

## Malpigmentation in *Diagramma pictum* and *Pardachirus marmoratus* Collected from the Arabian Sea Coasts of Oman

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**Abstract** Cases of partial hyper pigmentation and malpigmentation were reported from *Diagramma pictum* and *Pardachirus marmoratus* collected from the Arabian Sea coasts of Oman. These cases are the first report on color anomalies in these two fish species. Hyper pigmentation spots were observed mainly on the side of *D. pictus*, while the malpigmentation patch was observed across the body of *P. marmoratus*. Both cases are not pathological, but they have an economic effects that the melanic or the ambicolored specimens may cause to the fishermen due to being unfavourable by the customers.

**Keywords** Melanosis; Flatfish; Haemulidae; Color aberration; Salalah; Metamorphosis

## Introduction

In fishes, malpigmentation occurs as either a deficiency (albinism or hypomelanosis) or an excess (melanism or hypermelanosis) of pigmentation (Simon et al., 2009; Jawad et al., 2013), while xanthism or xanthochroism is a certain form of hypomelanism, where the bright yellow or orange body coloration became prevailing (Lewand et al., 2013). Such changes will reduce its marketing price as it can discourage the customer from buying and on the survival of the fish in the environment (Heemstra and Randall, 1993). Malpigmentation in teleosts has been widely studied in Pleuronectiform fishes in relation to developing asymmetry (Venizelos and Benetti, 1999; Barton, 2010), but it has been also noticed in other fish groups in the wild but to a lesser extent (Brito and Caramaschi, 2005; Jawad et al., 2013).

The flatfish usually has a symmetrical body skin in the period from hatching to metamorphosis in which larval-type melanophores are evenly distributed. The pigmentation cells are speedily formed on only the ocular side during the process of metamorphosis, while the blind-side skin shows no pigment pattern (Byun et al., 2007). The ambicoloration could be partial, involving the parts on the ocular or the blind sides (Chabot et al., 2007). The etiology of these abnormalities has not been resolved, although these conditions have no pathogenic effect on the fish (Soutar, 1995).

*Diagramma pictum* and *Pardachirus marmoratus* are among the commercially important fish species in Oman. They are marine species living in association with reefs. Their distribution is confined to the Indian Ocean. *Diagramma pictum* is a solitary species prefers muddy, sandy or silty substrates in protected bays or estuaries (Kuiter and Tonozuka, 2001). It feeds on benthic invertebrates and fishes (Sommer et al., 1996). *Pardachirus marmoratus* lives in shallow coastal waters, on sand and mud bottoms (Sommer et al., 1996). It feeds mainly on bottom living invertebrates. This species is characterized in producing a bitter toxic substance from the bases of the dorsal and anal fin rays that deters predation, even by sharks (Lieske and Myers, 1994).

Jawad and Al-Mamry (2009), Jawad and AL-Kharusi (2013), Jawad et al. (2013), Jawad and Ibrahim (2014) and Ibrahim and Jawad (2017) were the only works have been performed on the color aberration in fishes from the Arabian Gulf and the Sea of Oman areas. No previous studies on ambicoloration of *P. playfairi* have been done in these areas before.

The aim of the present study are: (1) to record and describe for the first time a partial ambicoloration in *D. pictum* and *P. marmoratus* from Omani waters; (2) to add a valuable information to the world marine science library. For these aims, this study is considered important.

## 1 Materials and Methods

One specimen of *D. pictum* and *P. marmoratus* were captured on 25<sup>th</sup> July 2012 in the waters of Salalah City on the Arabian Sea coasts of Oman. The specimens were collected during the ichthyological survey at the Arabian Sea coasts of Oman by Al-Mustaquila trawler vessel. Demersal trawl with a 40 mm cod end net at depth 430 m was used for 1.5–2.0 nautical miles at a speed of approximately 3 knots, 0.5 h tows. Body and fins were examined carefully for external parasites, malformations, amputations and any other morphological anomalies. Once in the laboratory, measurements were recorded to the nearest millimetre. The specimens were fixed in 10% formalin and later preserved in 70% ethanol for deposit in the fish collection of the Marine Science and Fisheries Centre, Ministry of Agriculture and Fisheries Wealth, Muscat, Sultanate of Oman. Catalogue numbers OMMSFC 01023 and 01024 for *D. pictum* and *P. marmoratus* respectively.

## 2 Results

Ambicoloration cases were observed in the two species of the two families studied. The description of the aberrant coloration distribution in each species studied is given below based on the case of color abnormality.

### I. Partial melanic pigmentation case

Family: Haemulidae

*Diagramma pictum* (Thunberg, 1792)

Normal coloration of the species:

Body with a uniform grey color on both dorsal and ventral sides. Fins are darker than body, with the posterior part of the dorsal and the whole caudal fins having dark spots.

Color of abnormal specimen (570 mm TL, 490 mm SL) (Figure 1).



Figure 1 *Diagramma pictum*, 570 mm TL, 490 mm SL, showing partial melanic pigmentation

The melanic spots distributed in both dorsal and ventral sides of the lateral, but they found mainly on the dorsal side. They dispersed from the nape to the base of the caudal fin. The pigments of those of the dorsal sides are darker than those of the ventral side. Pigments get diffused toward the ventral side, with the most ventral diffused patch is located just dorsal to the cloaca. On the dorsal-lateral side of the fish, there are two centres for melanic spots. One is located under the spinous part of the dorsal fin and the other under the spinous part of this fin. Several melanic spots with different sizes and grades of coloration are present between the two centres and beyond them towards the head and the caudal fin. On the ventral-lateral side and under the 1<sup>st</sup> centre of aggregation of melanic spots, there are 3 pale large spots. Towards the posterior part of the fish, several pale large melanic pigments are present.

### II. Ambicoloration case

Family: Soleidae

*Pardachirus marmoratus* (Lacepède, 1802)

Normal coloration of the species:

Body mainly with olive green coloration, with a number of indistinct rounded or irregular pale, dark edged areas. Some of which are with or without a dark central spots. Numerous small dark spots on head, body and fins. The blind side should be completely white.

Color of abnormal specimen (370 mm TL, 359 mm SL) (Figure 2).



Figure 2 *Pardachirus marmoratus*, 370 mm TL, 359 mm SL, showing ambicoloration

A broad pale band extending diagonally from the posterior part of the dorsal fin and to the area just below the operculum, and spreading backward to cover the whole base of the anal fin. The areas with original coloration appeared to be restricted to the head, operculum and the 2/3 of the base of the dorsal fin. Another patch of the original coloration is found covering the posterior mid-body and over the caudal fin. Except for the small dark spots, all other dark spots and dark edged areas that are located in the malformed location appeared to be pale.

### 3 Discussion

In fishes, color changes can be in two types, camouflage, which is a physiological origin and the irreversible skin color change due to the differentiation and development of chromatophores with growth. This study is concerned with the latter type of color change.

In the specimen of *D. pictum*, the body side shown to be the most affected area than any other parts of the fish body. Such variation in partial melanic pigmentation is could be due to the causes stated by Roulin and Ducrest (2011). They found that maneuvering of the genes of the melanocortin system or of their products will have significant effects on a set of characters. On the other hand, Slominski et al. (2004) found that the level of activity of the different melanocortins is correlated across tissues. Other studies indicated that with the aid of neuroendocrine communication, the activity of the melanocortin system can be locally regulated and coordinated (Slominski and Wortsman, 2000; Slominski, 2005; Zbytek et al., 2006) and such manipulation could vary between tissue of the fish body (Hoglund et al., 2000).

Severe hyperplasia of dermal melanophores can accompany skin melanosis, which bring about the darkened skin. On the other hand, hyperpigmentation in teleost fishes can cause melanophore hyperplasia. Such an effect has been stated previously in a number of fish species (Noguera et al., 2013; Ramos et al., 2013).

It was impossible to determine the cause of the partial melanism for the specimen reported in the present study. However, the state of the specimen studied did not support the hypothesis that melanism can be as a result of a parasitic infestation. Hsiao (1941) reported that an Atlantic cod *Gadus morhua* probably developed melanism as a result of having the skin heavily infested by trematode larvae. The macroscopic examination of the skin of the specimens studied showed presence of no parasites.

The mechanism of the presence of ambicolored patches in *P. marmoratus* is different from that in *D. pictum*. The large ambicolored patch could be resulted as abnormal differentiation of pigments cells in a limited area of eyed-side of the fish that happened during the metamorphosis. In the normal flatfish and before the metamorphosis, chromatoblasts are evenly distributed on the left and right epidermal sides and the eye will gradually migrates to one side during this event. Accompanying such migration, the stem cells in the skin on the

ocular side differentiate into adult-type pigment cells, while the chromatoblasts on the blind side slowly shrink and breakdown during metamorphosis resulting into a colored-asymmetrical individuals (Minami, 1982; Kang et al., 2014). This defect in coloration is an indication for the melanic patches are not made by transient movement of pigment in chromatophores, but were formed irreversibly by differentiation of chromatophores. Such anomaly in flatfishes may occur during metamorphosis and when the eye migrates to the other side of the head (Gartner, 1986), depending upon the asymmetry of organizational environments that potentially regulate latent chromatophore precursor survival, proliferation and differentiation (Bolker and Hill, 2000; Hamre et al., 2007). Accordingly, the partially pigmented eyed-side could be due to abnormalities in the asymmetry of the regulatory system (Barton, 2010). This has not yet been studied in the flatfish species of Oman. Thus, further experimental research is needed to test this hypothesis.

*Diagramma pictum* and *P. marmoratus* studied having high economic value and being fished regularly from the coasts of the Arabian Gulf (Amer and Al-Gaber, 2006; Al-Abdulrazzak and Pauly, 2013). The absence of any previous record of melanism or ambicoloration in those species could indicate; (1) that the occurrence of this abnormality is very rare; (2) this colour aberration might overlook and special attention was paid to them. However, specific attention to these anomalies is required in order to achieve a more comprehensive knowledge about the occurrence of melanic hyper-pigmentation in deep-water fish species. In addition to economic effects that the melanic or the ambicolored specimens may cause to the fishermen due to being unfavourable by the customers, melanism showed to interferes with social interactions and reproductive success in some fish species (Heemstra and Randall, 1993).

#### Authors' contributions

All authors have contributed equally toward the publication of this paper.

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