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Asymmetry in certain morphological characters of the carangid species *Decapterus russelli*, collected from the Lemah coastal area, on the northern part of Oman Sea

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Abstract

Asymmetry analysis has been carried out for some bilateral characters of *Decapterus russelli* (Family: Carangidae) collected from Oman Sea. The results showed that postorbital length demonstrated the highest incidence of asymmetry among the characters studied. The lowest asymmetry value was for the number of pectoral fin rays. An increasing trend in the asymmetry value with fish length is also obtained for preorbital length, number of pectoral fins and number of lateral line scutes. A similar trend is also evident in the postorbital length and eye lens diameter of individuals with body sizes <160 mm. The possible causes of asymmetry in this species are herein discussed in relation to different pollutants and their presence in the area.

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INTRODUCTION

Members of the family Carangidae are among the most important commercial fish in Oman Sea generally and in the Sultanate of Oman in particular. Several species have been observed in the area and along the coasts of Oman (Randall 1995).

Meristic and morphometric characters are highly sensitive to environmental factors and show a significant defect once they became exposed to environmental stress (Fowler 1970). Environmental stress is an environmental influence that affects the structure and function of an organism in such a way that its Neo-Darwinian fitness is reduced (Calow 1989).

The differential development of a bilateral character on two sides of an organism is known as asymmetry (Van Vallen 1962, Palmer and Strobeck 1986, Leary and Allendorf 1989). Fluctuating asymmetry results from the inability of individuals to undergo identical development of a trait on both sides of the body. It is also suggested that fluctuating asymmetry represents a measure of the sensitivity of development to environmental stress (Moller and Pomiankowski 1993). Asymmetry usually increases under environmental stress, due to the failure of the homeostatic regulatory mechanism. Such developmental effects might occur before the concentration of toxicant in water or food reaches a level high enough to produce morbidity (Bengtson and Hindberg 1985).

This work studied the bilateral asymmetry phenomenon in selected morphological characters of the carangid species *Decapterus russelli,* collected from Lemah, on the northern part of Oman Sea.

MATERIALS AND METHODS

Specimens of *D. russelli* were collected from Lema, north of Oman Sea (Fig. 1), on January 3rd, 2009. This carangid species is pelagic and it is found in large numbers in the coastal areas of the Oman Sea. The five bilateral characters used to compare asymmetry were as follows: (1) Length of the pre-orbital distance (mm), measured from the mouth to the anterior edge of the orbit; (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) number of pectoral fin rays, a count of the total number of pectoral fin rays, including the uppermost ray; and (5) number of the lateral line scutes, a count of the total number of scutes found at the posterior horizontal stretch of the lateral line (see Fig. 2).

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Fig. 1. Map showing collecting site of *Decapterus russelli*.



Fig. 2. Schematic diagram showing the morphometric characters used in the study.

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. In the statistical analysis, the square coefficient of asymmetry variation (CV^2_a) for meristic and morphometric characters was calculated according to Valentine et al. (1973) as:

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

where S_{r+l} is the standard deviation of the signed difference,
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.

To eliminate scaling problems associated with growth in morphometric characters (non-discrete, measurable), each measurement was divided by a conventional standardizing measurement (e.g., head length was used in the present study). Every morphometric measurement was treated in a similar manner and the squared coefficient of asymmetry was determined as before.

RESULTS

The results of the asymmetry data analysis of the previously listed characters of *Decapterus russelli* collected from Lemah, on the northern part of Oman Sea, are shown in Table 1. The highest value was recorded for the postorbital length and the lowest value for the number of pectoral fin rays.

Table 1

Squared coefficient asymmetry (CV^2_a) values and character means (X_{r+l}) of *Decapterus russelli*.

Character	CV^2_a	n	Character mean	% of individuals with asymmetry
Preorbital length	18.368	129	25.179	47.3
Postorbital length	24.827	129	30.394	46.5
Number of pectoral fin ray	11.550	126	40.921	27.8
Eye diameter	21.357	129	24.350	41.9
Number of lateral line scutes	14.054	125	68.152	37.6

The percentage of individuals showing asymmetry in preorbital length was the highest among the percentages recorded for asymmetry of the five characters (47.3% of the total fish studied) and the lowest percentage was for individuals with asymmetry in the number of pectoral fin rays (27.8% of the total fish studied). Individuals of *Decapterus russelli* were grouped into length classes (Table 2). A weak trend of increase in the asymmetry values was noticed

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Table 2

Squared coefficient of asymmetry and character means (X_{r+l}) by size class of *Decapterus russelli*.

Size Class	n	CV^2_a	Character mean X_{r+l}	% of individuals with asymmetry
Preorbital length				
130-140	2	0.194	11.32	50
141-150	39	3.280	12.27	46.15
151-160	55	10.457	12.61	61.50
161-170	28	30.479	13.31	61.20
171-180	4	1.422	12.57	50.00
Postorbital length				
130-140	2	1.43	13.25	50
141-150	39	13.61	14.65	51.28
151-160	56	27.36	15.38	49
161-170	28	11.14	16.24	37.7
171-180	4	118.5	15.36	50
Eye lens diameter				
130-140	2	0.0004	11.6	50
141-150	39	4.357	11.99	30.76
151-160	56	17.09	12.05	46.42
161-170	28	9.08	12.57	53.57
171-180	4	2.25	12.65	66.66
Number of pectoral fin ray				
130-140	2	5.806	20.75	50
141-150	39	14.550	20.44	25.89
151-160	56	6.907	20.51	18.51
161-170	28	4.405	20.42	18.5
171-180	4	42.700	19.78	50
Number of lateral line scutes				
130-140	2	0	32.5	100
141-150	39	7.03	33.92	25.64
151-160	56	8.03	34.19	35.84
161-170	28	10	34.3	46.15
171-180	4	5.81	34.37	75

in the preorbital length, number of pectoral fin rays and number of lateral line scutes. An increasing trend, but only in fish <160 mm, is also noticed in the postorbital length and eye lens diameter.

DISCUSSION

There is some variation in the asymmetry values among the five morphological characters studied in *D. russelli*. At the present time it is impossible to evaluate the level of asymmetry of those characters and to determine if they are higher or lower than average due to the lack of data

regarding natural asymmetry in this part of the world. However, characters like postorbital length and eye lens diameter showed higher asymmetry values than those of the other characters studied. High asymmetry values for postorbital length have also been recorded in several freshwater and marine fish species (Al-Hassan et al. 1990; Al-Hassan and Hassan 1994; Jawad 2001, 2003). Such agreements in results of asymmetry might indicate the vulnerability of those two characters to immediate changes in the environment. It is impossible at this stage to confirm that these levels of asymmetry correlate to various types of environmental pollution, and the morphology of the fish species in question is not available. However, based on previous studies, it is possible to conclude that there is a direct correlation between environmental stress, due to pollution, and asymmetry in this species. Such environmental factors are present in the waters of Oman Sea. On the other hand, the low asymmetry values displayed by the three other characters (preorbital length, number of lateral line scutes and number of pectoral fin rays) might be explained on the basis that those characters are less vulnerable to environmental stresses. This may be the case when the developmental period of the preorbital length, lateral line scutes and number of pectoral fin rays do not coincide with the presence of adverse environmental events (Jawad 2003). Other factors, including genetic ones, might be responsible for the asymmetry in these characters, but these can not be discussed at this stage due to the lack of genetic data on the ichthyofauna of Oman.

The origin and cause of asymmetry in fish can depend on several factors, one of which is environmental stress, which leads to an increased level of asymmetry, but might occur at low levels before causing wide spread death (Bengtsson and Hindberg 1985).

Pollution of sea water and sediments by hydrocarbons, heavy metals, pesticides and organic matter are considered the main cause of environmental stress. Pollution is not unusual for Oman Sea, as reports of adverse conditions in this part of the world continue alerting people to local ecological disasters (De Mora et al. 2004, De Mora et al. 2005, Al-Darwish et al. 2005, Tolosa et al. 2005, Abdel Gawad et al. 2008, Khan 2008).

The environmental causes might be natural events. 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, since 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 et al. 2001) where there was a trend of increase in the asymmetry value with the increase in fish length. The number of

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the lateral line scutes was identical in only one length (130-140 mm). The results also show a trend of increasing asymmetry with fish length in small individuals (<160 mm) for postorbital length and eye lens diameter. This trend is probably the result of incomplete development; character means are always lowest in smaller size classes (Valentine et al. 1973). The same results were obtained by Valentine et al. (1973) 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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