



Reversal and ambicoloration in two flounder species (Paralichthyidae, Pleuronectiformes)

LUIZ CONSTANTINO DA SILVA JUNIOR^{1,2}, AMANDA C. DE ANDRADE¹,
MAGDA F. DE ANDRADE-TUBINO¹, MARCELO VIANNA¹

¹ Laboratório de Biologia e Tecnologia Pesqueira, Avenida Prof. Rodolfo P. Rocco, 211 – Prédio do CCS – Bloco A – Sala A0-54 – Ilha do Fundão – Cidade Universitária – Rio de Janeiro – RJ – CEP: 21949-900.
² E-mail: lconstantino@gmail.com

Abstract. One reversed *Citharichthys macrops* Dresel, 1885 and two ambicolored *Paralichthys isosceles* Jordan, 1891 specimens were caught in Guanabara Bay and Ilha Grande Bay, respectively. The prior is the first record of reversal for the genus in the Southwestern Atlantic Ocean and the first for the species in the world, whereas the latter are the first record for the species in Brazil. In both cases, the abnormal specimens are meristically and morphometrically similar to the normal individuals.

Key words: Guanabara Bay, Ilha Grande Bay, Rio de Janeiro, Demersal Fisheries.

Resumo. Reversão e anficoloração em duas espécies de linguados (Paralichthyidae, Pleuronectiformes) Um espécime reverso de *Citharichthys macrops* Dresel, 1885 e dois espécimes anficoloridos de *Paralichthys isosceles* Jordan, 1891 foram capturados na Baía de Guanabara e Baía da Ilha Grande, respectivamente. O indivíduo reverso é o primeiro registro do gênero no Atlântico Sudoeste e o primeiro da espécie no mundo. Os anficoloridos são os primeiros registros deste caso no Brasil. Em ambos os casos, os espécimes anômalos são, merística e morfometricamente, similares aos indivíduos normais das espécies.

Palavras Chave: Baía de Guanabara, Baía da Ilha Grande, Rio de Janeiro, Pesca Demersal.

Among other features, Pleuronectiformes is considered a monophyletical order based on the ontogenetic migration of one of the eyes to the opposite side of the body. Due to their particular development, flounders typically have an asymmetrical external coloration, pigmented on the ocular side and unpigmented on the blind (Hensley 1997). According to the orientation of the eye migration, they may be dextral (eyes and colour on the right side) or sinistral (eyes and color on the left side) (Díaz de Astarloa 1997).

Occasionally, individuals display eyes and pigmentation on the expected blind and unpigmented side, a phenomenon called reversal (Díaz de Astarloa 1997). Other malformations reported for flounders include pigmentation defects, such as ambicoloration. This is a widely reported phenomenon for flatfish (e. g. Hussakof 1914, Gudger 1935, Gudger & Firth 1935, Gudger 1936, Díaz de Astarloa 1994, Díaz de Astarloa 1998,

Chaves *et al.* 2002, Carnikián *et al.* 2006, Macieira *et al.* 2006) and occurs when the blind side, usually lacking pigmentation, is ontogenetically colored, characterized by the presence of similar pattern elements (including ocelli) on both sides of the body (Bolker *et al.* 2005).

The specimens analyzed in this paper, one reversed *Citharichthys macrops* Dresel, 1885 and two ambicolored *Paralichthys isosceles* Jordan, 1891, were caught in regular surveys, employing shrimping boats and using trawl nets, in Guanabara Bay and Ilha Grande Bay, respectively, both in Rio de Janeiro state.

Citharichthys macrops is one of the five *Citharichthys* species known in Brazilian waters. It can be easily recognized by its spotted pattern on the caudal fin. Such spots (three or four) remain visible even after fixation and conservation. This marine species is usually found in shallow waters, less than 40 m deep, away from bays and estuaries. Its

distribution ranges from North Carolina (USA) to Santa Catarina (Brazil) (Figueiredo & Menezes 2000).

Paralichthys isosceles is one of the five *Paralichthys* species known in Brazilian waters. The species is easily recognized due to three conspicuous dark ocelli in the posterior half of the body, ctenoid scales on the blind side and a small freckle between the third and fourth rays of the left pelvic fin. Due to their medium to large size and wide distribution, from Southeastern Brazil to Patagonia (Argentina), *Paralichthys* is the only genus of Pleuronectiformes in Brazil with commercially important species (Figueiredo & Menezes 2000).

Ten sinistral *C. macrops* individuals (Figure 1a) as well as the reversed specimen (Figure 1b) (Total Length, TL = 133 mm, Standard Length, SL = 107.8 mm and Total Weight, TW = 27.2 g) were caught in Guanabara Bay (22°55'36.8" S; 43°07'48.1" W) in February 2006, in waters between 7.5 and 10.0 meters deep. These specimens were catalogued in the Museu de Zoologia, Universidade de São Paulo (MZUSP) under the following registration numbers: MZUSP 91681 (1 reversed specimen) and MZUSP 91682 (10 normal specimens).

The reversed *C. macrops* had a lower number of dorsal and anal fin rays than the mean number of rays counted for the typical specimens (Table I). However, Figueiredo & Menezes (2000) report a number of dorsal fin rays ranging from 74 to 85 and the anal fin rays from 56 to 64. The morphometrical characteristics are also in accordance with the information in the literature (Figueiredo & Menezes 2000; Munroe 2002). Therefore, externally, the dextral specimen is a mirror image of the normal sinistral *C. macrops*.

Reversal appears to be rare in *Citharichthys* flounders, with only two previous cases reported in the Northern Atlantic Ocean: *C. spilopterus* (Castillo-Rivera & Kobelkowsky 1992) and *C. abbotti* (Dawson 1969 *apud* Castillo-Rivera & Kobelkowsky *op. cit.*). However, some species in the sinistral Paralichthyidae family have a high reversal rate (Munroe 2002). For instance, up to 40% of individuals are reversed in *Paralichthys californicus* (Ginsburg 1952 *apud* Díaz de Astarloa 1997). The present study is the first record of reversal for the genus in the Southwestern Atlantic and the first for *Citharichthys macrops*.

Eleven normal individuals, as well as two ambicolored *P. isosceles* specimens (Figure 2) (TL = 124.0 and 263.0 mm, SL = 98.8 and 220.0 mm and TW = 14.7 and 184.3 g, respectively), were caught

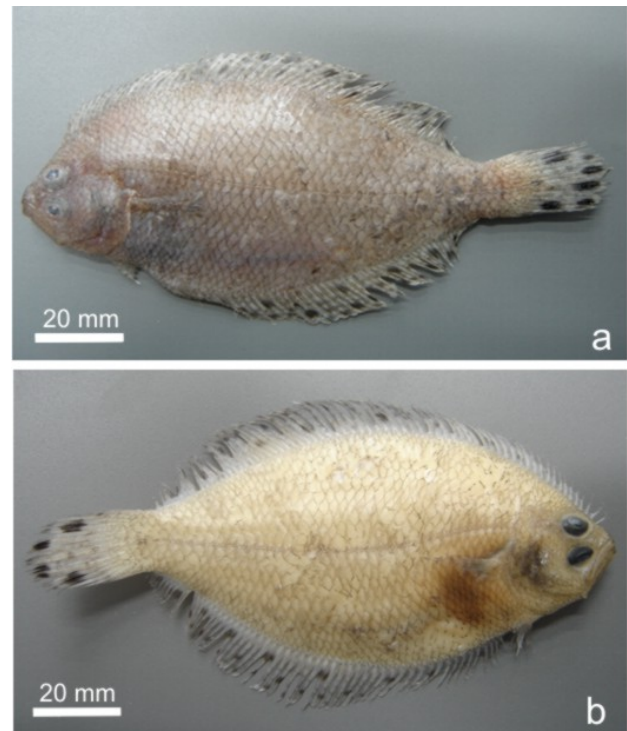


Figure 1. a) Typical *Citharichthys macrops*, MZUSP 91682; b) Reversed *C. macrops*, MZUSP 91681, both caught at Guanabara Bay, Rio de Janeiro state.

in January 2006 in waters about 60.0 meters deep, outside Ilha Grande Bay (23°27'78.4" S; 44°12'26.5" W).

The first was almost fully ambicolored, with lack of pigmentation restricted to the cephalic region, while the second showed pigmentation only on the posterior portion of the body. Similar patterns were described for *P. orbignyanus* on the Uruguayan coast (Carnikián *et al.* 2006). All specimens were catalogued in MZUSP under the following registration numbers: MZUSP 91683 (2 ambicolored specimens) and MZUSP 91684 (11 normal specimens).



Figure 2. A typical (above) and an ambicolored (below) *Paralichthys isosceles*, caught at Ilha Grande Bay, Rio de Janeiro state. Voucher numbers are MZUSP 91684 and MZUSP 91683, respectively.

Table I – Measurements and countings for ten typical *Citharichthys macrops* and one reversed specimen.

Measurements and Countings	Typical <i>C. macrops</i> (n=10)			Reversed	Figueiredo & Menezes (2000)
	Range	Mean	SD		
Standard Length (SL - mm)	82.5 - 155.8	117.6	25.8	107.8	-
Height (%SL)	45.3 - 51.6	48.4	1.8	50.8	-
Head Length (%SL)	22.9 - 27.3	24.5	1.4	26.3	-
Eye Diameter (%SL)	4.6 - 7.4	5.8	1.2	6.0	-
Upper Maxilla (%SL)	8.3 - 13.5	10.3	1.9	10.5	-
Dorsal Fin Rays	77 - 84	80.6	2.5	74,0	74 - 85
Anal Fin Rays	60 - 63	61.3	1.0	57,0	56 - 64
Pectoral Fin Rays	10.0 - 11.0	10.8	0.3	10,0	-
Gill Rakers (Upper + Lower)	4 - 6 + 13 - 16	5.1 + 15.3	0.6 + 1.2	5 + 14	4 - 6 + 12 - 16
Lateral Line Scales	39 - 45	42.8	1.1	40.0	37 - 44

S.D. = Standard Deviation

Table II shows that neither ambicolored *P. isosceles* demonstrated morphological differences in relation to the normal ones. Both morphometric and meristic mean values fall within the species' range (Figueiredo & Menezes 2000), as in the reversed *C. macrops*.

Ambicoloration is particularly common in *Paralichthys*, with reported cases for both

Northwestern (e.g. Hussakof 1914, Gudger 1935, Gudger 1936) and Southwestern Atlantic (e.g. Díaz de Astarloa 1994, Díaz de Astarloa 1998, Carnikián *et al.* 2006), including a report for *P. isosceles* in the Southwestern Atlantic (Díaz de Astarloa 1998). However, the ambicolored specimens described in this paper are the first record for the species in Brazilian waters.

Table II – Measurements and countings for regular and ambicolored *Paralichthys isosceles*.

Measurements and Countings	Typical <i>P. isosceles</i> (n=11)			Reversed <i>P. isosceles</i> (n=2)			Figueiredo & Menezes (2000)
	Range	Mean	S. D.	Range	Mean	S. D.	
Standard Length (SL - mm)	125.6 - 189.3	141.9	19.3	98.8 - 220.0	159.4	19.3	-
Height (%SL)	43.2 - 46.2	44.6	1	42.8 - 45.2	44.0	1	-
Head Length (HL) (%SL)	27.4 - 29.1	28.2	0.7	27.5 - 27.8	27.7	0.7	-
Eye Diameter (ED) (%SL)	5.8 - 7.4	6.6	0.5	6.0 - 6.8	6.4	0.5	-
HL/ED	3.8 - 4.7	4.3	0.3	4.1 - 4.6	4.3	0.4	3.7 - 4.8
Dorsal Fin Rays	83 - 87	86	1.6	86 - 87	86.5	0.7	79 - 92
Anal Fin Rays	67 - 73	69	1.7	67 - 68	67.5	0.7	67 - 72
Pectoral Fin Rays	11 - 12	11	0.5	11	11	0	-
Gill Rakers (Lower + Rudimentary Upper)	9 - 12 + 2 - 4	9.7 + 2.8	0.9 + 0.6	9 - 10 + 3	9.5 + 3	0.7 + 0	9 - 11 + 2 - 3
Lateral Line*	47 - 52	50	1.3	50	50	0	46 - 52

S.D. = Standard Deviation

* - Series of scales above the straight portion of the Lateral Line

Studies about pigmentation defects of flatfishes have been carried out for over a hundred years, but the causes of abnormalities still can't be pinpointed. A number of environmental, nutritional, hormonal and neurological aspects are accountable for these phenomena, for fishes in captivity (Venizelos & Benetti 1999). The present study does not intend to discuss the causes of these abnormalities, but only to single out the fact that such malformations are registered in Ilha Grande Bay and Guanabara Bay.

Despite coloration differences, no

morphological or meristic parameters were altered in either flounder species.

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