Chapter 63
Fish Deformities in the Freshwater Fishes of Iraq: A Short Review and a Study Case on the Indian Catfish *Heteropneustes fossilis*

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Abstract Situations fish meeting during embryogenesis and early life history can cause lasting influences not only on morphology, but also on development rate, life history and behavioural appears.

As a case study, an incidence of absence of pelvic fins in the Indian catfish *H. fossilis* collected from Al-Hammar Marsh, south of Iraq was described. The specimen is a mature male of 148 mm in total length. Comparison of the abnormal specimen with a normal *H. fossilis*, shows considerable changes in the posterior part of the axial skeleton,the course of the intestine and especially the extent and shape of the body cavity. Comments are also made to account for such an abnormality. At the end of the chapter, a future studies are suggested.

63.1 Introduction

Morphological characters appear as a result of a complex relations between genes and environment (Gilbert and Epel 2008), and development influences are produced by circumstances that organisms undergo throughout embryogenesis (Martin et al. 2013). The early the environmental chaos, the sturdier its long-lasting impacts can be (Lindström 1999). Developmental impacts are frequently overlooked when studying life-history difference, and morphological changes in features, such as growth rate, age at maturity, can simply be misunderstood for genetic diversity. Consequently, likely influences of early damage should be thought about when studying ecological difference along environmental grades or between conflicting environments (Jonsson and Jonsson 2014).

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The present chapter sheds light on the freshwater fish abnormalities studies of Iraq that published during the last 40 years. This short review will give an idea about what has been made and what needs to be done in the field of fish abnormalities study in Iraq in order to have an idea about the health of the environment and plan for the future environment. At the end of the chapter, a study case of anomaly in the Indian catfish was given as an example of the several cases of abnormalities that may occur in the freshwater system of Iraq.

63.2 Fish Abnormality Studies in Iraq.

In Iraq, studies reporting on cases of morphological anomalies in the freshwater fish species have not started until 1982, when Al-Hassan (1982) published the first scientific account reporting on some abnormal vertebral cases obtained in some freshwater fish species collected from Basrah Province waters. During the last 40 years, nine scientific reports were published on Iraqi freshwater fish species. These reports described different cases of abnormalities in both the external morphology of the fish and its skeletal parts. Due to the lack of expertise in Iraq, the publication on the cases of anomalies in fishes has delayed until the last two decades of the twentieth century and due to the political unsettle in this country, there was a big gap of no publication on records for the period 1987–2014.

Table 63.1 shows the types of abnormalities observed in some freshwater fish species collected from the southern parts of Iraq. It is clear that the vertebral anomalies were the dominant type of deformities in the cases observed. Within the vertebral abnormalities, coalescence of vertebrae was the common aberration that affecting the vertebral column of the fish species, where there were six species reported this type of vertebral deformity. Within the minor anomalies, the bifurcation of the neural and the haemal spines came was second common anomaly. *Mesopotamichthyes sharpeyi* was the most species with large number of cases of abnormalities. Except for the loss of vertebrae, fusion of neural spines, lordosis and eye abnormalities, this species has shared all other types of abnormalities so far observed and described. *Luciobarbus xanthopterus* was second in having abnormality varieties. This species shared *M. sharpeyi* in both coalescence of vertebrae and bifurcation of neural and haemal spines. The remaining species were observed with less variety than *M. sharpeyi* and *L. xanthopterus*. The studies showed that the type of the abnormality was not confined to a certain locality. This means that the causes of these deformities were present in all the localities studied from Baghdad at the Middle of Iraq and to Basrah Province in the south.

Table 63.1 Types of fish abnormalities observed in freshwater fish species collected from Iraq

Type of abnormality	Species	Part of the fish body	Reference	Locality
Vertebral anomalies				
Coalescence of vertebrae				
	Mesopotamichthys sharpeyi	Caudal vertebrae	Al-Hassan (1982, 1983)	Shatt al-Arab River, Basrah
	M. sharpeyi	Caudal vertebrae	Al-Hassan and Na'ma (1986)	Euphrates River, Nasiria
	M. sharpeyi	Caudal vertebrae	Al-Hassan and Na'ma (1986)	Shatt al-Arab River, Basrah
	M. sharpeyi	Caudal vertebrae	Al-Hassan (1987)	Shatt al-Arab River, Basrah
	Luciobarbus xanthopterus	Thoracic vertebrae	Al-Hassan (1982)	Shatt al-Arab River, Basrah
	L. xanthopterus	Caudal vertebrae	Al-Hassan (1987)	Shatt al-Arab River, Basrah
	L. xanthopterus	Caudal and thoracic vertebrae	Jawad et al. (2015)	Al-Huwaiza marsh
	Carasobarbus luteus	=	Al-Hassan (1982, 1983)	Shatt al-Arab River, Basrah
	Aphanius dispar	Caudal vertebrae	=	Shatt al-Arab River, Basrah
	Gambusia affinis	Caudal vertebrae	Al-Hassan (1985)	Tigris River, Baghdad
	Planiliza abu	Caudal vertebrae	Al-Hassan (1985)	Shatt al-Arab River, Basrah
Compact vertebrae				
	Mesopotamichthys sharpeyi	Thoracic vertebrae	Al-Hassan (1982, 1983)	Shatt al-Arab River, Basrah
	Mastacembelus mastacembelus	Caudal and thoracic vertebrae	Jawad et al. (2016)	Euphrates River, Nasiria
Bifurcation of neural and haemal spines				
	M. sharpeyi	Caudal vertebrae	=	Shatt al-Arab River, Basrah
	C. luteus	=	=	Shatt al-Arab River, Basrah
	L. xanthopterus	=	=	Shatt al-Arab River, Basrah
	L. xanthopterus	Caudal vertebrae	Al-Hassan (1987)	Shatt al-Arab River, Basrah
Undulation of haemal spines				
	M. sharpeyi	Caudal vertebrae	=	Shatt al-Arab River, Basrah
Abnormal calcification				
	M. sharpeyi	Caudal vertebrae	=	Shatt al-Arab River, Basrah

(continued)

Table 63.1 (continued)

Type of abnormality	Species	Part of the fish body	Reference	Locality
Loss of neural spines				
	M. sharpeyi	Thoracic vertebrae	Al-Hassan (1983)	Shatt al-Arab River, Basrah
Loss of vertebrae	*C. luteus*	Thoracic vertebrae	=	Shatt al-Arab River, Basrah
Fusion of neural spines	*G. affinis*	Caudal vertebrae	=	Tigris River, Baghdad
Lordosis	*C. luteus*	Caudal vertebrae	Jawad et al. (2014)	Al-Hammar marsh
Eye abnormalities	*Pampus argenteus*	Eye	Jawad et al. (2018)	Shatt al-Arab River, Basrah

63.3 Effect of Heavy Metals on Fish

Among the common pollutants that stand behind the fish deformities are heavy metals. Since the responsible for all the anomalies so far being described from the inland fish species of Iraq are the heavy metals, it is appropriate to devote a section of this chapter to talk briefly on the role of the heavy metals in causing deformities in fishes in general. Such an information will be a short guide to those who plan for a healthy environment in Iraq in the future.

Heavy metals were behind many fish abnormalities in natural groups as well as in laboratory-cultivated specimens (Cheng et al. 2000).The occurrence of contaminants and mainly heavy metals in the aquatic habitats of fish evidences of harsh hostile impacts on the organisms and has been a matter of fear for many years (Muramoto 1981). In the 1970s, numerous efforts were made to recognise the impacts of heavy metals on organisms such as the influence of cadmium on vertebral deformities of *Cyprinus carpio* (Muramoto 1981) and *Pimephales promelas* (Pickering and Gast 1972) or the effect of zinc on the vertebral column of *Phoxinus phoxinus* (Bengtsson 1974). Generally speaking, metals can be deliberated as biologically important and supplementary.The lack of an essential metal can therefore lead to contrasting health consequences, while its high intensity can also result in negative effects which are similar to or destructive than those initiated by non-essential metals (Kennedy 2011). The most usually present heavy metals in fish organisms are cadmium, lead, mercury, zinc, copper, nickel, cobalt, molybdenum, chromium and tin. Among them, the most frequently investigated, relative to fish abnormalities, include cadmium, copper, lead, zinc, mercury and chromium. Heavy metals accumulate in the tissues of aquatic animals and convert to toxic when levels reach particular toxicity verges, values which differ meaningfully between metals, metal species, taxonomic species and organism life stages. Fish consumption of metals is mainly through the gills and the digestive track, and to a smallerextent, via the skin (Kennedy 2011). Also, fish anomalies have uncontrollable results on fish groups since they distract their survival, growth rate, health and shape (Boglione et al. 2013). Some of the most usual anomalies can be found in the vertebral column (Koumoundouros et al. 2002; Sfakianakis et al. 2006), the swim bladder (Chatain 1994), the cephalic region (Georgakopoulou et al. 2007), the fins (Favaloro and Mazzola 2003) and the lateral line (Sfakianakis et al. 2013). The highest continuing of the mare, the ones in the vertebral column and mainly lordosis (V-shaped dorsal–ventral curvature), kyphosis (Λ-shaped dorsal–ventral curvature) and scoliosis (lateral curvature).

Heavy metals may destructively distract many metabolic events in developing fish, ensuing in growing interruption, morphological and functional deformities, or death of the most subtle individuals. Furthermore, heavy metals trigger energy-expending detoxification procedures; therefore, in fish that are heavily affected by heavy metals have less energy to be utilised for development. The majority of investigations on heavy metals in relation to the growth of fish on growing fish showed great cases of death, late hatching, deformation in the external features changed and skeletal deformities (Jezierska et al. 2009).

In numerous instances, fish anomalies are simple to discriminate, even macroscopically, and therefore present a great benefit over other approaches particularly for scientists working on the field away from the laboratory equipment. Toxicants are often joining the food chain through water, micro-organisms, plants, fish, and then arrive into human bodies by drinking water and fishery products**.** Several current investigations show the build-up of many metals on animals' livers and kidneys particularly in closed seas such as the Mediterranean and address the need for a careful observations (Storelli et al. 2005).

63.4 Loss of Pelvic Fins in the Indian Catfish, *Heteropneustes fossilis* Collected from Al-Hammar Marsh, Basrah, Iraq–a Study Case

Absence of pelvic fins in teleost fish has been previously identified and accredited to inherited or post-natal anomalies, in addition to chemical pollution (Slooff 1982). Deformities in growth or the whole non-appearance of this pair of fins promote queries on additional advanced useful variations in the shape of the fish as a consequence of habitat modification. Pelvic fins are normally deliberated as the part responsible for turning the fish body, whereas their hydrodynamic role has got minor care corresponds to the pectoral and median fins (Lauder and Drucker 2004).

One specimen of the Indian catfish *Heteropneustes fossilis* (total length = 148 mm, standard length = 132 mm, weight = 156.3 g) lacking the pelvic fins was found in the shallow area of Al-Hammar marsh east of Basrah City, Iraq on November 2018 (Fig. 63.1a, b). In addition, one normal specimen (Fig. 63.1c) with total length = 149 mm, standard length = 135 mm, weight = 160 g was obtained from the same locality for comparison. Eutrophication and town, industrialised and agricultural contamination are deliberated to be the chief human impacts affecting the marsh areas in Iraq (Yaseen et al. 2016; Mahdi and Fawzi 2014).

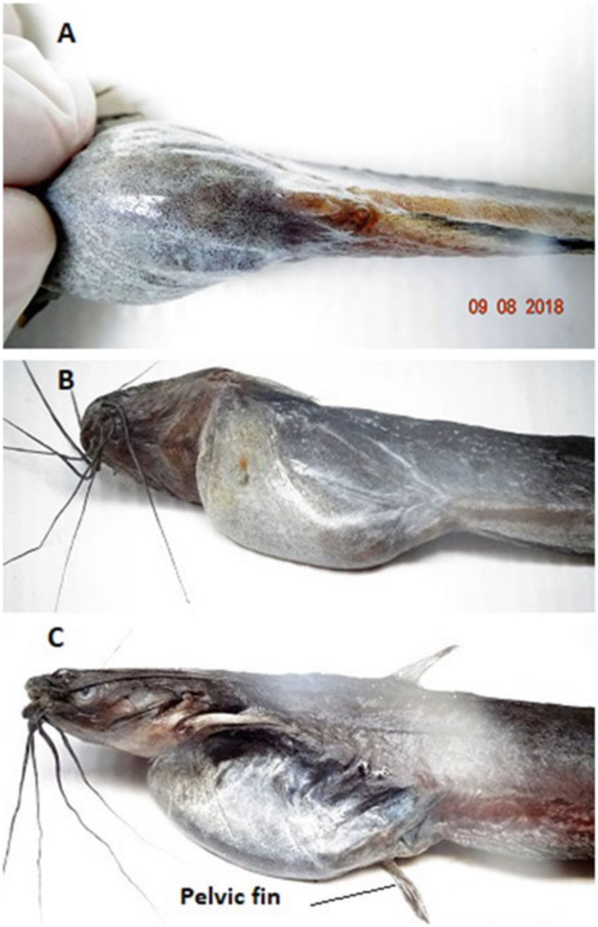

Fig. 63.1 The Indian catfish *Heteropneustes fossilis*. (**a**), Abnormal specimen, 148 mm TL showing absence of pelvic fins (a close up view); (**b**) general view; (**c**) normal specimen, 135 mm TL

So to ratify the lack of the entire pelvic assembly, the abnormal specimen captured in the marsh area was dissected and related with a normal specimen of the same standard length (Fig. 63.1c).The studied materials were kept in 70% ethanol and deposited at the fish collection of the Fisheries and Marine Resources Department, College of Science, University of Basra, Basrah, Iraq.

Exterior inspection of the area where the origins of the pelvic fins must be occur (underneath the pectoral fins) has shown no mark or excised and was normal looking, demonstrating that the specimens never established the exact structures. This was further inveterate by dissection of the specimen. Though, the pterygiophores of the dorsal and anal fins, the vertebrae and the air bladder in the examined specimen seemed normally grown.

Since only one deformed specimen was captured and no genetic study was conceivable, it might be expected that the perceived anomaly may have been a consequence of a genetic mutation, or could be accredited to the dilapidation of the water class of the marsh area.

63.5 Future Research

Before we proceed to put a plan to improve the environment where the fishes are living in, it is important to ask the following questions of what grade parental and early habitat impacts disturb upcoming acts of fishes and what the genetic, epigenetic, neural and hormonal contrivances are? For instances, environmental influences throughout development might have influence on the adult morphology that is hard to understand when testing acts onthe organism in the field**.** Deprived of this data, climate modification influences could be incorrect. Since there is a time gap between the reason and consequence, influences of such early impressions are mainly exposed through long-lasting experimental studies.The relations between early impacts, behaviour, growth and life-history features are not very well understood, and new data about these events will be valued for accepting the population and species influences in relation to natural and human-made habitat modifications and climate modification.

Early habitat influences on later functioning in fishes are as yet a poorly studied field. New investigations must be intended at establishing the contrivances of this plasticity, and how the norms of reaction are and copy changes in capability of the fishes to react to habitat modifications? By growing the appreciation of relations between habitats and genotypes, the aptitude to imagine population reactions to early influences on later morphologic plasticity will be established.

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