Some data on the growth of *Arius proops* (Ariidae, Siluriforme) in the estuaries of French Guyana

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Received September 23, 1988, accepted December 12, 1988.

Lecomte F., F. J. Meunier, R. Rojas-Beltran. *Aquat. Living Resour.*, 1989, **2**, 63-68.

Abstract

The skeletochronological analysis of pectoral spiny rays in the silurid *Arius proops*, collected during the "little summer of March", confirms the presence of a slow growth period during March and April in the rivers of French Guyana. Moreover, this study shows that the longevity of the species is short, 3 and a half years for the females and 3 years for the males, while their growth rate is relatively high, especially during the first half of their life.

Keywords : Arriidae, French Guyana, growth, skeletochronology.

*Quelques données sur la croissance d'*Arius proops *(Ariidae, Siluriforme) dans les estuaires de Guyane française.*

Résumé

L'analyse squelettochronologique des rayons épineux pectoraux du silure *Arius proops*, capturé pendant le « petit été de mars », confirme la présence d'une période de croissance ralentie de mars à avril dans les rivières de la Guyane française. L'étude montre que la longévité chez cette espèce est courte, 3 années et demie pour les femelles et 3 années pour les mâles; en outre, le taux de croissance est assez élevé, surtout durant la première moitié de la vie des poissons.

Mots-clés : Ariidae, Guyane française, croissance, squelettochronologie.

INTRODUCTION

In French Guyana, *Arius proops* (="mâchoiron blanc") is a common catfish in the estuaries and represents an important resource for the local human population (Planquette and Rojas-Beltran, 1984). Knowledge of the biology of this species is very limited and based on a single paper by Puyo (1949). But the management of any fish species requires accurate information on age and growth, along with other life history data. Skeletochronological studies using appropriate skeletal elements can provide such biological data (Casselman, 1983, 1987; Meunier, 1988).

Recent skeletochronological studies have shown that Ariidae present two annual growth cycles, as do some other South American freshwater fishes (Lecomte *et al.*, 1985*a*, 1986; Meunier *et al.*, 1985) or African tropical fishes (Poinsard and Troadec, 1966; Blacke and Blacke, 1978; Robben and Van Den Audenaerde, 1984). There are two fast growth seasons alternating with two slow growth seasons each year which may be linked with the wet and dry seasons

(Lowe-McConnell, 1964; Lecomte *et al.*, 1986). Moreover, *Arius proops* reaches a large size and exhibits a relatively high growth rate (Lecomte *et al.*, 1986); but it has been difficult to develop a growth curve for this species because of the heterogeneity of the samples (*see* Lecomte *et al.*, 1985 *b*).

The aim of the present paper is to characterize the growth pattern of *A. proops* in the estuaries of French Guyana based on samples of fishes taken during a limited period of time. To assess the age of the specimens the skeletochronological method (Casselman, 1983) was used. Actually, the use of fin-ray sections is probably the most advisable for Siluriformes (Sneed, 1951; Marzolf, 1955; Van Der Waal and Schoonbee, 1975; Olatunde, 1979; Meunier, 1988; *inter alia*).

MATERIAL AND METHODS

Between March and May 1986, 97 fishes (from 50 to 71.5 cm long, standard length) were caught with trammel nets in the estuary of the Approuague river (*fig.* 1). In addition, 29 fishes (from 25 to 38.5 cm long, standard length) were sampled from the Sinnamary river. The dorsal and the left pectoral fin spines were removed from each specimen and stored in paper envelopes and air-dried.

The spines were cut directly (without embedding in a polyester resin) at two precise levels (a "basal" and a "high" level) with a low-speed sawing machine (Isomet) (*fig.* 2). Following the results of Lecomte *et al.*, (1985 *a*), there was one centimeter between the two sectioning levels. The sections (120 to 160 µm in thickness) were viewed through a microscope and a projecting microscope.

In order to refine our interpretations of the histological data we compared the results of the present study with those obtained in a previous study based on monthly samples of four rivers of French Guyana, from April 1982 to March 1983 (*see* Lecomte *et al.*, 1985 *b*).

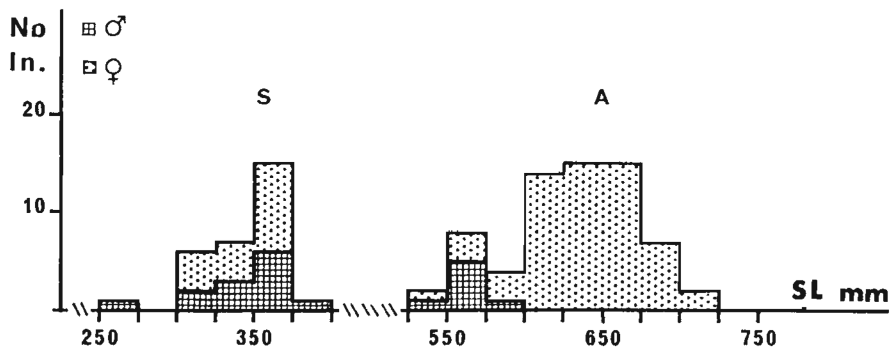


Figure 1. — Diagram showing the length frequencies (standard length: SL) of females (dotted) and males (squared) caught in the estuaries of the Sinnamary river (S) and the Approuague river (A). (No: Number of specimen)

RESULTS

Histological study of the spiny rays

The basal sections show a more or less triangular shape, whereas the high sections are rather ovoid. The margin of the sections has an irregular aspect which is the result of the typical tuberculated ornamentations of the spines. In both cases we can define an apical region and two posterior lateral lobes which are generally attenuated in the high level sections (*fig.* 3).

In all cross sections, the spiny rays appear as a ring of compact bone lining a wide lumen, the medullar cavity. This bone tissue is cellular and it contains numerous vascular canals. In the anterior half of the sections, most of the vascular canals are radially oriented, whereas in the posterior lobes, the vascular canals are more often aligned longitudinally rather than radially (*fig.* 3, 4 and 5).

The medullar cavity enlarges regularly as the fish grows (*fig.* 6 *a* to *d*). The walls of the cavity show secondary bone lamellae which are separated from the main bulk of the spine by cementing lines (*fig.* 1, 5, 6 *c*). This secondary bone is the result of remodelling processes (Meunier, 1987) that occur all along the enlargement of the cavity.

On examination using reflected light, the sections show alternate narrow translucent and wide opaque bands (*fig.* 6 *c*, *d*). The narrow marks are slow growth zones or *annuli* and the wide bands correspond to fast growth zone or "zone" (Meunier, 1988). A complete cycle of growth on the sections comprises a wide zone and a narrow *annulus* (Casselman, 1983, 1987; Meunier, 1988).

DISCUSSION

Skeletochronological interpretation

In previous works, the analysis of the distance separating the last translucent growth mark from the

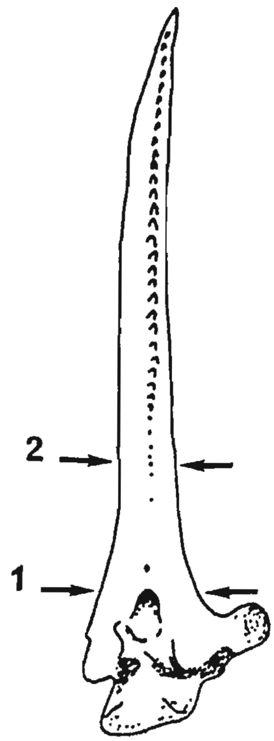


Figure 2. — Posterior view of the pectoral spine of *Arius proops* showing the basal aperture and the two levels of sectioning: (1) "basal" level; (2) "high" level.

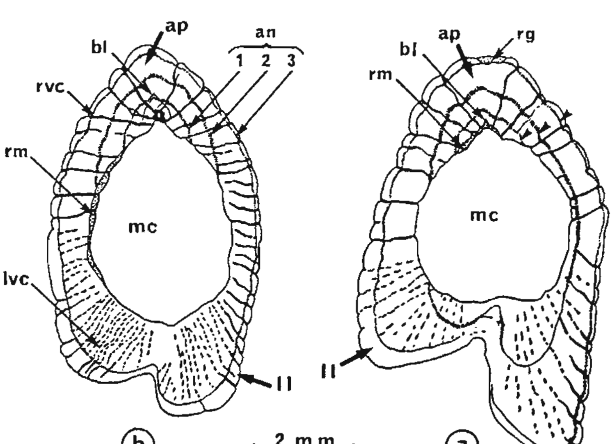
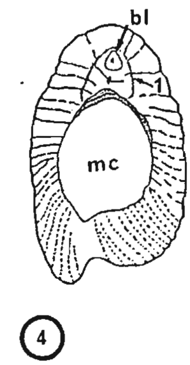


Figure 3. — Drawing of two cross sections of a pectoral spiny ray (a specimen from the study of Lecomte *et al.* (1985*b*): (a) basal level; (b) high level. One can see 3 *annuli* (an 1, 2, 3) and the great development of the medullar cavity (mc) that has almost destroyed the birth line (bl) in (a). The dotted areas indicate either the secondary bone that results from remodeling (rm) on the walls of the medullar cavity, or regenerated bone (rg) after a superficial injury of the spine. (ap = apical region; ll = lateral lobes; lvc = longitudinal canals; rvc = radial vascular canals).



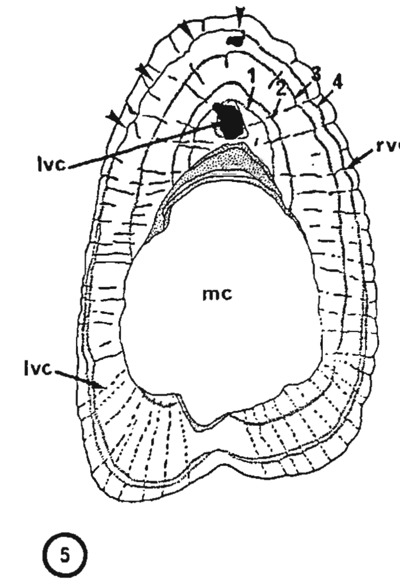


Figure 4. — Drawing of cross section of a spiny ray: young fish with one *annulus*. The formation of a second *annulus* is imminent. The medullar cavity (mc), out of centre, is relatively narrow and the birth line (bl) is obvious.

Figure 5. — Drawing of cross section of a spiny ray: fish with 4 *annuli*. Growth has just taken place. Remodelling (dotted areas) has destroyed the birth line and part of the 3 first *annuli*. The arrow heads show a resorption line that demarkates a regenerated area of bone after a superficial injury (lvc = longitudinal vascular canals; mc = medullar cavity; rvc = radial vascular canals).

edge of the spine in monthly samples has shown that the *annuli* are laid down twice a year in the rivers and the estuaries of French Guyana (Lecomte *et al.*, 1985*a*; Meunier *et al.*, 1985). The *annulus* formation seems to be synchronized with the two dry seasons, the "little summer of March" that occurs in March and/or April according to the year and the "great dry season" that occurs from July to October (Boye *et al.*, 1979). Thus, during one year there are two cycles of growth in the estuaries of French Guyana.

It is interesting to note that most fish caught in March and April (*) had spiny rays with an *annulus* at the margin of the sections. Specimens collected in May, on the other hand show clearly fast growing bone between the last *annulus* and the margin of the rays. These observations confirm that an *annulus* was being laid down between March and April, which corresponds to the "little summer", and consequently that the growth of the fish was very slow or had stopped during this period. Thus, in agreement with our previous hypothesis (Lecomte *et al.*, 1986), these

(*) In 1986, the "little summer of March" was particularly dry and this dry season was very pronounced during two months, March and April.

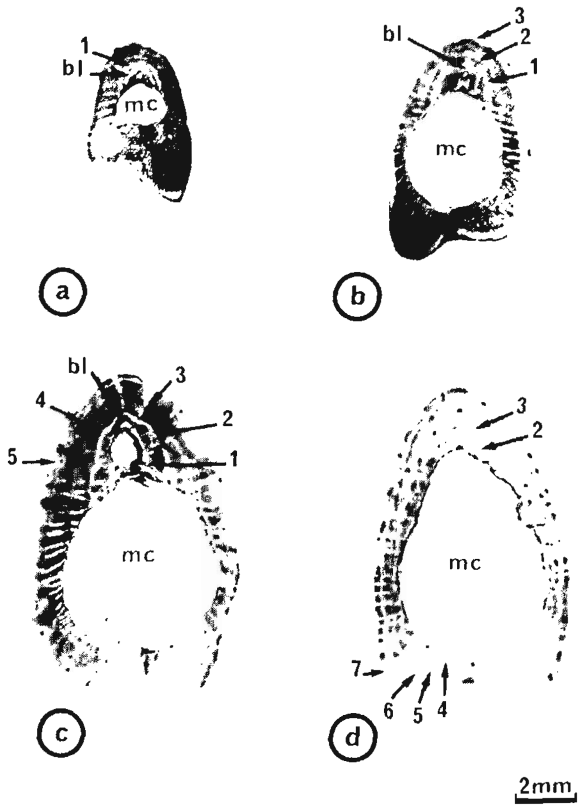


Figure 6. — Cross sections of pectoral spines of four fishes showing the growth marks and the important enlargement of the medullar cavity (mc). This cavity develops due to the resorption processes that destroy more or less the oldest growth marks, especially the 2 or 3 first *annuli.* (a) 27 cm, 1 *annulus*; (b) 50 cm, 3 *annuli*; (c) 70 cm, 5 *annuli*; (d) 69 cm, 7 *annuli* [(a) and (b) from the previous study Lecomte *et al.*, 1985 *b*]. [(bl) = birth line].

results confirm that *A. proops* has two cycles of growth per year.

We have interpreted the first narrow translucent mark as a "birth line" (= "ligne de naissance": Castanet, 1978). Indeed, this growth mark demarcates a narrow fibred bone area that shows some longitudinal vascular canals (*fig.* 3, 6). This specific area characterizes the initium of the ray. For this species, as for other siluroids, the birth line could correspond to the margin of the spiny ray at the time of resorption of the yolk (Boët, 1981) or when the young leaves the mouth cavity of the male after the incubation period (Lecomte *et al.*, 1985 *a*).

Growth pattern of *Arius proops*

Length growth

In our sampling males are relatively scarce, so it has not been possible to undertake a statistical analysis of their growth and to compare it with the growth of females. But it appears clearly that the growth of females is faster than males.

Most recent growth studies use back-calculation methods to obtain a more accurate approximation of normal growth. In this study we were not able to use back-calculation methods, the width of the spiny rays varies from one spine to another; indeed the irregular tuberculated ornamentations introduce an important factor of variation in spine diameters. In another hand, the remodelling processes which contribute to enlarge the medullar cavity are very developed. Generally the initium of the fin ray is quickly but unentirely resorbed (*fig.* 3 to 6), probably as soon as the second cycle of growth had started; therefore it is very difficult to localise the origin of the axis for the measurements of successive bone increments. In fact, for *A. proops* it is impossible to define an axis for annual growth increment measurements which gives a significant linear relationship with the standard length of fish. Thus, we only present a growth curve of the observed lengths by combining both samples (Approuague and Sinnamary estuaries) (*fig.* 7).

We lack specimens showing respectively 1 and 3 *annuli.* In French Guyana, the whereabouts of Ariidae juvenile specimens between the stage of buccal incubation and the "two *annuli*" age class is unknown. Net selectivity does not explain the lack of very young fish in the samples of *A. proops* caught in the estuaries (Boujard et Rojas-Beltran, 1988). Therefore the pattern of seasonal growth during the two first growth cycles (before and after the formation of the first *annulus*) is uncertain. The mean length of the fish belonging to the "three *annuli*" age class can be extrapolated and is about 51 cm. This value is in good agreement with those obtained in a previous study (Lecomte *et al.*, 1985 *b*) which indicates that the mean length of this age class varies from between 50 and 54 cm depending on the estuary.

A growth model using the Von Bertalanffy equation is not realistic because of the lack of several age groups. However, we can propose data to characterize the cyclical progression of growth in length. The duration of each of the two fast growth periods each year is unknown. Thus, in order to simplify, we have postulated that a complete growth cycle (one fast-growing and one slow-growing period) is 6 months long. In such a case, it is possible to evaluate the mean growth increments (standard length) for each period of 6 months throughout the life of the fish (*table* 1).

Attainment of first sexual maturity

The growth rate of bone in both males and females decreases with age and shows a very distinct decrease after the third *annulus* (*fig.* 7, *table* 1), during the second year of life. It is well known that such a decrease is linked to the attainment of sexual maturity in Vertebrates (Castanet *et al.*, 1977; Meunier *et al.*, 1979; Castanet, 1985; Castanet and Naulleau, 1985). For *A. proops* first maturity occurs in fish from 50 to 53 cm long (Le Bail *et al.*, 1984). This value corresponds to the mean length of fishes belonging to the

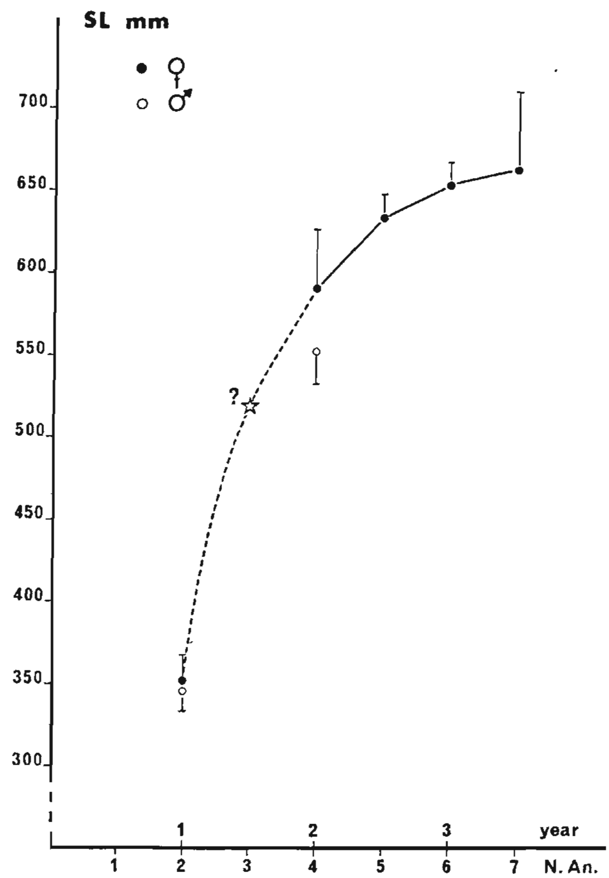


Figure 7. — Annual growth in length (standard length: SL) of *Arius proops*. The dotted line extrapolates the growth between the "two *annuli*" group (from the Sinnamary river) and the "four *annuli*" group (Approuague river); the star indicates the mean value of the length for fishes with three *annuli*. (N.an. = number of *annuli*).

Table 1. — Annual and six-monthly growth increments (mm) in *Arius proops* (males and females mixed): fish growth between 2 *annuli*, data from a previous study (Lecomte *et al.*, 1985 *b*); and present study.

Years	1		2		3	
Numbers of annuli	1	2	3	4	5	6
Lecomte *et al.*, 1985 *b*						
Annual growth	465		104		67	
Six-monthly growth	230	235 (*)	65	39	22	44
Present study						
Annual growth	350		227		76	
Six-monthly growth	175	175 (*)	160	67	55	21

(*) Because of the lack of fishes of the "one *annulus*" age class, we have arbitrarily divided the annual length increment into two equal parts for the six-monthly growth.

class 3 *annuli* in our sampling. Therefore, the fish can probably breed for the first time after the third fast growing period.

Longevity

Longevity in the Approuague estuary can be estimated from the maximum number of *annuli* found in the biggest fishes sampled. The oldest female and the oldest male showed respectively 7 and 6 *annuli* in their spiny rays in addition to the birth line. So they were respectively at least 3 years and a half and 3 years old at the time of sampling. These results are in agreement with those of a previous work (Lecomte *et al.*, 1986). It seems that the longevity of the female is about 6 months longer than that of the male. This absolute longevity for *A. proops* seems relatively short. Another Ariidae, *A. couma* which lives in rivers, has a longevity of about 5 years (Lecomte *et al.*, 1985 *a*; Meunier *et al.*, 1985). *A. parkeri*, another common silurid of the estuaries, shows similar short longevity, approximately 4 years (unpubl. results). It is important to contrast this short longevity with the rapid growth of *A. proops* in assessing the value of this fish as a source of food in the estuaries of French Guyana.

CONCLUSION

The present work provides some data concerning the growth of *Arius proops* in the estuaries of French Guyana. These fishes grow swiftly during the 18 first months and show a short longevity, females being larger and older than males. Sexual maturity is attained after the third period of fast growth, at a length of about 51 cm long.

These results obtained from skeletochronological methods have to be confirmed by complementary studies: either by new ecological observations (especially the recruitment of very young fishes), or by experimental growth studies, particularly those using vital labelling. For the latter, the recommendations of Beamish and McFarlane (1983) or Casselman (1987) should be followed to confirm the specific growth pattern or "scénario de croissance" (two cycles of growth per year) of this species in the estuaries of French Guyana.

Acknowledgements

This study was financially supported by a grant from INRA (Institut National de la Recherche Agronomique): AIP INRA n° 30/4446, "Production Piscicole Tropicale".

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