

Scientific Note

Ambicoloration and morphological aberration in the sole *Achirus declivis* (Pleuronectiformes: Achiridae) and two other cases of color abnormalities in achirid soles from southeastern Brazil

Raphael Mariano Macieira, Jean-Christophe Joyeux and Leandro Pereira Chagas

Three cases of color abnormalities and one of morphological aberration in flatfishes of the genus *Achirus* are described from the Piraquê-Açú River estuary, Espírito Santo, Brazil. One specimen of *A. declivis* has 75% of the blind side with coloration like that of the ocular side. Another specimen of the same species is strongly hypomelanistic. A third specimen has incomplete eye rotation and a hooked dorsal fin. An ambicolored *A. lineatus* is also described.

Três casos de anormalidades pigmentares e um caso de malformação morfológica são descritos em linguados do gênero *Achirus* do estuário do Rio Piraquê-Açú, Espírito Santo, Brasil. Um espécime de *A. declivis* tem 75 % do lado cego com coloração idêntica àquela do lado oculado. Um outro indivíduo desta mesma espécie tem hipomelanização acentuada. Um terceiro espécime tem rotação incompleta do olho e início da nadadeira dorsal em formato de gancho. Um espécime de *A. lineatus* ambicolorido é também descrito.

Key words: Flatfishes, Hypermelanosis, Hypomelanosis, Abnormal eye rotation, Malformation.

Color abnormalities have been reported for a variety of flatfish species (*e.g.*, Dawson, 1962; White & Hoss, 1964; Taylor *et al.*, 1973; Gartner, 1986; Diaz de Astarloa, 1995, Venizelos & Bennetti, 1999; Bolker & Hill, 2000, Chaves *et al.*, 2002, Purchase *et al.*, 2002). Their occurrence in laboratory-reared fishes has been associated with stress during larval metamorphosis, but whether color anomalies result from more general metabolic problems is unclear (Venizelos & Benetti, 1999; Purchase *et al.*, 2002). Pigmentation anomalies can occur on both sides of the body. Hypomelanosis results in white patches or areas devoid of normal pigmentation on either ocular or, less frequently, blind side of the body. On the other hand, hypermelanosis refers to the presence of pigmented patches on the blind side (Venizelos & Benetti 1999). Ambicoloration specifically refers to the presence of ocular-side color and pattern on the blind side. Aberrant coloration and head deformities, that are the two most common types of abnormalities in flatfishes (see Dalhberg, 1970; Gartner, 1986), may be re-

lated to each other through the eye migration process during metamorphosis. Okada *et al.* (2003) considered ambicoloration to occur through the development of two sides with pigmentation characteristic of the ocular side (*i.e.*, two “ocular sides”) with abnormal (primary ambicoloration) or normal (secondary ambicoloration) eye location in post-metamorphic individuals. Similarly, albinism would result from the development of a pigmentation pattern characteristic of the blind side on both sides of the body (*i.e.*, two “blind sides”) with (primary albinism) or without (secondary albinism) eye mislocation. Secondary coloration could, at least in some cases, be caused by injuries (Gartner, 1986). Animals affected by either abnormality often present aberrations in their scales, in isolation or in groups, with scales larger or smaller than normal or mis-oriented to angles up to 180° off the typical orientation (Dawson, 1962).

Here we report on color and head anomalies in two species of American soles, the plainfin sole *Achirus declivis*

Chabanaud, 1940 and the lined sole *Achirus lineatus* (Linnaeus, 1758). There are few previous records of similar aberrations in achirid soles. Color anomalies have been described for *Achirus lineatus* (but only for laboratory-reared fishes), *Gymnachirus melas* Nichols, 1916 and *Trinectes maculatus* (Bloch & Schneider, 1801) (see Dawson, 1962, Houde, 1971, Koski, 1974, and Gartner, 1986). Head malformations have only been reported for tank-raised *A. lineatus* (Houde, 1971) and wild *T. maculatus* (Dawson, 1962; Gartner, 1986).

The sole specimens were caught in the Piraquê-Açú River (40°09' W and 19°57' S), the northern arm of the Piraquê-Açú Piraquê-Mirim Estuarine System (PAPM), county of Aracruz, Espírito Santo, Brazil. Overall, the estuarine area is well preserved with only a low to moderate level of human impact (Barroso, 2004). Sampling was done monthly between April 2003 and June 2004 during daytime using a 9.3 m otter trawl of 13 mm mesh between knots in the wings and 5 mm in the cod-end. All trawl samples ($n = 126$) were kept on ice and frozen until processing. Four abnormal specimens of the genus *Achirus* were found among 252 *A. declivis* and 388 *A. lineatus*. In the laboratory, specimens were thawed, fixed in 10% formaldehyde solution and stored in 70% ethanol. Surface areas were estimated using the grid method on a digital photograph in imaging software (Håkanson, 1981). All specimens

were radiographed. Radiographs and specimens were deposited in the fish collections at the Museu de História Natural, Universidade Estadual de Campinas (ZUEC 6274-6276) and the Departamento de Ecologia e Recursos Naturais, Universidade Federal do Espírito Santo (UFES 0095).

An ambicolored adult *A. declivis* (Figs. 1a-b), 108.8 mm standard length (SL), was caught at about 3.5 m depth. The ocular side of this specimen presented the typical uniform brown color with 12 dark transversal lines characteristic of the species. The blind side was 75%-pigmented with coloration similar to that of the ocular side, but differed in having only 7 dark transversal lines. The specimen also had brownish white spots (ocular side) and white patches (blind side) that do not occur in normally-colored individuals. Typically, in this species the anterior half to two-thirds of the blind side is unpigmented, whereas the posterior (caudal) portion is uniformly tan to light gray. Radiographs did not show any skeletal anomaly. Scalation was normal.

An hypomelanistic adult *A. declivis* (Figs. 1c-d), 119.1 mm SL, was caught at about 9.5 m depth. It had abnormal coloration on its ocular side, which was whitish tan with six very faint transversal lines and also with numerous grayish brown to blackish spots. The blind side showed the normal pigmentation pattern for the species. No osteological abnormality was detected on radiographs and scalation was normal.

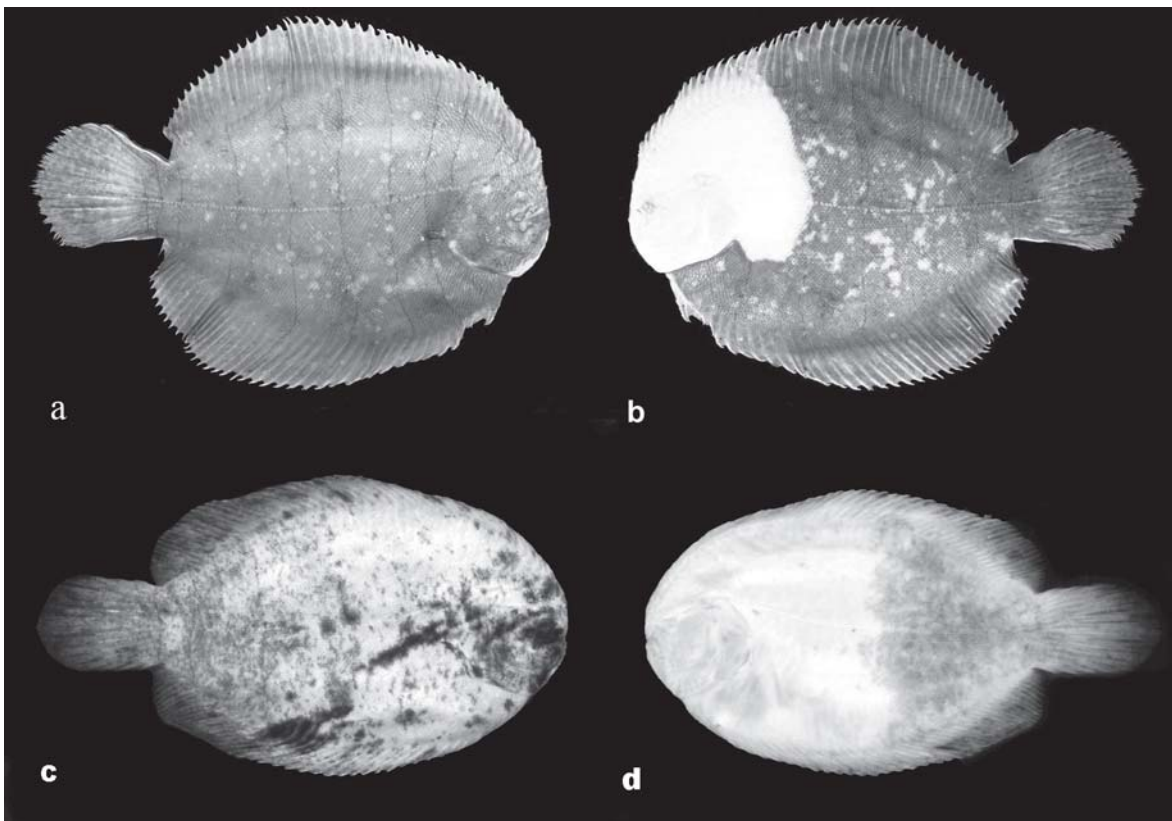


Fig. 1. Abnormal pigmentation patterns in the plainfin sole *Achirus declivis* from the Piraquê-Açú River, Espírito Santo, southeast Brazil: (a) ocular side of ambicolored 108.8 mm SL specimen (ZUEC 6274); (b) blind side of the individual represented in a; (c) ocular side of hypomelanistic specimen 119.1 mm SL (ZUEC 6275); (d) blind side of the individual represented in c. Photographs by Raphael M. Macieira.

Ambicoloration was also recorded in a juvenile (57.7 mm SL) *A. lineatus* caught at about 4 m depth. Ocular-side coloration was typical for the species, dark brown with many sprinkled black spots. Eleven percent of the blind side had pigmentation identical to that of the ocular side, but this pigmentation was limited to two small triangles in the gular and nape regions, respectively. The remainder of the underside was white with a few brownish patches on the rear quarter of the body, consistent with coloration typical for the species. Scalation was normal. Radiographs did not evidence osteological deformity.

A malformed adult *A. declivis* (Fig. 2a), 94.9 mm standard length, was captured at about 9.7 m depth. The eye rotation was approximately normal in extent, but the underside of the head showed a large gaping hole where the left eye had initiated migration at metamorphosis (Fig. 2b). There were no scales on the walls of the hole. At its center, the hole presented a hollow, approximately conical (upside down) structure of hard, bone-like material that may be the remnants of the eye socket. (This structure, broken off at its base before radiographing, was deposited with the specimen.) Also, the

eye migration route over the skull was unfilled, leading to a strong hooking of the anterior part of the dorsal fin (Figs. 2c & 2d). Radiographs did not reveal any osteological anomaly other than those of the head. Over the body and fins, the scales were normal in shape, size and orientation. However, the scales anterior to the left eye and on the hook were thick and erected. There was no indication of a previous, healed injury in this region. A few discolored brownish tan patches, frequently missing a few scales, were present on the anterior portion of the ocular side, mostly above the lateral line. The posterior portion had four scratches, mostly below the lateral line, with the same color and scale characteristics as that of the patches. These superficial anomalies probably resulted from freezing and trawl damage.

The present report is the first record of coloration and morphological anomalies in *A. declivis*. It is also the first record of a wild ambicolored specimen of *A. lineatus*. It is our opinion that the ambicolored and hypomelanized specimens described here present secondary malpigmentation. Since none of these individuals presented both anomalous color and incomplete eye migration, and also because none pre-

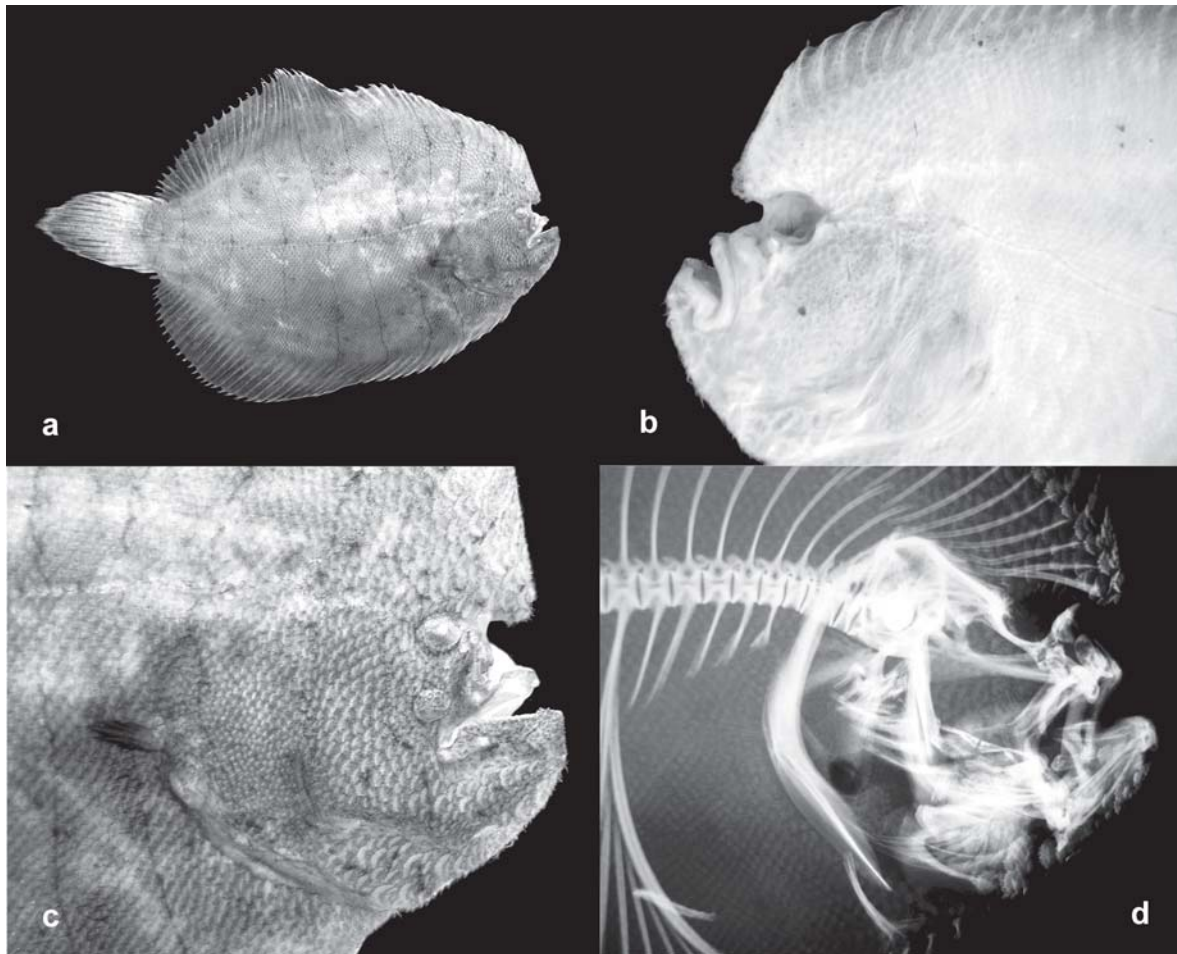


Fig. 2. Incomplete eye rotation and incomplete development of the dorsal fin over the skull in the plainfin sole *Achirus declivis* (UFES 0095; 94.9 mm SL) from the Piraquê-Açu River, Espírito Santo, southeast Brazil: (a) ocular side; (b) detail of blind side of the head; (c) ocular side of the head; (d) radiograph of the head. Photographs by Raphael M. Macieira.

sented any skeletal deformity (other than on the head) or unusual scaling, the study brings no support to a direct relationship between the two anomalies (*e.g.*, Dahlberg, 1970). In fact, Okada *et al.* (2003) noted that in cultured Japanese flounder (*Paralichthys olivaceus*) with 'serious abnormal eye location', individuals can have normal coloration or primary or secondary miscoloration, with miscoloration either albinism or ambicoloration.

In Pleuronectiformes where abnormal pigmentation has been reported in natural populations (Gartner, 1986), the reported occurrence varies between 0.01% for partial albinism and 0.23% for ambicoloration (see Dahlberg, 1970, and references therein). Rates for ambicoloration in Achirids of the PAMP estuary were 0.40% in *A. declivis* and 0.26% in *A. lineatus*, while rates for hypomelanization were 0.40% in *A. declivis* and 0.00% for *A. lineatus*. These rates, possibly underestimated, are slightly higher than those cited by Dahlberg (1970) for a variety of flatfish species. In fact, since sampling in the Piraquê-Açu River was not directed toward the detection of anomalies in fishes, other abnormal flatfish specimens could have been overlooked during processing.

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