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ASYMMETRY ANALYSIS STUDY ON *Callionymus margaretae* REGAN, 1906 COLLECTED FROM THE ARABIAN SEA COASTS OF OMAN

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Summary

Asymmetry analyses have been carried out for some bilateral characters of *Callionymus margaretae* Regan, 1906 collected from the Arabian Sea coasts of Oman. The results showed that the level of asymmetry of the character postorbital length was the highest among those asymmetry values obtained for the remaining characters studied. The lowest value was that for the head length. An increasing trend in the asymmetry value with fish length is also obtained for preorbital and postorbital lengths. The possible cause of the asymmetry in this species is herein discussed in relation to different pollutants and their presence in the area.

Key words: asymmetry, morphology, *Callionymus*, Arabian Sea, Oman

INTRODUCTION

Members of the family Callionymidae are among the important demersal fishes in the Arabian Sea coasts of Oman. Several species have been observed in the area and along the coasts of Oman (R a n d a l l, 1995).

The effect of the environmental factors on meristic and morphometric characters show a significant defect once those characters became exposed to (F o w l e r, 1970). Environmental stress is the total environmental influences that affect the structure and function of an organism in such a way that their Neo-Darwinian fitness is reduced (C a l o w, 1989).

Asymmetry is the differential development of a bilateral character between the sides

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of an organism (V a n V a l l e n, 1962; P a l m e r and S t r o b e c k, 1986; L e a r y and A l l e n d o r f, 1989). On the other hand, 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 (M o l l e r and P o m i a n k o w s k i, 1993). Asymmetry usually increased under environmental stresses, due to the failure of homeostatic regulatory mechanism. Such developmental effects might occur before the concentration of toxicant in water or food reaches level high enough to produce morbidity (B e n g t s s o n and H i n d b e r g, 1985).

This work studied the bilateral asymmetry phenomenon in selected morphological characters of the callionymid species, *Callionymus margaretae* collected from Arabian Sea coasts of Oman.

MATERIALS AND METHODS

Specimens of *C. margaretae* were collected from the Arabian Sea coast of Oman on the 3rd January 2008. This callionymid species is demersal and it is found on sand and muddy bottoms and it si common on the Omani coasts of the Arabian Sea. The five bilateral characters used to compare asymmetry were as follows: (1) Length of the pre-orbital distance (mm): measured from 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) Head length (mm): measured from mouth to the posterior edge of operculum. Meristic characters: (5) Number of pectoral fin rays: a count of the total number of pectoral fin ray, including the most upper 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. In the statistical analysis, the square coefficient of asymmetry variation (CV^2_a) for meristic and a morphometric character was calculated according to V a l e n t i n e 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, 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.

To eliminate scaling problems associated with growth in morphometric characters (non discrete, measurable), each measurements 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 squared coefficient of asymmetry was determined as before.

RESULTS

The results of asymmetry data analysis of the previously listed characters of *C. margaretae* collected Arabian Sea coasts of Oman are shown in Table 1. The highest value was recorded for the postorbital length and the lowest value for the head length.

Table 1. Squared coefficient asymmetry (CV^2_a) values and character means (X_{r+l}) of Callionymus margaretae

Tablica 1. Kvadrat vrijednosti koeficijenta asimerije (CV^2_a) i srednje vrijednosti (X_{r+l}) Callionymus margaretae

Character (mm) Vrijednosti (mm)	CV^2_a	N Broj	Character mean Srednja vrijednost	% of individuals with asymmetry % primjeraka sa asimetrijom
Preorbital length / preorbitalna dužina	19.10	44.00	0.73	11.36
Postorbital length / postorbitalna dužina	125.27	44.00	1.43	43.18
Eye diameter/dijametar oka	65.00	44.00	0.59	4.55
Number of Pectoral Fin ray / broj žbica u prsnoj peraji	31.58	42.00	16.65	59.52
Head length/dužina glave	18.57	44.00	1.91	31.82

The percentage of the individuals showing asymmetry in the number of pectoral fin rays character was the highest among the percentages recorded for the five characters (59.52% of the total fish studied) and the lowest percentage was for the individuals with asymmetry in number of pectoral fin rays (4.55% of the total fish studied). Individuals of *C. margaretae* were grouped into length classes (Table 2). An increasing trend in the asymmetry value with fish length is also obtained for preorbital and postorbital lengths.

DISCUSSION

There is some variation in the asymmetry values among the five morphological characters studied in *Callionymus margaretae*. 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

Table 2. Squared coefficient of asymmetry (CV2a) and character means (X r+1) by size class of Callionymus margaretae *(PL – Preorbital length, PoL – Postorbital length, ELD - Eye lens diameter, HL - Head length, NPF - Number of pectoral fin ray, % IA - % of individuals with asymmetry)*

Tablica 2. Kvadrat vrijednosti koeficijenta asimerije (CV2a) i srednje vrijednosti (X r+l) različitih veličina Callionymus margaretae *(PL –Preorbitalna dužina , PoL –Postorbitalna dužina, ELD - Dijametar leće oka, HL - Dužina glave, NPF - Broj žbica prsne peraje, % IA - % primjeraka sa asimetrijom)*

Parameters Parametri		Size Class / Veličina (mm)															Total
		6.0-7.0	7.1-8.0	8.1-9.0	9.1-10.0	10.1-11.0	11.1-12.0	12.1-13.0	13.1-14.0	14.1-15.0	15.1-16.0	16.1-17.0	17.1-18.0	18.1-19.0	19.1-20.0	20.1-21.0	
N Broj	PL	1	1	1	3	1	3	5	5	7	5	2	4	2	3	1	44
	PoL	1	1	1	3	1	3	5	5	7	5	2	4	2	3	1	44
	ELD	1	1	1	3	1	3	5	5	7	5	2	4	2	3	1	44
	HL	1	1	1	3	1	3	5	5	7	5	2	4	2	3	1	44
	NPF	1	1	1	3	1	3	5	5	7	5	2	4	2	3	1	44
CV2a	PL	0	0	0	0	0	21.77	0	66.67	83.25	0	0	0	86.30	0	0	-
	PoL	0	0	0	17.30	17.50	22.77	26.02	61.26	64.81	73.46	74.00	247.07	311.42	0	0	-
	ELD	0	0	0	0	0	0	0	0	0	546.90	0	0	0	0	0	-
	HL	0	0	0	0	0	8.50	19.60	28.0	10.60	17.90	0	16.60	0	3.50	0	-
	NPF	0	0	0	24.90	0	7.70	7.00	36.40	21.50	53.80	0	8.90	8.90	21.80	0	-
X r +1	PL	0.80	0.40	0.50	0.50	0.50	0.52	0.64	0.60	0.75	0.78	0.85	0.98	0.98	0.97	1.00	-
	PoL	1.60	0.90	0.90	1.10	1.10	1.30	1.20	1.30	1.50	1.50	1.70	1.70	1.70	1.90	1.90	-
	ELD	0.60	0.50	0.40	0.70	0.50	0.50	0.56	0.58	0.59	0.58	0.70	0.62	0.62	0.70	0.60	-
	HL	2.10	1.40	1.20	1.60	1.50	1.60	1.70	1.90	1.90	1.90	2.20	2.10	2.20	2.50	2.70	-
	NPF	16.50	16.50	17.00	16.30	17.00	17.00	16.30	16.90	16.30	15.90	17.00	16.80	16.80	17.50	18.50	-
% IA	PL	0	0	0	0	0	33.33	0	40.00	14.29	0	0	0	50.00	0	0	-
	PoL	0	0	0	33.33	33.34	66.66	40.00	80.00	42.85	80.00	81.00	50.00	100.00	0	0	-
	ELD	0	0	0	0	0	0	0	0	0	40.00	0	0	0	0	0	-
	HL	0	0	0	0	0	66.67	60.00	40.00	42.90	40.00	0	25.00	0	33.30	100.00	-
	NPF	100.0	100.0	0	66.67	0	1	25.00	80.00	57.20	80.00	0	50.00	50.00	66.67	100.00	-

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 the Arabian Sea coasts of Oman. On the other hand, the low asymmetry values displayed by the three other characters (preorbital length, head length 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, head length and number of pectoral fin rays do not coincide with the presence of adverse environmental events (J a w a d, 2003; J a w a d et al., 2010). 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 (B e n g t s s o n and H i n d b e r g, 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 the Omani waters, as reports of adverse conditions in this part of the world continue alerting people to local ecological disasters (R a m a m u r t h y, 1991; B a d a w y and A l – H a r t h y, 1991; S e n G u p t a et al., 1993).

The environmental causes might be natural events. Several factors are known to produce nutritional deficiencies such as various pathogens and various population phenomena (B e n g t s s o n and H i n d b e r g, 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 (A l – H a s s a n et al., 1990; A l – H a s s a n and H a s s a n, 1994; A l – H a s s a n and S h w a f i, 1997; J a w a d et al., 2001, 2010) where there was a trend of increase in the asymmetry value with the increase in fish length. The results show a trend of increasing asymmetry with fish length for the preorbital and postorbital lengths. This trend is probably the result of incomplete development; character means are always lowest in smaller size classes (V a l e n t i n e et al., 1973). The same results were obtained by V a l e n t i n e 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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Sažetak

ANALIZA ASIMETRIJE *Callionymus margaretae* REGAN, 1906 SAKUPLJENIH UZ OBALU ARAPSKOG MORA U OMANU

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Analize asimetrije riba provedene su na primjercima *Callionymus margaretae* Regan, 1906 sakupljenima uz obalu Arapskog mora u Omanu. Rezultati istraživanja pokazali su da su vrijednosti postorbitalne dužine bile najviše između vrijednosti dobivenih prema ostalim značajkama. Najniža je vrijednost bila za dužinu glave. Povećanje trenda vrijednosti asimetrije zabilježeno je za preorbitalnu i postorbitalnu dužinu. U radu se raspravlja o mogućem uzroku asimetrije kod riba u odnosu na različita onečišćenja i njihovu prisutnost u tom području.

Ključne riječi: asimetrija, morfologija, *Callionymus,* Arapsko more, Oman

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