is quite difficult to interpret thus leading to lower age estimates. This is lower than that of fin rays and otoliths (Ihde and Chittenden, 2002). In other studies, the pelvic fin rays of inconnu (Howland et al. 2004), the African Sharptooth Catfish *Clarias gariepinus* (Khan et al. 2011) and pectoral fin rays of *Atractosteus spatula* (Buckmeier et al. 2012) have been ideal in offering an alternative to the usual lethal structures. As opposed to the other methods, the removal of fin rays and spines does not need one to kill the fish. This is contrary to what is normally done like the removal of other structures including vertebrae, dentary bones, opercular bones and cleithra. The otoliths and fins have to be properly examined before their age can be examined. In marine and freshwater fishes, calcified otoliths the common and most people prefer using them (Pannella 1974; DeVries and Frie 1996). However, the fish being studied has to be sacrificed. The ageing techniques have undergone significant transformation and advancements. In effect, the methods for reading age have changed from largely a single to multiple structure comparisons. This is often done with a view to determining the best possible approach to determining the age of the population or species (Zymonas and McMahon 2009; Howland et al. 2004; Khan et al. 2011; Buckmeier et al. 2012).

Ekingen and Polat (1987) reported that *Capoeta capoeta umbla*, which lives in Keban Dam reservoir, is the most suitable bony structure in the comparative age determination, followed by vertebrae, dorsal fin ray, operculum and scales.

Şen (1993), reported that the most clear age rings were found in otoliths in determining the best age determination methods in *Chondrostoma regium* (Heckel, 1843) and *Chalcalburnus mossulensis* (Heckel, 1843) species living in Keban Dam Lake.

Aydın (2000) stated that *Capoeta capoeta umbla* (Heckel, 1843), living in Lake Hazar, showed the clearest rings in otoliths in age determination in bony structures.

Ozturk et al., (2000), *Capoeta capoeta umbla* (Heckel, 1843) living in the Hazar Lake in the determination of the best read bony structures in the study of the otoliths and the most reliable bony structures are expressed in otoliths.

Aydın and Şen (2002) reported in *Capoeta capoeta umbla* (Heckel, 1843) living in the Hazar Lake that the clearest age rings between the right and left sides of the same bony structures were seen in otoliths.

Bostanci and Polat (2000), the age determination methods of *Solea lascaris* living in the Black Sea, have made the determination of all otolith-broken otoliths, and as a result of this study reported that they get reliable results from the otoliths broken throughout the center.

Yuce (2006), *Mystus halepensis* (Valanciennes, 1839) in the Keban Dam Lake, found the most clear age rings in the right otoliths in the comparative age determination from bony structures.

Polat et al. (1992) reported that age determination methods of *Capoeta tinca* (Heckel, 1843) living in Altınkaya Dam Lake are the most reliable bony formation vertebrae.

Polat and Işık (1995), in their study with the least error in the determination of age is the most appropriate bony formation is vertebral and it was reported that the flake followed by close reliability.

Gümüş (1998), in the age-verification study by the accumulation tracking method in the bony structures of the mirror carp, emphasized that the false rings on the vertebrate of the mirror carp were low, the ring character was very clear and clear and it was an extremely reliable structure in both validation and age determination studies.

It should be noted that reliable bony formation may change in populations of the same species living in habitats with different ecological characteristics. As a matter of fact, Bostancı (2005,) reported that the *Carassius auratus gibelio* subspecies were more reliable in the Bafra Fish Lakes population and otoliths in the Egirdir Lake population. For this reason, determining the bony formation from which age data required for fish biology studies should be taken should always be the first step (Yılmaz and Polat, 2008)

5. Conclusion

In the comparative age determination of *C. carassius* in Duhak River population, the vertebrate and otolith gave similar results, but it was difficult to see the rings in the center due to thickening of the otolith at very advanced ages, and the most reliable bony structures were vertebra, otolith, scales and operculum respectively.

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