

Some characteristic features of the axial skeleton of *Zanclorhynchus* (*Zanclorhynchinae: Congiopodidae*) off Crozet Islands, Southern Ocean

Abstract

The goal of this work is to describe previously unpublished data about axial skeleton of *Zanclorhynchus*, one of the most numerous, but still poorly known genus from the islands of the Indian sector of the Southern Ocean.

Keywords: *Zanclorhynchus*, axial skeleton, Southern Ocean

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Introduction

According to the latest data¹, the genus *Zanclorhynchus* Günther, 1880, includes two species: *Zanclorhynchus chereshevi* Balushkin et Zhukov, 2016 and *Z. spinifer* Günther, 1880 with two subspecies—nominative *Z. spinifer spinifer* Günther, 1880 and *Z. spinifer heracleus* Zhukov Balushkin, 2018.

Despite the fact that in a number of cases *Zanclorhynchus* dominate in number and constitute a significant part of the diet of top predators, the genus still remains weakly studied. Until recently, only a few articles were devoted to the anatomy of that fishes,²⁻⁴ in general information is limited to inclusion in lists with a brief description.⁵

Zanclorhynchus have highest values in number (approximately 2/3 of the total catch of trawling) on the shelf of the Kerguelen Archipelago with a density of more than 10000 sps/km², the largest numbers are recorded in the northwest of the islands at a depth of 200-1000 m⁶. On the Macquarie shelf *Zanclorhynchus* is the second (24.8%) in number species.⁷ On the Kerguelen Archipelago *Zanclorhynchus* is in the diet of the Gentoo penguin *Pigoscelsipapua*,⁸ also these penguins feed on *Zanclorhynchus* near the island of Macquarie - constitute almost 40% of the diet.⁹ They enter the diet of the Porbeagle *Lamna nasus* on the Kerguelen Archipelago (Cherel and Duhamel 2003). On the Heard Island otoliths of *Zanclorhynchus* were found in the faecal material of the Antarctic fur seals *Arctocephalus gazella*¹¹. Is a favorite food among the ichthyofauna of the Hooker's sea lions *Phocartoshookeri* off Macquarie Island (Mc Cahon et al. 1999).¹² In the same area the Rockhopper Penguin *Eudyptes chrysocome* also feeds on *Zanclorhynchus*.¹³

Material and methods

The axial skeleton was studied under X-ray images obtained on a PRDU-02 X-ray diffractometer. Were studied 44 specimens of *Zanclorhynchus*: ZIN no. 40248–26 specimens, SSS "Skif", cruise no. 3, station no. 944/33, trawl no. 18, Crozet Islands, 45°51' S, 49°47' E, depth 235-260 m, 04.12.1970, collector A.F. Pushkin; ZIN no. 45675–4 specimens, MFFT "Aelita", station no. 41, Crozet Islands, 45°52' S, 49°54' E, depth 230 m, 25.01.1968, collectors A.I. Karpenko and G.S.

Volya; ZIN no. 5630–14 specimens, sampled in the same trawl with ZIN no. 40248.

Results and discussion

The number of vertebrae is 33 - 36, including urostyle. In the overwhelming majority of cases (94%) the number of vertebrae is 34 (48%) or 35 (46%).

The number of proximal radials before D2 strictly corresponds to the number of vertebrae +1. The proximal radial, serving as a support, and not only associated with the fin ray through the distal and middle radials, is considered to be the corresponding to the ray.¹³ A double number of proximal radials between the first and second neural spines is explained by the loss of the first vertebrae (one or two), which is considered an autapomorphy among the superfamily Scorpaenoidea sensu Imamura 2004.^{3,14} About 2/3 of the studied *Zanclorhynchus* have proximal radials (free between D1 and D2, either corresponding to ray at the end of D1 or at the beginning of D2), entering in double between neural spines. In this case, not far (up to 6 vertebrae, usually 1 or 2), there is necessarily a pair of neural spines without an interneuralia between them (Figure 1).

One specimen was found to have no free proximal radials between the dorsal fins (Figure 2), and the last spiny ray D1 is supported by two interneuralia. This mistake in ontogenesis, highly likely, led to the disappearance of the subsequent interneuralia. The normal development of proximal radials in the second dorsal fin is due to the presence of several segmentation centers in ontogenesis. In Teleostei, there are three main centers: the "occipital", from which the segmentation goes back; "central" - the differentiation of the vertebrae goes in both directions and "caudal" with the development of the vertebrae in the rostral direction¹³. Here we can see the presence of the "occipital" center, the error in which led to the absence of free proximal radials between dorsal fins, and the "central" segmentation center that caused the normal development of D2 (the first ray of which have no corresponding radial yet).

Before the anal fin there usually is free interhaemalia, which enters between the haemal spines of the first two caudal vertebrae is connected

with the first ray of the anal fin through the distal and middle radials (Figure 3A), the corresponding ray is absent or extremely reduced (Figure 3B), the normal ray is developed on the first interhaemalia in 4% of cases. Usually the first ray of the second dorsal fin is shortened,

sometimes reduced so that it can be seen only on the X-ray image (Figure 3C), probably it could completely disappear in similar way as the first ray of the anal fin.

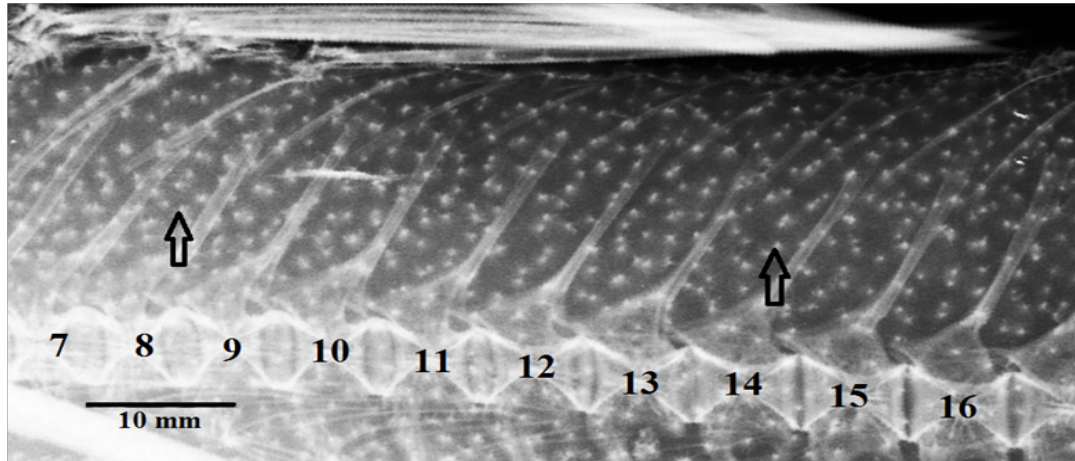


Figure 1 X-ray image of the area between two dorsal fins ZIN no. 40248 (21). Numbers indicate the number of the vertebrae (16th vertebra - 1st caudal), arrows - an empty gap between the neural spines and a gap with pair of incoming inter neuralia.

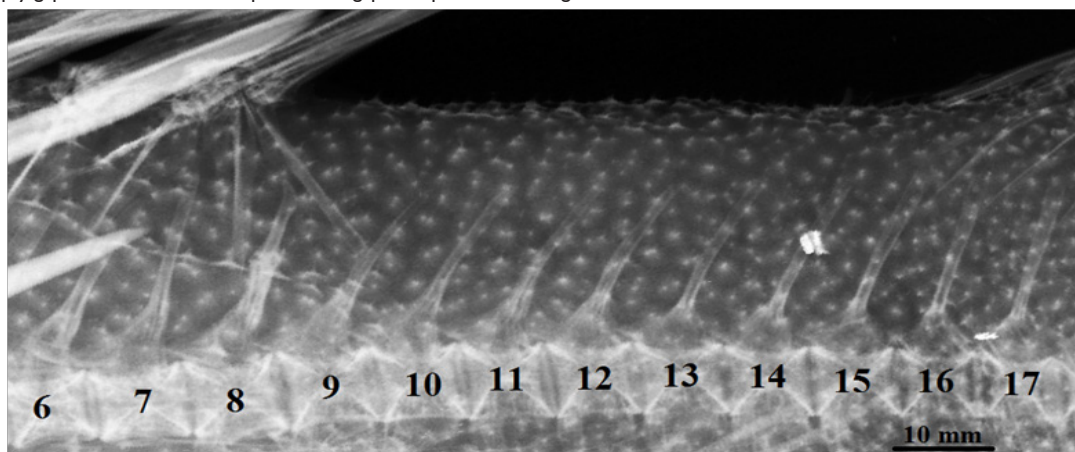


Figure 2 X-ray image of the area between two dorsal fins ZIN no. 40248 (22). Numbers indicate the number of the vertebrae (16th vertebra - 1st caudal).

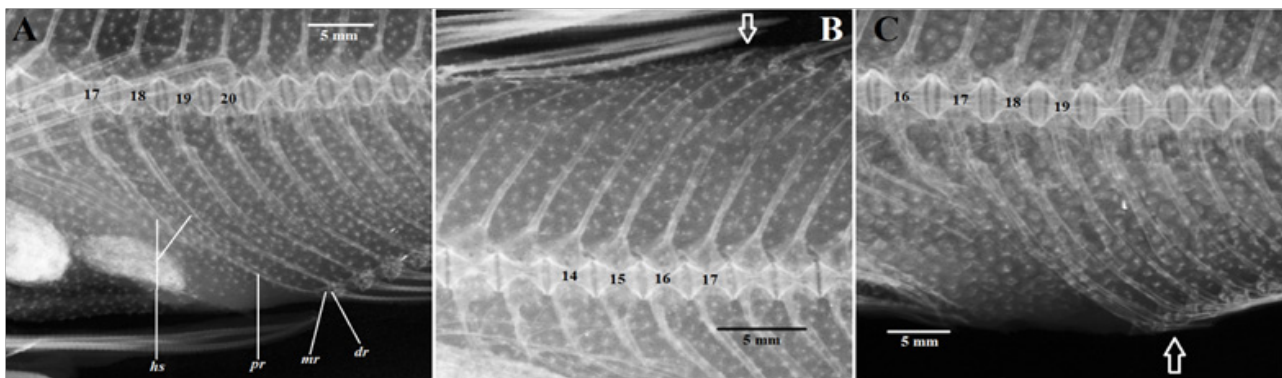


Figure 3 X-ray images of the rostral parts of anal and second dorsal fins, numbers indicate the number of the vertebrae (A–17th vertebra = 1st caudal, B and C–16th vertebra=1st caudal), arrows indicates extremely reduced rays; A–anal fin ZIN no. 56301 (7) with first free interhaemalia, *hs*–haemal spine, *pr*–proximal radial, *mr*– middle radial, *dr*–distal radial; B–second dorsal fin ZIN no. 56301 (14); C–anal fin ZIN no. 45675 (2).

The last proximal radial in the anal and second dorsal fins is shortened and expanded, the so-called “stay”. In about 80% of cases, it serves as a support for the last two shortest rays, in a 20% “stay” supports only one. Of the last three interneuralia and interhaemalia, often (about 60% of cases), two of them double enters between the spines of both the neural and haemal (Figure 4).

In the caudal fin, there are strictly 12 principal nonbranched segmented rays, 6 rays on each hypural plate, upper and lower. Two epuralia take part in support of two marginal upper rays, others upper marginal rays (0–4) supports by last neural spine. 1–2 lower marginal

rays supports by last haemal spine. All margin rays are nonbranched and non segmented. The first preural vertebra (*pu*) in about 10% of the *Zanclorhynchus* has doubled spines, neural and/or haemal (Figure 5A) (Figure 5C). In nototheniids, for example, the complex structure of the first preural vertebra appeared by the separation of the originally unified structure¹³. Detection of the specimen ZIN no. 56301 (3) with separate vertebrae (Figure 5B) (Figure 5D) allows us to surely conclude that a complex first preural vertebra appeared by merging of two vertebrae. The existence of such an individual reversion can indicate the phylogenetic youth of this merging.

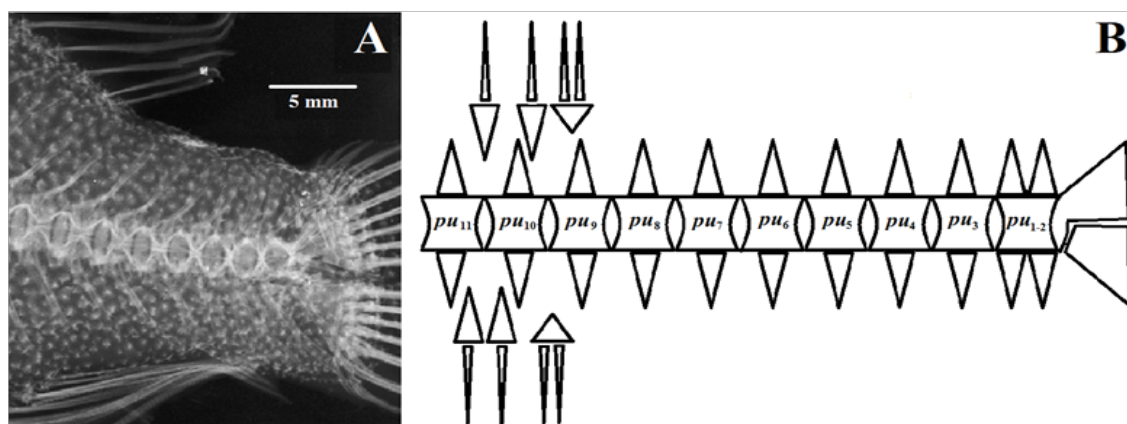


Figure 4 The caudal parts of second dorsal and anal fins ZIN no.56301 (6), *pu*9–26th vertebrae (11th caudal vertebrae), A–X-ray image, B–scheme.

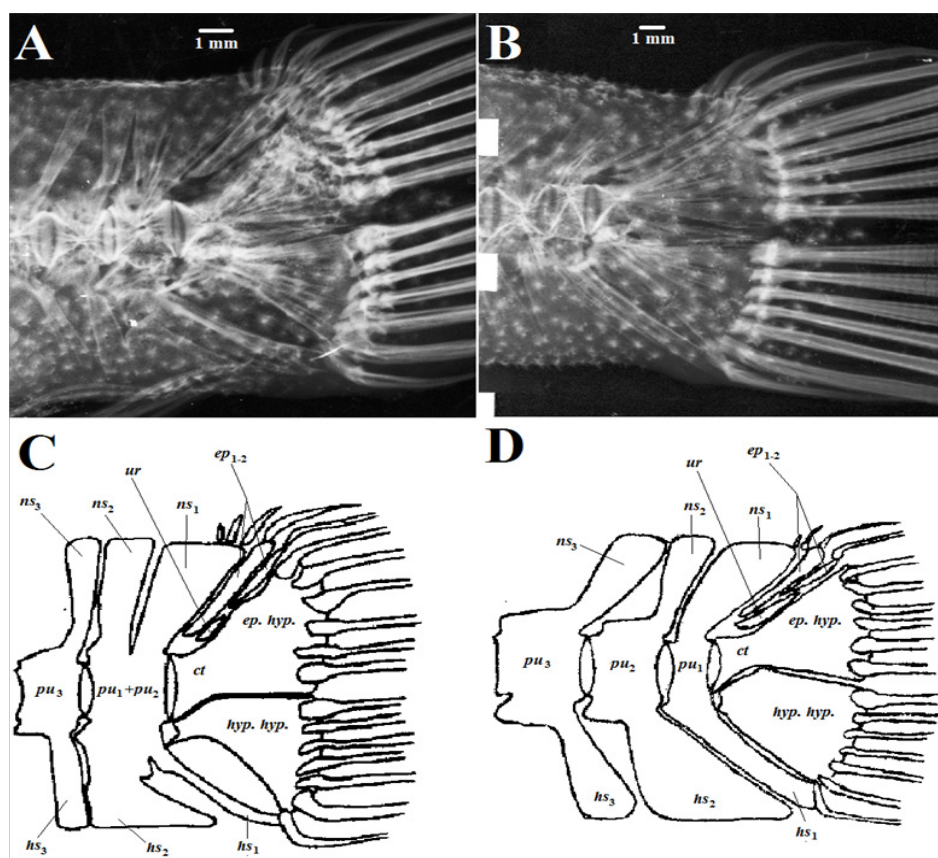


Figure 5 A and C–*pu*1+*pu*2 merged ZIN no. 56301 (2); B and D–*pu*1 and *pu*2 separated ZIN no. 56301 (3); *ct*–urostyle, *ns*_{1–3}–neural spines, *hs*_{1–3}–haemal spines, *ep.hyp.*, *hyp.hyp.*–upper and lower hypural plates respectively, *ep*_{1–2}–epuralia, *ur*–uroneuralia.

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Conflict of interests

The author declares that there is no conflict of interest.

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