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Four New Tilefishes from the Northeastern Indian Ocean, with a Review of the Genus *Branchiostegus*

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Abstract Four new tilefishes of the genus *Branchiostegus* (Branchiostegidae) are described from southern Indonesia and northwestern Australia. These species are clearly distinguished from their congeners by combinations of: colouration, fin height, jaw length and position, shape of the preoperculum and caudal fin, body proportions and meristics. A key to all 16 species known world-wide, figures of 15 species, and a summary of their synonyms are presented.

The tilefishes (Perciformes: Branchiostegidae) presently include three genera and 23 nominal species (plus five undescribed species) world-wide. One genus, *Branchiostegus*, previous to this paper contained 11 species plus four new species described herein. Hiramatsu and Yoshino (pers. comm.) are describing another new species from Okinawa. The closely related sand tilefishes or blanquillos (Malacanthidae) are comprised of two genera and 11 species. Branchiostegids are found at intermediate depths generally 100–300 m (range from 20–600 m) along the margins of continents or oceanic islands (Dooley, 1978); some may inhabit burrows in soft bottom areas (Able et al., 1982, 1987). Recent collections by personnel from: the 1979–81 three-nation (Australia, Indonesia, West Germany) "JETINDOFISH" survey off Indonesia, and the Australian, Western Australian, Northern Territory museums off western Australia, have resulted in the first known

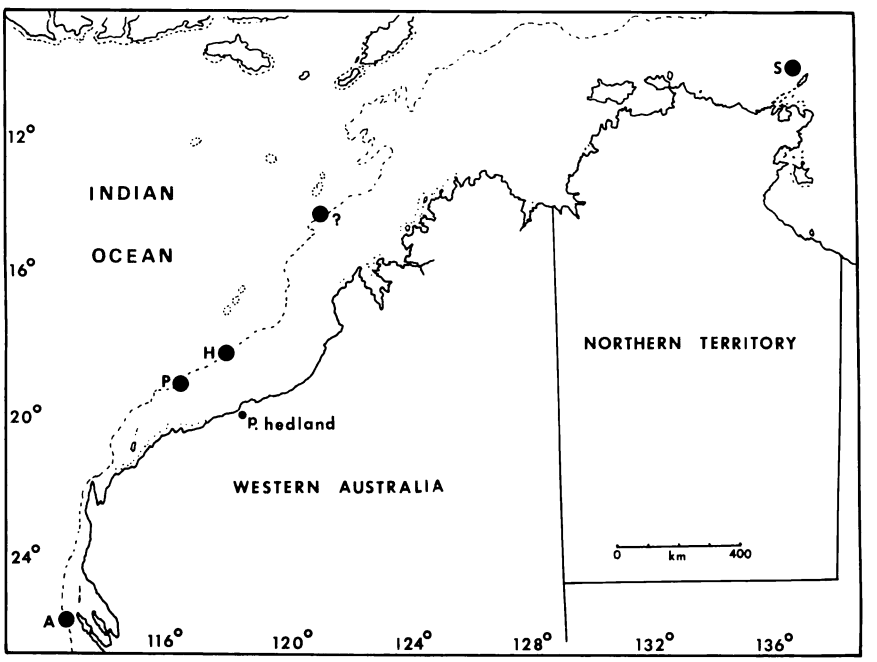
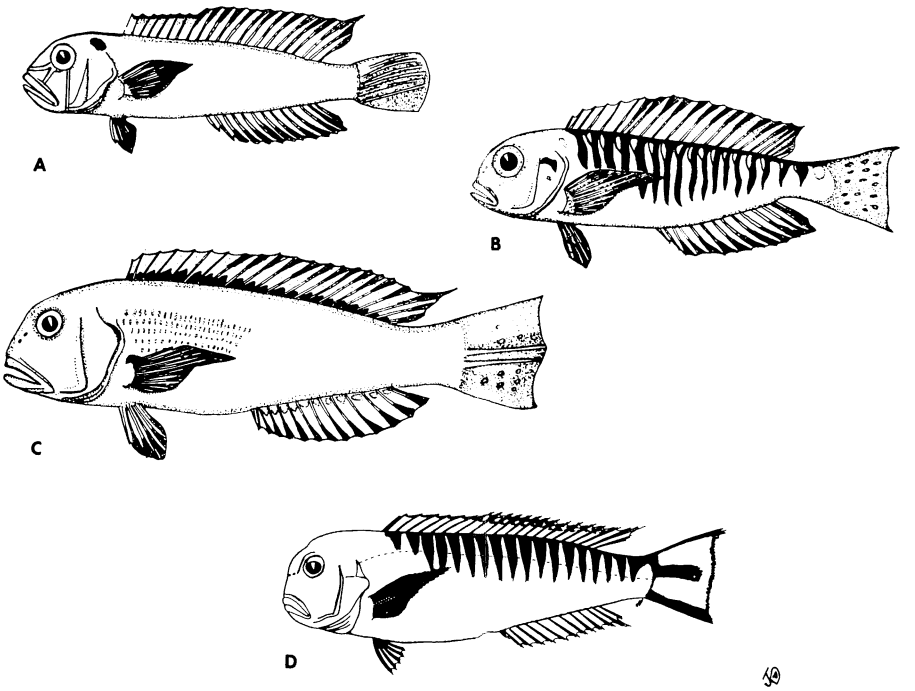


Fig. 1. Approximate localities of the species of *Branchiostegus* from the northeastern Indian Ocean. Dashed line represents the 200 meter depth contour. A, *B. australiensis*; H, *B. hedlandensis*; P, *B. paxtoni*; S, *B. sawakinensis*; ?, an unidentified specimen (WAM P28273-003). *B. gloerfelti* found, off western central Sumatra, is not shown.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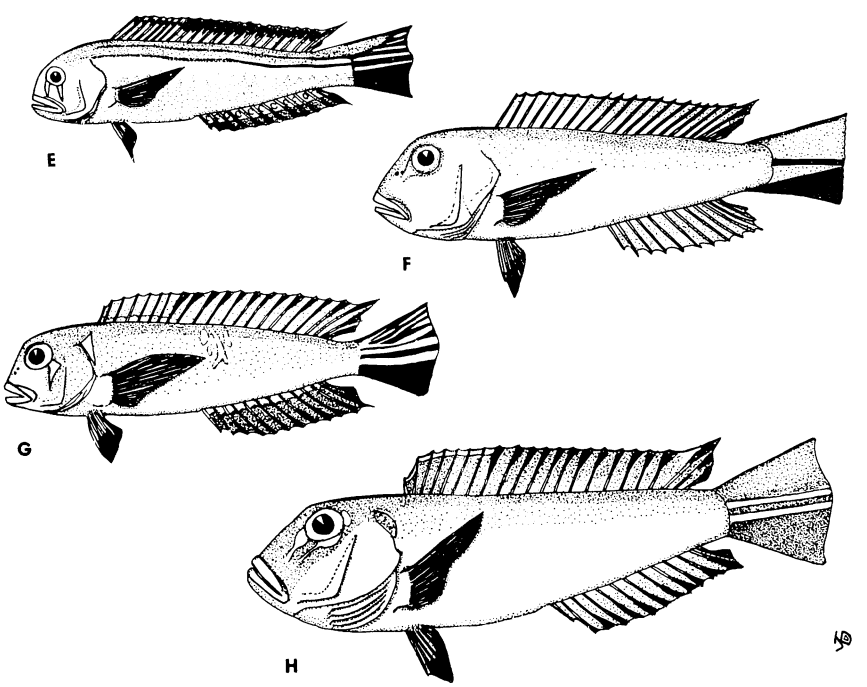
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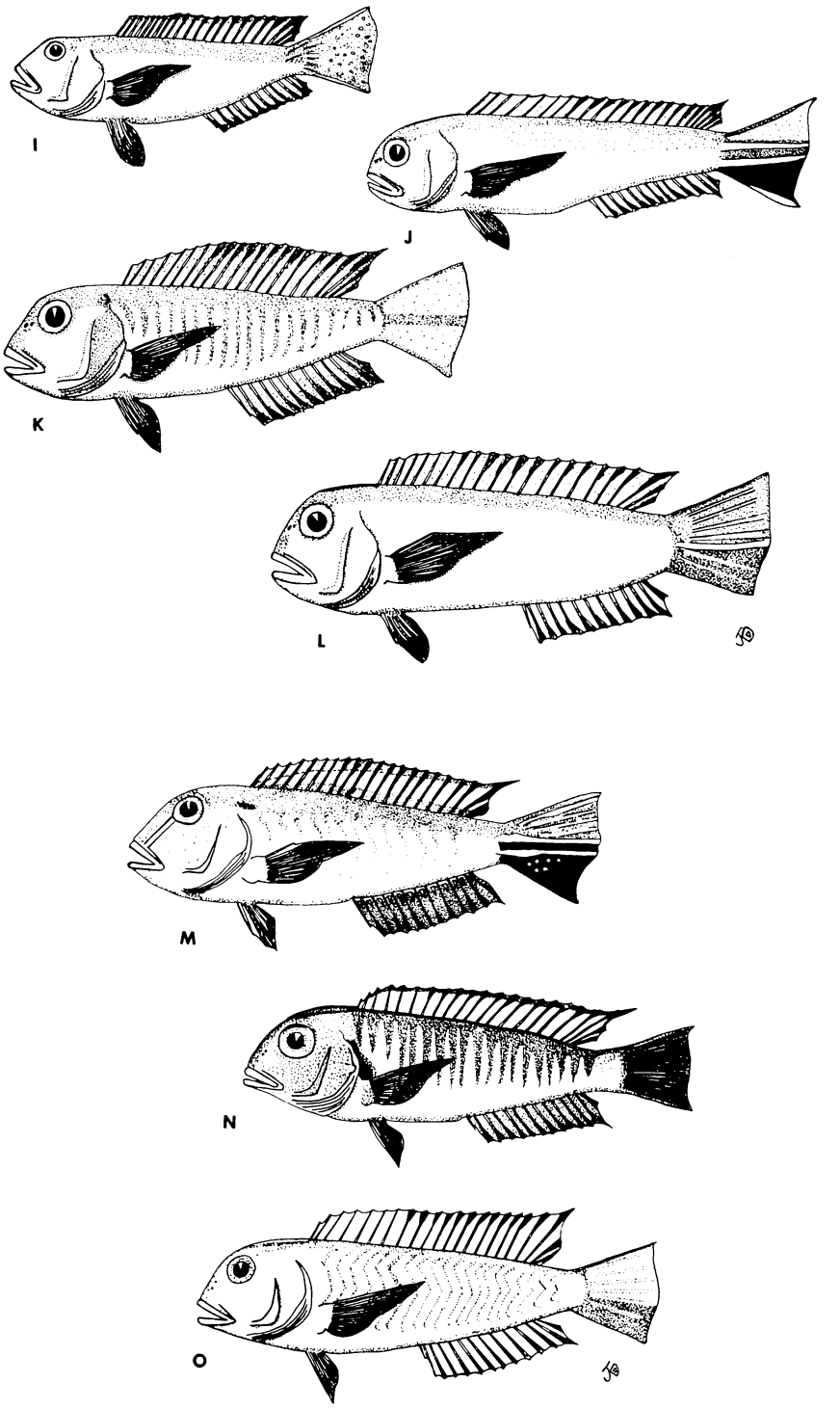

Fig. 2. Line drawings of the species of *Branchiostegus*. A, *vittatus*; B, *doliatus*; C, *sawakinensis*; D, *serratus*; E, *argentatus*; F, *ilocanus*; G, *japonicus*; H, *australiensis*; I, *albus*; J, *wardi*; K, *gloerfelti*; L, *hedlandensis*; M, *auratus*; N, *semifasciatus*; O, *paxtoni*.

specimens of *Branchiostegus* from the eastern Indian Ocean (Fig. 1).

The genus *Branchiostegus* is an especially problematic group of tilefishes. Relatively few specimens are available in museum collections. The species (particularly after preservation) are often quite similar in general morphological and meristic characters. The head profile, position of the jaws, predorsal ridge and body colouration—particularly the latter—are the best field characters (Fig. 2). The shape of the first haemal spine and adductor mandibulae musculature are usually useful internal diagnostic features (Marino and Dooley, 1982).

Prior to this, *Branchiostegus* was represented in Australasian waters by: 1) *B. wardi* Whitley, 1932 from the Gulf of Papua to southern Queensland (Noosa Heads), Sydney, N. S. W. and off neighbouring New Caledonia in depths between about 70–250 m; 2) *B. serratus* Dooley et Paxton, 1975 from Queensland (N. of Townsville; Cape Moreton) and the coast of New South Wales, caught in depths of 110–150 m, often in the same trawl with *B. wardi*; 3) *B. sawakinensis* Amirthalingam, 1969, a new record for Australia, has been collected off Wessel Island, northern Australia (Northern Territory Museum) and is not uncommon in northwestern and northern Australian waters (CSIRO, WAM specimens) (Gloerfelt-Tarp and Kailola, 1984). This wide-ranging species is found from the Red Sea and eastern Africa to the Philippines (Dooley and Rau, 1982). *B. sawakinensis* occurs in depths of 110–183 m in the Philippines, 88–110 m from the Red Sea, and 130–145 m in northern Australia.

The present paper is based upon limited material. Seven years have transpired since the initial specimens were collected. No additional specimens, nor fresh colour notes have been received in the interim. Notwithstanding, we feel that the specimens on hand represent four new species and that additional future specimens will support our premise.

Materials and methods

Measurements were made with dial calipers to the nearest 0.5 mm and follow those defined by Hubbs and Lagler (1958). Measurements are expressed as percent standard length (SL) or percent head length (HL). Head length measures from the tip of the snout to the tip of the opercular spine. Cheek depth was measured from the lower orbital rim to the lower margin of the preoperculum (Dooley, 1978). Vertebral counts were taken from radiographs. A question mark preceeding the synonym denotes a doubtful species description.

The holotypes of *B. gloerfelti* and *B. australiensis* have been deposited at the Western Australian Museum, Perth (WAM). The types of *B. hedlandensis* and *B. paxtoni* are at the Australian Museum, Sydney (AMS).

Branchiostegus Rafinesque, 1815
(Synonymy after: Dooley, 1978)

Coryphaena (non Linnaeus, 1758) Houttuyn, 1782: 315 (type-species: *Coryphaena japonica* Houttuyn, 1782 by original designation); Houttuyn's description was based on the general similarity to Linnaeus' *Coryphaena*; the description was very brief and general without a mention of a type-specimen disposition; a junior homonym of *Coryphaena* Linnaeus, 1758, a genus of coryphaenid; Lacepède 1802: 209.

Coryphaenoides (non Gunner 1765) Lacepède, 1802: 219 (type-species: *Coryphaenoides hottuynii* Lacepède, 1802 by original description; a junior synonym of *Coryphaena japonica* Houttuyn, 1782 and *Coryphaena branchiostega* Gmelin, 1788); the description is brief and general; type-specimen disposition was not mentioned; a junior homonym of *Coryphaenoides* Gunner, 1765, a genus of macrourid; Lacepède, 1832: 299.

Branchiostegus Rafinesque, 1815: 86; type-species: *Branchiostegus hottuynii* (Lacepède, 1802).

Latilus Cuvier in Cuvier and Valenciennes, 1830: 368; type-species: *Latilus argentatus* Cuvier, 1830 by original description and a substitution for *Coryphaena sinensis* Lacepède, 1802; a *nomen dubium*; type was described by Cuvier in Cuvier and Valenciennes, 1830; the type-specimen (MNHN 8153) was deposited at Muséum National d'Histoire Naturelle, Paris.

Summary of synonyms of the *Branchiostegus* species

1. *Branchiostegus japonicus* (Houttuyn, 1782).
Coryphaena japonica Houttuyn, 1782.
? *Coryphaena branchiostega* Gmelin, 1788.
? *Coryphaenoides houttuynii* Lacepède, 1802.
Latilus japonicus Jordan and Snyder, 1901.
Latilus ruber Kishinouye, 1907.

2. *Branchiostegus argentatus* (Cuvier, 1830).

? *Coryphaena sinensis* Lacepède, 1802.
Latilus argentatus Cuvier, 1830.
Latilus sinensis Jordan and Snyder, 1901.
Latilus tollardi Chabanaud, 1924.
Branchiostegus sericus Herre, 1935.
Branchiostegus sericeus: Fowler, 1949 (misspelled).
Branchiostegus tollarai: Kuronuma, 1961 (misspelled).
Branchiostegus argentatus: Dooley, 1978.

3. *Branchiostegus doliatus* (Cuvier, 1830).
Latilus doliatus Cuvier, 1830.
Latilus doleatus: Swainson, 1839 (misspelled).

4. *Branchiostegus auratus* (Kishinouye, 1907).
Latilus auratus Kisihnouye, 1907.
Branchiostegus auratus: Schmidt and Lindberg, 1930.
Branchiostegus japonicus auratus: Ochiai, 1953.
Branchiostegus auratus: Yoshino et al., 1984.

5. ? ***Branchiostegus vittatus*** Herre, 1926.
6. ? ***Branchiostegus ilocanus*** Herre, 1928.
7. *Branchiostegus semifasciatus* (Norman, 1931).
Latilus semifasciatus Norman, 1931.
8. *Branchiostegus wardi* Whitley, 1932.
9. *Branchiostegus sawakinensis* Amirthalingam, 1969.
10. *Branchiostegus serratus* Dooley et Paxton, 1975.
11. *Branchiostegus albus* Dooley, 1978.
12. *Branchiostegus australiensis* sp. nov.
13. *Branchiostegus gloerfelti* sp. nov.
14. *Branchiostegus paxtoni* sp. nov.
15. *Branchiostegus hedlandensis* sp. nov.
16. *Branchiostegus* sp. (from Okinawa, being described by Hiramatsu and Yoshino).

Key to the species of *Branchiostegus*

1a. Pored lateral-line scales 67–72 (modally 70); dorsal fin VII (rarely VI), 15; body with 18–19 dark tapered vertical bars; operculum, predorsal ridge, and area above pectoral fin axil with no dark pigment ....*serratus* (eastern Australia)

1b. Pored lateral-line scales 47–51; dorsal fin VI, 16 (rarely 15) or VII, 15 (rarely VII, 14); either 16–20 dark tapered vertical bars, light vertical bars, or no bars; operculum, predorsal ridge, with or without dark pigment.. 2

2a. Dorsal fin VI, 16 (rarely 15); body with a series of 16–20 distinctly dark vertical bars tapering ventrally 3

2b. Dorsal fin VII, 15 (rarely VIII, 14); body without distinctly dark tapering vertical bars (body may have faint reddish vertical body markings corresponding to underlying myomeres) 4

3a. Distinct dark vertical body bars number 19 or 20; dark prominently elevated predorsal ridge; large dark area extending from pectoral fin axil to upper opercular opening .....*semifasciatus* (West Africa)

3b. Distinct dark vertical body bars number 16 to 18; lightly pigmented predorsal ridge not prominently elevated; no large dark area above pectoral fin axil.....*doliatus* (South Africa, Mauritius and Reunion Islands)

4a. Body with 6 or 7 rows of dark spots on scales between lateral line and pectoral fin base (may be faint); dark areas between each dorsal ray along base of dorsal fin; caudal margin doubly emarginate with lower half grey with yellow spots, usually two thin yellow stripes in the central caudal; anal fin pale with clear areas between soft rays..... *sawakinensis* (Red Sea; South Africa, Philippines, north and northwestern Australia)

4b. Body without rows of dark spots on body scales; no dark areas along base of dorsal fin membrane between each ray 5

5a. Jaws do not reach past a vertical line through anterior rim of orbit 6

5b. Jaws reach beyond a vertical line through anterior rim of orbit 8

6a. Preoperculum indented above angle; light coloured predorsal ridge; caudal fin with numerous yellow spots, yellow rays, and light upper and lower margins; body whitish or silvery with some underlying pink; dorsal and anal fins clear with dark margin; broad white pelvic fins; no markings on cheek or snout ....*albus* (South Korea, Japan, East China Sea, Taiwan, South China Sea to Vietnam)

6b. Preoperculum not indented above angle; dark coloured predorsal ridge; caudal fin with distinct yellow stripes and/or dark lower lobe, dark upper and lower margins; body light pink or silvery; dorsal fin clear yet may have yellow or black margin; anal fin clear; pelvics colourless and not broad; markings on cheek or snout may be present 7

7a. Caudal fin with dark ventral lobe and two central yellow stripes; two silvery or golden areas extending from suborbital rim to near upper jaw; snout, top of head, upper body red; sides and belly silvery white ....*australiensis* (Shark Bay, Western Australia, possibly Sumatra)

7b. Caudal fin with a dark ventral lobe and a single central dark stripe, remainder of fin yellowish; suborbital and snout bright yellow, snout with triangular orange spot on lower medial portion; top of head and upper body dusky brown (in alcohol); sides and belly silvery.....*ilocanus* (Philippines)

8a. Distinct suborbital bars extending to near or over upper jaw 9

8b. No distinct suborbital markings extending to near or over upper jaw 10

9a. Two or three silvery, or white coloured suborbital bars 11

9b. A single narrow, pearly or silvery anterior suborbital bar extending to maxilla; head yellowish; dorsal fin may have small dark spot between first and second spines, yellow upper dorsal membrane narrowing posteriorly, base of membrane also yellow, both yellow dorsal fin bands separated by narrow white streaks and central translucent areas; anal fin membrane dusky with small white blotches along base between each ray; caudal fin doubly emarginate, lower lobe dusky with several small yellow spots and two central yellow stripes; upper caudal margin white near tip and with 3 or 4 radiating yellow stripes; upper margin of pectoral not dark; pelvics yellowish with white anterior margin; body reddish-silver with no longitudinal stripes ....*auratus* (East China Sea, Japan, South Korea, Taiwan, South China Sea)

10a. Three suborbital bars: one pearl-coloured band extending from anterior suborbital to snout, a wider pearl-coloured bar extending from anterior suborbital to maxilla, a third silvery bar extending from posterior suborbital down scaled portion of cheek to branchiostegal membrane; snout bright pink; upper margin of spinous dorsal membrane black; upper margin of soft dorsal membrane yellow, basal portion pearly; caudal subtruncate or somewhat doubly emarginate; six diagonal yellow stripes on upper two-thirds of caudal; body silvery pink with large dark spot above lateral line near upper opercular margin; dark predorsal ridge.....*vittatus* (Philippines)

10b. Two suborbital bars: parallel silvery bars extending from below the orbit and narrowing to over maxilla; head silvery; dorsal fin membrane with a series of dark medial spots becoming larger on soft ray membrane, remaining membrane pink or clear; distal half of anal fin membrane dusky, proximal portion translucent and may have small elliptical white spots; caudal fin doubly emarginate, lower two-thirds dusky with 4 or 5 yellow longitudinal stripes, upper third of caudal pink with dark upper margin; upper margin of pectoral dark; pelvics translucent with white anterior margin; body pink with two dark stripes along entire length; light coloured predorsal ridge ....*argentatus* (East China Sea, Japan, South Korea, Taiwan, South China Sea, Nhatrang, Vietnam)

11a. Large silvery white triangular marking from posterior orbital to midpreoperculum; a silver triangular marking at upper opercular opening, upper body red with several irregular yellow markings near mid-body, silvery iris usually with dark blotch along upper rim; caudal fin membrane dusky, darker ventrally; two broad yellow parallel stripes in center of caudal, 5 or 6 yellow stripes on upper lobe, upper margin of caudal dark (reddish).....*japonicus* (East China Sea, South Korea, Japan, South China Sea, Taiwan, South Vietnam)

11b. No large silvery triangular marking on posterior orbital nor at upper opercular opening; body without irregular yellow markings mid-dorsally; no dark blotch along upper rim of iris; caudal fin membrane light, dusky or dark ventrally; yellow stripes present or absent on caudal, upper margin of caudal light or dark 12

12a. A dusky yellow area on dorsal fin membrane between first and third spines; caudal yellow above and greenish gray below with two parallel yellow stripes in center ....sp. (Okinawa)

12b. No dusky-yellow area on dorsal fin membrane between first and third spines; caudal light above and light dusky or dark ventrally, yellow stripes present or absent 13

13a. Predorsal ridge and surrounding area light (pale yellowish); high dorsal and anal fins (13% and 12% SL, respectively); faint vertical body bars.....*gloerfelti* (eastern

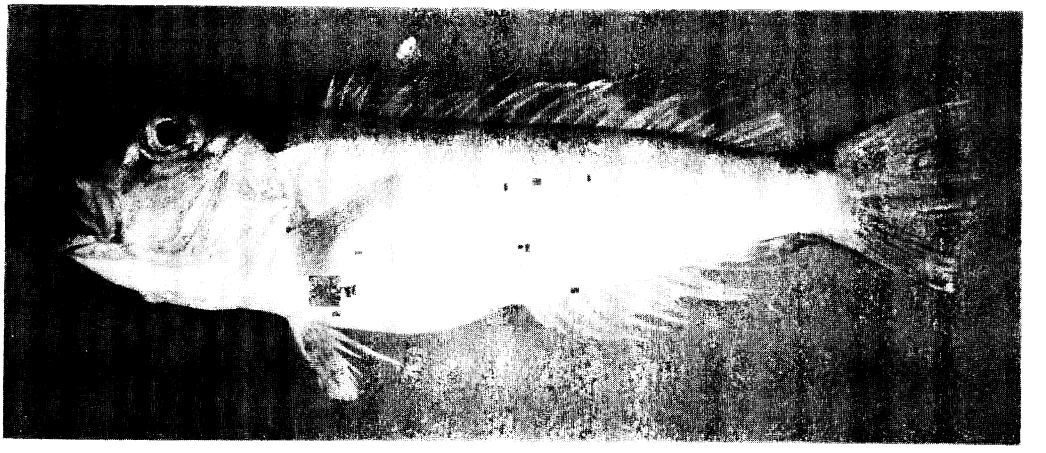

Fig. 3. Photograph of the holotype of *Branchiostegus australiensis*, WAM P. 27217-004, 266 mm SL.

Indian Ocean, western central Sumatra)

13b. Predorsal ridge entirely dark or dark with a pale medial seam; dorsal fin height 9–11% SL; anal fin height 7–9% SL; may be faint reddish body markings corresponding to underlying myomeres 14

14a. Caudal fin with black triangular patch on lower lobe, lower margin light, dorsal lobe yellow with some gray, upper margin dusky, two central broad yellow stripes; body depth (23–26%, modally 25% SL); jaws extend to a vertical line drawn from posterior pupil rim; dark predorsal ridge .... *wardi* (eastern Australia, Gulf of Papua to southern Queensland, Sydney, and New Caledonia)

14b. Caudal fin dusky, lacking black triangular patch on lower lobe, lower margin dusky, dorsal lobe light with dusky upper margin, several light yellow radiating stripes corresponding to some of the rays; body depth 25–27% SL; jaws extend to under anterior or middle of pupil; predorsal ridge pale with dark edges 15

15a. Interorbital space 22–24% HL; suborbital depth 21% HL; predorsal ridge low; preopercular angle about 90 degrees ....*paxtoni* (northwest of Port Hedland, Western Australia)

15b. Interorbital space 28–29% HL; suborbital depth 19–21% HL; predorsal ridge very prominent; preopercular angle about 110 degrees..... *hedlandensis* (north of Port Hedland, Western Australia)

Branchiostegus australiensis sp. nov.

(Figs. 1, 2H, 3; also see Gloerfelt-Tarp and Kailola, 1984: 150, labelled "*B.* sp. cf. *argentatus*", for colour photo)

Holotype. WAM P. 27217-004, 266 mm SL, collected southeast of Shark Bay (26°21′S, 112°35′E), 164–170 m depth, from FV Hui Kung, Western Australia, 3 March 1981.

Diagnosis. This species differs from its congeners by the following combination: black, raised dorsal ridge; absence of vertical body bars; black margin on dorsal and upper pectoral fins; silvery markings at anterior and below the orbit; caudal fin colouration of dusky ventral lobe and two yellow, parallel central bands.

B. australiensis is most similar to *B. argentatus* and *B. wardi*—both with rather similar colouration. From *B. argentatus* it can be distinguished by its shorter jaw (to anterior third of pupil cf. to hind edge of orbit), larger preopercular angle (110° cf. 85–95°), higher vertical fins (10.2, 9.4 respectively, cf. 8.7), more scale rows below lateral line (23 cf. 16–20) and absence of large, dark elongate areas on dorsal fin membrane (as in *B. argentatus*). From *B. wardi*, it can be distinguished by its slightly larger head (29% cf. 25–28% SL), slightly higher vertical fins (10.2, 9.4 respectively cf. 9% SL, both), silvery streak and golden crescent between orbit and maxilla (uniform silvery cheek in *B. wardi*) and paler lower caudal fin lobe (black in *B. wardi*). *B. japonicus* is also somewhat similar to *B. australiensis*, but can be distinguished

by its rounded caudal fin with four radiating yellow stripes over upper two-thirds, a triangular silver marking posterior to eye, more acute preoperculum, pale dorsal and pectoral fin margins, etc.

Description. Dorsal fin rays VII, 15; anal fin II, 12; pectoral fin 18; pelvic I, 5; principal caudal rays 17 (9+8); procurrent caudal rays 12+10; cheek scales from preopercular angle to orbital rim 8; opercular scale rows 7; scales above lateral line about 7 (some lost); scales below lateral line 23; pored lateral line scales to hypural crease 48+3 on tail; first arch gill rakers 9+14 (two are rudimentary); total gillrakers on four arches 55 (including all rudimentary gillrakers); vertebrae 10+14; two predorsal supports.

Measurements are given in percent SL in Table 1; additional measurements in percent SL are: length of lower jaw 12.7%; snout to upper margin of preoperculum 21.2%; preopercular length 13.3%.

Head blunt, snout profile oblique (about 115° angle); upper jaw protrusible; maxillary extends anteriorly to midway between first nostril and upper lip, posteriorly extends to under anterior third of pupil. Teeth on upper jaw number about 16 on each side in a single row of moderately sized canines with enlarged tooth at extreme posterior margin; 2–3 inner rows of fine canines widening to 6–8 rows anteriorly. Lower jaw with a single row of about 18 moderately sized canines on each side with enlarged tooth at extreme posterior margin; 6–7 rows of fine canines in a patch on either side of symphysis. No teeth on palatines, vomer nor tongue; well developed pharyngeal teeth.

Gill membranes free from isthmus; prominent darkly pigmented predorsal ridge from over anterior third of pupil to near origin of dorsal fin; anterior nostril surrounded by a thin cutaneous tube, posterior nostril open and oval shaped; preopercular angle about 110°, fine serrae on its upper limb to just below angle; operculum ends in single blunt spine or tab; pseudobranch well developed, numbering about 38 filaments; gill rakers elongate, longest about 3–4 times in eye diameter.

Scales large, embedded in pockets, ctenoid over most of body, cycloid in head region; scales on cheek operculum, and extended on top of head to anterior margin of pupil. Scales on pectoral base; interoperculum and branchiostegal membrane naked; caudal fin with fine scales, other fins naked.

Continuous dorsal fin originates above pectoral base, its height 10.2% SL; dorsal spines thin, first two united at bases and shorter than remaining five spines, posterior five spines all shorter than rays. Fifteen branched dorsal rays, 13th longest, reaching to base of caudal rays, 15th divided to base.

Anal fin continuous, its height 9.4% SL, originates below fifth dorsal ray; two slender anal spines, first small (1/5 of second) and difficult to see, second less than 1/2 length of anal rays. Twelve branched rays—penultimate ray elongate, reaching to hypural base; last ray divided to base.

Pectoral fin pointed, longest ray reaching to mid-anus; all rays branched except first two and last; first ray stout and less than 1/3 length of longest. Pelvics pointed, their origin below pectoral base, reaching to below middle of pectoral. Caudal fin with doubly emarginate margin, all but upper and lower rays branched.

Colour of fresh holotype silvery white below lateral line, including cheek and operculum. Body above lateral line orange-brown; top of head, snout and suborbital regions also orange-brown. Chin and branchiostegal membranes milky white. Upon preservation, dark underlying chevron markings appear on sides of body, corresponding to myomeres. Upper body colouration fades to darker brown, lower body colouration remains. Faint series of parallel orange lines appear along sides of body; outline of lateral line scales becomes more distinct. Additional fresh colouration: iris golden, pupil black; silvery white streak from anterior lower orbit to maxilla, a golden crescent mark from middle of suborbital extends faintly as thin line to maxilla; pectoral and pelvic membranes orange proximally and transparent distally; anal membrane transparent with some white colouration distally; dorsal fin generally transparent in anterior half with some diffuse white pigment posteriorly, thin yellow margin along spinous portion to about fifth soft ray, tips of remaining dorsal rays black. Caudal fin membrane dusky, darker ventrally, lighter near margins; bases of principal rays light or yellowish; two distinct yellow, parallel central bands on caudal. Most of the colouration fades markedly upon preservation except for the dusky pigmented areas and the dark pigment on the prominent predorsal ridge.

Etymology. The specific name refers to the country of the type-locality.

Distribution. Known only from the type locality. However, a colour photograph in Gloerfelt-Tarp and Kailola (1984: 150) of a specimen caught off Sumatra and labelled "*Branchiostegus* cf. *argentatus*" appears to be *B. australiensis*. If so, this species has a broad distribution, with Shark Bay being at its southern extreme.

Branchiostegus gloerfelti sp. nov.
(Figs. 1, 2K; also see Gloerfelt-Tarp and Kailola, 1984: 150, labelled "*B.* sp. cf. *doliatus*", for colour photo)

Holotype. WAM P. 28304-001, 235 mm SL, collected during the JETINDOFISH survey off central Sumatra, ca. 00°22′S; 98°44′E. (field number PJPW-2071); 50–70 m depth; forwarded to the senior author by P. J. P. Whitehead (BMNH).

Diagnosis. This species can be distinguished from all other species of *Branchiostegus* by the following character combination: pale predorsal ridge; high dorsal and anal fins; caudal fin with truncate hind margin and grey median stripe; jaws reaching to under anterior third of orbit, and few rows of scales below lateral line.

No other branchiostegid has such elevated vertical fins (D. 13%, A. 11.7% SL; closest are *B. japonicus*—10%, and *B. paxtoni*—8.9–11.3% SL). A pale predorsal ridge is shared only with *B. serratus* (which has 67–72 lateral line scales (cf. 48) and dark vertical body bars) and *B. albus* (which has smaller eye—20–24% HL cf. 28% HL in *B. gloerfelti*; shorter jaws—not reaching orbit; and different caudal fin colouration). *B. japonicus* and *B. paxtoni* can further be distinguished from *B. gloerfelti* by having more acute preopercular margin (90°–95° cf. 105° in *B. gloerfelti*) and different colouration of caudal fin, as well as predorsal ridge.

Description. Dorsal fin rays VII, 15; anal fin II, 12; pectoral fin 18; pelvic I, 5; principal caudal rays 17 (9+8); procurrent caudal rays 9+10; cheek scales from preopercular angle to orbital rim 9; opercular scale rows 8; scales above lateral line 8; scales below lateral line about 17 (some lost); pored lateral line scales to hypural crease 48+3 on tail; gill rakers (first arch) 7+14 (two are rudimentary); total gill rakers on four arches 50 (including rudimentary gill rakers); vertebrae 10+14; two predorsal supports.

Measurements are given in percent SL in Table 1; additional measurements in percent SL are: length of lower jaw 15.1%; snout to upper margin of preoperculum 24.5%; preopercular length 15.2%.

Snout profile oblique (about 120° angle); upper jaw protrusible; maxillary extends anteriorly to midway between first nostril and upper lip, posteriorly extends to under anterior third of orbit. Teeth on upper jaw number about 22 on each side in a single row of moderately sized canines with posterior last two enlarged and antrorsely curved; 1–2 inner rows of fine canines widening to 4–5 rows anteriorly. Lower jaw with a single row of about 17 moderately sized canines on each side; 4–5 rows of fine canines in patch on either side of symphysis. No teeth on palatines, vomer nor tongue; pharyngeal teeth well developed.

Gill membranes free from isthmus; predorsal ridge lightly pigmented and extending from mid-orbit to near origin of dorsal fin; anterior nostril in a thin cutaneous tube, posterior nostril open and oval shaped; preopercular angle about 105°, fine serrae on its upper limb to angle; operculum ends in single blunt spine; pseudobranch well developed, numbering about 31 filaments; gill rakers elongate, longest about 1/4 orbit diameter.

Scales large and embedded in pockets, ctenoid over most of body and cycloid in head region (many scales lost or if present are replacement scales); scales on cheek, operculum and extend on top of head to mid-orbit. Scales on pectoral base; interoperculum and branchiostegal membrane naked; caudal fin scaled, other fins naked.

Continuous dorsal fin, originates above pectoral base, its height 13% SL: dorsal spines thin, first two united at bases and shorter than the remaining five spines; all spines shorter than rays. Fifteen branched dorsal rays: 13th longest and reaching hypural crease, 15th divided to near base.

Anal fin continuous, its height 11.7% SL, its origin below sixth dorsal ray. Anal spines thin, first very small (1/4 of second), second spine less than one third length of anal rays; both spines united at bases. Twelve branched rays, penultimate ray elongate and reaching to hypural base, last ray divided to base.

Pectoral fin pointed, longest ray reaching just past anus; all rays branched except first two and last; first ray stout and less than one third longest

ray. Pelvic pointed, its origin below pectoral origin, extending to below middle of pectoral. Caudal fin margin truncate (all but upper and lower rays branched).

Colour known only from a preserved specimen on which little colour remains. Upper body dark, dark pigment on mid and upper preoperculum and operculum; lower body light, interorbital area dark, snout light, predorsal ridge light (yellow?); dorsal and anal fins with transparent membranes, pectoral fin rays with faint (yellow?) pigment, upper half of fin membrane with dusky area, rays with faint light pigment. A colour photograph in Gloerfelt-Tarp and Kailola (1984: 150) as "*B.* cf. *doliatus*" of a specimen taken off central Sumatra is (according to T. Gloerfelt-Tarp, pers. comm.) that of the holotype.

Etymology. The specific name is in honor of Thomas Gloerfelt-Tarp for his contribution to our knowledge of Indonesian fishes.

Distribution. Known only from the holotype collected from 50–70 m depth off Sumatra (ca. 00°22′S; 98°44′E) (exact type locality unclear). The species is probably more widely distributed in the eastern Indian Ocean.

Branchiostegus hedlandensis sp. nov.
(Figs. 1, 2L)

Holotype. AMS I. 22807-050, 260 mm SL collected 175 km north of Port Hedland, Western Australia (18°32′S, 118°17′E) by J. R. Paxton on the R/V 'Soela', 2 April 1982 via Engel bottom trawl; depth of capture 200–204 m, station number S02.82.13–15.

Paratype. AMS I. 22807-058, 225 mm SL; collection data as for holotype.

Diagnosis. *B. hedlandensis* can be distinguished from its congeners by the following character combination: predorsal ridge prominent, pale and with dark edges; caudal fin with dusky lower lobe and upper margin, remainder with yellow streaks.

The only other species with a dual-pigmented predorsal ridge are *B. vittatus* and *B. paxtoni*. In *B. vittatus*, the ridge is dark with pale edges. From *B. hedlandensis*, *B. paxtoni* can be distinguished by its low ridge (high in *B. hedlandensis*), more acute preopercular angle (90° cf. 110°), slightly longer jaws and suborbital depth, and narrower interorbital space (22–24% HL cf. 28–29% HL in *B. hedlandensis*). The caudal fin colouration appears comparable in both species. Of the three remaining species known from northwestern Australia, *B. serratus* and *B. sawakinensis* can easily be distinguished by colouration, *B. australiensis* less so: compared to this species, *B. hedlandensis* can be further separated by its fewer gill rakers, lower anal fin and wider interorbital. From the remaining species possessing a dark lower lobe of caudal fin (*B. wardi*, *B. japonicus*, *B. argentatus* and *B. ilocanus*), characters including fin height, eye size, body colouration, jaw length and preopercular angle further exclude *B. hedlandensis*.

Description. This is of the holotype, and where different from the holotype, data for the paratype are given in parentheses: Dorsal fin VII, 15; anal fin II, 12; pectoral fin 18; pelvic I, 5; principal caudal rays 17, 9+8; cheek scales from preopercular angle to orbital rim 7; (opercular scales not determined as many were lost); scales above lateral line 7; scales below lateral line 21 (20); pored lateral line scales 50+3 on tail (40+4); gill rakers 7+12, including one rudiment (7+14); total rakers on four gill arches 51 (52); vertebrae 10+14; two predorsal supports.

Measurements not included in Table 1 are given in percent SL: length of lower jaw 12.9% (12.4%); snout to upper margin of preoperculum 21.7% (22%); preopercular length 13.8% (13.4%).

Head with oblique profile of about 120° angle; upper jaw protrusible; maxillary extends anteriorly to midway between first nostril and upper lip, posteriorly extends to under anterior edge of pupil. Teeth on upper jaw about 18 on each side in single row of moderately, including two slightly enlarged teeth at posterior margin, sized canines; 1–2 inner rows of fine canines widening to 5–6 rows anteriorly (17, including two enlarged posterior teeth). Lower jaw with single row of about 15 moderately sized canines, including 1 or 2 slightly enlarged teeth at posterior margin (16, with no enlarged teeth), a patch of fine teeth on either side of symphysis; no teeth on palatines, vomer nor tongue; pharyngeal teeth well developed.

Gill membranes free from isthmus; predorsal ridge from over anterior third of pupil to dorsal fin origin; anterior nostril surrounded by thin cutaneous tube, posterior nostril oval shaped. Preopercular angle about 110°, with fine serrae on upper limb only; single blunt spine on operculum; pseudobranch well developed, numbering about 36 (about 42); gill rakers thin, longest about 5–6 (6) times in eye diameter.

Scales large, embedded in pockets, easily lost; ctenoid over most of body, some cycloid in head region; many replacement scales; scales on cheek, operculum and extending on top of head to just past midorbit; scales on pectoral base; interoperculum and branchiostegal membrane without scales; caudal fin with fine scales, other fins naked.

Low continuous dorsal fin originates above pectoral base, its height 9.1% (9.7%) SL; dorsal spines thin, first two united at bases and shorter than remaining five spines; all spines shorter than rays. Thirteenth ray longest, reaching beyond hypural crease, 15th ray divided to base.

Anal fin continuous, its height 7.4% (7.9%) SL, its origin below fifth dorsal ray; anal spines thin, first difficult to discern (about 3 times into second), both spines united at bases; second spine about one half length of rays. Rays branched, penultimate ray elongate and nearly reaching hypural crease, last ray divided to base.

Pectoral fin broad and pointed, longest ray reaching just short of anus, all rays branched but for first two and last; first ray stout and about one third longest ray. Pelvic blunt (somewhat pointed), its origin in line with pectoral origin, and reaches two-thirds length of pectoral. Caudal fin doubly emarginate, all but upper and lowermost rays branched.

Colouration known only from preserved specimens on which little colour remains. Upper body (above lateral line) dusky; lower body pale; myomeres dark red, visible through lighter overlying colour; predorsal ridge with pale central seam bordered by slightly darker pigment. Operculum a faded orange-yellow; membranes of dorsal, anal, pelvic and pectoral fins transparent; pectoral rays faintly yellow. No dark pigment on dorsal, anal, pectoral, nor pelvic fins, but lower half and upper margin of caudal fin dusky, remaining caudal rays yellowish.

Etymology: The specific name refers to the type-locality.

Branchiostegus paxtoni sp. nov.
(Figs. 1, 2O)

Holotype. AMS I. 22828-017, 255 mm SL, collected 190 km northwest of Port Hedland, Western Australia (19°01′S; 117°12′E); 14 April 1982 in 202–200 m depth by Engel trawl on the R/V 'Soela'.

Paratype. AMS I. 22828-028, 205 mm SL; data as for holotype.

A third specimen of *Branchiostegus* sp. (220 mm SL) was collected with the types of *B. paxtoni*. As it does not appear to be conspecific and remains unidentified, we removed it from that registered lot and have given it the AMS number I. 22828-029. The jaws of this specimen extend posteriorly to just under the anterior orbital rim (in *B. paxtoni* the jaws extend to midorbit); the predorsal ridge simply has an unpigmented (pale) seam, (in *B. paxtoni* the pale seam is bordered by darker (reddish-orange) pigment). Other colouration is similar (badly faded) to *B. paxtoni*. Counts and meristics are also similar to *B. paxtoni*.

Diagnosis. *Branchiostegus paxtoni* can be distinguished by the following combination of characters: predorsal ridge low, pale with dark edges; caudal fin with yellow streaks, its upper margin and lower lobe dusky; jaws extending to below mid-orbit.

Only *B. gloerfelti* has higher dorsal fins (13% SL), but it has a pale predorsal ridge, more obtuse preoperculum and rounded caudal fin margin (doubly emarginate in *B. paxtoni*). The similar *B. hedlandensis* can be further distinguished from *B. paxtoni* by the wider interorbital (28–29% HL cf. 22–24% HL in *B. paxtoni*), more obtuse preoperculum and slightly shallower suborbital. Other comparisons with remaining species are as for *B. hedlandensis*.

Description. Dorsal fin VII, 15; anal fin II, 12; pectoral fin 18 (19 in paratype); pelvics I, 5; principal caudal rays 17, 9+8 (10+9 in paratype); procurrent caudal rays 3; cheek scales from preopercular angle to orbital rim 11 (8); opercular scale rows 6 (7); scales above lateral line 8 (7); scales below lateral 20; pored lateral line scales 49+4 on tail (49+3); gill rakers on first arch 8+13 (9+14 including two rudimentary); total gill rakers on four arches 51 (55) including all rudimentally gill rakers; vertebrae 10+14.

Measurements are given in percent SL in Table 1; and additional measurements in percent SL are: length of lower jaw 14.0% (12.7%); snout to upper margin of preoperculum 21.6% (21.2%); preopercular length 13.3% (13.2%).

Head profile rounded, of about 105° angle (100° on paratype); upper jaw protrusible; maxillary extends posteriorly to under midorbit; teeth on upper jaw moderately sized canines, about 19 on each side, including two enlarged canine teeth at posterior margin, 1–2 inner rows widening to 5–6 rows anteriorly (13–15 teeth on each side of upper

jaw). Lower jaw with single row of about 12 moderately sized canines, including 1 or 2 slightly enlarged teeth at posterior margin (15 teeth), a patch of 5–6 rows of fine teeth at anterior edge of lower jaw; no teeth on palatines, vomer nor tongue; pharyngeal teeth well developed.

Gill membranes free from isthmus; a slightly raised predorsal ridge from above midorbit to origin of dorsal; anterior nostril enclosed in a thin cutaneous tube, posterior nostril oval shaped; preopercular angle about 90°, fine serrae on upper limb only; single blunt spine on operculum; pseudobranch well developed, numbering about 36 (32); gill rakers thin, longest about 1/5 eye diameter.

Scales large, embedded in pockets and easily lost; ctenoid over most of body, many replacement ones, some cycloid scales in head region; scales on cheek, operculum, and extending on top of head to over anterior one-third of orbit; interoperculum and branchiostegal membrane without scales; scales on pectoral base; caudal with fine scales, other fins naked.

Dorsal fin continuous, its height 11.3% (8.9%) SL and its origin above pectoral base; spines thin, first two united at bases and shorter than remaining five; all spines shorter than rays: 13th ray longest, reaching beyond hypural fold to base of caudal rays, 15th ray divided to base.

Height of continuous anal fin 7.1% (7.7%) SL, its origin below fifth dorsal ray. Anal spines thin, first very reduced (about twice into second), both spines united at bases; second spine about one half length of rays. Rays branched, penultimate elongate, nearly reaching to hypural crease, last ray divided to base.

Pectoral fin broad and pointed, longest ray just reaching anus, all rays branched but for upper and lower two (paratype as for holotype except second lower ray on left side not branched); first ray stout and about one third length of longest ray. Pelvic lobe-shaped (somewhat pointed in paratype), its origin below pectoral origin, reaching two-thirds along pectoral fin length. Caudal fin doubly emarginate, all but upper and lower principal rays branched.

Table 1. Measurements of the types of the four new species of *Branchiostegus* in percent standard length. Percent head length shown in parentheses. Square brackets equal actual head length (cm).

	B. australiensis	*B. gloerfelti*	*B. hedlandensis*		*B. paxtoni*	
	Holotype WAM P. 27217-004	Holotype WAM P. 28304-001	Holotype AMS I. 22807-050	Paratype AMS I. 22807-058	Holotype AMS I. 22828-017	Paratype AMS I. 22828-028
Standard length (mm)	266	235	260	225	255	205
Body depth	25.9	29.8	26.7	26.0	27.0	25.4
Body width	11.6	12.9	13.7	12.0	13.0	12.2
Dorsal fin length	53.8	55.7	55.0	54.0	52.9	59.3
Dorsal fin height	10.2	13.0	9.1	9.7	11.3	8.9
Anal fin length	29.3	25.3	29.3	26.0	30.7	27.8
Anal fin height	9.4	11.7	7.4	7.9	7.1	7.7
Pectoral fin length	24.2	29.0	22.6	24.0	24.2	24.9
Pelvic fin length	14.7	15.6	12.7	13.5	14.0	13.3
Peduncle length	15.0	14.6	15.3	15.0	15.2	16.0
Peduncle depth	11.1	9.1	10.4	10.4	10.6	10.1
Head length	[7.8]29.3	[7.4]31.3	[7.3]28.0	[6.3]27.8	[7.1]27.7	[5.6]27.3
Head depth	26.1	29.6	26.9	25.9	26.1	23.7
Snout length	11.3	12.8	11.7	12.2	11.1	10.9
Predorsal length	32.3	34.3	31.3	33.0	32.7	33.3
Length upper jaw	11.8	13.4	11.9	11.8	12.8	11.6
Opercular length	7.9	8.5	7.5	7.1	7.8	6.7
Cheek depth	11.5	11.5	10.9	10.7	11.3	10.8
Suborbital depth	(21.8)6.4	(19.2)6.0	(20.7)5.8	(18.7)5.2	(21.1)5.9	(20.9)5.7
Orbit diameter	(29.4)8.6	(28.4)8.9	(29.0)8.1	(31.0)8.6	(30.0)8.3	(28.6)7.8
Interorbital width	(22.6)6.6	(22.4)7.0	(28.2)7.9	(28.8)8.0	(24.2)6.7	(22.3)6.1

Colour known only from badly faded preserved specimens: body above lateral line dusky; lower body pale, but faintly yellowish red; darker pink color of myomeres showing through overlying pale colour; predorsal with pale central seam bordered by darker reddish pigment; dorsal, anal, pelvic and pectoral fins faintly yellowish, nearly translucent; caudal fin with numerous yellowish caudal rays, lower half and upper margin dusky as in *B. hedlandensis*.

Etymology. The specific name is a patronym after Dr. John R. Paxton of the Australian Museum, Sydney whose efforts have resulted in the recognition of several new species of Australian tilefishes.

Remarks

The authors wish to thank Drs. Hayashi and Yoshino for drawing our attention to the validity of *B. auratus* (Kishinouye, 1907). Yoshino et al. (1984) established that *B. auratus* is not conspecific with *B. argentatus* as previously cited by Dooley (1978). In addition, Dooley's (1978) figure 20 of *B. japonicus* (after Abe, 1965) is actually *B. auratus*. Recent fresh colour photographs and additional morphometric data of this comparatively scarce species clearly document its specific status. Masuda et al. (1984), Machida (1985: figs. 265, 266), Hayashi (1985), and Yamada et al. (1986) also include excellent colour photographs of *B. albus*, *B. japonicus* and *B. argentatus*.

Figure 2-1A of Hayashi (1985) labelled as *B. argentatus*, is *B. albus*; 2-1D shown as "unknown species" is actually *B. argentatus*. Figure 2-2D is *B. argentatus*, not an "unknown species."

A new species of *Branchiostegus* is being described by Drs. Hiramatsu and Yoshino, from Okinawa. The species has some similarities to our *B. australiensis* but appears to be distinct. An outline drawing of the species can be found in Yamada et al. (1986: 163, fig. A.). The distinctive colouration includes: dorsal fin membrane with a dark blotch between the first and third spines, dorsal rays black, upper caudal margin white, caudal fin yellow above and greenish gray below with one medial yellow stripe. Dr. Yoshihiko Machida kindly provided a translation of portions of Yamada et al. (1986). Also, unpublished portions of the species description were generously sent by Dr. Tetsuo Yoshino to the second author (pers. comm.).

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北東インド洋から得られたアマダイ科の4新種とアマダイ属のレビュー

James K. Dooley・Patricia J. Kailola

インドネシア南部とオーストラリア北西部から得られたアマダイ科アマダイ属 *Branchiostegus* の4新種を記載した．これらはいずれも色彩，鰭の高さ，顎の長さ，位置，前鰓蓋骨と尾鰭の形，体の各部の相対長，計数形質などにより同属の他種と明瞭に識別できる．世界中の同属16種の検索表，15種の図，シノニムの要約を併せて示した．