Acta Ichthyologica et Piscatoria 53, 2023, 45–49 | DOI 10.3897/aiep.53.101350

PENSOFT.

ACTA ICHTHYOLOGICA ET PISCATORIA

Records of malformed sea catfishes (*Ariopsis seemanni* and *Ariopsis guatemalensis*) (Actinopterygii: Siluriformes: Ariidae) off San Blas (Mexican Pacific)

Felipe GUZMÁN-MORALES[1], Angélica Yomira RAMOS-ÁVILA[1], Mariana DÍAZ-SANTANA-ITURRIOS[2], Esperanza GRANADOS-AMORES[3], Jasmín GRANADOS-AMORES[4]

1 *Programa de Maestría en Ciencias Biológico Agropecuarias, Universidad Autónoma de Nayarit, Xalisco, Nayarit, Mexico*
2 *Marine Conservation Medicine and Ecosystem Health, Centinela del Mar A.C., La Paz, Baja California Sur, Mexico*
3 *Programa de Doctorado en Ciencias Biológico Agropecuarias, Universidad Autónoma de Nayarit, Xalisco, Nayarit, Mexico*
4 *Escuela Nacional de Ingeniería Pesquera (ENIP-UAN), San Blas, Nayarit, Mexico*

https://zoobank.org/73AA157C-7258-4C69-A568-5A02ED13E2C7

Corresponding author: Jasmín Granados-Amores (j.granados@uan.edu.mx)

Academic editor: Adnan Tokaç ♦ **Received** 1 February 2023 ♦ **Accepted** 4 April 2023 ♦ **Published** 20 April 2023

Citation: Guzmán-Morales F, Ramos-Ávila AY, Díaz-Santana-Iturrios M, Granados-Amores E, Granados-Amores J (2023) Records of malformed sea catfishes (*Ariopsis seemanni* and *Ariopsis guatemalensis*) (Actinopterygii: Siluriformes: Ariidae) off San Blas (Mexican Pacific). Acta Ichthyologica et Piscatoria 53: 45–49. https://doi.org/10.3897/aiep.53.101350

Abstract

Fish malformations can be an important hint for assessing the well-being of their populations and the quality of their habitats. Malformations have been observed in species of the order Siluriformes, including the family Ariidae. In this study, we report malformations in the blue sea catfish, *Ariopsis guatemalensis* (Günther, 1864), and the tete sea catfish, *Ariopsis seemanni* (Günther, 1864), collected in San Blas, Mexico. The malformations include missing eye, cleft lip, and malformed barbels. Such malformations could be blamed on substantial levels of pesticides in the environment, genetic factors, and/or a pathogenic effect of some parasites specific to the studied fish species.

Keywords

abnormality, Ariidae, deformity, estuarine system, ichthyology, Siluriformes, Mexican Pacific

Introduction

Fish malformations are visible internal or external changes or abnormalities caused by environmental stresses, parasitic infections, genetic mutations, nutrient deficiencies, and exposure to chemicals (Yokoyama et al. 2004; Kelly et al. 2010). The physiological functioning of fish can worsen through the presence of such malformations and their effects include deficient buoyancy, feeding, and reproductive difficulties, as well as problems in avoiding predators (Eissa et al. 2009). Therefore, recording malformations is an important task to properly monitor the well-being of fish populations and water quality.

Malformations have been reported for several families in the order Siluriformes (see Wakida-Kusunoki and Amador del Ángel 2017). The siluriform fish family Ariidae comprises about 150 species, popularly known as sea catfishes, 13 of which have been recorded in the Mexican Pacific (Rodríguez-Romero et al. 2012; Robertson and Allen 2015; Palacios-Salgado et al. 2018). The main characteristics distinguishing sea catfishes are their long barbels located in the buccal area and their large-sized lapilli otoliths (Acero and Betancur-R 2002; Marceniuk and Menezes 2007; Bogan and Agnolin 2011). Other important anatomical features include bony plates on the head and near the dorsal fin, and a leading spine in both pectoral and dorsal fins, present in some species (Ribeiro et al. 2012).

Albinism has been the most frequently reported abnormality in several species of the family Ariidae (i.e., Gupta and Bhowmik 1958; Rajapandian and Sundaram 1967; Baragi et al. 1976; Krishna Pillai and Somvanshi 1979; Das et al. 2006; Chavan et al. 2008; Leal et al. 2013; and Wakida-Kusunoki and Amador del Ángel 2017), although there are some studies describing morphological malformations found in these fish. For instance, a specimen of *Carlarius latiscutatus* (Günther, 1864) showed severely deformed fin rays and spines, possibly caused by water pollution (Ugbomeh et al. 2022). For the Mexican coasts in particular, Chávez and Saucedo Barrón (1988) reported conjoined twins of *Ariopsis felis* (Linnaeus, 1766) in Celestun, Yucatan. For the same species (*Ariopsis felis*) collected off the coast of Tabasco, Wakida-Kusunoki and Amador del Ángel (2017) described vertebral malformations. Maldonado-Coyac et al. (2015) reported an ocular malformation in *Bagre panamensis* (Gill, 1863) collected in Mazatlan, Sinaloa. More recently, Tirado León (2019) found vertebral malformations in seven sea catfish species belonging to four genera: *Bagre panamensis*; *Bagre pinnimaculatus* (Steindachner, 1876); *Cathorops liropus* (Bristol, 1897); *Cathorops raredonae* Marceniuk, Betancur-R et Acero, 2009; *Occidentarius platypogon* (Günther, 1864); *Ariopsis guatemalensis* (Günther, 1864); and *Ariopsis seemanni* (Günther, 1864). To increase the current knowledge concerning malformations in species of the family Ariidae, the aim of this study was to record such features detected in sea catfishes caught during fishing activities in San Blas, Nayarit, Mexican Pacific.

Methods

Over a one-year period (September 2015 through September 2016), we advertised the purchase of malformed fishes at the port of San Blas, Nayarit, Mexico. Fishermen who captured "deformed" fishes and were willing to help us delivered the material collected to the facilities of Escuela Nacional de Ingenieria Pesquera of Universidad Autonoma de Nayarit in exchange for the promised reward. Six specimens of sea catfishes were collected as bycatch in an estuarine zone 0.5–1.0 km away from the port of San Blas. In this area, fishing is conducted in brackish shallow (<3 m) water, where fishermen (usually 2 per vessel) arrive in boats and deploy seine nets (9–10 cm mesh size) to catch the fish. The specimens were preserved in ice and transported to the Laboratory of Genetics and Geometric Morphometrics of the Escuela Nacional de Ingenieria Pesquera of Universidad Autonoma de Nayarit. Each sea catfish was identified at the species level following Kaliola and Bussing (1995) and Robertson and Allen (2015). Specimens were labeled and deposited in the Collection of Malformed Fish located in the laboratory mentioned above (Voucher numbers: CPMIP 8, CPMIP 10, CPMIP 13, CPMIP 15, CPMIP 18, and CPMIP 21). The standard length (SL) of the specimens was recorded using a vernier caliper. A normal (in terms of its diagnostic features) individual of each species was used as a control/comparison. Malformed and control specimens were photographed using a 20.2-megapixel Canon EOS70D digital camera

Results

The six collected sea catfishes were identified as *Ariopsis guatemalensis* (*n* = 3) and *A. seemanni* (*n* = 3). Four of these specimens (*Ariopsis guatemalensis* (CPMIP 13 and CPMIP 21) and *A. seemanni* (CPMIP 15 and CPMIP 18)) showed morphological malformations such as missing eye, cleft lip, malformed barbels, comparatively small eye, and abnormal tooth plate. The two remaining sea catfishes (CPMIP 10 and CPMIP 8) were the control specimens (normal) representing each respective species. The specific characteristics of the normal and malformed specimens are described in the following sections.

Diagnostic features. Defined following Kaliola and Bussing (1995) and Robertson and Allen (2015). *Ariopsis guatemalensis*: eye small, 25% of distance between eyes; palate teeth arranged in four patches, medial patches narrowly separated at midline and continuous with outer patches; four tooth patches similar size; 3 pairs of barbels (on chin and both jaws) (see specimen CPMIP 10, Fig. 1B, 1F, 1H). *Ariopsis seemanni*: eye large, 36%–63% of distance between eyes; thin lower tooth plate and divided in two sections (see specimen CPMIP 8, Fig. 1J, 1L).

Descriptions of the abnormal features. *Ariopsis guatemalensis*: specimen CPMIP 13 lacked the right eye opening and the eyeball (Fig. 1A). Specimen CPMIP 21 featured a small (41.7% of right eye size, Fig. 1D) and undeveloped left eye (Fig. 1C). In addition, this fish had a cleft lip, thus, malformed upper tooth plate and barbels (Fig. 1E and 1G). *Ariopsis seemanni*: specimen CPMIP 15 showed a comparatively small right eye (43% of left eye size, Fig. 1J) (Fig. 1I). Specimen CPMIP 18 had a malformed lip and lower plates (Fig. 1K).

Discussion

Studies reporting fish malformations have attributed their presence to biotic and abiotic factors affecting the fish during their life cycle (Overstreet and Edwards 1976; Pragatheeswaran et al. 1987; Kelly et al. 2010; Tirado León 2019). However, while it is not possible to detect a true correlation between such factors and malformations from specimens caught in the wild—as experiments

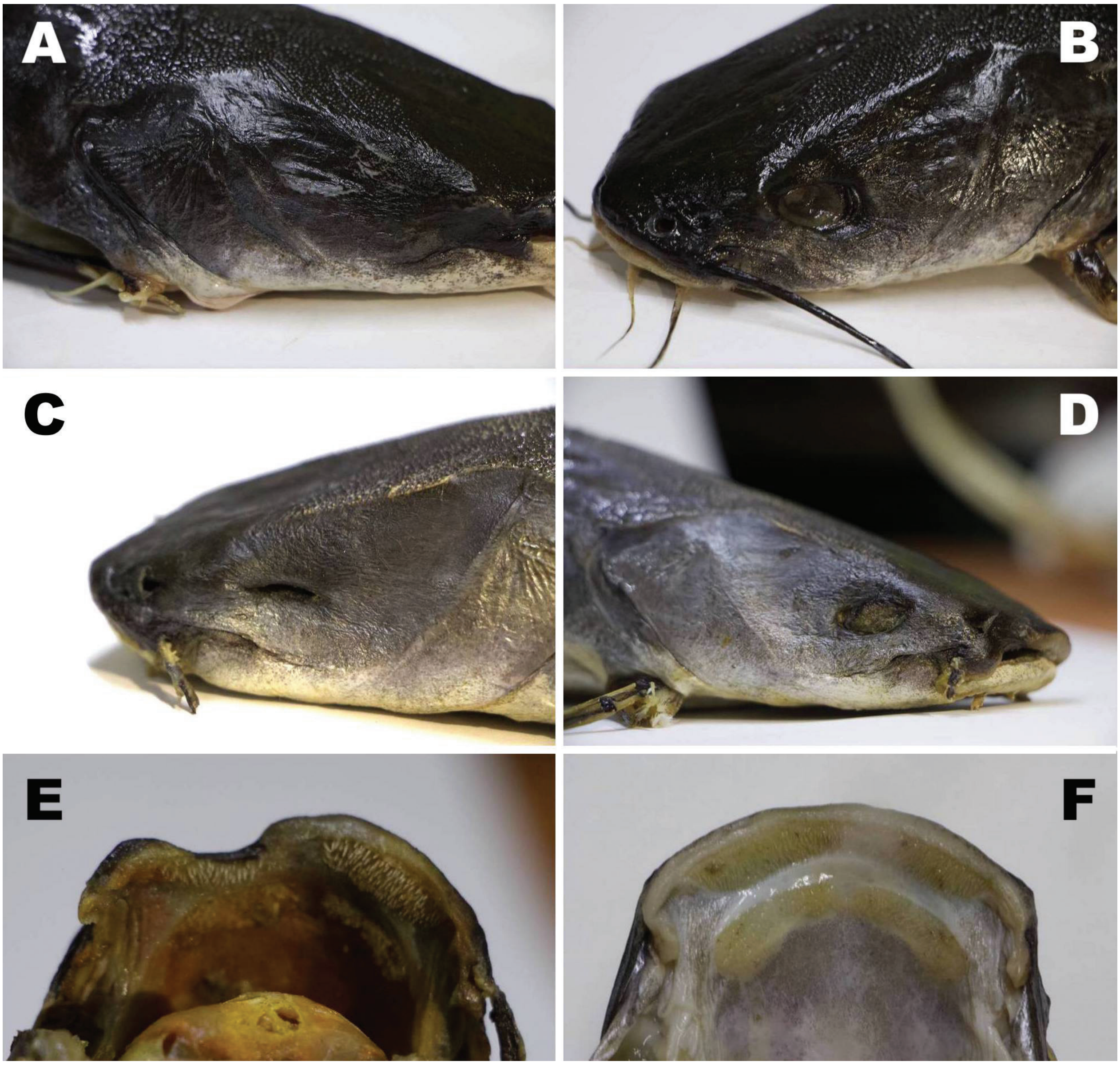

Figure 1. Malformations of *Ariopsis guatemalensis* and *Ariopsis seemanni* collected off San Blas (Mexican Pacific). **A**) specimen of *A. guatemalensis* lacking right eye (CPMIP 13); **B**) normal left eye of a specimen of *A. guatemalensis* (CPMIP 10); **C**) specimen of *A. guatemalensis* with small undeveloped eye (CPMIP 21); **D**) normal right eye of a specimen of *A. guatemalensis* (CPMIP 21); **E**) malformed upper tooth plate and cleft lip of a specimen of *A. guatemalensis* (CPMIP 21); **F**) specimen of *A. guatemalensis* with normal lip and tooth plate (CPMIP 10). **[Figure continues on next page]**

under controlled conditions would be required—knowing the biology and ecology of the species under study can shed light on the causes that could be triggering the development of these malformations. For instance, Chávez and Saucedo Barrón (1988) suggested that oxygen deficiencies, either due to high egg density or to aerial exposure in low tide during egg incubation, could have caused the formation of conjoined twins in *Ariopsis felis*. In addition, for this species (*Ariopsis felis*), the vertebral malformations detected by Wakida-Kusunoki and Amador del Ángel (2017) were attributed to several factors including exposure to pesticides, poor immunologic response, injuries at a certain stage of the fish life cycle, or fluctuations in the water quality of the coast of Tabasco. Moreover, Maldonado-Coyac et al. (2015) reported that the ocular malformation found in *Bagre panamensis* could have been triggered both by anthropogenic activities in Mazatlan, Sinaloa and the genetic configuration of the specimen. Finally, Tirado León (2019), who found vertebral malformations in several sea catfish species including the two species in the presently reported study (*Ariopsis guatemalensis* and *A. seemanni*), obtained the malformed fish from different locations on the coast of Nayarit, counting our sampling site (San Blas), and suggested that parasitic infections and the chronic exposure to pollutants such as pesticides and heavy metals were the two main factors causing such malformations. Indeed, the coast of Nayarit is subjected to the constant

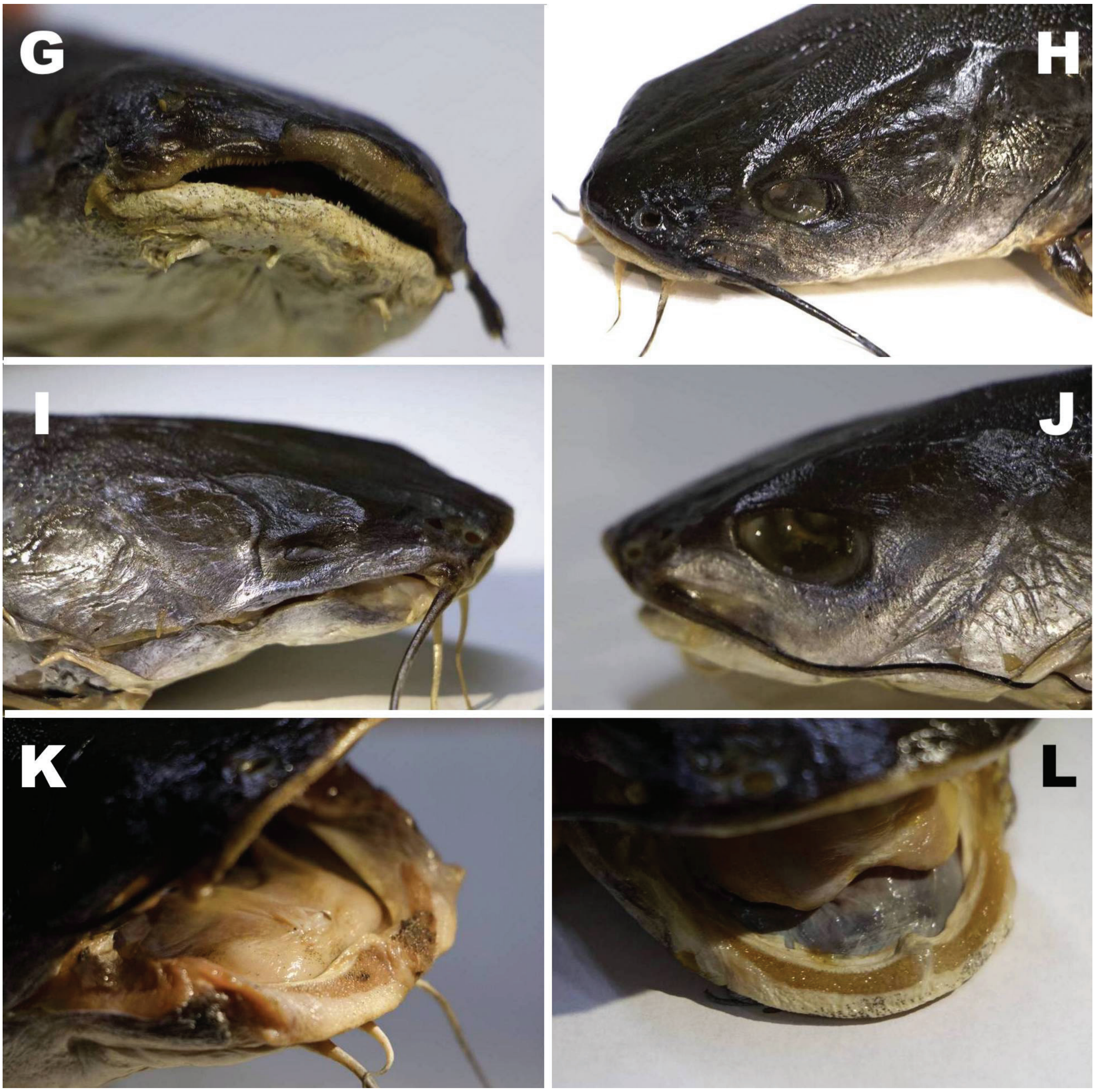

Figure 1 (Continuation). Malformations of *Ariopsis guatemalensis* and *Ariopsis seemanni* collected off San Blas (Mexican Pacific). **G**) malformed barbels of a specimen of *A. guatemalensis* (CPMIP 21); **H**) normal barbels specimen of a specimen of *A. guatemalensis* (CPMIP 10); **I**) specimen of *A. seemanni* with small right eye (CPMIP 15); **J**) normal left eye of a specimen of *A. seemanni* (CPMIP 8); **K**) specimen of *A. seemanni* with malformed lower tooth plate (CPMIP 18); **L**) normal lower tooth plate of *A. seemanni* (CPMIP 8).

input of pesticides and concomitant heavy metals that are washed from agricultural fields of the state or carried from very distant locations by many rivers such as the Colorado, Sonora, Yaqui, Mayo, Fuerte, Sinaloa, Culiacan, San Lorenzo, Acaponeta, San Pedro, Lerma-Santiago, Armeria, Coahuayana, Balsas, Papagayo, Verde, Tehuantepec, and Suchiate (Espinosa-Carreon et al. 2004). In addition, the presence of parasites has been reported in the fishery resources of the study area (Cunningham et al. 2005; Álvarez-Guerrero and Alba-Hurtado 2007; Kelly et al. 2010). Although we concur with the possible causes of malformations discussed by Tirado León (2019) for the two species treated in our study, we are aware that more environmental monitoring studies are needed on the Pacific Mexican coasts. We suggest that sea catfishes could thus be used as bioindicators of an environmental stress.

Acknowledgments

The authors thank the fishermen who carried out artisanal fisheries in the port of San Blas, Nayarit, Mexico. This work was translated into English by SciLangTranslation.

References

Acero PA, Betancur-R R (2002) Description of *Arius neogranatensis*, a new species of sea catfish from Colombia, with an identification key for Caribbean ariid fishes. Aqua 6: 5–10.

Álvarez-Guerrero C, Alba-Hurtado F (2007) Estuarine fish and turtles as intermediate and paratenic hosts of *Gnathostoma binucleatum* in Nayarit, México. Parasitology Research 102(1): 117–122. https://doi.org/10.1007/s00436-007-0738-x

Baragi VM, Yaragal RB, James PSBR (1976) On an albino of the marine cat fish, *Tachysurus tenuispinis* (Day). Matsya 2: 82.

Bogan S, Agnolin FL (2011) Descripción de una nueva especie de bagre marino fósil (Teleostei, Siluriformes, Ariidae) del Mioceno de la provincia de Río Negro, Argentina. Papéis Avulsos de Zoologia 51(25): 373–382. https://doi.org/10.1590/S0031-10492011002500001

Chavan BB, Sundaram S, Sawant AD, Das T (2008) Record of complete albinism in marine catfish, *Osteogeneiosus militaris* (Linnaeus, 1758), landed at Mumbai. Marine Fisheries Information Service, Technical and Extension Series 197: 15–17.

Chávez H, Saucedo Barrón CJ (1988) Colecta de ejemplares siameses del bagre *Arius felis* (Linnaeus) en Yucatán, México (Pisces: Ariidae). Annales de la Escuela Nacional de Ciencias Biológicas 32: 117–121.

Cunningham ME, Markle DF, Watral VG, Kent ML, Curtis LR (2005) Patterns of fish deformities and their association with trematode cysts in the Willamette River, Oregon. Environmental Biology of Fishes 73(1): 9–19. https://doi.org/10.1007/s10641-004-3153-5

Das T, Chavan BB, Sundaram S (2006) A rare record of albino catfish, *Arius caelatus* landed at Mumbai. Marine Fisheries Information Service, Technical and Extension Series 188: 21–22.

Eissa AE, Mustapha M, El-Husseiny IN, Saeid S, Saleh O, Borhan T (2009) Identification of some skeletal deformities in freshwater teleosts raised in Egyptian aquaculture. Chemosphere 77(3): 419–425. https://doi.org/10.1016/j.chemosphere.2009.06.050

Espinosa-Carreon TL, Strub PT, Beier E, Ocampo-Torres F, Gaxiola-Castro G (2004) Seasonal and interannual variability of satellite-derived chlorophyll pigment, surface height, and temperature off Baja California. Journal of Geophysical Research 109(C3): C03039. https://doi.org/10.1029/2003JC002105

Gupta PD, Bhowmik RM (1958) A case of albinism in *Arius jella* Day from India. Science and Culture 24(6): 283.

Kaliola PJ, Bussing WA (1995) Ariidae. Bagres marinos. Pp. 860–886. In: Fischer W, Krupp F, Schneider W, Sommer C, Carpenter KE, Niem V (Eds) Guía FAO para identificación de especies para los fines de la pesca. Pacífico Centro-Oriental. 3 Vols. FAO, Rome.

Kelly DW, Thomas H, Thieltges DW, Poulin R, Tompkins DM (2010) Trematode infection causes malformations and population effects in a declining New Zealand fish. Journal of Animal Ecology 79(2): 445–452. https://doi.org/10.1111/j.1365-2656.2009.01636.x

Krishna Pillai S, Somvanshi VS (1979) A case of complete albinism in marine cat fish *Arius caelatus* (Valenciennes). Indian Journal of Fisheries 26(1/2): 240–241.

Leal ME, Schulz UH, Albornoz PL, Machado R, Ott PH (2013) First record of partial albinism in two catfish species of *Genidens* (Siluriformes: Ariidae) in an estuary of southern Brazil. Brazilian Archives of Biology and Technology 56(2): 237–240. https://doi.org/10.1590/S1516-89132013000200008

Maldonado-Coyac JA, Escobar-Sánchez O, Ramírez-Pérez JS, Moreno-Sánchez XG, Palacios-Salgado DS (2015) First case of abnormality in the chihuil sea catfish (*Bagre panamensis*) from Mexican waters. Fish California and Game 101(3): 188–192.

Marceniuk AP, Menezes NA (2007) Systematics of the family Ariidae (Ostariophysi, Siluriformes), with a redefinition of the genera. Zootaxa 1416(1): 1–126. https://doi.org/10.11646/zootaxa.1416.1.1

Overstreet RM, Edwards RH (1976) Mesenchymal tumors of some estuarine fishes of the northern gulf of México. II. Subcutaneous fibromas in the southern flounder, *Paralichthys lethostlgma*, and the sea catfish, *Arius felis*. Bulletin of Marine Science 26: 41–40.

Palacios-Salgado DS, Flores-Ortega JR, Zavala-Leal OI, Granados-Amores J, Nieto-Navarro JT, Tapia-Varela R, Ruiz-Velazco JMJ, Moreno-Sánchez XG, Cadena-Roa MA (2018) Length–weight relationship for sea catfishes (Siluriformes: Ariidae) from the southeastern Gulf of California with new records on maximum length. Journal of Applied Ichthyology 34(3): 700–702. https://doi.org/10.1111/jai.13511

Pragatheeswaran V, Loganathan B, Natarajan R, Venugopalan VK (1987) Cadmium induced vertebral deformities in an estuarine fish, *Ambassis commersoni* Cuvier. Proceedings of the Indian Academy of Science 96(4): 389–393. https://doi.org/10.1007/BF03179592

Rajapandian ME, Sundaram KS (1967) A case of complete albinism in the marine cat-fish *Tachysurus dussumieri* (Cuvier and Valenciennes). Journal of the Marine Biological Association of India 9(1): 194–195.

Ribeiro EB, Almeida ZS, Carvalho-Neta RNF (2012) Hábito alimentar do bagre *Sciades herzbergii* (Siluriformes, Ariidae) da Ilha dos Caranguejos. Maranhão, Brasil. Arquivo Brasileiro de Medicina Veterinaria e Zootecnia 64(6): 1761–1765. https://doi.org/10.1590/S0102-09352012000600048

Robertson DR, Allen GR (2015) Peces Costeros del Pacífico Oriental Tropical: sistema de Información en línea. Versión 2.0 Instituto Smithsonian de Investigaciones Tropicales, Balboa, República de Panamá. http://biogeodb.stri.si.edu/sftep/es/pages

Rodríguez-Romero J, López-Martínez J, Herrera-Valdivia E, Hernández-Vázquez S, Acevedo-Cervántes A (2012) Elenco taxonómico de los peces acompañantes de la captura de camarón en la porción oriental del Golfo de California. Pp. 71–91. In: López Martínez J, Morales-Bojórquez E (Eds) Efectos de la pesca de arrastre en el Golfo de California. Centro de Investigaciones Biológicas del Noroeste, S.C. y Fundación Produce Sonora, México.

Tirado León DE (2019) Caracterización de malformaciones vertebrales en bagres (Siluriformes: Ariidae) del litoral de Nayarit, México. Tesis de Maestría. Universidad Autónoma De Nayarit.

Ugbomeh AP, Jawad LA, Frank JJ, Akani GC (2022) Report on the incidences of skeletal anomalies in three fish species from Bonny tributary (Niger delta), Nigeria. Proceedings of the Zoological Institute RAS 326(1): 14–22. https://doi.org/10.31610/trudyzin/2022.326.1.14

Wakida-Kusunoki AT, Amador del Ángel LE (2017) Vertebral deformities in hardhead catfish *Ariopsis felis* (Siluriformes: Ariidae) in the southeastern Mexico. Revista de Biología Marina y Oceanografía 52(1): 159–162. https://doi.org/10.4067/S0718-19572017000100013

Yokoyama H, Freeman MA, Yoshinaga T, Ogawa K (2004) *Myxobolus buri*, the myxosporean parasite causing scoliosis of yellowtail, is synonymous with *Myxobolus acanthogobii* infecting the brain of the yellowfin goby. Fisheries Science 70(6): 1036–1042. https://doi.org/10.1111/j.1444-2906.2004.00903.x