

A REVIEW OF THE ARCHERFISHES (FAMILY TOXOTIDAE)

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[Received 16 July 1977. Accepted 27 September 1977. Published 31 December 1978.]

ABSTRACT

The six species of *Toxotes* which constitute the fish family Toxotidae are reviewed. This group, commonly known as archerfishes, is renowned for its ability to knock down insects from overhanging vegetation with squirts of water ejected from the mouth. The habitat consists of mangrove-lined estuaries and freshwater streams of southeast Asia, northern Australia and the islands of the western Pacific in the Indonesia-New Guinea-Philippines region. A brief diagnosis, illustrations, and tables of counts are presented for each of the following species (approximate distributions indicated in parentheses): *blythi* (Burma), *chatareus* (widespread from India eastward to northern Australia and New Guinea), *jaculator* (widespread from India to the New Hebrides), *lorentzi* (northern Australia and New Guinea), *microlepis* (Thailand, Sumatra, and Borneo), *oligolepis* (eastern Indonesia, New Guinea, and northern Australia). A generic diagnosis and key to the species are also provided.

INTRODUCTION

The perciform family Toxotidae is comprised of a single genus, *Toxotes*, which contains six species: *T. blythi* Boulenger, *T. chatareus* (Hamilton), *T. jaculator* (Pallas), *T. lorentzi* Weber, *T. microlepis* Günther, and *T. oligolepis* Bleeker. These fishes exhibit one of nature's most remarkable feeding adaptations which has been the subject of papers by Zolotnisky (1902), Gill (1909), Smith (1936 and 1945), and Allen (1973). When suitable prey, usually a small insect, is sighted the fish rises to the surface and ejects an aqueous 'bullet' by forcefully compressing the gill covers, thus propelling a jet of water from the mouth. The aim is uncannily accurate to a

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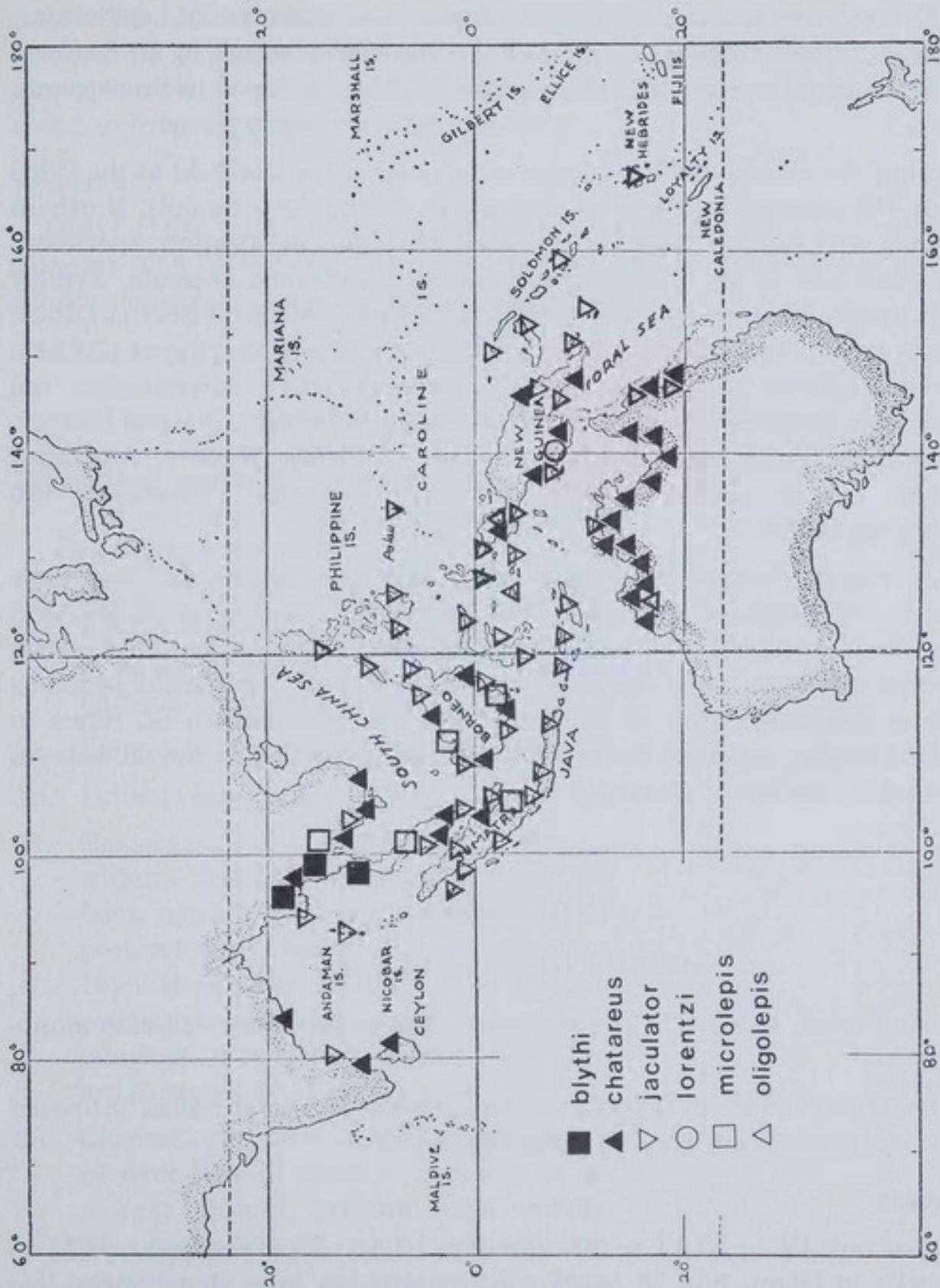
distance of several feet and in most cases the victim is knocked into the water and devoured. The special adaptation of the oral cavity was described in detail by Smith (1945). According to his description the palate contains a deep longitudinal groove which is converted to a tube when the tongue is pressed against the roof of the mouth. When the gill covers are suddenly compressed water is forced from the pharynx into this palatine canal, and with the tip of the tongue acting as a valve, the flow of water, under pressure, is regulated.

Toxotes chatareus and *T. jaculator* are the most widespread members of the family occurring over a large area extending from Sri Lanka and the east coast of India eastward through the tropics to the Palau Islands, New Guinea, Solomon Islands, and the New Hebrides. A summary of the distribution of the six species is shown in Map 1. *T. jaculator* is normally found in brackish water in the vicinity of mangroves; the other species are frequently encountered in freshwater and several of these probably breed there. However, there is little published information on the reproductive habits. According to Smith (1945) the newly hatched young of *T. jaculator* are seen in the Bangkok region during May and by the first week of July a total length of 13 to 15 mm is attained. The maximum length recorded for *Toxotes* is approximately 40 cm (see remarks section for *T. chatareus*) and in some localities they are netted for food or caught by sport anglers.

The stimulus for the present study was my initial lack of success in identifying a species of *Toxotes* recently collected in the extreme northern section of Western Australia. It did not correspond with any of the species currently recognised from Australia, nor with several others which are generally accepted as junior synonyms. Eventually it was identified as *T. oligolepis*, a poorly known species described by Bleeker (1876) from the Molucca Group of Indonesia.

The family has not been reviewed previously on a comprehensive basis, although Fowler and Bean (1929), and Weber and de Beaufort (1936) included all the species except *T. blythi* in their respective monographs of the fishes of the Indo-Australian Archipelago and the Philippine Islands. In addition, Bleeker (1876 and 1877) reviewed the known species and provided illustrations of *chatareus*, *jaculator*, *microlepis*, and *oligolepis*. Sanders (1934) described a fossil species, *Toxotes beauforti*, from the early Tertiary of Central Sumatra. It is remarkably similar to modern *Toxotes* except for the possession of six instead of four or five dorsal spines.

Fowler and Bean (1929) gave a brief account of '*Toxotes squamosus*' Hutton from New Zealand, but Weber and de Beaufort (1936) have shown



Map 1: Distribution of *Toxotes*.

that this species is a bramid and therefore unrelated. Bleeker (1876) had previously included it in a new monotypic genus, *Amblytoxotes*. Whitley (1968) listed this species as *Lepidotus squamosus* in the family Lepidotidae. '*Toxotes antiquus* Agassiz is a fossil species, which according to Eastman (1914) is not a toxotid, but rather a labrid, which he placed in a new genus, *Gillidia*.

During the present study *Toxotes* were observed in the field at the Palau Islands (Micronesia), Madang (New Guinea), Cairns (Queensland), Northern Territory and the far north of Western Australia. In addition, specimens were examined at the following institutions: Australian Museum, Sydney (AM); British Museum (Natural History), London (BMNH); Fisheries Office, Department of Agriculture, Stock, and Fisheries, Konedobu, Papua (DASF); Museum National d'Histoire Naturelle, Paris (MNHN); Rijksmuseum van Natuurlijke Histoire, Leiden (RMNH); National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); Western Australian Museum, Perth (WAM); and Zoologisch Museum, Universiteit van Amsterdam (ZMA).

Proportional measurements were taken with dial calipers to the nearest 0.5 mm. The height of the tallest dorsal spine was measured from the level of the basal articulation. The interorbital width refers to the least width, measured between the anterior portion of the eyes. The caudal peduncle depth is the least depth of the tail base. The abbreviation SL refers to standard length, measured from the tip of the upper jaw to the tail base, as indicated by the line of flexure.

TAXONOMY

GENUS *TOXOTES* CUVIER

Toxotes Cuvier, 1817: 338 (type species, *Sciaena jaculatrix* Pallas by monotypy).

Trompe Gistel, 1848: 109 (type species, *Sciaena jaculatrix* Pallas; proposed as a replacement name for *Toxotes* Cuvier).

Diagnosis

Dorsal rays IV to VI, 11 to 14; anal rays III, 15 to 18; pectoral rays 11 to 15; scales in lateral line 25 to 47; horizontal scale rows above lateral line 3 to 7, below lateral line 8 to 15; gill rakers on lower limb of first branchial arch 2 to 8. Greatest body depth 1.8 to 2.5, head length 2.3 to 3.2, both in

standard length. Snout 3.2 to 4.2, eye 2.9 to 4.9, interorbital 2.7 to 3.8, caudal peduncle depth 2.3 to 3.4, pectoral fin length 1.0 to 1.8, pelvic fin length 1.8 to 2.5, all in head length. Penultimate dorsal spine usually the longest, 1.3 to 2.3 in head length. Colour in preservative generally uniform tan or brown, or with a pattern consisting of a series of dark bars, large spots, or irregular stripes on a light ground.

Remarks

Gistel (1848) did not give a reason for his substitution of *Trompe* for *Toxotes*. The latter name has otherwise been generally accepted as the valid generic designation since the description by Cuvier.

KEY TO THE SPECIES OF *TOXOTES*

- | | | | | | | | | | |
|-----|---|-----|-----|-----|-----|-----|-----|-----|---------------------|
| 1a. | Dorsal spines 4; series of 4 or 5 black bars on upper sides (widespread, India to the New Hebrides) | ... | ... | ... | ... | ... | ... | ... | <i>T. jaculator</i> |
| 1b. | Dorsal spines normally 5; colour variable with either series of bars, spots, or irregular stripes on sides, or colour uniform without markings | ... | ... | ... | ... | ... | ... | ... | 2 |
| 2a. | Lateral line scales usually less than 38 | ... | ... | ... | ... | ... | ... | ... | 3 |
| 2b. | Lateral line scales usually 39 to 50 | ... | ... | ... | ... | ... | ... | ... | 6 |
| 3a. | General coloration uniform tan or brown without markings (may have about 10 faint, narrow bars on upper sides in life); pectoral rays usually 14 (occasionally 15); lateral line running in a straight course; gill rakers on lower limb of first branchial arch 2 to 4 (usually 3) (northern Australia and New Guinea) | ... | ... | ... | ... | ... | ... | ... | <i>T. lorentzi</i> |
| 3b. | General coloration consisting of a series of dark bars or relatively large spots on a light ground; pectoral rays usually 13 (rarely 11, 12, or 14); lateral line arched over pectoral region; gill rakers on lower limb of first branchial arch 5 to 8 | ... | ... | ... | ... | ... | ... | ... | 4 |

- 4a. Colour pattern consisting of a series of 6 or 7, alternating large and small black spots (except in small juveniles, see Plates 2-6) (widespread, India to New Guinea and N. Australia *T. chatareus*
- 4b. Colour pattern consisting of a series of 4 or 5, wedge-shaped black bars or saddles without intervening small spots (see Plates 10 and 11) (Molucca Islands, W. New Guinea, Kimberley region of W. Australia, and possibly Philippine Islands *T. oligolepis*
- 5a. Colour pattern consisting of a series of irregular horizontal dark stripes on a light ground (see Plate 1) (Burma) *T. blythi*
- 5b. Colour pattern consisting of a series of 4 or 5 rounded dark spots along back (see Plate 9) (Thailand, Sumatra, and Borneo) *T. microlepis*

TOXOTES BLYTHI BOULENGER

(Plate 1; Tables 1 and 2)

Toxotes blythi Boulenger, 1892: 143 (type locality: Tenasserim, Burma).

Toxotes microlepis (non Günther) Day, 1875: Plate 30, Fig. 1 (Irrawaddi River, Burma).

Diagnosis

Dorsal rays V,12 to 14; anal rays III,16 to 18; pectoral rays 13; scales in lateral line 41 to 47; horizontal scale rows above lateral line 5 to 6, below lateral line 14 to 15; gill rakers on lower limb of first branchial arch 2 to 6 (usually 5 or 6). Greatest body depth 2.2 to 2.3, head length 2.6 to 2.9, both in standard length. Snout 3.2 to 3.6, eye 3.1 to 3.5, interorbital 3.0 to 3.4, caudal peduncle depth 2.6 to 2.9, pectoral fin length 1.3 to 1.5, pelvic fin length 1.9 to 2.0, all in head length. Fourth dorsal spine the longest, about 1.5 in head length.

Colour in alcohol: ground colour yellowish, but with silvery metallic sheen; a series of dark brown to blackish spots and longitudinal markings on

sides and fins (see Plate 1); dorsal and anal fins dusky to yellowish; caudal, pelvic, and pectoral fins yellowish.



Plate 1: *Toxotes blythi*, paralectotype, 91.5 mm SL, Tenasserim, Burma.

Distribution

T. blythi is known only from the Andaman Sea drainage of Burma between the Irrawaddi River system and Tenasserim. The latter location represents the type locality and is on the upper part of the Malay Peninsula, about 250 km southwest of Bangkok.

Remarks

Day's (1875-8) illustration of *T. microlepis* from the Irrawaddi River actually represents *T. blythi*. The colour pattern of the latter species is very different from other *Toxotes* and it is difficult to understand the basis for Day's confusion, except for the similarity in scale size.

Apparently there are very few specimens of *T. blythi* in museum collections. I have examined the syntypes, 7 specimens, 61 to 131 mm SL which are deposited at BMNH (register number 1891.11.30.20-26). The specimens are in good condition and the largest is here designated as the lectotype. In addition, a specimen, 74 mm SL, from Kokurit, Burma was examined at RMNH.

TABLE 1

Fin ray and gill raker counts for species of *Toxotes*.

| | Dorsal Rays | | | | | | Anal Rays | | | | | | Pectoral Rays | | | | | | Lower Limb Gill Rakers | | | | | | | |
|-------------------|-------------|----|----|----|----|----|-----------|----|----|----|----|----|---------------|----|----|----|---|----|------------------------|---|----|----|----|--|--|--|
| | IV | V | VI | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 11 | 12 | 13 | 14 | 15 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| <i>blythi</i> | | 8 | | | 3 | 4 | 1 | | 4 | 3 | 1 | | | 8 | | | 1 | | | | | | | | | |
| <i>chatareus</i> | 2 | 93 | 1 | | 33 | 41 | 22 | 10 | 65 | 20 | | 1 | 7 | 82 | 6 | | | | | | 2 | 65 | 29 | | | |
| <i>jaculator</i> | 37 | 1 | | 2 | 29 | 7 | | 2 | 28 | 8 | | | 3 | 35 | | | | | | | 2 | 18 | 18 | | | |
| <i>lorentzi</i> | | 13 | | | | 3 | 10 | 1 | 10 | 2 | | | | | 10 | 3 | 1 | 11 | 1 | | | | | | | |
| <i>microlepis</i> | | 21 | | | | 14 | 7 | 2 | 7 | 12 | | | 9 | 11 | 1 | | | | | | 11 | 9 | 1 | | | |
| <i>oligolepis</i> | 1 | 39 | | | 26 | 14 | | 24 | 9 | 4 | | | 2 | 35 | 3 | | | | | | 5 | 27 | 7 | | | |

TABLE 2

Lateral line scale counts for species of *Toxotes*.

| | | | | | | | | | | | | | | | | | | | | | | | | |
|-------------------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| <i>blythi</i> | | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 |
| <i>chatareus</i> | | | | | | 18 | 18 | 13 | 12 | 14 | 7 | 7 | 5 | 1 | | | | 2 | 1 | 1 | 2 | 1 | | 1 |
| <i>jaculator</i> | | | 8 | 11 | 7 | 10 | 2 | | | | | | | | | | | | | | | | | |
| <i>lorentzi</i> | | | | | | | | | | | | | | | | 4 | 2 | 1 | 2 | | 2 | 1 | 6 | 3 |
| <i>microlepis</i> | | | | | | | | | | | | | | | | | | | 5 | 3 | 3 | 3 | 2 | |
| <i>oligolepis</i> | | 1 | | | 1 | 5 | 10 | 18 | 3 | 2 | | | | | | | | | | | | | | |

TOXOTES CHATAREUS (HAMILTON)

(Plates 2-6; Tables 1-3)

Coius chatareus Hamilton, 1822: 101 and 370 (type locality: mouth of Ganges River, India).

Toxotes carpentariensis Castelnau, 1878: 47 (type locality: Norman River, Gulf of Carpentaria).

Toxotes dorsalis Whitley, 1950: 242 (type locality: Flinders River, near Hughenden and Richmond, Queensland).

Toxotes ulysseus Whitley, 1950: 243 (type locality: Townsville, Queensland).

Diagnosis

Dorsal rays IV to VI (usually V), 12 to 14; anal rays III, 15 to 17 (usually 16); pectoral rays 11 to 14 (usually 13); scales in lateral line 29 to 37 (usually 29 to 32); horizontal scale rows above lateral line 3 to 5, below lateral line 9 to 11; gill rakers on lower limb of first branchial arch 5 to 7. Greatest body depth 1.9 to 2.4, head 2.5 to 3.0, both in standard length. Snout 3.3 to 4.1, eye 3.5 to 4.9, interorbital 2.7 to 3.7, caudal peduncle depth 2.4 to 3.2, pectoral fin length 1.0 to 1.3, pelvic fin length 1.8 to 2.4, all in head length. Fourth dorsal spine usually the longest (sometimes third is the longest), 1.3 to 2.3 in head length.

Colour in alcohol: there is a certain amount of variation in the colour pattern which is related to the developmental stage and geographic location (see Plates 2-6). The basic pattern of specimens in excess of about 70 mm SL is as follows: ground colour whitish to dusky grey or tan, sometimes with silvery sheen; a series of 6 or 7 black spots on upper side of body; spinous dorsal fin dusky or blackish; soft dorsal fin dusky or blackish, frequently with pale central band; caudal fin whitish or yellowish to very dusky; anal fin similar to soft dorsal or pale basally grading to blackish on outer half of fin; pelvic fins whitish to yellowish grading to dusky on outer portion; pectoral fins usually pale, but sometimes upper rays dusky, particularly in larger specimens. Nearly all of the specimens from freshwater possess a series of alternating light and dark horizontal bands (approximately one per scale row) on the sides which are of variable intensity, but are usually most prominent on the ventral body region. Several specimens collected in the Kimberley region of Western Australia by J.B. Hutchins are extremely dusky over the entire body, thus obscuring the characteristic spots. According to the collector these fish were normal coloured, but assumed the dusky pattern shortly after death. The juvenile colour pattern is illustrated in Plate 5.

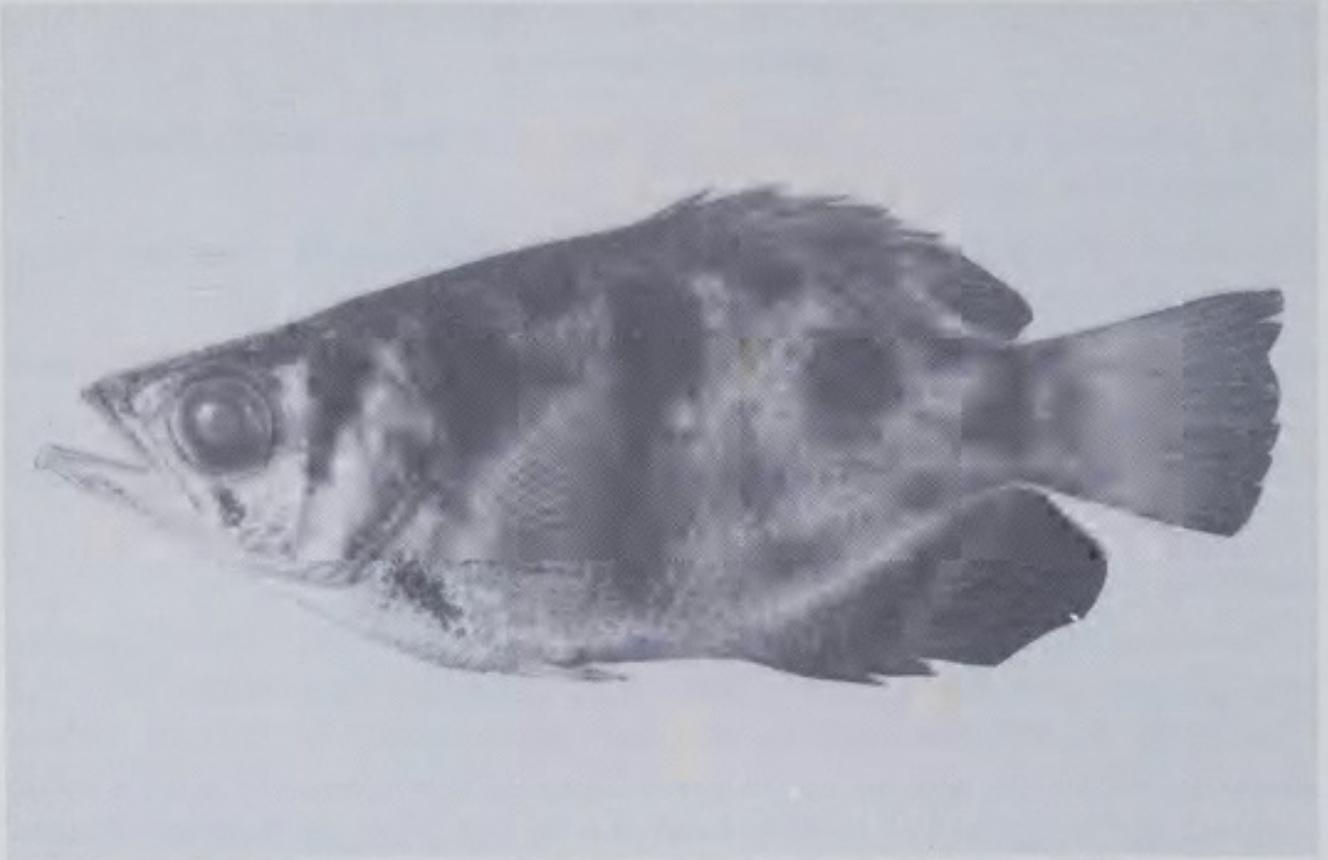


Plate 2: *Toxotes chatareus*, juvenile specimen, 40 mm SL, Parry Creek (freshwater), near Wyndham, Western Australia.

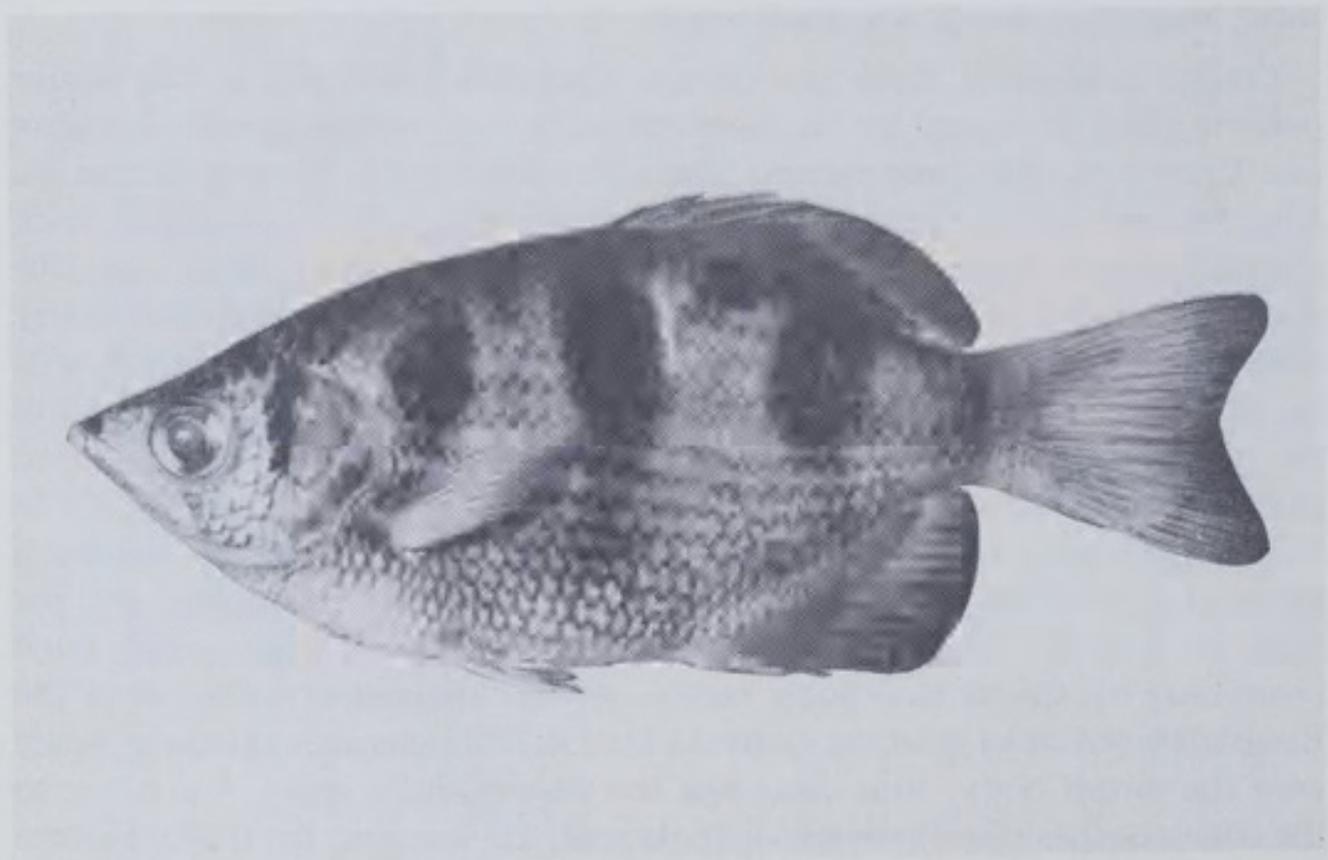


Plate 3: *Toxotes chatareus*, 91 mm SL, Lawley River (freshwater), Western Australia.

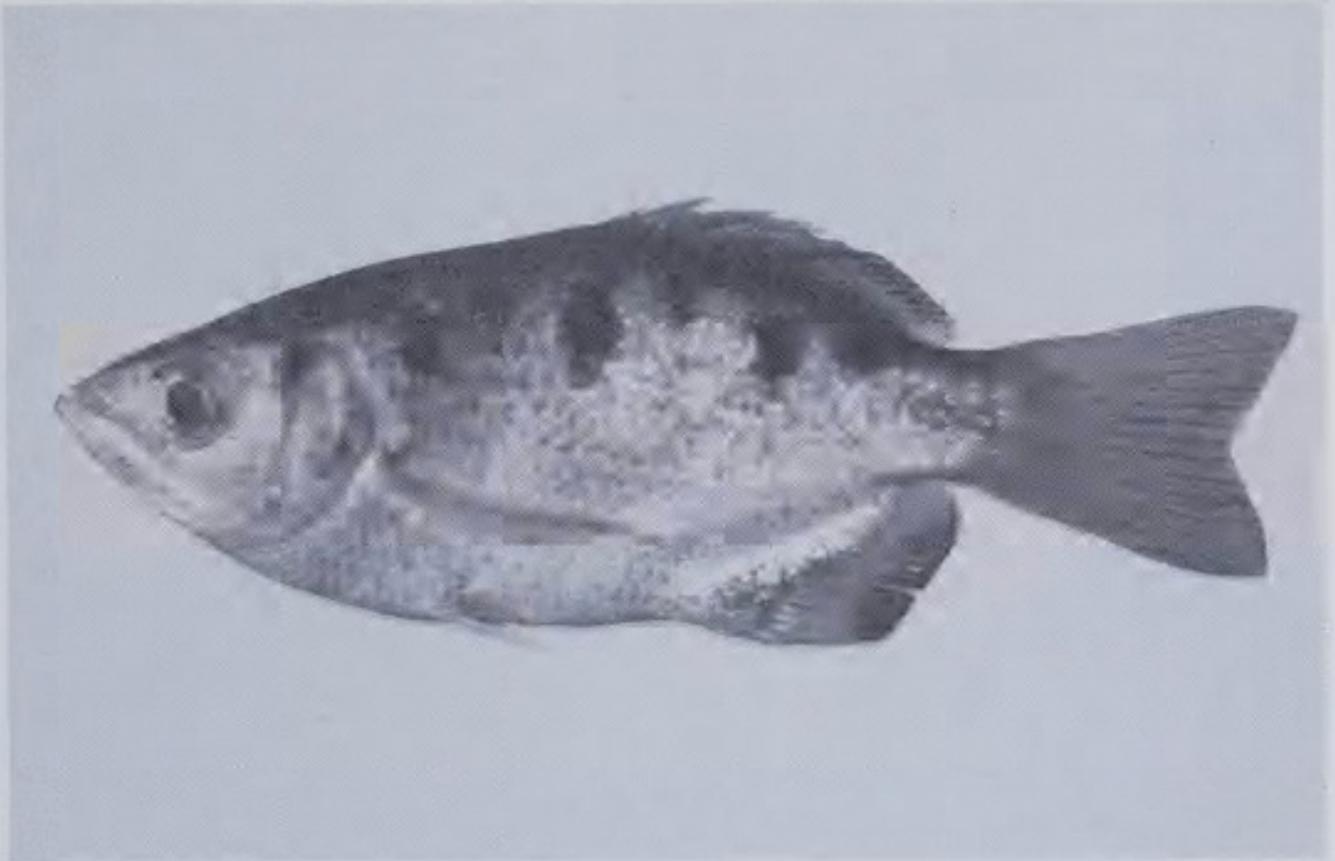


Plate 4: *Toxotes chatareus*, 84 mm SL, Behn River (freshwater), Western Australia.

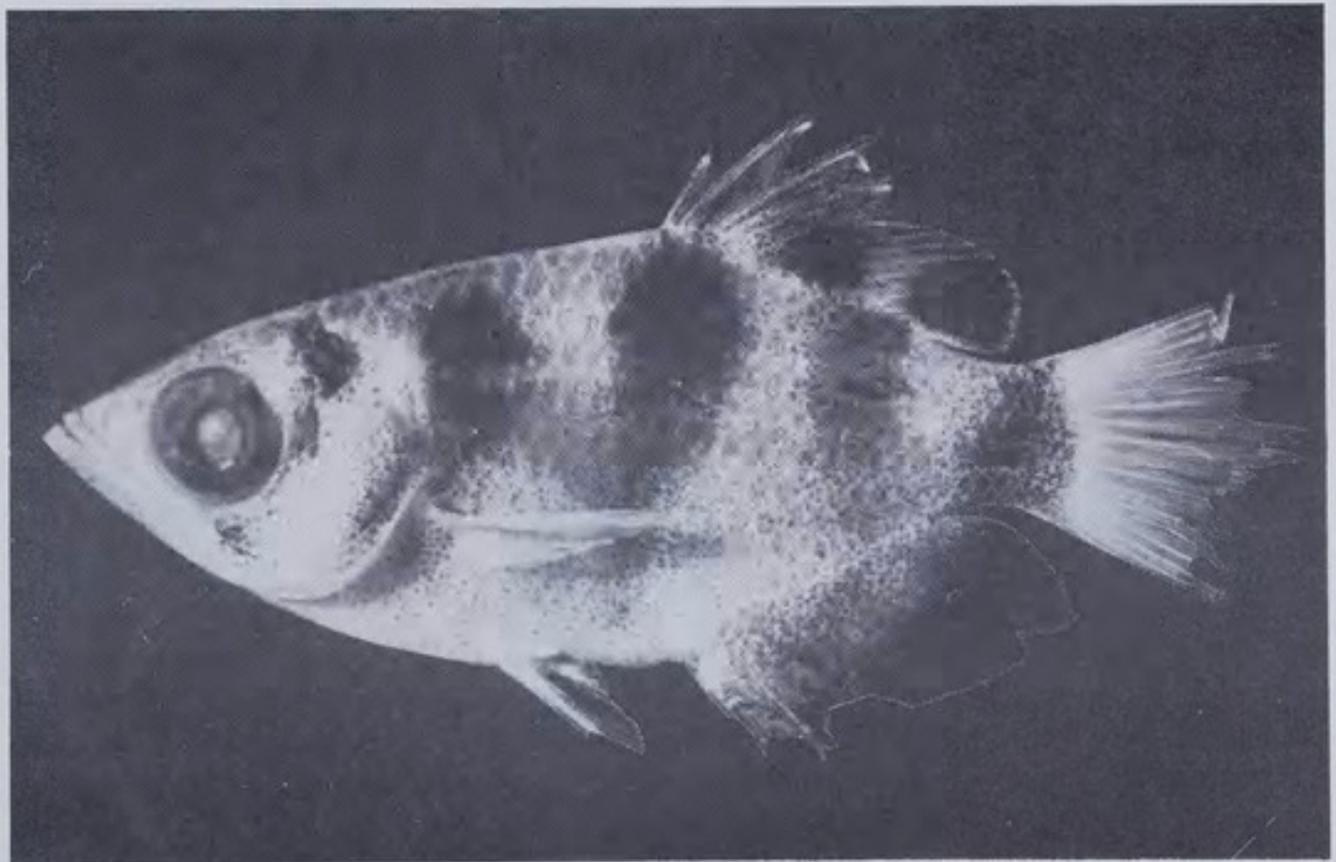


Plate 5: *Toxotes chatareus*, juvenile specimen, 21 mm SL, Cairns, Queensland (brackish water).

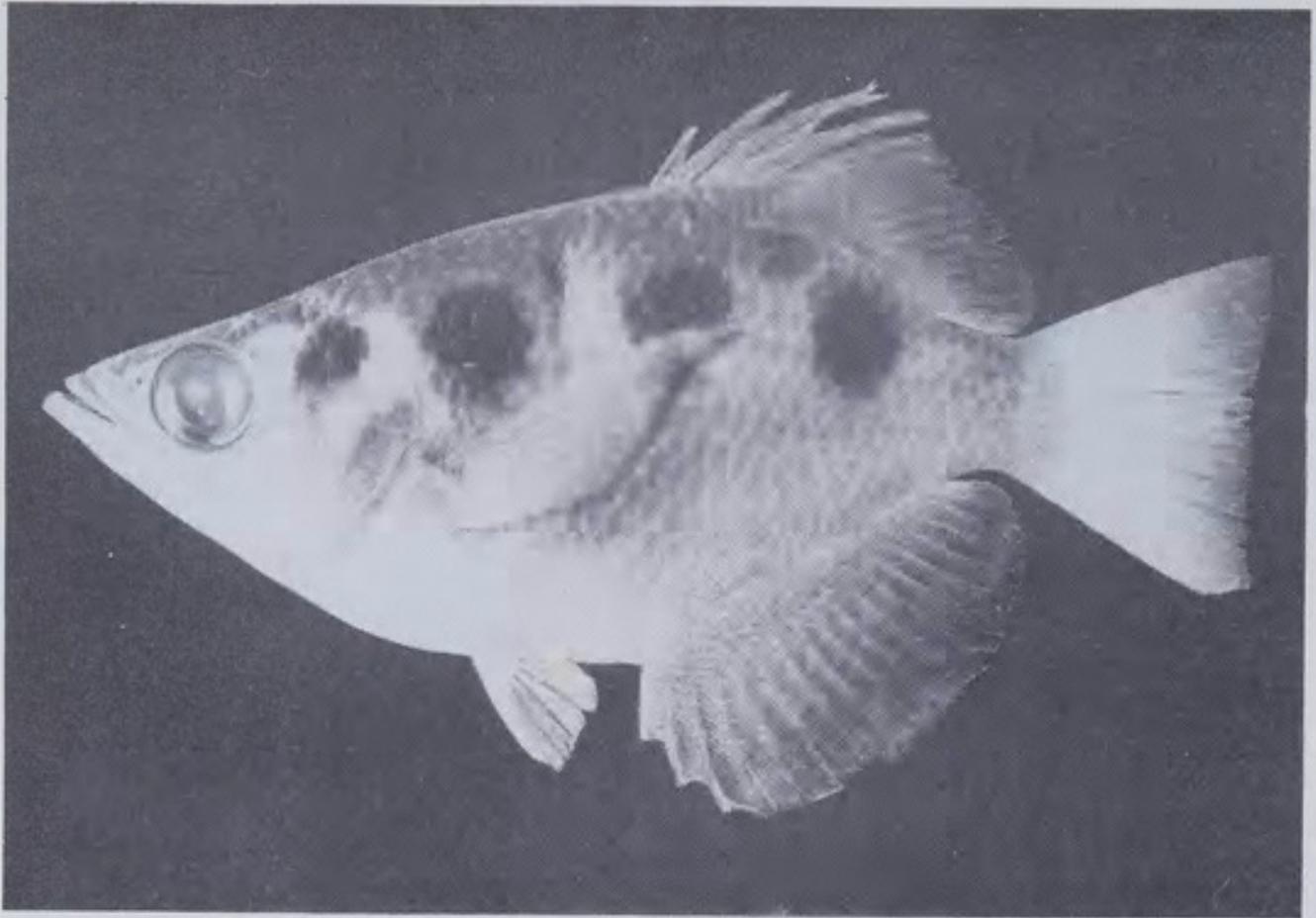


Plate 6: *Toxotes chatareus*, 74 mm SL, Cairns, Queensland (brackish water).

Distribution

T. chatareus has a relatively widespread distribution. Weber and de Beaufort (1936) recorded it from the following localities: India, Malay Peninsula, Thailand, Vietnam, Singapore, Sumatra, Borneo, New Guinea and northern Australia. In addition, Smith (1945) and Munro (1955) recorded it from Burma and Sri Lanka respectively.

The coastal population of *T. chatareus* in northern Australia extends approximately between Derby in Western Australia and Townsville on the Pacific coast of Queensland. Freshwater populations are distributed throughout far northern Australia and New Guinea in river systems flowing into the Timor and Arafura Seas and the Gulf of Carpentaria. I have examined specimens from the following rivers (progressing eastward): *Western Australia* — King Edward, Carson, Lawley, Durack, Pentacost, and Ord; *Northern Territory* — Victoria, Darwin, South Alligator, East Alligator, and Roper; *Queensland* — O'Shannassy, Gregory, Flinders, Saxby, and Archer; *New Guinea* — Bensbach, Morehead, Fly (including Lake Murray), Sepik, and Laloki.

T. chatareus exhibits considerable variation with regard to maximum body depth and dorsal spine structure. These characters are influenced by growth, geographic locality and environmental conditions. Judging from the examination of gonads and the capture of small juveniles, breeding populations are present in both brackish and pure freshwater. On the basis of certain morphological features it seems likely that divergence is occurring amongst the various populations in the Australia-New Guinea region. For example, specimens from freshwater in northern Australia are generally more slender in shape and have a significantly lower spinous dorsal fin composed of relatively weak spines in comparison with specimens from brackish water. The dorsal spine difference was dramatically demonstrated in specimens which I collected from the Victoria River, Northern Territory during October and December 1977. Individuals taken from brackish water near Timber Creek had very robust spines, with the longest of these significantly taller than the overall height of the soft dorsal fin. A subsequent collection from freshwater, approximately 100 km upstream at the Victoria Highway Bridge, yielded specimens which were virtually identical in appearance except the dorsal spines were relatively feeble and the tallest ones were about equal in height to the soft dorsal rays. Perhaps the stronger, taller spines are due to an increased calcium intake amongst fish living in brackish water. *Toxotes* are easily kept in captivity, therefore it would be worthwhile to conduct an experiment to determine the effect of different salinities on the spine morphology. Although the number of New Guinea specimens examined during this study was insufficient, freshwater populations from this region are generally deeper bodied and have a higher spinous dorsal in comparison with their freshwater relatives from northern Australia. A summary of data comparing dorsal spine height and body depth is presented in Table 3.

T. chatareus is capable of penetrating well inland. Lake (1971) reported its occurrence above Riversleigh Station, some 200 km up the Gregory River in northern Queensland. During the present study it was collected from distances ranging up to 175-200 km upstream on the Roper, Edith, and King Rivers, in the Northern Territory. Dr Tyson Roberts (pers. comm.) recently collected it from the Fly River of New Guinea at localities 509 and 859 km upstream from the sea. Specimens as small as 8 mm SL were taken at both locations, thus indicative of a freshwater breeding population. Dr Roberts also collected the largest known *Toxotes*, a specimen of *T. chatareus* 400 mm SL, from the Upper Fly River. The previous record was 270 mm SL reported for *T. chatareus* by Weber and de Beaufort (1936).

T. carpentariensis was distinguished by Castelnau on the basis of a dorsal spine count of six compared with four or five spines in other members of

the genus. I have examined the holotype at MNHN and conclude that it is synonymous with the Australian freshwater form of *T. chatareus*, but apparently the dorsal count represents an anomaly. The specimen is otherwise morphologically similar to numerous individuals examined from the Kimberley region of Western Australia and the Gulf of Carpentaria drainage system, which possess five dorsal spines. It is a dried specimen, 173 mm SL, in relatively poor condition and overall yellow-brown in colour without distinctive markings.

I have examined 193 specimens, 13-207 mm SL, from New Guinea and northern Australia. This includes Whitley's types of *T. dorsalis* (AM I.13056-13058) and *T. ulysses* (AM IA.2220), which represent specimens from freshwater and brackish water respectively. According to Hora (1924), Hamilton (sometimes cited as Hamilton-Buchanan) did not keep collections of the numerous fishes he described; therefore a type specimen for *T. chatareus* does not exist. However, the illustration which accompanies the original description of this species is clearly diagnostic.

TABLE 3

Comparison of the height of the spinous dorsal fin and body depth of *Toxotes chatareus* with relation to size, locality, and habitat (expressed in percent of standard length).

| Size Class (mm SL) | Height of Spinous Dorsal | | |
|--------------------|--|-------------------------|--------------------------|
| | Australia-New Guinea Brackish Water | Australia Freshwater | New Guinea Freshwater |
| | \bar{X} (N indicated in parentheses) | | |
| 20-59 | 25.1 (29) | 20.3 (24) | 24.0 (2) |
| 60-99 | 26.0 (5) | 19.1 (35) | 23.7 (7) |
| 100-149 | 25.9 (4) | 16.9 (10) | 20.4 (2) |
| 150+ | 26.1 (4) | 16.9 (4) | 23.8 (5) |
| | Body depth | | |
| 20-59 | 47.9 (28) | 45.5 (23) | 49.9 (2) |
| 60-99 | 48.1 (5) | 46.2 (36) | 49.0 (7) |
| 100-149 | 49.1 (4) | 45.6 (10) | 47.1 (3) |
| 150+ | 48.6 (4) | 46.2 (5) | 46.9 (7) |

TOXOTES JACULATOR (PALLAS)

(Plate 7; Tables 1 and 2)

Sciaena jaculatrix Pallas, 1767: 186 (type locality: Batavia [Jakarta] Java).

Scarus schlosseri Gmelin, 1789: 1228 (based on Pallas' description of *Sciaena jaculatrix*).

Diagnosis

Dorsal rays IV or V, 11 to 13 (usually IV, 12); anal rays III, 15 to 17; pectoral rays 12 or 13 (usually 13); scales in lateral line 26 to 30; horizontal scale rows above lateral line 3 or 4, below lateral line 8 or 9; gill rakers on lower limb of first branchial arch 5 to 7 (usually 6 or 7). Greatest body depth 2.1 to 2.4, head length 2.3 to 2.7, both in standard length. Snout 3.4 to 3.7, eye 3.2 to 3.6, interorbital 2.8 to 3.8, caudal peduncle depth 2.5 to 3.4, pectoral fin length 1.2 to 1.4, pelvic fin length 2.1 to 2.4, all in head length. Third dorsal spine the longest, 1.7 to 1.9 in head length.

Colour in alcohol: ground colour whitish to tan, sometimes with silvery sheen, grading to brown on dorsal surface, a series of 4-5 black bars, primarily on upper sides; dorsal, anal, and pelvic fins blackish; caudal fin pale to dusky; pectoral fins pale.

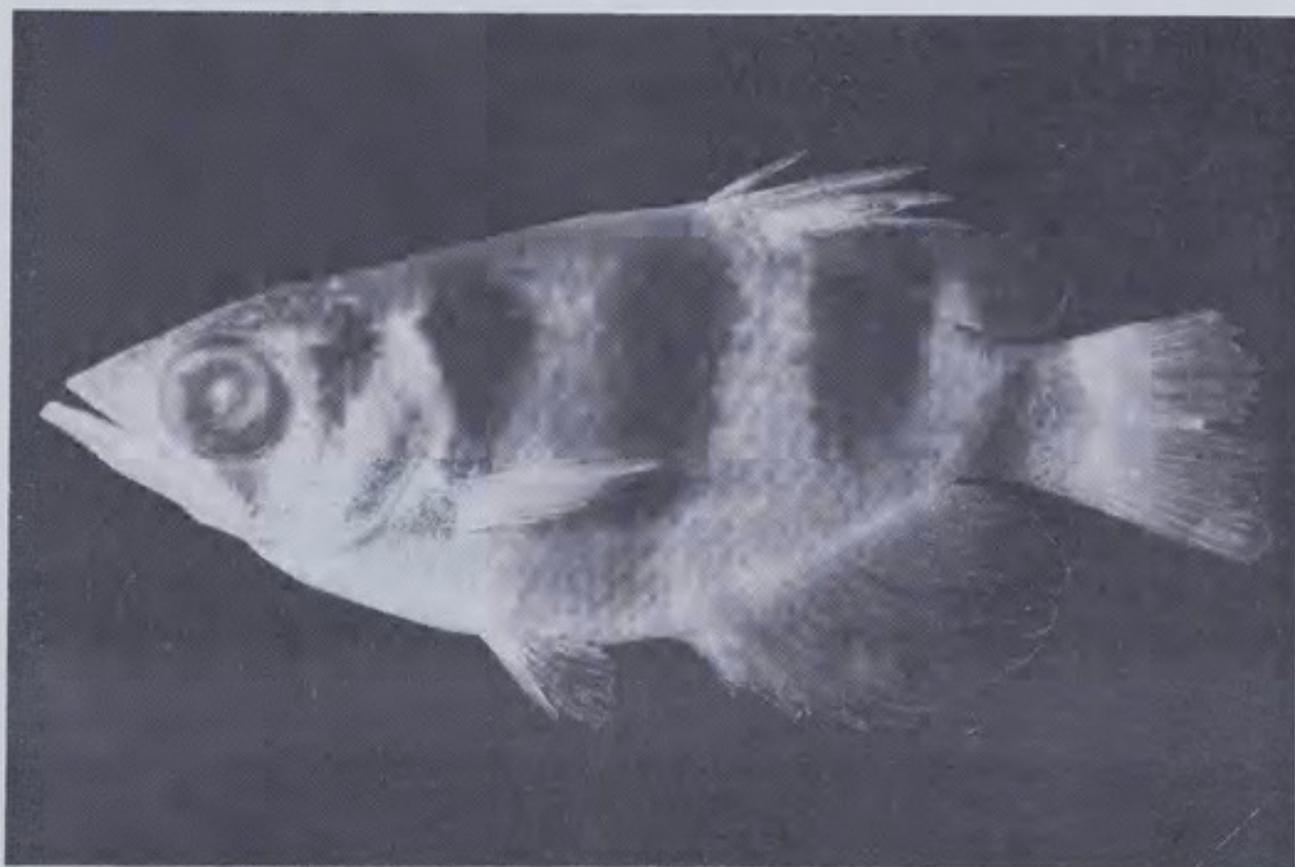


Plate 7: *Toxotes jaculator*, 33 mm SL, Cairns, Queensland.

Distribution

T. jaculator is the most widely distributed member of the family. Weber and de Beaufort (1936) recorded it from the following localities: India, Andaman Islands, Burma, Thailand, Malay Peninsula, Singapore, Vietnam, Philippine Islands, numerous localities throughout the Indonesian Archipelago, New Guinea, northern Australia (Darwin), New Britain, Woodlark Island, Admiralty Islands, Solomon Islands, and the New Hebrides. In addition, Herre (1939) recorded it from the Palau Islands.

There are relatively few specimens available from northern Australia, but I have examined several examples from the northeastern coast of Queensland between Innisfail and Cooktown. It was originally reported from Darwin by Castelnau (1873), but I am unable to verify this record. McCulloch (1929) recorded the species from northwestern Australia and Whitley (1948) also included it in his list of the fishes of Western Australia. However, these records are doubtful and are perhaps based on several old specimens at WAM which are labelled as *T. jaculator*, but were re-identified as *T. chatareus* during the present study.

Remarks

Smith (1945) provided a historical resumé of the nomenclature of *T. jaculator*. There is no type specimen, however, the original description by Pallas was accompanied by a poor, but nevertheless diagnostic illustration. Fortunately this is the only member of the family which possesses four dorsal spines, otherwise it might be confused with other *Toxotes*, particularly *T. oligolepis*.

This species inhabits mangrove estuaries and the lowermost reaches of freshwater streams. I have made collections and observations at the Palau Islands, New Guinea (Madang), Ambon, and Cairns, Australia. In most cases it was encountered in murky, brackish water in the vicinity of mangroves. However, in the Palau Islands around Koror it can be seen in relatively clear water. A series of nocturnal dives at this locality revealed that it remains stationary among dense mangrove roots at this time. During the day solitary individuals or groups of up to about 20 individuals feed continually at the surface. The adults roam considerable distances along the shore, rarely venturing out over deep water. Young fish form small aggregations around half-submerged stumps or logs, and under overhanging branches. Both juveniles and adults feed on a variety of insects and spiders which are 'shot' down or taken as they float on the surface. The stomach of a 20 cm TL specimen collected at Madang, New Guinea was packed full of flower buds and contained several small insects.

From personal experience, more than one species of *Toxotes* is rarely encountered at a given locality. However, *T. jaculator* and *T. chatareus* were collected together from mangrove creeks in the vicinity of the Admiralty Island near Cairns, Queensland.

I have examined 51 specimens, 23-159 mm SL from the Philippine and Palau Islands, Celebes, Ambon, New Guinea, Trobriand Islands, Solomon Islands, and Queensland. One of these, a specimen (DASF FOZ441) 126 mm SL, from the Trobriand Islands has an aberrant dorsal count consisting of five spines.

TOXOTES LORENTZI WEBER

(Plate 8; Tables 1 and 2)

Toxotes lorentzi Weber, 1911: 232 (type locality: freshwater pool near Merauke, South New Guinea [Irian Jaya]).

Diagnosis

Dorsal rays V,13 or 14; anal rays III,15 to 17 (usually 16); pectoral rays 14 or 15 (usually 14); scales in lateral line 39 to 47; horizontal scale rows above lateral line 7, below lateral line 12 or 13; gill rakers on lower limb of first branchial arch 2 to 4 (usually 3). Greatest body depth 2.1 to 2.5, head 2.7 to 3.2, both in standard length. Snout 3.7 to 4.1, eye 3.8 to 4.4, interorbital 3.0 to 3.8, caudal peduncle depth 2.3 to 2.5, pectoral fin length 1.7 to 1.8, pelvic fin length 1.8 to 2.1, all in head length. Fourth dorsal spine the longest, 2.0 to 2.3 in head length.

Colour in alcohol: ground colour dusky brown on back grading to yellowish on ventral surface; dorsal, anal, and caudal fins dusky; pelvic and pectoral fins yellowish.

A colour transparency of a fresh specimen taken by Mr John Lake reveals the presence of approximately 10 faint, narrow bars on the upper sides extending to slightly below the midline. The sides are silvery and the pectoral base is dark.

Distribution

T. lorentzi is known from the Merauke River and vicinity of Balimo (8°01'S, 142°57'E) in the central portion of southern New Guinea. It has also been reported from the Northern Territory, Australia at Yam Creek (Daly River system) by Whitley (1950) and at Sawcut, Deaf Adder, and Baroalba Creeks (South Alligator River system) by Pollard (1974).

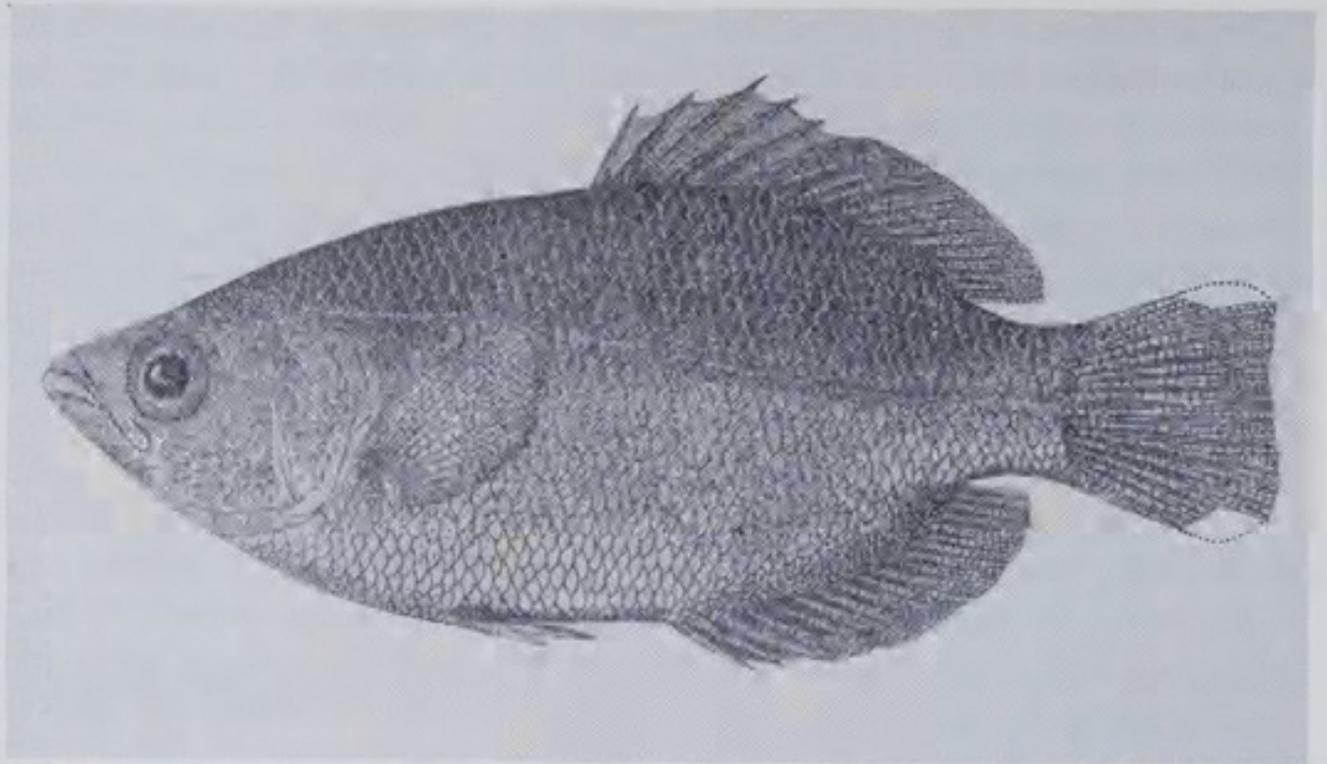


Plate 8: *Toxotes lorentzi*, approximately 77 mm SL, New Guinea (drawing from Weber and de Beaufort, 1936).

Remarks

Weber and de Beaufort (1936) and Whitley (1950) suggested that *T. lorentzi* is the most primitive species of archerfish because of its lack of distinctive markings, small scale size, straight course of the lateral line, the more anterior position of the dorsal, and the less elevated body. Furthermore, Whitley (1950) erected the genus *Protoxotes* for this species on the basis of these features. However, I agree with Taylor (1964), who regarded it as a synonym of *Toxotes*. None of the characters listed above seem to offer conclusive evidence of a more primitive state.

I have examined 13 specimens, 69-150 mm SL, including the two syntypes, 85 and 96 mm SL which are deposited at ZMA (register number 112.449). The largest syntype is here designated as the lectotype.

TOXOTES MICROLEPIS GÜNTHER

(Plate 9; Tables 1 and 2)

Toxotes microlepis Günther, 1860: 68 (type locality: Siam [Thailand]).

Diagnosis

Dorsal rays V,13 to 14; anal rays III,15 to 17; pectoral rays 13 to 15 (usually 13 or 14); scales in lateral line 42 to 45; horizontal scale rows above

lateral line 6 to 7, below lateral line 14 to 15; gill rakers on lower limb of first branchial arch 6 to 8. Greatest body depth 1.8 to 2.1, head length 2.6 to 2.8, both in standard length. Snout 3.5 to 3.8, eye 2.9 to 3.8, interorbital 3.0 to 3.2, caudal peduncle depth 2.7 to 3.0, pectoral fin length 1.4 to 1.6, pelvic fin length 1.9 to 2.1, all in head length. Fourth dorsal spine the longest, 1.4 to 1.6 in head length.

Colour in alcohol: ground colour yellowish; a series of 4 or 5 rounded dark brown spots along back from upper part of gill opening; a narrow dark bar sometimes present across caudal peduncle; dorsal fin white to yellowish except with black spot near posterior edge and a second one sometimes on anterior soft rays; remainder of fins white to yellowish except pelvics and outer edge of anal fin dusky.

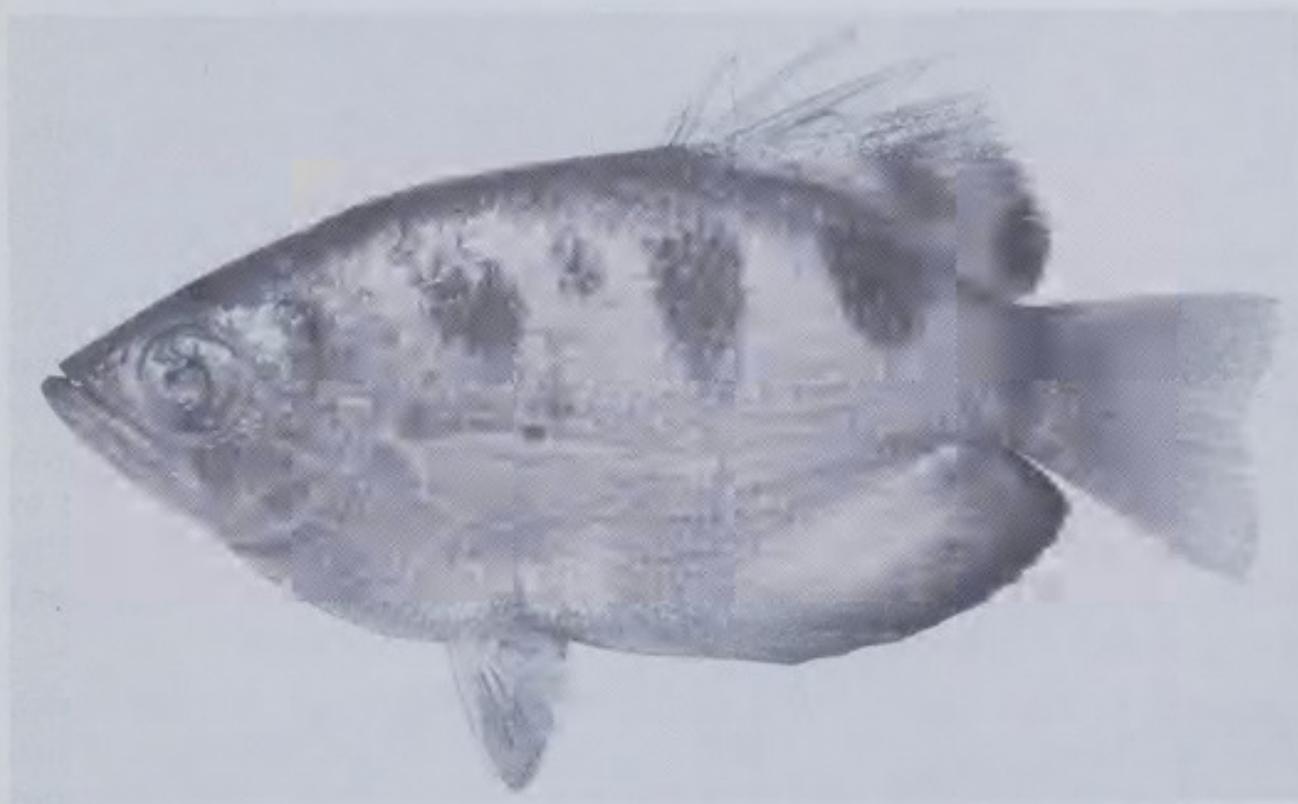


Plate 9: *Toxotes microlepis*, 120 mm SL, Borneo.

Distribution

T. microlepis has been reported from Thailand, Sumatra (near Palembang), and Borneo. Smith (1945) stated that it is a river fish in Thailand and seems to penetrate further inland than *T. jaculator* and *T. chatareus*. He reported it as being common in the lower Menam Chao Phya and also examined specimens from the Nakon Nayok, one of the tributaries of the Bangpakong. Weber and de Beaufort (1936) reported a number of Borneo localities including Bandjermasin, Tepoe, Sintang, Smitau, and Sanggan.

Remarks

The record of *T. microlepis* from Burma by Fowler and Bean (1929) is erroneous and actually refers to *T. blythi*. Day (1875) is responsible for this error as he incorrectly identified specimens of *blythi* from the Irrawaddi River as *microlepis*. The inclusion of the latter species in his monograph of Indian fishes was apparently based on surmise and is probably inaccurate. There are no further records of *microlepis* from India.

I have examined 21 specimens, 38-123 mm SL, including the three syntypes, 40-123 mm SL, which are deposited at BMNH (register number 1859.7.1.43-45). The largest is here designated as the lectotype.

TOXOTES OLIGOLEPIS BLEEKER

(Plates 10 and 11; Tables 1 and 2)

Toxotes oligolepis Bleeker, 1876: 162 (type locality: probably Buru, Molucca Islands).

Diagnosis

Dorsal rays IV or V, 12 or 13 (usually V, 12 or 13); anal rays III, 15 to 17; pectoral rays 12 to 14 (usually 13); scales in lateral line 25 to 33; horizontal scale rows above lateral line 3 or 4, below lateral line 9 or 10; gill rakers on lower limb of first branchial arch 6 to 8 (usually 7). Greatest body depth 2.0 to 2.3, head length 2.4 to 3.0, both in standard length. Snout 3.4 to 4.2, eye 3.2 to 3.8, interorbital 3.1 to 3.7, caudal peduncle depth 2.4 to 3.2, pectoral fin length 1.1 to 1.5, pelvic fin length 2.0 to 2.5, all in head length. Fourth dorsal spine the longest, 1.7 to 2.1 in head length.

Colour in alcohol: ground colour whitish to yellow, sometimes with silvery sheen, grading to brown on dorsal surface; a series of five black bars, primarily on upper sides, the last sometimes in the form of a rounded spot mid-laterally on caudal peduncle; dorsal and anal fins dusky, usually with central pale band; caudal fin pale to dusky; pelvic fins pale to slightly dusky; pectoral fins pale with uppermost rays frequently dusky.

Distribution

T. oligolepis is known from the Molucca Islands, Irian Jaya (West New Guinea), and the Fitzroy, Meda, May, and Isdell River systems of the Kimberley region, Western Australia. The only previous reliable record was that of the type (Molucca Islands, probably Buru) although, according to Weber and de Beaufort (1936), Fowler wrote to them stating there were two

specimens of *oligolepis* from New Guinea in the U.S. National Museum. However, Fowler and Bean (1929) did not list this extralimital locality in their treatment of Philippine toxotids. During the present study, however, I examined two unregistered lots at RMNH containing eight specimens, 22-93 mm SL, of *T. oligolepis* from Lake Jamoer, Irian Jaya. In addition,

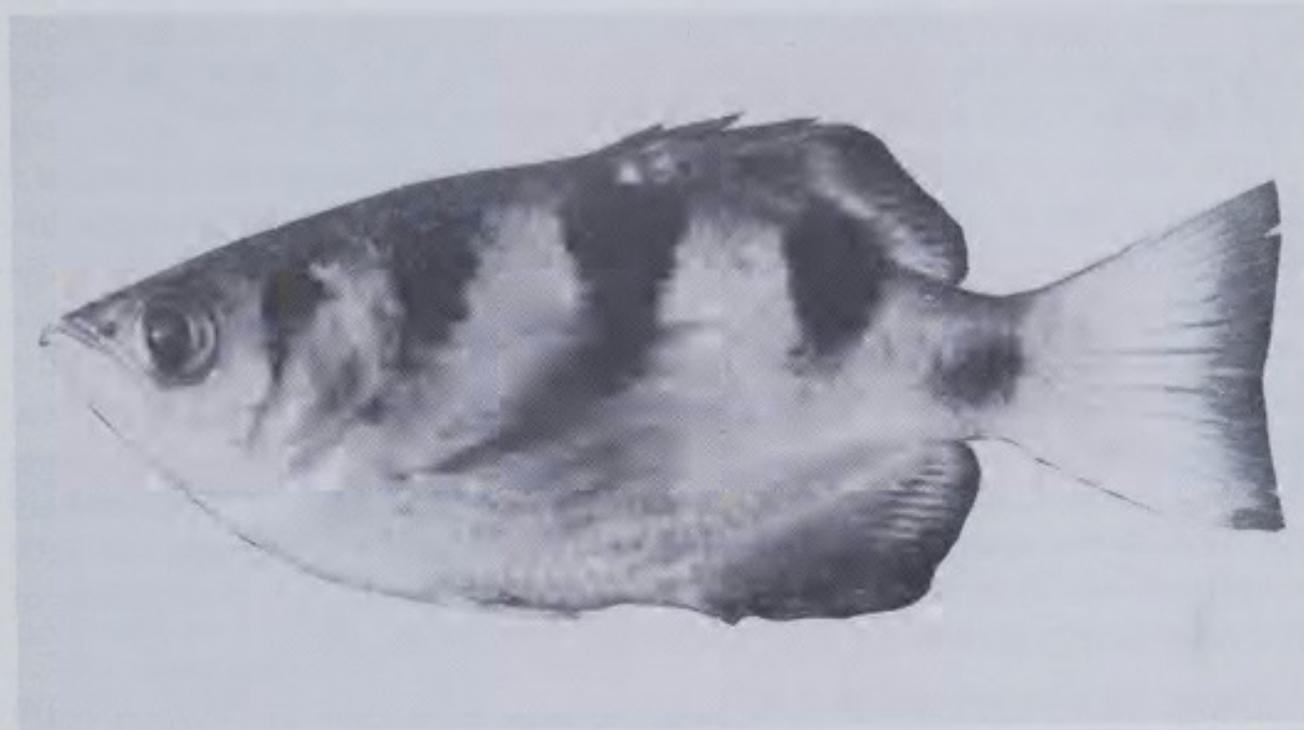


Plate 10: *Toxotes oligolepis*, 95 mm SL, Lennard River, Western Australia.

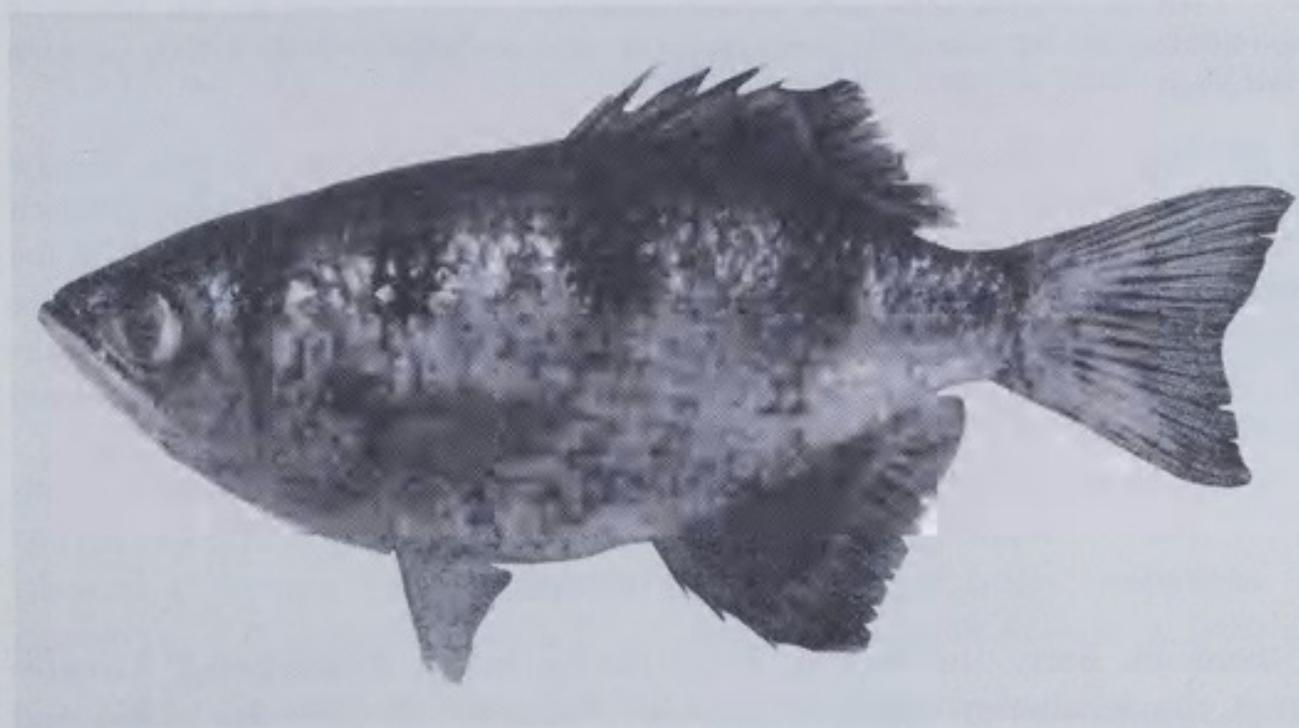


Plate 11: *Toxotes oligolepis*, 126 mm SL, Plain Creek, Western Australia.

Herre (1953) recorded this species from the Pansipit River, Batangas Province, Luzon, Philippine Islands. The specimens were collected by him during 1933-34, but I have not been able to locate them. It is possible they were deposited in the Bureau of Science Collection at Manila, which was subsequently destroyed during World War II.

Remarks

I have examined 48 specimens, 22-127 mm SL, including the type, 112 mm SL, which is deposited at RMNH (register number 5835).

The status of the Western Australian population is uncertain. There is a possibility that it may represent a distinct species or at least a subspecies. The Western Australian specimens are deeper bodied (\bar{X} = 48.5% of the standard length vs. 44% for the type) and possess a higher lateral line scale count. The type specimen has 25 lateral line scales on the right side; the left side is damaged, but counting scale pockets it appears there were approximately 28 scales. The Western Australian specimens usually have 30 or 31 scales, although the counts range between 29-33. Unfortunately the type is the only known specimen from the Molucca Islands and until more material becomes available I must reserve judgement on the status of the Australian population.

There are also differences between the populations known from Western Australia. The specimens from the Isdell system are more slender (average depth 46.7% of SL for seven specimens, 100-127 mm SL) than those from the Fitzroy, Meda, and May Rivers (average depth 50.0% of SL for nine specimens, 64-94 mm SL) and there is also a difference in colour pattern (see Plates 10 and 11).

Whitley (1950) included 'variety from Mandurah' in his key to the toxotids of Australia. I have identified the specimen (AM IB.2156) on which this entry was based as *T. oligolepis*. The specimen was received by the Australian Museum from the Western Australian Museum during the late 1800s. The locality of Mandurah, Western Australia is undoubtedly a mistake as this location, which is situated about 60 km south of Perth, lies well outside the distributional limits of *Toxotes*.

ACKNOWLEDGEMENTS

I thank Mr Barry Hutchins of WAM for his recent collections of *Toxotes* from the Kimberley region of Western Australia. Mr Hutchins' 1975 and 1976 collections and my own in this area during 1974 were made possible

because of expeditions organised by the Western Australian Department of Fisheries and Wildlife. These trips were supervised by Dr Andrew Burbidge, Director of the Wildlife Research Centre. Dr Winston Baily of the University of Western Australia assisted with the collection of specimens during 1974. I am also grateful to Drs M.L. Bauchot (MNHN), M. Boeseman (RMNH), D. Hoese (AM), H. Nijssen (ZMA), J. Paxton (AM), V. Springer (USNM), and P. Whitehead (BMNH) for allowing me to examine specimens under their care. Mrs Patricia Kailola, formerly of DASF sent a large and valuable collection of *Toxotes* from New Guinea. Finally, I thank my wife, Mrs Connie Allen, for her careful preparation of the typescript.

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