

## On the Validity of the Tetraodontid Fish *Arothron manilensis* (Procé)

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Lacepède (1798: 486, pl. 24, fig. 1) provided the first description of the puffer *Arothron immaculatus* but gave it only the common name *Tetrodon* Sanstache. Bloch and Schneider (1801: 507) proposed the scientific name *Tetrodon immaculatus*, citing little more than the description and figure of Lacepède. No type locality was given, but it was most likely Mauritius since Lacepède's description and figure were taken from the manuscripts of Commerson.

De Procé (1822: 130) described *Tetrodon manilensis* (misspelled *manillensis* by later authors) from Manila Bay, Philippines. His description was also very brief, but his mention of eight or ten narrow greenish stripes has been regarded as sufficiently diagnostic.

Between 1829 and 1855 six synonyms of *immaculatus* and three of *manilensis* were named (see synonymy in the two species accounts below).

Bleeker (1855a, 1855b) was the first to place these puffers in the genus *Arothron* Müller; however, he classified them in *Crayracion* Walbaum in his Atlas Ichthyologique (1865). Most recent authors, including Tyler (1980), have used *Arothron* for these two species (or just for *immaculatus* when they believed they were synonymous).

Günther (1870: 291) considered them as varieties of one species, *Tetrodon immaculatus*, preferring to use *virgata* for the striped variety instead of *manilensis*. He listed the synonymy and specimens separately under the two varietal headings.

Since 1870 nearly all authors have followed Günther in regarding *immaculatus* and *manilensis* as a single species. Exceptions are Kendall and Goldsborough (1911: 335) who recorded striped specimens from Fiji and Arno, Marshall Islands as *Tetraodon manillensis* and believed the presence or absence of stripes is a specific-level difference (although offering no other characters for differentiation); Seale (1935: 377) who recorded a specimen from Fiji as *T. manillensis*; Matsuura (1984: 147) who recorded *A. manilensis* from Truk and regarded it as distinct on the basis of color pattern; and Matsuura in Masuda *et al.* (1984: 365, pl. 332,

E, F).

Jordan and Seale (1906: 370–71) wrote, “Apparently Dr. Günther is right in regarding *Tetraodon manillensis*, with the back streaked, as the young of *Tetraodon immaculatus*, in which species the back is plain olive. Specimens before us from Negros, in the Philippines, show that the black stripes on the back disappear with age. Both Günther and Bleeker record specimens of the striped form, *manillensis*, of 10 to 12 inches in length. All our Samoan specimens are young, and all have the black stripes, but we have no doubt that they are specifically identical with the unstriped *Tetraodon immaculatus*. The best distinctive character of this species is the black edge to the caudal.”

Herre (1924: 490) concluded, after examining 40 preserved specimens from the Philippines and Borneo and observing ten living individuals in an aquarium, “These color phases often seem to have no relation to size or maturity, though the striped form is probably sexually immature.”

Abe (1949: 121) regarded the striped individuals from the “Malay Archipelago, Micronesia, Queensland and New South Wales” as a subspecies, *Tetraodon immaculatus manillensis*. It is true that there are differences in the geographical distribution of *immaculatus* and *manilensis* (Fig. 1). Only *immaculatus* is found in the western Indian Ocean and only *manilensis* at the islands of Oceania. But both occur in Indonesia, the Philippines, and the Ryukyu Islands. The author has collected both at the island of Lombok, Indonesia. Clearly these two forms cannot be regarded as subspecies.

An effort was made to find some character in addition to color whereby *immaculatus* might be distinguished from *manilensis*. Closely related tetraodontid fishes are often difficult to separate. Fin-ray counts are nearly always the same within a genus and even within broad generic groupings (subfamilies). Because of much individual variation, the amorphous body and loose skin, proportional measurements vary greatly within a species. It was noticed, however, that the caudal fin of *manilensis* is longer on the average than that of *immaculatus*. Measurements were made of numerous specimens of both forms (Fig. 2). The difference in caudal length is obviously significant, though there is broad overlap. The mean ratio of caudal length to standard length (SL) is 2.66 for

*manilensis* and 3.00 for *immaculatus*. The remaining fins are also longer on the average for *manilensis*. It is therefore concluded that these two forms are species.

Specimens were examined at, or loans obtained from, the following institutions: Academy of Natural Sciences of Philadelphia (ANSP), Bernice Pauahi Bishop Museum, Honolulu (BPBM); British Museum (Natural History), London (BM[NH]); California Academy of Sciences, San Francisco (CAS, SU); Museum National d'Histoire Naturelle, Paris (MNHN); Rijksmuseum van Natuurlijke Historie, Leiden (RMNH); Senckenberg Museum, Frankfurt (SMF); U.S. National Museum of Natural History, Washington, D.C. (USNM); and the Zoölogisch Museum, Amsterdam (ZMA).

In addition, John R. Paxton has examined material for the author at the Australian Museum, Sydney (AMS) and Gerald R. Allen did the same for the Western Australian Museum, Perth (WAM).

Lengths of specimens listed in Material examined are standard length. Proportional measurements (except those of caudal fin length) are based on specimens greater than 90 mm SL. These measurements have been rounded to the nearest .05. Caudal length measurements were made of 66 specimens of *A. manilensis* and 75 of *A. immaculatus*. Not all data points could be plotted on Fig. 2 because of the superimposition or broad overlap of symbols.

***Arothron immaculatus***  
(Figs. 1–3)

*Tetrodon immaculatus* Bloch and Schneider, 1801: 507 (no locality).

*Tetraodon sordidus* Rüppell, 1829: 64; Rüppell, 1837: 60, pl. 16, fig. 4 (type locality, Massaua, Red Sea).

*Tetraodon parvus* De Joannis, 1835: no. iv, pl. 15 (type locality, near Quseir, Red Sea).

*Tetraodon scaber* Eydoux and Souleyet, 1841: 214, pl. 10, fig. 1 (type locality, Macao).

*Tetraodon Kunhardtii* Bleeker, 1851a: 97 (type locality, Padang, Sumatra).

*Tetraodon aspilos* Bleeker, 1851b: 495 (type locality, Riouw).

*Tetrodon Basilevskianus* Basilevsky, 1855: 262 (type locality, China).

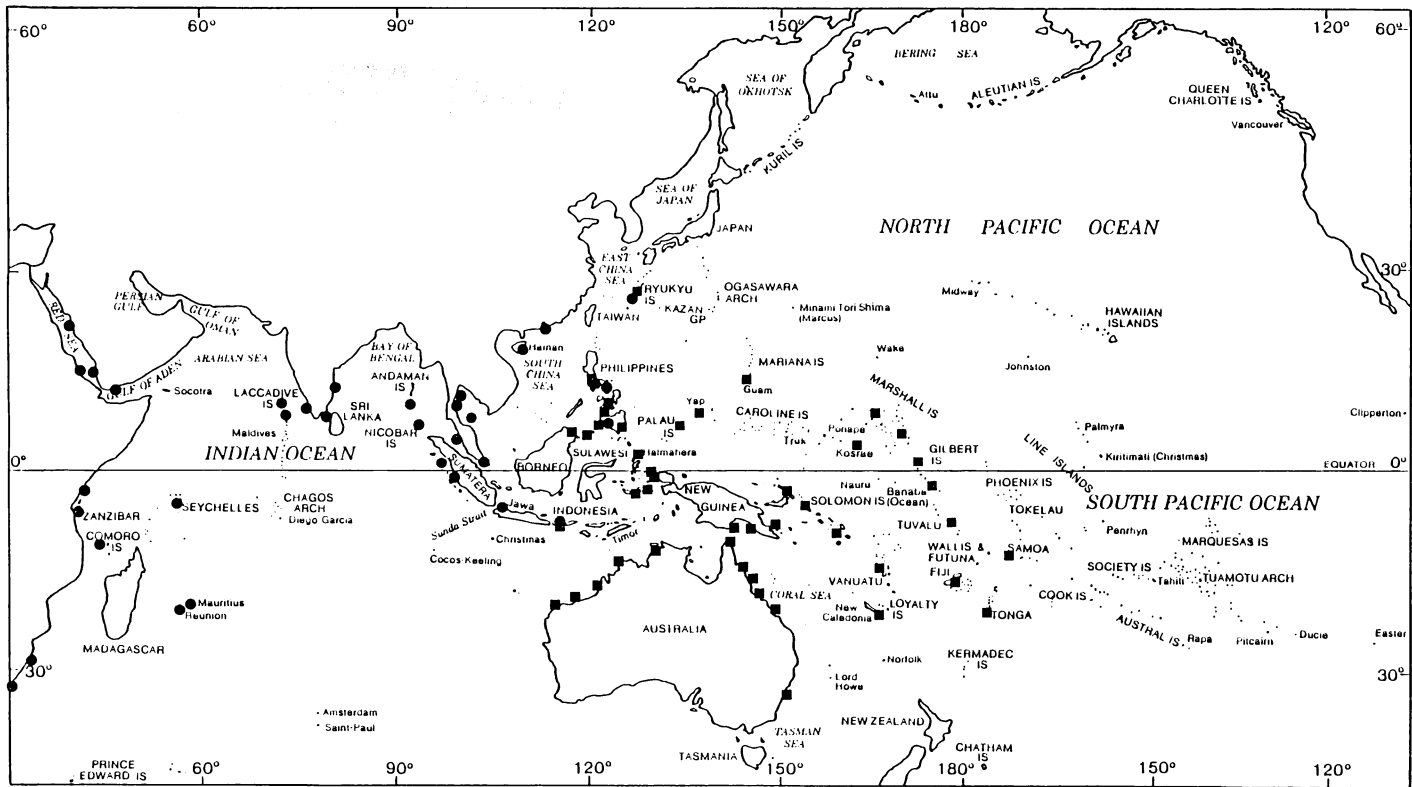
**Diagnosis.** Dorsal rays 9–11 (usually 10); anal rays 9–10 (usually 10); pectoral rays 16–19; gill

rakers 6–8 (four specimens). Nasal organ anterior and medial to eye, consisting of two fleshy tentacles branching from a common base (no opening visible). Head and body covered with small slender spinules except posteriorly on caudal peduncle (naked area broader ventrally) and regions around mouth, eye, dorsal and anal fins and pectoral fin, and gill opening. Head length (measured to upper end of gill opening) 2.6–2.9 in SL; snout short and obtuse, 2.25–2.4 in head; fleshy eye diameter 5.0–6.8 in head; interorbital space flat (except at margins), the least bony width 2.65–3.1 in head; caudal peduncle compressed, the least depth 2.3–2.5 in head. Dorsal and anal fins rounded to slightly pointed, the dorsal entirely anterior to the anal; longest dorsal ray 2.2–2.7 in head; longest anal ray 2.25–2.8 in head; caudal fin slightly rounded and moderately long, 2.6–3.6 ( $\bar{x}$ =3.00) in SL; pectoral fins truncate to slightly rounded, 2.4–3.0 in head. Color in preservative dark brownish gray dorsally, shading to whitish ventrally, the region of gill opening and pectoral fin base often darker, the edge of upper lip whitish; median fins light brownish gray, the caudal conspicuously edged with blackish; pectoral fins pale. In life the color is often olivaceous dorsally, the median fins yellowish, the pectorals with yellow rays and hyaline membranes.

**Remarks.** *A. immaculatus* ranges from the Red Sea (Rüppell, 1829) south to Port Alfred, South Africa (Smith, 1949), eastward through Indonesia (Bleeker, 1865) to the western Pacific where it is distributed north to southern Japan (Kyushin *et al.*, 1982). Among the intervening records are India (Russell, 1803); Pinang (Cantor, 1849); Nicobars (Kner, 1865); Zanzibar and Gulf of Aden (Playfair and Günther, 1867); Mauritius and Port Natal (=Durban) (Günther, 1870) (Günther's specimen *l* from New Caledonia is *A. manilensis*, not *immaculatus*); Madagascar, Comoros, Réunion and Seychelles (Bleeker and Pollen, 1874); Sri Lanka (Munro, 1955); Laccadives (Jones and Kumaran, 1980); and the South China Sea (Kyushin *et al.*, 1982).

Of the habitat of this species Smith (1949) wrote, "usually found in weedy areas, often in estuaries." Bishop Museum specimens have been collected from seagrass beds and mangrove areas in 1–1.5 m and by trawling over silty bottoms in 17 m.

Largest specimens examined, RMNH 12378



Randall: Validity of *Arothron manilensis*

Fig. 1. Distribution of *Arothron immaculatus* (●) and *A. manilensis* (■). Some localities are not specific enough to be plotted, such as those for *immaculatus* from Madagascar, South China Sea and China.

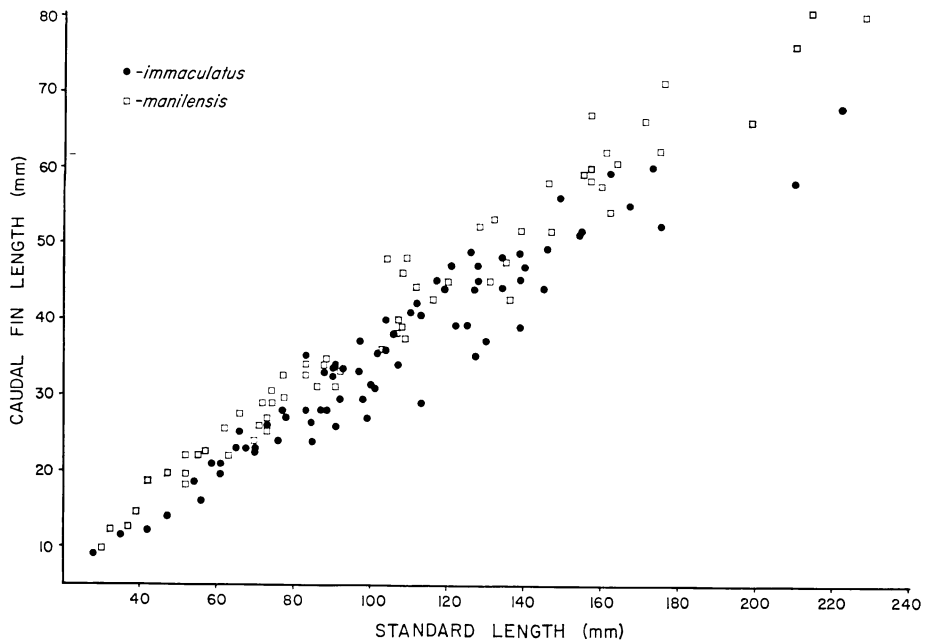


Fig. 2. Relationship of caudal fin length to standard length of *Arothron immaculatus* (●) and *A. manilensis* (□).

from the Gulf of Aden and ANSP 113348 from Mozambique, both 222 mm SL.

**Material examined.** RED SEA: MNHN 3505, 66 mm. Kamaran, RMNH 15984, 4: 85–128 mm. Jeddah, USNM 147542, 134 mm. GULF OF ADEN: RMNH 12378, 2: 140–222 mm. KENYA: Mombasa, USNM 258391, 139 mm. SOUTH AFRICA: Natal, BM(NH) 1862.12.19.23–24, 2: 97–106 mm; SU 31446, 146 mm; ZMA 108.913, 127 mm. St. Lucia, ANSP 117527, 87 mm. Richards Bay, ANSP 117522, 8: 29.5–38 mm. Durban, ANSP 113351, 165 mm. False Bay, BM(NH) 1979.3.23.73–74, 2: 70–88 mm. MADAGASCAR: ANSP 72340, 176 mm; MNHN 1901–6, 117 mm; RMNH 4417, 42 mm; USNM 199269, 4: 78–104 mm. Nossi Bé, ANSP 104861, 27 mm; ANSP 105211, 16 mm. MOZAMBIQUE: Delagoa Bay, ANSP 113348, 222 mm. MAURITIUS: BPBM 20140, 3: 77–124 mm; MNHN 1568, 149 mm; MNHN 3503, 112 mm; MNHN 3504, 107 mm; MNHN B.1461, 167 mm. SEYCHELLES: ANSP 106656, 54.5 mm; MNHN 1892–127, 77 mm; MNHN 3502, 162 mm. INDIA: Cochin, BPBM 27563, 145 mm. Vizagapatam, SU 41913, 2: 20–28 mm. Madras, ANSP 111511, 50 mm; BM(NH) 1889.2.1.4145, 173 mm; RMNH 8830, 113 mm. SRI LANKA: Jaffna, ANSP 117628, 2: 72.5–80 mm; ANSP 117638, 4: 70–81 mm. Trincomalee, ANSP 117606, 2: 15.5–19.5. Wadge Banks, ANSP 117646, 153 mm; ANSP 117678, 2: 189–202 mm. BURMA: ANSP 110853, 50 mm.

ANDAMAN ISLANDS: SU 37111, 105 mm. INDONESIA: BM(NH) 1867.11.28.103, 3: 93–155 mm; RMNH 7346, 5: 56–210 mm. Sumatra, ANSP 2777, 175 mm; SU 8378, 154 mm. Nias, ZMA 110.374, 119.5 mm. Jawa (Java), RMNH 4000, 35 mm. Jakarta, ANSP 90154, 111 mm; ZMA 110.199, 125 mm; ZMA 110.215, 121 mm. Lombok, BPBM 29961, 93 mm. SINGAPORE: USNM 142935, 73 mm. THAILAND: Phuket, ANSP 100835, 61: 13.5–50 mm. Gulf of Thailand, CAS 41121, 4: 87–127 mm; CAS 41123, 82.5 mm; CAS 41126, 5: 91–113 mm; CAS 41127, 3: 67–76 mm; CAS 41132, 5: 99–122 mm; CAS 41133, 85 mm; CAS 41137, 89 mm; CAS 41143, 100 mm; CAS 41144, 3: 92–101 mm; CAS 41145, 5: 54–61 mm. BORNEO: Sandakan, SU 27798, 139 mm. PHILIPPINES: CAS 26611, 92 mm. Panay, SU 39260, 59 mm; SU 39261, 70 mm. Lubang, SU 20250, 83 mm. Luzon, SU 9430, 47 mm; SU 39263, 137 mm. CHINA: Hainan, SU 25658, 61 mm. LOCALITY UNKNOWN: MNHN 1566, 87 mm; MNHN 1569, 175 mm; MNHN B. 1465–66, 2: 125–139 mm.

*Arothron manilensis*  
(Figs. 1–2, 4)

*Tetodon manilensis* de Procé, 1822: 130 (type locality, Bay of Manila).

*Tetodon virgatus* Richardson, 1846: 62, pl. 39, figs. 8, 9 (type locality, Port Jackson = Sydney).



Fig. 3. *Arothron immaculatus*, BPBM 20140, 102 mm SL, Mauritius.

*Holacanthus pilosus* Gronow in Gray, 1854: 28 (type locality, Indian Ocean).

*Dibolomycter longicaudus* Bibron in Duméril, 1855: 279 (no locality).

**Diagnosis.** Dorsal rays 9–11 (usually 10); anal rays 9–10 (usually 10); pectoral rays 16–19; gill rakers 6–7 (four specimens). Nasal organ anterior and medial to eye, consisting of two fleshy tentacles which branch from a common base (no opening visible). Head and body covered with small slender spinules (sometimes embedded), except posteriorly on caudal peduncle (naked area broader ventrally) and regions around mouth, eye, dorsal and anal fins and pectoral fin, and gill opening. Head length 2.6–2.85 in SL; snout short and obtuse, 1.9–2.3 in head; fleshy eye diameter 5.35–6.6 in head; interorbital space flat (except at margins), the least bony width 2.4–3.0 in head; caudal peduncle compressed, the least depth 2.3–2.6 in head; dorsal and anal fins rounded to slightly pointed, the dorsal entirely anterior to anal; longest dorsal ray 1.85–2.35 in head; longest anal ray 2.0–2.45 in head; caudal fin slightly rounded and very long, 2.25–3.2 ( $\bar{x}$ =2.66) in SL; pectoral fins truncate to slightly rounded, 2.5–3.1 in head. Color in preservative brownish gray dorsally, shading to whitish ventrally, with eight to 20 narrow dark stripes on each side (the number highly variable, but tending to increase with age), these stripes progressively fainter ventrally; one to three of these dark stripes encircling gill opening anteriorly; edge of upper lip whitish; region of gill opening and pectoral fin base often dark; fins

light brownish or yellowish gray, the caudal conspicuously edged in blackish. In life the back is light brownish gray to greenish, the stripes usually dark brown to black dorsally and brownish yellow ventrally; median fins yellowish or light yellowish brown, the pectorals with yellowish rays and clear membranes.

**Remarks.** This species occurs from Indonesia (Bleeker, 1865), north to the Ryukyu Islands (Kamohara and Yamakawa, 1967), south to New South Wales (Richardson, 1846; Grant, 1982), and east to the Marshall Islands (Kendall and Goldsborough, 1911), Samoa Islands (Fowler, 1900), and possibly the Society Islands (see below). Among the other localities are Cape York, Australia (Günther, 1870); New Ireland (Peters, 1876); New Guinea (Alleyne and Macleay, 1877); Fiji (Günther, 1880); Funafuti (Waite, 1897); Guam (Seale, 1901); Vanuatu (New Hebrides) (Seale, 1906, who misidentified it as *Tetraodon aerostaticus* Jenyns; corrected by Fowler, 1928); the Tonga Islands and Gilbert Islands (Kiribati) (Fowler, 1928); and Palau Islands (Belau) (Abe, 1949).

One specimen from Tahiti (BPBM 28057, 232 mm SL), is only provisionally identified as *A. manilensis*. It is unusual in having 34 narrow dark stripes on each side and a very robust body. The caudal fin is contained 3.05 times in the SL, hence on the short side for *manilensis*. This specimen is the only one that has been taken east of Samoa. Additional material from the Society Islands is needed to ascertain if this fish is merely

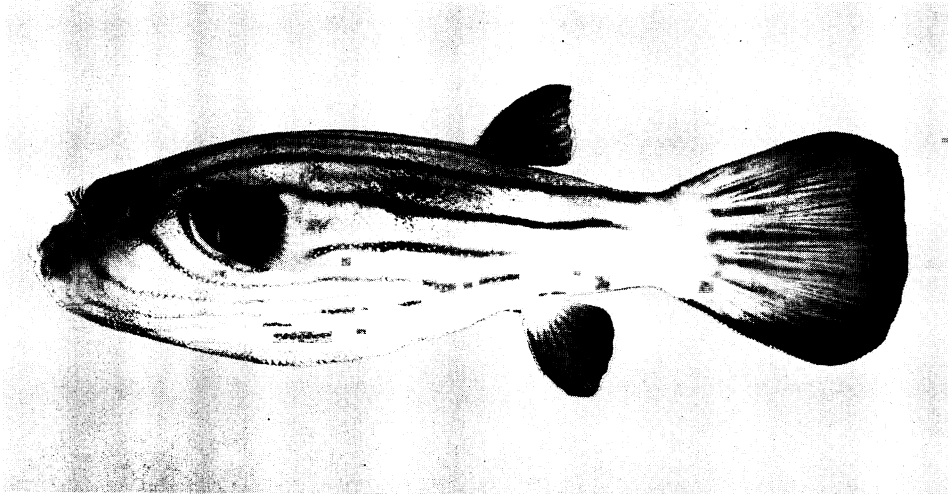


Fig. 4. *Arothron manilensis*, BPBM 17365, 157 mm SL, Guadalcanal.

an extreme variant of *manilensis* or if it represents a different population or even a different species.

*A. manilensis* is found in shallow protected waters, generally where the sea is somewhat turbid and the bottom silty sand or mud, with or without heavy benthic plant growth; it readily penetrates brackish habitats.

Apart from the 232-mm Tahitian example, the largest specimen examined is BPBM 9507, 228 mm SL, 310 mm TL; it was collected by the author from a seagrass bed in Belau at a depth of 1 m. Matsuura *in* Masuda *et al.* (1984: 365) has given the maximum standard length as 45 cm which would seem to be an error.

**Material examined.** INDONESIA: RMNH 7333, 5: 52–132 mm. Jakarta, SMF 7289, 69.5 mm. Lombok, BPBM 29833, 199 mm; SMF 8647, 74 mm. Ambon, BM(NH) 1858. 4. 21. 170, 128 mm; ZMA 108. 916, 88.5 mm; ZMA 110.201, 111.5 mm. Seram (Ceram), BM(NH) 1863.3.30. 7, 195 mm. Morotai, RMNH 20230, 39 mm. Aru Islands, ZMA 108.922, 88 mm. Waigeo, ZMA 109.914, 4: 52–107 mm. BORNEO: Sabah, Darvel Bay, ANSP 113571, 144 mm. PHILIPPINES: SMF 9631, 91 mm. Sulu Archipelago, BPBM 14216, 77.5 mm; MNHN A. 2284, 4: 55–73 mm; ZMA 108.923, 136 mm; ZMA 110.203, 146 mm. Guinlo, CAS 45960, 131 mm. Negros, BM(NH) 1933. 3. 11. 807, 103 mm. TAIWAN: Ta-fan-lieh, ANSP 113679, 61 mm. NEW GUINEA: MNHN B.1494, 210 mm. Sorong, ZMA 108. 918, 62 mm. Madang, BPBM 13654, 88 mm. Port Moresby, USNM 258987, 5: 42–83 mm; USNM 258990, 104 mm. Trobriand Islands, ANSP 117113, 72 mm; ANSP 117128, 4: 33–41 mm,

ANSP 117129, 60 mm; ANSP 117146, 15: 42–52 mm. QUEENSLAND: Prince of Wales Island, BPBM 5095, 109 mm. York Peninsula, BM(NH) 1927.2.11.149, 162 mm. Port Molle, BM(NH) 1881.10.12.46, 116 mm. North West Islet, BM(NH) 1933.1.25.229, 92 mm. Little Hope Island, ANSP 113466, 102 mm; ANSP 113496, 96.5 mm. SOLOMON ISLANDS: Guadalcanal, BPBM 17365, 2: 108–157 mm. Tulagi, USNM 123498, 171 mm. VANUATU (NEW HEBRIDES): BPBM 1057, 52 mm. NEW CALEDONIA: MNHN 1887–920, 71 mm; USNM 258991, 86 mm. FIJI: Ovalau, BM(NH) 1890. 2. 26. 200, 135 mm. Viti Levu, ANSP 106815, 97 mm; BPBM 5097, 155 mm. PALAU ISLANDS: BPBM 9507, 228 mm; BM(NH) 1874. 11. 19. 24, 214 mm; CAS 56169, 4: 120–160 mm. MARIANA ISLANDS: ANSP 87243, 215 mm; Guam, BPBM 250, 30 mm; BPBM 5096, 178 mm; CAS 56173, 161 mm; USNM 124014, 109 mm. CAROLINE ISLANDS: Yap, CAS 56172, 157 mm. Kosrae, BPBM 28290, 32 mm. LOCALITY UNKNOWN: MNHN B.1494, 175 mm; RMNH 7364, 164 mm.

**Material examined by Paxton, Australian Museum.** NORTHERN TERRITORY: Darwin, AMS I.6092, 165 mm. QUEENSLAND: Prince of Wales Island, AMS I.19356-017, 4: 44–60 mm. Cape York, AMS I.20774-005, 4: 40–60 mm. Cooktown, AMS I. 14484-5, 2: 70–80 mm. Cape Tribulation, AMS I. 22708-011, 85 mm. Mouth of Daintree River, AMS I.22722-010, 7: 35–52 mm. Townsville, AMS I. 23319-036, 3: 18–115 mm. Port Douglas, AMS I. 22072-025, 3: 70–72 mm. Whitsunday Island, AMS I. 22878-002, 2: 82–100 mm. Mackay, AMS I. 22770-003, 3: 36–37. NEW SOUTH WALES: Forster, AMS

I.15840-009, 140 mm. NEW GUINEA: Sek Harbor, AMS I.16662-001, 122 mm. Trobriand Islands, AMS I.17093-012, 12: 42–56 mm. SOLOMON ISLANDS: Bouganville, AMS A.12363, 48 mm. Guadalcanal, AMS I.17482-008, 33 mm. VANUATU: Vati, AMS IA.6034, 83 mm. GILBERT ISLANDS: Abaiang, AMS I.18041-001, 67 mm.

**Material examined by Allen, Western Australian Museum.** WESTERN AUSTRALIA: Exmouth Gulf, WAM P23401-001. Port Samson, WAM P7612-001. Dampier Archipelago, WAM P21054-001. Broome, WAM P27274-007. Admiralty Gulf, WAM P25674-004. QUEENSLAND: Mouth of Daintree River, WAM P27775-013. NEW GUINEA: Daru, WAM P28154-001. Total of 20 specimens, 50–150 mm.

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#### スジモヨウフグの学名の検討

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スジモヨウフグ *Arothron manilensis* は従来カスミフグ *A. immaculatus* と混同されていた。スジモヨウフグの体には暗色の縦線があるが、カスミフグにはない。また、スジモヨウフグの尾鱗はカスミフグよりも長く、他の鱗も同様の傾向を示す。したがって、両者は別種と考えるのが妥当である。スジモヨウフグは西太平洋に分布し、インド洋には分布しない。一方、カスミフグはインド洋と西太平洋の一部に分布する。両者の分布は琉球諸島、フィリピン、インドネシアで重なっている。