First Report of A Xanthic Phenotype of the Silver Carp, Hypothalamichthys molitrix (Valenciennes, 1844) (Teleostei: Cyprinidae) from Maharashtra Fish Seed Production Centre, India

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Abstract On 21st November 2016 and 4th January 2017, two specimens of silver carp Hypothalamichthys molitrix (TL 750-762 mm, SL 610-470 mm) were reported for the first time from Maharashtra Fish Seed Production Centre, Maharashtra, India. This condition of the skin, in which yellow coloration predominates is called xanthism. This is the first ever report of xanthism H. molitrix. The yellow colour is covering the whole body of the two malformed specimens. Head, eyes and fins were having a faint orange coloration. In the abnormal specimens, red to orange spots replacing the dark spots found in the normal specimens. Other deformities such as distorted lateral line were noted in one of the abnormal specimens.

Keywords Cyprinidae; Xanthism; Silver carp; India

1 Introduction
Many alien fish species have been illegally brought into India by private aquaculturists, entrepreneurs and aqua-industrialists for immediate gains and several ponds and lakes were stocked with these species in the 1950s (Singh and Lakra, 2011). The silver carp was introduced in 1959 with the aim to enhance the aquaculture sector and increasing yields.

Silver carp Hypothalamichthys molitrix (Valenciennes) is belong to the family Cyprinidae. It is originally described as species of the genus Leuciscus and subsequently placed in the genus Hypothalamichthys (Oshima, 1919). This species is native to eastern Asia and has been broadly introduced to southern Asia, Europe and North America (Kolar et al., 2007). It has a deep and spindle-shaped body, laterally compressed with a well-developed keeled abdomen that extends from the throat to the vent (Figure 1). Adult coloration is typically gray-black dorsally, upper sides olivaceous grading to silver laterally and ventrally. Fins are dark and without true spines; however, in larger individuals the anterior ray of the pectoral fins is thickened, stiff and is finely serrated posteriorly.

Several freshwater fish groups have shown variable cases of xanthism including members of the families Centrachidae (Allen and Neill, 1953), Cichlidae (Webber et al., 1973), Cyprinodontidae (Turner and Liu, 1977), Lepisosteidae, (McIlwain and Waller, 1972; Tyler, 1990), Percidae (Denoncourt 1976) and Poeciliidae (Angus and Blanchard, 1991). The phenomena of xanthism have a genetic basis that explains the wide range presence across a wide taxonomic spectrum (Angus and Blanchard, 1991). It characterised by a partial or predominant yellow skin or integument colour that affects small parts of populations of some species (Smith, 1971, Béarez et al., 2006).

The xanthic phenotype has an impact on the survival of the individuals bearing this case, where they are conspicuous to the predator more than those individuals with normal coloration (Endler, 1980). This unfortunate occurrence of visibility makes the xanthic individuals within each species rare (Turner and Liu, 1977; Pattengill-Semmens, 1999).
As far as the authors are concern, no xanthic phenotype has been on record of the silver carp from both the wild and the artificial habitats. Therefore, the aim of this study is to document and describe for the first time ever the presence of xanthic case for this species.

2 Material and Methods
Two specimen of silver carp *Hypophthalmichthys molitrix* (TL 750-762 mm, SL 610-470 mm, normal specimen TL 297 mm, SL 282 mm) were obtained on 21st November 2016 and 4th January 2017. The specimens were supplied by Maharashtra Fish Seed Production Centre, Kesapuri camp, near Majalgaon Tahasil, Maharashtra, India (Figure 1). It is a circular hatchery and includes one breeding pond, three spawning tank, three nursery pond, six rearing pond and three stocking ponds. Its area is 12 acre, with pond size 150 x 100 x 6 and 180 cm maximum depth (depth 6 feet). Source of water is from Majalgaon reservoir and wells. Body and fins were examined carefully for external parasites, malformations, amputations and any other morphological anomalies. The specimens were kept frozen at the Maharashtra Fish Seed Production Centre, Maharashtra, India. Once in the laboratory, measurements were recorded to the nearest millimetre.

3 Results
Xanthic phenotype was described from two specimens of *H. molitrix*. The description of the distribution of the xanthic pigmentations is given below based on the actual observation (Figure 2) and compared with that of the normal specimen (Figure 3a). They have the following body proportions: total length 750, 762 mm; standard length 610, 470 mm; head length 195, 151 mm; predorsal fin length 170 mm, 175; prepectoral fin length 200, 163 mm; preanal fin length 495, 390 mm; caudal fin length 140, 110 mm.

The whole body of the two xanthic phenotype specimens is covered with yellow color, with faint orange color on head except the eye and all fins (Figure 3b). The dark pigmentations found on the whole body of the normal specimen were disappeared. Instead, there were red to orange spots of different sizes were distributed in the ventral side of the fish body. These spots have aggregated mainly in the areas of the pelvic and anal fins, and caudal peduncle.

One of the xanthic specimen has shown a distorted lateral line. The distortion is observed in the ascending part of the lateral line posterior to the head and in the area dorsal to the anal fin (Figure 4a; b).

Figure 1 View of the pond of Maharashtra Fish Seed Production Centre, where the fish specimens obtained
4 Discussion

In fishes, the xanthophores that showed the golden color are called the xanthophores. Changing in the density of these chromatophores, the color of the fish body can be changed accordingly. The presence of the melanic chromatophores usually masks the appearance of the xanthophores, but with the complete disappearance of the former from any region of the fish body, xanthophores became revealed (Webber et al., 1973) and the case known as xanthochromism. In such condition, the chromatophores contain E-carotene and canthaxanthin and import a golden colour (Webber et al., 1973). It has been suggested that xanthophores may even be over-produced in the absence of melanophores or other pigment cells (Angus and Blanchard, 1991).
In both marine and freshwater fishes, the xanthic pigmentation in general and the xanthic phenotype, in particular, are uncommon variants (Palacios-Salgado and Rojas-Herrera, 2012), but golden phases in reef fish are relatively common, especially in Hawaii and the Red Sea (Pattengill-Semmens, 1999). No xanthic phenotype for any fish species was reported from India and in particular for the silver carp *H. molitrix*. Therefore, the present study is important as it is report for the first time the appearance of the xanthic phenotype in reared *H. molitrix* specimens.

The case of xanthism in *H. molitrix* is consider a severe case with the complete disappearance of the melan chromatophores. Such result were observed in several fish species (Palacios-Salgado and Rojas-Herrera, 2012; Pattengill-Semmens, 1999). Unlike other studies, the present xanthic phenotype has no areas on its body that retain the original coloration. This means that a mutation in the gene for xanthophores in all body regions has taken place that leads to a lost in the black pigments (Lister et al., 1999; Watanabe and Kondo, 2015). In zebrafish, Odenthal et al. (1996) found that some mutation in about 7 genes will lead to faint or dark yellow colour. Mutations can affect the nervous system and cause a reversible colour change, which leads to permanent colour patterns. The xanthic pigmentation observed in *H. molitrix* appeared to be permanent and is probably the result of a single gene recessive mutation (see Dunham and Children, 1980). Because the occurrence of this xanthic pigmentation of *H. molitrix* was not reported in other areas of the world, this mutation appears to have occurred locally and subsequently spread throughout the relatively isolated gene pool.

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