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ASYMMETRY OF SOME MORPHOLOGICAL CHARACTERS OF *UPENEUS DORIAE* (OSTEICHTHYES: MULLIDAE) COLLECTED FROM THE SEA OF OMAN

SUMMARY

Asymmetry analysis have been carried out for five bilateral characters of *Upeneus doriae* (Günther, 1869) (Osteichthyes: Mullidae) collected from a coastal area near Muscat City in the Middle region of the Sea of Oman. The results showed that the level of asymmetry of the preorbital length is higher than those of the other characters studied. The number of pelvic fin rays showed the lowest asymmetry value. The possible cause of the asymmetry in this species has been discussed in relation to different pollutants and their presence in the area. A trend of increase in the asymmetry values with the fish length was noticed in the pre- and post-orbital lengths and head length.

INTRODUCTION

The differential development of a bilateral character between the sides of an organism is known as asymmetry (VAN VALEEN, 1962; LEARY and ALLENDROF, 1989).

Fluctuating asymmetry results when a trait present on both sides of the body does not undergo identical development. It is also known that fluctuating asymmetry represents a measure of developmental sensitivity to environmental stress (MØLLER and POMIANKOWSKI, 1993; JAWAD, 2001; 2003; 2004). Asymmetry usually increases under environmental stresses due to the failure of the homeostatic regulatory mechanism. These developmental effects might occur before the concentration of toxicants in the water or food reaches levels high enough to produce morbidity (BENGTSON and HINDBERG, 1985).

Fluctuating asymmetry studies were never performed on the species in

question, but there are few studies on record about other fish species in Oman waters (JAWAD *et al.*, 2010; AL-MAMRY *et al.*, 2011a; 2011b). Therefore, the present study is considered an addition to what previously published on morphological asymmetry in Oman fishes.

The present work studied the bilateral asymmetry phenomenon in selected morphological characters of the mullid species, *Upeneus doriae* collected from Muscat City in the Middle region of the Sea of Oman and designed to determine: (1) whether bilateral asymmetry occurs in the chosen characters; (2) the extent of asymmetries; (3) the direction of the asymmetrical development, as shown by one side tending to have a larger number of elements.

MATERIAL AND METHODS

Study site

The Sultanate of Oman lies on the coasts of two seas, the Sea of Oman and The Arabian Sea. This country has an extensive coastline of 3,165 km, which includes the Sea of Oman in the North and the Arabian Sea in the South. Muscat is located in N-E Oman, at 24°00'N and 57°00'E with the Sea of Oman at the N and W periphery of the city.

The marine area in the vicinity of Muscat City is characterized with in-shore islands, rocky stacks and mangrove forests. In addition, the coasts can be of several types, delta, raised gravel terraces, coastal cliffs and sandy (THANGARAJA, 1995). The hydrological factors such as water temperature, salinity and pH values showed variation in water column. THANGARAJA (1995) reported the annual range 36.8 – 38.5‰ for salinity and 7.7 – 8.9 for pH. Recently, AL-SHAQSI *et al.* (2007) gave different values for the above mentioned factors (23.13 – 26.69 °C, 18.04 – 32.74 °C, 35.32 – 41.46 ‰ and 7.03 - 8.98 respectively).

Sampling methods and sample analysis

On March 2011, 49 specimens of *Upeneus doriae* ranging in size between 130-160 mm were collected from Muscat City in the Middle region of the Sea of Oman using seine net. They were caught in a coastal area of 30 m depth with sand-rocky bottom. They were grouped into length classes of 10 mm.

The five bilateral characters used to compare asymmetry were: (1) Length of the pre-orbital distance (mm): measured from the anterior tip of the mouth to the anterior edge of the eye (2) Length of the post-orbital distance (mm): measured from the posterior edge of the eye to the posterior edge of the operculum (3) Eye diameter (mm): measured from the anterior to the posterior edges of the eye (4) Head length (mm): measured from the anterior tip

of the mouth to the posterior edge of operculum (5) Number of pectoral fin rays (a meristic character): a count of the total number of pectoral fin rays, including the uppermost ray. Most characters were counted and measured under a binocular dissecting microscope. For specimens too large to fit under a microscope, a magnifying glass was used.

These characters are the most vulnerable to any changes in the environment (BENGTSON and HINDBERG, 1985), and they are comparatively easy to evaluate.

Statistical analysis

The statistical analysis included calculating the squared coefficient of asymmetry variation (CV_a^2) for characters according to VALENTINE *et al.* (1973):

$$CV_a^2 = \frac{s_{r-l} \cdot 100}{\bar{x}_{r+l}}$$

Where s_{r-l} is the standard deviation of signed differences and \bar{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, in the case of meristic characters. When dealing with morphometric characters, to obviate scaling problems associated with growth, each measurement must be divided by a suitable general size measurement; in the present case head length was used as the standardizing measurement. Each of the morphometric characters was treated as such before obtaining the signed differences.

RESULTS

The results of asymmetry data analysis of the listed characters of *Upeneus doriae* are shown in Table 1. The highest value was recorded for the preorbital length and the lowest value for the number of pectoral fin rays while the eye diameter showed no asymmetry.

The percentage of the individuals showing asymmetry in the preorbital length character was the highest among the percentages recorded for the five characters (35.07% of the total fish studied, 49 specimens) and the lowest percentage was for the individuals with asymmetry in number of pectoral fin rays (15.32% of the total fish studied).

The result of the asymmetry direction as whether individuals are left side or right side have shown that all the characters studied are left side, the left side showing higher values than the right side, except for pectoral fin rays where the species showed to be dextral. Of specimens exhibiting pectoral fin ray asymmetry, 78.2% had larger right side counts. Of the specimens show-

Table (1). Squared coefficient asymmetry (CV^2_a) values and character means \bar{x}_{r+l} of *Upeneus doriae*.

Character	N	Character mean	CV^2_a	% of individuals with asymmetry
Preorbital length	49	1.35	41.15	35.07
Postorbital length	49	2.29	12.29	28.09
Eye diameter	49	1.13	0	0
Number of Pectoral Fin rays	49	3.67	4.47	15.32
Head length	49	15.19	25.81	26.79

Table 2. Squared coefficient of asymmetry and character means \bar{x}_{r+l} by size class of *Upeneus doriae*.

Size Class	n	CV^2_a	character mean \bar{x}_{r+l}	% of individuals with asymmetry
Preorbital length				
13.0-14.0	18	15.78	1.24	22.22
14.1-15.0	21	42.51	1.33	33.33
15.1-16.0	10	63.13	1.51	30.00
Total	49			
Postorbital length				
13.0-14.0	18	5.74	2.15	27.77
14.1-15.0	21	5.94	2.27	33.33
15.1-16.0	10	7.01	2.54	30.00
Total	49			
Head length				
13.0-14.0	18	0.99	3.43	11.11
14.1-15.0	21	7.86	3.65	28.57
15.1-16.0	10	2.76	4.02	50.00
Total	49			
Number of pectoral fin ray				
13.0-14.0	18	66.13	14.61	11.11
14.1-15.0	21	8.05	15.38	19.05
15.1-16.0	10	9.02	15.7	10.00
Total	49			

ing asymmetry in pre and postorbital length and head length 68.5%, 79.5% and 55.7% are left sided respectively.

Individuals of *Upeneus doriae* were grouped into length classes (Table 2). An increasing trend in the asymmetry value with fish length is obtained for preorbital and postorbital lengths.

DISCUSSION AND CONCLUSIONS

The asymmetry value showed some variation among the five morphological characters studied in *U. doriae*. Due to the nature of the present study as a preliminary one, and since fish sample were obtained from only one locality, it is impossible to evaluate comparatively the level of asymmetry of those characters and to determine if they are higher or lower than the average. Future studies are needed to sample polluted and non-polluted areas in the Sea of Oman in order to compare the asymmetry value of various characters.

Character like preorbital length showed higher asymmetry value than those of the remaining characters. Such high asymmetry value of this character was also recorded in several freshwater and marine fish species (AL-HASSAN *et al.*, 1990; AL-HASSAN and HASSAN, 1994; JAWAD, 2001; 2003; JAWAD *et al.*, 2010; AL-MAMRY *et al.*, 2011a; b).

The low fluctuating asymmetry value obtained for the other bilateral characters can be explained on the basis that these characters are designated with high functional importance and highly canalized during ontogeny (MØLLER and POMIANKOWSKI, 1993).

The detrimental effect of asymmetry on the size of the fins has a functional importance in fishes (GONÇALVES *et al.*, 2002). As they play an important role in locomotion, the pectoral fins have functional value and thus the efficiency of predator evasions probably depends on their functionality (GONÇALVES *et al.*, 2002). The asymmetry value recorded for pectoral fin rays of *U. doriae*, it is quite possible for such asymmetry to hinder the basic functions of the pectoral fin.

Taxonomic and racial studies usually use data obtained from pectoral fin ray counts and measurements of orbital diameter, pre and postorbital lengths. These characters are regularly used by taxonomists to set up the unique morphological features of the species in question. Any interchanging counts and differences in dimensions from left and right sides of *U. doriae* will introduces an additional source of variation to taxonomists who depend on these characters in separating this species or its populations. Bilateral asymmetry has shown to create problems to fish taxonomists (PARENTI, 1982).

Pollution of sea water and sediments by hydrocarbons, heavy metals, pes-

ticides and organic matter are considered the main cause of environmental stress. This state of pollution is not unusual for the coastal environment of the Sea of Oman where different pollutants were reported to affect its water for at least in the last twenty years (DE MORA *et al.*, 2005; AL-DARWISH *et al.*, 2005; ABDEL GAWAD *et al.*, 2008; KHAN, 2008).

Several Authors have shown a (VALENTINE *et al.*, 1973; AL-HASSAN *et al.*, 1990; AL-HASSAN and HASSAN, 1994; AL-HASSAN and SHWAFI, 1997; JAWAD *et al.*, 2001; 2010; AL-MAMRY *et al.*, 2011a; 2011b) trend of increase in the asymmetry value with the increase in fish length. Due to the comparatively small size of some size classes, this was not clearly shown in our study except for pre- and postorbital lengths whose asymmetry increased with fish length. VALENTINE *et al.* (1973) showed such a trend in selected fish species collected from California, U.S.A. They suggested two possible hypotheses that may account for such a trend; these are the ontogenetic changes which are an increase in asymmetry with size (age) and the possible historical process which is a secular increase in asymmetry.

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