



Report on the incidences of skeletal anomalies in three fish species from Bonny tributary (Niger delta), Nigeria

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Submitted October 26, 2021; revised January 2, 2022; accepted January 10, 2022.

ABSTRACT

Three cases of skeletal anomalies in fishes *Elops lacerta* Valenciennes, 1847 (family Elopidae), *Oreochromis niloticus* (Linnaeus, 1758) (Cichlidae) and *Arius latiscutatus* Günther, 1864 (Ariidae) collected in the Elechi Creek, a tributary of the Bonny River (Niger delta) were reported for the first time in the present study. The anomalies are pugheadness, complete absence of pelvic fins and deformed dorsal, pectoral and pelvic fins. Three specimens of *E. lacerta* have shown the case of pugheadness but at different levels of severity. The specimen of *O. niloticus* showed a complete absence of the pelvic fins. Externally, the area where the bases of the pelvic fins should be found (underneath the pectoral fins) showed a normal scale covering (in scale form and size). Internally and by using radiography, no trace of the pelvic fins and the basipterygia were observed. The specimen of *A. latiscutatus* showed severe deformation of the finrays of the dorsal, pectoral and ventral fins. The spines of the pectoral and dorsal fins were also deformed. Pollution from Port Harcourt appears to be causing the skeletal deformities described.

Keywords: *Arius latiscutatus*, Bonny tributary, *Elops lacerta*, fin deformation, Niger delta, *Oreochromis niloticus*, pugheadness, Port Harcourt, skeletal anomalies

Об аномалиях скелета у трех видов рыб из притока р. Бонни (дельта Нигера), Нигерия

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Представлена 26 октября 2021; после доработки 2 января 2022; принята 10 января 2022.

РЕЗЮМЕ

В работе описаны 3 варианта аномалий скелета у пресноводных рыб *Elops lacerta* Valenciennes, 1847 (семейство Elopidae), *Oreochromis niloticus* (Linnaeus, 1758) (Cichlidae) и *Arius latiscutatus* Günther, 1864 (Ariidae), пойманных в притоке р. Бонни (Нигерия). Обнаруженные аномалии – «голова мопса», полное отсутствие брюшных плавников и деформация спинного, грудных и брюшных плавников. Деформация

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головы разной степени выявлена у 3 экземпляров *E. lacerta*. У экземпляра *O. niloticus* брюшные плавники полностью отсутствовали; область под грудными плавниками, где они должны находиться, имела нормальное очертание (по форме и размеру чешуек). Рентгенография показала отсутствие тазовых костей и базиптеригий. У экземпляра *A. latiscutatus* заметно деформированы спинной, грудные и брюшные плавники, в том числе шипы спинного и грудных плавников. Описанные деформации скелета связывают с антропогенным загрязнением среды углеводородами в районе Порт-Харткорт.

Ключевые слова: *Arius latiscutatus*, р. Бонни, *Elops lacerta*, деформация плавников, р. Нигер, *Oreochromis niloticus*, «голова мопса», Порт-Харткорт, аномалии скелета

INTRODUCTION

A large number of fish anomalies have been defined and discussed since Dawson's inclusive work on fish abnormalities (Dawson 1964, 1971; Tutman et al. 2000; Al-Mamry et al. 2010; Jawad and Al-Mamry 2011, 2012; Näslund and Jawad 2021). These anomalies have been used as a method to check the health of the environment based on the existence of high fish anomaly cases in polluted wild areas (Bengtsson 1979).

Gudger (1930, 1959) outlined the history of the pughead anomaly. He proposed that the French naturalist Pierre Belon in 1554 issued the first figure of a pughead anomaly in female salmonid fish. Since 1554, a great number of published works have described this condition in diverse species of fish, frequently from Europe and North America (Hickey et al. 1977; Shariff et al. 1986; Jawad and Hosie 2007; Macieira and Joyeux 2007; Jawad et al. 2015).

The pughead anomaly is an adverse osteological state that can cause aberration of the maxilla, premaxilla, or infraorbital bones, with varying levels of severity (Hickey 1972). The distressed specimens frequently display protruding eyeballs, intensely steep foreheads, and partial closure of the mouth (Shariff et al. 1986). The pughead anomaly is normally infrequent in wild populations, and most of the acknowledged cases are single specimens, mainly in large estuarine systems (Dahlberg 1970; Berra and Ray-Jean 1981; Catelani et al. 2017). A large number of cases of pughead were discovered in more polluted waters (Sloof 1982).

Generally, fin deformities are well recognized in both wild and aquaculture fish (Divanach et al. 1996), but those of the anal fin are not adequately reported (Hussain 1979; Jawad et al. 2013). Incidences of fusion, dysgenesis, extra formation, displacement of the fin supporting elements (Koumoundouros et al. 2001) and curvature of the rays and spines (Daoulas

et al. 1991) are reported for a wide range of fish species. Absence or abnormal development of pelvic fins in fishes has been previously reported and credited to inherited or postnatal deformities (Graham et al. 1986), in addition to chemical pollution (Sloof 1982). Anomalies in growth or the complete absence of these fins raise questions on additional deviations in body morphology because of environmental factors (Graham et al. 1986). Pelvic fins are usually treated as manipulating parts, and their hydrodynamic role has not been much considered compared to the other types of fins in the fish body (Lauder and Drucker 2004; Yamanoue et al. 2010).

Reports on abnormal fish specimens from Nigeria are scarce, notably the works of Olatunji-Akioye et al. (2010), and Fagbuafo and Oso (2011).

The aim of the present study was to identify and describe skeletal abnormalities in fishes in order to assess for environmental monitoring purposes. The article reports on cases of pugheadness in *Elops lacerta* Valenciennes, 1847 (Family Elopidae), absence of pelvic fins in *Oreochromis niloticus* (Linnaeus, 1758) (Cichlidae) and several instances of deformities in the pectoral and pelvic fins of the catfish *Arius latiscutatus* Günther, 1864 (Ariidae). All these cases of anomalies were described in fish specimens collected from Elechi creek in the area of a regional and international transportation hub Port Harcourt, Nigeria.

MATERIAL AND METHODS

The fish specimens examined in the present study and that showed different levels of skeletal abnormalities were a part of fish sampling routine performed in the brackish water of Elechi Creek, a tributary of the upper reaches of the Bonny River in the delta of Niger (Fig. 1). The total number of fish specimens per each species were 40 and only one specimen of each species had shown abnormality.

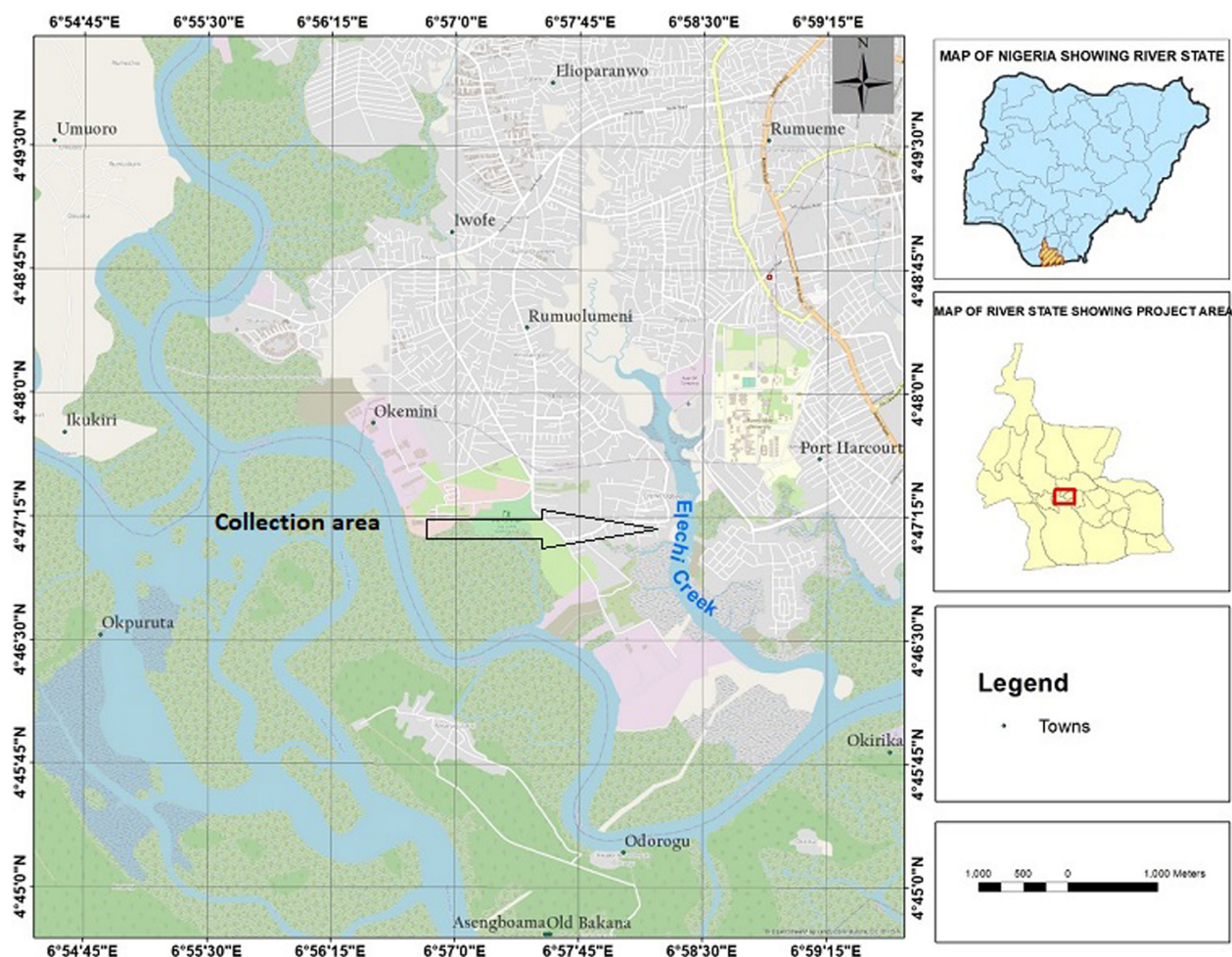


Fig. 1. Map showing the locality of collecting fish samples.

Fish specimens were captured during the period of 5th to 19th June 2019. Fish specimens were obtained from fishermen operating in the Elechi Creek using cast and gill nets. For comparison purposes, normal specimens of *E. lacerta*, *O. niloticus* and *A. latiscutatus*, with total length (TL) of 164, 167 and 280 mm respectively were obtained from the same catch at the same fishing localities. Specimens' body and fins were examined carefully for malformations, absence and any other external deformities. All fish length were measured to the nearest millimetre. Specimens were identified following Whitehead (1990), Trewavas (1983) and Schneider (1990) for *E. lacerta*, *O. niloticus* and *A. latiscutatus* respectively. The specimens were then shipped to the second author at Auckland, New Zealand for further investigations. X-rays were made at the Radiography Department,

Green Lane Hospital, Auckland, District Health Board, New Zealand. The X-ray exposure was 27 kVp and 6.3 mAs and magnification at 1.8. The specimens were deposited in the fish collection of the Unitec (Auckland, New Zealand) under the specific name and the locality.

RESULTS

The abnormal specimens examined were three specimen of *E. lacerta* (which inhabits marine, freshwater and brackish habitats), with TL 117, 150 and 170 mm, a specimen of *O. niloticus* (inhabits freshwater and brackish habitats), with TL 130 mm and a specimen of *A. latiscutatus*, with TL 272 mm (marine and brackish species). These specimens shown to bear different skeletal abnormalities and fins aberration.

Pugheadness Deformity

Elops lacerta

Three specimens have exhibited pugheadness, but at different levels of severity. The mild pugheadness was observed in specimen 150 mm *TL*, 7 mm preorbital length (4.67% *TL*) and 4 mm postorbital length (2.67% *TL*). This specimen is compared to normal fish having 164 mm *TL*, 9 mm preorbital length (5.48% *TL*) and 5 mm postorbital length (3.05% *TL*) (Fig. 2A,B).

The abnormal specimen was shown to have a slightly short splanchnocranium and a normal premaxillary and maxillary bones and slightly upward directed dentary. The mouth was not closed. On both sides of the head, the opercular plate was normal. The ethmoid and upper jaw regions are anterior-posterior compressed bringing the deformed ethmoid and upper jaw regions close to the eye and close to the nostril (Fig. 2C). Internally, there are slight deformations in the vomer and parasphenoid, nasals, frontals, vomer, and palatines bones. The premaxilla and maxilla appeared deformed (Fig. 2D).

A moderate level of pugheadness was observed in the 2nd specimen 170 mm *TL*, 5 mm preorbital length and 5 mm postorbital length (2.94% *TL* both). In this specimen, the damage was greater than in the specimen of the 1st case. In this specimen, the snout is very short and very close to the anterior edge of the eye (Fig. 2E). Internally, the vomer, parasphenoid and the nasals bones were slightly damaged and deformed (Fig. 2F).

The 3rd specimen showed a severe case of pugheadness. This specimen had 117 mm *TL*, 3 mm preorbital length (2.56% *TL*) and 4 mm postorbital length (3.41% *TL*). Externally, this specimen showed a complete deformation of the upper anterior part of the head, with mouth partially open. Internally, the vomer and parasphenoid, nasals, frontals, vomer, and palatines bones all appeared to be deformed in addition to the maxilla and the premaxilla (Fig. 2G). In this specimen, the forehead is steep in the pughead specimen in contrast with the normal specimen (Fig. 2H).

Absence of the pelvic fins

Oreochromis niloticus

The specimen showing the complete absence of the pelvic fin is 130 mm *TL* and 110 mm *SL* (Fig. 3A,B) compared to a normal specimen of 167 mm *TL* and 133 mm *SL* (Fig. 4A,B). Externally, the area where

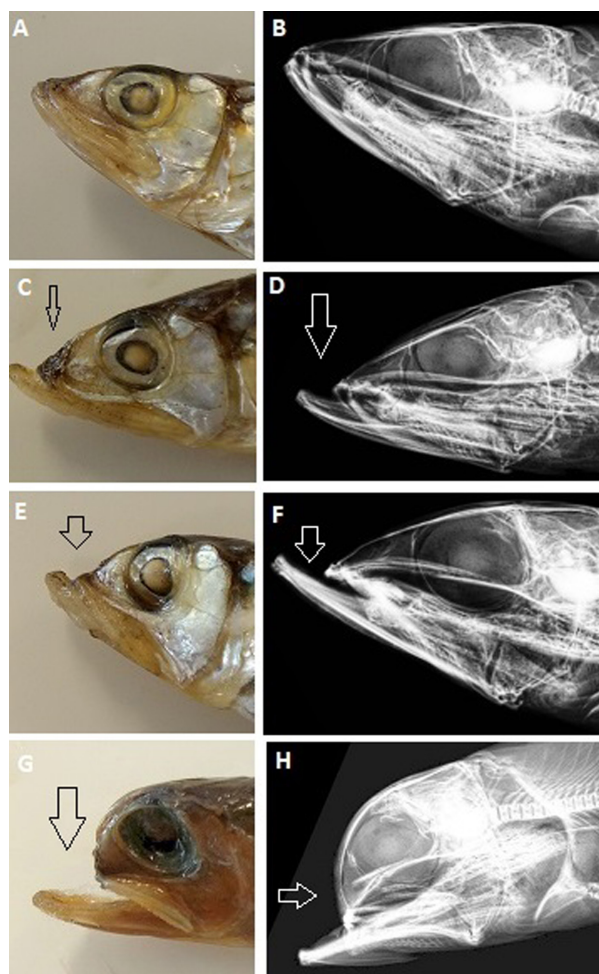


Fig. 2. *Elops lacerta* showing different level of pugheadness, head of fish and radiograph: A, B – normal specimen 164 mm *TL*; C, D – mild level of pugheadness, 150 mm *TL*; E, F – moderate level of pugheadness, 170 mm *TL*; G, H – severe level of pugheadness, 117 mm *TL*.

the bases of the pelvic fins should be found (underneath the pectoral fins) shows a normal scale covering (in form and size), indicating that the specimen was never injured. Internally and by using radiography, no trace was observed of the pelvic fins and the basipterygia (Fig. 3B). No other osteological abnormalities were observed in this specimen.

Deformation of the dorsal, pectoral and pelvic fins

Arius latiscutatus

The deformed specimen measured 293 mm *TL*, 280 mm *SL*, compared to the normal specimen of 280 mm *TL* (Fig. 5A,B). Externally, the abnormal specimen showed a severe deformation of the finrays

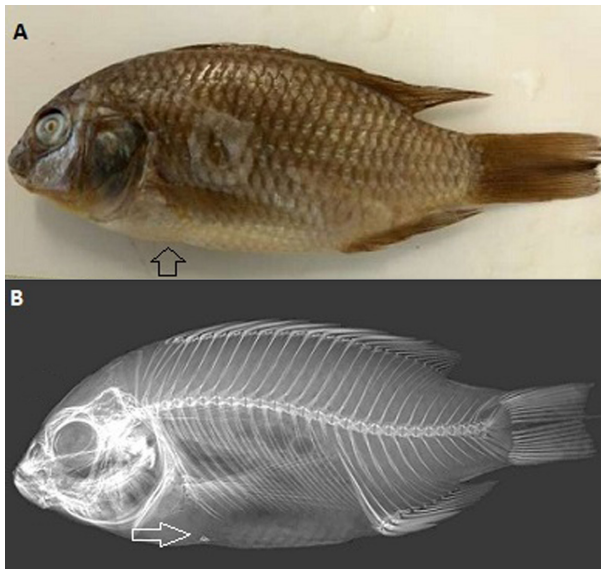


Fig. 3. *Oreochromis niloticus*, abnormal specimen 130 mm TL lacking pelvic fins (A) and radiograph (B).

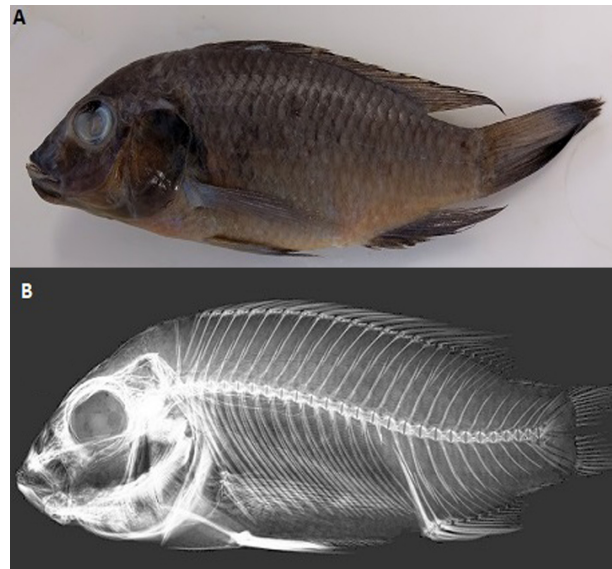


Fig. 4. *Oreochromis niloticus*, normal fish 167 mm TL with the presence of pelvic fins (A) and radiograph (B).



Fig. 5. *Arius latiscutatus*, normal specimen 280 mm TL: lateral (A) and ventral (B) sides.

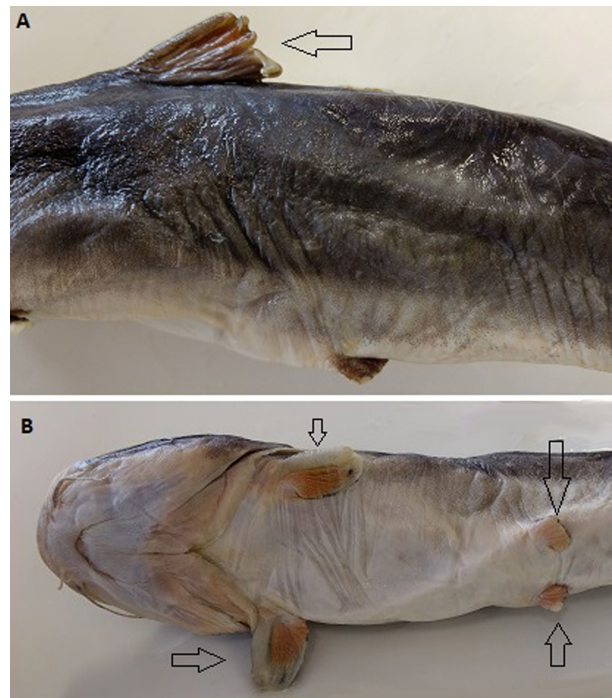


Fig. 6. *Arius latiscutatus*, abnormal specimen 293 mm TL: A – deformed dorsal fin; B – deformed pectoral and pelvic fins (arrows).

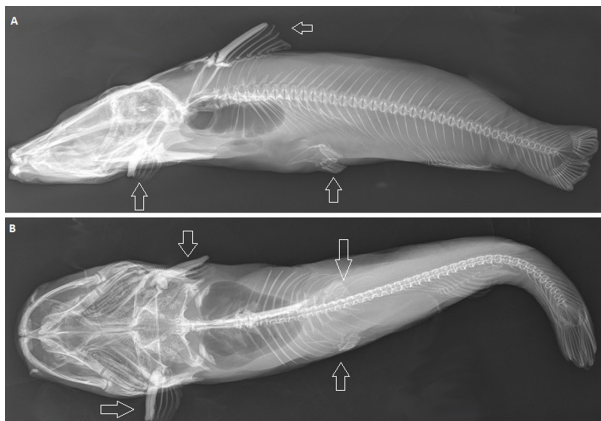


Fig. 7. *Arius latiscutatus*, radiographs: A – normal specimens 280 mm TL; B – abnormal specimen 293 mm TL with fins deformation.

of the dorsal, pectoral and pelvic fins (Fig. 6A,B). The spines of the pectoral and dorsal fins were also deformed. Internally, the radiography showed the fin-rays are shorter than normal and twisted (Fig. 7A) compared to the normal specimen (Fig. 7B).

DISCUSSION

This is the first study examining the occurrence of different types of skeletal anomalies in adult wild teleosts fish species from the brackish water environment in Nigeria.

Hickey et al. (1977) suggested that the case of pugheadness in fishes could be seen in four stages: normal, primary, secondary and tertiary stage. The present cases of pugheadness observed in three specimens of *E. lacerta* represent the primary, secondary and tertiary stages in the scheme proposed by Hickey et al. (1977). Gudger (1959) related the diverse forms of pughead anomaly recounted from England, France, Ireland and the United States. In all these incidences, the lower jaw was longer than the upper, which is similar to what we obtained for the pugheadness of *E. lacerta*. Our result also agrees with that of Al-Hassan (1988) on *Johnius aneus* Bloch, 1793, and Jawad and Hosie (2007) on *Pagrus auratus* (Forster, 1801). Other results have shown similar cases of pugheadness in several fish species from around the world (Macieira and Joyeux 2007, Francini-Filho and Amado-Filho 2013, Jawad et al. 2014). In the tertiary case of pugheadness showed by the third specimen of *E. lacerta* (117 mm TL) in the forehead area, the ethmoid seems to be bent downward and backward causing partial blockage to the mouth. Besides, the anomaly was mild and left the mouth open for feeding activity in the primary and secondary cases of pugheadness (Specimens no. 1, 150 mm TL, no. 2, 170 mm TL).

The dislodgment of the posterior part of the skull shown in the radiograph of the tertiary case of pugheadness (Specimen no. 3, 117 mm TL) of *E. lacerta* could have a direct influence on the brain. Meanwhile the preorbital area was compacted very much and the nasal openings were lost in this specimen; the nasal organs and perhaps the olfactory nerve were lost too. Fishes with severe head anomaly may have a reduced ability to breathe and feed, which would result in the inability to compete for food (Bortone 1972; Hickey 1973). Full examination of the brain is essential to determine the injuries that could happen to the brain because of this anomaly.

The complete absence of pelvic fins in the present specimen of *O. niloticus* is infrequently reported in cichlid fishes. Nevertheless, reports on similar incidences are available for several fish species (Baburao 1975; Parimala 1983; Hore and Ahmad 2010; Jose et al. 2020). In spite of the absence of pelvic fins in the *O. niloticus* examined, all the other traits were comparable to those of the normal specimen, and it has not affected the normal growth of the fish.

Currently, deformities in fishes are very common, and this can be explained by the increasing human activities in the aquatic habitats. Several causes have been attributed to the loss of paired fins in fishes, including the exposure during early developmental stages to changes in physical, chemical and biological factors (Jose et al. 2020). Further research is needed to explore the causes behind the case of pelvic fin absence in *O. niloticus* examined in the present study.

The deformations in the dorsal, pectoral and pelvic fins observed in the specimen of *A. latiscutatus* can be as a result of the effects of several environmental and biological factors such as water temperature, vitamins and trace elements factors (Sahashi 2015), although there is no evidence in this study to support these effects. The other factor might be the causative agent as Shikano et al. (2005), Tiira et al. (2006) and Yamamoto et al. (2013) suggested is the lack of genetic diversity in the fish population. Among the biological factors are the parasitic invasions and viral infections that can often act as causes of skeletal anomalies (including impaired development of fins. These reasons need to be verified in further studies on this species collected from the waters of Nigeria.

Pollutants can yield the deviations in the skeletal system of the fish in two ways, either (1) by modification of the biological procedures essential for keeping the biochemical integrity of bone, or (2) neuromuscular impacts, which cause anomalies without a chemical change in vertebral composition (Raj et al. 2004).

The oil pollution status in Elechi Creek, Nigeria, aided by high water temperature and low dissolved oxygen level seems to be causing the skeletal deformities described. The city of Port Harcourt, Nigeria Jubail City is a principal centre for export of Nigeria's oil (Snowden and Ekweozor 1990). Through this port thousands of oil barrels are exported daily and hundreds of tonnes of commercial goods are landed and dispatched. Oil tankers and commercial vessels do these events. This shipping activity heavily pollutes the marine habitat near Port Harcourt City.

Recently, environmental investigations have shown that the level of pollution with different chemicals (mainly oil and its derivatives) is apparent in water, aquatic fauna, flora, and sediments near Port Harcourt City (Ayotamuno et al. 2006, Damsgard et al. 2006; Vincent-Akpu and Babatunde 2013).

Credit authorship contribution statement

Laith A. Jawad: conceptualization, formal analysis, writing – original draft, supervision. Adaobi P. Ugbomeh, Joy J. Frank, Godfrey C. Akani: investigation, formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ACKNOWLEDGEMENTS

Our sincere thanks to David Smith, Smithsonian Institution, USA for reading the manuscript.

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