

Sexual Dimorphism and an Abnormal Intersexual Specimen in the Bothid Flounder *Bothus pantherinus*

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Abstract Secondary sexual characters of *Bothus pantherinus* (Rüppell) were examined. An abnormal specimen, among 109 normal specimens, had mosaic characters of both sexes. In the histological observation, the gonad was consisted mostly of testis, but in part ovarian tissue was recognized. The specimen may be considered as an abnormal intersex.

Introduction

Intersexuality, which occurs frequently in fishes was discussed in detail by Atz (1964) and noted by Dawson (1964, 1966, 1971) in both normal and abnormal specimens. In neither of them intersexuality is reported in the order Pleuronectiformes except in a hybrid specimen (Aron, 1958).

In the order Pleuronectiformes, it is well known that certain species, including those of the family Bothidae, shown most remarkable differences between sexes. Their secondary sexual characters are found in length of fins, spines on head, interorbital width, teeth, scales, and coloration. A complete male with fully developed organs is so different from a female that it may be mistaken for another species (Norman, 1934; Matsubara, 1955; Amaoka, 1969).

Among specimens of *Bothus pantherinus* (Rüppell), collected from the Seychelles Bank of the Indian Ocean, an abnormal specimen showing some external characters of both sexes was discovered.

In the present paper, the secondary sexual characters in the normal specimens and the intersexual specimen were compared. A histological observation on the gonads was also made.

Material and methods

The specimens of *B. pantherinus* examined in the present study were caught from the Seychelles Bank, southwestern area of the Indian Ocean, by means of a trawl net of the training ship "Koyo Maru" of Shimonoseki

University of Fisheries during November and December, 1968. The specimens are deposited in the Fisheries Museum, Shimonoseki University of Fisheries. The specimens were defrosted with water after 3 or 4 months in frozen condition, and preserved in 10 percent formalin. They are 50 males, 59 females, and 1 intersex, measuring 97~176 mm, 86~187 mm and 144 mm in standard length, respectively. Measurements to the body were made in accordance with the method used by Norman (1934).

For histological observation, gonads of the intersexual specimen and of the normal ones of each sex, which were subequal in size and were collected on the same date and at the same locality, were embedded in paraffin, sectioned serially at 8 μ in thickness, and stained with Delafield's hematoxylin and eosin.

Result

1. Sexual dimorphism

Pectoral fin on the ocular side: In the male, the fin becomes greatly elongate and filamentous with growth, extending to the posterior end of the dorsal fin in a specimen 120 mm in standard length, and to or beyond the caudal base in a larger specimen (Fig. 1, A). In the female, it is not elongate, and the length shows about constant value to the standard length (about 4.8~6.2 in standard length) (Fig. 1, B). In the abnormal specimen, the fin is not fully elongate as observed in the adult male of about same size, but extending to nearly below the 13th ray of the dorsal fin counted from the posterior end (Fig. 1, D).

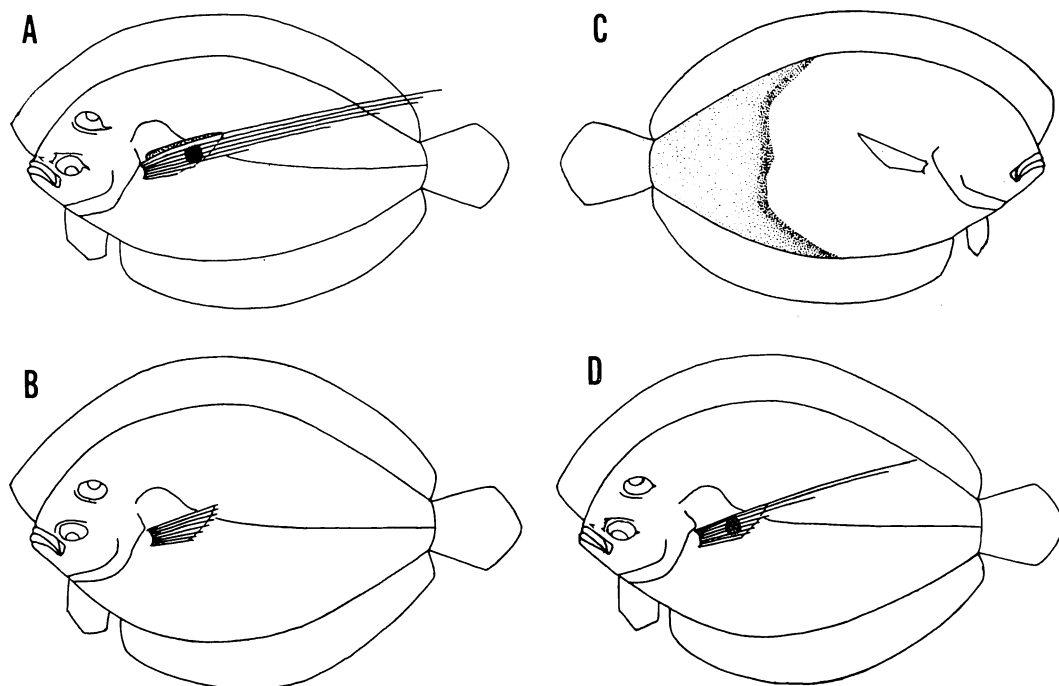


Fig. 1. Diagrammatic illustration of body parts showing sexual dimorphism in *Bothus pantherinus*. A, ocular side in male; B, ocular side in female; C, blind side in male; D, ocular side in intersex.

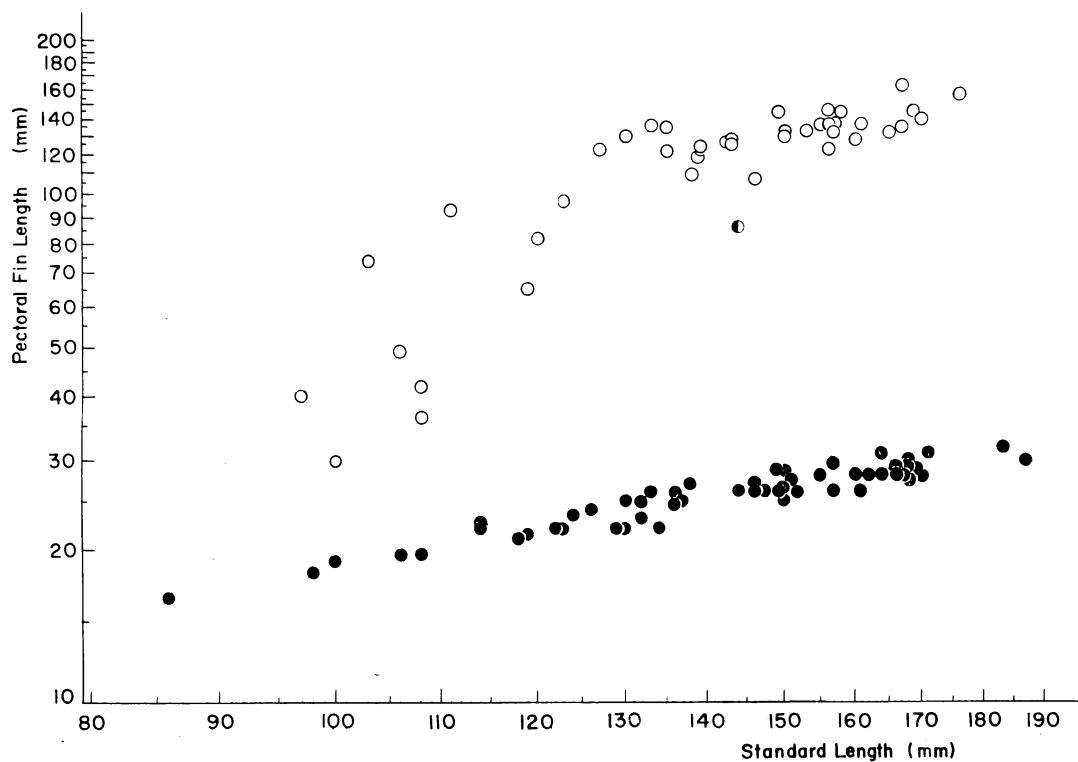


Fig. 2. Relation of pectoral fin length on ocular side to standard length in *Bothus pantherinus*. (○), male; (●), female; (◐), intersex.

It is found that the significant differences between sexes consist in the relative growth of the pectoral fin on the ocular side. In the abnormal specimen the length of the pectoral fin is nearly equal to that of a male than that of an intermediate between both sexes (Fig. 2). In addition, the male has the first and sometimes the second rays surrounded by a heavy, strong, broad fin-membrane extending $\frac{1}{3}$ the length of the ray (Fig. 1, A). But in the female and the abnormal specimens no change in the membrane is seen (Fig. 1, B, C).

Rostral and orbital spines: In the male, the spines are well developed on the snout, and even in front of the lower eye, but vary in the developmental degree (Fig. 1, A). In the female, neither the rostral nor the orbital spine was seen (Fig. 1, B). The abnormal specimen has feeble spines on the snout and before the lower eye (Fig. 1, D).

Orbital tentacle: The male has a tentacle directed backward, on the hinder part of each eye (Fig. 1, A). It is seen in specimens more than about 140 mm in standard length, but is rudimentary or absent in specimens less than 130 mm in standard length. The tentacle is wanting in the female, and is very short in the abnormal specimen (Fig. 1, B, D).

Coloration: The male has a large dark blotch near the basal part of the pectoral fin on the ocular side. It is a little smaller than eye and located between the second and the sixth rays (Fig. 1, A). In the female, the blotch is entirely wanting (Fig. 1, B). In the abnormal specimen, it is obscure but its size is equal to that of the male (Fig. 1, D).

On the other hand, in the male, the body on the blind side is stained with pale brown on the posterior half (though the stained portion varies within the species) and becomes darker in a narrow marginal zone (Fig. 4, E). In the female and the abnormal specimens, the blind side is uniformly pale (Fig. 4, G, I).

2. Gonad

Macroscopically, the gonad of the abnormal specimen had a portion of a different color on the anterior part (Fig. 3). On the cross section, the most of the gonad was clearly furnished with testicular characteristics. The primary and secondary spermatocytes are

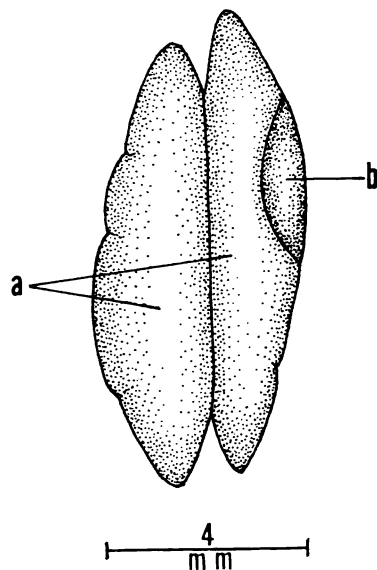


Fig. 3. Frontal aspect of gonad from intersexual specimen in *Bothus pantherinus*. a, testicular part; b, ovarian part.

arranged along the wall of the seminiferous tubules, and a few sperm cells are developed in the middle part. They are similar in developmental degree to those of a normal male. But in the portion with the different color, the tubular structure is located in the center, and its periphery has the germ cells bearing the ovarian tissues, stained well with hematoxylin (Fig. 4, A, B). A nucleus is observed in some cells, though it is not distinct, and each cell is surrounded by the follicle cells (Fig. 4, C). On the other hand, in the normal female the ovaries are in the early yolk vesicle stage of oogenesis.

Discussion

The cases of intersexuality of fishes, which were discussed in detail and clearly defined by Atz (1964) and listed bibliographically by Dawson (1964, 1966, 1971), are roughly divided into two types: that termed hermaphroditism frequently occurring in such fishes as the Myctophiformes, Serranidae, and Platycephalidae (Fujii, 1970, 1971), and that rarely happening as an abnormal case. But in any case, intersexuality in the order Pleuronectiformes is known only from one example, the hybrid between *Platichthys stellatus* (Pallas)

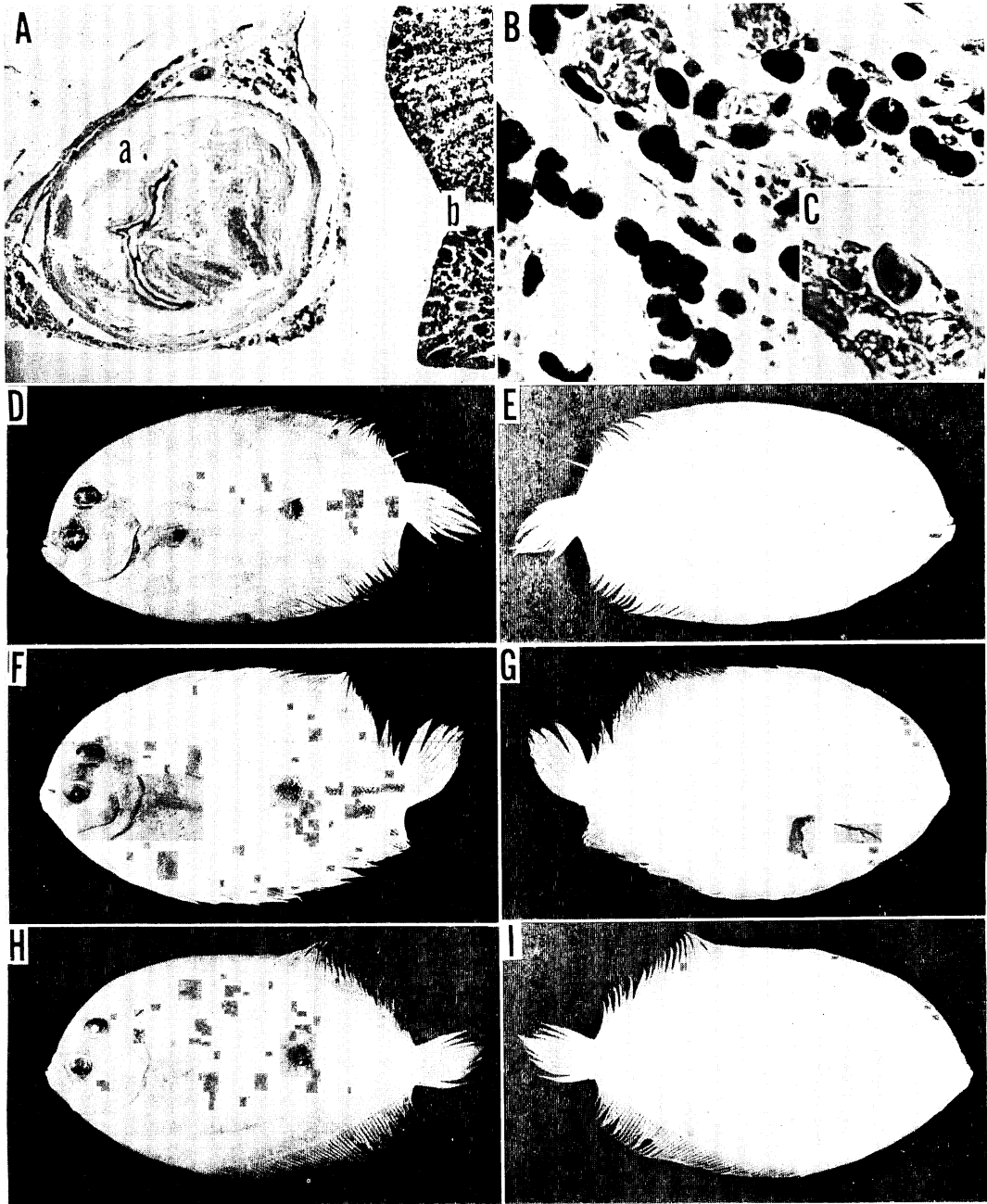


Fig. 4. Microphotographs of gonad (A-C) and photographs of both body sides (D-I) in *Bothus pantherinus*. A, cross section of gonad of intersexual specimen ($\times 150$); B, partial magnification of periphery of the left (a), darkly stained with hematoxylin ($\times 1000$); C, oocyte in which a somewhat distinct nucleus and follicle cells were observed ($\times 1100$); D, ocular and E, blind side in male specimen, 158 mm in standard length; F, ocular and G, blind side in intersexual specimen, 144 mm in standard length; H, ocular and I, blind side in female specimen, 139 mm in standard length. a, tubular structure with ovarian tissues, darkly stained with hematoxylin; b, testicular part.

and *Parophrys vetulus* Girard (Aron, 1958).

The major part of the gonad in the present specimen is the testis. In the attached portion, a distinct nucleus was not seen in each germ cell. The nucleus was probably damaged in the process of defrosting. The portion, however, is probably the ovarian tissues, since obtuse nuclei and follicle cells are partly detectable. Since the abnormal specimen shows the mosaic secondary sexual characters as shown above, the present abnormal specimen may be an intermediate between both sexes. It, however, is not clear whether the germ cells bearing ovarian tissues develop as functional eggs or not, and also what the tubular structure located in the center of the portion is doing.

It could not be decided whether the present intersexual specimen is a normal or abnormal hermaphrodite, since only one example has been found. But such intersexuality occurs rarely in fishes of the Pleuronectiformes, and the sex ratio examined in 109 specimens of the present species is about 1:1. Therefore, the present specimen is probably abnormal.

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トゲダルマの二次性徴と異常な間性の1個体

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シエシエル諸島海域から採集されたトゲダルマ *Bothus pantherinus* (Rüppell) の二次性徴を調べた結果、雌雄両性の特徴を現わす1個体を見出した。この個体は有眼側の胸鰭長、吻棘、眼前棘、眼上皮弁および胸鰭上の斑紋は雄的であるが、胸鰭基部の鰭膜の形および無眼体側の色彩は雌的であった。この個体の生殖腺は大部分精巣であるが、左側の精巣に色調の異なる部位が認められた。精巣には第1・第2精母細胞および精子が見られたが、異常部位では中央部に管状構造物があり、その周辺にはヘマトキシリンに濃染される初期の卵細胞と卵巣の組織がある。これらのことから、この個体は間性であると考えられる。ヒラメ・カレイ類 (Pleuronectiformes) では今までに間性が1例しか報告されていないこと、および性比が約1:1であることから、この個体は異常な間性であると推定される。

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