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FLUCTUATIG ASYMMETRY IN THE OTOLITH OF THE MUGILID FISH *LIZA KLUZINGERI* (DAY, 1888) FROM PERSIAN GULF NEAR BANDAR ABBAS

SUMMARY

Fluctuating asymmetry was calculated for the otolith length, width, and thickness in the adult fish *Liza klunzingeri*. The results showed that the level of asymmetry of the otolith width was the highest among the three asymmetry values obtained. The asymmetry value was zero for the otolith thickness. The results also showed that the lowest level of asymmetry in the otolith length was at the fish length ranging between 14.1-15.0 mm, and the higest at the fish length 17.1-18.0 mm, while asymmetry was zero at fish length 12.1-13.0. For the otolith width, the lowest level of asymmetry is at the fish length ranging between 13.1-14.0 mm and the highest at the fish length ranging between 17.1-18.0 mm while the value of asymmetry was zero in the fish length ranging from 12.1-13.0 mm. The possible cause of the asymmetry in this species has been discussed in relation to the general presence of pollutants in the area. An increasing asymmetry with the fish length (age) was noticed.

INTRODUCTION

The differential development of a bilateral character between the sides of an organism is known as asymmetry (Van Vallen, 1962; Palmer and Strobeck, 1986; Leary and Allendroff, 1989). Fluctuating asymmetry which is a random deviation from perfect bilateral system can reflect developmental instability (Palmer, 1994; Fey and Hare, 2008), which is the inability of an organism

to compensate for disturbances during development (Zakharov, 1992), and can be affected by stress related to environmental or genetic conditions. As a consequence, high fluctuating asymmetry could indicate the worst condition of larvae that experience unfavourable environments. Thus, the bilateral asymmetry measure could show an environmental effect on the condition of the organism.

The relationship between fish condition and fluctuating asymmetry has been studied for adult fishes, and a number of measurements have been proposed, including the number of gill arks, pectoral fin rays, fish body proportions, eye spot area, or otolith size and shape (Al-Hassan *et al.,* 1990; Al-Hassan and Hassan,1994; Escós *et al.,*1995; Somarakis *et al.,* 1997a; b; Jawad, 2001; 2003; 2004; Øxnevad *et al.,* 2002; Gonçalves *et al.,* 2002;).

Recently, the consequences for a fish to have asymetrical otoliths have been reviewed and determined by Gagliano *et al*. (2007) and Gagliano and McCormick (2009). Such consequences affect survival of young individuals because obstacle them in finding proper places for settlement.

As fluctuating asymmetry studies were never performed on the otolith dimensions of the species in question or on that of the same species from other localities in Iranian waters the present study represents the first study on fish otolith asymmetry of the Iranian waters.

The present work studied fluctuating asymmetry in the otolith length, width, and thickness of the fish *Liza klunzingeri* collected from Persian Gulf near Bandar Abbas.

The present study should like to add material in the detection of suitable settlement habitats by the larvae of *Liza klunzingeri*.

MATERIALS AND METHODS

Description of sampling area

Bandar Abbas city, capital of Hormozgan province, Iran, lies between 56 15E 26 58N. Its port is one of the most important commercial and fishing ports of Iran, and it is located in the middle of the Strait of Hormoz linking the Persian Gulf to the Sea of Oman, 1,501 km from Tehran and 500km to the south of Kerman.

The climate in Bandar Abbas is usually hot and humid during summer and moderate in winter. Maximum temperature in summers can reach up to 49 °C while in winters the minimum temperature drops to about 5 °C. The annual rainfall is around 251 mm and the relative humidity is 66%.

The sea currents, as in the other part of the Persian Gulf, move anticlockwise. Annual average surface temperature of water is 26.5°C. Fluctuations in temperature at nearshore areas is highest and exceed 20°C (16-36°C) than

that at open Gulf areas (17-34°C). Salinity varies between 36.5-37 ppt. The dense saline water of the western Gulf (now 40 ppt) sinks towards the trough along the Iranian coast and is returned southward in greater depths. It exits the Persian Gulf via the Strait of Hormuz as a deep water current, providing the driving forse for the renewal of the Gulf water. *Liza klunzingeri* fish individuals live between 10 and 20 m below the sea level. The species is common in most parts of the Persian Gulf and distributes in estuaries, creeks and comes near shore with high tide.

Sample collection

Fish specimens (250) of *Liza klunzingeri* were collected using purse sien net from only one location on 03 July 2007 (Fig. 1). Otolith length, width and thickness were used to study the asymmetry level in the fish species. In the present study, fluctuating asymmetry was not correlated with sex because larvae are not recognizable sex wise and asymmetries develop in the early stages of the fish life and any compensational growth during the larval stage cannot correct it. This is because such anomalies persist and became a load on the individual further in its life.

Bandar Abas locality was chosen as it represents the main fishing ground for the species in question and asymmetry study for *L. kluzingeri* is important to the effect of this phenomenon on the settlement of the larvae of this species in this important fishing ground.

Statistical analyses

The statistical analysis was based on the squared coefficient of asymmetry variation (CV^2_a) for the three otolith dimensions according to Valetine *et al.*(1973):

$$CV^2_a = (S_{r\text{-}l} \text{ X } 100/X_{r+l})^2$$

Where $S_{r\text{-}l}$ is the standard deviation of signed differences and X_{r+l} is the mean of the character, which is calculated by adding the absolute scores for both sides and dividing by the sample size.

RESULTS

The results of asymmetry data analysis of the otolith length, width, and thickness of *Liza klunzingeri* collected from waters of Badar Abbas, Persian Gulf, are shown in Table 1. The results showed that the level of asymmetry of the otolith width was the highest among the three asymmetry values obtained. There was no asymmetry in regard with the otolith thickness. For the three otolith characters studied in the present work, the results showed that asym-

metry was correlated with fish length (Table 2) showing its lowest and highest values in fish ranging in length between 14.1-15.0 mm and 17.1-18.00 mm respectively. The asymmetry value was zero in fish ranging 12.1-13.0 mm for the three otolith characters studied.

The percentage of the individuals showing asymmetry in the otolith width character was the highest among the percentages obtained for the three otolith characters (Table 1).

Table 1. Squared coefficient of asymmetry (CV^2_a) valueand character means (X_{r+l}) of *Liza klunzingeri*

Character	CV^2_a	N	Character mean	% of individuals with asymmetry
Otolith length	4.226	30	5.70	50
Otolith width	14.056	30	2.62	56.67
Otolith thickness	0.000	30	0.74	0

Table 2. Squared coefficient of asymmetry and character means by size of *Liza klunzingeri*

Character	**CV^2_a**	**N**	**character mean X_{r+l}**	**% of individuals with asymmetry**
Otolith length				
12.1-13.0	0	1	4.60	100
13.1-14.0	0	2	5.57	0
14.1-15.0	1.051	8	5.58	25
15.1-16.0	5.951	15	5.70	60
16.1-17.0	7.987	2	6.03	100
17.1-18.0	8.367	2	6.50	50
Total		30		
Otolith width				
12.1-13.0	0	1	2.14	0
13.1-14.0	1.052	2	2.44	50
14.1-15.0	5.525	8	2.63	25
15.1-16.0	21.033	15	2.61	46.67
16.1-17.0	26.660	2	2.70	100
17.1-18.0	28.987	2	3.04	0
Total		30		
Otolith thickness				
12.1-13.0	0	1	0.50	0
13.1-14.0	0	2	0.70	0
14.1-15.0	0	8	0.73	0
15.1-16.0	0	15	0.73	0
16.1-17.0	0	2	0.75	0
17.1-18.0	0	2	1.05	0
Total		30		

DISCUSSION

In vast number of animal *taxa* asymmetry in morphological characters is usually negatively correlated with the animal fitness (e.g. Møller and Nielsen, 1997; Martin and Lopez, 2001; Bergstrom and Reimchen, 2003). The studies on the possible effect of asymmetry on dispersal and recruitment of individuals are lacking (Matesi, 1997; Breuker *et al*., 2007).

In fishes, abnormal swimming activity (Helling *et al*., 2003) and interference with correct sound localization resulting in inability of individuals to integrate with the habitat they are living in (Lychakov and Rebane, 2005), are consequences results of the bilateral asymmetry in otolith mass.

The variations in the dimensions of the otolith of *Liza klunzingeri*, can affect the capability of the young individuals to locate and settle down in their suitable habitats (Gagliano and McCormick, 2004; Gagliano *et al*., 2008). Due to the asymmetry observed, settlement of larvae might be affected. Since the species in question is among the commercial species in Iran, such studies are considered relevant to the ecology of the species in order to assess its stock in the area.

For the variation in the asymmetry values obtained among the three morphological characters of the otolith of *Liza klunzingeri*, it is impossible to evaluate the level of asymmetry of those characters and to determine if they are higher or lower than the average due to the lack of data regarding otolith asymmetry in this part of the world.

Due to unavailable data on the correlation between different environmental pollutions and the morphology of the fish species in question to evaluate asymmetry along a pollution gradient, or from fish taken from impacted vs control (non impacted) sites, it is not possible at this stage to have precise indication on the significance of this phenomenon. However, based on previous studies in this field, it is possible to suggest a correlation between environmental stress due to pollution and asymmetry in the morphology of this species. Such environmental factors are present in the Persian Gulf waters in general and the Iranian coasts of the Persian Gulf in particular (Fowler, 1993; Zahed, 2002; Pourebrahim and Yavari, 2003; Vossoughi *et al.,* 2005; Haapkylä *et al.,* 2007; Zahed *et al.,* 2010).

The environmental causes might be natural events, and several factors are known to produce nutritional deficiencies such as various pathogens and various population phenomena (Bengtsson and Hindberg, 1985), and it is highly possible that these factors may be in action in Oman Sea as they seem to be common in the aquatic environment.

Several authors have shown a relationship between the coefficient of asymmetry and fish length (Al Hassan *et al.,* 1990; Al Hassan and Hassan, 1994; Al Hassan and Shwafi, 1997; Jawad, 2001) where there was a trend of

increase in the asymmetry value with the increase in fish length. The otolith morphological characters studied were identical and gave zero value for the asymmetry coefficient in several length groups studied. The results also show a trend of increase of otolith length and width asymmetry value with fish length.

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