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ANOMALIES IN *CIRRHINUS MRIGALA*, A COMMERCIALLY IMPORTANT FRESHWATER FOOD FISH, FROM GURDASPUR DISTRICT OF PUNJAB

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ABSTRACT

Cirrhinus mrigala, an important Indian major carp and commonly known as Mrigal, is widely distributed in Indian lotic and lentic water bodies and is cultured in ponds in various Indian states. During the survey of deformed fishes, eight specimens of *Cirrhinus mrigala*, brought and reared in some fish ponds of Gurdaspur district of Punjab were seen at Gumat fish market, Jammu, and have been described for various morphological and vertebral deformities. The deformities, as noticed in the aberrant fish specimens of *Cirrhinus mrigala* are generally post dorsal and are most probably induced by excessive use of pesticides in agricultural fields in the area resulting in surface and ground water contamination.

INTRODUCTION

Increasing pollution load caused by irrigation, industries, thermal power plants, sewage discharge and indirect sources such as atmospheric pollutants, is ultimately faced by the biological communities inhabiting lotic and lentic water bodies. Among aquatic organisms, fish is the most important and is eaten worldwide. It is considered as a rich source of protein, vitamins, minerals, carbohydrates and fats. The economy of some coastal countries largely depends on fishing industry. Besides, it provides employment opportunities to millions of people associated directly or indirectly with this industry. Pollutants in various water bodies may cause direct mortality and even extinction or may induce anomalies through change in the chromosomal structure of the cell in fish and other aquatic organisms. Under blue revolution programme, culture of major carps viz. *Labeo rohita*, *Cirrhinus mrigala*, *Catla catla*, *Ctenopharyngodon idellus*, *Hypophthalmichthys molitrix* etc. has been started in many districts of Punjab. These cultured fishes are consumed not only in various districts of Punjab but are exported to neighboring states including J&K. Anomalies in *Cirrhinus mrigala,* a commercially important food fish, have earlier been reported by Sarkar and Konar (1993), Rath *et al.*(1995), Gupta *et al.*(1998, 2000 and 2002), Dutta *et al.* (2006); Dutta and Gupta(2008).

The objective of this study is to add to the existing knowledge on fish teratology from this part of the country.

MATERIALS AND METHODS

Punjab state, the area of present study, extends from 29º32′ to 32º32′ NL to 73º55′ to 76º50′ EL, occupying a total land area of 50, 362km^2 is situated in north-west of India. The state is wedged between Pakistan on west, J&K on north, Himachal Pradesh on the north-east and Haryana and Rajasthan on south. On physical ground, topography of Punjab can be divided into upper portion of sub-shivalik area and the east of Punjab is situated on Sutlej and Ghaggar river basins. The divided Punjab has two major rivers viz. Ravi and Beas. Punjab state is leading producer of food grains in the country.

During the survey of fish market in Jammu, eight deformed specimen of *Cirrhinus mrigala,* brought from Gurdaspur district of Punjab, were seen at Gumat fish market and analyzed for:

1. Morphological examination

Fresh fish specimens were examined grossly for morphological abnormalities. Notable morphological deformities were photographed with Digital Camera and fish was preserved in 10% neutral buffered formalin.

2. Morphometric examination

A total of 13 morphometric measurements were recorded for each Fish (Table 1).

3. Radiological examination

These deformed specimens were examined by radiography using Fuji Green Base Film with SOFTEX CMB-2 at 10 milliamps

and 50kv. for 0.25 sec. For comparison, normal fish specimen was also radiographed.

RESULTS

Various morphological and vertebral deformities as observed in the collected fish specimens include.

***Cirrhinus mrigala* showing post-dorsal dome, a trough between dorsal and caudal region and disposition of anal fin (Figs. 2a-c).**

This solitary aberrant specimen of *Cirrhinus mrigala*, measuring 31.8cm and weighing 550g, was recognized by the presence of post-dorsal dome and a trough between dorsal and caudal region and disposition of anal fin. In a normal fish, anal fin falls short of caudal fin base, whereas in this aberrant fish, longest anal fin ray extends beyond caudal fin base (Fig. 1a) The number of lateral line scales is 42 in both normal and abnormal fish. The lateral line is normal and runs from anterior to the posterior end of the body. In this aberrant fish specimen, lateral line, after 17th scales, posteriorly forms a trough followed by a dome between 24 to 38 scales. Number of fin rays in paired and unpaired fins of this aberrant fish showed no deviation from the normal fish. Body ratio showed a well marked variation from the normal fish (Table 1)

Radiological examination has revealed the presence of 35 and 34 vertebrae, in normal and abnormal fish, respectively (Figs.1b and 2c). Vertebral column, in the aberrant fish, between 1st to 14th vertebrae, forms an arc giving the appearance of a dome. Between 15th to 27th vertebrae, vertebral column forms a semi-circular trough, 15th to 18th vertebrae forms the anterior limb of trough, 19th to 22nd vertebrae the bottom and 23rd to 27th vertebrae form the posterior limb of trough. Vertebrae have reduced intervertebral space and vertebral thickness. Posteriorly, vertebral column between 28th to 34th vertebrae is slightly truncated and vertebral thickness and intervertebral spaces reduced.

***Cirrhinus mrigala* showing post-dorsal truncated body with anal dome, reduced caudal peduncle and disposition of anal fin (Figs. 3a-c).**

Measuring 27.5cm and weighting 580g, this abnormal specimen of *Cirrhinus mrigala,* was recognized by the presence of post-dorsal truncated body with anal bulge, disposition of fins and short peduncle. In this abnormal fish specimen, there is no abnormality in the location of dorsal, pectoral and pelvic fin. Anal fin, however, extends beyond the origin of bilobed caudal fin base. In normal fish, anal fins fall short of caudal fin base. Lateral line scales in aberrant fish are reduced and overlapping in the caudal peduncle region. Number of fin rays in dorsal, pectoral, pelvic, anal and caudal fin in normal and abnormal fish showed no variation. There is well marked deviation in body ratios of this abnormal fish (Table 1).

X-ray analysis revealed that post-dorsal truncated body with anal bulge, short caudal peduncle and disposition of anal fin is caused by hook shaped appearance of vertebral column between 26th to 34th vertebrae, reduction in size of 28th and 29th vertebrae, intervertebral space reduction between 30th to 34th vertebrae.

***Cirrhinus mrigala* showing reduced mouth with protruded lips and shorter head with lateral bulge in opercular region (Figs. 4a-c)**

Recognized by reduced mouth with protruded lips and short head with lateral bulge in the opercular region, this aberrant specimen of *Cirrhinus mrigala* measured 22.5cm and weighing 300g. Unlike normal fish, in this aberrant fish, head is blunt, short and forms a bulge on both the sides of operculum. There is no variation in the number of unpaired and paired fin rays in this aberrant fish from normal fish. Radiological study revealed reduction in size of opercular bones.

***Cirrhinus mrigala* showing truncated post-dorsal body, reduced caudal peduncle, degenerated caudal fin and disposition of dorsal and anal fin (Figs.5a-c)**

This aberrant specimen of *Cirrhinus mrigala* showing truncated post-dorsal body reduced caudal peduncle and degenerated caudal fin measured 20cm and weighed 320g.

Placement of dorsal, pectoral and pelvic fin, in this aberrant fish, is like normal fish. Anal fin, however, in this abnormal fish extends beyond caudal fin base. Caudal fin has a single lobed, unlike in normal fish, with only four fin rays. Lateral line scales in normal fish are 42 whereas in the aberrant fish specimen the number of lateral line scales is 35 and are

Table 1: Comparison of various morphological features of normal and abnormal specimens of *Cirrhinus mrigala* (Ham. Buch.)

	Normal fish	Abnormal fishes						
Ratios with total body length	Fish 1	Fish 2	Fish 3	Fish 5	Fish 6	Fish 7	Fish 8	Fish 9
Head length	5.22	6.49	5.61	6.6	5.7	5.35	5.23	4.49
Body height	5.2	4.41	4.58	4.76	3.94	4.81	4.5	4.02
Pre-dorsal length	2.78	2.79	2.04	2.56	2.47	2.78	2.42	2.38
Post-dorsal length	1.58	2	1.37	1.6	2.05	1.6	1.7	1.72
Pre-anal length	1.6	1.16	1.43	1.5	1.62	1.55	1.47	1.55
Post-anal length	2.97	7.22	2.86	2.99	2.74	3.12	3.09	2.91
Length of pectoral fin	6.09	6.36	4.15	5.26	5.84	5.35	5.23	5.48
Length of pelvic fin	7.1	7.57	5.23	6.66	6.9	6.6	6.18	6.54
Length of anal fin	7.3	6.36	4.68	5.88	7.35	6.45	5.66	5.95
Length of caudal fin	4.57	4.12	3.38	5	361	5.07	4.78	5.97
Pectoral-pelvic origin distance	4.12	4.67	6	4.1	4.56	7.2	3.31	7.6
Pelvic-anal origin distance	4.49	5.3	4.58	4.8	5.7	3.9	7.85	2.7
Anal-caudal origin distance	6.09	13.82	2.86	7.69	2.05	5.01	7.1	6.1

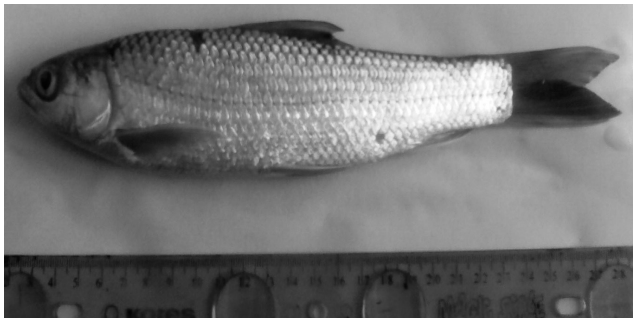

Figure 1a: Normal specimen of *Cirrhinus mrigala* (Ham. Buch.)

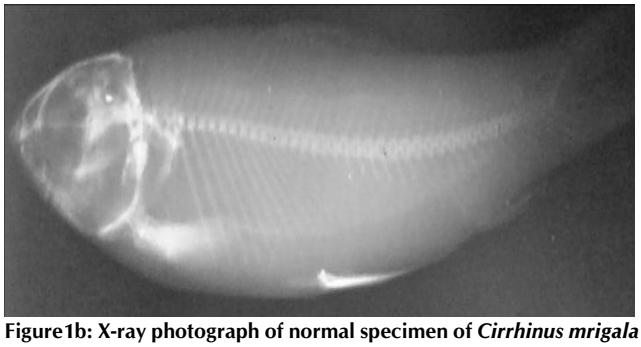

Figure1b: X-ray photograph of normal specimen of *Cirrhinus mrigala* (Ham. Buch.)

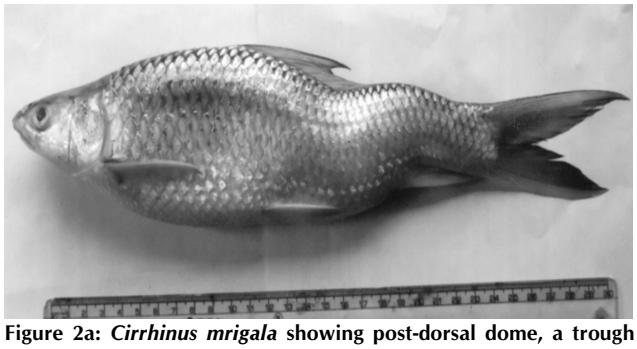

Figure 2a: *Cirrhinus mrigala* showing post-dorsal dome, a trough between dorsal and caudal region and disposition of anal fin

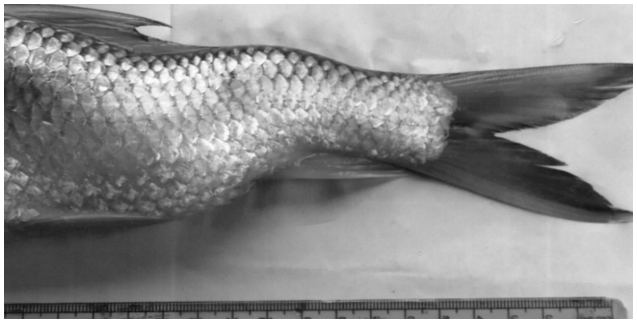

Figure 2b: Post-dorsal dome, a trough between dorsal and caudal region and disposition of anal fin

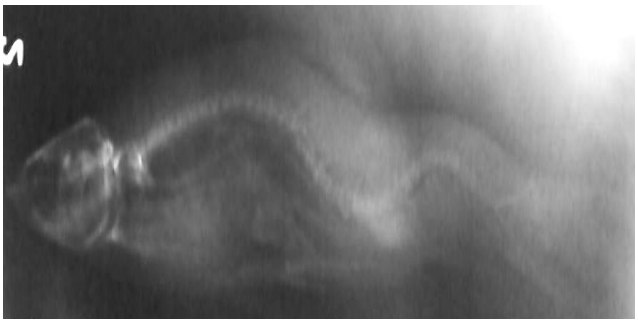

Figure 2c: X-ray photograph of aberrant specimen of *Cirrhinus mrigala* (Ham. Buch.)

Figure 3a: *Cirrhinus mrigala* showing post-dorsal truncated body with anal dome, reduced peduncle and disposition of anal fin

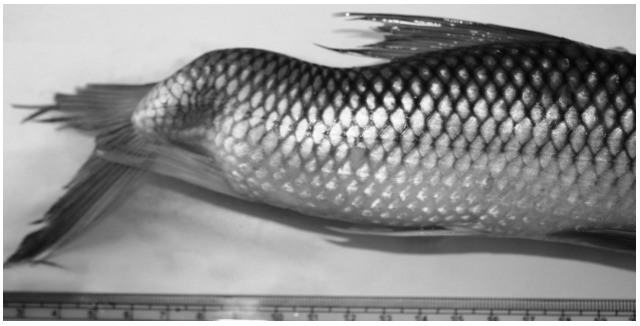

Figure 3b:Post-dorsal truncated body with anal dome, reduced peduncle and disposition of anal fin

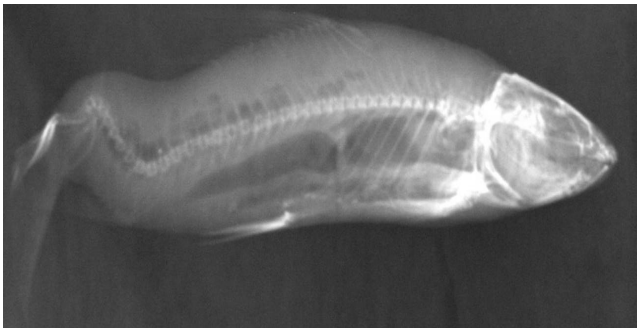

Figure 3c: X-ray photograph of aberrant specimen of *Cirrhinus mrigala* (Ham. Buch.)

reduced posteriorily in the caudal region. Number of dorsal, pectoral, pelvic anal and caudal fin rays in normal and abnormal fish is 13, 9, 7, 6 and 20 and 13, 9, 7, 6 and 4, respectively. There is great variation in body ratios of this aberrant specimen from a normal fish (Table 1).

Radiological examination revealed that truncated post-dorsal body, reduced caudal peduncle and disposition of dorsal and anal fin is due to upward curvature of vertebral column between 24^{th} to 32^{nd} vertebrae and reduced intervertebral spaces and vertebral thickness between last 6 vertebrae.

***Cirrhinus mrigala* showing truncated post-dorsal body, left lateral bulge and right lateral depression in anal region (Figs. 6a-c)**

Figure 4a: *Cirrhinus mrigala* showing reduced mouth with protruded lips and reduced head with lateral bulge in the opercular region

Figure 4b: Reduced mouth with protruded lips and reduced head with lateral bulge in the opercular region

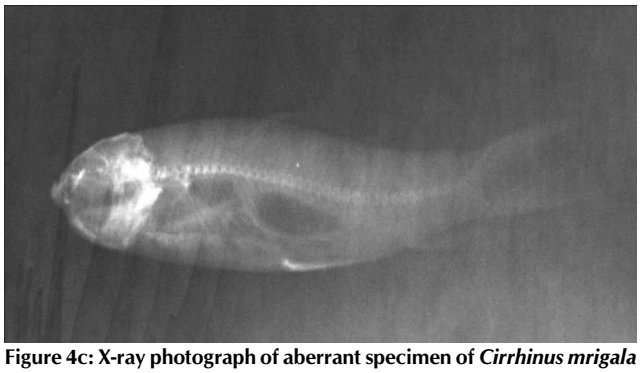

Figure 4c: X-ray photograph of aberrant specimen of *Cirrhinus mrigala* (Ham. Buch.)

This adult aberrant specimen of *Cirrhinus mrigala*, measuring 22.8cm and weighing 620g, was recognized by short, truncated body with left lateral bulge and right lateral depression in anal region. Like normal fish, in this aberrant fish, dorsal fin originates anterior to the middle of body, longest pectoral fin ray falls short of pelvics and longest pelvic fin ray falls short of anal. In normal fish, longest anal fin ray falls short of caudal fin base, whereas longest anal ray extends beyond the caudal fin base, in this aberrant fish. There is no deviation in paired and unpaired fin rays of normal and this aberrant fish. Body ratios in this aberrant fish showed a well marked variation from the normal fish (Table 1).

Radiographical analysis revealed that truncated post-dorsal body, left lateral bulge and right lateral depression in anal region is caused by the formation of dome in vertebral column in first ten vertebrae, fusion of 18th to 20th vertebrae leading to the formation of undifferentiated mass, L-shaped structure formation by vertebral column between 24th to 29th vertebrae; 24th to 27th vertebrae forming its vertical limb and 28th and

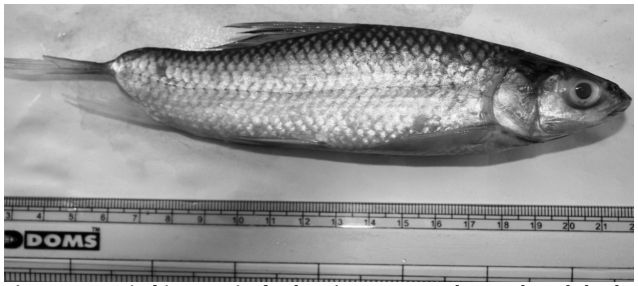

Figure 5a: *Cirrhinus mrigala* showing truncated post dorsal- body, reduced caudal peduncle, degenerated caudal fin and disposition of dorsal and anal fin

Figure 5b: Truncated post- dorsal body, reduced caudal peduncle, degenerated caudal fin and disposition of dorsal and anal fin

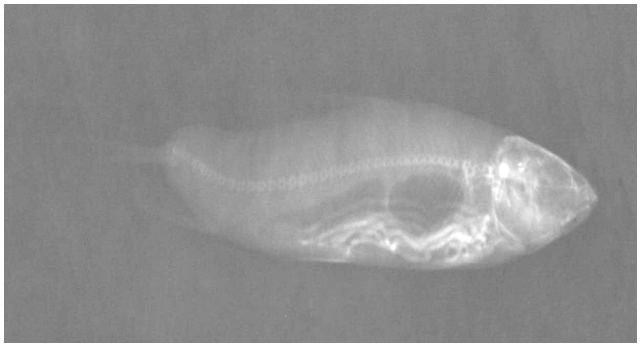

Figure 5c: X-ray photograph of aberrant specimen of *Cirrhinus mrigala* (Ham. Buch.)

29th vertebrae forming its horizontal limb.

***Cirrhinus mrigala* showing post-dorsal dome and disposition of dorsal and anal fin (Figs.7a-c)**

This aberrant specimen of *Cirrhinus mrigala,* measuring 28.4cm and weighing 190g, was recognized by post-dorsal dome and disposition of dorsal and anal fin. In the normal specimen, dorsal fin location is more towards the snout than the caudal fin base. Contrary to this, in this abnormal fish, dorsal fin is located more towards the caudal fin base than the snout. Like normal fish, in this aberrant fish, longest pectoral fin ray falls short of pelvic fin base and longest pelvic fin ray falls short of anal fin base. Anal fin, in this abnormal fish extends beyond the caudal fin base. In normal fish, however, anal fin falls short of caudal fin base. Lateral line in normal fish, with 42 scales, runs from anterior to the posterior side of the body and extends up to the base of caudal fin. In this abnormal fish, lateral line with 42 scales runs normally up to 25th scale, between 24th to 26th scales lateral line is turned upward and runs straight posteriorly. Scales in the caudal

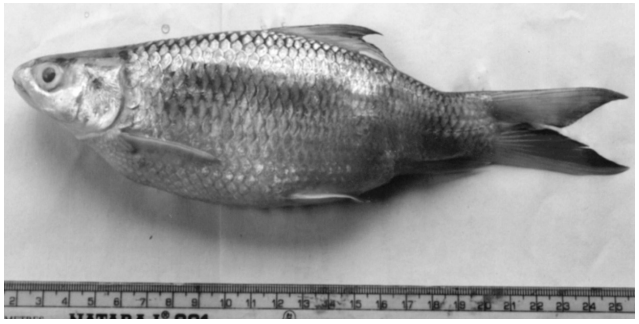

Figure 6a: *Cirrhinus mrigala* showing truncated post-dorsal body, left lateral bulge and right lateral depression in anal region

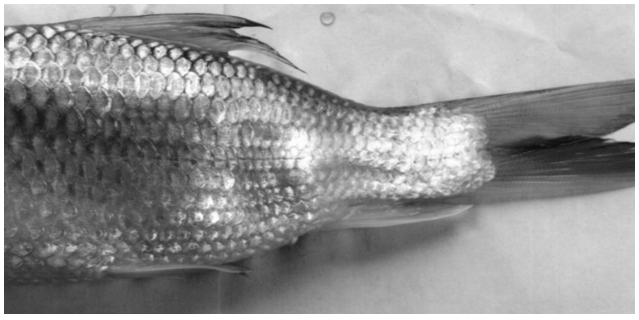

Figure 6b: Truncated post dorsal body, left lateral bulge and right lateral depression in anal region

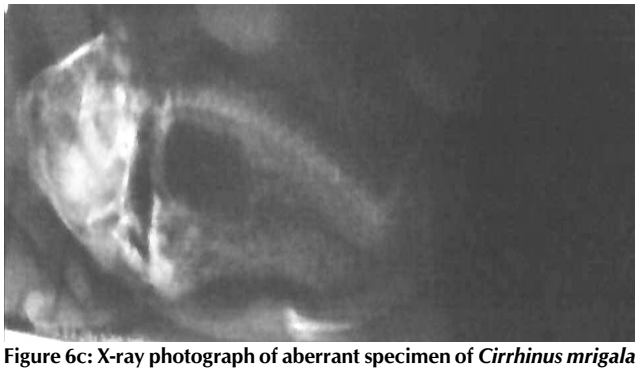

Figure 6c: X-ray photograph of aberrant specimen of *Cirrhinus mrigala* (Ham. Buch.)

peduncle region of this abnormal fish are shot and overlapping. The number of dorsal, pectoral, pelvic, anal and caudal fin in the normal and abnormal fish is same. A well marked variation in the body ratios of normal and abnormal fish is noticed (Table 1).

X-ray examination has revealed the presence of 35 and 34 vertebrae, in normal and abnormal fish, respectively (Fig.1b). In the normal fish, vertebral column, is streamlined and runs from anterior to the posterior end of the body. In this abnormal fish, first five vertebrae of the vertebral column, after complex vertebrae, have reduced intervertebral space and vertebral thickness. Upward curvature of vertebral column between 25^{th} to 31^{st} vertebrae results in formation of post-dorsal dome and disposition of dorsal and anal fin.

***Cirrhinus mrigala* showing post dorsal truncated body, a bulge at the caudal peduncle region and disposition of dorsal and anal fin (Figs.8a-c)**

This aberrant specimen of *Cirrhinus mrigala,* measuring 27.4cm and weighing 210 g, showed post dorsal truncated

Figure 7a: *Cirrhinus mrigala* showing post dorsal dome and disposition of dorsal and anal fin

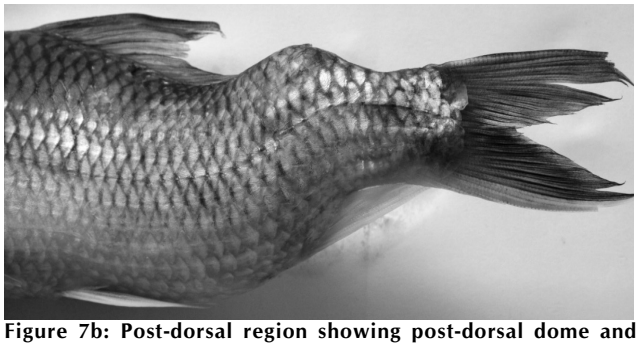

Figure 7b: Post-dorsal region showing post-dorsal dome and disposition of anal fin

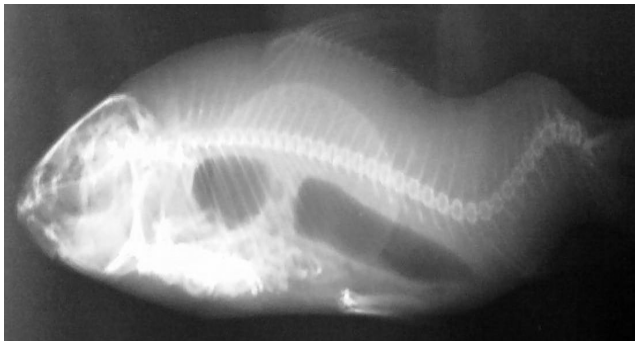

Figure 7c: X-ray photograph of aberrant specimen of *Cirrhinus mrigala* (Ham. Buch.)

body, a bulge at the caudal peduncle region and disposition of dorsal and anal fin. Unlike normal fish, anal fin reaches almost half of the caudal fin. In normal fish, anal fin fall short of caudal fin base. Caudal fin in both normal and abnormal fish is bilobed. There is no deviation in the paired and unpaired fin rays from the normal fish. The deformed specimen exhibits a well marked variation in the body ratios from the normal fish (Table 1).

Radiological examination has revealed the presence of 35 and 30 vertebrae, in normal and abnormal fish, respectively (Fig.1b). X-ray analysis revealed the thickening of 17th vertebrae, the fusion of vertebrae between 18th to 19th and 20th to 22nd vertebrae and reduction in intervertebral space and vertebral thickness between 23rd to 27th vertebrae. Posteriorily, 28^{th} to 30^{th} vertebrae in vertebral column, are clustered and degenerated. Urostyle is not demarcated.

***Cirrhinus mrigala* showing post anal bulge, short caudal peduncle and disposition of dorsal and anal fin (Figs.9a-c).**

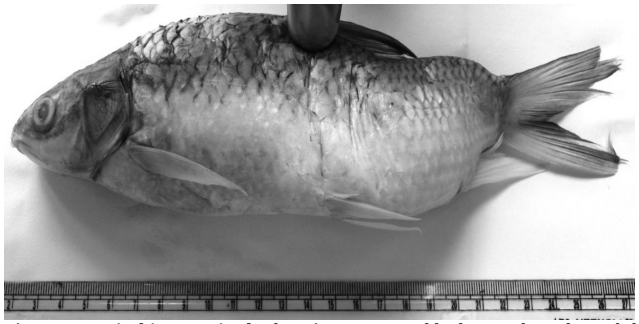

Figure 8a: *Cirrhinus mrigala* showing post-anal bulge, reduced caudal peduncle and disposition of dorsal and anal fin

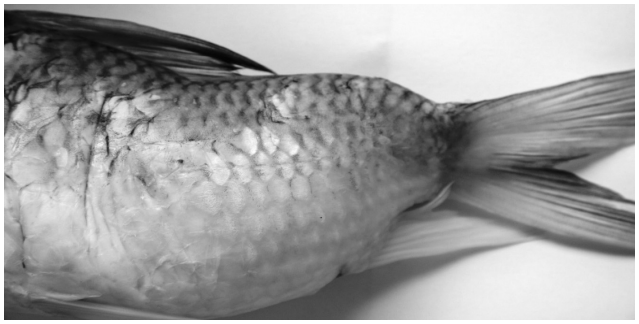

Figure 8b: Post-dorsal region showing reduced caudal peduncle and disposition of anal fin

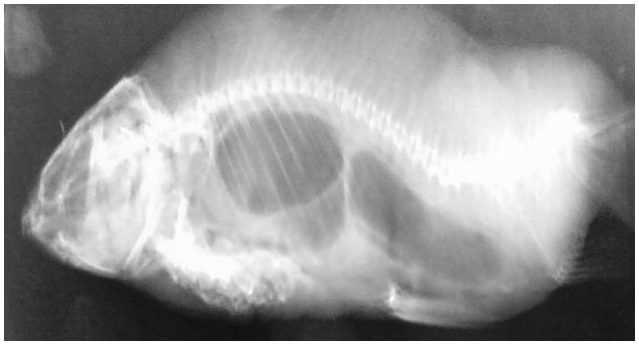

Figure 8c: X-ray photograph of aberrant specimen of *Cirrhinus mrigala* (Ham. Buch.)

This deformed specimen of *Cirrhinus mrigala* measuring 34cm and weighing 350g was recognized by the presence of post-anal bulge, truncated caudal peduncle and disposition of dorsal and anal fin. In normal fish, dorsal fin is located more towards the snout than the caudal fin base. In this aberrant fish, dorsal fin is located more towards the caudal fin base. Like normal fish, pectorals fall short of pelvics, pelvics fall short of anal and anal fin rays fall short of caudal fin base. Lateral line in this abnormal fish like normal fish, is streamlined with 42 scales and extends up to the base of caudal fin lobe. In the post-anal region scales are short and overlapping. Number of fin rays of this abnormal fish shows no deviation from the normal fish, whereas, a well marked variation is seen in the body ratios of both normal and abnormal fish (Table 1).

X-ray study revealed post-anal bulge, reduced caudal peduncle and disposition of dorsal and anal fin is caused by upward turning of vertebral column between 23rd to 31st vertebrae and clustering in vertebral column between 25th to 31st vertebrae.

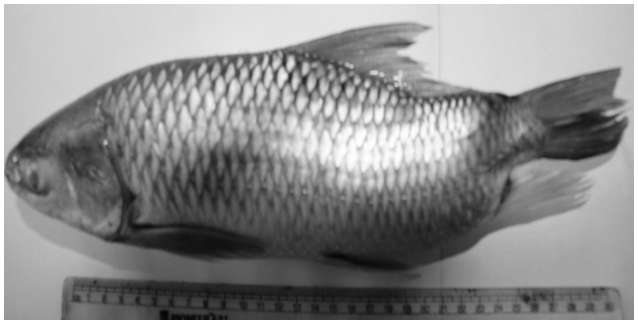

Figure 9a: *Cirrhinus mrigala* showing post-anal bulge, reduced caudal peduncle and disposition of dorsal and anal fin

Figure 9b: Post-dorsal region showing anal bulge, reduced caudal peduncle and disposition of anal fin

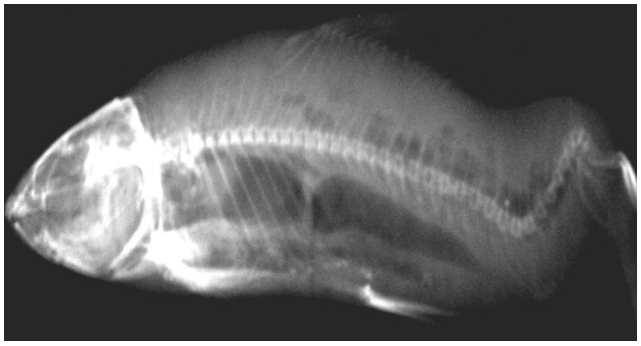

Figure 9c: X-ray photograph of aberrant specimen of *Cirrhinus mrigala* (Ham. Buch.)

DISCUSSION

Fish anomalies have been ascribed to multiple factors like currents (Hilger, 1992; Divanach *et al.*, 1997; Cerezo *et al.*, 2005), temperature variations (Milton, 1971; Gluth and Hanke, 1983), salinity fluctuation, low dissolved oxygen (Turner and Farley, 1971), high CO_2 concentration in water (Martens *et al.*, 2006), pollutants like chlorinated hydrocarbons, organophosphates, pesticides, heavy metals (Kessabi *et al.*, 2009 and Lin Sun *et al.*, 2009), exposure to ultraviolet radiations, dietary vitamin deficiency(Newsome and Piron, 1982; Kanozaw, 1993 and Azzaydi *et al.*,1999), parasitic infection(Stauth, 2004; Yokoyama *et al.*, 2005 and Cunningham *et al.*, 2005), inbreeding (Pandey and Awasthi, 1994) and dense rate of stocking(Pearsons and Hopley, 1999), hereditary factors (Ando *et al.* 1995), developmental error

(Shekhar and Dutta, 1993 and Gupta *et al*., 2000) and injury (Dutta and Kumar, 1991 and Devadoss, 1983).

In Punjab, the leading state in food grain production in the country, there is a steep rise in pesticides use in the past 36 years ranging from 213 metric thousand tons in 1970-71 to 1692 metric thousand tons in 2006-07(http:// www.punenvis.nic.in). Therefore, various anomalies in the *Cirrhinus mrigala*, under discussion, are most probably induced by pesticides used in agricultural fields in Punjab, causing surface and groundwater contamination. Pesticide induced anomalies have also been reported in other aquatic animals like amphibians (Kavlock, 1998; Quellet *et al*., 1997).

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