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Ambisexuality in a South American cichlid : *Satanoperca* aff. *leucosticta*

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Abstract

Thirty eight *Satanoperca* aff. *leucosticta* were collected in French Guyana rivers and the histology of the gonads was studied. While the structure of the ovaries follows the general pattern known for other cichlids, previtellogenic oocytes are present in the outer layer of all the testes, whatever the spermatogenetic stage.These oocytes never grow nor mature. Histological observation of all of the gonads has not revealed whether this cichlid is hermaphroditic or gonochoristic.

Keywords : Fish, cichlid, South America, ambisexuality, intersexuality, hermaphroditism, testis, ovary.

Ambisexualité chez un cichlidé sud-américain : Satanoperca *aff.* leucosticta.

Résumé

Trente-huit *Satanoperca* aff. *leucosticta* ont été pêchés dans des rivières de Guyane Française et l'histologie des gonades a été étudiée. Tandis que la structure des ovaires est semblable à celle connue chez les cichlidés, des ovocytes en prévitellogenèse sont présents à la périphérie de tous les testicules quel que soit leur stade spermatogénétique.Ces ovocytes ne maturent jamais. L'observation histologique des gonades n'a pas permis de savoir si ce cichlidé est hermaphrodite ou gonochorique.

Mots-clés : Poisson, cichlidé, Amérique du Sud, ambisexualité, intersexualité, hermaphrodisme, testicule, ovaire.

INTRODUCTION

Ambisexuality is rather widespread among teleosts, mainly among marine species. It has been reported for several families of Perciformes but only one paper has described the occurrence of intersexual gonads in cichlids (Peters, 1975). In the "Mbuna", a group of cichlid fishes living in an African lake, the testes contain oocytes mostly confined to the outer layer of the gonad, in addition to male germ cells, while only female germ cells are present in the ovaries.

We have had the opportunity to collect specimens of *Satanoperca* aff. *leucosticta* living in French Guyana rivers. Because the two sexes did not seem to be evenly distributed as a function of weight, suggesting a possible successive hermaphroditism, we have analyzed the gonads histologically.

MATERIAL AND METHODS

Sixteen *Satanoperca* aff. *leucosticta* (Le Bail *et al.*, 1984) were caught in the Oyapock river by means of nets with small meshes or by poisoning with Rotenone. Twenty two were netted in the Kourou river. These samples were obtained during the minor wet season (December) and during the minor dry season (March, Kourou only).

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The gonads were removed, under a binocular magnifier if necessary, fixed in Bouin Hollande, and then embedded in paraplast. The smallest gonads were preembedded in 2% agar. Five µm thick sections were stained with Regaud hematoxylin, orange G and aniline blue.

RESULTS

Weight distribution

The distribution of the specimens as a function of the total weight (the eviscerated weight was consistently equal to 94-98% of the total weight) is shown in *figure* 1. Males were always heavier than the largest females.

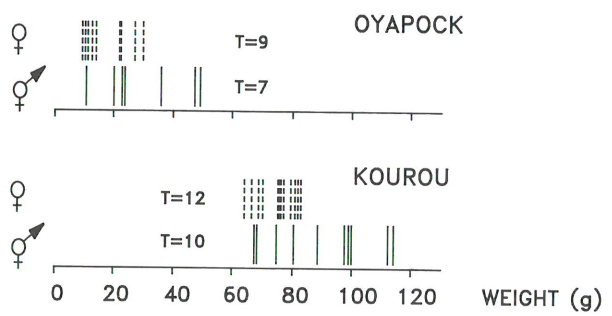


Figure 1. – Distribution of the sampled males and females of *Satanoperca* aff. *leucosticta*, as a function of the total weight.

Histology of the gonads

The organization of the ovaries follows the general pattern described for other cichlids. The ovaries of females collected in December were mainly in previtellogenesis (GSI = 0.10 to 0.29%) or at the end of previtellogenesis (cortical alveoli formation; GSI = 0.5%), while those of females caught in March in the Kourou river were in vitellogenesis or ovulating (GSI = 0.3 to 3.7%).

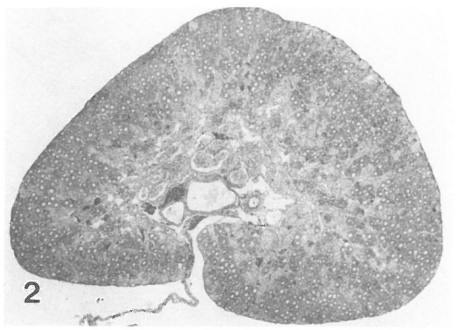
The structure of all the testes was similar to that described by Peters (1975) in the "Mbuna". The testes were composed of radially oriented tubules, which converged in the central part to the main duct. In the outer layer of the testes, the tubules were mainly filled with previtellogenic oocytes and, just beneath the albuginea, with gonia or young oocytes (*fig.* 2 and 3). Every oocyte was associated with some somatic cells. Their nucleus contained from one to three nucleoli, like the ovarian oocytes at the same size. In the central part of the gonad, the tubules contained male germ cells, and typical spermatogenesis occurred. In most of the males, active spermatogenesis was observed and variable amounts of spermatozoa were present in the main duct. Spermatogonia, or pachytene spermatocytes, predominated in the male part of the gonad in three males starting or resuming spermatogenesis. In these testes some spermatozoa were also present. The absolute and relative thickness of the oocyte layer was variable depending on the size of the animal and on the stage of spermatogenesis. It was especially thick in large males (100 and 112 g total weight) which were in a regressed spermatogenesis stage and in these cases the male part was, in comparison, very restricted. On the contrary, when spermatogenesis was very active, the oocyte layer was relatively thin and was interspersed with some cysts of male germ cells. Usually, oocytes were not scattered in the male part. This was, however, the case in one large male resuming a very active spermatogenesis (presence of a high number of spermatogonia). In this testis also, degenerating oocytes were observed in larger numbers than in the other testes. In a small male (10.5 g total weight), which was probably beginning its first gametogenesis, the outer layer contained only some previtellogenic oocytes, but small pachytene oocytes were more abundant than in older testes (their nucleus was larger than that of pachytene spermatocytes) (*fig.* 4). Clusters of conspicuous interstitial cells, probably Leydig cells, were observed between the tubules throughout the male part (*fig.* 5) but also in the oocyte layer (*fig.* 3). The concentration of blood vessels did not differ obviously between the two gonad parts.

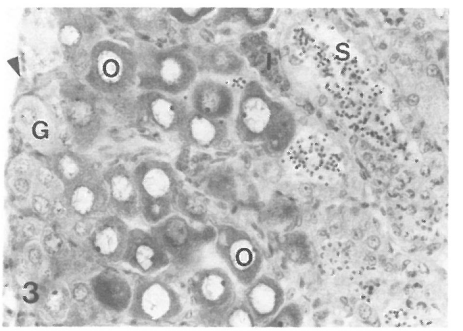
The male GSI usually varied between 0.1 and 0.3%.

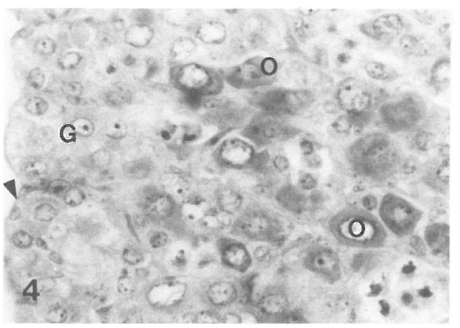
DISCUSSION

The mean weight of samples of *Satanoperca* aff. *leucosticta* collected either in Oyapock or in Kourou differed significantly. This may be due to morphometric differences between the animals from the two rivers (it has been observed that specimens of three species netted in the Kourou river were significantly larger than those netted in the other French Guyana rivers; Le Bail, unpubl.), but this may also be due to the catching methods which have been used and to the small size of the two samples.

In agreement with Peters (1975), we have never observed that the oocytes present in the testes start yolk deposition and produce mature oocytes. On the contrary, in the testes spermatogenesis was complete and spermatozoa were often present in the main ducts. Therefore, these animals can be considered as functional males. Our observations point out that the peculiar type of ambisexuality affecting only the male gonad, described by Peters, is not restricted to an African cichlid group. It would be interesting to know if it occurs in other cichlid species or even in other







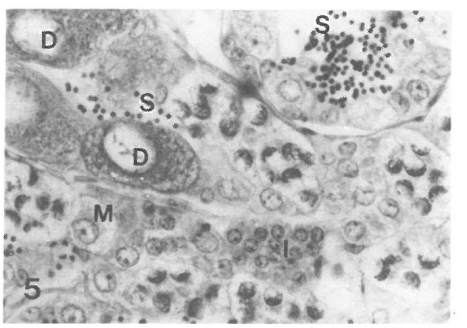


Figure 2. – Cross section of a testis, $M \times 40$.

Figure 3. – Detail of the outer layer and of the transition to the central male part of the testis, $M \times 440$.

Figure 4. – Young male beginning its first spermatogenesis. Detail of the outer layer of the testis, $M \times 540$.

Figure 5. – Transition between the outer layer and the central part of a testis. Some degenerating oocytes and several cysts of spermatocytes are visible, $M \times 550$.

G, oogonia; O, young previtellogenic oocyte; I, interstitial cells; D, degenerating oocyte; M, spermatogonium; S, spermatozoa; arrowhead, albuginea.

families. In *Satanoperca* aff. *leucosticta* there is no apparent difference between the testicular oocytes and the ovarian oocytes of the same size. In particular, they both have one to three large nucleoli.

Young oocytes were observed in all the testes that we have analysed. In all protandric teleosts (known to date), oocytes are present in the functional testes (Reinboth, 1988). But also, in some protogynous species, young oocytes are still present amidst the active spermatogenetic tissue (Reinboth, 1988). There was no histological evidence to suggest that any of the 38 pairs of gonads examined was in the phase of sex inversion. However, animals have not been caught throughout the year, so that a period of sex inversion could have been missed. Therefore, we are unable to say whether this species is protandric, protogynous or merely gonochoristic (in this case, young oocytes should be permanently present in the testes of the males which would never change sex). The difference in weight distribution of the males and females could argue in favour of protogyny. However, the number of animals collected is too low to substantiate this hypothesis, since the difference could be due to sex-specific differences in growth rate, differential localization of the two sexes or selective capture.

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