

The Age Determination of Black Pomfret (*Parastromateus niger*), based on Otolith Cross Sections in Iranian Coast of Oman Sea

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Abstract

This study was conducted to determine the age of Black Pomfret (*Parastromateus niger*), based on otolith cross sections. The age of Black Pomfret was determined in the Oman Sea (Sistan and Baluchistan province), examining 94 specimens, in September 2012. From 94 otolith, 36 was sectioned and determined by age. The oldest specimen belonged to the female, with the total length of 56 cm, 6 years old and also the youngest specimen belonged to the female, with the total length of 21 cm, was estimated in 1 year. The smallest and largest specimens were 21 and 56 cm and 190 and 2161 g, respectively. The relationship between otolith size and the size and age of the fish showed that the otolith size has a strong and direct correlation with the age, total length and weight of the fish.

Keywords: Age determination; Black Pomfret; *Parastromateus niger*; Otolith; Oman sea

Introduction

Black Pomfret, *Parastromateus niger*, belongs to the Class Actinopterygii, Order Perciformes, family Carangidae and genus *Parastromateus* [1]. This species is the only known member of its genus. Its coloration is silvery grey to bluish brown and attains 55 cm. It's a pelagic species often occurring in large schools in 15-40 m, generally over muddy bottoms [2]. It is distributed from across the Persian Gulf and Oman Sea, tropical, subtropical and temperate seas of the world, Indian and Pacific oceans, China and the Malay archipelago [3] and is one of the most important species to local commercial fisheries.

The age composition of a fish stock is an important parameter used in stock assessment models in fisheries management [4]. Knowing the age of a fish provides a clue to its longevity, age at first maturity, age of recruitment, and growth. Therefore, ageing fish accurately is indispensable to the understanding of the dynamics of their stocks [5,6]. Changes in age structure of population or growth rates can be used to detect environmental changes and/or ecological conditions influencing the growth. Slow growth may indicate limited food resources, overpopulation, competition with another species, or unfavorable environmental conditions [7]. Age determination in bony fish can be carried out by counting seasonal growth annuli appearing on hard structures such as the otolith, scale, fin ray, and spine. Otolith is the most preferred of these structures [4,5].

Otoliths are structures located in the inner ear cavity of all fish and serve as a balance organ and also aid in hearing. Otoliths are composed mainly of calcium carbonate (CaCO₃) mostly in the form of aragonite. They have been used traditionally to obtain information about the taxon, age and size of fish. The size and shape also vary considerably among species [8]. Besides age and growth determination, otoliths have been the object of study in many different fields, such as fish biology (hearing and balance in fish), larval fish ecology, species identification, fish stock identification, growth parameters and migration and environmental reconstruction of the fish habitat [6,8]. From its first documented use in 1899, using fish otoliths as age structures has become ubiquitous [9]. Investigations of the time-keeping properties of fish otoliths have indicated that age is explained principally in term of otolith weight and fish length [10]. On the other hand, otolith size is highly correlated with fish size since they are both controlled by the same metabolic

process [11]. Theoretically, a pair of annual rings is formed every year, an opaque summer ring and a hyaline winter ring. The opaque ring is formed during the growth season and is broader than the hyaline ring, which is formed during the winter period, where the growth slowdown. The age of the fish is usually determined by counting the hyaline rings [12]. Any major change in the environment in which a fish lives is likely to produce a ring. In the earth's temperate zones differences between summer and winter are marked by both changes in water temperatures and amounts of food available. Also some when daily increments of growth have been detected on fish otoliths [8].

The aim of this study is to examine the relationship between otolith length, width and weight and fish length and age in samples of *P. niger* collected from the commercial catch landed from the Oman and tests the hypothesis that this strictly objective measurement can be used to determine age of this fish. This research was the first study of these relationships for *P. niger* from Oman sea.

Material and Methods

94 specimens were collected through commercial fisheries and fisheries research area of Oman waters in September 2012 in Sistan and Baluchistan province (Figure 1). The fish were measured (total length, centimeter) and weighed (total weight, gram) and the sex were identified with direct observation of gonads after dissection. From each fish, sagittal otolith were removed. Of 94 otolith, 36 was cleaned, dried, weighed to nearest 0.1 mg and then stored dry in labelled envelopes.

Biometric characters include length, height and area of otolith that was determined from whole otolith against black background, using reflected light, viewed and photographed with a low power stereo-

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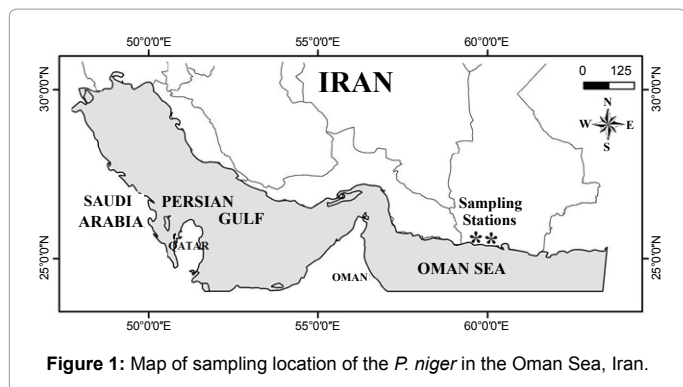


Figure 1: Map of sampling location of the *P. niger* in the Oman Sea, Iran.

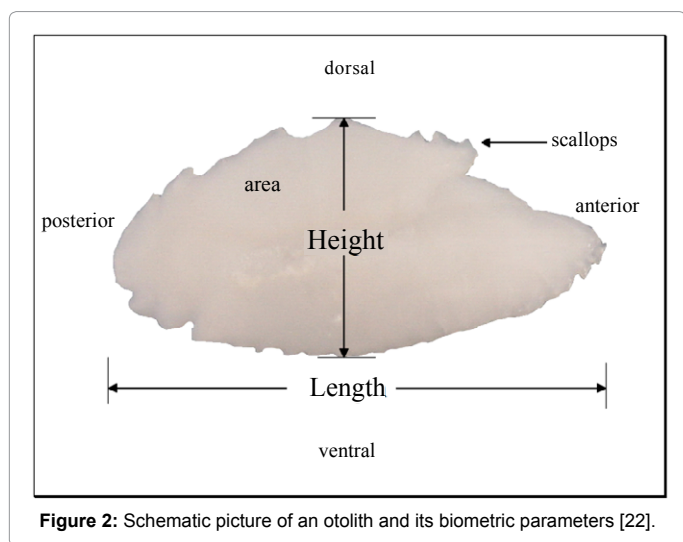


Figure 2: Schematic picture of an otolith and its biometric parameters [22].

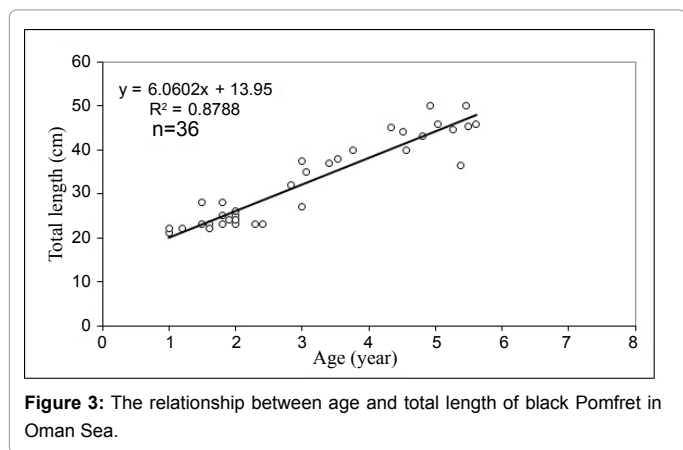


Figure 3: The relationship between age and total length of black Pomfret in Oman Sea.

microscope with EZ40 camera (Figure 2).

The otoliths embedded in highly transparent resin and transversely sectioned through the nucleus, using a low-speed rotating precision saw (60 rpm). The section thus obtained, about 400 μm thick, is glued onto a glass slide by thermoplastic cement, ground and polished [13,14]. Then sections were photographed with stereomicroscope at 10x magnification under reflected light. Viewed thus, the hyaline (winter) zones appear as narrow dark bands and the opaque (summer growth) zones as broader milky zones. The age was estimated as the

number of hyaline zones. The minimum number of readers is accepted as 5 persons.

Images of cross sections were analyzed using Adobe Photoshop CS6 and SPSS (version 21) and Microsoft Excel software package was used to analyze the data (frequency distribution of length, weight and age) and to examine the relationship between otolith and fish parameters and age (linear regression).

Results

Frequency distribution of length, weight and age

Of 94 specimens of *P. niger*, 57 specimens were females, 35 specimens were males and two species were not detectable. Table 1 shows the frequency, mean, minimum, maximum and range of total length, fish weight and age.

The relationship between age and total length

There is a linear equation in the form of $y=6.0602x+13.95$ and correlation is ($R^2=0.8788$) in relationship between age–total length (male and female), so there is a strong and direct relationship between these two traits (Figure 3).

The relationship between age and total weight

There is a linear equation in the form of $y=424.99x+548.21$ and correlation is ($R^2=0.9085$) in relationship between age–total weight (male and female), so there is a strong and direct relationship between these two traits (Figure 4).

The relationship between age and otolith length

There is a linear equation in the form of $y=0.7469x+4.8111$ and correlation is ($R^2=0.8384$) in relationship between age–otolith length, so there is a strong and direct relationship between these two traits (Figure 5).

Character	Frequency	Minimum	Maximum	mean	Variance	Standard deviation
Total length (cm)	94	21	56	30.59	115.79	10.76
Weight (g)	94	190	2161	611.97	330058.49	574.50
Age (year)	94	1	6	3	2.17	1.47

Table 1: Frequency distribution of length, weight and age of black Pomfret in Oman Sea-2012.

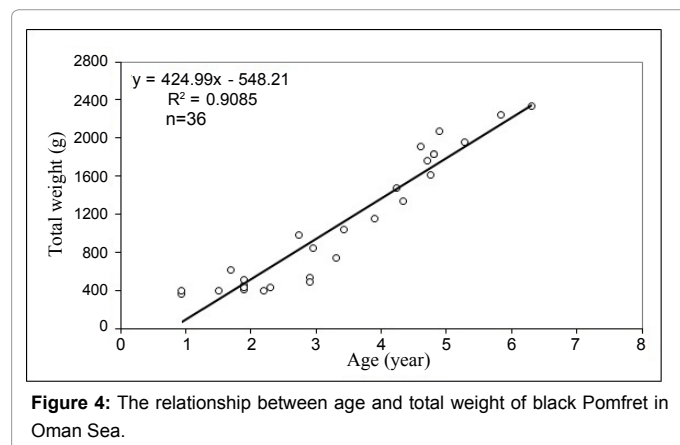


Figure 4: The relationship between age and total weight of black Pomfret in Oman Sea.

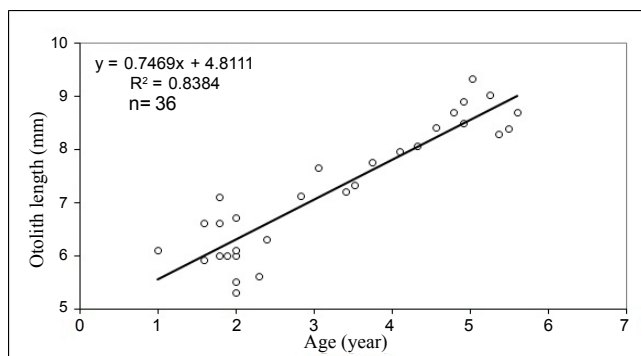


Figure 5: The relationship between age and otolith length of black Pomfret in Oman Sea.

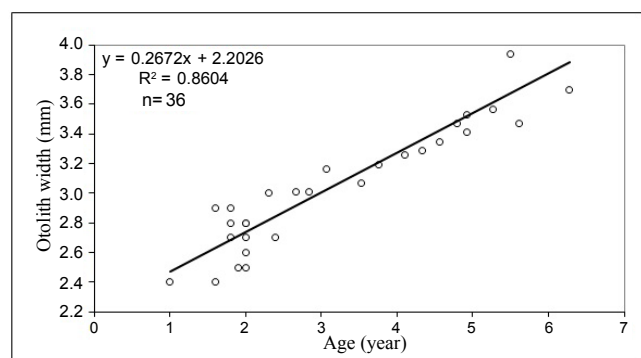


Figure 6: The relationship between age and otolith width of black Pomfret in Oman Sea.

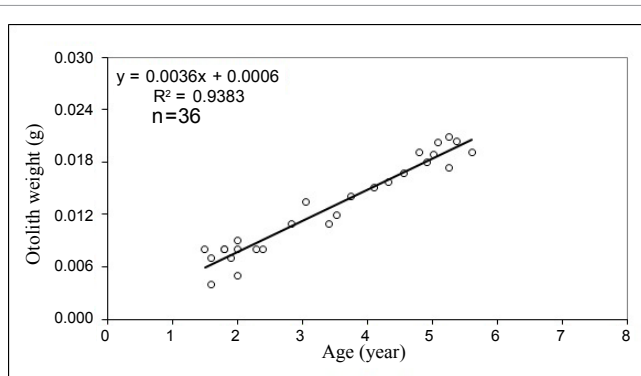


Figure 7: The relationship between age and otolith weight of black Pomfret in Oman Sea.

The relationship between age and otolith width

There is a linear equation in the form of $y=0.2672x + 2.2026$ and correlation is ($R^2=0.8604$) in relationship between age–otolith width, so there is a strong and direct relationship between these two traits (Figure 6).

The relationship between age and otolith weight

There is a linear equation in the form of $y=0.0036x+0.0006$ and correlation is ($R^2=0.9383$) in relationship between age–otolith weight, so there is a strong and direct relationship between these two traits (Figure 7).

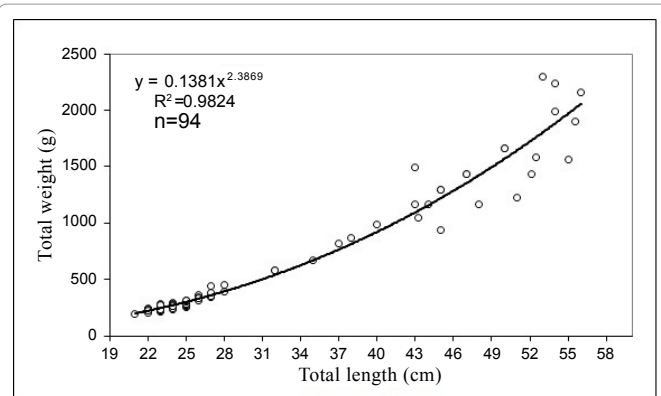


Figure 8: The relationship between total length and total weight of black Pomfret in Oman Sea.

The relationship between total length and total weight

There is an exponential equation in the form of $y=0.1381x^{2.3869}$ and correlation is ($R^2=0.9824$) in relationship between total length and total weight and $b=2.3869$, that showed negative allometric growth (Figure 8).

Discussion

Daily increment technology has been widely applied in fish ecology and fisheries science. Otolith analyses should play an important role in the investigation and protection of the wild resource and fisheries management in the future [15]. According to studies that showed morphological characteristics of somatic growth of the fish otolith increases with age, this variables will increase parameters connection of length, and weight of otolith significantly (positive correlation). With increasing of age of Black Pomfret showed that the highest amount of the correlation is in relation between the otolith weight and its age ($R^2=0.9383$). It is well known that there is often a high degree of correlation between body length and the sizes and weights of the otoliths in fish [16]. The results showed on Black Pomfret that the otolith length has a significant linear relationship with fish length ($R^2=0.8607$). This logarithmic regression with positive correlation ($R^2>0.9$) also obtained only to four species of salmon by Casteel [17], respectively. In various studies explained that the relation between the length of otolith and the length of fish there are a significant linear regression and positive correlation ($R^2>0.8$) in such include steelhead trout, *Salmo gairdneri*, [18] and also in species of northern anchovy, *Engraulis mordax*, have been observed [19].

The ratio also between length of fish and the length of otolith was estimated from 15 species of rock fish, *Sebastes* spp. studied by Echeverria [16] that linear correlation was significant ($R^2>0.92$), but 13 species of rock fish indicated significant correlation ($R^2>0.8$), and in two of them calculated nearly significant correlation ($R^2 \geq 0.61$). Hunt [20] investigated that weight of otolith as the best indicator to determine the age and length of the fish and also the most easily measured parameter to be determined, that our results also confirm it. Thus correlation between fish size and the size of the otolith (ear stones) resulted that the length, width, and weight, are standard indicators for the growth measurement. Also this research studies showed in food habits and food chain of predators (marine mammals, Sea birds, fish and other predators), in order to determine the size of fish that are usually hunting according to length, width or weight of otolith achieved useful [21]. Black pomfret is one of the most important fish species with high commercial value that catch throughout the

Iranian coastal strip of Oman Sea. Due to the economic importance of this species and the lack of enough information of its population and operational status, this study was essential for correct management, for sustainable exploitation of its resources. Also this suggests that otolith could be used in research on wild populations of other species for age determinations, birth date back-calculations, growth rate estimates in the early life history stages, population discrimination, spawning location investigation, etc in this area [22].

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