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ABSTRACT

Skeletal deformities are frequent problems in cultured fish populations due mainly to unfavorable abiotic conditions, inappropriate nutrition, and genetic factors. These may cause erratic swimming, decrease of conversion rate, growth, and market value. The aim of this case report was to present the occurrence of deformities in juvenile cobia and groupers from an offshore marine farm in Ilhabela, São Paulo, Brazil. Nine cobias and seven juvenile groupers, that presented deformities, were euthanized and fixed in 10% formaldehyde. They were tagged, processed, and stained with "Alcian Blue" (AB) and "Alizarin Red-S" (ARS) for visualization of cartilage and bone tissue, respectively. After evisceration, radiographic examination was performed. The deformities observed in cobia were atrophy of the operculum, disorganization of the gill lamellae, deformity of the lower jaw, kyphosis, and scoliosis. Groupers presented lower jaw deformity and saddleback syndrome. The farm studied in this case report had poor management standards, fed commercial feed for freshwater herbivorous fish and cooked sardines, high inbreeding and absence of adequately trained professionals to manage these species. The sum of these factors must have directly influenced the appearance of these deformities. It is necessary to control this situation to minimize the incidence of malformations that have economic impact to farmers.

Keywords: operculum atrophy, kyphosis, scoliosis, saddleback syndrome

RESUMO

As deformidades esqueléticas são problemas frequentes em populações de peixes cultivados devido, principalmente, a condições abióticas desfavoráveis, nutrição inapropriada e fatores genéticos. Estas podem causar natação errática, diminuição do índice de conversão, do crescimento e do valor no mercado. O objetivo deste relato de caso foi apresentar a ocorrência de deformidades em cobias e garoupas juvenis provenientes de uma fazenda marinha em sistema offshore, em Ilhabela, São Paulo, Brasil. Nove cobias e sete garoupas juvenis, que apresentavam deformidades, foram sujeitos à eutanásia e fixados em formol a 10%. Os espécimes foram registrados, processados e corados com "Alcian Blue" (AB) e "Alizarin Red-S" (ARS) para visualização de tecido cartilaginoso e ósseo, respectivamente. Os peixes foram eviscerados para o exame radiográfico. As deformidades observadas em cobia foram: atrofia do opérculo, desorganização das lamelas branquiais, deformidade do maxilar inferior, cifose e escoliose. As garoupas apresentaram deformidade do maxilar inferior e síndrome de Saddleback. Os peixes deste relato de caso estiveram sob manejo deficiente, alimentados com ração comercial para peixes herbívoros de água doce e sardinhas cozinhadas, alta consanguinidade e ausência de profissionais adequadamente treinados para o manejo dessas espécies. A soma desses fatores influenciou diretamente na aparição dessas deformidades, precisando ser controlados para minimizar a incidência de malformações que tenham impacto econômico para os produtores.

Palavras-chave: atrofia do opérculo, cifose, escoliose, síndrome de saddleback

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INTRODUCTION

Morphological deformities of skeleton, fins and scales occur in both wild and farmed fish during larval and juvenile development stages, and they are related to several physiological, environmental, genetic, xenobiotic, and nutritional factors (Lall & Lewis-McCrea, 2007). However, the prevalence of deformities in wild fish is usually very low (Diggles, 2013). Most of the skeletal deformities in fish include jaw, operculum, spinal (lordosis, kyphosis, scoliosis, and vertebrae fusion), and fin malformation such as saddleback syndrome, characterized by loss of one or more hard spines of the dorsal fin (Diggles, 2013). Vertebral deformities may occur when fish is exposed to unsuitable conditions during embryonic development such as low dissolved oxygen, water temperature changes, transportation, or incubation (Hattori et al., 2004). Deformities are also associated to physiological, xenobiotic, nutritional, and genetic factors during larval and juvenile development stages of cultured freshwater and marine fish (Cahu et al., 2003; Blogione et al., 2001; Ma et al., 2016).

These deformities have an impact on aquaculture reducing the market value of fish products (Nagano et al., 2007). In addition, skeletal deformities also decrease swimming ability, conversion index, growth, survival (Gavaia et al., 2009), and can lead to functional impairment (Noble et al., 2012). Thus, it is difficult for farmers to elucidate the causes of the deformities during the production of larval and juvenile fish (Haga et al., 2011). The aim of this report was to show the occurrence of deformities in juvenile cobia and grouper from an offshore fish farm in Brazil.

CASUISTRY

A high occurrence of deformities in cobia and grouper reared in offshore floating cages was observed in a hatchery in Ilhabela, São Paulo, Brazil in 2012. The specimens were fed during the larval stage with Artemia sp. enriched with vitamin C supplementation. Fingerlings aged 11dph (days post-hatch) were kept in 1m³ cages containing 100 animals each. Fishes were fed three times a day at 8% of biomass per day with commercial feed for freshwater fish, cooked sardines and vitamin supplement. Water temperature was 22°C.

A sample of nine juvenile cobia (length ranging from 14.6 to 17.8cm) and seven juvenile grouper (length ranging from 10.8 to 12.9cm) that showed functional and morphological changes were collected from the hatchery. These were anesthetized with benzocaine (100mg/L) and euthanatized by spinal cord section and fixed in 10% formalin. In addition, the specimens were examined, photographed and the morphological changes were recorded and classified according to the type and severity of the deformity. Two specimens of each species were processed according to the technique described by Taylor and Van Dyke (1985) and stained with “Alcian Blue” (AB) and “Alizarin Red-S” (ARS) for visualization of cartilaginous and bone tissues respectively. Fish were eviscerated for radiographic examination (X-Ray Siemens Tridoros Model 812E equipment), using high resolution Min-R 2000 (Kodak) Film, applying 36 kV to 200mA and 20-25mAs.

RESULTS AND DISCUSSION

The deformities observed in cobia were operculum atrophy, disorder of gill lamellae, lower jaw deformity, kyphosis, and scoliosis. Cobia with operculum atrophy also showed disorder of gill lamellae (Figure 1A and 1B). According to Boglino et al. (2012), live feed used for marine finfish larvae needs to be enriched with essential fatty acids to provide a balanced diet. However, larval stages in the hatchery were fed with Artemia sp. and supplemented only with vitamins. This protocol contains a reduced range of food for the larvae and could lead to nutritional imbalances or nutritional deficiencies (Watanabe, 1993), which suggests that some of the deformities such as kyphosis and scoliosis could be originated by nutritional requirements during the first stages.

Lower jaw deformities in cobia were also observed. Nagano et al. (2007) reported that the first anomalies observed during seven-band grouper developmental stages were jaw deformities, in particular the lack of supramaxilla or twisted upper and lower jaws. Some species such as striped trumpeter (Latris lineata) have requirements of highly unsaturated fatty acids (HUFA) and low concentrations in diets could be
related to jaw malformation (Cobcroft et al., 2001).

Nagano et al. (2007) showed there are several possible explanations for skeletal deformities in intensive aquaculture such as nutrition, streamflow, bacterial infection, light intensity, and water temperature. Furthermore, the farm studied in this case report had poor management standards, mainly due to fish were feed with commercial feed for herbivorous freshwater fish and cooked sardines, what means that fish were not received species-specific nutritional requirements. Cobia is a carnivorous pelagic fish and presented a relatively high protein requirement (Fraser & Davies, 2009). In addition, pathogens are possibly present in the fish used as feed. Hine & MacDiarmid (1997) mention that cooking food is likely to destroy fish pathogens in contaminated fish, although lightly cooked or raw fish may still contain viable organisms.

Some specimens showed operculum atrophy and disorder of gill lamellae, which can be related to nutritional requirements. Koumoundouros et al. (1997) mentions that vitamin C deficiency has frequently been related to the genesis of gill-cover shortening. It was observed that the vitamin C supplement used in the farm was expired. This may have resulted in loss of ascorbic acid by oxidation.

The specimens of grouper showed lower jaw deformity and saddleback syndrome. In addition, deformities in neural processes and proximal pterygiophore of saddleback grouper (Figure 1C, 1D e 1E) were observed in radiography and using AB and ARS staining. A high incidence of skeletal deformities has been described in the jaws and vertebral column during the larval and juvenile stages in seven-band grouper (E. septemfasciatus) and most of them presented abnormal maxilla curvature and lordosis (Nagano et al., 2007). Some studies developed by Cahu et al. (2003) reported that phospholipids, particularly phosphatidylchinositol, reduced spinal malformations in larval D. labrax. In the present report, the examination of the skeletal deformities using radiography (Figure 1F) confirmed the deformities according to previous descriptions of saddleback syndrome in other fish species.

It is difficult to define the etiology of high rates of deformities in farmed fish due to the wide range of possible factors. However, nutritional and environmental factors must be controlled to minimize the occurrence of malformations to produce the minimum impact for farmers. Recent data provide more evidence of the important role
of several dietary components for larvae in early stages (Cahu et al., 2003).

Some nutritional factors such as an expired supplement of vitamin C in the diet could have been responsible for the skeletal deformities, because of the instability and the loss of activity in the vitamin. Cahu et al. (2003) mentions that ascorbic acid supplied in the diet is crucial for fish larvae development, since most of the species are unable to synthesize vitamin C. In this report, causative factors of skeletal deformities could not be totally identified due to various external parameters in the hatcheries. However, the most likely is that nutritional and genetic factors were affecting skeletal development in these fish.

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