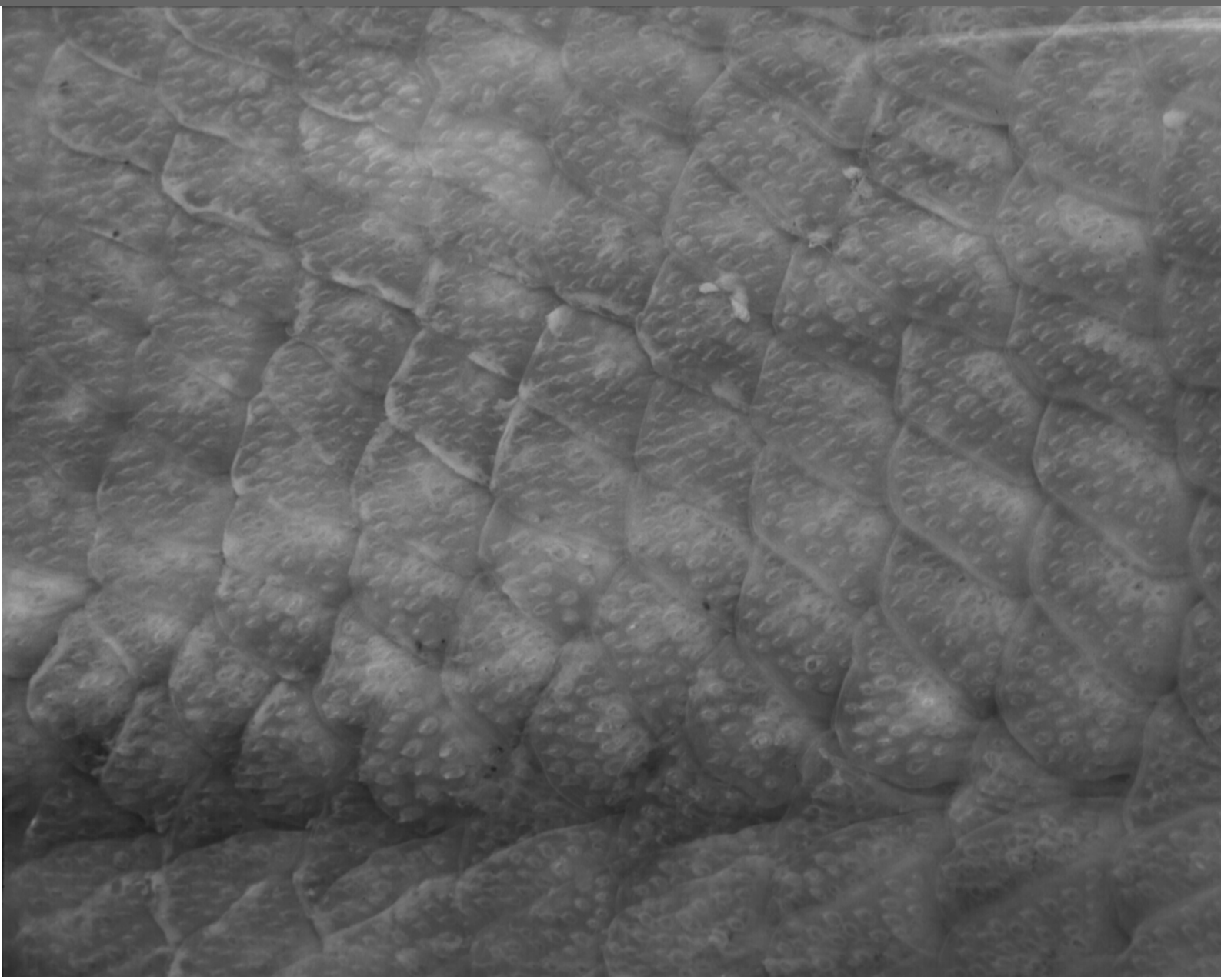
SMITHIANA

Special Publication 2

October 2003



A new flatfish of the Indo-Pacific genus *Asterorhombus* (Pleuronectiformes:Bothidae)

Dannie A. Hensley and John E. Randall

Publications in Aquatic Biodiversity
by the South African Institute for Aquatic Biodiversity

SAIAB

Margaret Mary Smith (1916 - 1987),
James Leonard Brierley Smith (1897 - 1968)
with their dog, Marlin

The publication series (Monographs, Bulletins & Special Publications) of the SAIAB (formerly the JLB Smith Insitute of Ichthyology), in its new format honors James Leonard Brierley Smith and Margaret Mary Smith with the name *Smithiana*, in recognition of their many years of devoted service to African aquatic biology. Their life's work, a team effort, established modern ichthyology in southern Africa and laid the groundwork for the expansion of aquatic biology throughout the region.

Front cover photograph: Scales of a preserved coelacanth specimen by James Stapley.

A new flatfish of the Indo-Pacific genus *Asterorhombus* (Pleuronectiformes: Bothidae)

Dannie A. Hensley[1] and John E. Randall[2]

ABSTRACT

Five species of *Asterorhombus* are currently recognized, *A. bleekeri*, *A. osculus*, *A. annulatus*, *A. intermedius*, and *A. fijiensis*. A new species, *Asterorhombus filifer*, is described from 19 specimens. It is easily separated from *A. bleekeri*, *A. osculus*, and *A. annulatus* by its palmate gill-rakers and its detached and longer first dorsal-fin ray. It is distinguished from *A. fijiensis* by less body depth, longer first dorsal-fin ray on the average, simpler membrane on this ray, narrower interorbital width, and both eyes usually with one tentacle (vs. 1-9 tentacles on upper eye only). *Asterorhombus fijiensis* and *A. filifer* are the only species of the genus with males having a wider interorbital than females. *Asterorhombus filifer* most closely resembles *A. intermedius*, which differs in having a longer first dorsal ray, smooth edge on the membrane of this ray, usually more lateral-line scales, and males with greater interorbital width. *Asterorhombus filifer* is the most wide-ranging species of the genus, extending from the western Indian Ocean to the Hawaiian and Society islands, and is the only species of *Asterorhombus* occurring on the Pacific Plate.

1) Department of Marine Sciences, University of Puerto Rico, Box 9013, Mayagüez, PR 00681-9013, USA.
2) Bishop Museum, 1525 Bernice St., Honolulu, HI 96817-2704, USA.

A new flatfish of the Indo-Pacific genus *Asterorhombus* (Pleuronectiformes: Bothidae)

D. A. Hensley and J. E. Randall

INTRODUCTION

Tanaka (1915) described *Asterorhombus stellifer* in Japanese as a new genus and species of bothid fish from a single specimen 110 mm in SL obtained from the Nagasaki Market. Norman (1934: 60) acknowledged Tanaka's help in translating the diagnosis to English but noted that the diagnosis was very brief; he was unable to treat the genus and species with certainty.

Amaoka (1969) recognized *Asterorhombus* as a valid genus and synonymized *A. stellifer* with *Platophrys* (*Arnoglossus*) *intermedius* Bleeker (1865). Thus, *A. stellifer* Tanaka (1915) [= *A. intermedius* (Bleeker, 1865)] is the type species of the genus, *fide* Amaoka, 1969. Norman (1934) considered *A. intermedius* a species of *Arnoglossus*. Chabanaud (1948) put the species into the genus *Asterorhombus* without comments. Amaoka provided a detailed description of *Asterorhombus* in which he classified only the single species *A. intermedius*. An important character used by Amaoka to define this genus was the presence of palmate gill-rakers, i.e. short, broad, with strong spines (see Amaoka, 1969: Fig. 112C or Amaoka et al., 1994: Fig. 2A).

Norman (1931) described *Engyprosopon fijiensis* from a specimen 83 mm in TL from Levuka, Fiji. Norman (1934) wrote, "In the peculiar form of the gill-rakers, as well as in other characters, this species resembles *Arnoglossus intermedius* (Bleeker) and should perhaps be included in that genus." Hensley (1984, 1986) placed *E. fijiensis* in *Asterorhombus*.

Amaoka and Arai (1998) described a new species, *Asterorhombus osculus*, from Western Australia, redescribed *Arnoglossus bleekeri* Macleay (1881) from Queensland, Gulf of Carpentaria, and Western Australia, and classified it in *Asterorhombus*. Norman (1934) had placed *Arnoglossus bleekeri* in *Engyprosopon*.

Norman (1934) synonymized *Anticitharus annulatus* Weber (1913) from Indonesia with *Arnoglossus intermedius* (Bleeker). Amaoka and Mihara (2001) examined the three syntypes of *A. annulatus* and recently collected 29 specimens from New Caledonia. They concluded that *A. annulatus* is a valid species of *Asterorhombus*, thus bringing the total species of the genus to five.

Asterorhombus osculus, *A. bleekeri*, and *A. annulatus* do not have palmate gill-rakers (Amaoka and Arai, 1998; Amaoka and Mihara, 2001) as was used in the generic definition given by Amaoka (1969) and Amaoka et al. (1994).

In the present paper we describe a new species of *Asterorhombus* with palmate gill-rakers. It is the most wide-ranging of the genus, occurring from the Comoro Islands to the Hawaiian Islands. It is the only species known to occur on the Pacific Plate. A revision of the genus *Asterorhombus*, which will include a key to the species, is planned by the first author.

METHODS

Methods for making counts and measurements on whole specimens followed those of Hubbs and Lagler (1949) with the following changes: because all dorsal- and anal-fin rays are unbranched, all ray elements were counted as individual rays; lengths of pelvic-fin bases were measured from the base of the first ray to the base of the last ray. Unless otherwise stated, measurements on whole specimens refer to those made on the ocular side. Standard length (SL) was used throughout. These measurements were made with dial calipers or an ocular micrometer to the nearest 0.1 mm. For regression analysis and analysis of covariance (ANCOVA), all variates were transformed to natural logarithms (ln) in all analyses. In all analyses SL was treated as the independent variable (X). Differences were considered significant at the $P \leq 0.05$ level. Regressions used in tests for sexual dimorphism were compared by ANCOVA according to procedures of Snedecor and Cochran (1967). Tests for allometry were performed with the geometric-mean-functional-regression model of Ricker (1973). In this model, confidence limits are determined for the slope (v). If unity is outside these limits, allometry is assumed (positive if below, negative if above); isometry is assumed if unity is within the limits.

The three species of *Asterorhombus* with palmate gill-rakers (*A. intermedius*, *A. fijiensis*, and the new species) also have the first dorsal-fin ray separated from the rest of the fin. Two important characters that differentiate these species are the length of this ray and the morphology of the membrane on the ray. Until recently, the ray's membrane has gone unnoticed by those describing or illustrating these species. An example of this is Norman's (1934:197-198, Fig. 146) account of *A. intermedius*. Here he mentioned and showed the first dorsal-fin ray as "somewhat prolonged and expanded distally." In another important description and drawing of the same species, Amaoka (1969:111-113, Fig. 66) described the first-dorsal fin ray as "prolonged," but made no mention of the membrane of this ray or showed a membrane in his drawing. Recently the morphology of this membrane has been described and illustrated for both *A. intermedius* and *A. fijiensis* (Amaoka et al, 1994; Senou et al., 1994; Lin et al., 1995; Hensley and Amaoka, 2001). It is important to note that the membrane of this ray is very fragile, tends to fold and curl easily, and in *A. intermedius* and the new species, where it runs nearly the entire length of the ray, it is very often completely furled around the ray. This is often true of freshy caught specimens and very frequent in preserved material. Fig. 2 shows a paratype of the new species where the

membrane is furled around the ray except for near the tip. In the holotype (Fig. 1) the membrane is not furled around the ray, although it became furled once fixed and preserved. Thus, it is very important to gently pull the membrane away from the ray with a probe when trying to examine it.

Sex was determined by inspection of gonads through a small incision made in the right side of the abdominal cavity. Institutional abbreviations are as listed by Leviton et al. (1985).

Asterorhombus filifer, sp. nov.

Figs. 1, 2, 3A

Arnoglossus intermedius [*non* Bleeker, 1865]: Woods, 1966: 65-66, Pl.124, fig. C (Marshall Ids, Bikini Atoll).

HOLOTYPE: BPBM 34871, 98.3 mm SL, male, NW Hawaiian Ids, Midway Atoll, wreckage at shore between cargo pier and launching ramp, depth 3-5 m, rotenone, J.E. Randall & J.L. Earle, 18 September 1991.

PARATYPES: INDIAN OCEAN: South Africa; SAIAB (RUSI) 64708, 28.0 mm SL, sex undetermined, KwaZulu-Natal, Sodwana Bay, north of Sponge Reef, 27°31' 04" S, 32°41'39" E, 26-28 m, P.C. Heemstra, 17 May 2001. Comoro Ids; ANSP 145284, 95.6 mm, female, Grande Comore, west side of fringing reef, 11°41'33" S, 43°14'27" E, 24.4 m or less, R/V Anton Bruun cr. 9, 27 November 1964. SAIAB (RUSI) 29059, 101 mm, female, Grande Comore, west coast north of Moroni, coral reef, 100-150 m offshore, 20-28 m, P.C. Heemstra, M.J. Smale, and R. Sanders, 20 October 1986. Seychelles; ANSP 107779, 59.6 mm, male, Amirante Ids, vicinity St. Joseph Id, southwest of Resource Id, 15.2-27.4 m, D. Dockins et al., 10 March 1964. ANSP 107789, 50.6 mm, male, Amirante Ids, D'Arros Id, off east side of Id, 29-33.5 m, D. Dockins et al., 9 March 1964. ANSP 108722, 76.1 mm, male, Amirante Ids, D'Arros Id, of east side of Id, 15.2-27.4 m, J.E. Böhlke et al., 5 March 1964. Mauritius; BPBM 24776, 60.5 mm, male, west coast of Flic en Flac, reef and some sand, 57 m, rotenone, J.E. Randall, D. Pelicier, J.S. Dench, and R.M. Bray, 7 April 1987. WESTERN PACIFIC OCEAN AND ADJACENT SEAS: Australia; AMS I.22578-038, 47.0 mm SL, sex undetermined, northern Queensland, Escape Reef, back reef slope, sand and coral in cave and gutter, 150°49' S, 145°50' E, D.J. Blake, G.R. Allen, and W.A. Starck, 28 January 1981. Chesterfield Bank; BPBM 33653, 42.6 mm, female, lagoon, southwest side, off Ile Longue, patch reef, 19°52' S, 158°19.8' E, 9 m, rotenone, J.E. Randall, M.L. Kulbicki, P.J. Doherty, et al., 24 August 1988. New Caledonia; BPBM 34263, 85.6 mm, male, lagoon near southeast end of St. Vincent Pass, rubble and sand near reef, 21°2.1' S, 165°57.8' E, 4 m, rotenone, M. Kulbicki, J.E. Randall, et al., 21 March 1990. Philippines; SAIAB (RUSI) 52650, 63.2 mm, male, Luzon, Bolinao, 16°23' N, 119°53' E, 30-35 m, P.C. Heemstra, 8 October 1995. USNM 260363, 47.5 mm, female, Negros, east of Bais, 36.6 m or less, V.G. Springer et al., 17 June 1978. Marshall Ids; USNM 141789, 24.1 mm, sex undetermined, Bikini Atoll, Arji Id, lagoon, 91 m offshore, 6-12 m, rotenone, E.S. Herald and V.E. Brock, 7 August 1946. Hawaiian Ids; BPBM 10028, 35 mm, sex undetermined, Oahu, off rocky islet at SW end of Waimea Bay, cave entrance, 10.7 m, Chemfish, J.E. Randall, L.A. Randall, and P.M. Allen, 27 July 1970. BPBM 22623, 60.8 mm, male, Oahu, Kaneohe Bay, W.J. Baldwin. MNHN 2001-1130, 79.2 mm, female, collected with holotype; NSMT-P 60932, 104.5 mm, female, Oahu, Kahe Pt., sand near edge of reef, 14 m, hand net, R. Holcom, early March 1997. Society Ids; ROM 61627, 31.0 mm, sex undetermined, Moorea, 300 m west of pass out of Cook Bay, 17°28'37" S, 149°49'45" W, dead coral, rock, coarse sand in broad (15 m wide) gully with gently sloping sides, 21-26 m, rotenone, R. Winterbottom, 13 December 1989.

DIAGNOSIS: A species of *Asterorhombus* having the following combination of characters: palmate gill-rakers; uniserial dentition in both jaws; first dorsal-fin ray separated from remainder of fin, elongate, 0.8-1.7 in head length, posterior membrane on ray broad, smooth-margined, and running nearly entire length of ray (Fig. 3A); both eyes usually with one tentacle, frequently branched; sexual dimorphism in interorbital width in specimens larger than ca. 60 mm SL, 8.9-18 in head length (1.6-3.1 % SL) in males, 15-21.2 (0.9-2.3 % SL) in females (Fig. 4); body depth 2.0-2.5 in SL (40.4-50.1 SL); lateral-line scales 56-67 (Fig. 5).

DESCRIPTION: Data for the holotype in parentheses are followed by those for the paratypes.

Morphometric data expressed as percent SL: head length (27) 27-31; body depth (46) 40-50; snout length (6.6) 6.6-9.7; upper-jaw length ocular side (11) 10-13, blind side (11) 10-13; lower-jaw length ocular side (15) 14-17, blind side (16) 14-18; lower-eye length (5) 5-8, upper-eye length (6) 6-7; interorbital width (2) 2-3 in males $\geq$ 6 cm SL, 1-2 in females (Fig. 4); pectoral-fin length ocular side (13) 13-17, blind side (13) 11-14; length of third pelvic-fin ray ocular side (11) 9-11, blind side (not measurable) 8-10; length of pelvic-fin base ocular side (9) 8-11, blind side (6) 4-6; length of first dorsal-fin ray in specimens $\leq$ 63 mm SL 27-39, in specimens $\geq$ 76 mm SL (20) 17-28; length of dorsal-fin ray near middle of fin (12) 10-13; length of first anal-fin ray (not measurable) 5-8; length of anal-fin ray near middle of fin (11) 11-13.

Morphometrics expressed as ratios of larger measurements: head length (4) 3-4, body depth (2) 2-3, both in SL. Measurements in head length: snout length (4) 3.0-5; upper-jaw length ocular side (3) 2-3, blind side (3) 2-3; lower-jaw length ocular side (2) 2, blind side (2) 2; lower-eye length (5) 4-5, upper-eye length (5) 4-5; interorbital width (12) 9-18 in males > ca. 60 mm SL, 13-33 in females (Fig. 4); pectoral-fin length ocular side (2) 2, blind side (2) 2-3; length of third pelvic-fin ray ocular side (3) 3, blind side (not measurable) 3-4; length of pelvic-fin base ocular side (3) 3-4, blind side (5) 5-8; length of first dorsal-fin ray in specimens < 63 mm SL 1, in specimens $\geq$ 76 mm SL (1) 1-2; length of dorsal-fin ray near middle of fin (2) 2-3; length of first anal-fin ray (not

Figure 1. Holotype of *Asterorhombus filifer*, BPBM 34871, 98.3 mm SL, male, Midway Atoll, Hawaiian Islands; from colour transparency by J. E. Randall.

Figure 2. Paratype of *Asterorhombus filifer*, RUSI 52650, 63.2 mm SL, male, Luzon, Phillipines; from colour transparency by J. E. Randall.

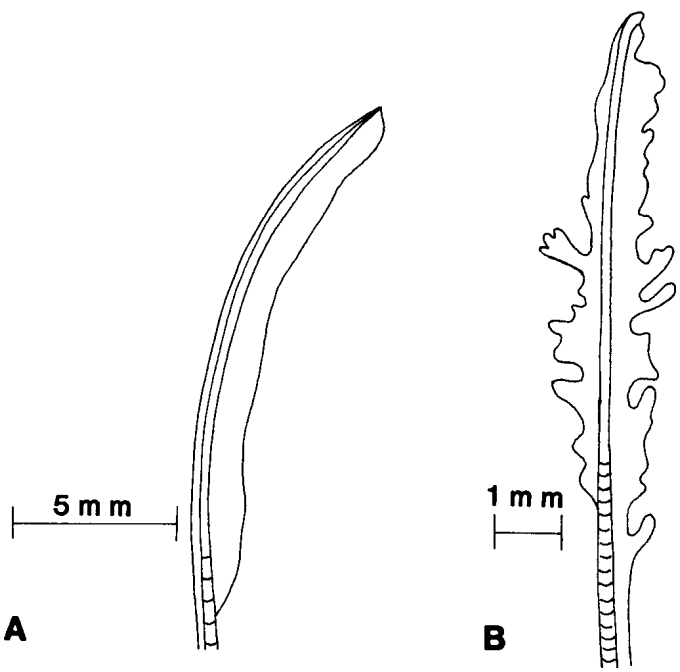


Figure 3. First dorsal-fin rays of (A) *Asterorhombus filifer*, BPBM 24776; *Asterorhombus intermedius*, RUSI 52648.

measurable) 3-6; length of anal-fin ray near middle of fin (2) 2-3.

Dorsal-fin rays (88) 81-87; anal-fin rays (69) 63-68; pectoral-fin rays ocular side (12) 11-12, blind side (11) 9-10; pelvic-fin rays ocular side (6) 5-6 (usually 6), blind side (6) 5-6 (usually 6): lateral-line scales (67) 56-66 (Fig. 5): upper gill-rakers ocular side (1) 0-2, lower (10) 6-10, total (11) 7-11; vertebrae (counts not available) 10 + 26-28.

Anterior profile of head nearly straight, becoming curved above nuchal area; slight to moderate indentation anterior to ventral half of upper eye. Anterior margin of upper eye slightly posterior to anterior margin of lower eye. Both eyes usually with one monolobed or multilobed tentacle. Rear end of maxilla below or slightly posterior to anterior margin of lower eye. Interorbital region scaled on posterior 1/4-1/2 area in specimens > ca. 60 mm SL, often scaleless in smaller specimens.

Nostrils of ocular side at same horizontal level as dorsal margin of lower eye, about midway between snout tip and anterior margin of lower eye, anterior nostril tubular, posterior nostril slit-like; nostrils of blind side similar to those of ocular side, anterior nostril at vertical from base of second dorsal fin ray. Tip of isthmus at vertical from rear margin of lower eye. Teeth in single series in both jaws, equally developed on both sides, anterior teeth in both jaws not much enlarged.

Base of first pelvic-fin ray on ocular side at tip of isthmus; base of first pelvic-fin ray on blind side at vertical between third and fourth ray or base of fourth ray of pelvic-fin on ocular side. First dorsal-fin ray with very narrow membrane anteriorly; posterior membrane broad with smooth margin; both membranes extending from near base to tip of ray (Fig. 3A).

Colour of fixed and preserved specimens: ground colour on ocular side tan. Some specimens with few or no markings. Specimens retaining markings with many scattered dark spots of variable sizes and degrees of darkness. Approximately five rows of spots discernible: 1) row of relatively small spots immediately proximal to bases of dorsal and anal fins, 2) another row of darker, larger spots immediately proximal to these, and 3) row of usually four distinct spots on straight section of lateral line, posteriormost usually darkest and most distinct. Median fins and ocular-side ventral fin with small, scattered dark spots. First ray of dorsal fin usually with 3-6 dark areas or bands. Interorbital region frequently with three dark bars, anterior- and posteriormost usually broader and darker than middle bar. Blind side light tan with no dark markings.

Colour in life: Based on colour photographs of BPBM 34871, 37832, 34263 and RUSI 52650. Spots more distinct than in preserved specimens. Median fins and ocular-side ventral fin also with whitish spots. Dark bands on first dorsal-fin ray very distinct, separated by whitish areas.

DISTRIBUTION: Indian Ocean: South Africa; Seychelles; Comoro Ids; Mauritius. Pacific Ocean: Coral Sea (Chesterfield Bank, New Caledonia, Great Barrier Reef); Society Ids (Moorea); Hawaiian Ids (Oahu, Midway Id); Marshall Ids (Bikini Atoll); Philippines (Luzon, Negros).

SIZE, HABITAT, SEXUAL DIMORPHISM, AND DEVELOPMENTAL VARIATION: The largest specimen examined was a female 104.5 mm in SL. The species is found near reefs, in gullies, or cave entrances on sand or coral- or rock-rubble bottoms at depths of 3-57 m.

Regressions of interorbital widths on SL showed males with significantly higher elevations (i.e. wider interorbital widths) than females when compared by ANCOVA (Fig. 4). Length of the first dorsal-fin ray shows negative allometry ($v = 0.6538 \pm 0.1321$), i.e. it becomes proportionately shorter with increased SL (compare Figs. 1 & 2).

ETYMOLOGY: This species is named *Asterorhombus filifer* from the combination of the Latin *filum*, filament, and *fero*, carry, in reference to the long first dorsal-fin ray, especially as it appears in small specimens and when the membrane is folded around the ray (Fig. 2).

REMARKS: *Asterorhombus filifer* differs from *A. bleekeri* , *A. osculus* , and *A.annulatus* in having 1) palmate gill-rakers, 2) the first dorsal-fin ray detached from remainder of fin and elongate (0.8-1.7 in head length; Fig. 6), and 3) sexual dimorphism in interorbital width (Fig. 4). In addition, it has uniserial dentition in both jaws vs. teeth in 2-3 rows in upper jaws of *A. bleekeri* and *A. osculus* (uniserial in *A. annulatus*).

Asterorhombus filifer can be distinguished from *A. fijiensis* by the following characters: (information on *A.*

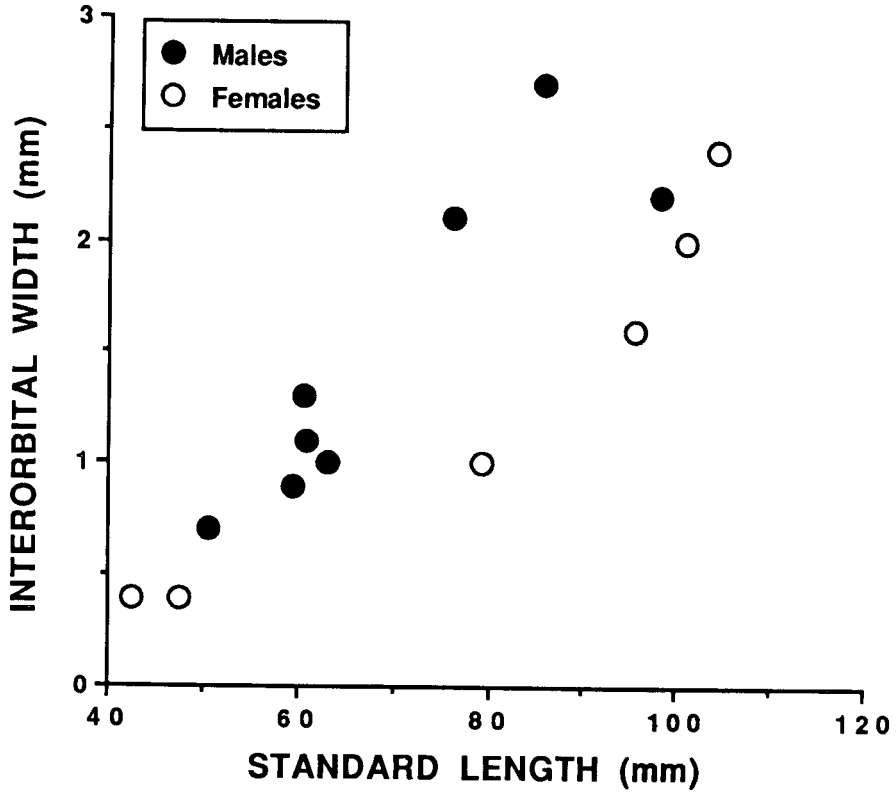


Figure 4. Plot of interorbital width against SL for *Asterorhombus filifer*.

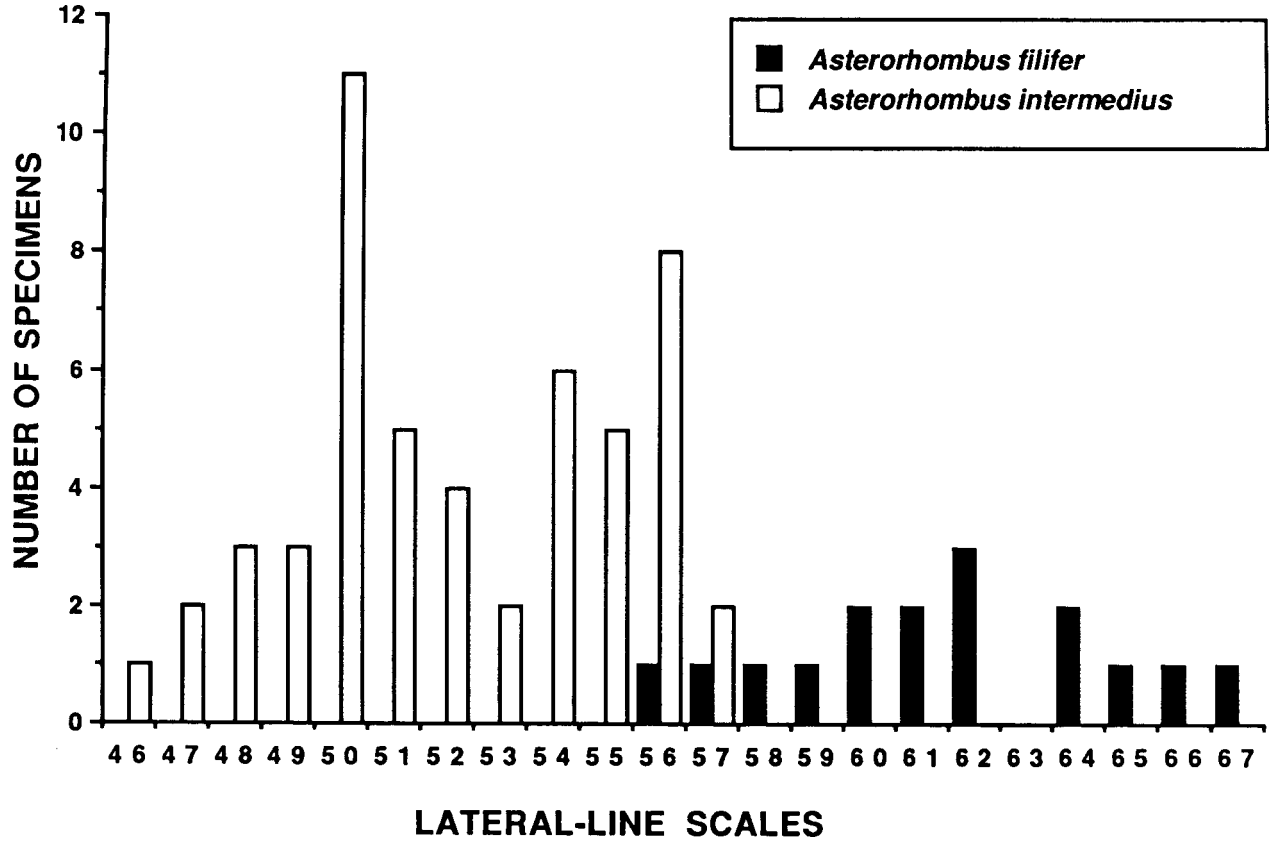


Figure 5. Frequency diagram of lateral-line scales for *Asterorhombus filifer* and *Asterorhombus intermedius*.

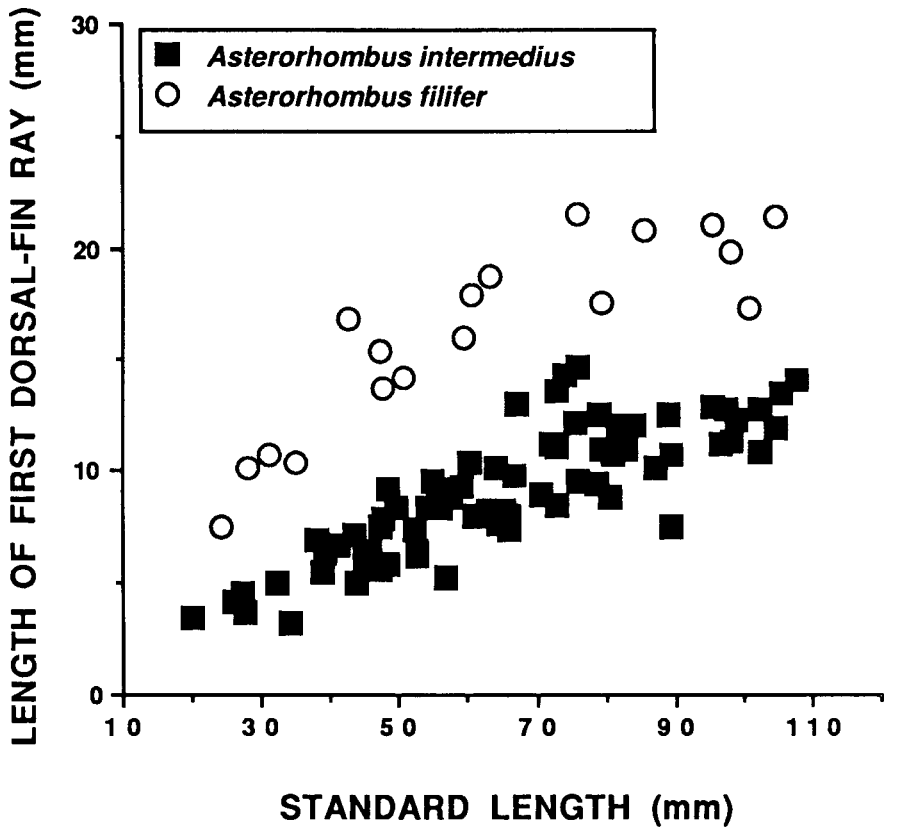


Figure 6. Plots of lengths of first dorsal-fin ray against SL for *Asterorhombus filifer* and *Asterorhombus intermedius.*

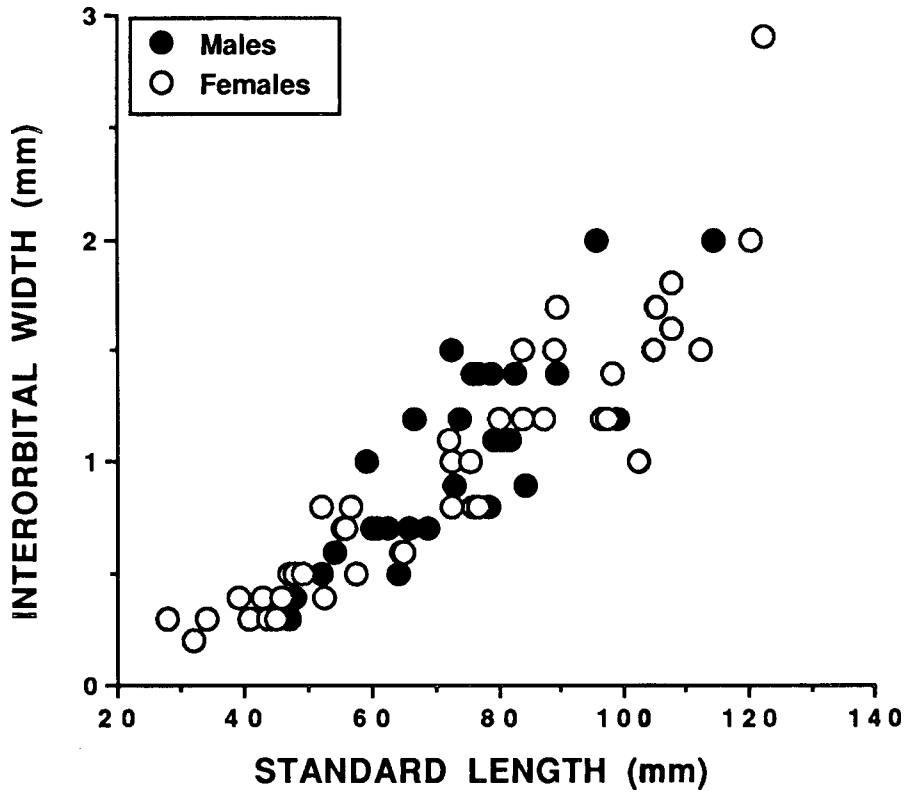


Figure 7. Plot of interorbital width against SL for male and female *Asterorhombus intermedius.*

fijiensis from Amaoka et al., 1994 and Hensley and Amaoka, 2001): body depth (1.7-1.9 in SL in *A. fijiensis* vs. 2.0-2.3 in *Asterorhombus filifer*; interorbital width in specimens larger than ca. 6 cm SL (3.7-5.8 in head length in males, 5.8-9.0 in females vs. 9-18 in males, 13-33 in females; Fig. 4); length of first dorsal-fin ray (1.5-2.8 vs. 0.8-1.7 in head length); morphology of membrane on first dorsal-fin ray (confined to tip of ray, with many folds, projections, and filaments vs. present on nearly entire length of ray, with smooth margins; Fig. 3A); ocular tentacles (1-9, often branched tentacles on upper eye, but absent on lower eye vs. both eyes usually with one tentacle, which is often branched).

Asterorhombus intermedius most closely resembles *A. filifer*. It was not uncommon to find *A. filifer* misidentified as *A. intermedius* in various collections, and there has been at least one published misidentification (i.e. Woods, 1966). They resemble each other in their lesser body depth and having a narrow interorbital region compared to *A. fijiensis*. In addition, both species have the membrane of the first dorsal-fin ray along most or the entire length of the ray (Fig. 3), i.e. not the complicated membranous structure limited to the tip of the ray as found in *A. fijiensis* (Amaoka et al. 1994, Figs. 1 & 3). However, *A. filifer* and *A. intermedius* differ in several characters. Comparing male and female interorbital widths regressed on SL for *A. intermedius* shows no significant difference in elevations, i.e. no sexual dimorphism in this character (Fig. 7) . This is in contrast to *A. filifer* where elevations of regression lines are significantly different (Fig. 4). Although both species are similar in having the first dorsal-fin ray membrane on most of the length of the ray, they show differences in length of the ray and morphology of the membrane. This ray is much longer in *A. filifer* compared to *A. intermedius* (Fig. 6; ray length 12 mm in 104.7 mm SL *A. intermedius* holotype) and *A. fijiensis* (Hensley and Amaoka, 2001). Edges of the membrane in *A. filifer* are smooth (Fig. 3A), while in *A. intermedius* they show sharp indentations, branching, and filamentous extensions (Fig. 3B; also see Lin et al., 1995: Fig. 4 and Hensley and Amaoka, 2001; membrane morphology in holotype of *A. intermedius* is very similar to that in Fig. 3B). Although both species usually have tentacles on both eyes, those in *A. intermedius* are only rarely branched (Hensley and Amaoka, 2001); and unbranched in holotype of *A. intermedius*, while most specimens of *A. filifer* have branched tentacles. Although there is a slight overlap in lateral-line scale counts, *A. filifer* usually has a higher count than *A. intermedius* (Fig. 5); (most lateral-line scales in holotype of *A. intermedius* were missing).

Assuming collecting of *Asterorhombus* species has been adequate to discern at least some rough patterns of distribution, three patterns can be seen. Three species of *Asterorhombus* appear to have restricted distributions: 1) A. osculus - Western Australia; 2) *A. bleekeri* - north and east coast of Queensland, including Gulf of Carpentaria, and Western Australia (Amaoka and Arai, 1998); and 3) *A. annulatus* - Flores, Timor, and Coral Sea (Amaoka and Mihara, 2001). Two species are much more broadly distributed: 1) *A. fijiensis* - western Indian Ocean, Western Australia, Ryukyu, South China Sea, Indo-Australian Archipelago, northern Great Barrier Reef, and Fiji; and *A. intermedius* - western Indian Ocean, including the Red Sea, to southern Japan, Taiwan, Indo-Australian Archipelago, and Tonga Islands (Lin et al., 1995; Hensley and Amaoka, 2001). The third pattern is shown by *A. filifer*. It extends from the western Indian Ocean to the Marshall, Hawaiian and Society islands; and it is the only species of *Asterorhombus* known to occur on the Pacific Plate.

Amaoka et al. (1994) were able to observe and photograph a live *A. fijiensis*. They found that the complicated membranous structure at the tip of the first dorsal-fin ray when in its natural state of folding, bore a remarkable resemblance to a small crustacean or fish. The live *A. fijiensis* would extend the first ray, bring the membranous structure near its mouth, and vibrate it. Although they never observed a prey species attracted to the membranous structure, they called it the esca and the ray the illicium. Senou et al. (1994) reported that the first dorsal-fin ray of *A. intermedius* and its wide membrane with complicated edging resembled a sandworm moving on the bottom. Lin et al. (1995) observed *A. intermedius* and saw that the first dorsal-fin ray was held up in the water and moved, resembling floating leaf-like algae. Shirai and Kitazawa (1998) observed a live *A. intermedius* and placed frozen krill in the tank. The fish approached the krill and rotated the first dorsal-fin at about a 45° angle above the vertical plane. It kept approaching the krill and finally darted at it and attacked it. The first dorsal-fin ray and membrane and associated behavior of these fishes have been interpreted as aggressive mimicry. If this is corroborated, they are the first known pleuronectiform fishes to exhibit this. An obvious need here is for more observations on live species of *Asterorhombus*. There have been no observations of living *A. filifer*. Although the first dorsal-fin ray of this species lacks the esca-type structure at the tip of the ray as in *A. fijiensis*, and the highly elaborate sculpturing of the membrane of this ray as in *A. intermedius*, it may possibly serve as a lure mimicking a worm or small eel.

COMPARATIVE MATERIAL EXAMINED: *Asterorhombus intermedius*: INDIAN OCEAN INCLUDING RED SEA: Red Sea; BMNH 1935.9.30.66-68, 3 specimens, 52.3-59.1 mm SL, males and females. BPBM 19871, 84.3 mm, female. MNHN 1967-593, 3, 77.0-122.3 mm, male and females. MNHN 1966-131, 2, 48.2-56.1 mm, male and female. MNHN 1966-132, 88.8 mm, female. MNHN 1966-134, 105.3 mm, female. MNHN 1966-133, 95.5 mm, male. USNM 260387, 2, 43.2-66.8 mm, females. USNM 257040, 8, 39.1-82.9, males and females. USNM 260388, 49.3 mm, female. USNM 257041, 107.7 mm, female. Madagascar; SAIAB (RUSI) 52648, 10, 74.5-100.1 mm, males and females; SAIAB (RUSI) 52651, 26.2 mm, sex unknown. Zanzibar; MNHN 1964-244, 2, 66.0-80.4 mm, females. USNM 260391, 2, 76.8-89.5 mm, male and female. Seychelles; ANSP 107788, 2, 56.7-87.2 mm, females. ANSP 107783, 34.3 mm, female. BMNH 1908.3.23:131-2, 2, 96.6-107.9 mm, females. MNHN 1982-22, 102.2 mm, male.

MNHN 1987-1870, 99.1 mm, male. Maldive Ids; BMNH 1901.12.31:114-115, 2, 32.2-69.0 mm, male and female. Sri Lanka; USNM 257039, 3, 33.9-60.2 mm, males. USNM 260390, 102.4 mm, female. Western Australia (Dampier Archipelago); NTM S.11924.008, 81.7 mm, male. WESTERN PACIFIC OCEAN INCLUDING TIMOR AND ARAFURA SEAS; NTM S.13321-005, 2, 79.0-79.3 mm, males. NTM S.1330-002, 57.6-64.2 mm, male and female. NTM S.12982-001, 80.8 mm, male. NTM S.11899-008, 73.0 mm, male. NTM S.10011-019, 27.8 mm, female. Australia (Queensland); AMS I.20555-010, 97.2 mm, female. AMS IA .3002, 67.0-72.8 mm, males. AMS E.6689-90, 4, 72.6-75.9 mm, males and females. ANSP 113517, 20.1 mm, sex unknown. ANSP 113512, 47.1 mm, male. ANSP 113499, 3, 27.1-52.6 mm, females and sex unknown. ANSP 113515, 2, 38.8-45.0 mm, male and female. ANSP 113518, 43.8 mm, female. BMNH 1925.7.22.49-52, 4, 47.0-89.2 mm, females. SIO 69-222, 70.5 mm, male. Solomon Ids; BPBM 15974, 112.6 mm, female. Tonga; ANSP 153436, 7, 48.2-78.7 mm, males and females. Sulawesi; RMNH 6746 (Holotype), 104.7 mm, female. USNM 260377, 2, 72.7-98.3 mm, females. USNM 260362, 65.3 mm, female. Hong Kong; NTUM 02485, 84.4 mm, male. CAS-SU 60949, 114.6 mm, male. Japan (Shikoku); BSKU 8376, 120.3 mm, female.

ACKNOWLEDGEMENTS

For the loan of and information regarding specimens we are very grateful to K. Amaoka, M.E. Anderson, M.L. Bauchot, A.C. Bentley, J. Chambers, M. Desoutter, W.N. Eschmeyer, P.C. Heemstra, M.A Hine, M. Holloway, T. Iwamoto, S.L. Jewett, M. McGrouther, V. Mthombeni, J. G. Ness, P. Pruvost, D. Rennis, B.C. Russell, W.G. Saul, S.-C. Shen, G. Shinohara, W.F. Smith-Vaniz, A.Y. Suzumoto, M.J.P. van Oijen, H.J. Walker, A. Wheeler, and R. Winterbottom. D.L. Ballantine's help with the photography and Loreen R. O'Hara's help with the drawing are greatly appreciated.

REFERENCES

Amaoka, K. 1969. Studies on the sinistral flounders found in the waters around Japan - taxonomy, anatomy and phylogeny. *J. Shimonoseki Univ. Fish.* 18(2): 65-340.

- - - , H, Senou & A, Ono. 1994. Record of the bothid flounder *Asterorhombus fijiensis* from the western Pacific, with observations on the use of the first dorsal-fin ray as a lure. *Jpn. J. Ichthyol.* 41(1): 23-28.

- - - & M. Arai. 1998. Redescription of a rare bothid, *Asterorhombus bleekeri* (Macleay), and description of a new species of *Asterorhombus* from northwestern Australia (Teleostei: Pleuronectiformes). *Ichthyol. Res.* 45(3): 249-257.

- - - & E. Mihara. (2001). *Asterorhombus annulatus* (Weber, 1913), a valid species distinct from *Asterorhombus intermedius* (Bleeker, 1866) (Pleuronectiformes: Bothidae). *Ichthyol. Res.* 48(2): 192-196.

Bleeker, P. 1865. Description de quelques espéces inédites de des genres *Pseudorhombus* et *Platophrys* de l'Inde Archipélagique. *Neder. Tijdschr. Dierk.* 2: 43-50.

Chabanaud, P. 1948. Notules Ichthyologique. XXXVIII. Addition à la faune de la Mer Rouge, *Asterorhombus intermedius. Bull. Mus. Hist. nat., Paris* (2) 20: 153.

Hensley, D.A. 1984. Bothidae (pp. 854-863). *In*: *Smiths' Sea Fishes*. M.M. Smith and P.C. Heemstra (eds.). Macmillan South Africa, Johannesburg, xx + 1047 pp.

- - - . 1986. Current research on Indo-Pacific bothids (p. 941). *In*: *Indo-Pacific Fish Biology*. T. Uyeno, R. Arai, T. Taniuchi, & K. Matsuura (eds.). Ichthyological Society of Japan, Tokyo, xii + 985 pp.

- - - , & K. Amaoka. 2001. Bothidae (pp. 3799-3841). *In*: *FAO species identification guide for fishery purposes. The Living Marine Resources of the Western Central Pacific. Vol. 6, Bony Fishes.* Part 4. K.E. Carpenter & V.H. Niem, eds. FAO, Rome.

Hubbs, C.L. & K.F. Lagler. 1949. Fishes of the Great Lakes Region. *Bull. Cranbrook Inst. Sci.* 26: 1-186.

Leviton, A.E., R.H. Gibbs, Jr., E. Heal, & C.E. Dawson. 1985. Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985(3): 802-832.

Lin, P.L., K.T. Shao & S.-C. Shen. 1995. Records of the genus *Asterorhombus* (Family Bothidae) and its two species from northern Taiwan and Taiping Island. *Acta Zoologica Taiwanica* 6(1): 25-32.

Macleay, W. 1881. Descriptive catalogue of the fishes of Australia. Part III. *Proc. Linn. Soc. N.S.W.* 6(1): 1-138.

Norman, J.R. 1931. Notes on flatfishes (Heterosomata). I. Notes on flatfishes of the Bothidae in the British Museum, with descriptions of three new species. *Ann. Mag. Nat. Hist.*, Ser. 10, (8): 507-510.

- - - 1934. *A Systematic Monograph of the Flatfishes (Heterosomata). Vol. I. Psettodidae, Bothidae, Pleuronectidae.* Trustees of the British Museum, London, 459 pp.

Ricker, W.E. 1973. Linear regression in fishery research. *J. Fish. Res. Bd. Canada* 30(3):409-434.

Senou, H., K. Amaoka, & A. Ono. 1994. Notes on two bothid flounders *Asterorhombus fijiensis* (Norman, 1931) and *A. intermedius* (Bleeker, 1866). *I.O.P. Diving News* 5(11): 4-5.

Shirai, Y., & H. Kitazawa. 1998. Peculiar feeding behavior of *Asterorhombus intermedius* in an aquarium. *Japan. J. Ichthyol.*, 45(1):47-50.

Snedecor, G.W., & W.G. Cochran. 1967. *Statistical Methods.* Iowa State University Press, Ames, 593 pp.

Tanaka, S. 1915. Ten new species of Japanese fishes. *Zool. Mag. Tokyo.* 27(4): 565-568.

Weber, M. 1913. *Die Fische der Siboga-Expedition*. E.J. Brill, Leiden, xii+710 pp.

Woods, L.P. 1966. Family Bothidae (pp. 62-66). In: Fishes of the Marshall and Marianas Islands. Vol. 3. Families Kraemeriidae through Antennariidae. L.P. Schultz and collaborators: L.P. Woods & E.A. Lachner. *Bull. U.S. Natl. Mus.* 202: vii+165.

SMITHIANA

SERIAL PUBLICATIONS FROM
THE SOUTH AFRICAN INSTITUTE FOR AQUATIC BIODIVERSITY

The Institute publishes original research on systematics, ecology, biology and conservation of fishes. Three series are produced at irregular intervals: the *Special Publication* series, the *Bulletin* series and the *Monographs* series.

Acceptance of manuscripts for publication is subject to the approval of reviewers from outside the Institute. Priority is given to papers by staff of the Institute, but manuscripts from outside the Institute will be considered if they are pertinent to the work of the Institute or use the Institute's collections. Colour illustrations can be printed at the expense of the author. Page charges will be mandatory for all non-staff or non-associates of the Institute, these charges will be at the discretion of the Editor. Fifty free copies of the publication will be supplied to the author or senior author. Additional reprints may be ordered at cost price.

Publications of the Institute are available by subscription or in exchange for publications of other institutions. Lists of the Institute's publications are available from the Publication Secretary at the address below. Past *Bulletins* are also available on the internet at http://bioline.bdt.org.br/fb, past *Special Publications* are at http://bioline.bdt.org.br/fs

INSTRUCTIONS TO AUTHORS

Manuscripts shorter than 30 pages will generally be published in the *Special Publications* series; longer papers will be considered for the *Bulletin* or *Monographs* series. Please follow the format of a recent *Bulletin* or *Special Publication*. The typescript must be double-spaced throughout with 25 mm margins all round; two hard copies must be submitted to the Editor. Each table or figure should be on a separate page and numbered with an Arabic numeral (not in sequence with text pages). All maps, graphs, charts, drawings and photographs should be numbered as figures. If two or more illustrations are grouped as one figure, they must be trimmed and spaced (but not mounted) as intended for final reproduction. Each part of a composite figure must be labelled with a capital letter; typewriter lettering is not acceptable. Illustrations larger than 21 x 30 cm should be avoided, or sent as a reduced bromide/line shot. Legends for figures should be on a separate page. A computer diskette/ CD, with the text in RTF, MSWord or Corel WordPerfect format, must be submitted with the hard copies. The inclusion of digital copies of all images and figures in acceptable formats (see web page) will expedite publication of the manuscript .

See extended *Instructions to Authors* at www.saiab.ru.ac.za/pubs.htm

STYLE OF THE HOUSE

Hyphens: Certain substantive compounds are hyphenated: gill-raker, soft-ray, type-species, type-locality, type-series, type-specimen. Other words often used together are not hyphenated unless they are used in adjectival expressions before a noun: anal fin / anal-fin rays; lateral line / lateral-line scales; gill arch / gill-arch filaments, etc.

Word usage: Although the following word pairs are often used interchangeably, we believe that consistent use of the first word as a noun and the second as an adjective will improve the precision of our writing: mucus / mucous; maxilla / maxillary; opercle / opercular, operculum / opercular. The operculum (= gill cover) comprises (usually) four separate bones: opercle, subopercle, preopercle and interopercle. The words preoperculum, suboperculum and interoperculum are unnecessary substitutes and not to be used for preopercle, subopercle and interopercle. The plural of operculum is opercula.

Decimal comma versus decimal point: Contrary to most journals published in South Africa and some European countries, we will not use a comma in place of a decimal point. Most computers do not read a comma as a decimal point. In addition, it is common in ichthyological papers to give sequences of measurements that include decimal numbers, with each measurement separated by a comma. If the comma is used to separate items in a series, as well as being used to indicate a decimal number, it will cause considerable confusion.

Fin formulae: Fin formulae will be designated as follows: D XII,10-12 indicates on continuous fin with 12 spines and 10-12 soft (segmented) rays; DX/I,10-12 indicates a fin divided to the base in front of the last spine; and D X+I,12 indicates two separate dorsal fins, the first with 10 spines and the second with 1 spine and 12 soft rays. If it is necessary to differentiate branched and unbranched soft-rays, lower-case Roman numerals will be used for unbranched rays and Arabic numerals for branched rays, e.g. D iii,S. Principal caudal-fin rays are defined as those that touch the hypural bones. The number of principal caudal rays is usually the number of branched rays plus two. If the principal caudal rays are in two separate groups, the number of rays in the dorsal group is given first: thus, "principal caudal rays 8+7" means that there are 15 principal caudal rays, with 8 rays in the dorsal group and 7 in the ventral group.

Abbreviations: Abbreviations normally end with a full stop: et al., e.g., etc., n.b., (note: these commonly used abbreviations of Latin words are not italicized). Dr (Doctor) and Mr (Mister) and compass directions (north, west, northwest, etc.) are abbreviated using capital letters without full stops: N, W, NW. We recommend the following abbreviations for ichthyological terms: SL - standard length, TL - total length, FL - fork length, GR - gill-rakers, LL - lateral line.

M. E. Anderson, Editor
L-A. Fargher, Layout and production
South African Institute for Aquatic Biodiversity (formerly J.L.B. Smith Institute of Ichthyology),
Private Bag 1015, Grahamstown 6140, South Africa.

ISSN 1684-4149

Published by the South African Institute for Aquatic Biodiversity
Private Bag 1015, Grahamstown, South Africa, 6140
www.saiab.ru.ac.za

formerly the JLB Smith Institute of Ichthyology