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REVIEW OF THE SHARPNOSE PUFFERFISHES (SUBFAMILY CANTHIGASTERINAE) OF THE INDO-PACIFIC

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SUMMARY

Twenty-two species of *Canthigaster* (Tetraodontidae; Canthigasterinae), including seven which are described as new, are recognized from the tropical Indo-Pacific: *C. amboinensis* (widespread Indo-Pacific), *C. bennetti* (widespread Indo-W. Pacific), *C. callisterna* (New South Wales; Lord Howe, Norfolk, and Kermadec islands; northern New Zealand), *C. compressa* (E. Indies; Melanesia; Philippine Islands), *C. coronata* (widespread Indo-W. Pacific), *C. epilampra* (W. Pacific), *C. inframacula* n. sp. (Hawaiian Islands), *C. investigatoris* (Andaman Islands), *C. jactator* (Hawaiian Islands), *C. janthinoptera* (widespread Indo-W. Pacific), *C. margaritata* (Red Sea), *C. marquesensis* n. sp. (Marquesas Islands), *C. natalensis* (Mauritius; South Africa), *C. ocellicineta* n. sp. (Melanesia; Great Barrier Reef), *C. punctatissima* (eastern Pacific), *C. pygmaea* n. sp. (Red Sea), *C. rapaensis* n. sp. (Rapa), *C. rivulata* (widespread Indo-W. Pacific), *C. smithae* n.sp. (Mauritius, and South Africa), *C. solandri* (widespread Indo-W. Pacific), *C. tyleri* n. sp. (Indian Ocean), and *C. valentini* (widespread Indo-W. Pacific). Notes are included on the ecology and distribution, and food habit data are presented for five species. Tables of meristic and morphometric characters, colour illustrations of 20 species, black-and-white photographs of three species, synonymies, and a diagnosis or description for each species are included.

INTRODUCTION

The tetraodontid subfamily Canthigasterinae is composed of the single genus, *Canthigaster*, which contains 23 species. These small (usually under 12 cm SL) fishes, commonly known as sharpnose puffers, are for the most part inhabitants of tropical reefs. The present paper deals with the taxonomy of the 22 species which inhabit the vast Indo-Pacific faunal region. Dr. James C. Tyler is investigating the systematics of the multi-patterned *C. rostratus* (Bloch) from the Atlantic Ocean. Seven species, including six which were recently collected by the authors at widely scattered localities in the Indian and Pacific Oceans, are herein described as new.

Traditionally the Canthigasteridae has been separated from the Tetraodontidae on the basis of its inconspicuous nostrils and characteristic body shape, which includes a laterally compressed form, an elongate and relatively pointed snout, and a carinate back. We supported this opinion until Dr. Tyler, who is studying the higher systematics of plectognaths, informed us of the discovery of a "missing link" of sorts between the canthigasterids and tetraodontids in the form of *Carinotetraodon somphongi* (Klausewitz),

a freshwater puffer from Thailand. This species is a tetraodontid, but bears some remarkable osteological similarities to *Canthigaster*, particularly with regards to the vertebral and caudal skeleton. Furthermore, it is the only tetraodontid, besides *Canthigaster*, which is able to erect a ridge of skin on the dorsal and ventral midline. Hence, a subfamilial ranking of the sharpnose puffers within the Tetraodontidae is suggested. This idea is also supported by Winterbottom (1974) in his myological study of the Tetraodontiformes.

The members of the group are probably better known for their general lack of characters, rather than for any distinguishing attribute. There is a monotonous sameness of external morphology from species to species, which according to Tyler (personal communication) holds true internally as well. Indeed, colour pattern differences constitute the most valuable "tool" for separating the species. Accordingly, we have illustrated all the species in colour except *C. investigatoris*, *C. punctatissima*, and *C. pygmaea*.

Contrary to the belief of some systematists, the colour pattern of Indo-Pacific species of *Canthigaster* is generally stable and is not influenced to any great extent by growth or geography. However, minor variations in the general pattern are not uncommon, and any two individuals of a given species rarely exhibit identical patterns of spots and lines. In all cases, except for *C. amboinensis* and *C. callisterna*, the juveniles (individuals less than approximately 35 mm SL) resemble the adults, although the number of spots or stripes may be reduced. Differences in fin-ray counts, interorbital width, and caudal peduncle length are useful to a lesser degree than colour.

Fraser-Brunner (1943) listed 15 species of *Canthigaster* in his generic synopsis of the Tetraodontoidea. These included *C. amboinensis*, *C. bennetti*, *C. callisternus*, *C. caudofasciatus*, *C. cinctus*, *C. compressus*, *C. janthinopterus*, *C. margaritatus*, *C. natalensis*, *C. papua*, *C. punctatissimus*, *C. rivulatus*, *C. rostratus*, *C. sancti-helenae*, and *C. valentini*. *C. sancti-helenae* is a probable synonym of *C. rostratus* from the Atlantic. The remaining Indo-Pacific species are recognized as valid in the present study except *C. caudofasciatus*, *C. cinctus*, and *C. papua* which are synonyms of *C. rivulata*, *C. coronata*, and *C. solandri* respectively.

The most recent and only noteworthy revision of *Canthigaster* is that of Le Danois (1961). However, this work cannot be seriously accepted. Only four species were recognized on the basis of the following broad colour pattern categories: (1) individuals with one or two longitudinal bands; (2) individuals with several transverse bands; (3) individuals with a large ocellus at the base of the dorsal fin; (4) individuals with spots, but without an ocellus. The valid entities within the genus are hopelessly confused under this scheme, which was also largely followed by Smith (1965).

Abe (1949) included six species in his account of the *Canthigaster* of Japan and adjacent regions. The most recent study of this group is a review of the species from Taiwan by Shen and Lim (1974). They recognize eight species, all of which are considered valid in the present study.

Canthigaster is omnivorous and feeds on a great variety of benthic organisms. Randall (1967) examined the stomach and gut contents of 26 specimens of *C. rostratus* from West Indian localities. He reported 18 different groups of food organisms, headed by marine spermatophytes (16.1% by volume) and sponges (15.0%). We present herein limited food habit data on five Indo-Pacific species: *amboinensis*, *bennetti*, *coronata*, *jactator*, and *solandri*.

Most of the species inhabit shallow water in the vicinity of coral reefs, sand flats, rubble areas, wreckage, and wharf pilings. However, at least two species, *C. epilampra* and *C. rivulata*, penetrate depths in excess of 35 fathoms, and two others, *C. inframacula* and *C. investigatoris* are known only from six specimens caught with a shrimp trawl and dredge in 55 to 86 fathoms.

Like other tetraodontids, they are capable of causing a violent form of fish poisoning if the flesh or internal organs are ingested by humans (see Halstead, 1967), or presumably by predatory fishes. *Canthigaster* also has a skin toxin which was reported by Eger and Starkus (1973). This toxin may serve as a repellent to predators. A dead adult of *C. solandri* was offered as food by J.E.R. to a 15-inch live snapper (*Lutjanus bohar*) in a tank at the Enewetak Marine Biological Laboratory. The snapper took the puffer into its mouth several times, but rejected it on each occasion. *Canthigaster* also possesses the ability to inflate its abdomen by swallowing water when frightened or injured. The above traits are probably adaptations which serve to compensate for the relatively poor swimming ability and resultant vulnerability to predation of these puffers.

C. amboinensis is the most widespread member of the genus, being distributed throughout the Indo-Pacific from East Africa to Central America. *C. coronata*, *C. rivulata*, and *C. solandri* are nearly as widespread with distributions which extend from East Africa to the Hawaiian Islands. *C. bennetti*, *C. janthinoptera*, and *C. valentini* have similar ranges, but are not found in the Hawaiian Islands. *C. epilampra* (western Pacific Ocean to the Hawaiian and Society Islands), *C. callisterna* (New South Wales, Lord Howe, Norfolk, and Kermadec Islands, and northern New Zealand), *C. compressa* (Palau Islands, Philippine Islands, East Indies, Amboina, and New Guinea), *C. natalensis* (Mauritius and southern Africa), *C. ocellicineta* (Fiji Islands, New Caledonia, Solomon Islands, and Great Barrier Reef, Philippines), *C. punctatissima* (eastern Pacific Ocean), *C. smithae* (Mauritius and South Africa), and *C. tyleri* (Maldive Islands, Grande Comore Islands, and Mauritius) are more restricted in their distributions. The remaining Indo-Pacific species, *C. inframacula* (Hawaiian Islands), *C. investigatoris* (Andaman Islands), *C. pygmaea* (Red Sea), and *C. rapaensis* (Rapa) have an apparent limited local distribution, although further collecting effort may expand their ranges.

MATERIALS AND METHODS

During the course of this study we have observed in the field, collected, and photographed in colour all the species except *C. punctatissimus* and the two deep-dwelling species, *C. investigatoris* and *C. inframaculus* (photographed only). The localities we visited include the Hawaiian Islands (G.R.A. and J.E.R.), Line Islands (J.E.R.), south-east Polynesia (J.E.R.), Marshall and Caroline Islands (G.R.A. and J.E.R.), Japan and Ryukyu Islands (J.E.R. and G.R.A.), New Guinea (G.R.A. and J.E.R.), New Britain (G.R.A. and J.E.R.), Solomon Islands (G.R.A. and J.E.R.), New Hebrides (G.R.A.), New Caledonia (G.R.A. and J.E.R.), Fiji Islands (G.R.A. and J.E.R.), eastern Australia, including Lord Howe Island (G.R.A. and J.E.R.), Mauritius (J.E.R.), Tanzania (J.E.R.), Red Sea (G.R.A. and J.E.R.), Philippines (G.R.A. and J.E.R.), Ceylon (G.R.A. and J.E.R.), Maldives (J.E.R.) and Panama (G.R.A.).

All the available *Canthigaster* were examined at the following institutions: Academy of Natural Sciences, Philadelphia (ANSP); Australian Museum, Sydney (AMS); Bernice P. Bishop Museum, Honolulu (BPBM); British Museum (Natural History), London [BM(NH)]; California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (FMNH); Museum of Comparative Zoology, Harvard University; Hebrew University of Jerusalem (HUJ); Musee d'Histoire Naturelle, Paris (MNHN); Rijksmuseum van Natuurlijke Historie, Leiden (RMNH); Senckenberg Museum, Frankfurt (SMF); United States National Museum of Natural History, Washington, D.C. (USNM); Zoological Museum, Amsterdam; Zoological Museum, University of Copenhagen. In addition, loan material was provided by the J.L.B. Smith Institute of Ichthyology of Rhodes University, South Africa (RUSI), the Western Australian Museum, Perth (WAM), and the Zoological Survey of India, Calcutta (ZSI).

Preserved specimens of *Canthigaster* are particularly susceptible to distortion because of the distensible skin and lack of scales. Therefore the range of body proportions given in the species accounts below are considerably variable. The peculiar morphology of *Canthigaster* necessitates the definition of certain measurements as follows (from Tyler, 1967): head length is measured from the tip of the upper jaw (the tip of the exposed dental plates) to the upper edge of the gill opening; eye diameter is the greatest diameter of unpigmented skin over the eye; postorbital length is measured from the upper edge of the gill opening to the closest point of unpigmented skin over the eye; interorbital width is the least width of the bony interorbital as measured externally through the skin; depth of body is the slightly oblique measurement from the origin of the dorsal fin to origin of anal fin; body width is measured at the level of the pectoral fin base; caudal peduncle depth is the least depth; caudal peduncle length is measured obliquely from the base of the middle caudal rays (indicated by line of flexure) to the base of the posteriormost anal rays.

GENERIC ACCOUNT

Genus **Canthigaster**

Canthigaster Swainson, 1893: 194 (type species, *Tetrodon rostratus* Bloch by subsequent designation of Swain, 1882).

Pilonotus Swainson, 1839: 328 (type species, *Tetrodon rostratus* Bloch by subsequent designation of Swain, 1882).

Tropidichthys Bleeker, 1854: 500 (type species, *Tetraodon valentini* Bleeker by subsequent designation of Jordan, 1919).

Anosmius Peters, 1855: 274 (type species, *Tetrodon (Anosmius) taeniatus* Peters, by original designation = *Tetraodon valentini* Bleeker).

Rhynchotus Bibron, in Dumeril, 1855: 280 (type species, *Tetrodon gronovii* Cuvier [nomen nudum] by original designation).

Eumycterias Jenkins, 1901: 399 (type species, *Eumycterias bitaeniatus* Jenkins by original designation = *Tetraodon rivulatus* Schlegel).

Lucubrapiscus Whitley, 1931: 334 (type species, *Eumycterias bitaeniatus* Jenkins by original designation).

DIAGNOSIS: Dorsal rays 8 to 12 (most species with 9 or 10); anal rays 8 to 11 (usually 9); pectoral rays 14 to 18 (usually 16 or 17); vertebrae 17 (8 + 9).

Body depth 2.1 to 3.2, head length 2.1 to 2.9, tip of snout to dorsal origin 1.2 to 1.5, to anal origin 1.1 to 1.4, all in the standard length. Snout length 1.3 to 1.8, postorbital length of head 3.5 to 5.0, eye diameter 3.3 to 5.9, interorbital width 2.8 to 5.3, depth of caudal peduncle 1.7 to 2.9, length of caudal peduncle 1.4 to 2.6, middle caudal rays 1.1 to 1.6, all in the head length.

Body moderately compressed; snout long, conical; back with a movable ridge of skin on mid-dorsal line; ventral profile of body varying from nearly straight to convex; caudal peduncle strongly compressed, tapering in width towards caudal fin base; dental plates strong, convex, divided at symphysis; a single inconspicuous nostril on each side of snout; interorbital flattened; pectoral fin broad with short rays; dorsal and anal fins slightly rounded; caudal fin truncate or slightly convex; pelvic fins absent; head and body with scattered tiny prickles (more evident when inflated).

KEY TO THE INDO-PACIFIC SPECIES OF *CANTHIGASTER*

- | | |
|---|----------------------------------|
| 1. Dorsal rays usually 11 or 12 | 2 |
| — Dorsal rays usually 8 to 10..... | 5 |
| 2. Anal rays usually 11 (occasionally 10); caudal fin brownish with or without pale spots, but never with cross-bands | 3 |
| — Anal rays usually 9 or 10; caudal fin pale with prominent to faint cross-bands | 4 |
| 3. Dorsal rays usually 12; interorbital without dark cross-bands; pale spots on caudal fin absent (Indo-Pacific, including eastern Pacific) | <i>amboinensis</i> (p.499) |
| — Dorsal rays usually 11; interorbital with dark cross-bands; pale spots (faint in preservative) on basal half of caudal fin (Mauritius, Reunion, southern coast of East Africa) | <i>natalensis</i> (p.500) |
| 4. Narrow dark brown lines present on interorbital and top of snout, becoming more numerous and irregular shaped with growth; subadults (below 50-60 mm SL) with white longitudinal band (about pupil width or slightly larger in diameter) extending from lower corner of mouth to base of caudal fin; upper and lower caudal fin margins dark; large dark blotch at base of dorsal fin absent; body depth 2.8 to 3.2 in SL; maximum size about 225 mm SL (New South Wales, Lord Howe, Norfolk, and Kermadec Islands, northern New Zealand)..... | <i>callisterna</i> (p.494) |
| — Narrow dark brown lines absent on interorbital and top of snout; subadults and adults without white longitudinal band on sides; caudal fin margins pale; large dark blotch present at base of dorsal fin; body depth 2.5 to 2.8 in SL; maximum size about 100 mm SL (this species also appears in Section 8 of key) (Rapa) | <i>rapaensis</i> n. sp.(p.492) |
| 5. Caudal fin with pattern of spots or vertical lines (sometimes wavy or broken) | 6 |
| — Caudal fin without spots or vertical lines | 12 |
| 6. Middle of side without two prominent dark bars extending to belly region | 7 |
| — Middle of side with two prominent dark bars extending to belly region (this unusual colour form exhibiting spotted caudal fin known only from Mauritius) | <i>valentini</i> (p.484) |
| 7. Lower sides of body (below and slightly behind pectoral fin) with a large dark spot, equal in size or larger than eye; black stripe, about equal in width or slightly less than eye diameter, extending from behind eye to upper caudal peduncle (sometimes faded in large adults) (Hawaiian Islands, 68 to 86 fathoms)..... | <i>inframacula</i> n. sp.(p.493) |
| — Lower sides of body without large dark spot; black stripe behind eye absent | 8 |
| 8. Predorsal region (including snout and interorbital) with pattern of either spots, stripes, wavy lines, transverse bands or combination of these; caudal fin with distinct or faint spots or with faint rows of vertical, wavy lines; dorsal rays usually 8 or 9 (occasionally 10) | 9 |
| — Predorsal region uniform brownish without pattern of spots, stripes, wavy lines, or transverse bars; caudal fin pale with 6 to 8 prominent, broken cross-bands; dorsal rays 10 or 11 (Rapa) | <i>rapaensis</i> n. sp.(p.492) |
| 9. Caudal fin with round spots (may be faint, especially in preservative); body with uniform spotting, except on ventral surface..... | 10 |
| — Caudal fin with series of faint, narrow undulating lines (sometimes broken); body covered with maze of blue, brown, or reddish undulating lines (Palau Islands, Philippine Islands, E. Indies; New Guinea, Solomon Islands, New Hebrides, Taiwan.) | <i>compressa</i> (p.483) |

10. Dorsal rays usually 9 or 10; anal rays usually 9; horizontal rows of spots on caudal peduncle usually greater than 10 (at least in specimens over 50 mm SL) 11
 — Dorsal and anal rays usually 8; horizontal rows of spots on caudal peduncle less than 10 (Red Sea) *margaritata* (p.481)
11. Caudal fin uniformly covered with distinct round spots; head usually with about 8 to 10 dark lines radiating from eye; cross-bands usually present on interorbital and upper portion of snout (Indo-W. Pacific, including Hawaiian Islands) *solandri* (p.479)
 — Caudal fin with faint round spots (at least in preservative), particularly apparent on basal portion; head usually lacking lines which radiate from eye; interorbital and upper portion of snout covered with small pale spots (tropical eastern Pacific) *punctatissima* (p.494)
12. Upper portion of head and body with 2 to 4 dark bars, wider than pale interspaces 13
 — Upper portion of head and body without dark bars 15
13. Upper portion of head and body with 4 dark bars, those of head and upper caudal peduncle forming abbreviated saddles; no ocellus at base of dorsal fin 14
 — Upper portion of sides with 2 dark bars; saddles on head and caudal peduncle absent; ocellus present at base of dorsal fin (Solomon Islands, Fiji Islands, New Caledonia, Great Barrier Reef) *ocellicincta* n. sp. (p.483)
14. First 2 bars of body with narrow extensions continuing below middle of sides; bar on head largely posterior to interorbital space; dorsal rays usually 9 (see couplet 6 also) (Indo-W. Pacific) *valentini* (p.482)
 — First 2 bars of body terminate at about middle of sides; bar on head largely confined to interorbital space; dorsal rays usually 10 (Indo-W. Pacific, including Red Sea and Hawaiian Islands) *coronata* (p.484)
15. Side of body with 1 or 2 dark longitudinal bands (sometimes fragmented) extending along side of body 16
 — Side of body without longitudinal bands 18
16. Upper back more or less uniform brown; anal rays 9; sides with 1 or 2 longitudinal bands 17
 — Upper back with brown vermiculated pattern; anal rays usually 10; side of body with 2 longitudinal and parallel bands, joining to form arc in front of gill opening (Indo-W. Pacific, including Hawaiian Islands) *rivulata* (p.490)
17. Side of body with a single dark longitudinal band extending from pectoral fin to caudal peduncle region, about equal to eye diameter in width (Marquesas Islands) *marquesensis* n. sp. (p.485)
 — Side of body with 2 dark bands, each less than pupil width, placed approximately at level of upper and lowermost ends of pectoral base, extending from anterior part of head to caudal base; bands sometimes fragmented or missing entirely (see 24 below) (south-western Indian Ocean, including Mauritius and South Africa) *smithi* n. sp. (p.487)
18. Body with uniform pattern of rounded spots, either whitish, bluish, brown or grey in colour, the largest at least 1/3 to 1/2 pupil size; dorsal portion of body usually same colour as sides; dorsal and anal rays usually 9 19

- Body without uniform pattern of rounded spots; dorsal portion of body usually darker than adjacent region on sides; dorsal rays 9 or 10; anal rays usually 9. 22
- 19. Pectoral rays usually 17 (occasionally 16); spots relatively close-set, usually more than 15 on side of caudal peduncle; maximum size at least 60 mm SL 20
- Pectoral rays usually 15; spots relatively scattered, usually less than 10 on side of caudal peduncle; maximum size only 40-45 mm SL (Red Sea). *pygmaea* n. sp. (p.496)
- 20. Spots on head and body mostly pale; ground colour brown 21
- Spots on head and body mostly pale; ground colour yellowish-tan (Indonesia and Indian Ocean, including Maldive Islands, Comoro Islands and Mauritius) *tyleri* n. sp. (p.495)
- 21. Usually more than 12 pale spots in an approximate vertical row from dorsal fin origin to anal fin origin; lines radiating from eye frequently present; dark spot or ocellus (sometimes only partially developed) frequently present at base of dorsal fin (Indo-W. Pacific) *janthinoptera* (p.493)
- Usually less than 10 pale spots in an approximate vertical row from dorsal origin to anal fin origin; lines radiating from eye absent; dark spot or ocellus at base of dorsal fin absent (Hawaiian Islands) *jactator* (p.494)
- 22. Pectoral rays 15 or 16 23
- Pectoral rays usually 17 (rarely 16) 24
- 23. Pectoral rays 15 or 16; dorsal rays 9 or 10; body depth 2.6 to 3.2 in SL (usually greater than 2.8); less than 30 small brown dots on side of caudal peduncle; dark spot or ocellus present at dorsal fin base (Indo-W. Pacific). *bennetti* (p.486)
- Pectoral rays 15; dorsal rays 9 or 10; body depth about 2.8; spots on side of caudal peduncle and ocellus at dorsal fin base absent (Andaman Islands, 55 fathoms) *investigatoris* (p.499)
- 24. Prominent dark brown blotch about 2 to 3 times size of eye, usually present at base of dorsal fin; several horizontal dark bands at caudal base slanting towards middle of fin; upper and lower margins of caudal fin pale (W. Pacific, including Hawaiian Islands) *epilampra* (p.489)
- Prominent dark brown blotch at base of dorsal fin absent; horizontal dark bands at caudal base absent; upper and lower margins of caudal fin dark (south-western Indian Ocean, including Mauritius and South Africa) *smithae* n. sp. (p.487)

SPECIES ACCOUNTS

Canthigaster solandri (Richardson)

Fig. 1A, B, C.

Tetraodon solandri Richardson, 1844: 125, pl. 57, figs. 4-6 (type locality, Polynesia).*Tetraodon papua* Bleeker, 1848: 638 (type locality, East Indian Archipelago).*Tetrodon petersii* Bianconi, 1855: 147, pl. 2, fig. 2 (type locality, Mozambique).*Canthigaster australis* Stead, 1907: 7, pl. II (type locality, Suwarow Island).*Canthigaster glaucospilotus* Fowler, 1944: 185, figs. 33 and 34 (type locality, New Hebrides).*Canthigaster saipanensis* Fowler, 1945: 73, fig. 18 (type locality, Saipan, Mariana Islands).

DIAGNOSIS: Dorsal rays 8 to 10 (usually 9); anal rays 8 to 10 (usually 9); pectoral rays 15 to 18 (usually 17).

Depth 2.1 to 2.7, head length 2.3 to 2.7, tip of snout to dorsal origin 1.2 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.3 to 1.5, postorbital length of head 3.6 to 4.5, eye 4.1 to 5.3, interorbital 2.9 to 4.6, depth of caudal peduncle 1.7 to 2.2, length of caudal peduncle 1.7 to 2.4, of middle caudal rays 1.1 to 1.5, all in head length.

Colour in alcohol reddish brown with numerous blue-white to greyish spots; darkish blotch or ocellus usually present at base of dorsal fin; ventral surface of body tan to pale brown without spots; head usually with about 8 to 10 dark lines radiating from eye, the continuations of which usually form cross-bands on the interorbital and upper portion of snout; lower portion of side of head with bluish to grey spots about equal to or smaller than pupil size in diameter; area immediately below eye sometimes with fine brown speckling which grades into larger spots below, tip of snout whitish; dorsal, anal, and pectoral rays with fine dark borders, remainder of ray and fin membranes transparent or yellowish; caudal fin red-brown to tan with bluish or reddish spots, the outer rows of which may be fused into irregular bars.

REMARKS: The differences between *C. solandri* and the closely related *C. margaritata* from the Red Sea are discussed under the remarks section for the latter species.

There is considerable variation in the size and number of spots in this widespread species. Juvenile specimens from Oceania (Fig. 1A) and both juveniles and adults from the western Indian Ocean generally have larger and fewer spots. Adults from Oceania (Fig. 1B) frequently exhibit spots which are relatively small and very numerous. The pattern of lines which radiate out from the eye is also variable; a few specimens lack these lines entirely. Occasionally the spots on the upper part of the back coalesce to form narrow stripes. These are often well developed in adult specimens ("papua" variety) from the Palau and Philippine Islands, Indonesia, and western Melanesia. In addition, the ground colour of the "papua" form is frequently darker than individuals from other localities. This variety is shown in Fig. 1C. A specimen, 84 mm SL, collected by J.E.R. at Mauritius has the upper back covered with narrow pale stripes, similar to those found in the "papua" form. In addition, the three outermost rows of spots on the posterior margin of the caudal fin coalesce to form wavy lines.

The type of *solandri* [BM(NH) 1858.6.61], a specimen 42.1 mm SL from Polynesia was examined by J.E.R.

We have examined 176 specimens, 9.5 to 84.6 mm SL from various Indo-W. Pacific localities including the Hawaiian Islands, Society Islands, Tuamotu Archipelago, Samoa Islands, Fiji Islands, Mariana Islands, Caroline Islands, New Guinea, Philippine Islands, East Indies, India, Ceylon, Seychelles Islands, Kenya, Mozambique, and South Africa. All of these localities have been reported previously by De Beaufort and Briggs (1962) as *C. margaritatus*, along with others such as Thornton Island, Phoenix Islands, Rotuma, Ellice Islands, New Britain, Palau Islands, China, Muscat, Aden, Madagascar, and Zanzibar. Smith and Smith (1963) listed it from Seychelles Islands. Shen and Lim (1974) reported it from Taiwan. In addition, specimens have been examined from the Line Islands, Austral Islands, Cook Islands, Tonga Islands, Marshall Islands, Gilbert Islands, Solomon Islands, Malacca Strait, and Mauritius which constitute new records for these areas. *C. solandri* is represented from Hawaii by only two specimens, one collected by J. W. Thompson sometime during the first quarter of this century, and the other by the junior author and his wife in 1956. At other localities visited by the authors *solandri* was generally the most common species of the genus on shallow rocky bottom, coral reefs, wharf pilings, etc. Our specimens have been collected in the depth range of one to 16 metres.

An analysis of the stomach and gut contents of eight specimens (60-77 mm SL) from five stations at Enewetak revealed 58.4% algae (mixed with detritus), 16.8% tunicates (mostly didemnids), 11.1% coral, 3.6% foraminifera, 1.8% bryozoans, 1.6% crabs, 1.4% ophuroids, 1.3% gastropods, 1.2% sponge, 0.8% polychaetes, and 2.0% unidentified.

Canthigaster margaritata (Ruppell)

Fig. 2A

Tetraodon margaritatus Ruppell, 1828: 66 (type locality, Red Sea).

DIAGNOSIS: Dorsal rays 8 or 9 (usually 8); anal rays 8 or 9 (usually 8); pectoral rays 16 to 18 (usually 17).

Depth 2.5 to 3.0, head length 2.2 to 2.5, tip of snout to dorsal origin 1.3, to anal origin 1.2 to 1.4, all in standard length. Snout 1.4 to 1.6, postorbital length of head 3.5 to 5.0, eye 4.0 to 5.9, interorbital 3.9 to 4.8, depth of caudal peduncle 2.2 to 2.9, length of caudal peduncle 1.9 to 2.6, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol reddish-brown with numerous whitish to greyish spots about size of pupil or smaller; ventral surface tan or light brown without spots; ocellus at base of dorsal fin weakly developed; head usually with about 6 to 10 dark lines radiating from eye; interorbital and tip of snout usually with combination of thin dark cross-bands and small brownish dots (difficult to detect in some preserved material); tip of snout tan; dorsal, anal, and pectoral rays light brown or dusky with fine dark borders; membranes transparent or yellowish; caudal fin reddish-brown with pale spots, the outer rows of which may be partially or completely fused into bars.

REMARKS: This species is closely related to *C. solandri* of the Indo-Pacific. However, there are good differences for separating the two. *C. margaritata* is the only member of the genus usually having 8 dorsal and anal rays. It is further separable from *solandri* by being less deep-bodied (Fig. 8) and by having generally fewer and larger spots on the body. In addition, the lines which radiate from the eye and the cross-bands on the interorbital are not as well developed as in *solandri*, sometimes scarcely apparent, at least in preserved specimens.

According to Dr. W. Klausewitz (personal communication) of SMF, the type specimen has been lost since at least 1852 when Ruppell published his "verzeichnis".

We have examined 35 specimens, 39.2 to 89.0 mm SL, from the Red Sea, the only known locality.

Canthigaster compressa (Marion de Procé)

Fig. 2B

Tetrodon compressus Marion de Procé, 1822: 130 (type locality, Manila, Philippine Islands).

Tetraodon striolatus Quoy and Gaimard, 1824: 203 (type locality, Timor).

Tetraodon insignitus Richardson, 1848: 20, pl. 9, fig. 1-2 (type locality, Sea of China).

DIAGNOSIS: Dorsal rays 8 to 10 (usually 9); anal rays 8 or 9 (usually 9); pectoral rays 15 to 18.

Depth 2.4 to 3.1, head length 2.4 to 2.6, tip of snout to dorsal origin 1.2 to 1.3, to anal origin 1.2 to 1.3, all in standard length. Snout 1.4 to 1.6, postorbital length of head 3.7 to 5.0, eye 4.4 to 5.5, interorbital 2.9 to 3.8, depth of caudal peduncle 2.0 to 2.4, length of caudal peduncle 1.7 to 2.3, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol generally red-brown dorsally, pale ventrally; sides covered with maze of irregular reddish lines; cheek with dense network of small spots; dorsal portion of snout with series of dark cross-bands, breaking up into irregular pattern on interorbital or immediately behind; eye with radiating dark lines continuous with cross-bars of snout; dorsal portion of body from orbits to upper caudal base with vermiculating dark stripes; prominent ocellus at base of dorsal fin; scattered brown spots on abdomen; midline of abdomen with brown stripe extending to anus; dorsal, anal, and pectoral fins pale; caudal fin covered with combination of spots and vertical wavy lines.

REMARKS: This species was observed by the authors at Madang and Samarai, New Guinea, and Guadalcanal, Solomon Islands. In these areas the fish were found chiefly around wharf pilings in silty harbours.

C. compressa is closely related to *C. solandri*. We separate the two principally by colour. Individuals of *solandri* were also present on the wharf pilings at Madang and Samarai, thus affording an opportunity for direct underwater comparison. The two species were usually seen in conspecific pairs or trios. Occasional agonistic chasing was observed when the two species encountered one another. On the other hand, conspecific agonistic behaviour was minimal.

Apparently there are no type specimens in existence. Marion de Procé (1822) stated that most of the specimens were destroyed before being sent to Europe during a revolt which took place in Manila. M. L. Bauchot (personal communication) stated there are no types at MNHN.

We have examined 107 specimens, 11.8 to 86.9 mm SL, from Palau Islands, Solomon Islands, New Guinea, Ambon, Borneo, and the Philippine Islands. De Beaufort and Briggs (1962) reported these areas, except Palau and Borneo, along with several Indonesian localities and New Hebrides. The records from Fiji and Hawaiian Islands listed by these authors are doubtful. In addition, it was recorded from Taiwan by Shen and Lim (1974).

***Canthigaster valentini* (Bleeker)**

Fig. 3A

Tetraodon gronovii Cuvier, 1829: 369 (nomen nudum).

Tetraodon Valentini Bleeker, 1953: 130 (type locality, Amboina).

Tetrodon (Anosmius) taeniatus Peters, 1855: 275 (type locality, Mozambique).

Rhynchotus laterofasciatus Bibron, in Dumeril, 1855: 282 (nomen nudum).

DIAGNOSIS: Dorsal rays 9; anal rays 9; pectoral rays 16 or 17 (usually 16).

Depth 2.5 to 2.9, head length 2.2 to 2.5, tip of snout to dorsal origin 1.2 to 1.3, to anal origin 1.2 to 1.4, all in standard length. Snout 1.4 to 1.6, postorbital length of head 4.2 to 5.0, eye 3.5 to 5.0, interorbital 2.8 to 4.2, depth of caudal peduncle 2.2 to 2.8, length of caudal peduncle 1.7 to 2.5, of middle caudal rays 1.4 to 1.5, all in head length.

Colour in alcohol pale tan or yellowish with four broad brownish or blackish bars (anteriormost bar connects rear portion of each eye, the two middle bars extend from mid-dorsal region to abdomen, posteriormost bar covers dorsal portion of caudal peduncle); pale portion of head and sides covered with numerous brown dots; usually 5 to 7 dark lines radiating from eye; fins pale except basal portion of upper and lower caudal fin margins, which are sometimes brownish. Small specimens tend to have fewer brown dots on the side of the head and body. A specimen, 82 mm SL, collected by J.E.R. at Mauritius has spots on the caudal fin.

REMARKS: Tyler (1967) clarified the taxonomy of the transversely barred species of *Canthigaster* (*coronata* and *valentini*). Previous to his work the name *cinctus* was sometimes applied to this species (Tanaka, 1912; McCulloch, 1912; Clark and Gohar, 1953; Randall and Randall, 1960; Marshall, 1964), as well as to *C. coronata*, the other barred species. The primary differences between *valentini* and *coronata* are colour pattern (refer to key) and dorsal and pectoral ray counts (Table 1). However, Tyler (1967) provides evidence for an increase in the number of fin rays with increased growth. He feels the modal difference in the counts may not be significant due to the larger average size (hence, higher counts) of *C. coronata* specimens. Tyler also found a significant difference in the interorbital width. The average interorbital width of 69 specimens of *C. valentini* he examined was 11.1% of the standard length, while that of eight specimens of *C. coronata* was 9.3% of the standard length. We examined 16 specimens of *C. coronata* which had an average interorbital width of 9.0% of the standard length.

The type of *valentini* appears to be lost. Tyler (1967) searched for it without success in several European museums including RMNH, where many of the Bleeker types are deposited. He concluded that the type specimen is either missing or its total length was not accurately reported by Bleeker. Three specimens (approximately 27-65 mm SL) catalogued under MNHN 219 and 2306 are registered as types, but the validity of this designation is doubtful.

We have examined 59 specimens, 13.2 to 67.8 mm SL from the Tuamotu Archipelago, Mariana Islands, Palau Islands, Ryukyu Islands, New Britain, Solomon Islands, Fiji Islands, Queensland, New South Wales, Lord Howe Island, and Muscat, Arabia. The following localities were previously listed by Tyler (1967): Tuamotu Islands, Caroline Islands, Mariana Islands, New Hebrides, Queensland, Bonin Islands, Japan, South Vietnam, Philippine Islands, Indonesia, Seychelles Islands, and Amirantes, Comoro Islands, Mauritius, Madagascar, Zanzibar, Mozambique, and South Africa. The largest specimen he examined measured 80.3 mm SL, from Mauritius. Shen and Lim (1974) recorded the species from Taiwan and R. H. Kuiter (personal communication) has taken it at Sydney, Australia.

C. valentini is one of the more common members of the genus. It occurs on coral reefs to depths of at least 20 metres.

The remarkable case of mimicry of *C. valentini* by the filefish *Paraluteres prionurus* has been described by several authors (Clark, 1951; Clark and Gohar, 1953; Randall and Randall, 1960; Tyler, 1966). The colour pattern and general body shape of *P. prionurus* is virtually identical to *C. valentini*. It is difficult to differentiate the two in the field, but they are readily separated in the laboratory. *P. prionurus* has a well developed dorsal spine, 26-27 dorsal fin rays, 23-24 anal fin rays, 11 pectoral rays and 12 caudal fin rays. Apparently the less abundant and relatively defenseless *Paraluteres* mimics *C. valentini* because of the latter's toxicity, thus enabling it to enjoy some freedom from predation.

***Canthigaster ocellicincta* n. sp.**

Fig. 3B; Table 2

HOLOTYPE: BPBM 15933, 50.1 mm SL, collected with rotenone off Tanavulu Point near entrance to Sandfly Passage, Florida Island, Solomon Islands, in 20-30 metres by G. Allen and J. Randall on 30 July 1973.

PARATYPES: AMS I.17500-001, 42.3 mm SL, same data as holotype; BPBM 18378, 2 specimens, 37.0 and 50.0 mm SL, collected with spear off east side of Mactan Island, Cebu, Philippine Islands in 43-53 metres by J. Randall on 27 June 1975; MNHN 1975-2, 35.7 mm SL, collected at New Caledonia in 1973, remaining data unavailable; USNM 211299, 33.4 mm SL,

same data as holotype; WAM P25283-004, 28.0 mm SL, collected off entrance to Suva Harbour, Viti Levu, Fiji Islands in 30 metres by B. Carlson, B. Goldman, and B. Russell on 10 July 1974.

DESCRIPTION: See Table 2 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 9; anal rays 9; pectoral rays 16.

Depth 2.6 (2.5 to 3.0), greatest body width 4.2 (4.0 to 4.5), head length 2.3 (2.1 to 2.4), distance from tip of snout to dorsal origin 1.3, to anal origin 1.3, all in standard length. Snout length 1.6 (1.5 to 1.8), eye diameter 4.1 (3.2 to 3.7), postorbital length of head 5.4 (4.4 to 5.9), least width of interorbital 3.4 (3.4 to 4.6), least depth of caudal peduncle 2.1 (2.3 to 3.1), length of caudal peduncle 2.2 (2.0 to 2.7), of dorsal fin base 5.1 (4.7 to 6.7), of anal fin base 5.4 (5.3 to 8.0), of longest dorsal ray 2.7 (2.5 to 2.8), of longest anal ray 3.2 (3.0 to 3.4), of longest pectoral ray 3.2 (2.7 to 3.3), of middle caudal rays 1.2 (1.2 to 1.3), all in head length.

Colour of holotype in alcohol: Ground colour of head and body tan; side of head with series of 8-9 faint stripes (blue in life), those on snout forming narrow lines confluent dorsally with those of opposite side; six narrow brown lines across interorbital; two brownish bars with intermediate whitish area between posterior portion of head and level of dorsal fin origin; narrow whitish margin on front of anteriormost bar; two pale brown stripes extending obliquely downwards from base of uppermost caudal rays to level of posteriormost dorsal ray; posterior portion of body and caudal peduncle with 5-6 horizontal rows of faint (bluish in life) spots; dark brown ocellus at base of dorsal fin; diffuse brown mid-ventral stripe from anus to level of pectoral base; fins translucent with rays thinly outlined with dark pigment.

The paratypes are similar in colouration except the two bars on the middle of the sides are darker.

REMARKS: *C. ocellincta* is most closely related to *C. valentini*, differing primarily with regards to colour pattern. The former species lacks dark saddles on the postorbital and upper caudal peduncle which are characteristic for *C. valentini*. In addition, the configuration of the dark bars and presence of an ocellus at the base of the dorsal fin of *ocellincta* are particularly diagnostic. See Figs. 3A and B for further colour comparisons.

Three of the type specimens were collected from a narrow ravine on the steep seaward slope off the northern end of Florida Island, Solomon Islands. The species also occurs at New Caledonia, Fiji Islands, and One Tree Island, Capricorn Group, Great Barrier Reef. Mr. Rudie Kuiter provided the authors with a colour transparency of a live aquarium specimen, approximately 20 mm SL, collected in 25 metres at One Tree Island.

Named *ocellincta* in reference to the characteristic colour pattern.

Canthigaster coronata (Vaillant and Sauvage)

Fig. 3C

Tetraodon (Anosmius) coronatus Vaillant and Sauvage, 1875: 286 (type locality, Hawaiian Islands).

Canthigaster cinctus Jordan and Evermann, 1905: 433, pl. 73 (type locality, Hawaiian Islands).

Canthigaster axiologus Whitley, 1931: 333 (substitute name for *cinctus* McCulloch, 1922).

DIAGNOSIS: Dorsal rays 9 or 10 (usually 10); anal rays 9 or 10 (usually 9); pectoral rays 16 or 17 (usually 17).

Depth 2.6 to 2.9; head length 2.2 to 2.6, tip of snout to dorsal origin 1.2 to 1.3, to anal origin 1.2 to 1.3, all in standard length. Snout 1.4 to 1.8, postorbital length of head 3.8 to 4.9, eye 4.1 to 4.9, interorbital 3.9 to 5.3, depth of caudal peduncle 2.2 to 2.9, length of caudal peduncle 1.8 to 2.1, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol pale tan or yellowish with four blackish or dark brown bars (anteriormost bar connects eyes and covers most of interorbital region; The two middle bars extend from mid-dorsal region to middle of sides, posteriormost bar covers dorsal portion of caudal peduncle); pale portion of head and sides with numerous brown dots (may be whitish on some specimens); usually 5 to 10 dark lines radiating from eye; fins pale except basal portion of upper and lower caudal fin margins, which may be brownish.

REMARKS: Tyler (1967) showed that the name *coronata* proposed by Vaillant and Sauvage (1875) precedes the name *cinctus*, which has been used by many authors (Jordan and Evermann, 1905; Jordan and Seale, 1906; McCulloch, 1922; McCulloch and Whitely, 1925; Gosline and Brock, 1960; Marshall, 1964; McKay, 1970) for this species. The differences between *C. coronata* and the closely related *C. valentini* are discussed under the remarks section for the latter species.

The type of *coronata* (MNHN 9006), a specimen 103.2 mm SL, from Hawaii was examined by J.E.R.

The distribution of *C. coronata* is relatively poorly known in spite of its widespread occurrence. Tyler (1967) examined 14 specimens, 53.8 to 103.4 mm SL, from the Hawaiian Islands, Philippine Islands, Seychelles Islands, Red Sea, and Somali. McCulloch (1922) reported it from Queensland as *C. cinctus*. We have examined 25 specimens, 39.5 to 103.2 mm SL from the Hawaiian Islands, Ifaluk Atoll (Caroline Islands), New South Wales, Western Australia, Japan, Red Sea, Mauritius, and Mozambique. In addition, we observed a pair in 27 metres depth at One Tree Island, Capricorn Group, Great Barrier Reef. R. Kuitert (personal communication) has collected this species as far south as Sydney, Australia. It was also reported from Taiwan by Shen and Lim (1974).

At Hawaiian Islands, *C. coronata* is most commonly seen below depths of about 15 metres, although occasional individuals are sighted in water as shallow as 6 metres. Tyler (1967) examined specimens that were dredged from 258-396 feet in the Hawaiian Islands.

An analysis of the stomach and gut contents of 12 specimens (64-97 mm SL) from six stations off Oahu, Hawaiian Islands revealed 13.3% algae (mixed with detritus), 11.9% gastropods, 10.0% crabs, 9.7% pelycypods, 8.9% polychaetes, 7.7% sponge, 7.0% sipunculids, 6.1% ophiuroids, 5.9% byozoans, 4.7% tunicates (mostly didemnids), 3.3% echinoids, 2.4% foraminifera, 1.7% amphipods, 0.7% shrimp, 0.1% isopods, and 6.6 unidentified.

***Canthigaster marquesensis* n. sp.**

Fig. 4A; Table 3

HOLOTYPE: BPBM 11129, 69.6 mm SL, collected with multiprong spear on north-west side of Sentinelle de l'Est, Nuku Hiva, Marquesas Islands in 15-18 metres by J. Randall on 14 May 1971.

PARATYPES: AMS I. 11678-001, 62.8 mm SL, collected with multiprong spear at bay on north side of Ua Pou, Marquesas Islands in 18 metres by J. Randall on 28 April 1971; BM(NH) 1972.10.241, 64.7 mm SL, same data as holotype; BPBM 11109, 89.0 mm SL, collected with rotenone off point at north side of Hanau Bay, Fatu Hiva, Marquesas Islands in 24 metres by J. Randall, D. Cannoy, and R. McNair on 21 April 1971; BPBM 11113, 67.0 mm SL, same data as preceding paratype except collected with multiprong spear in 28 metres by J. Randall on 20 April 1971; BPBM 11124, 60.0 mm SL, collected with rotenone on west side of Sentinelle de

l'Ouest, Nuku Hiva, Marquesas Islands in 31 metres by J. Randall, D. Cannoy, and D. Bryant on 16 May 1971; BPBM 11126, 2 specimens, 52.9 and 71.9 mm SL, same data as holotype except collected in 24 metres on 1 May 1971; BPBM 11146, 2 specimens, 33.3 and 66.0 mm SL, collected with rotenone off point at south end of Vaitahu Bay, Tahuata, Marquesas Islands in 35-42 metres by J. Randall, D. Cannoy, and J. Haywood on 23 April 1971; CAS 15453, 67.0 mm SL, same data as holotype; USNM 208267, 53.4 mm SL, same data as holotype.

DESCRIPTION: See Table 3 for measurements of selected types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 10 (two paratypes with 9); anal rays 9; pectoral rays 17 (one paratype with 18).

Depth 2.8 (2.7 to 2.9), head length 2.7 (2.6 to 2.8), tip of snout to dorsal origin 1.4 (1.3 to 1.4), to anal origin 1.3 (1.2 to 1.3), all in standard length. Snout 1.5 (1.4 to 1.7), postorbital length of head 3.8 (3.5 to 4.4), eye 4.3 (3.7 to 5.5), interorbital 4.1 (3.8 to 4.4), depth of caudal peduncle 2.4 (2.3 to 2.6), length of caudal peduncle 1.6 (1.5 to 1.8), of middle caudal rays 1.4 (1.2 to 1.5), all in head length.

Colour of holotype in alcohol: head and body generally brownish dorsally; tan ventrally; prominent dark brown longitudinal band, about equal to eye diameter in width, extending from pectoral fin axil to caudal peduncle; dorsal portion of body with network of dark irregular blotches; dark spot, about size of eye, at base of dorsal fin; dark blotch about size of pupil anterior to and slightly below pectoral fin base; area surrounding mouth whitish with brownish zebra-like stripes; perimeter of eye narrowly whitish, intersected by brownish spokes, those of the opposite side not meeting over snout or interorbital; series of approximately 15 to 20 narrow, parallel pale lines on postero-ventral region of body (lower caudal peduncle for the most part), extending diagonally in antero-ventral to postero-dorsal direction, intersecting prominent longitudinal band; five to six brownish horizontal bands at caudal base, slanting towards middle of fin; dorsal, anal, pectoral, and caudal fins pale.

REMARKS: *C. marquesensis* is closely related to *C. epilampra*. The two species have similar fin ray counts, but can be distinguished on the basis of colour pattern (Fig. 3A and C), body depth, and caudal peduncle length. *C. marquesensis* tends to be less deep-bodied than *C. epilampra* (Fig. 10), and usually has a longer caudal peduncle (Fig. 11).

Named *marquesensis* in reference to the type locality. It has not been collected outside of the Marquesas Islands.

***Canthigaster bennetti* (Bleeker)**

Fig. 2C; Table 4

Tetodon ocellatus (non Bloch) Bennett, 1830: 21.

Tropidichthys Bennetti Bleeker, 1854: 504 (type locality, Amboina).

Canthigaster constellatus Kendall and Goldsborough, 1911: 336, pl. 7, fig. 2 (type locality, Paumotu Islands).

Tropidichthys oxylophius Smith, 1931: 159, pl. 16 (type locality, Port Alfred, South Africa).

DIAGNOSIS: Dorsal rays 9 to 11 (usually 9-10); anal rays 8 to 10 (usually 9); pectoral rays 14 to 16 (usually 15). See Table 4 for additional information.

Depth 2.6 to 3.2, head length 2.6 to 2.8, tip of snout to dorsal origin 1.4, to anal origin 1.3 to 1.4, all in standard length. Snout 1.4 to 1.6, postorbital length of head 3.6 to 5.0, eye 4.0 to

5.5, interorbital 4.0 to 4.8, depth of caudal peduncle 2.1 to 2.7, length of caudal peduncle 1.4 to 1.7, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol generally brownish dorsally, pale tan ventrally; head, back, and sides with numerous small brown and white spots; indistinct dark blotch or ocellus at base of dorsal fin, about size of eye or slightly larger; upper part of caudal peduncle with one to several indistinct dark stripes (sometimes broken); eye with radiating brown lines, those from opposite side not meeting over snout or interorbital; several broken vertical brown lines on cheek just posterior to mouth; faint brown stripe on ventral mid-line from chin to anus; dorsal, anal, and pectoral fins pale with dark-edged fin rays; caudal fin mostly pale, sometimes brownish basally.

REMARKS: The differences between *C. bennetti* and its closest relative *C. epilampra* are discussed under the remarks section for the latter species. Whereas most specimens of other members of the genus have a strong modal count of a single number of dorsal rays, the modal dorsal ray count for *bennetti* includes two rays (see Table 4).

Bleeker (1854) based his description on nine examples, 45-81 mm TL from Amboina. Dr. M. Boeseman (personal communication) reported that RMNH 7360 contains 60 specimens which were purchased at the auction of Bleeker's collections in 1879. He said that 31 of these specimens are too small, but any of the remaining 29 may be syntypes. It is not possible to ascertain which 9 of the 29 are the syntypes or even to be certain that any are types.

Tropidichthys oxylophius described by Smith (1931) is most likely a synonym of *C. bennetti*. The description is based on a juvenile specimen, 32 mm TL, from the mouth of the Kareiga River, near Port Alfred, South Africa. Smith's colour description agrees closely with a specimen of *C. bennetti*, 23.5 mm SL, from Mozambique. We have also examined a specimen, 29.0 mm SL, from off the Xora River, which is a short distance south-west of Port Alfred. The only obvious discrepancy between *T. oxylophius* and *C. bennetti* is Smith's record of only 13 pectoral rays. We have not examined the type which is lodged at the Albany Museum, South Africa.

We have examined 127 specimens, 23.5 to 74.5 mm SL, including specimens from the Society Islands, Tuamotu Archipelago, Fiji Islands, Queensland, New Hebrides, New Guinea, Ambon, Philippine Islands, and Maldives Islands. De Beaufort and Briggs (1962) listed all these localities along with Samoa Islands, Santa Cruz Islands, Ponape (Caroline Islands), other East Indian Islands, Singapore, Ceylon, and Zanzibar. Smith and Smith (1963) reported it from Seychelles Islands. It has also been recorded from Taiwan by Shen and Lim (1974). In addition, we have examined specimens from Guam, Palau Islands, New South Wales, Farquhar Islands (Indian Ocean), Kenya, Tanzania, and Mozambique which constitute new distribution records. R. Kuitert (personal communication) has collected *C. bennetti* as far south as Sydney, Australia.

C. bennetti was observed by the senior author at Palau Islands and New Guinea. It was most abundant in shallow sandy areas to depths of about 10 metres. The pale coloration of the body forms an effective camouflage in this habitat. An analysis of the stomach and gut contents of three specimens (54-75 mm SL) from a single station at Samarai Island, New Guinea revealed 85% algae, 3.3% barnacle appendages, 2.6% sponge, 2.0% gastropods, 1.3% bryozoans, 1.0% foraminifera, 0.6% echuroids, 0.3% sipunculids, 0.3% polychaetes, 0.3% copepods, and 3.3% unidentified.

***Canthigaster smithae* n. sp.**
Fig. 5C; Table 5

Canthigaster rostratus (non Bloch) Smith, 1965: 4.

HOLOTYPE: BPBM 18009, 73.0 mm SL, collected with rotenone in 30 metres off Flic en Flec, west coast of Mauritius, Indian Ocean by J. Randall on 20 November 1973.

PARATYPES: BPBM 18010, 2 specimens, 27.0 and 43.1 mm SL, collected with spear and quinaldine in 37 metres about 3 km south-west of Grand Baie, Mauritius, Indian Ocean by J. Randall on 11 November 1973; USNM 213575, 63.6 mm SL, same data as preceding specimen; RUSI 2231, 51.5 mm SL, Durban, South Africa; WAM P25126-001, 50.0 mm SL, collected with spear in 35 metres about 1.6 km north of Flic en Flec, Mauritius, Indian Ocean by J. Randall on 1 December 1973; USNM 215969, 55.5 mm SL, collected with rotenone in 20 m off north-west shore of North Island, Agalega Islands (approximately 10° 20'S, 56° 34'E) by V. Springer on 14 April 1976.

DESCRIPTION: See Table 5 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 10 (one paratype with 9); anal rays 9; pectoral rays 17 (one paratype with 16).

Depth 2.8 (2.7 to 3.1), greatest body width 4.0 (3.6 to 4.2), head length 2.5 (2.1 to 2.4), distance from tip of snout to dorsal origin 1.4 (1.3 to 1.4), to anal origin 1.3 (1.2 to 1.4), all in standard length. Snout length 1.5 (1.6 to 1.9), eye diameter 4.3 (2.9 to 4.1), postorbital length of head 3.8 (3.5 to 5.5), least width of interorbital 3.7 (3.9 to 5.5), least depth of caudal peduncle 2.3 (2.3 to 3.5), length of caudal peduncle 1.8 (2.0 to 2.2), of dorsal fin base 4.3 (5.4 to 6.3), of anal fin base 4.7 (5.5 to 6.3), of longest dorsal ray 2.6 (2.1 to 2.5), of longest anal ray 3.1 (2.4 to 3.3), of longest pectoral ray 2.7 (2.7 to 2.9), of middle caudal rays 1.6 (1.3 to 1.6), all in head length.

Colour of holotype in alcohol: head and body generally whitish, but abruptly more or less uniform brown on dorsal surface above level of lower boundary of eye; pale portion covered with numerous small brown spots, becoming lighter on ventral surface, those in approximate longitudinal rows, one just above pectoral base and the other just below it somewhat darker giving overall appearance of a pair of longitudinal lines which extend across side to dorsal and ventral base of caudal fin; spots on region below lower jaw joining to form series of thin concentric curved lines with open side directed antero-ventrally; dark stripe sometimes present on mid-ventral line; series of spoke-like dark brown lines radiating from eye, those from opposite side not meeting over snout or interorbital, spaces between these lines white; 4-5 irregular and elongate dark-rimmed white markings extending from just below and slightly behind eye to position on sides level with distal tips of middle pectoral rays; dorsal, anal, and pectoral fins translucent with dark-edged rays, outer portion of caudal slightly dusky; prominent dark margin on dorsal and ventral edge of caudal fin.

The four largest paratypes have the same general colour scheme except the brown coloration of the back is darker and most of the spots on the sides are very faint. In addition, the 43.1 and 63.6 mm specimens exhibit a more prominent pair of longitudinal bands on the side. These bands are similar to those found in *C. rivulata*, but rather than forming an arc in front of the gill opening they continue as separate parallel bands to the snout tip. These markings are well differentiated in the largest paratype, each being composed of a whitish line with dark brown borders. The elongate dark-rimmed marks found between the eye and pectoral region of the holotype represent the remnants of this band. The 51.5 and 63.6 mm paratypes are further distinguished by the presence of a series of vertical lines on the lower side of the snout and anterior cheek region. The former specimen also possesses a series of lines on the dorsal region of the caudal peduncle which if viewed from above form V-shaped markings with the open end directed anteriorly. Also the dark margins on the caudal are faint in this specimen and are only visible on the basal part of the fin.

The 27.0 mm paratype has a poorly differentiated colour pattern. It is basically brownish on the dorsal third of the body and pale below. The small spots are not apparent, but there is a faint longitudinal brown line extending along the side below the pectoral fin. The dark caudal margins are narrow, but nevertheless discernible.

REMARKS: *C. smithae* appears to be closely related to *C. epilampra* and *C. rapaensis* from the Pacific, differing from these species primarily on the basis of colour pattern.

Named in honour of Mrs. Margaret M. Smith, Director of the J.L.B. Smith Institute of Ichthyology, Rhodes University, South Africa. Mrs. Smith assisted the junior author in making fish collection at Mauritius and also sent us one paratype of *C. smithae* collected off Durban (reported and figured as *C. rostratus* by Smith, 1965).

***Canthigaster epilampra* (Jenkins)**

Fig. 4B

Tropidichthys epilamprus Jenkins, 1903: 486, fig. 3 (type locality, Hawaiian Islands).

DIAGNOSIS: Dorsal rays 10; anal rays 9; pectoral rays 16 to 18 (usually 17).

Depth 2.5 to 2.7, head length 2.3 to 2.7, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.3 to 1.6, postorbital length of head 3.8 to 4.5, eye 3.6 to 4.7, interorbital 3.3 to 4.0, depth of caudal peduncle 2.2 to 2.7, length of caudal peduncle 1.6 to 2.3, of middle caudal rays 1.4 to 1.6, all in head length.

Colour in alcohol mostly pale except brownish on dorsal portion of head and body; prominent dark brown blotch about two to three times size of eye usually present at base of dorsal fin; numerous small brown dots covering side of head and body; faint brown stripe on ventral midline from chin to anus; several diagonal brown lines emanating from mouth, about equal to eye diameter in length; 7 to 12 brown lines radiating from eye, those from opposite side not meeting over snout or interorbital; a small black-ringed white ocellus a short distance above gill opening sometimes present; several horizontal bands at caudal base slanting towards middle of fin; dorsal, anal, pectoral, and caudal fins pale. A specimen 80.6 mm SL, from Guadalcanal, Solomon Islands, lacks the dark blotch below the dorsal fin. Instead there is a series of more or less concentric dark brown lines (bluish in life) in this region.

REMARKS: *C. epilampra* differs from its closest relative *C. rapaensis* in modal dorsal fin ray count and caudal fin coloration (see remarks section for the latter species). These species, in turn are closely allied to *C. marquesensis* and *C. bennetti*. They are generally deeper bodied than *marquesensis* (Fig. 9), and tend to have a shorter caudal peduncle (Fig. 9), *C. bennetti* differs by having a less deep body (Fig. 10), a longer caudal peduncle (Fig. 10), broader interorbital (4.0 to 4.8 in SL, compared to 3.3 to 4.0 for *epilampra* and *rapaensis*), fewer pectoral rays (Table 1), and fewer spots in the caudal peduncle region (usually less than 30, while *epilamprus* generally has more than 50 sometimes faded in preservative). *C. epilampra* is also closely related to *C. smithae* from the Indian Ocean, differing mainly in colour pattern.

The type of *epilampra* (Cat. No. 50853), a specimen 70.7 mm SL from Maui is at USNM.

Fowler (1928) and Gosline and Brock (1960) were in error in placing *C. epilampra* in the synonymy of *rivulata*.

C. epilampra is usually restricted to depths below 25 metres, but is occasionally encountered in shallow water. It has previously been recorded only from the Hawaiian Islands, but we have taken it at the Society Islands, Rarotonga, Palau Islands, and the Solomon Islands. Future collections, particularly on deeper reefs, will probably reveal its presence at other Pacific localities. We examined 15 examples, 32.0 to 91.0 mm SL.

Canthigaster rapaensis n. sp.

Fig. 4C; Table 6

HOLOTYPE: BPBM 12952, 78.0 mm SL, collected with multiprong spear off south side of Ruea Point, Rapa in 13 metres by J. Randall on 9 February 1971.

PARATYPES: AMS I. 16588-001, 96.9 mm SL, same data as holotype; BPBM 12662, 84.1 mm SL, collected with multiprong spear at reef off Haurei Bay, Rapa in 25-31 metres by J. Randall on 17 February 1971; BPBM 12983, 61.0 mm SL, collected with multiprong spear on reef at entrance to Haurei Bay, Rapa in 12-15 metres by J. Randall on 18 February 1971; USNM 208277, 73.6 mm SL, collected with multiprong spear at reef off Haurei Bay, Rapa in 25-31 metres by J. Randall on 17 February 1971; USNM 208346, 81.6 mm SL, collected with multiprong spear on reef at entrance to Haurei Bay, Rapa in 12-15 metres by J. Randall on 18 February 1971.

DESCRIPTION: See Table 6 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 10 (10 or 11); anal rays 9 (9 or 10); pectoral rays 18 (16 to 18).

Depth 2.7 (2.5 to 2.8), greatest body width 4.3 (4.0 to 4.3), head length 2.4 (2.1 to 2.5), distance from tip of snout to dorsal origin 1.3 (1.3 to 1.5), to anal origin 1.3, all in standard length. Snout length 1.5 (1.4 to 1.7), eye diameter 4.3 (3.9 to 4.9), postorbital length of head 4.2 (3.7 to 4.3), least width of interorbital 4.2 (3.9 to 4.9), least depth of caudal peduncle 2.4 (2.3 to 2.6), length of caudal peduncle 2.0 (1.7 to 2.1), of dorsal fin base 5.0 (4.5 to 5.4), of anal fin base 5.5 (4.9 to 7.5), of longest dorsal ray 2.7 (2.2 to 2.9), of longest anal ray 3.0 (2.8 to 3.5), of longest pectoral ray 2.7 (2.7 to 3.0), of middle caudal rays 1.4 (1.3 to 1.5), all in head length.

Colour of holotype in alcohol: Head and body generally pale brown; numerous small brown spots on sides of head and body; diffuse blackish patch at base of dorsal fin, larger than eye; predorsal region including dorsal portion of snout and upper rim of orbits dark brown; dark brown stripe on ventral midline extending from chin to anus; several spoke-like dark lines radiating from eye, those from opposite side not meeting over snout or interorbital; several short brown stripes (sometimes broken) on side of cheek; dorsal, anal, and pectoral fins translucent with dark-edged rays; each fin ray of caudal with three to five brown bands, membraneous portion of fin pale.

The 61.0 mm and 81.6 mm paratypes possess a small, black-ringed white ocellus a short distance above the gill opening. This feature is also present in certain individuals of *C. epilampra*.

REMARKS: *C. rapaensis* is closely related to *C. epilampra* and is probably a derivative of the ancestral stock of that species. They differ on the basis of modal dorsal ray count and colour pattern of the caudal fin. One-half of the type specimens of *C. rapaensis* possess 11 dorsal rays and the remainder have 10 rays, whereas 15 individuals of *C. epilampra* we examined possess 10 rays. The distinctive pattern of broken lines on the caudal fin exhibited by *C. rapaensis* is lacking in *C. epilampra*. For further comparison with closely related species refer to the remarks section for *C. epilampra*.

Named *rapaensis* in reference to the type locality.

Canthigaster rivulata (Schlegel)

Fig. 5A

Tetraodon rivulatus Schlegel, 1850: 285, pl. 124, fig. 3 (type locality, Nagasaki Bay, Japan).

Tetrodon caudofasciatus Günther, 1870: 304 (type locality unknown).

Eumycterus bitaeniatus Jenkins, 1901: 400, fig. 12 (type locality, Hawaiian Islands).

Canthigaster notospilus Fowler, 1941: 278, fig. 31 (type locality, Hawaiian Islands).

DIAGNOSIS: Dorsal rays 9 or 10 (usually 10); anal rays 9 or 10 (usually 10); pectoral rays 16 to 18 (usually 17).

Depth 2.6 to 3.0, head length 2.4 to 2.7, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.4 to 1.7, postorbital length of head 3.5 to 4.5, eye 3.3 to 5.2, interorbital 3.0 to 4.0, depth of caudal peduncle 2.2 to 2.8, length of caudal peduncle 1.7 to 2.1, of middle caudal rays 1.2 to 1.7, all in head length.

Colour in alcohol generally pale tan; side of body with two longitudinal and parallel dark bands, usually less than eye diameter in width, extending from pectoral region to caudal peduncle; bands joining each other, forming an arc in front of gill opening; lower band may be faint or absent on some specimens; dorsal portion of body (above uppermost band) with brownish vermiculated pattern; small dots or broken lines sometimes on sides of head and body; faint spoke-like lines sometimes radiating from eye; dark blotch at base of dorsal fin; dark spot on pectoral base; dorsal, anal, pectoral, and caudal fins pale.

REMARKS: *C. caudofasciatus* from the Indian Ocean is here recognized as a synonym. We have examined 31 specimens, 21.8 to 124.3 mm SL from the Somali coast of East Africa. They are essentially identical to Pacific specimens of *rivulata*. Jordan and Dickerson (1908) were the first to point out that *C. bitaeniatus* Jenkins is the young of *C. rivulata*.

The types of *rivulata*, 80-123 mm SL (catalogue numbers 1568-1571, 4653a, and 4653b) are at RMNH. Boeseman (1947) selected RMNH 4653a, a specimen 85 mm SL, as the lectotype.

We have examined 64 specimens, 21.8 to 147.0 mm SL from the Hawaiian Islands, Japan, Taiwan, South China Sea, Seychelles Islands, and Somali. Previous records include the Hawaiian Islands, Taiwan (Shen and Lim, 1974), Japan, Western Australia (McKay, 1970), Seychelles Islands (Smith and Smith, 1963), and South Africa (Smith, 1949). At the latter locality it is found to depths of at least 40 fathoms.

C. rivulata is a relatively deep dwelling species in the Hawaiian Islands, although juveniles are occasionally encountered on shallow reefs. Adults have been taken in trawl hauls from depths as great as 100 metres.

***Canthigaster inframacula* n. sp.**

Fig. 7C; Table 7

HOLOTYPE: USNM 208483, 76.0 mm SL, collected with 12.5 metre shrimp trawl from M/V "Townsend Cromwell" in 68 to 86 fathoms off north shore of Oahu, Hawaiian Islands (21°40'N, 158°07'W) by P. Struhsaker on 12 July 1972.

PARATYPES: AMS I. 16764-001, 110.6 mm SL, same data as holotype; BPBM 15934, 2 specimens, 84.7 and 102.9 mm SL, same data as holotype.

DESCRIPTION: See Table 7 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 10; anal rays 10 (10 or 11); pectoral rays 18 (17 or 18).

Depth 2.6 (2.4 to 2.8), greatest body width 4.8 (4.2 to 4.9), head length 2.6 (2.5 to 2.6), distance from tip of snout to dorsal origin 1.3, to anal origin 1.3, all in standard length. Snout length 1.7 (1.5 to 1.6), eye diameter 5.0 (4.6 to 5.9), postorbital length of head 4.2 (4.0 to 4.2), least width of interorbital 3.0 (2.9 to 3.0), least depth of caudal peduncle 2.3 (2.3 to 2.6),

length of caudal peduncle 1.9 (1.7 to 2.2), of dorsal fin base 4.7 (3.8 to 4.2), of anal fin base 4.7 (3.9 to 4.4), of longest dorsal ray 3.1 (2.6 to 3.2), of longest anal ray 2.9 (2.7 to 3.1), of longest pectoral ray 2.8 (2.7 to 3.1), of middle caudal rays 1.5 (1.5 to 1.6), all in head length.

Colour of holotype in alcohol: head and body light olivaceous grey dorsally, shading to whitish on lower sides and abdomen; a slightly irregular blackish stripe from eye to upper base of caudal fin (diffuse just behind eye); an irregular roundish black spot larger than eye on lower side between pectoral base and origin of anal fin; head and body except thorax and abdomen with well-separated small brownish to blackish spots, most numerous dorsally on snout; brownish lines radiating anteriorly, dorsally, and posteriorly from eye; a few brownish lines also present dorsally at front of snout, on nape, back, and dorsally on caudal peduncle; dorsal, anal, and pectoral fins translucent, slightly yellowish; dorsal and anal base with brownish lines and small brown spots; caudal fin pale with faint brownish spots arranged in approximately vertical rows.

The paratypes are similarly patterned except the stripe behind the eye of the largest paratype is very faint and nearly indistinguishable posterior to the level of the dorsal fin. The large dark spot on the lower sides is also faint in this specimen.

REMARKS: The fin ray counts, colour pattern, and large size attained indicate a relationship to *C. callisterna* and *C. rivulata*. The black spot on the lower sides, on which the specific name is based, is particularly diagnostic for this species. Although *C. inframacula* is presently known only from the Hawaiian Islands, it is possible that it will be found at other Pacific Islands. Deeper water collections are wholly lacking for most of Oceania.

Named *inframacula* in reference to the diagnostic black spot on the lower half of the body.

Canthigaster callisterna (Ogilby)
Fig. 5B and Fig. 11

Tetrodon callisternus Ogilby, 1889: 74, pl. 3, fig. 5 (type locality, Lord Howe Island).

DIAGNOSIS: Dorsal rays 11; anal rays 10 or 11 (usually 10); pectoral rays 17 or 18 (usually 18).

Depth 2.8 to 3.2, head length 2.4 to 2.8, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.4, all in standard length. Snout 1.6 to 1.8, postorbital length of head 3.7 to 4.4, eye 3.8 to 4.7, interorbital 3.0 to 3.7, depth of caudal peduncle 2.6 to 2.9, length of caudal peduncle 1.6 to 2.3, of middle caudal rays 1.3 to 1.5, all in head length.

Colour in alcohol reddish brown dorsally, whitish ventrally; dorsal portion of body (above eye level) covered with small dark spots, connecting to form maze of broken lines on mid-dorsal surface; head usually with about 12 brownish lines radiating from eye; snout and predorsal region with numerous irregular dark lines, cheeks with series of oblique dark lines, whitish ventral region overlaid with light brown spots, the largest about equal to pupil size; many specimens (all sub-adults below about 50-60 mm SL) with whitish longitudinal band (with spots) on middle of sides, about equal to eye diameter in width, extending from snout to base of caudal fin (see Fig. 12); margins of band darker than surrounding body region giving appearance of two faintish stripes; usually an imperfect ocellus formed of concentric broken lines at base of dorsal fin; dorsal, anal, and pectoral fins pale; caudal fin pale with series of faint bars, upper and lower margins of fin dark brown.

REMARKS: *C. callisterna* and *C. rivulata*, the two largest species in the genus, are closely related. Colour pattern and the dorsal fin ray count constitute the principle differences between the two species (Table 1).

The syntypes of *callisterna* (AMS I. 1485 and I. 1965), 2 specimens, 82.0 and 140.0 mm SL from Lord Howe Island, were examined by G.R.A. We have seen 30 specimens, 36.3 to 225.0 mm SL, from New South Wales, Lord Howe and Norfolk islands. Whitley (1968) reported it from northern New Zealand, the Kermadec Islands, and New South Wales.

***Canthigaster janthinoptera* (Bleeker)**

Fig. 6A

Tropidichthys janthinopterus Bleeker, 1855: 429 (type locality, Ambon).

DIAGNOSIS: Dorsal rays 9 or 10 (usually 9); anal rays 9 or 10 (usually 9); pectoral rays 16 to 18 (usually 17).

Depth 2.2 to 2.6, head length 2.4 to 2.6, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.5 to 1.6, postorbital length of head 3.6 to 4.3, eye 4.1 to 4.7, interorbital 3.0 to 3.8, depth of caudal peduncle 1.8 to 2.3, length of caudal peduncle 1.9 to 2.5, of middle caudal rays 1.3 to 1.5, all in head length.

Colour in alcohol brownish with numerous white spots on sides of head and body; ventral portion of body from anus to lower jaw usually tan and lacking spots; head usually with spoke-like lines radiating from eye; dark blotch or ocellus sometimes present (sometimes poorly developed) at base of dorsal fin; caudal fin uniform tan to brownish; remainder of fins translucent with rays thinly outlined with dark pigment. The orange stripes on the side of the head of the illustrated specimen from Lord Howe Island (Fig. 6A) is a variable feature which appears in some adults.

REMARKS: *C. janthinoptera*, *C. jactator*, and *C. punctatissima* form a close-knit complex, differing from each other primarily with regards to colour pattern. The latter species are apparently derived from the former. It is difficult to determine if *C. jactator* and *C. punctatissima* have evolved to the species level. However, it is our opinion that these populations are adequately isolated geographically and exhibit sufficient colour pattern differences to merit this distinction. The most useful features for separating these species are the size and number of pale spots which cover the body, presence or absence of either lines radiating from the eye or a dark spot or ocellus at the base of the dorsal fin and caudal fin coloration. *C. jactator* from the Hawaiian Islands generally has larger (about equal to pupil) and less numerous pale spots on the head and body. These usually number about 8-11 in an approximate vertical row from the dorsal origin to the anal origin, while *C. janthinoptera* (Indo-W. Pacific) and *C. punctatissima* (eastern Pacific) generally have more than 12 (usually 14 to 17). Specimens of *C. janthinoptera* from the Line Islands and south-east Oceania frequently have spot patterns similar to *jactator*, but unlike that species they usually exhibit either an ocellus (may be only partially developed) or dark spot at the base of the dorsal fin and poorly developed lines or "spokes" which radiate from the eye. Many examples from this region possess both features. Four of 19 specimens from the Seychelles Islands possessed an ocellus, and all had well developed eye spokes. The dorsal base ocellus and eye spokes are also lacking in *C. punctatissima*. This species further differs from both *janthinoptera* and *jactator* by having pale spots on the caudal fin. These are a continuation of the spot pattern on the body and are most apparent on the basal portion of the fin.

The type of *janthinoptera* (RMNH 7359), a flattened and discoloured specimen (33.0 mm SL) from Ambon was examined by J.E.R.

We have examined 89 specimens, 26.3 to 62.2 mm SL, from Pitcairn Island, Oeno Atoll, Mangareva, Marquesas Islands, Society Islands, Austral Islands, Cook Islands, Marshall

Islands, Wake Island, Solomon Islands, Fiji Islands, New Hebrides, Queensland, Lord Howe Island, Chagos Archipelago, Seychelles Islands, Madagascar, Tanzania, Mozambique, and South Africa. Most of these localities represent new records. It was previously reported from Ponape (Caroline Islands), New Hebrides, Philippine Islands, Ambon, Sula Islands, Celebes, and Comores by De Beaufort and Briggs (1962). In addition, it has been recorded from the Seychelles Islands (Smith and Smith, 1963), Taiwan (Shen and Lim, 1974), and the Marshall Islands (as *C. jactator*; Woods, in Schultz *et al.*, 1966). We have also recently collected specimens at Western Australia and the Maldive Islands which represent new locality records.

***Canthigaster jactator* (Jenkins)**

Fig. 6B

Tropidichthys jactator Jenkins, 1901: 399, fig. 1 (type locality, Hawaiian Islands).

DIAGNOSIS: Dorsal rays 9 or 10 (usually 9); anal rays 9 or 10 (usually 9); pectoral rays 16 to 18 (usually 17).

Depth 2.3 to 2.7, head length 2.3 to 2.7, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.1 to 1.3, all in standard length. Snout 1.4 to 1.7, postorbital length of head 3.8 to 4.6, eye 3.6 to 4.8, interorbital 3.1 to 3.9, depth of caudal peduncle 1.8 to 2.2, length of caudal peduncle 1.7 to 2.4, of middle caudal rays 1.4 to 1.6, all in head length.

Colour in alcohol brown with numerous white spots on sides of head and body; ventral portion of body from anus to lower jaw usually tan and lacking spots; caudal fin uniform tan to brownish; remainder of fins translucent with rays thinly outlined with dark pigment.

REMARKS: Refer to the preceding remarks section for a discussion of the relationship between *C. jactator*, *C. janthinoptera* and *C. punctatissima*.

The type of *jactator* (catalogue number 49703), a specimen 41.9 mm SL from Oahu, is at USNM.

This species, which is confined to the Hawaiian Islands, is the most common shallow water member of the genus found there. An analysis of the stomach and gut contents of 18 specimens (43-65 mm SL) from five stations off Oahu revealed 37.6% sponges, 21.9% algae (mixed with sand and detritus), 13.7% tunicates (mostly didemnids), 7.5% bryozoans, 3.5% polychaetes, 2.7% ophiuroids, 2.2% gastropods, 1.1% foraminifera, 1.1% echinoids, 1.0% coral, 0.8% sipunculoids, 0.8% pelecypods, 0.7% crabs, 0.5% fish, 0.3% tubeworms, 0.1% amphipods, and 3.5% unidentified.

***Canthigaster punctatissima* (Günther)**

Fig. 12

Tetrodon punctatissimus Günther, 1870: 302 (type locality, Pacific coast of Panama).

Tetrodon oxyrhynchus Lockington, 1881: 116 (type locality, Gulf of California).

Canthigaster punctatissimus reticulatus Breder, 1937: 50 (type locality, Baja, California).

Canthigaster brederi Whitley, 1959: 323 (substitute name for *punctatissimus reticulatus* Breder).

DIAGNOSIS: Dorsal rays 8 to 10 (usually 9); anal rays 8 to 10 (usually 9); pectoral rays 15 to 18 (usually 17).

Depth 2.3 to 2.7, head length 2.3 to 2.7, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.5 to 1.7, postorbital length of head 3.7 to 4.7,

eye 3.7 to 5.0, interorbital 3.1 to 3.6, depth of caudal peduncle 1.8 to 2.4, length of caudal peduncle 1.6 to 2.3, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol brown with numerous white spots on sides of head and body; ventral portion of body from anus to lower jaw usually tan and lacking spots; caudal fin tan to brownish with small pale spots (may be faded in preservative), particularly apparent on basal portion of fin; remainder of fins translucent with rays thinly outlined with dark pigment.

REMARKS: Refer to the remarks section for *C. janthinoptera* for a discussion of the relationship between *C. punctatissima*, *C. jactator* and *C. janthinoptera*.

The type of *punctatissimus*, a specimen 70.0 mm SL from Panama is at BM(NH).

We have examined 36 specimens, 12.7 to 67.0 mm SL, from the Gulf of California, Pacific coast of Mexico, Costa Rica, Panama, Revillagigedo Islands, Clipperton Island, and Galapagos Islands.

***Canthigaster tyleri* n. sp.**

Fig. 6C; Table 8

HOLOTYPE: BPBM 18014, 63.4 mm SL, collected with rotenone in 30 metres off Flic en Flec, west coast of Mauritius, Indian Ocean by J. Randall on 20 November 1973.

PARATYPES: ANSP 109816, 33.5 mm SL, collected with rotenone on west side of fringing reef off Grande Comore Island, Comoro Islands (11° 41'33"S, 43° 14'27"E) in 0-25 metres by scientific party of *Anton Bruun* on 27 November 1964; BM(NH) 1974. 3.11.8, 45.9 mm SL, collected with rotenone among coral and rubble at entrance to large cave in 20 metres at Bandos Island, North Male Atoll, Maldive Islands by R. Lubbock and J. Serpell on 15 July 1973; BPBM 18011, 49.2 mm SL, collected with emulsified rotenone at Cathedral Reef, off Flic en Flec, Mauritius by J. Randall and D. Pelicier on 25 November 1973; BPBM 18042, 52.2 mm SL, collected with spear at entrance to cave off south side of Villingili Island, Maldive Islands in 32 metres by J. Randall on 17 March 1975; WAM P25169-001, 58.0 mm SL, collected with rotenone off Latahalat, S.E. coast of Ambon, Molucca Islands, Indonesia in 40 metres by G. Allen and J. Randall on 29 January 1975.

DESCRIPTION: See Table 8 for measurements of the types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 9; anal rays 9; pectoral rays 16 (16 or 17).

Depth 2.7 (2.7 to 3.1), greatest body width 4.6 (4.3 to 4.6), head length 2.5 (2.2 to 2.5), distance from tip of snout to dorsal origin 1.4 (1.3), to anal origin 1.3 (1.2 to 1.3), all in standard length. Snout length (1.6 to 1.7), eye diameter 4.3 (3.3 to 5.1), postorbital length of head 4.2 (4.2 to 4.8), least width of interorbital 3.3 (3.6 to 4.8), least depth of caudal peduncle 1.5 (2.2 to 2.7), length of caudal peduncle 1.8 (2.0 to 2.7), of dorsal fin base 5.1 (4.8 to 6.5), of anal fin base 5.1 (5.1 to 6.2), of longest dorsal ray 4.3 (2.8 to 4.5), of longest anal ray 3.3 (3.1 to 3.5), of longest pectoral ray 3.2 (2.7 to 3.2), of middle caudal rays 1.4 (1.4 to 1.7), all in head length.

Colour of holotype in alcohol: head and body light tan, paler ventrally; dark brown spots about size of pupil or smaller covering sides of head and body; belly with scattered whitish spots; snout with 7-8 narrow brown cross-bars dorsally, the anterior ones entirely encircling snout; eye with radiating brown lines; series of thin brown lines forming hexagonal and circular designs on interorbital and pre-dorsal regions; fins pale with dark-edged rays.

The paratypes from the Indian Ocean are similar except there is some variability in the pattern of lines on the interorbital and pre-dorsal portion of the back. In addition, the intensity of the large spots on the sides is variable, particularly in life, ranging in colour from dark brown to orange-brown. All specimens have a circular design on the nape which in the paratypes is surrounded by a maze of fine dark lines. The cross-bars on the snout and lines on the interorbital-predorsal are more prominent in the specimen from the Maldives Islands.

The 58.0 mm paratype from Ambon, Indonesia has fewer and larger spots on the body. In addition, the large dark spots are absent on the head except a single vertical row immediately anterior to the pectoral base. The ventral portion of the head and body is profusely covered with faint spots arranged roughly in a band extending from the chin to the anal base. In life these spots were bluish and the ground colour of the band was yellow. The area surrounding the eye was also yellow with prominent blue lines radiating from the orbit.

REMARKS: This species is morphologically similar to *C. solandri* and *C. margaritatus*, but differs greatly in colour pattern. The prominent peak on the nape is also a significant feature which is not found on most of the species of the genus.

C. tyleri is known from the Molucca Islands, Maldives Islands, Comoro Islands, and Mauritius. Further collecting, particularly in deeper water, will probably yield additional specimens from other localities in the Indian Ocean and Indo-Malayan region.

Named in honour of Dr. James C. Tyler, who sent us the first specimen from the Comoro Islands which is now designated as a paratype.

***Canthigaster pygmaea* n. sp.**

Fig. 15; Table 9

HOLOTYPE: BPBM 18012, 30.3 mm SL, collected with emulsified rotenone in 3 metres about 100 metres south of marine lab at Eilat, Israel, Gulf of Aqaba, Red Sea by J. Randall and O. Gon on 24 September 1974.

PARATYPES: BM(NH) 1975. 1.13.1-2, 2 specimens, 27.3 and 28.0 mm SL, collected with emulsified rotenone in 21 metres $\frac{1}{2}$ km north of Fjord, Gulf of Aqaba, Red Sea by J. Randall and O. Gon on 26 September 1974; BPBM 17875, 37.0 mm SL, collected with spear in 6 metres at Harvey Reef about 19 km south of Port Sudan, Red Sea by J. Randall on 10 October 1974; BPBM 17876, 2 specimens, 37.0 and 38.5 mm SL, collected with rotenone in 6-20 metres on fringing reef front about 500 metres north of entrance to Port Sudan Harbour, Red Sea by J. Randall on 15 October 1974; CAS 31792, 23.1 mm SL, collected with emulsified rotenone in 2 metres at Ras Muhammed, off southern end of Sinai Peninsula, Red Sea by J. Randall, O. Gon, and A. Levy on 19 September 1974; CAS 31793, 5 specimens, 28.0-38.0 mm SL, collected with rotenone in 0-3 metres at bay between Marsa Mokrakh and El Himeira, Gulf of Aqaba, Red Sea by V. Springer on 15 July 1969; HUF. 4756, 3 specimens, 30.0-40.8 mm SL, collected at Ras Muhammed, Red Sea on 7 August 1968; HUF. 7005, 2 specimens, 30.0 and 32.0 mm SL, collected at Ras El Hameirah, Gulf of Aqaba, Red Sea on 17 December 1967; HUF. 7006, 2 specimens, 29.5 and 32.5 mm SL, same data as preceding specimens; HUF. 7007, 10 specimens, 23.1-39.1 mm SL, collected at Gulf of Smithonia, Gulf of Aqaba, Red Sea on 26 June 1967; HUF. 7008, 4 specimens, 25.7-29.5 mm SL, collected at same locality as preceding specimens on 30 August 1967; MNHN 1975-3, 25.6 mm SL, collected with emulsified rotenone in 15 metres about 1 km north of Coral Island, Gulf of Aqaba, Red Sea by J. Randall and O. Gon on 23 September 1974; SMF 13227, 4 specimens, 13.0-30.0 mm SL, collected with rotenone in 25-30 metres at El Himeira, Gulf of Aqaba, Red Sea by V. Springer on 9 September 1969; USNM 212284, 13 specimens, 23.9-33.5 mm SL, collected with rotenone in 5

metres at reef near road off Marsa Mugabila, northwest coast of Gulf of Aqaba, Red Sea by V. Springer on 17 July 1969; USNM 212287, 23 specimens, 22.5-36.4 mm SL, collected with rotenone in 12 metres near Ras Burqa, northwest coast of Gulf of Aqaba, Red Sea by V. Springer on 23 July 1969; USNM 212286, 15.6 mm SL, collected with rotenone in 20-23 metres at Ras Muhammed, Red Sea by V. Springer on 28 September 1969; WAM P25124-001, 35.7 mm SL, collected with holotype; WAM P25125-001, 2 specimens, 17.2-31.3 mm SL, collected with rotenone in 25-30 metres at El Himeira, Gulf of Aqaba, Red Sea by V. Springer on 9 September 1969.

DESCRIPTION: See Table 9 for measurements of selected types. The counts and proportions of the paratypes are indicated in parentheses when differing from those of the holotype.

Dorsal rays 9 (8 to 10); anal rays 9 (9 or 10); pectoral rays 15 (14 to 16).

Depth 2.5 (2.5 to 2.8), greatest body width 4.3 (3.3 to 4.9), head length 2.2 (2.0 to 2.4), distance from tip of snout to dorsal origin 1.3 (1.1 to 1.3), to anal origin 1.3 (1.2 to 1.3), all in standard length. Snout length 1.7 (1.6 to 1.9), eye diameter 4.4 (3.5 to 4.4), postorbital length of head 4.4 (3.8 to 5.2), least width of interorbital 4.5 (3.8 to 4.8), least depth of caudal peduncle 2.6 (2.1 to 2.9), length of caudal peduncle 2.1 (1.7 to 2.5), of dorsal fin base 5.2 (4.9 to 7.2), of anal fin base 6.8 (4.9 to 7.2), of longest dorsal ray 3.1 (2.5 to 4.8), of longest anal ray 3.6 (2.9 to 3.6), of longest pectoral ray 3.0 (2.7 to 3.7), of middle caudal rays 1.5 (1.3 to 1.4), all in head length.

Colour of holotype in alcohol: head and body generally grey-brown, slightly lighter on ventral surface; numerous small round spots on side, those over most of body faintly grey with dark dot in centre, those on ventral surface and lowermost portion of side prominently dark; dark brown spot, about size of eye or slightly smaller at base of dorsal fin; most of eye except anterior edge broadly rimmed with dark brown; side of snout and cheek with 9 narrow grey bars with dark outlines, not joining those from opposite side across dorsal surface of snout; fins pale with dark-edged rays.

The paratypes are similar in coloration, but vary greatly with respect to the intensity of the spots on the side and bars on the head. In many individuals these are solidly dark and more prominent than those exhibited by the holotype. The number of bars on the head is also variable, ranging from about 4-9.

REMARKS: This species appears to be related to the *C. janthinoptera* complex (i.e., *C. janthinoptera*, *C. jactator*, *C. punctatissima* and *C. tyleri*). It is clearly distinct on the basis of its colour pattern and unusually small size. In addition, it differs from the other members of the complex and most *Canthigaster* by its low pectoral ray count which is nearly always 15.

This species is apparently confined to the Red Sea at depths ranging from two to at least 25-30 metres, usually in the vicinity of caves.

Named *pygmaea* with reference to the very small size. The gonads of several specimens were examined revealing mature ova in females of only 25 mm SL.

***Canthigaster amboinensis* (Bleeker)**

Fig. 7A

Pylonotus amboinensis Bleeker, 1865: 180 (type locality, Ambon).

Tropidichthys psegma Jordan and Evermann, 1903: 209 (type locality, Hawaiian Islands).

Tropidichthys oahuensis Jenkins, 1903: 485, fig. (type locality, Hawaiian Islands).

Canthigaster polyophthalmus Pietschmann, 1938: 51, pl. 1, fig. c (type locality, Hawaiian Islands).

DIAGNOSIS: Dorsal rays 10 to 12 (usually 12); anal rays 10 or 11 (usually 11); pectoral rays 16 or 17 (usually 17).

Depth 2.3 to 2.5, head length 2.4 to 2.9, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.1 to 1.3, all in standard length. Snout 1.4 to 1.6, postorbital length of head 3.5 to 4.1, eye 3.8 to 5.4, interorbital 2.9 to 3.6, depth of caudal peduncle 2.0 to 2.5, length of caudal peduncle 1.6 to 2.0, of middle caudal rays 1.3 to 1.6, all in head length.

Colour in alcohol generally brown; head and sides with numerous pale spots with dark centres; snout crossed by several dark lines; eye with several dark lines radiating from the posterior edge and arching dorsally, not joining those of opposite side; cheeks with parallel rows of small blackish dots forming lines which curve ventrally towards throat; dorsal, anal, and pectoral fins blackish at base, remainder of fin pale brown or reddish; caudal fin brown.

REMARKS: The usual combination of 12 dorsal and 11 anal rays serves to separate *amboinensis* from all other *Canthigaster*. Small juveniles (under about 35 mm SL) are similar in appearance to *C. janthinoptera*. Pietschmann's (1938) description of *C. polyophthalmus* is based on a juvenile *amboinensis*, 33 mm SL.

Bleeker based his description of this species on two examples, 95 and 114 mm TL. RMNH obtained one specimen (Cat. No. 7361) 76 mm SL (95 mm TL) at the auction of Bleeker's collections in 1879. It is apparently one of the syntypes and was examined by J.E.R. The remaining syntype is missing.

C. amboinensis is a wide-ranging species which occurs throughout the tropical Indo-Pacific region and has penetrated the eastern Pacific. We have examined 38 specimens, 26.0 to 106.5 mm SL, from the Hawaiian Islands, Line Islands, Marquesas Islands, Society Islands, Samoa Islands, Marshall Islands, New Hebrides, Solomon Islands, New Britain, Ambon, Queensland, Christmas Island (Indian Ocean), Seychelles Islands, Comoro Islands, and Mauritius. Most of these localities represent new records except the Hawaiian Islands, Samoa Islands, Seychelles Islands, and Ambon which were listed by De Beaufort and Briggs (1962). In addition, they recorded *C. amboinensis* from the Fiji Islands, Gilbert Islands, Japan, Philippine Islands, New Guinea, and Natal. Hobson and Walters (1968) recorded it from the Galapagos Islands and Shen and Lim (1974) reported it from Taiwan. We provisionally identify a 30.2 mm specimen from Durban, South Africa as *C. amboinensis* although it may represent a juvenile *C. natalensis*. It differs from that species, however, by having 12 dorsal rays and lacks dark markings on the chin and mid-ventral line. In addition, there are no cross-bars on the snout and interorbital.

This species is usually encountered in very shallow water, frequently in the lower reaches of the surge zone. It is one of the faster swimming members of the genus. An analysis of the stomach and gut contents of four specimens (50-80 mm SL) from four stations off Oahu, Hawaiian Islands revealed 43.6% algae (mixed with detritus), 12.7% polychaetes, 12.0% echinoids, 8.2% ophiuroids, 4.8% tunicates (mostly didemnids), 4.7% gastropods, 3.7% coral, 2.1% pelecypods, 0.8% amphipods, 0.5% sponge, 0.4% foraminifera, 0.3% sipunculids, and 3.2% unidentified.

***Canthigaster natalensis* (Günther)**

Fig. 7B

Tetrodon amboinensis var. *natalensis* Günther, 1870: 303 (type locality, Natal).

DIAGNOSIS: Dorsal rays usually 11 (8 in one specimen); anal rays 10 or 11; pectoral rays 16 or 17 (usually 16).

Depth 2.5 to 2.7, head length 2.5 to 2.6, tip of snout to dorsal origin 1.3 to 1.4, to anal origin 1.2 to 1.3, all in standard length. Snout 1.5 to 1.7, postorbital length of head 3.5 to 3.8, eye 3.8 to 6.8, interorbital 3.2 to 3.7, depth of caudal peduncle 2.1 to 2.7, length of caudal peduncle 1.8 to 2.1, of middle caudal rays 1.4 to 1.6, all in head length.

Colour in alcohol of three specimens, 69-83 mm SL, from Mauritius, Indian Ocean generally brown, lighter on ventral surface; numerous white spots, about 1/3 to 1/2 pupil size, on side and also faintly visible on basal half of caudal fin; small dark spots of similar size widely scattered among pale spots, but not particularly apparent due to brown ground colour; side of snout with series of 4-7 dark bars joining those from opposite side on dorsal surface; 2-3 similar lines sometimes joined to former, but perpendicular to them in orientation, on lower part of head extending from lower jaw to level of gill opening; dark blotch or lines usually present on chin; dark stripe (sometimes broken) on mid-ventral line from posterior part of head to anus; edge of eye with several dark lines radiating in all directions, those on dorsal part meeting opposite members on interorbital; cheeks with patch of small white spots, sometimes coalesced to form irregular broken lines; dorsal, anal, and pectoral fins whitish with dark-edged rays; caudal fin dusky to brownish. Two specimens, 52 and 104 mm SL, from the southern coast of East Africa are similar, but lack white spots on the side, although numerous dark ones are present. Perhaps this alteration in colour is due to the action of preservation. In addition, the smaller specimen possesses several dark vertical lines on the cheek, just below the eye.

REMARKS: *C. natalensis* is closely allied to *C. amboinensis*, from which it is perhaps derived. Although we have not examined a sufficient number of *C. natalensis* (see Table 1) there appears to be significant differences in the dorsal and pectoral ray counts between these species. *C. amboinensis* nearly always possess 12 dorsal rays whereas the normal complement for *C. natalensis* appears to be 11. The latter species usually has 16 pectoral rays compared with 17 for *C. amboinensis*. Furthermore, there are significant colour differences (Fig. 7).

Günther (1870) described *C. natalensis* as a subspecies or variety of *C. amboinensis*, but he only examined one individual. We have not examined the type specimen which is lodged at the British Museum, but Günther's brief description is diagnostic, particularly his mention of short horizontal and vertical lines on the side of the head and spots on the basal half of the caudal fin.

We have examined five specimens, 52.0-104.0 mm SL, from Reunion, Mauritius, Mozambique and Durban Bay, South Africa. Three of these were collected at Mauritius by J.E.R. at depths ranging from three to 10 metres.

***Canthigaster investigatoris* (Annandale and Jenkins)**

Fig. 13 and 14

Tropidichthys investigatoris Annandale and Jenkins, 1910: 16, pl. 1, fig. 4 (type locality, Andaman Islands).

DIAGNOSIS: Dorsal rays 9 or 10; anal rays 10; pectoral rays 15.

The following proportions are from one of the two syntypes, 40.7 mm SL. Figures in parentheses represent the measurement in millimetres. Depth 2.8 (14.3), head length 2.2 (18.6), tip of snout to dorsal origin 1.2 (33.1), to anal origin 1.3 (32.2), all in standard length. Snout 2.1 (9.0), postorbital length of head 4.0 (4.7), eye 3.4 (5.4), interorbital 4.0 (4.6), depth of caudal peduncle 3.3 (5.7), length of caudal peduncle 2.6 (7.2), of middle caudal rays 1.5 (12.5), all in head length.

Colour in alcohol uniformly tan with several narrow brown lines crossing snout and interorbital; 2-3 similar lines extending horizontally from upper caudal peduncle and dorsal fin base to pectoral region; fins tan, probably translucent in life.

REMARKS: The colour pattern in combination with the low pectoral ray count are distinctive characters. It is probably allied to *C. bennetti*, but differs appreciably with regards to colour and depth distribution.

This species is known on the basis of only two syntypes dredged from a depth of 55 fathoms off the Andaman Islands, Indian Ocean. One of these (ZSI F437/1), a specimen, 40.7 mm SL, was examined by G.R.A.

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REVIEW OF THE SHARPNOSE PUFFERFISHES

- Fig. 1. A. *Canthigaster solandri*, 52mm SL, Marshall Islands.
B. *Canthigaster solandri*, 74mm SL, Marshall Islands.
C. *Canthigaster solandri*, 67mm SL, Palau Islands.
- Fig. 2. A. *Canthigaster margaritata*, 74mm SL, Gulf of Aqaba, Red Sea.
B. *Canthigaster compressa*, 57mm SL, Solomon Islands.
C. *Canthigaster bennetti*, 66mm SL, Palau Islands.
- Fig. 3. A. *Canthigaster valentini*, 55mm SL, Great Barrier Reef.
B. *Canthigaster ocellicincta*, holotype, 50mm SL, Solomon Islands.
C. *Canthigaster coronata*, 54mm SL, Japan.
- Fig. 4. A. *Canthigaster marquesensis*, holotype, 70mm SL, Marquesas Islands.
B. *Canthigaster epilampra*, 69mm SL, Hawaiian Islands.
C. *Canthigaster rapaensis*, holotype, 78mm SL, Rapa, Austral Islands.
- Fig. 5. A. *Canthigaster rivulata*, 128mm SL, Japan.
B. *Canthigaster callisterna*, 225mm SL, Lord Howe Island.
C. *Canthigaster smithae*, holotype, 73mm SL, Mauritius.
- Fig. 6. A. *Canthigaster janthinoptera*, 59mm SL, Lord Howe Island.
B. *Canthigaster jactator*, 36mm SL, Hawaiian Islands.
C. *Canthigaster tyleri*, holotype, 65mm SL, Mauritius.
- Fig. 7. A. *Canthigaster amboinensis*, 58mm SL, Society Islands.
B. *Canthigaster natalensis*, 86mm SL, Mauritius.
C. *Canthigaster inframacula*, holotype, 76mm SL, Hawaiian Islands.

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Table 1. Fin Ray Counts For Species Of *Canthigaster* From The Indo-Pacific

| Species | Dorsal | | | | | Anal | | | | | Pectoral | | | |
|-----------------------|--------|-----|----|----|----|------|-----|----|----|----|----------|----|----|----|
| | 8 | 9 | 10 | 11 | 12 | 8 | 9 | 10 | 11 | 14 | 15 | 16 | 17 | 18 |
| <i>amboinensis</i> | | | 1 | 6 | 19 | | | 5 | 21 | | | 5 | 21 | |
| <i>bennetti</i> | | 34 | 46 | 1 | | 4 | 75 | 2 | | 1 | 49 | 31 | | |
| <i>callisterna</i> | | | 2 | 16 | | | | 17 | 1 | | | 1 | 12 | 4 |
| <i>compressa</i> | 5 | 65 | 13 | | | 6 | 77 | | | | 2 | 35 | 40 | 6 |
| <i>coronata</i> | | 1 | 17 | | | 1 | 12 | 5 | | | | 5 | 12 | 1 |
| <i>epilampra</i> | | | 15 | | | 1 | 14 | | | | | 1 | 11 | 3 |
| <i>inframacula</i> | | | 4 | | | | | 3 | 1 | | | | 2 | 2 |
| <i>investigatoris</i> | | 1 | 1 | | | | | 2 | | | 2 | | | |
| <i>jactator</i> | | 14 | 3 | | | | 16 | 1 | | | | 1 | 12 | 4 |
| <i>janthinoptera</i> | 2 | 67 | 10 | | | 2 | 74 | 3 | | | 1 | 16 | 53 | 9 |
| <i>margaritata</i> | 18 | 3 | | | | 19 | 2 | | | | | 1 | 18 | 2 |
| <i>marquesensis</i> | | 2 | 11 | | | | 13 | | | | | | 12 | 1 |
| <i>natalensis</i> | 1 | | | 4 | | | | 2 | 3 | | | 4 | 1 | |
| <i>ocellicincta</i> | | 5 | | | | | 5 | | | | | 5 | | |
| <i>punctatissima</i> | 3 | 18 | 3 | | | 5 | 18 | 1 | | | | 3 | 19 | 2 |
| <i>pygmaea</i> | 3 | 42 | 1 | | | | 44 | 2 | | 2 | 41 | 3 | | |
| <i>rapaensis</i> | | | | 3 | | | 5 | 1 | | | | 1 | 3 | 2 |
| <i>rivulata</i> | | 5 | 52 | | | | 6 | 51 | | | | 5 | 46 | 6 |
| <i>smithae</i> | | 1 | 5 | | | | 6 | | | | | 1 | 5 | |
| <i>solandri</i> | 3 | 117 | 22 | | | 9 | 132 | 1 | | | 2 | 42 | 92 | |
| <i>tyleri</i> | | 5 | | | | | 5 | | | | | 4 | 1 | |
| <i>valentini</i> | | 12 | | | | | 12 | | | | | 11 | 1 | |

Table 2. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster ocellincincta*

| Morphometric measurement | Holotype | | Paratypes | | |
|-------------------------------------|---------------|---------------------|----------------|----------------|-------------------|
| | BPBM 15933 | AMS I. 17500-001 | MNHN 1975-2 | USNM 211299 | WAM P25283-004 |
| Standard length (mm) | 50.1 | 42.3 | 35.7 | 33.4 | 28.0 |
| Body depth | 391 | 407 | 356 | 371 | 336 |
| Greatest body width | 240 | 222 | 221 | 228 | 250 |
| Head length | 427 | 411 | 448 | 443 | 479 |
| Snout length | 269 | 270 | 255 | 272 | 282 |
| Eye diameter | 104 | 113 | 140 | 135 | 129 |
| Interorbital width | 126 | 121 | 109 | 99 | 104 |
| Least depth of caudal peduncle | 204 | 182 | 165 | 180 | 154 |
| Length of caudal peduncle . . . | 198 | 203 | 182 | 174 | 179 |
| Snout to dorsal origin | 772 | 766 | 759 | 796 | 804 |
| Snout to anal origin | 796 | 780 | 798 | 796 | 796 |
| Length of dorsal fin base | 84 | 87 | 67 | 78 | 71 |
| Length of anal fin base | 80 | 78 | 56 | 69 | 64 |
| Longest dorsal ray | 156 | 163 | 157 | 159 | 171 |
| Longest anal ray | 134 | 135 | 132 | 150 | 143 |
| Length of pectoral fin | 132 | 154 | 148 | 150 | 146 |
| Length of caudal fin | 343 | 340 | 336 | 344 | 357 |

Table 3. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster marquesensis*

| Morphometric measurement | Holotype | | Paratypes | | | |
|-------------------------------------|---------------|---------------|---------------|---------------|-------------------------|----------------|
| | BPBM 11129 | BPBM 11109 | BPBM 11145 | BPBM 11126 | AMS I. 11678- 001 | USNM 208267 |
| Standard length (mm) | 69.6 | 89.0 | 82.1 | 71.9 | 62.8 | 53.4 |
| Body depth | 352 | 340 | 366 | 344 | 344 | 371 |
| Greatest body width | 265 | 227 | 238 | 195 | 247 | 275 |
| Head length | 371 | 369 | 387 | 373 | 369 | 388 |
| Snout length | 246 | 253 | 272 | 239 | 245 | 264 |
| Eye diameter | 86 | 82 | 91 | 76 | 96 | 94 |
| Interorbital width | 91 | 84 | 102 | 90 | 84 | 92 |
| Least depth of caudal peduncle | 157 | 148 | 152 | 145 | 151 | 165 |
| Length of caudal peduncle . . . | 230 | 226 | 231 | 234 | 252 | 234 |
| Snout to dorsal origin | 741 | 721 | 743 | 727 | 731 | 747 |
| Snout to anal origin | 754 | 755 | 771 | 776 | 783 | 777 |
| Length of dorsal fin base | 80 | 66 | 73 | 68 | 76 | 79 |
| Length of anal fin base | 72 | 66 | 62 | 58 | 61 | 62 |
| Longest dorsal ray | 155 | 140 | 158 | 157 | 151 | 172 |
| Longest anal ray | 105 | 107 | 116 | 129 | 115 | 135 |
| Length of pectoral fin | 134 | 124 | 138 | 122 | 140 | 150 |
| Length of caudal fin | 270 | 239 | 256 | 261 | 271 | 315 |

Table 4. Fin Ray Counts Of *Canthigaster bennetti* From Different Localities

| Locality | Dorsal | | | 8 | Anal | | Pectoral | | |
|------------------|--------|----|----|---|------|----|----------|----|----|
| | 9 | 10 | 11 | | 9 | 10 | 14 | 15 | 16 |
| Society Islands | 3 | 13 | | | 15 | 1 | | 6 | 10 |
| Tuamotus | 1 | 3 | | 1 | 3 | | | 2 | 2 |
| Guam | 2 | 3 | | | 5 | | | 2 | 3 |
| Palau | | 1 | | | 1 | | | 1 | |
| New Guinea | 1 | 1 | 1 | | 3 | | | 2 | 1 |
| New Hebrides | 3 | 8 | | 1 | 10 | | | 5 | 6 |
| Farquhar Islands | 5 | 2 | | | 6 | 1 | 1 | 6 | |
| East Africa | 19 | 15 | | 2 | 32 | | | 25 | 9 |
| TOTALS | 34 | 46 | 1 | 4 | 75 | 2 | 1 | 49 | 31 |

Table 5. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster smithae*

| Morphometric measurement | Holotype | | | RUSI 2231 | Paratypes | | |
|-------------------------------------|---------------|----------------|--|--------------|-----------------------|---------------|---------------|
| | BPBM 18009 | USNM 213575 | | | WAM P25126- 001 | BPBM 18010 | BPBM 18010 |
| Standard length (mm) | 73.0 | 63.6 | | 51.5 | 50.0 | 43.1 | 27.0 |
| Body depth | 362 | 319 | | 353 | 364 | 348 | 352 |
| Greatest body width | 251 | 244 | | 282 | 242 | 232 | 230 |
| Head length | 403 | 415 | | 427 | 432 | 425 | 467 |
| Snout length | 268 | 245 | | 256 | 272 | 251 | 244 |
| Eye diameter | 93 | 102 | | 120 | 110 | 118 | 159 |
| Interorbital width | 108 | 91 | | 108 | 106 | 97 | 85 |
| Least depth of caudal peduncle | 178 | 157 | | 175 | 184 | 158 | 133 |
| Length of caudal peduncle . . . | 219 | 197 | | 194 | 220 | 200 | 156 |
| Snout to dorsal origin | 719 | 747 | | 777 | 720 | 731 | 759 |
| Snout to anal origin | 785 | 774 | | 816 | 780 | 740 | 833 |
| Length of dorsal fin base | 95 | 71 | | 80 | 80 | 72 | 81 |
| Length of anal fin base | 85 | 71 | | 78 | 76 | 72 | 74 |
| Longest dorsal ray | 155 | 164 | | 186 | 186 | 188 | 219 |
| Longest anal ray | 130 | 126 | | 155 | 140 | 174 | 178 |
| Length of pectoral fin | 147 | 149 | | 151 | 160 | 155 | 163 |
| Length of caudal fin | 258 | 261 | | 330 | 310 | 332 | 333 |

Table 6. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster rapaensis*

| Morphometric measurement | Holotype | | Paratypes | | | |
|-------------------------------------|---------------|-------------------------|---------------|----------------|----------------|---------------|
| | BPBM 12952 | AMS I. 16588- 001 | BPBM 12662 | USNM 208346 | USNM 208277 | BPBM 12983 |
| Standard length (mm) | 78.0 | 96.9 | 84.1 | 81.6 | 73.6 | 61.0 |
| Body depth | 372 | 408 | 363 | 368 | 359 | 377 |
| Greatest body width | 233 | 237 | 213 | 233 | 251 | 238 |
| Head length | 412 | 402 | 392 | 417 | 398 | 413 |
| Snout length | 269 | 270 | 268 | 278 | 268 | 248 |
| Eye diameter | 96 | 83 | 86 | 99 | 95 | 105 |
| Interorbital width | 96 | 102 | 100 | 85 | 90 | 85 |
| Least depth of caudal peduncle | 172 | 165 | 155 | 172 | 170 | 161 |
| Length of caudal peduncle . . . | 205 | 236 | 214 | 208 | 193 | 216 |
| Snout to dorsal origin | 749 | 741 | 672 | 717 | 709 | 738 |
| Snout to anal origin | 776 | 757 | 773 | 772 | 792 | 785 |
| Length of dorsal fin base | 82 | 74 | 87 | 81 | 76 | 77 |
| Length of anal fin base | 74 | 73 | 68 | 81 | 53 | 72 |
| Longest anal ray | 154 | 138 | 139 | 147 | 156 | 187 |
| Length of pectoral fin | 138 | 116 | 119 | 123 | 129 | 148 |
| Length of caudal fin | 295 | 279 | 269 | 276 | 281 | 328 |

Table 7. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster inframacula*

| Morphometric measurement | Holotype | AMS I. 16764-001 | Paratypes | |
|-------------------------------------|----------------|---------------------|---------------|---------------|
| | USNM 208483 | | BPBM 15934 | BPBM 15934 |
| Standard length (mm) | 76.0 | 110.6 | 102.9 | 84.7 |
| Body depth | 388 | 402 | 422 | 354 |
| Greatest body width | 205 | 226 | 234 | 201 |
| Head length | 392 | 383 | 398 | 387 |
| Snout length | 234 | 260 | 248 | 237 |
| Eye diameter | 79 | 65 | 72 | 85 |
| Interorbital width | 132 | 127 | 136 | 130 |
| Least depth of caudal peduncle . . | 170 | 165 | 164 | 151 |
| Length of caudal peduncle | 203 | 230 | 238 | 179 |
| Snout to dorsal origin | 779 | 770 | 788 | 797 |
| Snout to anal origin | 783 | 761 | 780 | 779 |
| Length of dorsal fin base | 83 | 101 | 97 | 92 |
| Length of anal fin base | 84 | 99 | 93 | 86 |
| Longest dorsal ray | 128 | 147 | 126 | 130 |
| Longest anal ray | 134 | 142 | 129 | 133 |
| Length of pectoral fin | 141 | 131 | 127 | 142 |
| Length of caudal fin | 268 | 253 | 260 | 240 |

Table 8. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster tyleri*

| Morphometric measurement | Holotype | | Paratypes | | ANSP 109816 |
|-----------------------------------|---------------|-------------------|---------------|-----------------------|----------------|
| | BPBM 18014 | WAM P25169-001 | BPBM 18011 | BM(NH) 1974.3.11.8 | |
| Standard length (mm) | 63.4 | 58.0 | 49.2 | 45.9 | 33.5 |
| Body depth | 375 | 379 | 370 | 349 | 322 |
| Greatest body width | 219 | 245 | 234 | 229 | 218 |
| Head length | 402 | 426 | 443 | 458 | 427 |
| Snout length | 256 | 248 | 268 | 281 | 254 |
| Eye diameter | 93 | 107 | 87 | 102 | 128 |
| Interorbital width | 121 | 117 | 112 | 102 | 90 |
| Least depth of caudal peduncle | 260 | 190 | 193 | 187 | 161 |
| Length of caudal peduncle . . . | 218 | 216 | 187 | 181 | 188 |
| Snout to dorsal origin | 740 | 750 | 762 | 795 | 770 |
| Snout to anal origin | 782 | 784 | 803 | 830 | 812 |
| Length of dorsal fin base | 79 | 84 | 91 | 85 | 66 |
| Length of anal fin base | 79 | 83 | 83 | 85 | 69 |
| Longest dorsal ray | * | 152 | 142 | * | 134 |
| Longest anal ray | 121 | 122 | 128 | * | 158 |
| Length of pectoral fin | 126 | 155 | 146 | 153 | 137 |
| Length of caudal fin | 287 | 300 | 289 | 275 | 301 |

* *damaged***Table 9. Morphometric Measurements (In Thousandths Of The Standard Length) For Type Specimens Of *Canthigaster pygmaea***

| Morphometric measurement | Holotype | | Paratypes | | | |
|------------------------------------|---------------|----------------|-----------------------|----------------|-------------|-------------|
| | BPBM 18012 | USNM 212287 | WAM P25124- 001 | USNM 212284 | HUJ 7006 | HUJ 7008 |
| Standard length (mm) | 30.3 | 36.3 | 34.2 | 32.8 | 29.5 | 26.1 |
| Body depth | 403 | 369 | 404 | 396 | 353 | 395 |
| Greatest body width | 234 | 273 | 205 | 305 | 251 | 268 |
| Head length | 446 | 433 | 424 | 473 | 468 | 494 |
| Snout length | 261 | 264 | 240 | 274 | 261 | 261 |
| Eye diameter | 102 | 118 | 96 | 116 | 112 | 142 |
| Interorbital width | 99 | 107 | 108 | 122 | 98 | 107 |
| Least depth of caudal peduncle | 168 | 165 | 199 | 186 | 163 | 172 |
| Length of caudal peduncle . . . | 215 | 215 | 243 | 253 | 190 | 215 |
| Snout to dorsal origin | 792 | 774 | 766 | 793 | 905 | 801 |
| Snout to anal fin origin | 792 | 804 | 743 | 793 | 814 | 774 |
| Length of dorsal fin base | 86 | 80 | 85 | 91 | 64 | 69 |
| Length of anal fin base | 66 | 80 | 73 | 88 | 68 | 69 |
| Longest dorsal ray | 142 | 91 | 155 | 149 | 156 | 172 |
| Longest anal ray | 132 | 138 | 129 | 128 | 129 | 146 |
| Length of pectoral fin | 149 | 129 | 149 | 152 | 132 | 153 |
| Length of caudal fin | 300 | 309 | 313 | 335 | 336 | 352 |

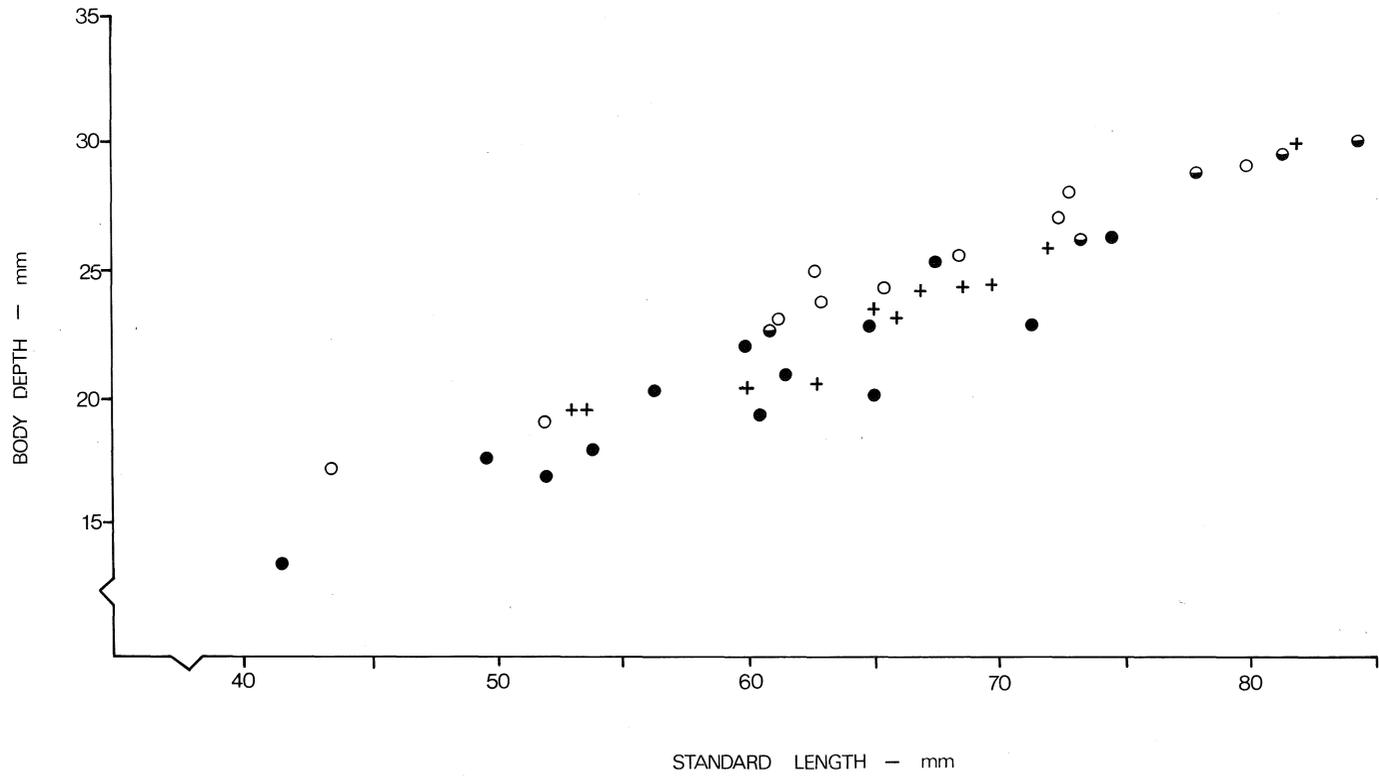


Fig. 9. Comparison of body depth with standard length for *Canthigaster bennetti* (solid dots), *C. epilampra* (hollow circles), *C. marquesensis* (crosses), and *C. rapaensis* (half-black circles).

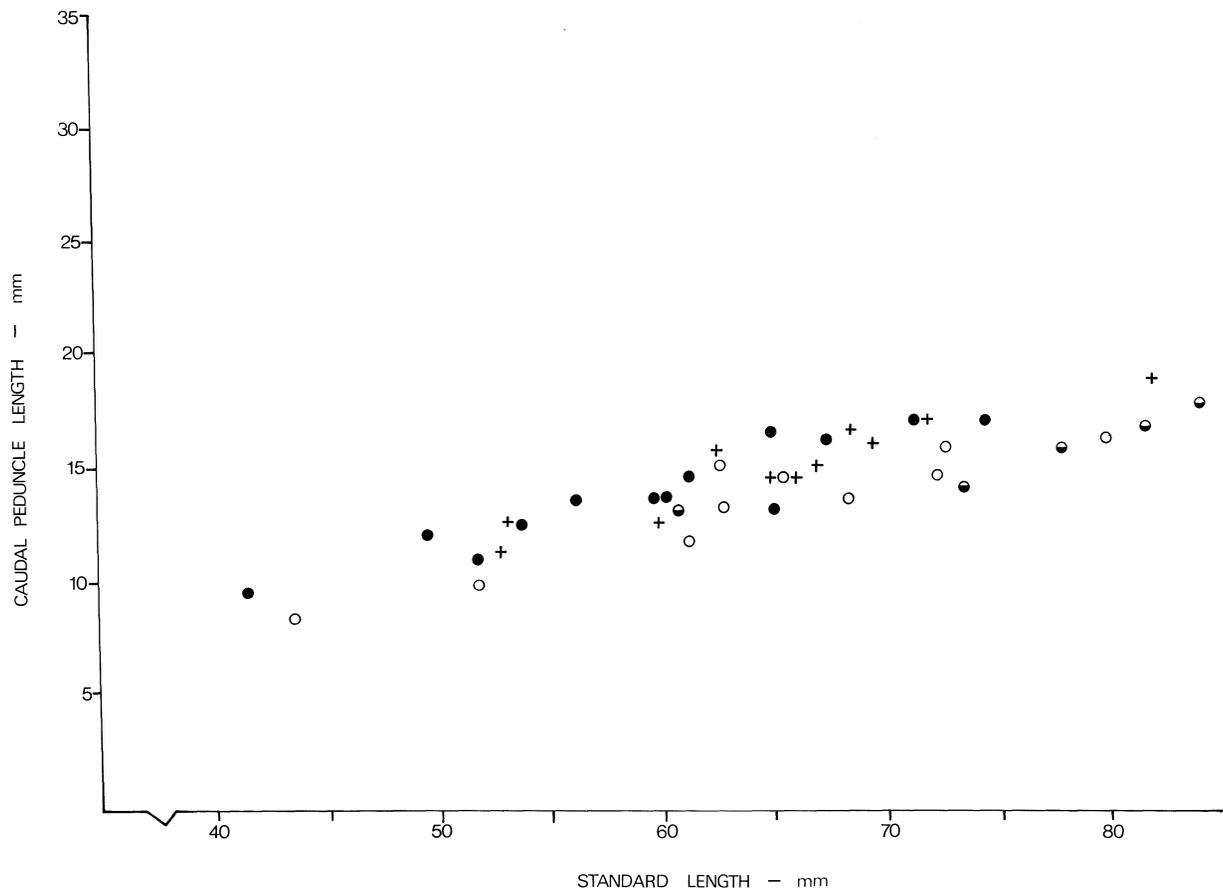


Fig. 10. Comparison of caudal peduncle length with standard length for *Canthigaster bennetti* (solid dots), *C. epilampra* (hollow circles), *C. marquesensis* (crosses), and *C. rapaensis* (half-black circles).



Fig. 11. Underwater photograph of juvenile of *Canthigaster callisterna*, 50 mm SL, Sydney, NSW. (R. Kuiter photo).

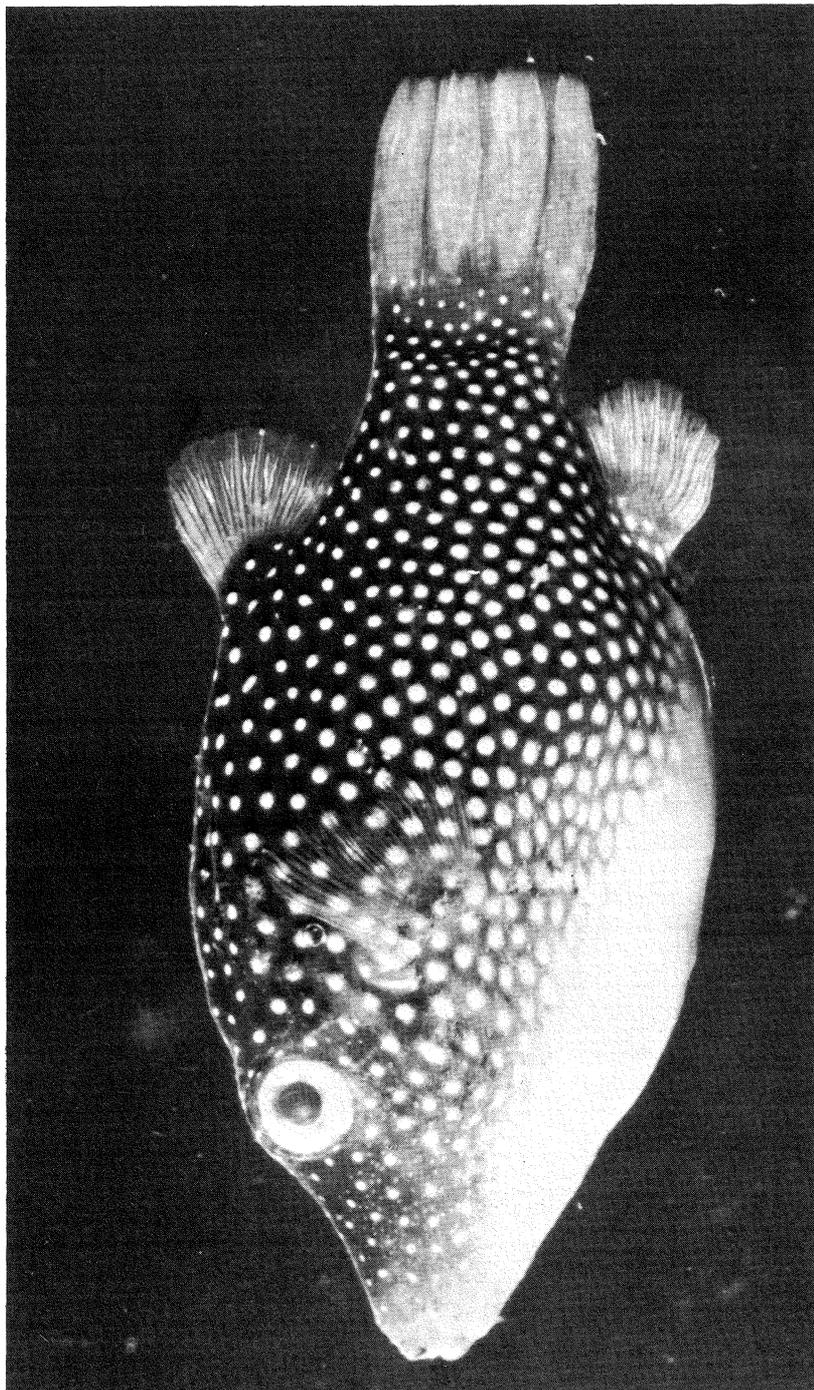


Fig. 12. *Canthigaster punctatissima*, 40 mm SL, Panama.



Fig. 13. *Canthigaster investigatoris*, syntype, 40.7 mm SL, Andaman Islands.

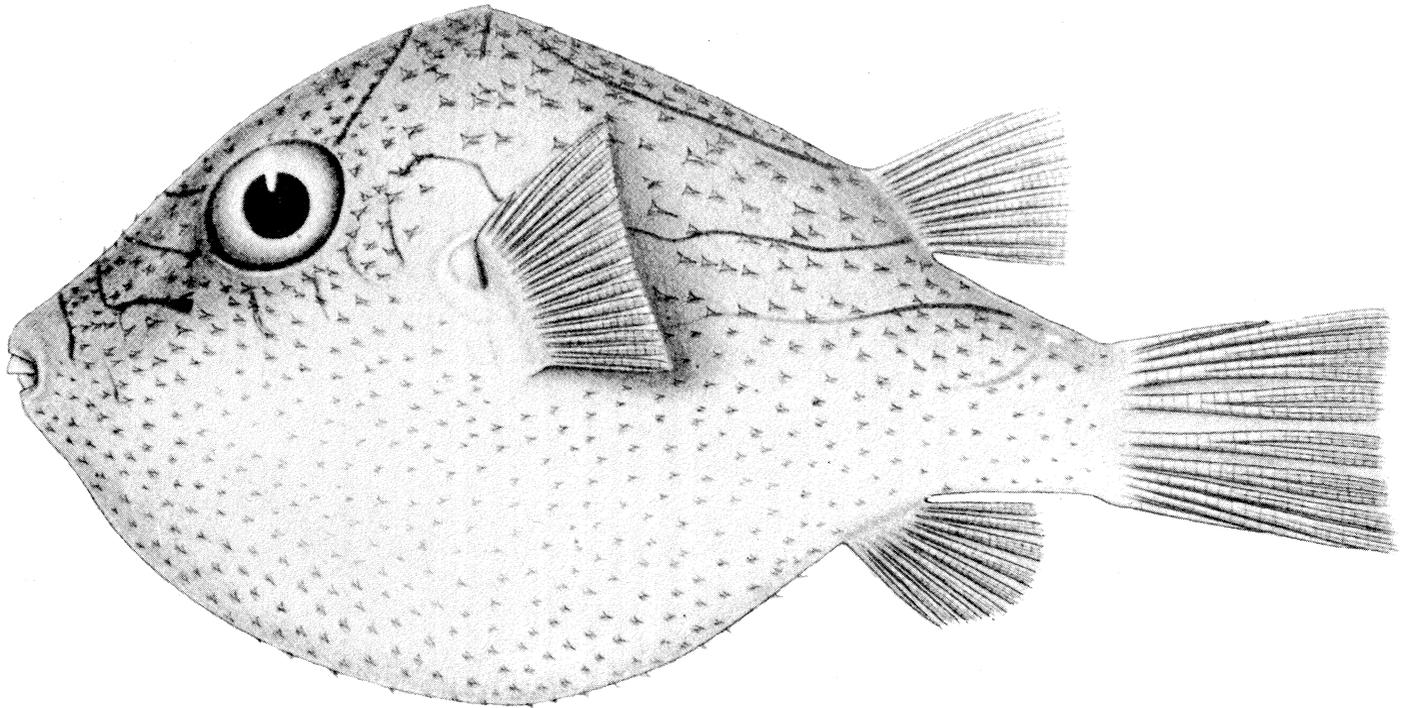


Fig. 14. *Canthigaster investigatoris*, drawing of syntype (from Annandale and Jenkins, 1910).

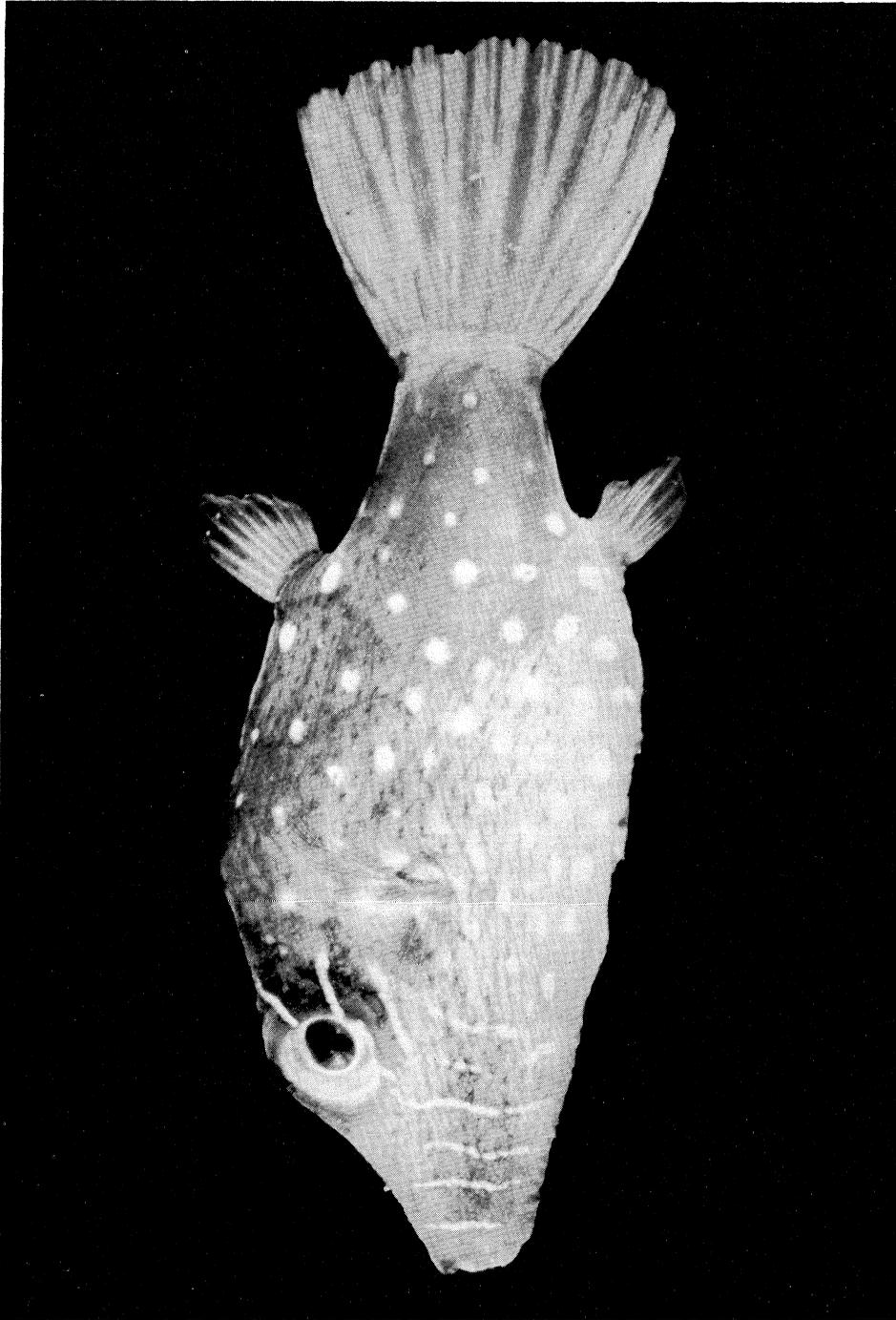


Fig. 15. *Canthigaster pygmaea*, holotype, 30 mm SL, Gulf of Aqaba, Red Sea.

REVIEW OF THE SHARPNOSE PUFFERFISHES

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Fig. 11. Underwater photograph of juvenile of *Canthigaster callisterna*, 50 mm SL, Sydney, NSW. (R. Kuitert photo).

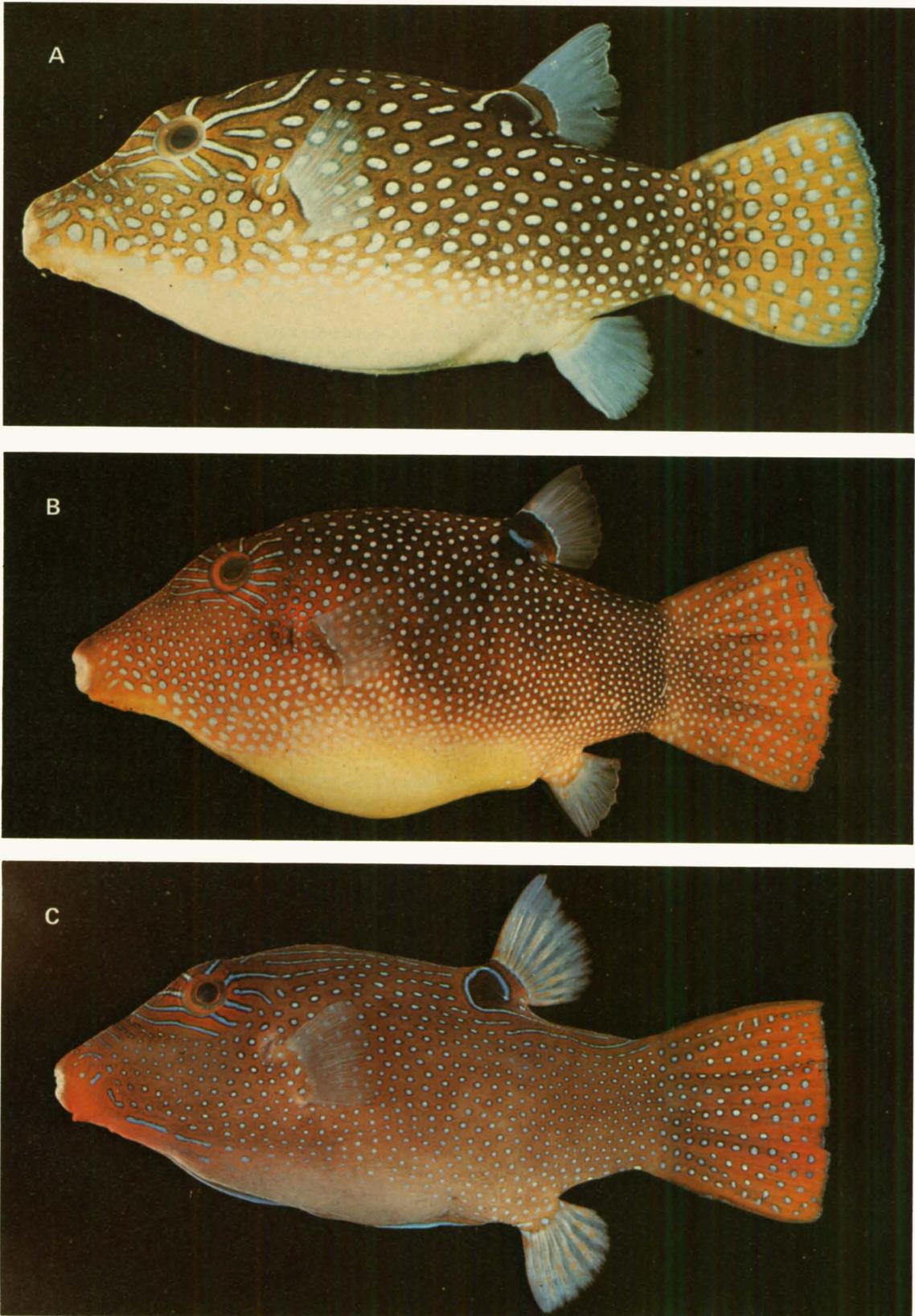


Fig. 1.

REVIEW OF THE SHARPNOSE PUFFERFISHES

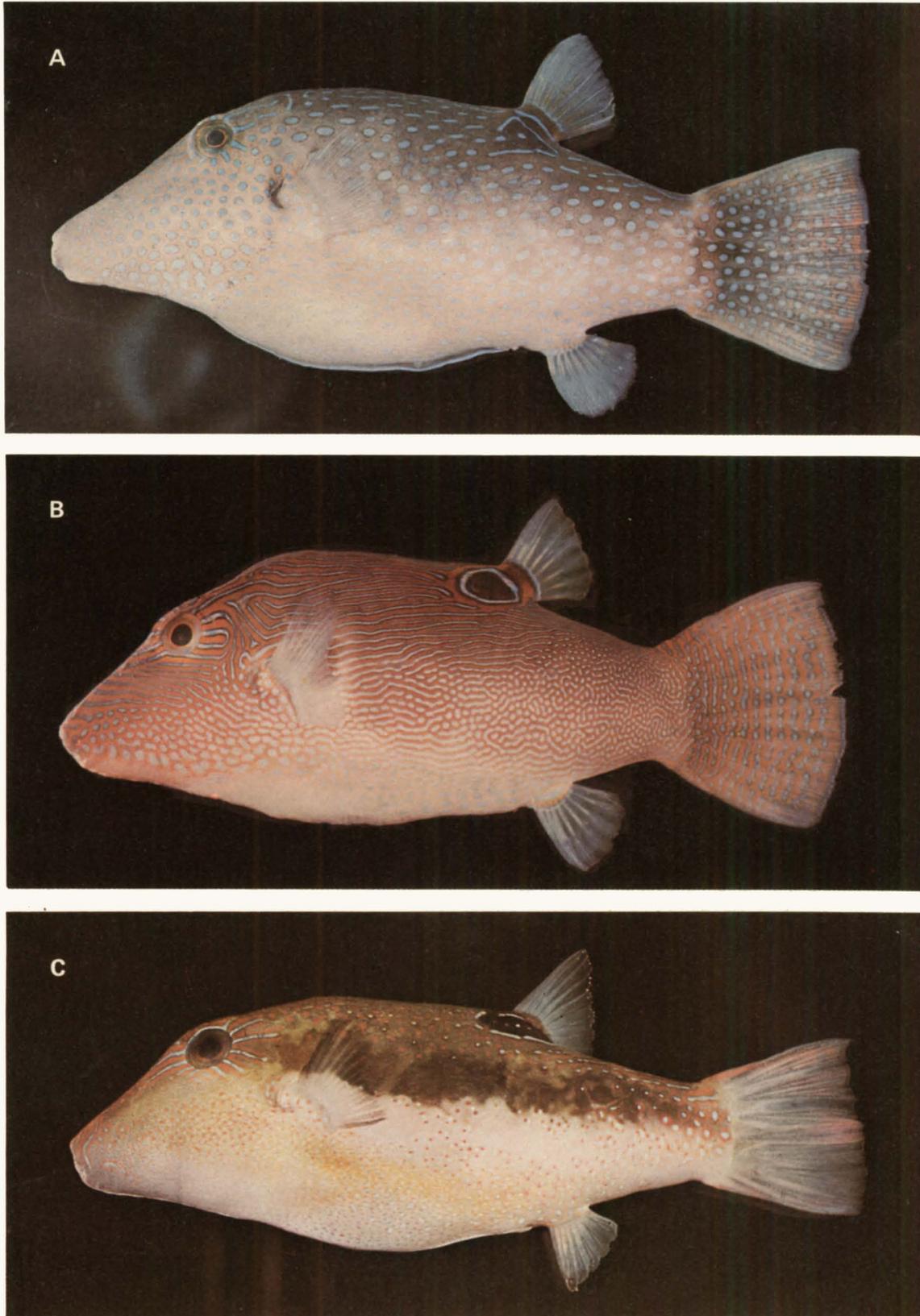


Fig. 2.

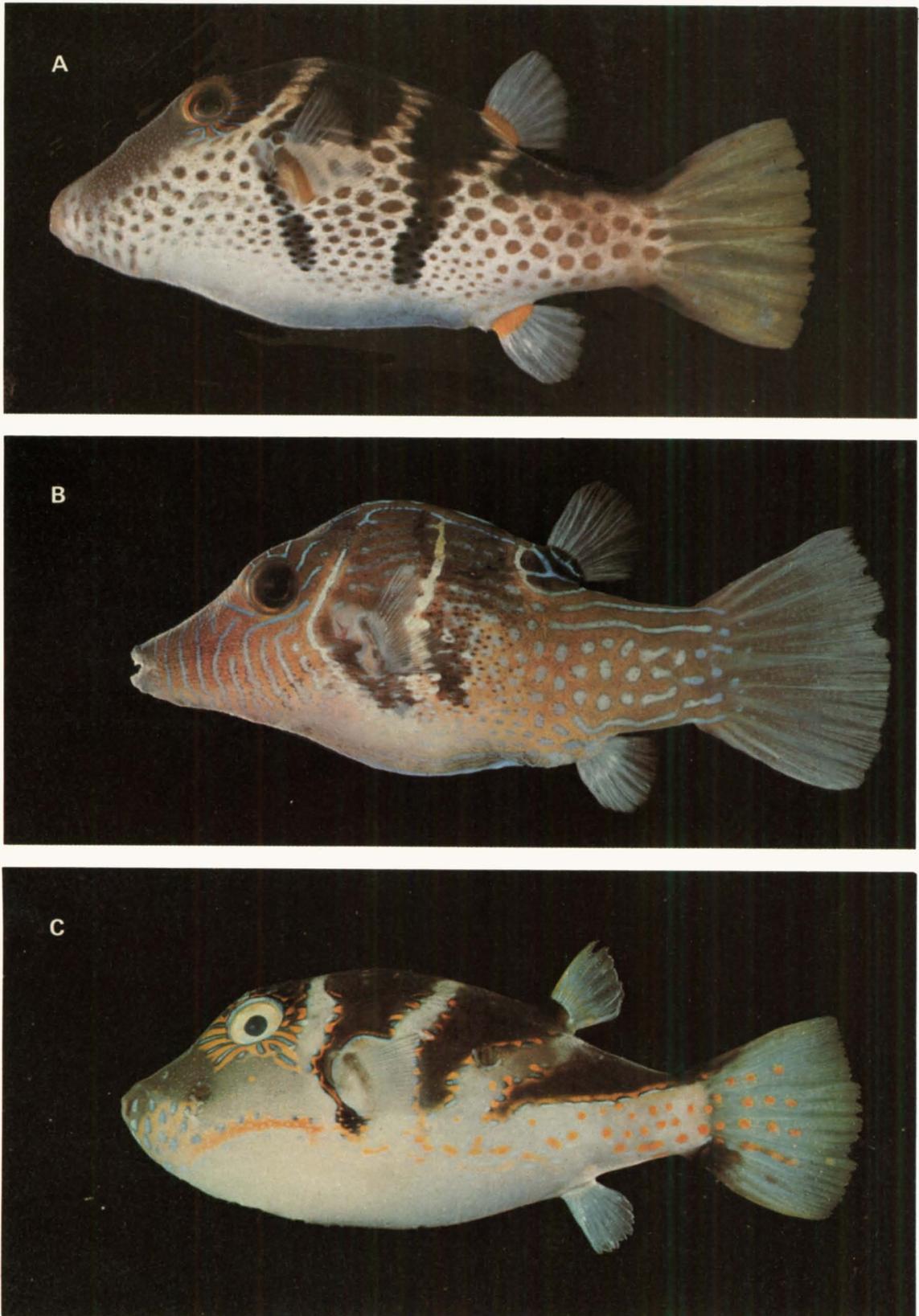


Fig. 3.

REVIEW OF THE SHARPNOSE PUFFERFISHES

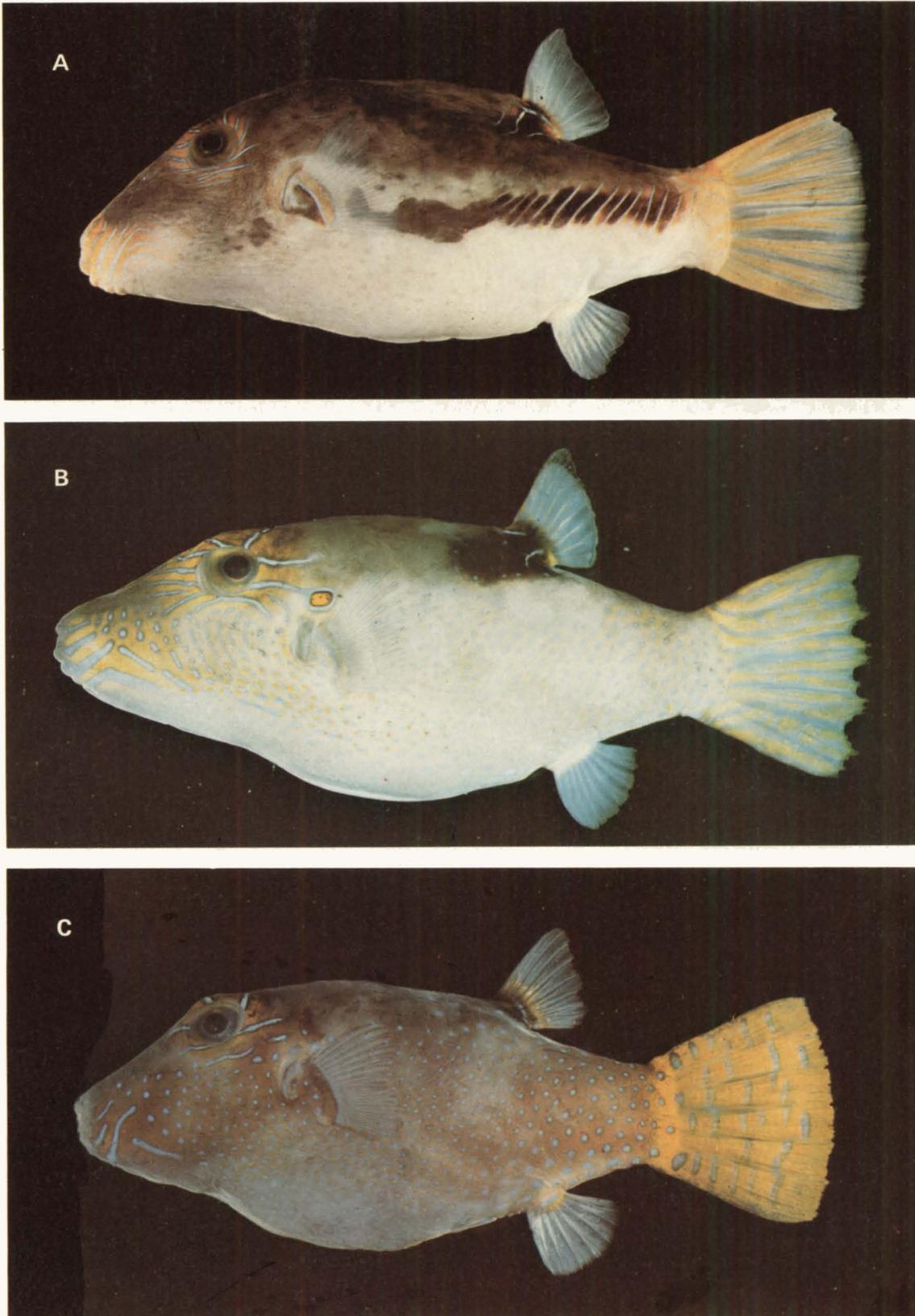


Fig. 4.

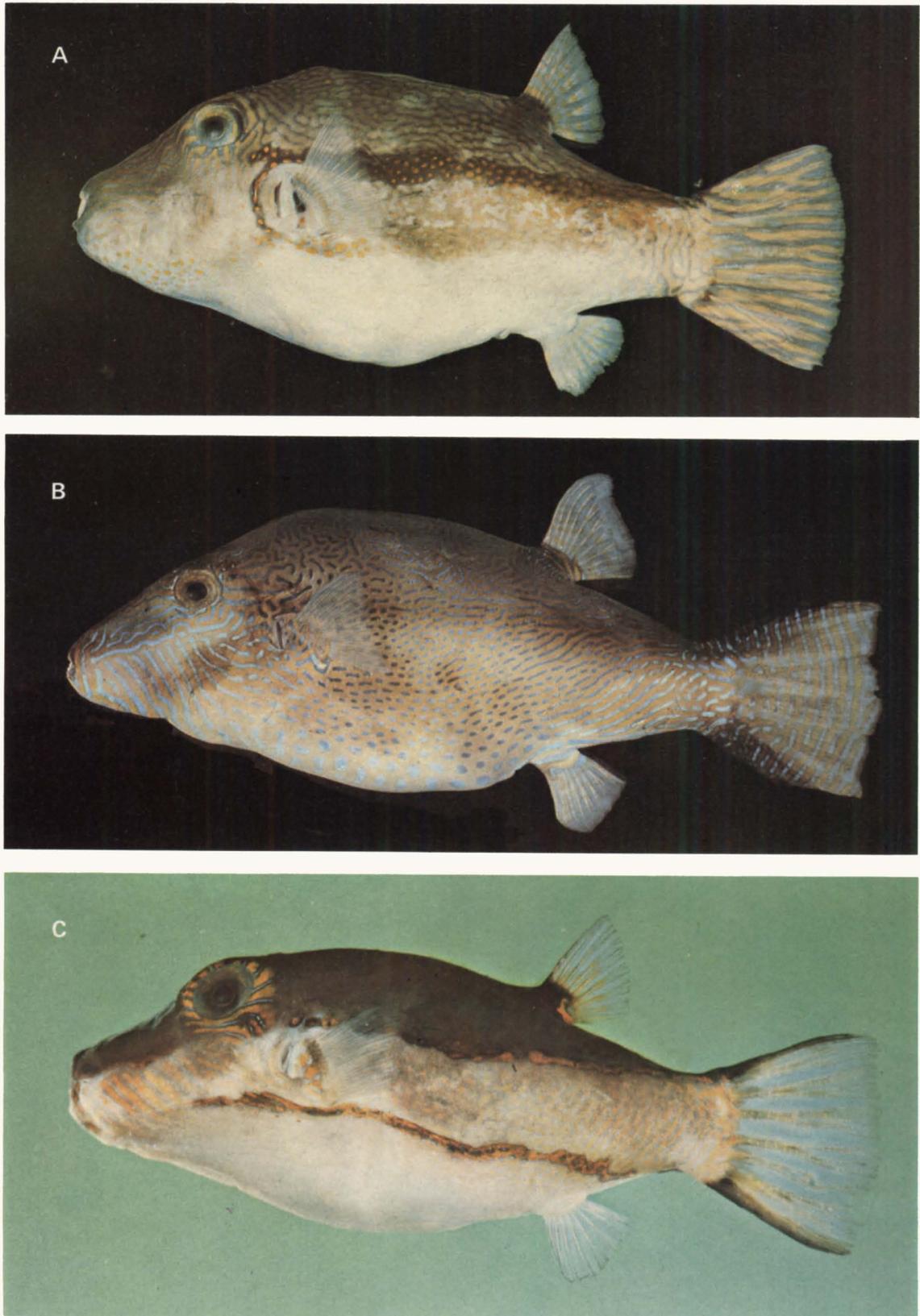


Fig. 5.

REVIEW OF THE SHARPNOSE PUFFERFISHES

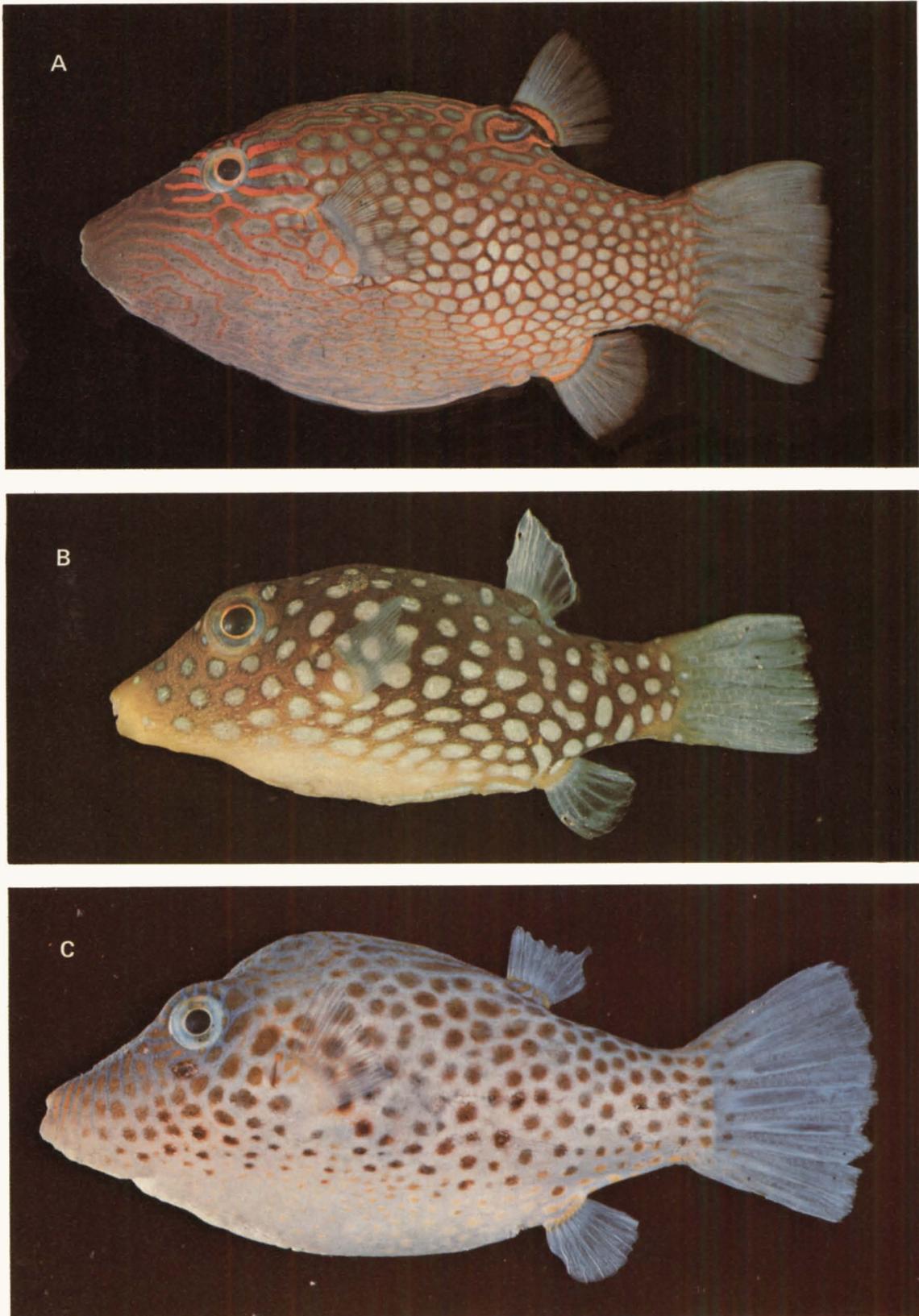


Fig. 6.

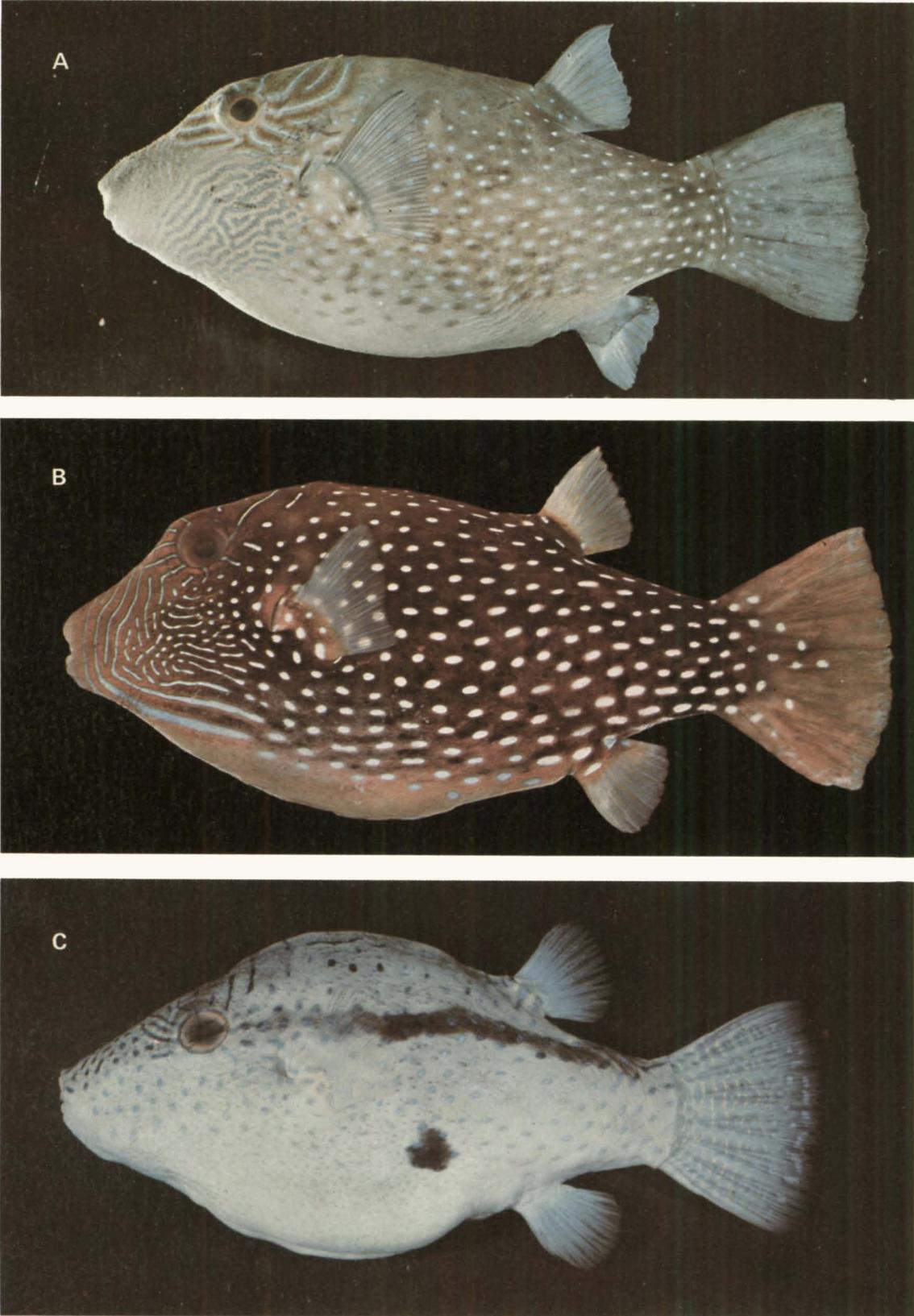


Fig. 7.