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Incidence of Lordosis in the Cyprinid Fish, *Carasobarbus luteus* and the Shad, *Tenualosa ilisha* Collected from Barash Waters, Iraq

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Abstract Incidences of severe lordosis involving two flexions are reported in a specimen of cyprinid fish *Carasobarbus luteus* and *Tenualosa ilisha*. For both species, the values for the angles lies between the lines passing through the sides of the vertebral column and enclosing the curvature and the depth of the curvature of the angle were obtained. Also, the ratio of the vertebral column to the fish total length of the deformed and the normal specimens of the two species were calculated. Possible causes for such anomalies were discussed.
Keywords Anomalies, Cyprinidae, Clupeidae, lordosis, vertebral column, Al-Hammar Marsh

Introduction

Skeletal deformities are relatively well described in several species of fish (Antunes and Da Cunha, 2002; Jawad and Al-Mamry, 2012; Jawad, 2013). They can be a result of a metabolic alteration due to several factors (physical, chemical and biological) inducing deviations, irreversible, natural or induced, morphology of fish (Divanach et al., 1996). These deformations are generally rare in wild populations (Boglione et al., 2001), and generally reflect an imbalance in the environment that the organism living in. Factors causing skeletal abnormalities in fish may also be genetic (Afonso et al., 2000; Sadler et al., 2001) or epigenetic.

Environmental conditions can contribute in causing skeletal deformities especially during larval development of fish. This may be due to the presence of pathogens (Villeneuve et al., 2005; Yokoyama et al., 2004) or the physico - chemical parameters in the environment, such as brightness, dissolved oxygen, pH, temperature and salinity (Ørnsrud et al., 2004; Sfakianakis et al., 2004), exposure to certain toxic substances, potentially teratogenic such as herbicides and organophosphorus pesticides (Koyama, 1996), polyaromatic hydrocarbons and heavy metals such as zinc, selenium, lead and cadmium that can alter the process of bone development and consequently lead to malformations (Louiz et al., 2007). Therefore, skeletal deformities can be used as an indicator of the presence of pollution in the environment (Von Westernhagen and Dethlefsen, 1997).

Lordosis is one of the most severe deformities observed in fishes; it develops either at the pre-hemal vertebrae due to non-inflation of the swimbladder (Chatain and Dewavrin, 1989) or at the hemal vertebrae as a result of the intense water-current velocity facing larval stages rearing (Kihara et al., 2002). The severity of the case of lordosis ranges from slight axial modification to acute lordosis angles (Divanach et al., 1996) and, therefore, study of the effects of deformity on body shape is of primary importance for fisheries and hatcheries (Sfakianakis et al,. 2004).

Carasobarbus luteus (Heckel, 1843) (Cyprinidae) is a species that lives in freshwater in the Tigris-Euphrates Rivers basin (Coad, 2010), while *Tenualosa ilisha* (Hamilton-Buchanon, 1822) (Clupeidae) is marine anadromous species enter rivers and freshwater marshes for laying eggs. Both species have high local economic importance. They exposed to many physical and chemical variations, from temperature to pollution, in the most threatened ecosystems they are living in.

In this study we carried out a morphological description of a case of lordosis in two teleost species *Carasobarbus luteus* and *Tenualosa ilisha*. This is the first report about this abnormality in Iraq.

1 Materials and Methods

On 12th December 2009 two adult specimens of *Carasobarbus luteus* and *Tenualosa ilisha* with severe case of lordosis were obtained from Al-Hammar Marsh, north of Basrah Province 600 Km south of Baghdad City Capital (30˚40′32.23″ N, 47˚35′03.18″ E) (Figure 1). Measurements for the normal and deformed specimens (Figures 2 and 3) of the two species are shown in Table 1. The skeleton of both normal and abnormal specimens of both species examined were prepared by boiling the fish to interpret the skeletal anomaly. The length of the vertebral column from the anterior margin of the first vertebra to the posterior margin of the last vertebra is divided by fish total length to produce a ratio that is used to compare abnormal with normal fish. The angle of vertebral deformation was measured from the centre of the deformity, which in the present cases is located in the caudal region by means of a digital protractor. To assess the degree of abnormality in individuals distorted, we measured the height of the curvature of the spinal column (HC). This corresponds to the distance between the tangent to the apical vertebra and a straight line which passes to the base of the two vertebrae limiting the curvature. The measurements were made using a digital calliper with accuracy of 0.01 mm. The depth of curvature (DC) is calculated according to the formula using the method of Louiz et al. (2007):

$$DC = (HC / SL) \times 100 \text{ (SL = standard length fish)}$$

Abdominal vertebrae are defined as the vertebrae situated immediately behind the skull and have no haemal process, caudal vertebrae are those vertebrae

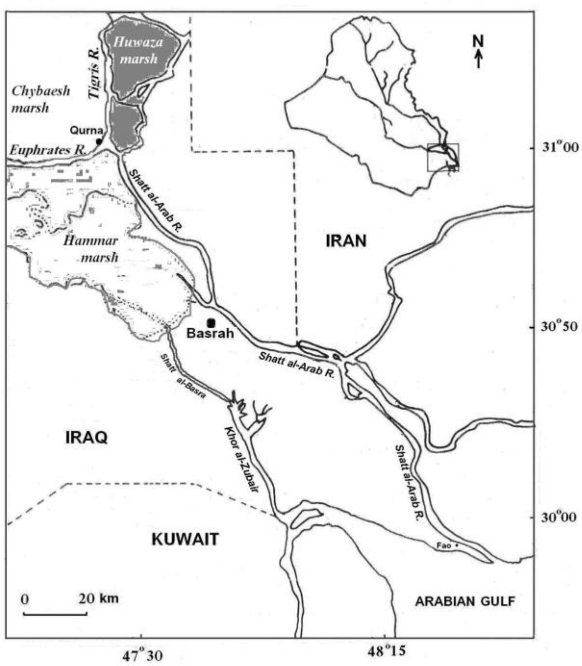

Figure 1 Map showing collection area

Figure 2 *Carasobarbus luteus*, 253 mm Total length, normal

Figure 3 *Carasobarbus luteus*, 324 mm Total length, Abnormal

Table 1 Body measurements of the normal and deformed specimens of *Carasobarbus luteus* and *Tenualosa ilishs*.

	Normal specimen	Abnormal specimen
Carasobarbus luteus		
Total length mm	253	324
Forked length mm	216	236
Standard length mm	209	222
Head length mm	41	50
Body depth mm	66	77
Tenualosa ilisha		
Total length mm	230	200
Forked length mm	198	164
Standard length mm	180	155
Head length mm	59	48
Body depth mm	57	54

with haemal processes fused together forming haemal spine ventrally, abdominal region is the region that includes abdominal vertebrae, and caudal region is the region that contains caudal vertebrae Chapleau (1988), Ramzu and Meunier (1999), and Nowroozi (2012). As the aim of the present study was to report and describe the abnormality cases in the specimens of the two species, no attempt was made to take the study further and to assess the damage at the histological and cellular levels and left for a future detailed study which will take into consideration comparison of the normal and abnormal specimens.

The vertebral column of the normal and abnormal specimens were deposited in the ichthyological collection of the Marine Science Centre, University of Basrah, Iraq.

2 Results

Spinal anomalies were visible on the fish body of the two species immediately after capture, with the spine curved at two places compared with the normal specimens (Figures 2~5). The internal body spaces and organs were normally developed and placed. The skeleton of the deformed specimens of the two species are compared with that of the normal for both species (Figures 6~9). For *C. luteus* specimen, two flexions of the vertebral column at the caudal region are present. One severe twisting at the 6th caudal vertebra and another slight bent at the 14th caudal vertebra. Slight bend of the neural and haemal spines is present in the caudal vertebrae 9th to 14th (Figure 8). The ratio of the vertebral column to the fish total length of the deformed specimen is 0.32, while it is o.63 in the normal specimen. The value of the angles lies between the lines passing through the sides of the vertebral

Figure 4 *Tenualosa ilisha*, 230 mm Total length, normal

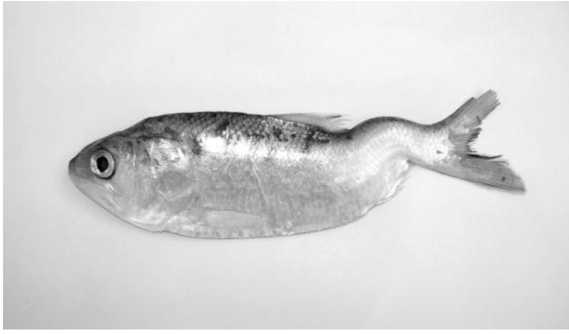

Figure 5 *Tenualosa ilisha*, 200 mm Total length, abnormal

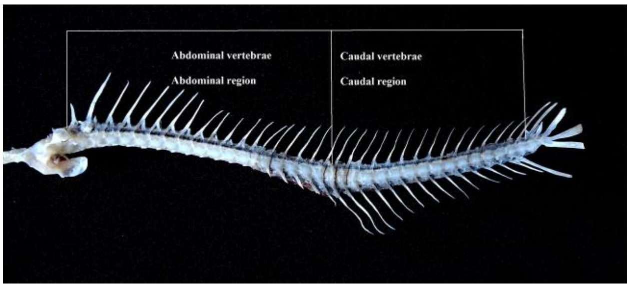

Figure 6 Normal vertebral column of *Carasobarbus luteus*

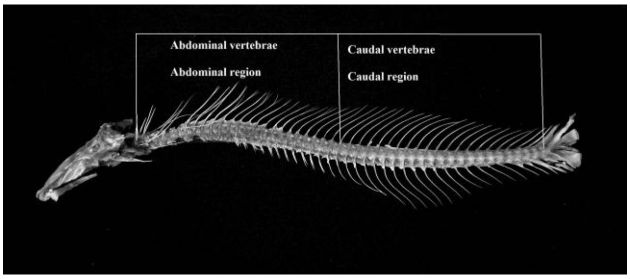

Figure 7 Normal vertebral column of *Tenualosa ilisha*

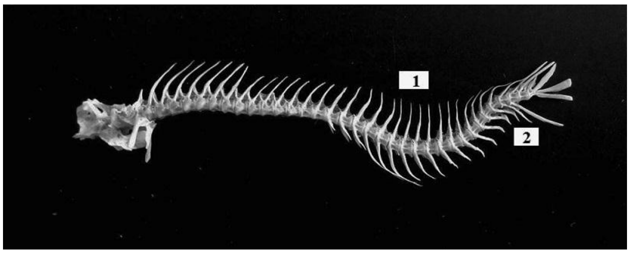

Figure 8 Abnormal vertebral column of *Carasobarbus luteus*

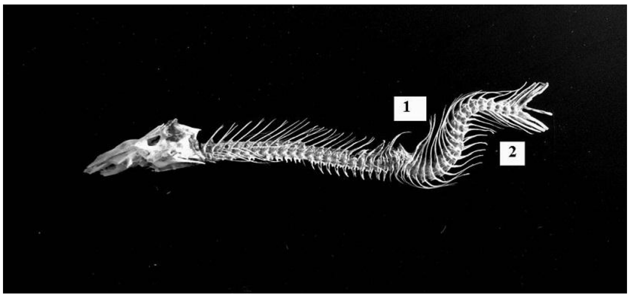

Figure 9 Abnormal vertebral column of *Tenualosa ilisha*

column and enclosing the curvature are 130˚ for angle no. 1 and 145˚ for angle no. 2. The depth of the curvature of angle no. 1 and 2 are 15.3 and 7.8 respectively.

The deformed specimen of *T. ilisha* showed two severe twisting of the vertebral column, the first is between the 5th and 6th abdominal vertebrae, and the second at the 15th caudal vertebra. The centra of the vertebrae 24th to 26th are severely deformed. Slight deformity is seen in the neural spine of the 18th to 21st abdominal vertebrae as they are not aligned, undulation of the haemal spine of the caudal vertebrae 26th and 27th and the haemal spine of the caudal vertebrae 27th to 30th shown to be curved backward. The ratio of the vertebral column to the fish total length of the deformed specimen is 0.4, while it is 0.5 in the normal specimen (Figures 9). The value of the angles lies between the lines passing through the sides of the vertebral column and enclosing the curvature are 90˚ for angle no. 1 and 106˚ for angle no. 2. The depth of the curvature for angle no. 1 and 2 are 6.2 and 28 respectively. No external lesions were observed on the body of the deformed specimens of the two species.

3 Discussion

The source of the causes of this disorder is not well understood. Nutritional, environmental and genetic causes have been cited. Environmental factors such as density of eggs, mechanical or thermal shocks, and presence of pollutants in the water, radiation, salinity, oxygen depletion and light intensity have also been reported to cause aberrations in development (Caris and Rice, 1990). This could have happened to the two species under investigation in this study as happened to individuals of other species in the same area. Cases of lordosis with variable percentages ranging between 10-18% were obtained for other fish species from Al-Hammar Marsh area and caused concern about the impact of deformed fish on resource sustainability (Ali, 2006).

Both water and sediments of Al-Hammar Marsh have been shown to have high levels of heavy metal (Al-Imarah et al., 2000). Such levels are also present in the tissue of several fish species including *C. luteus* and *T. ilisha* living in Al-Hammar Marsh as Al-Imarah, et al (2006) has reported. High pollutant levels are also recorded in both environment and fish tissue of in areas around the area where the specimens of the two species were collected (Al-Imarah et al., 2008).

Pollutants shown to disturb number of internal mechanisms inside the fish body during its early life stages (Kihara et al., 2002; Jacquemond, 2004). They may interfere with the level of pH by elevated carbon dioxide. Cell will react to sustain normal serum osmosis and resume the normal blood pH. This may cause bone decalcification due to the presence of excessive carbonic acid generated as blood pH normalises (Sarkar and Kapoor, 1956; Andrades et al., 1996).

Variation in water temperature of Al-Hammar Marsh is very large, ranging from 8-37℃ (Douabul et al., 2012). Such a large variation in water temperature will definitely have a direct effect on the development of the vertebral column of the fish larvae.

To elucidate the severity of the case of lordosis observed in the present study, the curvatures caused by the lordotic case of anomaly were evaluated by measuring the angle between the two sides of the lordotic part of the vertebral column. The lower the angle is the severe the lorodosis case is. The curvature of 90° in the case of *T. ilisha* is considered a severe lordotic cases, while other angles in both species are moderate. However, they are still employing actual pressure on the daily activity of the fish. This result is backed by the results of the depth of the curvature (higher than that of the normal specimen) and the ratio of the vertebral column to the total fish length (Lower than that of the normal specimen). Similar results were obtained by Chang et al. (2010) on thornfish, *Terapon jarbu* and Louiz et al. (2007) on some members of the family Gobiidae. Due to the presence of lordosis case in the present specimens of the two species and to the fact that such anomaly is interfere with the ability of the fish to swim normally (Başaran, 2006), it seems that they had been in great competition for food and such struggle is the main component for survival in the wild environment.

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