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NOTE

Taillessness and skeletal deformity in striped piggy *Pomadasys stridens* (Osteichthyes: Haemulidae) from the Persian Gulf

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ABSTRACT: Taillessness (absence of the caudal fin and some of the caudal peduncle) and skeletal deformity is described in 2 striped piggy *Pomadasys stridens* (Haemulidae) specimens collected from the Persian Gulf along the coast of Hormuz Island, Iran. Deformed specimens were entirely missing caudal fins along with at least 1 caudal vertebra, caudal portions of vertebral columns were bent dorsoventrally, posterior sections of swim bladders were reduced in size, and caudal vertebral centra were compacted anteroposteriorly in 1 individual. Environmental conditions in the Persian Gulf may be responsible for these deformities, but genetic causes cannot be entirely ruled out.

KEY WORDS: *Pomadasys stridens* · Haemulidae · Deformity · Malformation · Persian Gulf

1. INTRODUCTION

A variety of skeletal abnormalities have been reported in marine fishes. Genetic and environmental factors, including anthropogenic pollution and climate change, are frequently implicated as plausible causative agents (von Westernhagen & Dethlefsen 1997, Jawad et al. 2018a,b). These reports include examples of fin abnormalities involving individuals completely missing their caudal fins and portions of their caudal peduncles (taillessness): whitespotted pygmy filefish *Rudarius ercodes* (Honma 1994), longhorn cowfish *Lactoria cornuta* (Tyler et al. 2014), and Richardson's ray *Bathyraja richardsoni* (Orlov 2011). Environmental factors, such as water temperatures and salinities that are above or below certain thresholds (Dunham et al. 1991, Kurokawa et al. 2008, Okamoto et al. 2009, Georgakopoulou et al. 2010) and compounds that are common water pollutants, such as polycyclic aromatic hydrocarbons (Heintz et al. 1999) and heavy metals (e.g. cadmium, nickel, and lead; Sfakianakis et al. 2015), have been identified as causative factors of skeletal deformity and taillessness in captive fishes. The causes of taillessness in wild fishes are difficult to determine conclusively, but environmental factors have been implicated in a range of skeletal deformities (Bengtsson et al. 1988, Wassenberg et al. 2005, Kessabi et al. 2013).

There is ongoing interest in documenting deformities in wild fishes because deformities can be used as bio-indicators to monitor ecosystem status (Vethaak & ap Rheinallt 1992, Sun et al. 2009). Fishes are valuable bio-indicator species in aquatic environments because they are sensitive to many toxicants, can be identified in the field and released without lethal sampling, and occupy a range of habitats and trophic

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levels (Whitfield & Elliott 2002). Studies that have successfully used fish deformity for environmental monitoring have employed a rigorous study design with large sample sizes of fish and temporal or spatial components (e.g. sampling before and after a pollution event or sampling in relatively unpolluted versus relatively polluted areas; Sun et al. 2009). However, many of these studies were at least partially inspired by reports from anglers or publications describing deformity in fishes collected opportunistically.

This study describes caudal skeletal deformity, including taillessness, in 2 *Pomadasys stridens* (Forsskål, 1775) individuals from the Persian Gulf, an area with large, natural salinity and temperature fluctuations and high levels of hydrocarbon (Fowler 1993) and heavy metal pollution (Pourang et al. 2005). *P. stridens* is a reef-associated commercially important fish that feeds on crustaceans and small fishes (Fischer et al. 1990). The species inhabits shallow, coastal waters of the western Indian Ocean including the Persian Gulf and the Red Sea and is reported as a Lessepsian migrant from the Mediterranean Sea (Akyol & Ünal 2016). Jawad (2013) reported hyperostosis in *P. stridens* from the Oman Sea. As far as we know, this is the first report of taillessness in *P. stridens*. This study adds to a growing literature documenting deformity of fishes in the Persian Gulf (Almatar & Chen 2010, Jawad et al. 2018b).

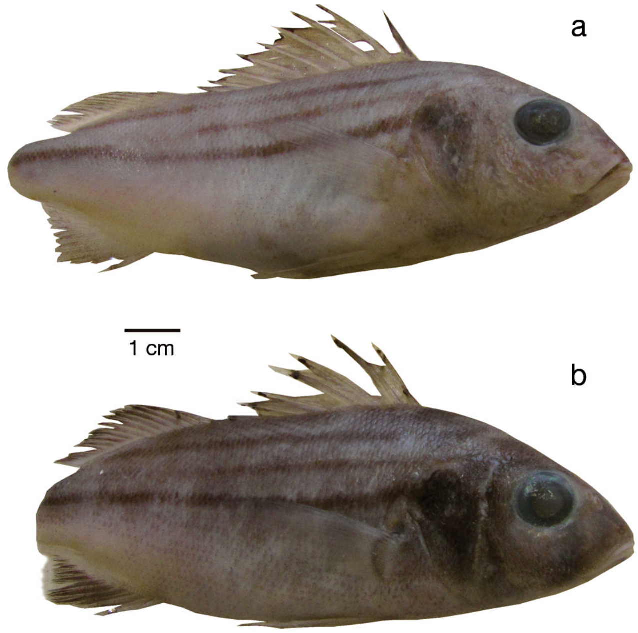

Fig. 1. Two tailless specimens of *Pomadasys stridens* collected from the Persian Gulf

2. MATERIALS AND METHODS

Two abnormal *P. stridens* specimens (Fig. 1) were obtained from fishers who collected the specimens with a trawl net (12 mm mesh) 5 km east of Hormuz Island (Strait of Hormuz, Persian Gulf) at the a depth of ~10 m during February 2017 (Figs. 1 & 2). Specimens were deposited in the Tarbiat Modares University aquatic animal collection (Catalog number: TAC1165F). Additionally, 5 non-deformed *P. stridens* were collected from a fish market on Hormuz Island. Measurements of standard length (SL), head length, and body depth were made with a dial caliper to an accuracy of 0.02 mm and body weights were measured with a digital scale to an accuracy of 0.01 g. Both abnormal and normal specimens were radiographed to visualize internal anatomy (Figs. 3 & 4).

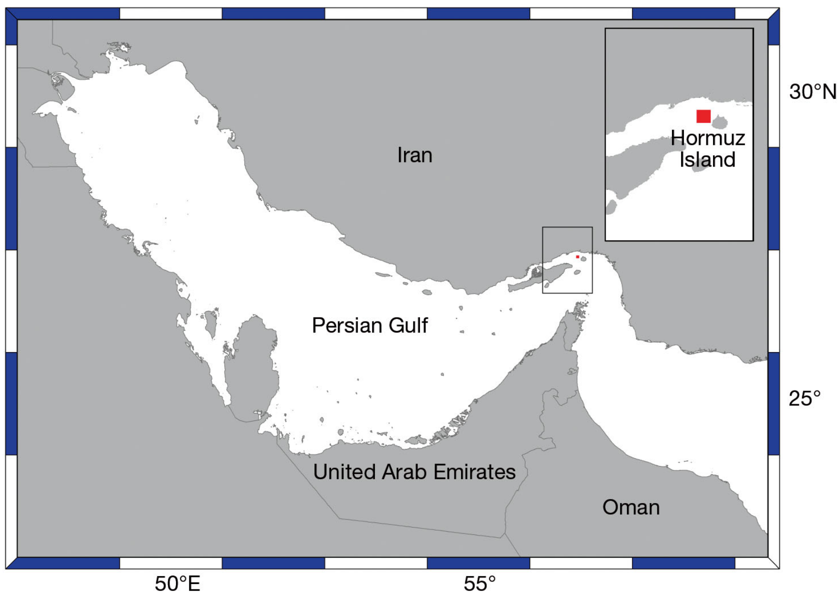

Fig. 2. Collection location of the 2 abnormal *Pomadasys stridens* specimens off western Hormuz Island, Persian Gulf

3. RESULTS

Abnormal *P. stridens* were 104.46 mm SL (referred to as the short specimen; Fig. 1b) and 114.10 mm SL (referred to as the long specimen; Fig. 1a) and weighed 36.4 and 38.2 g, respectively (Fig. 1). Dissection of abnormal specimens and visualization of gonads revealed both individuals were male. There

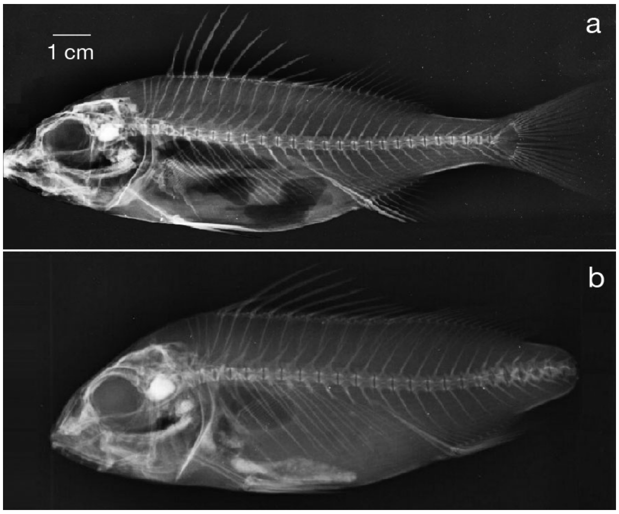

Fig. 3. Radiographs of (a) normal and (b) abnormal specimens of *Pomadasys stridens* from the Persian Gulf

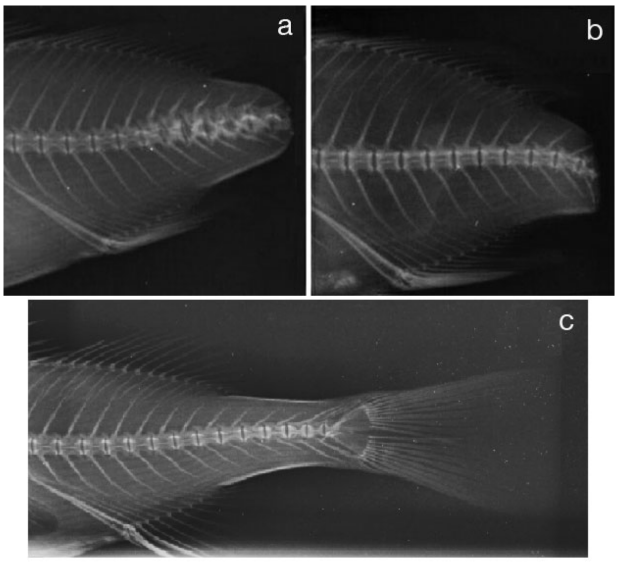

Fig. 4. Radiographs of caudal vertebra from (a,b) the 2 abnormal and (c) 1 normal *Pomadasys stridens* from the Persian Gulf

were 24 and 25 vertebrae in the abnormal specimens, including 11 abdominal plus 13 caudal (short individual) and 11 abdominal plus 14 caudal (long individual) vertebrae. The normal radiographed specimen had 11 abdominal and 15 caudal vertebrae (Fig. 3). In the shorter abnormal specimen the vertebral centra of the 7 posterior-most caudal vertebrae were deformed (enlarged dorsoventrally and compacted anteroposteriorly; Fig. 4a). There was a slight dorsal and ventral bend in the posterior portion of the vertebral column in the long and short abnormal specimens, respectively. In the normal radiographed specimen, the swim bladder was composed of 2 chambers. The posterior chamber was the larger of the two and extended posteriorly to the 10th abdominal vertebra. In the abnormal specimens the posterior swim bladder chamber was small and only extended posteriorly to the 7th abdominal vertebra. The abnormal specimens appeared to have larger, hypercalcified otoliths relative to the normal radiographed specimen (Fig. 3). The abnormal specimens had deeper average body depths relative to the 5 normal specimens when expressed as a ratio of the body depth at the origin of the anal fin to head length: 89.1 % for abnormal versus 82.5 % for normal specimens. The caudal peduncles of the deformed *P. stridens* exhibited no apparent scarring or concavity, were covered in scales, and there were no signs of cracks or damage to the terminal vertebrae.

4. DISCUSSION

This study reports taillessness in striped piggy from the Persian Gulf. In deformed specimens, the caudal fins were entirely missing, caudal regions of the vertebral column and swimbladder were abnormal, and otoliths appeared large and hypercalcified.

The causes of deformity in the Persian Gulf *P. stridens* cannot be determined conclusively. However, several lines of evidence suggest abiotic environmental factors may have caused the deformities in *P. stridens*. The Persian Gulf experiences large, natural salinity and temperature fluctuations (Abuzinada et al. 2008). High levels of heavy metal and hydrocarbon pollution have been documented in the water, sediment, and marine organisms of the Persian Gulf, particularly in and near the Strait of Hormuz, one of the busiest waterways in the world (Fowler 1993). Experimental research has demonstrated that temperature (Kurokawa et al. 2008, Georgakopoulou et al. 2010), salinity (Okamoto et al. 2009), heavy metals (Sfakianakis et al. 2015), and hydrocarbons (Wassenberg et al. 2005) can cause skeletal deformities. Otolith hypercalcification and swim bladder deformities, similar to those observed in our specimens, have been attributed to unfavorable abiotic conditions and physiological stress, particularly during early life stages (Payan et al. 2004). Comparative studies have linked heavy metal and hydrocarbon pollution to deformities in wild fish populations, including fin and vertebral deformities (Bengtsson et al. 1988, Wassenberg et al. 2005). We cannot entirely rule out genetic factors as a potential cause of deformity in *P. stridens*. Genetic factors, such as deleterious genes, especially in cases of inbreeding (Mrakovčić & Haley 1979), can cause skeletal deformities in fishes. However, many studies examining the causes of deformity in captive and wild fishes have implicated environmental, rather than genetic factors (Bengtsson et al. 1988, Dunham et al. 1991, Wassenberg et al. 2005, Kurokawa et al. 2008, Okamoto et al. 2009, Kessabi et al. 2013) and the abiotic conditions, pollution, and high incidence of fish deformities in the Persian Gulf point to abiotic environmental explanations for the observed taillessness in *P. stridens* (Fowler 1993, Pourang et al. 2005, Almatar & Chen 2010, Jawad et al. 2018b).

There are reports attributing deformities in wild fishes, including taillessness, to attempted predation (Honma 1994, Tutman et al. 2010), but this is likely not the cause of taillessness in our *P. stridens* specimens. Fish injuries from attempted predation often result in external scarring that can be visible for years when severe damage is inflicted. In some cases scales do not regrow following epidermal regeneration at wound sites and predation events often leave distinct concave wounds or bite marks (Honma 1994). The caudal regions of the deformed *P. stridens* exhibited no apparent scarring or concavity, were covered in scales, and there were no signs of cracks or damage to terminal vertebrae. Our observation of 2 similar tailless specimens simultaneously, and the nature of the deformities suggests attempted predation is not the cause these caudal abnormalities.

The caudal fin is integral for fish mobility and loss of the caudal fin has negative effects on swimming performance, hindering a fish's ability to obtain food and avoid predators (Fu et al. 2013). However, there are reports of fishes reaching adult sizes despite suffering from severe deformities. Tailless individuals may be able to survive by increased reliance on dorsal, anal, and pectoral fins and the caudal portion of the body for swimming (Tutman et al. 2010, Tyler et al. 2014). This may explain our observation of increased development of trunk and caudal peduncle muscles.

Without additional data, causes of the observed caudal deformity in *P. stridens* cannot be definitively determined. However, the natural fluctuations in salinity and temperature, pollution, and previous reports of fish deformities in the Persian Gulf suggest that the abiotic environment may have been the cause. Documentation of fish abnormalities in the Persian Gulf and surrounding areas may provide additional insight into the relationships between human activities, the abiotic environment, and fish deformity.

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