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of Titan Trigger fish, *Balistoides
viridescens* (Bloch and
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Tetraodontiformes) from the
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by Muhammad Afrisal

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To cite this article: M Afrisal *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **370** 012035

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Osteological study of Titan Trigger fish, *Balistoides viridescens* (Bloch and Schneider, 1801) (Balistidae: Tetraodontiformes) from the Spermonde Archipelago Waters

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Abstract: The aim of this research was to describe the osteology of *Balistoides viridescens*. The specimen described was collected from the Paotere Fish Market, Makassar City. The weight and total length of the specimen were 2.85 kg and 46 cm respectively. Osteological description was conducted after the specimen had been prepared and X-rayed. The specimen was cleaned and the flesh separated from the bones (skeleton) using a boiling method. The skeleton was then dried under the sun for 2 weeks. The dried bones were then prepared and arranged for osteological description. Photographs were taken with a Samsung EK-GC100 Camera. The results show that *B. viridescens* has a compressed body shape, a small mouth with incisiform teeth, 7 abdominal vertebrae, 7 pairs of ribs, 9 caudal vertebrae, and one urostyle vertebra.

1. Introduction

Fish of the family Balistidae are commonly called trigger fishes or *ikan pakol*. This family of marine fishes includes several species of coral associated fishes that are widespread in the waters of the Indo-West Pacific [1]. The titan triggerfish *B. viridescens* is a relatively large reef-associated triggerfish characterized by enlarged scales above the pectoral fin base and just behind the gill opening, a prominent groove in front of the eye, 5 or 6 rows of small anteriorly projecting spines on the caudal peduncle, yellowish gray to brown body colour, and dark brown or greenish colouration in the centre of the scales [2].

The triggerfish *B. viridescens* is a fish that lives in tropical coastal waters and is quite rarely found. One type of research which can support the management of fish resources such as *B. viridescens* is to analyse the morphometric, meristic and genetic variations, in order to see the differences between and grouping of individuals and populations, (e.g. similarity indices, genetic and cluster distances) [3]. Morphometric and meristic methods can also be used to identify abnormalities in the bone structure of fish or other abnormalities. The presence of abnormalities in fish is strongly influenced by environmental factors, as well as mineral deficiencies and genetic disorders [4].

Osteology studies are very important because the development of the skeleton and skeletal osteology studies are also needed because these characters are related to eating habits and are *homoplastic* (may disappear or appear dependent on the environment at any time) [5]. In addition, skeleton morphological information can be used to describe fish phylogeny from the beginning of its growth to the adult stage and assess the extent of evolution [6].



Although several research have observed the biological aspects and management of *B. viridescens* fish from various distribution regions, so far the research had not explored deeply the osteology of this species. So it is interesting to do this research in order to describe the bone structure of this fish.

2. Materials and Methods

This study was conducted from May to July 2018. A sample of the titan trigger fish, *Balistoides viridescens*, was obtained from fishermen in the Paotere fish market in Makassar City, South Sulawesi Province, Indonesia. The sample was cleaned to remove any dirt and the fins were splayed during preservation in 10% formalin and the specimen was then dried. The skeletal structure of the dried sample was viewed using soft X-Ray (General Electric 500T; voltage 35 Kv; automatic exposition cell 5 Ma. s) [7]. The X-ray results were printed on Fuji X-Ray medical film (11x14 mm). The skeleton was then prepared through boiling and drying. To clean the remaining muscles and scales from the skeleton after boiling, the sample was washed and rinsed in hot water. The rinsing was carried out using great care prevent damage to the fragile bones, followed by a final cleaning using a soft brush.

The cleaned bones were dried under sunlight for 2 weeks. Once the bones were white and stiff, the samples were coated with a preservative varnish using a clear (transparent) spray. Any detached bones were then assembled into one complete skeletal unit using glue before osteological examination. The skeleton and various skeletal components were photographed using a Samsung EK-GC100 camera. The compound bone structure was described based on Rojo (1991) [8].

3. Results

3.1. Morphology

Based on observation of the sample before and after preservation, *B. viridescens* has a compressed body shape (Figure 1).

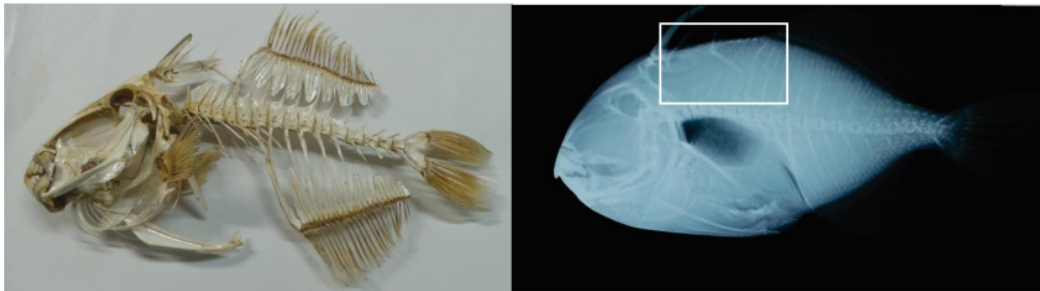


Figure 1. The titan triggerfish *B. viridescens* specimen used in this study: (a) skeleton; (b) X-ray.

Based on visual and X-Ray observation, *B. viridescens* had a compressed body shape, with two dorsal fins (the first dorsal fin has 3 hard spines while other has 25 soft rays). The soft ray tips were branched. The first spines on the dorsal fin are large, while the second and third spines are shorter, sharply pointed, and can be locked upright. The pelvic fin rays are clearly visible, extending past the dorsal fin. There are 22 anal fin rays and 14 pectoral fin rays. Examination of the X-Rays revealed some bone structures that are not externally visible. In addition, the X-ray showed that the *B. viridescens* swim bladder was wide and closed (not linked to the oesophagus). X-ray results can also help in identifying the presence of bone abnormalities in fish.

The suboperculum of the *B. viridescens* specimen was thin and relatively wide (Figure 2a). The operculum is curved and tapered on the tip. The edges of the preoperculum were smoother and finer, becoming membrane-like, towards the posterior edge (Figure 2b). The operculum section was relatively wide and thick (Figure 2c).

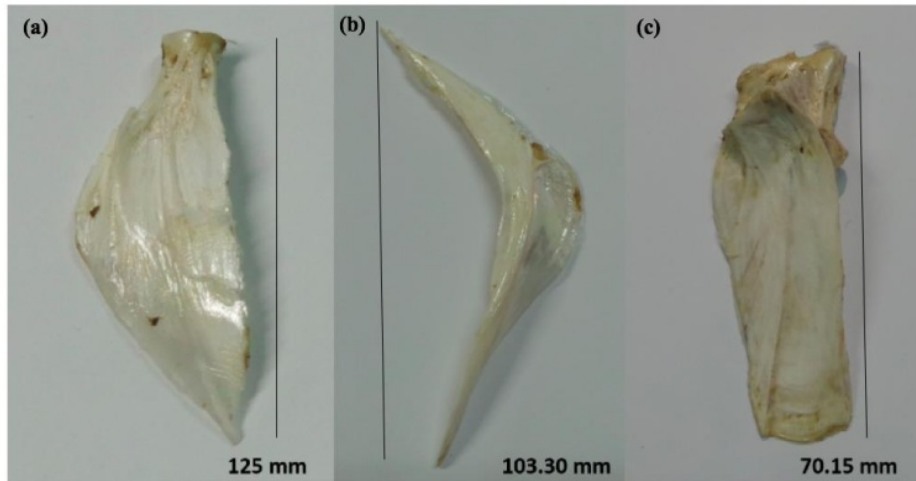


Figure 2. *B. viridescens* skeletal components: (a) suboperculum, (b) preoperculum, (c) operculum.

The *B. viridescens* specimen had chisel-shaped teeth. Each tooth consisted of two layers (outer and inner) (Figure 3). The fish had 4 pairs of teeth in the outer row of the upper jaw and 3 pairs in the inner row while there were 3 pairs of teeth in the lower jaw. The upper teeth were longer than the lower teeth. The premaxilla and dentary sections were separated into 2 parts.



Figure 3. Titan trigger fish *Balistoides viridescens* dentition: (a) outer teeth (b) inner teeth (c) mandibular.

Maxilla in *B. viridescens* fish has a small and flexible size that will play a role in opening and closing the mouth (Figure 4a). This fish has only one pelvic fin with a long spine which was thorny at the edges (Figure 4b). The branchiostegal structures consisted of several bony parts, namely the ceratohyal, hypohyal, epihyal and branchiotegal rays (Figure 4c). There are 6 rays with the first and last rays being rather wide compared to the middle rays.

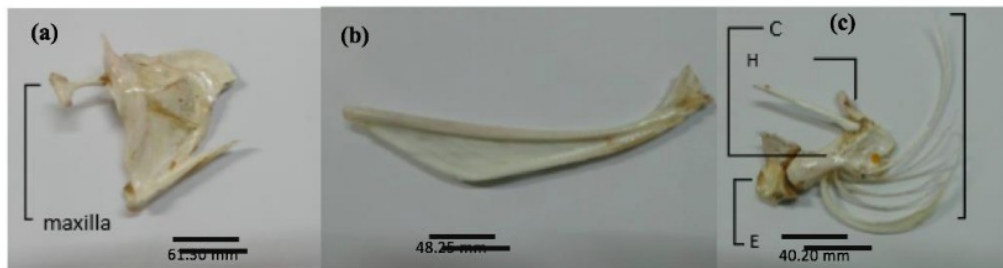


Figure. 4. *B. viridescens* skeletal components: (a) maxilla, (b) pelvic spine, (c) branchiostegal structures (C = ceratohyal; H = hypohyal; E = epihyal).

3.2. Abdominal vertebrae, caudal vertebrae and urostyle vertebrae

The spine of the *B. viridescens* specimen comprised 7 abdominal aorta vertebrae, 7 pairs of *costae*, 9 caudal vertebrae, and one urostyle vertebra (Fig. 5). There were 9 caudal vertebrae in the *B. viridescens* specimen, comprised of neural arch, neural spine, and haemal spine vertebrae (Fig. 5 and 6). The neural spines are longer and very sharp, while haemal spines are shorter and somewhat blunt. The distance between the first and fifth caudal vertebrae is wider and tends to be tilted forward compared to the sixth to ninth caudal vertebrae which tend to be narrower and tilted backward. In the first to fifth spinal vertebrae, the haemal canal, is still clearly visible, and provides a space for blood vessels to pass through. This fish has thorny scales which are like thick hardened petals and are arranged in a tile formation around the base of the tail.

The urostyle vertebra in *B. viridescens* is in the last centrum with the position pointing to the caudal area. In the urostyle vertebra, there are two wide hypural shapes. At the base of the urostyle vertebra, they functions as an attachment point for the epural and paraphypural (Fig. 7). The backwardly-orientated process of the urostyle results in a homocercal tail, where the fused caudal vertebrae are oriented slightly towards the dorsal region, so that the caudal fin is divided asymmetrically from the inside but divided symmetrically when viewed externally.

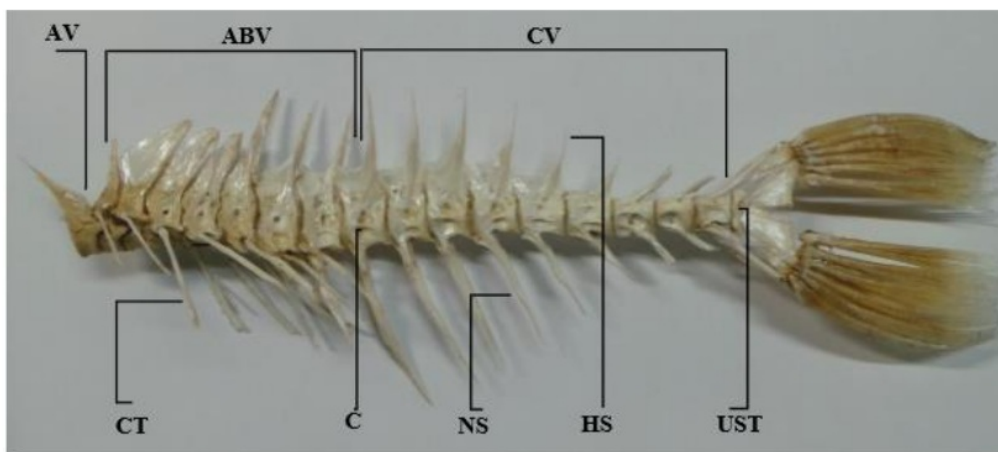


Figure. 5. *B. viridescens* vertebrae: AV: axial vertebrae, ABV: abdominal vertebrae; CV: caudal vertebrae; CT: costae; C: centrum; NS: neural spine; HS: haemal spine; C: centrum; UST: urostyle.



Figure 6. Features of the 7th *B. viridescens* caudal vertebra: NS: neural spine, NA: neural arch, NC: neural canal, C: centrum, HA: haemal arch, HS: haemal spine.

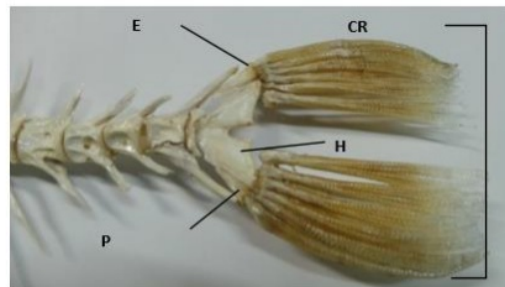


Figure 7. Features of the *B. viridescens* urostyle vertebra: E: epural region, P: paraphypural region, H: hypural region, CR: caudal fin rays.

4. Discussion

Skeletal morphology plays an important role in fish taxonomy and phylogeny [9], and serves to detect the presence of spinal or abnormal abnormalities as well as making comparisons between species [10]. In addition, [7] mentioned that the number of bone structures can also be used in determining new types or identifying cryptic species [3].

The morphological character of the titan triggerfish *B. viridescens* bears a resemblance to the Indo-Pacific family of Monacanthidae. Similarities include the presence of two or more dorsal fin spines, only the first of which is long and prominent, a laterally compressed body, fewer and less massive teeth in the jaws, shagreen-like scales, with the individual basal plates small and not readily distinguishable from one another to the unaided eye [2].

The operculum of *B. viridescens* has a distinct shape compared to fish from other families. The *B. viridescens* specimen had a subtle preoperculum fringe at both ends. This feature differs from the family Terapontidae where the operculum has two hard spines on the back, the lower hard spines are longer and stronger, and the back fringe of the preoperculum is jagged [2].

Titan triggerfish has a small mouth with denser teeth. This is related to food and eating habits. Trigger fish are carnivorous animals and in nature, Titan triggerfish hunt for prey on the level of coral reefs in the form of small fish [11]. The number of teeth in *B. viridescens* is higher than that of the family Monacanthidae. Monacanthidae dentition consists of 6 teeth in the outer part of the upper jaw and 6 or fewer teeth in the lower jaw (Kimura & Matsuura, 2003).

The titan triggerfish fish has a maxilla that is relatively small, short and flexible. This is related to the opening of the mouth which is supported by the nearly terminal mouth type. In addition, the titan triggerfish only has one pelvic fin with a pointed tip. This is different from the majority of fishes that, in general, have a pair of pelvic fins consisting of hard spines and soft rays.

B. viridescens has fewer caudal vertebrae (9) than several other fish species. For example, *Tor tambroides* (Family; Cyprinidae) has 19 abdominal vertebrae, 18 pairs of ribs, 16 caudal vertebrae and

one urostyle vertebra [12], while *Zaprora silenus* (Family Zaproridae), has 35-37 caudal vertebrae [13] and the Genus *Cryptacanthodes* (Family; Cryptacanthodidae) has 53-55 caudal vertebrae [14].

5. Conclusion

A specimen of the triggerfish *B. viridescens* was described osteologically. The body shape was laterally compressed, with a small mouth and incisiform teeth. The vertebrae comprised 7 abdominal vertebrae, 7 pairs of ribs, 9 caudal vertebrae, and one urostyle vertebra. The morphology and osteological characters of the family Balistidae, including this species, are relatively similar to those of the family Monacanthidae.

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