Հայաստանի Գիտությունների Ազգային Ակադեմիա
Национальная Академия Наук Армении
National Academy of Sciences of Armenia

Հայաստանի Կենսաբանական Հանդես
Биологический Журнал Армении
Biological Journal of Armenia

• Փորձարարական և տեսական հոդվածներ • Экспериментальные и теоретические статьи •
• Experimental and theoretical articles •

Biolog. Journal of Armenia, 1 (64), 2012

STUDY OF THE ASYMMETRY IN AUXIS THAZARD (LACEPEDE, 1800) (FAMILY: SCOMBRIDAE) COLLECTED FROM THE BAY OF OMAN

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Fluctuating asymmetry (FA) which is defined as random deviation from perfect symmetry of an organism can be used to judge the viability of an organism and the possibility to survive in natural population. In order to estimate the FA in *Auxis thazard* (Lacepede, 1800), the number of rays in pectoral fins and measurement of four body metric characteristics were determined on both sides of body in 55 individuals from one population of *Auxis thazard* (Lacepede, 1800) collected from waters of Muscat City, The Bay of Oman. Units of asymmetry were determined as absolute value of difference between counts on both sides of body. Results indicate that the level of asymmetry of the preorbital character was higher than those of the rest of the characters studied. The possible cause of the asymmetry in this species has been discussed in relation to different pollutants and their presence in the area. The usefulness of information in future taxonomic studies on *A. thazard* (Lacepede, 1800) has also been addressed. A trend of increase in the asymmetry values with the fish length was noticed in the preorbital and head lengths.

Bilateral asymmetry - Oman Bay-Sultanate of Oman - Auxis thazard

Ֆլուկտուացող ասիմետրիան (ՖԱ), ինչը որոշվում է որպես օրգանիզմի բացարձակ սիմետրիայից կամայական շեղում, կարող է օգտագործվել գնահատելու համար օրգանիզմի կենսունակությունը և բնական պոպուլյացիայում գոյատևելու կարողությունը: *Auxis thazard* (Lacepede, 1800)-ի ՖԱ-ն որոշելու համար Օմանի ծոցի Մուսկաթ Սիթին շրջապատող ջրերից ընտրված մեկ պոպուլյացիայի 55 առանձնյակների մարմի երկու կողմերում որոշվել են. կրծքի լողաթևի ճառագայթների թիվը և, կատարվել են մարմնի 4 ձևաբանական բնութագրերի չափումներ: Որպես ասիմետրիայի միավոր ընդունվել է մարմնի երկու կողմերի տվյալների միջև եղած տարբերության բացարձակ արժեքը: Արդյունքները ցույց են տալիս, որ նախաօրբիտալ պարամետրի ասիմետրիայի մակարդակը գերազանցում է մնացած հետազոտված պարամետրերի մակարդակները: Այդ տեսակների մոտ ասիմետրիայի հնարավոր պատճառը տարբեր ախտոտվածություններն են և դրանց առկայությունը միջավայրում: Բերվում է նաև տեղեկատվություն *Auxis thazard* (Lacepede, 1800) ապագա տաքսոնոմիկ հետազոտությունների մասին: Նշվում է նաև ասիմետրիայի մեծացման միտում՝ կախված ձկան մարմնի ինչպես նախաօրբիտալ, այնպես էլ գլխի երկարությունից:

Երկկողմանի ասիմետրիա - Օմանի ծոց - Օմանի Սուլթանատ - Auxis thazard

Флуктуирующая асимметрия (ФА), которая определяется как произвольное отклонение от идеальной симметрии организма, может быть использована для оценки жизнедеятельности организма и способности выжить в естественной популяции. С целью определения ФА у *Auxis thazard* (Lacepede, 1800) на обеих сторонах тела у 55 индивидуумов из одной полуляции *Auxis thazard* (Lacepede, 1800) отобраных из вод вокруг Сити Мускат у побережья Оманского залива, определялись число лучей у грудного плавника и измерение четырех морфологических черт тела. Единица асимметрии определялась как абсолютное значение разницы между данными на обеих сторонах тела. Результаты показали, что уровень асимметрии преорбитального параметра был выше уровней остальных изученных параметров. Возможная причина асимметрии у этих видов обсуждается в связи с разными загрязнениями и их наличием в среде. Указана также информация о будущих таксономических исследованиях на *Auxis thazard* (Lacepede, 1800). А также отмечена тенденция увеличения асимметрии в зависимости от преорбитальной длины и длины головы рыбы.

Двустороняя асимметрия - Оманский залив - Султанат Омана - Auxis thazard

Fluctuating asymmetry (FA) has been recommended by a number of studies as a sensitive indicator for detecting environmental disturbance [21, 26, 28 and 33]. It is a morphological deviation from normal asymmetry which can be quickly detected at low levels of stress before levels high enough to cause widespread morbidity or changes in community structure are reached [11]. Positive correlations beʠ tween FA and environmental stresses have also been observed in various aquatic studies [15, 16, 17, 18, 22, 23, 30 and 34].

The only published study on the fluctuating asymmetry studies on Omani fish species is that of [18] and [6, 7]. Therefore, the present study is considered addition to the studies of asymmetry already present on Omani fish fauna. The objectives of the present preliminary study were to determine: (1) if 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; and (4) the possible usefulness of information in future taxonomic studies of *A. thazard*.

Materials and methods. Fish specimens of *Auxis thazard* were collected from Muscat coastal area, Oman Bay. 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) Orbital 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 ray, including the most upper ray. Meristic characters: (5) Head length (mm): measured from mouth to the posterior edge of operculum. 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.

The statistical analysis included calculating the squared coefficient of asymmetry variation (CV^2_a) for meristic and metric characters according to Valentine et al. (1973):

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

where S_{r-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. To obviate scaling problems associated with growth in metric characters, each measurement was divided by suitable general size measurements, e.g. head length was used as the standardizing measurement. Each of the metric characters was treated as such before obtaining the signed differences.

Results and Discussion. The results of asymmetry data analysis of the previously listed characters of *A. thazard* collected from Muscat coastal area, on the middle region of Oman Bay are shown in Tab.1. The highest value was recorded for the preorbital length and the lowest value for the head length.

The percentage of the individuals showing asymmetry in the preorbital length character was the highest among the percentages recorded for the five characters (89.27 % of the total fish studied) and the lowest percentage was for the individuals with asymmetry in head length (69.55% of the total fish studied). Individuals of *A. thazard* were grouped into length classes (Tab. 2). An increasing trend in the asymmetry value with fish length is obtained for preorbital and head lengths.

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

Character	CV^2_a	N	Character mean	% of individuals with asymmetry
Preorbital length	154.57	55	22.96	89.27
Postorbital length	16.35	55	56.55	87.09
Eye diameter	55.74	55	16.39	81.82
Number of Pectoral Fin ray	47.33	55	22.36	74.39
Head length	12.11	49	95.40	69.55

Table 2. Squared coefficient of asymmetry and character means (X_{r+l}) by size class of *Auxis thazard*.

Size Class	N	CV^2_a	character mean X_{r+1}	% of individuals with asymmetry
Preorbital length				
32.1-33.0	1	0	23.80	100.00
33.1-34.0	2	55.03	19.38	100.00
34.1-35.0	5	67.54	20.89	80.00
35.1-36.0	7	70.45	22.77	85.71
36.1-37.0	14	81.44	21.17	78.57
37.1-38.0	6	85.57	23.22	100.00
38.1-39.0	5	86.95	22.75	50.00
39.1-40.0	2	92.03	26.14	100.00
40.1-41.0	5	98.79	25.36	100.00
41.1-42.0	7	99.03	25.25	80.00
42.1-43.0	1	100.00	21.00	100.00
Total	**55**			
Postorbital length				
32.1-33.0	1	0	49.75	100.00
33.1-34.0	2	9.25	48.83	100.00
34.1-35.0	5	18.85	50.82	100.00
35.1-36.0	7	10.33	53.86	85.71
36.1-37.0	14	16.63	54.16	85.71
37.1-38.0	6	15.61	56.63	66.67
38.1-39.0	5	1.38	60.25	100.00
39.1-40.0	2	18.56	61.45	100.00
40.1-41.0	5	10.12	61.45	85.71
41.1-42.0	7	19.82	62.53	100.00
42.1-43.0	1	0	63.25	100.00
Total	**55**			
Eye diameter				
32.1-33.0	1	0	16.70	100.00
33.1-34.0	2	35.14	16.70	100.00
34.1-35.0	5	128.83	14.61	80.00
35.1-36.0	7	32.19	16.44	100.00
36.1-37.0	14	58.55	15.76	71.43
37.1-38.0	6	81.39	16.79	100.00
38.1-39.0	5	20.16	15.75	50.00
39.1-40.0	2	39.90	18.05	80.00
40.1-41.0	5	42.92	17.01	85.71
41.1-42.0	7	42.62	16.78	80.00

42.1-43.0	1	0	17.00	0
Total	**55**			
Head length				
32.1-33.0	1	0	85.15	100.00
33.1-34.0	2	9.26	83.65	100.00
34.1-35.0	5	13.34	85.85	80.00
35.1-36.0	7	14.09	92.16	42.86
36.1-37.0	14	18.09	91.42	78.57
37.1-38.0	6	19.85	95.68	50.00
38.1-39.0	5	20.10	97.50	50.00
39.1-40.0	2	21.16	102.89	100.00
40.1-41.0	5	24.05	104.09	85.71
41.1-42.0	7	25.48	105.52	80.00
42.1-43.0	1	26.97	100.50	100.00
Total	**55**			
Number of pectoral fin ray				
32.1-33.0	1	0	24.00	0
33.1-34.0	2	125.29	22.00	50.00
34.1-35.0	5	135.03	21.60	100.00
35.1-36.0	7	25.45	22.60	60.00
36.1-37.0	14	47.05	21.96	64.29
37.1-38.0	6	19.07	22.90	60.00
38.1-39.0	5	10.10	22.25	50.00
39.1-40.0	2	13.71	22.60	80.00
40.1-41.0	5	24.57	22.10	100.00
41.1-42.0	7	53.39	22.90	80.00
42.1-43.0	1	0	24.00	0
Total	**55**			

The results of the asymmetry direction as whether individuals are left-handed or right-handed have shown that all the characters studied are dextral. For pectoral fin ray count, bilateral asymmetry occurred in 74.39 of the total of 55 *A.thazard* examined. Of specimens exhibiting asymmetry, 66.2% had larger right side counts. As to the preorbital, postorbital lengths, orbital diameter and head length, the bilateral asymmetry exhibited was 89.27, 87.09, 81.82 and 69.55 respectively. Of these asymmetric specimens, 348.5%, 459.5%, 345.7% and 348.9% are right sided respectively.

There is some variation in the asymmetry values among the five morphological characters studied in *A. thazard*. Since the present work is only a preliminary investigation about the asymmetry in some metric and meristic characters of *A. thazard* and since fish specimens were obtained from only one locality, it is impossible to evaluate the level of asymmetry of those characters and to determine if they are higher or lower than the average. Further studies are required that involve fish samples from polluted and non-polluted localities in the Bay of Oman in order to compare the asymmetry values of various characters. However, based on previous studies in this field, 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 coastal area of the Bay of Oman [1, 2, 12, 13, 19 and 31]. Character like preorbital length has shown showed higher asymmetry value than those of the remaining characters. High asymmetry value for this character was also recorded in several freshwater and marine fish species [3, 5, 15, 16, 17, 18]. Such agreements in results of asymmetry might indicate the vulnerability of this character to the immediate changes in the environment. On the other hand, the low asymmetry values obtained for the remaining four characters used in this study, might be explained on the basis that these characters are designated with high functional importance and are highly canalized during ontogeny thus giving low level of FA [22, 26].

Several characters of functional importance might be affected by asymmetry [14] among these characters the size of the fins. The functional value of the pectoral fins is employed in the important role that they play in locomotion and thus the efficiency of predator evasions probably depends on their functionality [14]. Oxygenation of the eggs during parental care is another important role of the pectoral fin, and recently [20] have demonstrated that the area of the pectoral fins correlates with paternal quality in sticklebacks *Gasterosteus aculeatus* L. With the asymmetry value recorded for pectoral fin ray count of *A. thazard*, it is quite possible for such asymmetry to hinder the basic functions of the pectoral fin.

Several authors have discussed the effects of the asymmetry on body proportions [9, 24 and 29]. The effect of asymmetry on the preorbital length might increase or decrease this area in the fish skull. Such changes might lead to differential enlargement which is restricted to the nasal pole of the eye. If such enlargement happened, retinal expansion will takes place [35]. Moreover, by having more space in the naso-temporal region this might affect fish visual acuity [35, 10].

The individuals of *A. thazard* appeared to be right-handed for the five characters chosen in this study. It is not possible at this stage to judge whether left handed or right handed individuals are the naturally successful individuals as such dextrality in these characters might interfere with important biotic functions of the fish [35].

In taxonomic and racial studies involving pectoral fin ray count, pre- and postorbital lengths, head length and orbital diameter interchanging counts and differences in dimensions from left and right sides of *A. thazard* 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 [27] and taxonomists of animal groups other than fish such as owl [25].

The origin and cause of asymmetry in fishes can depend on several factors, one of which is environmental stress which at low levels enhances asymmetry in fish [8]. Metal impact on development of meristic characters and bones in fishes has already been demonstrated by [8]. Pollution of sea water and sediments by hydrocarbons, heavy metals, pesticides and organic matter is not unusual for the coastal environment of Oman Bay as reported elsewhere for the recent twenty years [1, 2, 12, 13, 19, 31]. Other environmental stressors can be natural events, various population phenomena [8] and conditions that can trigger nutritional deficiencies such as various pathogens. It is highly possible that these factors may be in action in Oman Bay waters as they seem to be common in many aquatic environments.

Several authors have shown a relationship between the coefficient of asymmetry and fish length [5, 3, 4, 15, 18, 6, 7] where there was a trend of increase in the asymmetry value with the increase in fish length. This trend is probably the result of incomplete development; character means are always lowest in smaller size classes [32]. The same results were obtained by [32] in selected fish species collected from California, U.S.A. and by [6, 7] in the carangid fish species, *Decapterus russelli, Callionymus margaretae and Leiognathus equulus* collected from the coastal north region of Oman Bay, Oman.

Acknowledgements

We would also like to thank the Ministry of Fisheries Wealth, the Agriculture and Fisheries Development Fund and the Marine Science and Fisheries Centre for giving us the opportunity to work on the fish samples within the qualitative and quantitative distribution of marine organisms in Sultanate of Oman and to provide the appropriate financial support.

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Received 23.07.2011