

## Note

# Otolith morphology and body size relationships of *Nemipterus japonicus* (Bloch, 1791) in the northern Oman Sea

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## ABSTRACT

Otolith morphology of the Japanese threadfin bream, *Nemipterus japonicus* (Family Nemipteridae) and its relationships to fish size was examined. Samples were collected from Chabahar area (the northern Oman Sea). Otolith descriptions were based on its outline, including otolith length (OL, mm), height (OH, mm), weight (OW, g) as well as perimeter (OP, mm), and sulcus acusticus features. Paired t-test showed no significant difference between left and right otolith dimensions. Regression models relating each otolith morphometric parameters to fish length and weight revealed the best one between otolith weight with fork length, body weight and otolith perimeter.

Keywords: *Nemipterus japonicus*, Oman Sea, Otolith morphology, Otolith morphometry

## Introduction

The Japanese threadfin bream, *Nemipterus japonicus* is a demersal species abundantly found in coastal waters of a wide geographical distribution (Russell, 1993; Golani and Sonin, 2006). Despite the increasing commercial importance of *N. japonicus* in Iran (Valinassab *et al.*, 2006), information on its biology is limited, particularly in Chabahar area where the main catch is landed.

Otolith studies form an important aspect in fish biology research. In most groups of teleost fishes, otolith comprises three pairs of mineralised structures in the inner ear, the largest of which is the saccular otolith (sagitta) (Nolf, 1985; Assis, 2005). Otolith shapes are shown to be species-specific (Hecht and Appelbaum, 1982; Gaemers, 1984) and also population-specific (Messieh, 1972; McKern *et al.*, 1974; Neilson *et al.*, 1985). For this reason, otoliths are widely used in the systematics (Akkiran, 1984). It is also possible to identify fish species through otolith analysis of the stomach contents of the predators. Studies on the otoliths in *N. japonicus* are limited (Hou *et al.*, 2012; Afshari *et al.*, 2013). The main objective of the present study was to provide new information regarding the saccular otolith morphology and its relationship to the body size in *N. japonicus* in the northern Oman Sea.

Fish samples were collected from the northern Oman Sea by fishing vessels equipped with bottom trawls (mesh size 80 mm in cod end) (Fig. 1), from September 2009 to May 2010.

Fish (*N. japonicus*) was identified following keys provided in Smith and Heemstra (1986). One hundred and fifty (150) individuals were randomly selected for

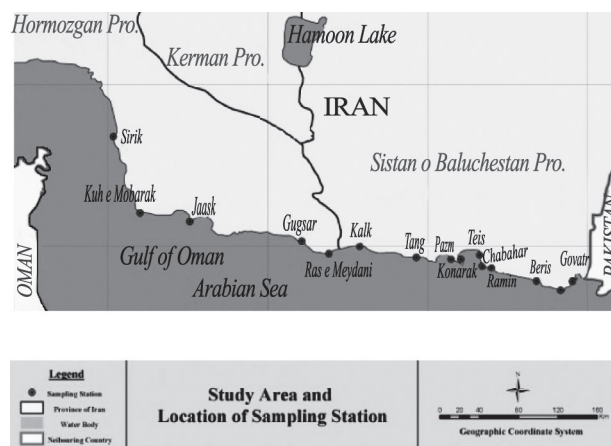


Fig. 1. Study area restricted to the northern Oman Sea (Iranian waters)

this work and their fork length (FL) and body weight were measured to the nearest 1 mm and 0.01 g, respectively. Sagittae (left and right) were removed by a cut through the cranium to expose them for removal with forceps, washed in distilled water and dried with towel and then cleaned from organic residues by incubation in 70% glycerin for 12 h and subsequent washing in distilled water, and stored dry in vials (Lewis and Mackie, 2002).

For analysing the of otolith with respect to size, the 150 fish of different sizes were grouped in to 3 categories based on fork length (Biswas, 1993): (I) 145 to 183 mm (n=32), (II) 183 to 221 mm (n=43), and (III) > 221 mm (n=75). In each group, the following characteristics were studied: shape, thickness, margins, scallops, rostrum, antirostrum, sulcus acusticus, ostium, cauda, collum, crista, excisura, postrostrum and pararostrum (Furlani *et al.*, 2007; Tuset *et al.*, 2008). For the examination of otolith morphometry and morphology, pictures of the right and left sagittae were taken with a digital camera under a stereo microscope model EZ40 at 8x magnification. The image of the internal side (medial or proximal) of the otolith was taken as this side presents the sulcus acusticus. To obtain a good image of the sagitta contour, it was contrasted with a homogeneous black background. The sagitta length (OL), height (OH) and perimeter (OP) were measured to the nearest 0.01 mm using Image Tool 3 software, and otolith weight (OW) was recorded with a precision of 0.001 g. The relationships of these parameters with the fish length (FL) and body weight (W) as well as otolith perimeter (OP) were built using regression models which fit best the data distribution. Differences between right and left sagittae were tested using a paired t-test (SPSS version 17.0). Otolith scallops of 130 individuals were also counted on the distal side.

No differences in the otolith morphology of the three fish size groups were observed. The morphological specifications were: Shape - rhomboidal, thick, crenate margins. Sulcus acusticus - heterosulcoid, ostial, median. Ostium - funnel-like, shorter than the cauda. Cauda - tubular, strongly curved, ending far from the posterior margin. Rostrum - rather long, broad, slightly peaked. Antirostrum - absent or very short, slightly

pointed; Collum - recognisable. Crista - well defined; Excisura - moderately wide with an acute, shallow notch, Postrostrum and Pararostrum - absent (Fig. 2). The proportions of otolith length to fork length and otolith height to otolith length were also determined to be 4.2 and 58.8, respectively.

The length and weight frequency distributions indicated that samples were in the range of 145-258 mm FL at body weights of 55.31-288.12 g.

The paired t-test did not show significant differences in morphological parameters between the left and right otoliths, therefore the left otolith of each pair was used in the measurements and illustration. The mean values of the morphometric characteristics of otoliths are shown in Table 1.

Linear regression model for the analysis of otolith length and height with FL and otolith perimeter showed more than 65% of the variance in the species. However, the relationship between otolith weight with FL and OP was exponential and explained more than 85% of the variance (Table 2, Fig. 3). The relationship of OL and OH with fish weight, described by the exponential regression model, showed more than 60% of the variance, whereas relationship of OW with fish weight was linear and explained more than 80% of the variance (Table 2, Fig. 3).

Otolith morphology varies between two species or may also differ between populations of a single species (Hopkins, 1986; Reichenbacher *et al.*, 2007). For the very same reasons, otolith morphology has been frequently used in species identification and even in some cases to separate the stocks (Stransky, 2001; Reichenbacher *et al.*, 2007).

Table 1. Morphometric characteristics of otolith in *N. japonicus*

N = 150	OL (mm)	OH (mm)	OP (mm)	OW (g)
Mean	8.9	5.2	21.7	0.07
Min.	5.9	3.8	15.6	0.03
Max.	11.5	6.7	26.7	0.13
Std.	1.44	0.75	3.1	0.04

OL : otolith length, OH : otolith height; OP : otolith perimeter; OW : otolith weight

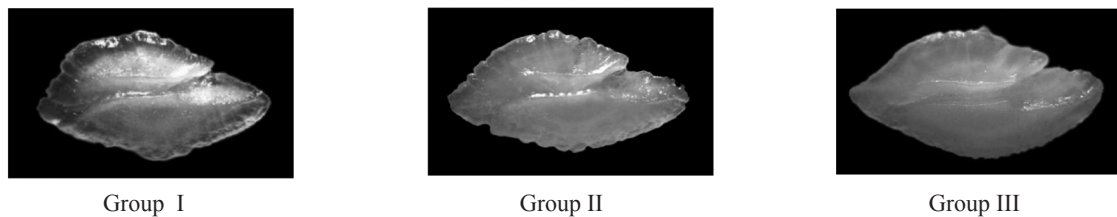


Fig. 2 .Otolith morphology in *N. japonicus* of different size groups ( X8)

Table 2. Relationships of otolith morphometric parameters (length, OL; height, OH; weight, OW) with fork length (FL), fish weight (W) and otolith perimeter (OP)

N = 150		FL	Weight	Perimeter
OL	Vs.	$OL = 0.0395FL + 0.4635$	$OL = 1.575W^{0.2251}$	$OL = 0.4326OP - 0.5621$
	R <sup>2</sup>	0.724	0.672	0.861
OH	Vs.	$OH = 0.0197 FL + 1. -0229$	$OH = 1.2124 W^{0.2332}$	$OH = 0.2212OP + 0.3977$
	R <sup>2</sup>	0.654	0.618	0.8218
OW	Vs.	$OW = 0.0000002FL^{2.356}$	$O.W = 0.0004W + 0.0058$	$OW = 0.00002OP^{2.57416}$
	R <sup>2</sup>	0.851	0.813	0.892

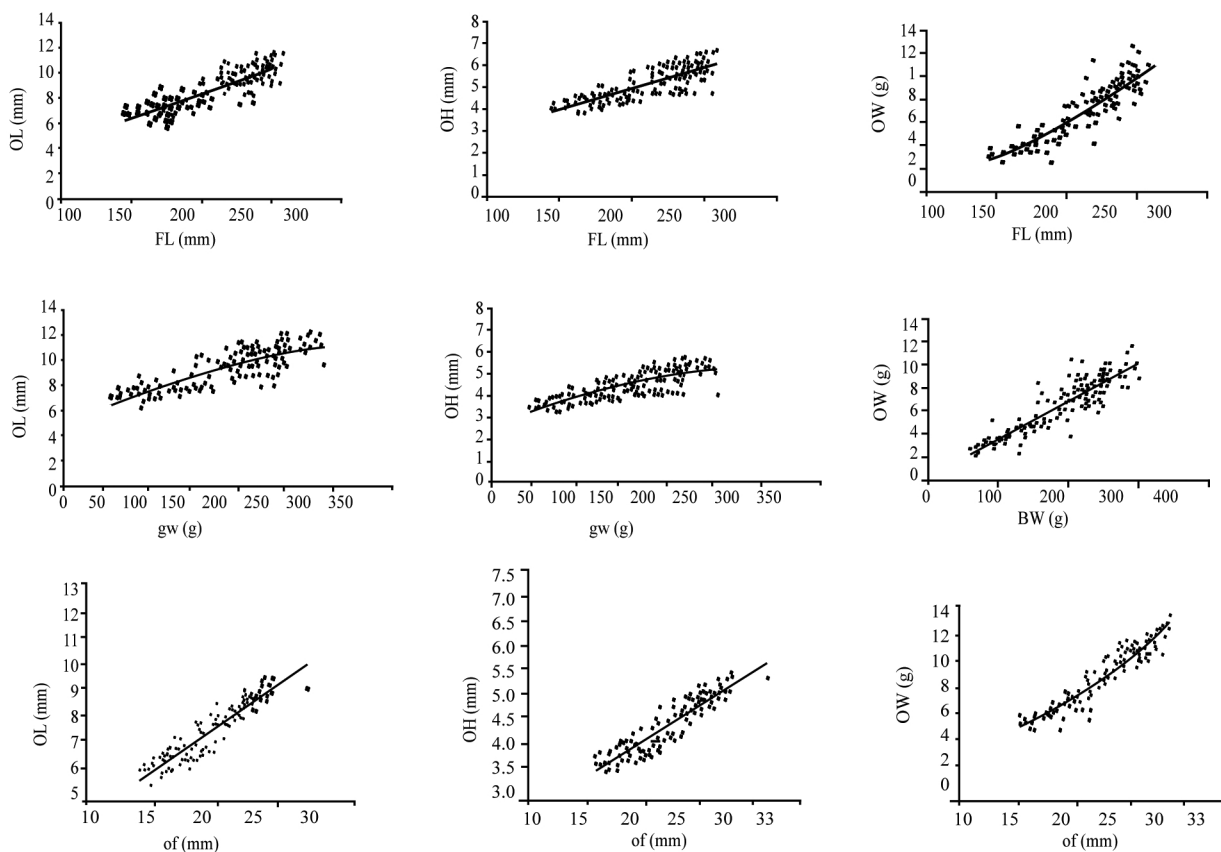


Fig. 3. Relationships of otolith length (OL), height (OH) and weight (OW) with fork length (FL), fish weight (W), and otolith perimeter in *N. japonicus* from the northern Oman Sea

In this study, no difference in the otolith morphology was found among the individuals of *N. japonicus*.

Although several special guides and identification keys for sagitta otolith of various fish species in different regions have been published (Morrow, 1979; Harkonen, 1986; Hecht, 1987; Smale *et al.*, 1995; Furlani *et al.*, 2007; Tuset *et al.*, 2008), it is believed that only certain geographical areas are covered and the access to reference materials is limited (Santos *et al.*, 2001). However, all of them concluded that most species could be detected based on specific morphological characteristics of sagitta otolith.

With respect to differentiating between the left and right otoliths, *N. japonicus* did not show significant difference in sizes between left and right sagittae. This observation is in agreement with Hunt (1992), Battaglia *et al.* (2010) and Jawad *et al.* (2011), while in contrast with the findings of Harvey *et al.* (2000) as well as Waessle *et al.* (2003).

Previous studies usually focused on the relationship between fish size and only one sagitta size (Wyllie, 1987; Gamboa, 1991; Granadeiro and Silva, 2000; Harvey *et al.*, 2000; Waessle *et al.*, 2003; Battaglia *et al.*, 2010).

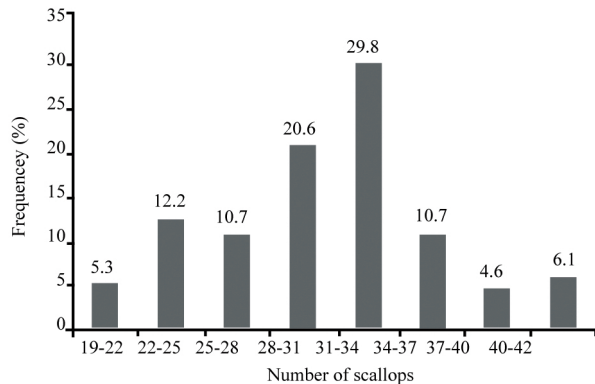


Fig. 4. The frequency (%) of scallops in *N. japonicus*' left otolith

This paper supplies additional information by considering the otolith length (OL), height (OH), weight (OW) and perimeter (OP). It is more reliable to use more than one equation (Table 2) since the tip of the otolith rostrum or the dorsal or ventral edges of the otolith may be damaged, making it impossible to measure the OL or OW.

Generally, length of fishes is linearly related to otolith length. Predicting the size of fishes can be accomplished with fair reliability on the basis of otolith length. This relationship, however, is not always applicable. Otolith length typically is linearly related to length of the fish until the fish reaches maximum size; thereafter, the otolith increases only in thickness (Blacker, 1974; Williams and Bedford, 1974). The results of this study showed that a linear relationship ( $R^2 = 0.724$ ) existed between sagitta and the fish lengths. Mckern *et al.* (1974), Spratt (1975), Brown and Mate (1983) and Wyllie (1987) developed linear models to describe the same relationship in other species of fishes.

Between body weight and otolith weight in *N. japonicus* a linear relationship ( $R^2 = 0.813$ ) was observed. Many researchers have proved significant linear correlation between fish weight and otolith weight (Beamish and Mahnken, 2001; Mossegaard and Reeves, 2001; Newman, 2002; Al-Dubakel and Abdullah, 2006). Hunt (1992) identified weight of sagitta otolith as the best indicator for estimating fish length and also it is the easiest parameter to measure.

All equations relating otolith variables to fish fork length, fish weight and otolith perimeter for *N. japonicus* specimens explained a relatively large proportion of the variance in the data (Table 2). Analysing the morphometric relationships, we conclude that otolith weight is a good indicator of fish fork length, fish weight and otolith perimeter (Table 2, Fig. 3). If otolith length is used to

estimate length and weight of fish and otolith perimeter, the regression explains more than 67% of data variation in this species. If otolith weight is used, the regression explains more than 81% of the variation in *N. japonicus*. The findings of the present study might also be used by researchers studying the food habits of top predators to determine the size and weight of fish-prey from length, height and or weight of the otoliths recovered from the gut contents.

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