Zootaxa 996: 1–44 (2005)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)
996

Review of the perciform fish genus *Symphysanodon* Bleeker (Symphysanodontidae), with descriptions of three new species, *S. mona*, *S. parini*, and *S. rhax*

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> *. . . of making many books there is no end; and much study is a weariness of the flesh.*
> Ecclesiastes 12:12

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Accepted by A.C. Gill: 3 Mar. 2005; published: 25 May 2005

Abstract

Symphysanodon mona, a new species of perciform fish, is described from a single specimen collected in Mona Passage off the west coast of Puerto Rico. It differs from all other species of *Symphysanodon* in having fewer gillrakers on the first gill arch (4 or 5 + 19–21 = 24 or 25 total vs. 8–14 + 20–29 = 28–42 total) and, additionally, from the other two Atlantic species of the genus (*S. berryi* and *S. octoactinus)* in two other features of gill-arch morphology, viz., in having a ventral branch of the obliquus dorsalis 3 muscle (vs. its absence in the other two species) and in having a posteriorly projecting extension of the cartilaginous lateral end of ceratobranchial 4 (vs. its absence in the other two species; *S. berry*i has a small accessory cartilage associated with the lateral end of ceratobranchial 4 which may also be present in *S. octoactinus*).

Symphysanodon parini, new species, known from 10 specimens collected over Sala y Gómez Ridge in the eastern South Pacific, can be distinguished from all other species of *Symphysanodon*, except *S. maunaloae* from the central and western Pacific, by the following combination of characters: segmented anal-fin rays 7, tubed lateral-line scales 45–50, total gillrakers on first gill arch 31–34 (9 or 10 + 22–24), sum of lateral-line scales and gillrakers on individual specimens 77–84**,** depth of body 22.5–24.7 % SL (4.0–4.4 times in SL), length of depressed anal fin 24.8–26.4 % SL, hypurals 1 & 2 autogenous, hypurals 3 & 4 represented by a single plate, and first caudal vertebra without parapophyses. It is distinguished from *S. maunaloae* by differences in mean numbers of tubed lateral-line scales (mean = 47.89 for *S. parini* vs. mean = 44.94 for *S. maunaloae*) and pectoral-fin rays (mean = 16.90 for *S. parini* vs. mean = 16.13 for *S. maunaloae*) and by differences in a few morphometric characters.

Symphysanodon rhax, new species, known from specimens collected off the Maldive Islands, northern Indian Ocean, is separable from all other species of *Symphysanodon*, except *S. berryi* from the Atlantic, by the following combination of characters: segmented rays in the anal fin 7, tubed lateral-line scales 50, gillrakers on the first gill arch 35–38 (10 or 11 + 25–27), sum of lateral-line scales and gillrakers on individual specimens 85–88**,** depth of body 20.6–24.8 % SL (4.0–4.9 times in SL), length of depressed anal fin 21.8–23.9 % SL, hypurals 1 & 2 autogenous, hypurals 3 & 4 represented by a single plate, and first caudal vertebra without parapophyses. It can be distinguished from *S. berryi* by its shorter second anal-fin spine and a suite of other morphometric characters. A key to *Symphysanodon* and a review of the other species of the genus are also presented.

Key words: Symphysanodontidae; *Symphysanodon mona*, new species; *Symphysanodon parini*, new species; *Symphysanodon rhax*, new species; key to *Symphysanodon*; review of *Symphysanodon*; Puerto Rico; Mona Passage; Sala y Gómez Ridge; Maldives

Introduction

The small to medium-sized perciform fishes of the genus *Symphysanodon* Bleeker inhabit waters over the continental shelf, upper continental slope, and submarine ridges and occur in similar depths in insular areas. The genus is known from 10 species—six previously described (*S. andersoni* Kotthaus, *S. berryi* Anderson, *S. katayamai* Anderson, *S. maunaloae* Anderson, *S. octoactinus* Anderson, and *S. typus* Bleeker), the three described herein, and a species known only from stomach contents of a specimen of *Latimeria cha-*

lumnae Smith collected off the Comoros in the western Indian Ocean. *Symphysanodon* has been treated variously as a member of the Acropomatidae, Serranidae, or Lutjanidae, but it lacks traits that would support assigning it to any of those families. Fourmanoir (1981), without explanation, erected the monotypic family Symphysanodontidae, an action that seems justified because *Symphysanodon* does not appear to possess characters that would allow its placement elsewhere. During an extensive study of the branchial morphology of bony fishes, the second author examined a specimen of *Symphysanodon*, collected in Mona Passage off the west coast of Puerto Rico, that differs from all other species of *Symphysanodon* in number of gillrakers on the first arch. It also differs from the other two Atlantic species and at least five of the other species of the genus in two other aspects of gill-arch structure. (Springer and Johnson, 2004, described and illustrated the dorsal gill-arch musculature of *S. berryi*.) The first author received from N. V. Parin material of the second new species, collected over the Sala y Gómez Ridge in the eastern South Pacific, and from the Natural History Museum in London specimens of the third new one, caught off the Maldive Islands in the northern Indian Ocean. The second new species is apparently most closely related to *S. maunaloae* from which it can be distinguished by mean numbers of pectoral-fin rays and tubed lateral-line scales and by several morphometric characters; the third new species is very similar to *S. berryi* but displays a number of morphometric differences.

Herein, we present a key to the new and previously described species of *Symphysanodon* and describe the three new species, comparing each with the other species occurring in the same ocean basin. Since Anderson (1970) revised *Symphysanodon*, the genus has been mentioned in a number of publications but usually with limited treatment. The most extensive accounts are by Kotthaus (1974), Lee (1989), and Anderson (2000, 2003). Consequently, we take this opportunity to provide updates on the other species of the genus.

Methods and abbreviations

Methods for making counts and measurements are those of Anderson (1970). Where possible, gillrakers (including rudiments, when present) and pectoral-fin rays were counted on the right side; lateral-line scales, on the left side. Many trawl-caught specimens of *Symphysanodon* have large numbers of scales rubbed off during capture, making it difficult or impossible to obtain accurate counts of lateral-line scales. The problem of enumerating missing lateral-line scales can be largely overcome by counting scale pockets, if they can be discerned, and by measuring with calipers scaleless and pocketless gaps in lateral lines and comparing those measurements with sections of lateral lines having scales that can be accurately counted. Gill arches and associated muscles were removed from specimens and then stained using the method of Springer and Johnson (2000). We used the notation of Ahlstrom et al. (1976), to express the formulae for the configurations of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores.

Institutional abbreviations are as listed in Leviton et al. (1985), except: IIPB (Instituto de Ciencias del Mar, Barcelona, Spain), INV PEC (INVEMAR, Instituto de Investigaciones Marinas y Costeras, Cerro Punta de Betin, Santa Marta, Colombia), MRS (Marine Research Section, Ministry of Fisheries and Agriculture, Malé, Republic of Maldives), ORSTOM (Office de la Recherche Scientifique et Technique Outre-Mer, Nouméa, New Caledonia), SAIAB (RUSI) (South African Institute for Aquatic Biodiversity, Grahamstown, Republic of South Africa), UF (Florida Museum of Natural History, University of Florida, Gainesville),YU (Yamaguchi University, Yamaguchi City, Japan), ZIKU (Zoological Institute, Kochi University, Kochi, Japan), ZISP (Zoological Institute, Academy of Sciences, St. Petersburg, Russia). Standard length is indicated by SL.

Key to the species of *Symphysanodon*

In the key, unless otherwise noted, scale counts are of numbers of tubed lateral-line scales (excluding any that are posterior to the base of the caudal fin), gillraker counts are of total numbers on the first gill arch (including rudiments, if present), and sums of scales plus gillrakers are based on single counts of each character from each specimen examined.

1a. Scales 60 or 61. Gillrakers 41 or 42. Sum of scales plus gillrakers 102—both sides. (Based on holotype only) .... ***S. andersoni***, western Indian Ocean

1b. Scales 55 or fewer. Gillrakers 24–42, usually fewer than 40. Sum of scales plus gillrakers on individual specimens 71–94 .... **2**

2a. Depth of body 2.8–3.1 times in SL (32–36% SL). Segmented rays in anal fin usually 8, occasionally 7. Gillrakers 38–42. Scales 45–48. Formula for configuration of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores 0/0/0 + 2/1 + 1/1/. Hypurals 3 & 4 autogenous .... ***S. octoactinus***, western Atlantic Ocean

2b. Depth of body 3.0–5.0 times in SL (20–33% SL, usually less than 30% SL). Segmented rays in anal fin 7 (very rarely 6). Gillrakers 24–40. Scales 42–55. Formula for configuration of supraneural bones, etc., almost always 0/0/0 + 2 + 1/1/1/, never 0/0/0 + 2/1 + 1/1/. Hypurals 3 & 4 represented by a single plate **3**

3a. Gillrakers 24 or 25 (4 or 5 on upper limb) .... ***S. mona***, new species, Mona Passage off Puerto Rico, western Atlantic Ocean

3b. Gillrakers 29–40 (9–12 on upper limb).. **4**

4a. Anal fin long, length of depressed anal fin 2.6–2.9 times in SL (34–39% SL). Depth of body 3.2–3.7 times in SL (27–31% SL). In fresh specimens yellow or orange band visible on side of body extending to or almost to caudal-fin base............ ***S. katayamai*** western and central Pacific Ocean

4b. Anal fin short, length of depressed anal fin 2.9–4.5 times in SL (22–34% SL, a specimen of *S. maunaloae* with anal fin 37.0% SL). Depth of body 3.0–5.0 times in SL (20–33% SL), 270 of 276 specimens (98%) examined with depth of body more than 3.4 times in SL (less than 29% SL). Side without yellow or orange band **5**

5a. Scales 42–50. Gillrakers 29–39. Sum of scales plus gillrakers on individual specimens 73–85 .... **6**

5b. Scales 48–55. Gill rakers 34–40. Sum of scales plus gillrakers on individual specimens 83–94 .... **7**

6a. Scales 42–47 (mean = 44.94). Pectoral-fin rays 15–17 (mean = 16.13). Least depth of caudal peduncle 10–13% SL. Length of third anal-fin spine 13–16% SL. Length of second anal-fin spine 11–15% SL .... ***S. maunaloae***, widely distributed, from French Polynesia and the Hawaiian Islands westward through the Pacific to the Philippines and Indonesia and apparently to the Strait of Malacca

6b. Scales 45–50 (mean = 47.89). Pectoral-fin rays 16–18 (mean = 16.90). Least depth of caudal peduncle 9–10% SL. Length of third anal-fin spine 12–13% SL. Length of second anal-fin spine 10–12% SL .... ***S. parini***, new species, Sala y Gómez Ridge, eastern South Pacific Ocean

7a. Length of anal-fin base 15–21% SL. Length of depressed anal fin 27–34% SL. Length of first anal-fin spine 4.8–7.2% SL. Scales 49–55. Gillrakers 36–40. Sum of scales plus gillrakers of individual specimens 86–94. Pectoral-fin rays 15–18, most frequently 16 (rarely 18). First segmented ray of pelvic fin only slightly produced, usually not extending to origin of anal fin. Caudal-fin lobes produced, but apparently never produced into extremely long filaments. Hypurals 1 & 2 represented by a single plate. Parapophyses present on first caudal vertebra.......... ***S. typus*** widely distributed in the Pacific Ocean from the Hawaiian Islands (in the north) and Wallis and Futuna (in the south) to the Philippines and Indonesia

7b. Length of anal-fin base 13–16% SL. Length of depressed anal fin 22–30% SL. Length of first anal-fin spine 3.0–5.6% SL. Scales 48–52. Gillrakers 34–39. Sum of scales plus gillrakers of individual specimens 83–90. Pectoral-fin rays 16–18, usually 17. First segmented ray of pelvic fin noticeably produced in males longer than ca. 85 mm SL, extremely filamentous in large individuals—occasionally reaching past fork of caudal fin. Caudal-fin lobes frequently produced into extremely long filaments in large males of *S. berryi* (caudal-fin lobes damaged in all specimens of *S. rhax* examined). Hypurals 1 & 2 autogenous. Parapophyses absent from first caudal vertebra **8**

8a. Length of second anal-fin spine 9.9–13.4% SL. Width of bony interorbital 7.2–9.0% SL. Least depth of caudal peduncle 9.5–11.9% SL.......... ***S. berryi*** western, central, and eastern Atlantic Ocean

8b. Length of second anal-fin spine 7.5–9.2% SL. Width of bony interorbital 6.6–7.3% SL. Least depth of caudal peduncle 7.1–9.7% SL .... ***S. rhax***, new species northern Indian Ocean off the Maldive Islands

Description of characters shared by the three new species of *Symphysanodon*

Because *Symphysanodon mona*, *S. parini*, and *S. rhax* are morphologically similar, it is appropriate to characterize them under a single heading and then to elaborate as necessary under the respective species accounts.

Snout relatively blunt. Anterior ends of premaxillae incised, forming a notch that receives the anterior ends of the dentaries. Dorsalmost margin of maxilla covered by very narrow suborbital with mouth closed. Mouth terminal; lower jaw inclined dorsally with mouth closed; jaws about equal. Maxilla reaching posteriorly to a vertical through middle of eye or to well beyond middle of eye. Anterior and posterior nares fairly closely set on each side of snout. Pseudobranchiae present. Interorbital region flattened. Premaxillae and dentaries with small teeth. Premaxillary teeth somewhat larger anteriorly; premaxillary notch toothless. Dentary with teeth extending from elevated posterodorsal surface of jaw almost to symphysis; usually a few larger teeth at anterior ends of dentaries fit into premaxillary notch with mouth closed; symphysis toothless. Vomer, palatines, pterygoids, and tongue (tongue not observed in *S. mona*, having been dissected away) apparently edentate (any teeth present on those structures are extremely small). Opercle with two flattened spines, the ventral one longer and better developed. Numerous small serrae on vertical limb of preopercle; usually a few larger serrae on horizontal limb; a spine or spine-like process at angle of preopercle. Dorsal fin continuous and not incised at junction of spines and segmented rays. Scales ctenoid (with ctenial bases in the posterior field proximal to marginal cteni—see Hughes, 1981; this is the transforming ctenoid scale of Roberts, 1993). Most of head, including maxillae, dentaries, lachrymals, and interorbital region with scales; much of dorsal aspect of snout without scales; lateral aspects of snout with or without scales. Dorsal and anal fins without scales, but with scaly sheaths at their bases. Large modified scales associated with pelvic fin, just dorsal to pelvic spine (axillary scales) and in ventral midline between the pelvic fins (interpelvic scales). Lateral line gently curved beneath dorsal fin. Caudal fin well forked.

Branchiostegals 7. Anal-fin rays III, 7. Pelvic-fin rays I, 5. Principal caudal-fin rays 17 (9 + 8); branched rays 15 (8 + 7). No spur on posteriormost ventral procurrent caudal-fin ray, but penultimate ventral procurrent caudal-fin ray shortened basally (see Johnson, 1975). Vertebrae 25 (10 precaudal + 15 caudal). Formula for configuration of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores 0/0/0 + 2 + 1/1/1/. Pleural ribs on vertebrae 3 through 10. First caudal vertebra without parapophyses. Short neural spine on second preural centrum. Autogenous haemal spine associated with second preural centrum. Parhypural autogenous, bearing a hypurapophysis. Hypurals 1 and 2 autogenous; 3 and 4 represented by a single plate, probably representing an ontogenetic fusion (based on unpublished studies by G. David Johnson of larvae of other species of *Symphysanodon*). Hypural 5 autogenous. Epurals 3.

***Symphysanodon mona*, new species**
Akarnax Slopefish
(Figures 1–4; Tables 1, 8, 9)

Holotype: USNM 371386, 86 mm SL; Mona Passage, off the west coast of Puerto Rico; 18°13’ N, 67°20’ W; 384 m; OREGON station 2645; 5 October 1959.

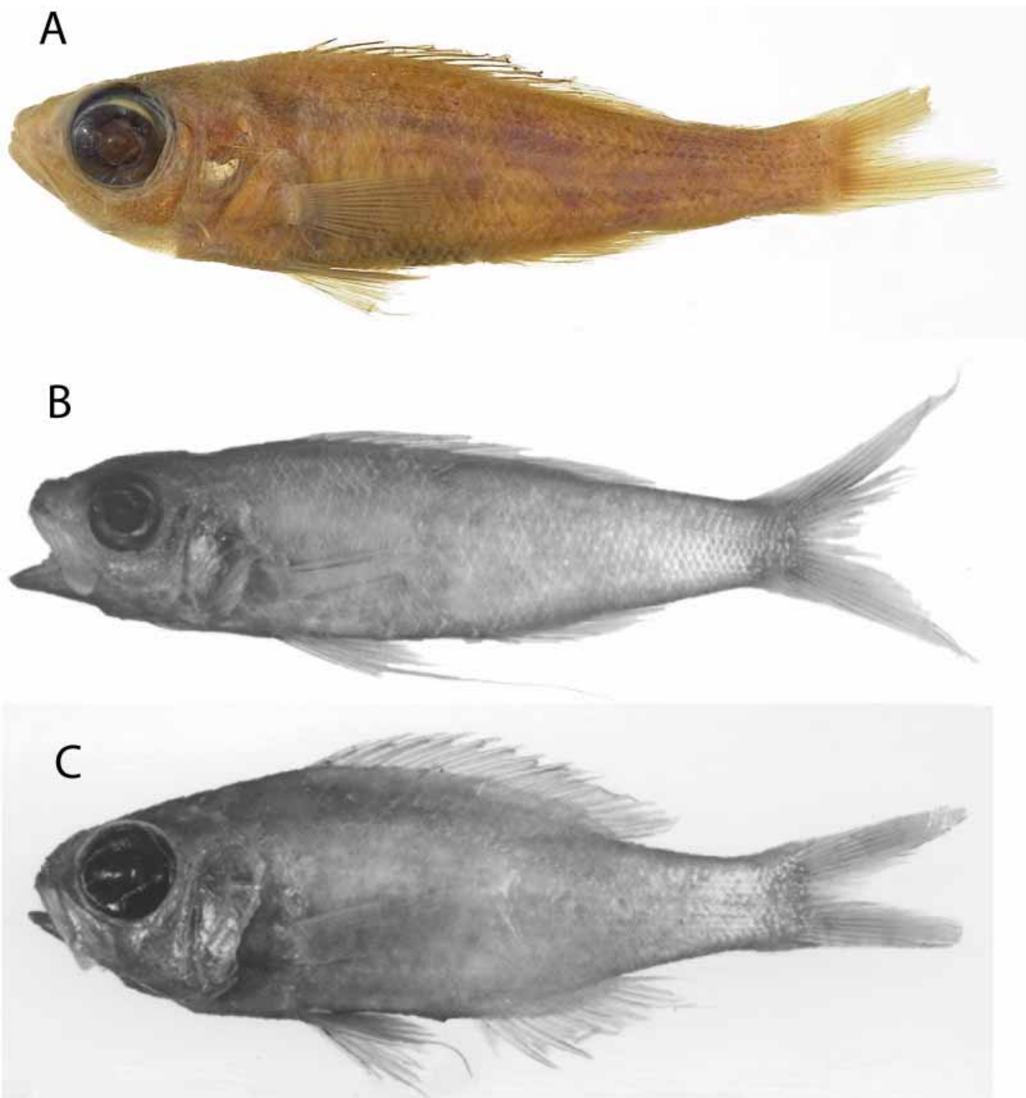

FIGURE 1. A. Holotype of *Symphysanodon mona,* USNM 371386, 86 mm SL. B. Holotype of *Symphysanodon berry*i, USNM 204086, 115 mm SL. C. Holotype of *Symphysanodon octoactinus*, USNM 204084, 79 mm SL.

Diagnosis. A species of *Symphysanodon* (Figure 1) distinguishable from all other species of the genus in having fewer gillrakers on first arch (4 or 5 + 19–21 = 24 or 25 total vs. 8–14 + 20–29 = 28–42 total). In addition, it differs from other Atlantic species in having a ventral branch of obliquus dorsalis 3 muscle (Figure 2, vs. its absence in the other two species) and in having a posteriorly projecting extension of the cartilaginous lateral end of ceratobranchial 4 (Figure 3A, vs. its absence in the other two species; *S. berryi* has a small accessory cartilage, Figure 3B, associated with the lateral end of ceratobranchial 4; the specimen of *S. octoactinus* examined may have had a very small accessory cartilage that was lost during dissection).

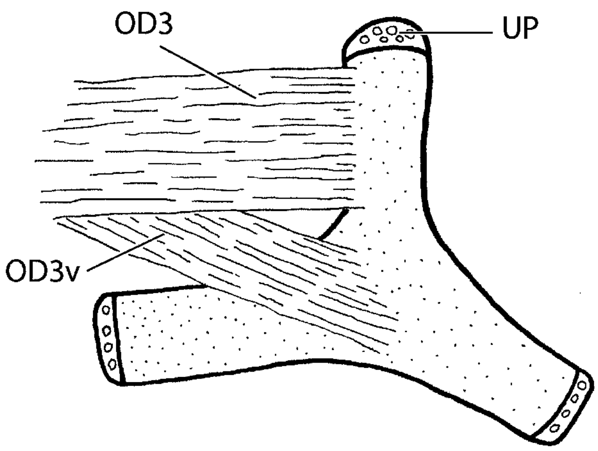

FIGURE 2. Diagrammatic anterior view of third left-side epibranchial of *Symphysanodon mona* (holotype, USNM 371386, 86 mm SL) to show position of obliquus dorsalis 3 (OD3) insertions (OD3v = ventral branch of OD3; UP = tip of uncinate process); OD3v is not present in *S. berryi* and *S. octoactinus*.

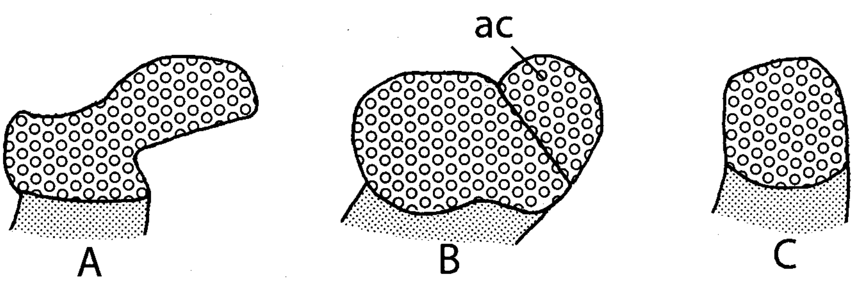

FIGURE 3. Diagrammatic views of the cartilaginous lateral ends of left-side ceratobranchials 4 of the three Atlantic species of *Symphysanodon*. A = *S. mona*, holotype, USNM 371386, 86 mm SL (note posteriorly projecting process); B = *S. berryi*, USNM 370558, 128 mm SL (ac = accessory cartilage); C = *S. octoactinus*, USNM 204085, 82 mm SL (may have had a small accessory cartilage that was lost in dissection).

Description. The characters included in the combined description of *S. mona*, *S. parini*, and *S. rhax* and those presented in the species diagnosis form part of the species description. Tubed scales in lateral line ca. 47 (many missing). Dorsal-fin rays IX, 10. Pectoral-fin rays 17. Procurrent caudal-fin rays 13 dorsally, 12 ventrally. Trisegmental pterygiophores: 3 associated with dorsal fin, 2 with anal fin. Epineurals associated with first 9 vertebrae. Uroneurals probably 2 pairs, not seen clearly on radiograph. (Johnson, 1984, reported 2 uroneurals for the genus and found 2 in a 15-mm cleared and stained larva of another species of *Symphysanodon*, pers. comm. 21 February 2003, and we found 2 uroneurals in radiographed specimens of each of the other species in the genus.) Internarial distance contained ca. 5 times in snout length. Pelvic fins and both caudal-fin lobes damaged; measurements of other body parts are presented in percentages of SL in Table 1.

TABLE 1. Morphometric data for Atlantic species of *Symphysanodon*: *S. mona*, *S. berryi*, *and S. octoactinus*. Standard lengths are in mm; other measurements, in percentages of standard length; > = slightly damaged.

	S. mona	*S. berryi*		*S. octoactinus*	
Character	Holotype	*n*	Range	*n*	Range
Standard length	86	164	36–160	24	58–115
Head, length	35.2	32	30.7–36.0	19	33.9–36.3
Head, depth	ca. 20	51	19.0–23.3	19	27.4–30.9
Snout, length	8.2	32	5.8–8.9	19	6.4–8.6
Fleshy orbit, diameter	11.2	32	8.6–13.2	19	12.1–15.4
Postorbital head, length	16.4	18	13.8–16.9	8	14.0–16.9
Suborbital width	0.6	22	0.7–1.2	19	0.6–1.0
Cheek, height	5.1	44	4.4–6.4	19	5.6–8.0
Upper jaw, length	16.1	44	13.4–16.5	19	14.4–16.5
Lower jaw length	15.7	51	12.4–15.9	19	16.0–18.4
Bony interorbital width	8.9	53	7.2–9.0	19	9.0–10.5
Body, depth	26.1	163	20.3–28.2	24	31.6–36.0
Caudal peduncle, depth	9.5	51	9.5–11.9	19	12.0–13.2
Caudal peduncle, length	26.3	15	25.0–29.8	8	26.2–27.5
Anal-fin base, length	14.3	131	12.7–15.8	19	16.5–18.8
Anal-fin length	25.0	127	22.8–30.3	18	28.5–32.3
Pectoral fin, length	>25	111	23.7–27.2	15	28.3–>30
First dorsal spine, length	6.2	32	5.0–8.5	15	6.1–7.8
Third dorsal spine, length	15.3	26	12.1–16.5	14	12.8–14.7
Fourth dorsal spine, length	17.2	25	14.2–18.9	17	13.8–16.5
Last dorsal spine, length	13.1	23	ca. 12–>15	17	14.1–16.4
Longest dorsal spine, length	17.2 (4th = 5th)	22	16.0–18.9 (4th, 5th, or 6th)	18	15.4–18.4 (5th, 6th, or 7th)
First anal spine, length	5.8	133	3.3–5.6	19	7.0–9.1
Second anal spine, length	11.5	129	9.9–13.4	18	13.0–14.9
Third anal spine, length	>13	122	11.1–15.0	19	14.9–18.0

Comparisons of Atlantic species of *Symphysanodon*. *Symphysanodon mona* is easily distinguished from the other Atlantic *Symphysanodon* on the basis of gillraker counts: *S. mona* with 4 or 5 + 19–21 = 24 or 25 total; *S. berryi* with 9–12 + 24–28 = 34–39 total; *S. octoactinus* with 12–14 + 26–29 = 38–42 total. Selected morphometric data for the Atlantic species of *Symphysandon* are compared in Table 1. In addition there are notable differences among the Atlantic species in the musculature and skeleton of the branchial region (see Figures 2 & 3). *Symphysanodon mona* has a ventral branch of the obliquus dorsalis 3 muscle (Figure 2, vs. its absence in the other two Atlantic species) and has a posteriorly projecting fingerlike extension of the cartilaginous lateral end of ceratobranchial 4 (Figure 3A, vs. its absence in the other Atlantic species; *S. berryi* has a small accessory cartilage, Figure 3B, associated with the lateral end of ceratobranchial 4, which is not present in *S. mona* and was not observed in *S. octoactinus*).

Distribution. Known only from the type locality: Mona Passage off the west coast of Puerto Rico in 384 m (see Figure 4). The holotype of *S. mona* was collected with a specimen of *S. berryi* (USNM 289922).

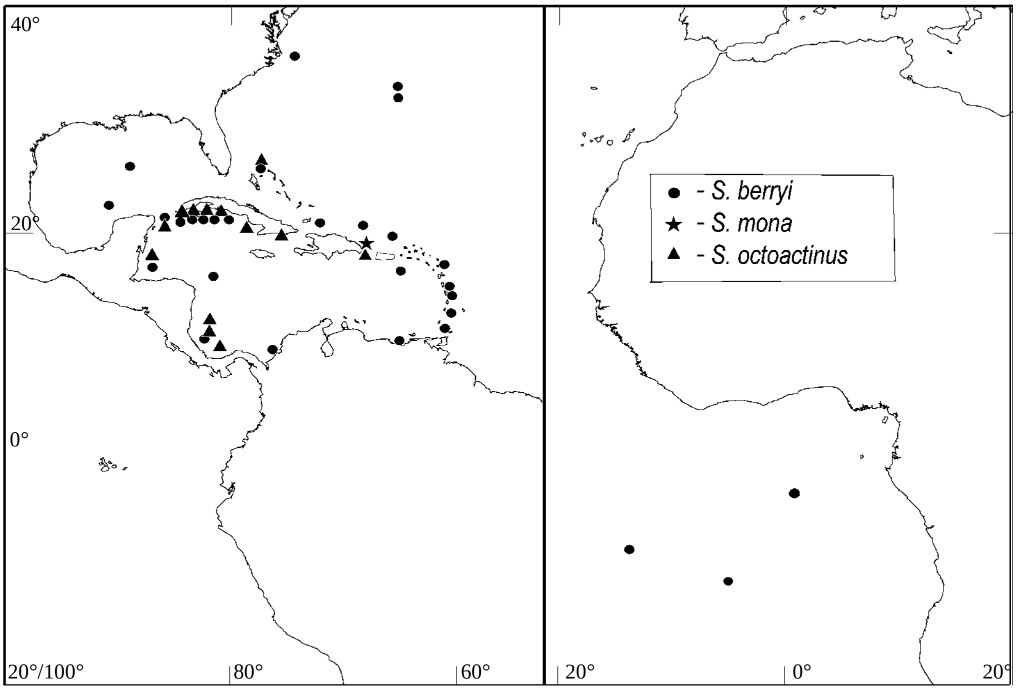

FIGURE 4. Localities of capture for specimens of Atlantic *Symphysanodon*: *S. berryi*, *S. mona*, and *S. octoactinus*. Some symbols represent more than one collection.

Etymology. The name *mona* refers to the type locality (Mona Passage) and is a feminine noun in apposition to *Symphysanodon*. The common name Akarnax Slopefish is derived from a Greek word meaning “a basslike fish” and from the fact that species of *Symphysanodon* have been collected frequently in slope waters.

Symphysanodon parini, new species

Sala y Gómez Slopefish

(Figures 5–9; Tables 2, 3, 8, 9)

Symphysanodon maunaloae (non Anderson, 1970): Kotylar and Parin, 1990: 114, fig. 6 (eastern South Pacific, Sala y Gómez Ridge; otolith morphology and age).—Parin, 1990: 21 (eastern South Pacific, Sala y Gómez Ridge).—Parin et al., 1990: 46 (eastern South Pacific, Sala y Gómez Ridge; feeding and trophic relationships).—Parin, 1991: 679, table 1 (eastern South Pacific, Sala y Gómez Ridge).—Parin et al., 1997: 173 (eastern South Pacific, Sala y Gómez Ridge).

Holotype: USNM 372776, 114 mm SL; Sala y Gómez Ridge, eastern South Pacific; 25°04' S, 97°28' W; 240–275 m; R/V PROFESSOR MESYATZEV trawl 41; 4 October 1984.

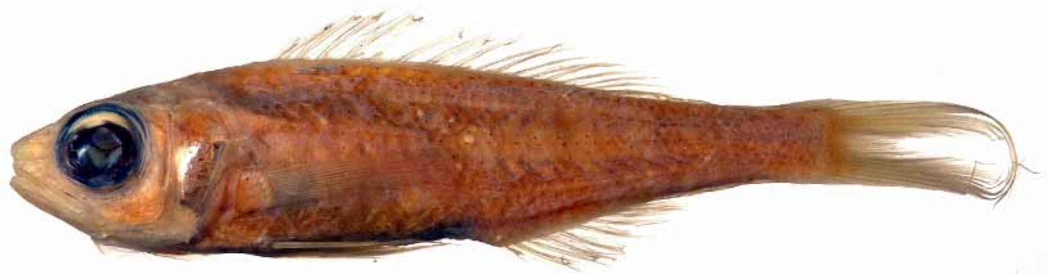

FIGURE 5. Holotype of *Symphysanodon parini*, USNM 372776, 114 mm SL.

Paratypes. USNM 375198, four specimens, 81–112 mm SL; IOAN uncatalogued, five specimens, 93–114 mm SL; all collected with the holotype.

Diagnosis. A species of *Symphysanodon* (Figure 5) separable from all other species of the genus, except *S. maunaloae*, by the following combination of characters: segmented rays in anal fin 7, tubed lateral-line scales 45–50, total gillrakers on first gill arch 31–34 (9 or 10 + 22–24), sum of lateral-line scales and gillrakers on individual specimens 77–84, depth of body 22.5–24.7 % SL (4.0–4.4 times in SL), length of depressed anal fin 24.8–26.4 % SL, hypurals 1 & 2 autogenous, hypurals 3 & 4 represented by a single plate, and first caudal vertebra without parapophyses. It can be separated from *S. maunaloae* by differences in mean numbers of tubed lateral-line scales (mean = 47.89 for *S. parini* vs. mean = 44.94 for *S. maunaloae*; see Table 2) and pectoral-fin rays (mean = 16.90 for *S. parini* vs. mean = 16.13 for *S. maunaloae*; see Table 2) and by differences in certain morphometric characters (see Figures 6–8).

Description. The characters included in the combined description of *S. mona*, *S. parini*, and *S. rhax* and those presented in the species diagnosis form part of the species description. Counts for the holotype are indicated by asterisks. Dorsal-fin rays IX, 9 or 10* (10 in 9 of 10 specimens). Pectoral-fin rays 16–18 (17*). Procurrent caudal-fin rays 13 or 14* dorsally, 12–14 (13*) ventrally. Trisegmental pterygiophores 2*–4 associated with dorsal fin, 2* or 3 with anal fin. Epineurals associated with first 8* or 9 vertebrae (first 8 vertebrae in 9 of 10 specimens). Uroneurals 2 pairs.* Internarial distance contained 6–8 times in snout length. Other morphometric data are presented in percentages of SL in Table 3.

TABLE 2. Frequency distributions of numbers of tubed lateral-line sacles and pectoral-fin rays in *Symphysanodon parini* and *S. maunaloae*. Counts for the holotype of *S. parini* are indicated by asterisks.

	Tubed lateral-line scales									
	42	43	44	45	46	47	48	49	50	Mean
S. parini				1	1*	2	–	4	1	47.89
S. maunaloae	1	9	11	9	17	6				44.94

	Pectoral-fin rays				
	15	16	17	18	Mean
S. parini		2	7*	1	16.90
S. maunaloae	5	52	14		16.13

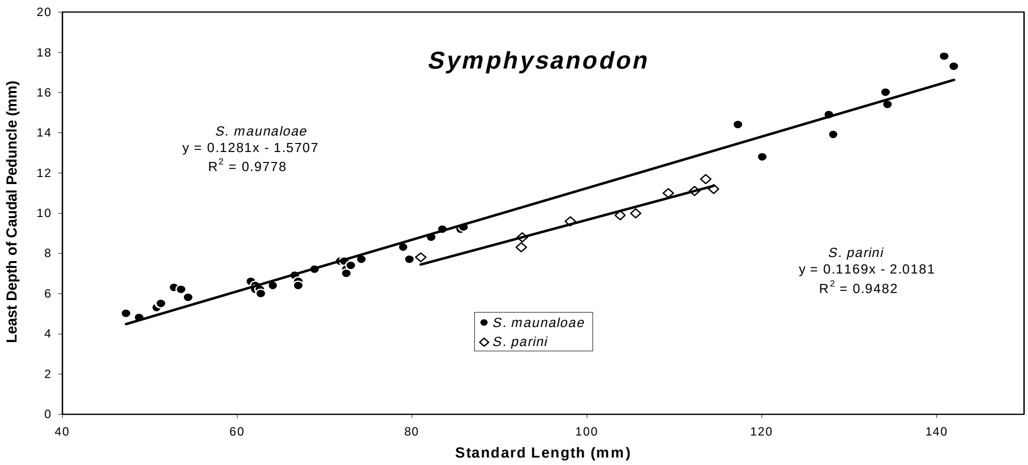

FIGURE 6. Comparison of least depth of caudal peduncle versus standard length in *Symphysanodon maunaloae* and *S. parini*.

Comparisons of *S. parini* with other Pacific species of *Symphysanodon*. *Symphysanodon parini* can be distinguished from *S. katayamai* by its shallower body (depth of body 22–25 % SL vs. 27–31 % SL), shorter anal fin (length of depressed anal fin 25–26 % SL vs. 34–39 % SL), and smaller numbers of gillrakers (total on first gill arch 31–34 vs. 35–40) and lateral-line scales (45–50 vs. 50–52); from *S. typus* by its shorter anal fin (length of depressed anal fin 25–26 % SL vs. 27 – >34 % SL) and smaller numbers of gillrakers (total on first gill arch 31–34 vs. 36–40) and tubed lateral-line scales (45–50 vs. 49–55); and from *S. maunaloae* by its larger mean numbers of tubed lateral-line scales (mean = 47.89 vs. mean = 44.94; see Table 2) and pectoral-fin rays (mean = 16.90 vs. mean = 16.13; see Table 2) and by its shallower caudal peduncle and shorter second and third anal–fin spines (see Figures 6–8).

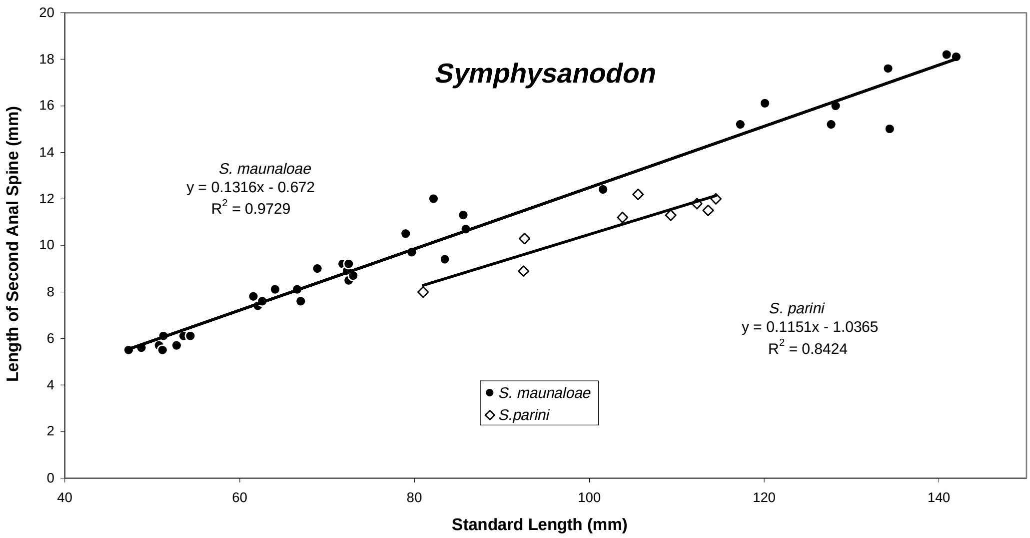

FIGURE 7. Comparison of length of second anal-fin spine versus standard length in *Symphysanodon maunaloae* and *S. parini.*

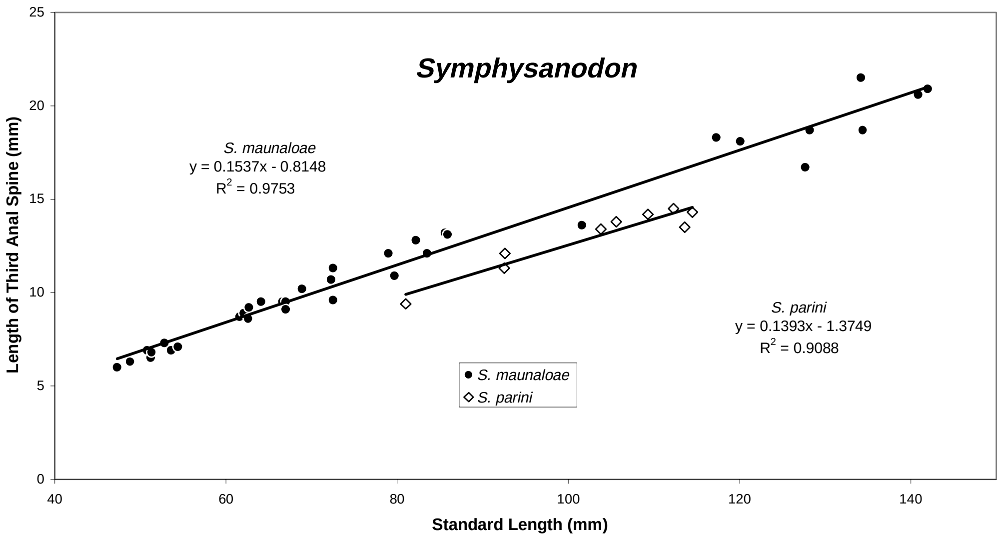

FIGURE 8. Comparison of length of third anal-fin spine versus standard length in *Symphysanodon maunaloae* and *S. parini*.

TABLE 3. Morphometric data for specimens of *Symphysanodon parini*. Standard lengths are in mm; other measurements, in percentages of standard length; > = slightly damaged.

	Holotype	Paratypes	
Character	USNM 372776	*n*	Range
Standard length	114	9	81–114
Head, length	32.1	9	30.7–33.9
Head, depth	18.2	9	17.7–21.9
Snout, length	6.6	9	5.8–8.1
Fleshy orbit, diameter	11.1	9	9.9–12.0
Postorbital head, length	12.9	9	12.3–14.3
Cheek, height	4.4	9	3.8–5.1
Upper jaw, length	14.3	9	13.0–14.4
Lower jaw, length	14.1	9	12.9–13.9
Bony interorbital width	8.7	9	7.9–8.9
Body, depth	23.4	9	22.5–24.7
Caudal peduncle, depth	9.8	9	9.0–10.3
Caudal peduncle, length	25.9	9	23.3–26.0
Anal-–fin base, length	15.5	9	14.4–15.6
Anal fin, length	24.9	9	24.8–26.4
Pectoral fin, length	26.4	9	24.4–27.1
Pelvic fin, length	ca. 26	9	22.6–29.0
Upper caudal-fin lobe	36.2	9	ca. 33–ca. 47
Lower caudal-fin lobe	32.9	9	ca. 30-ca. 44
First dorsal spine, length	5.1	8	4.1–6.2
Second dorsal spine, length	9.7	9	9.2–11.0
Third dorsal spine, length	12.6	8	12.1–>13.6
Fourth dorsal spine, length	13.5	9	13.0–15.9
Last dorsal spine, length	12.4	7	11.9–13.2
Longest dorsal spine, length	14.2 (5th)	8	13.8–16.1 (4th or 5th)
First anal spine, length	4.8	9	4.3–6.2
Second anal spine, length	10.5	8	9.6–11.6
Third anal spine, length	12.5	8	11.6–13.1

Sexuality and sexual dimorphism. Histological examination of the gonads of all available specimens of *S. parini* showed that nine individuals (81–114 mm SL) are males and one (98 mm SL) is a female with no indication of hermaphroditism. In our limited sample size we found no evidence of sexual dimorphism. This contrasts with the situation in *S. maunaloae* which seems to show distinct differences between the sexes in lengths of pelvic fins and caudal-fin lobes (see below). The absence of obvious sexual dimorphism in external morphology may be an additional character distinguishing *parini* from *maunaloae*.

Distribution. Known only from the Sala y Gómez Ridge, eastern South Pacific (Figure 9). The type specimens were collected in 240–275 m; Parin et al. (1997: 173) reported this species from depths of 240–300 m.

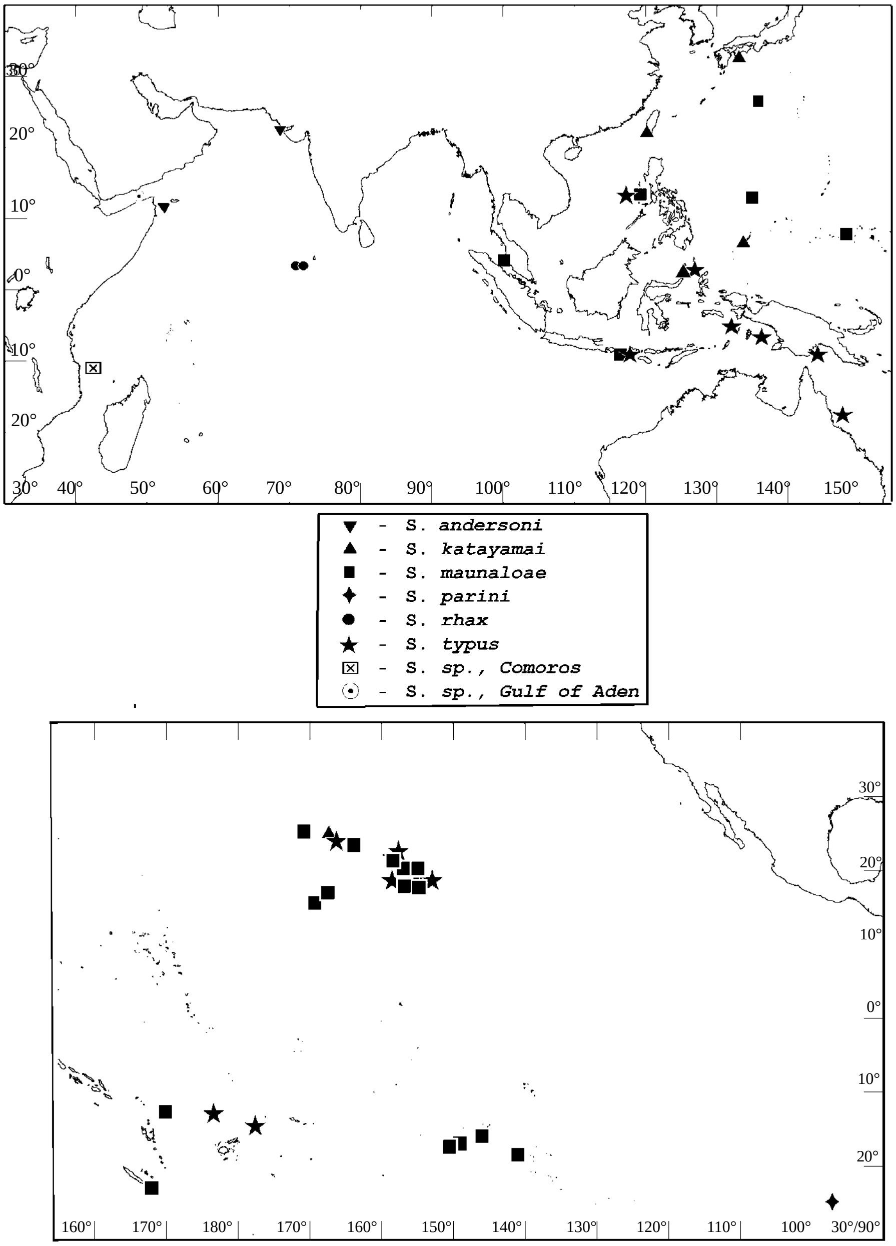

FIGURE 9. Localities of capture for specimens of Indo-Pacific *Symphysanodon*: *S. andersoni*, *S. katayamai*, *S. maunaloae*, *S. parini*, *S. rhax*, *S. typus*, the *Symphysanodon* sp. from the Comoros, and the *Symphysanodon* sp. from the Gulf of Aden. Some symbols represent more than one collection.

Etymology. We are pleased to name this species for N.V. Parin of the P. P. Shirshov Institute of Oceanology, Moscow, who provided the material on which the description is based and who has been of invaluable assistance to us and other ichthyologists for many years.

***Symphysanodon rhax*, new species**
Maldives Slopefish
(Figures 9–15; Tables 4, 5, 8, 9)

Holotype: BMNH 2003.1.5.1, 144 mm SL; Maldive Islands, northern Indian Ocean; 04°11' N, 72°55' E; 218 m; R/V DR FRIDTJOF NANSEN cruise: Maldives station no. 13; 21 August 1983.

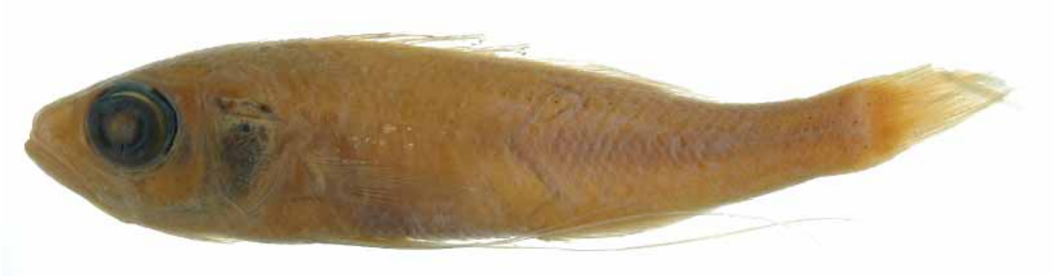

FIGURE 10. Holotype of *Symphysanodon rhax*, BMNH 2003.1.5.1, 144 mm SL.

Paratype. BMNH 2003.1.5.2, 134 mm SL, from the same station as the holotype.

Other specimens, not part of the type series. BMNH 1997.9.17:2, one specimen, 64 mm SL; R/V DR FRIDTJOF NANSEN survey of the Maldives, 04°05' N, 73°23' E.—BMNH 1997.9.17:6–8, three specimens, 128–136 mm SL; R/V DR FRIDTJOF NANSEN survey of the Maldives, 04°11' N, 72°55' E.

Diagnosis. A species of *Symphysanodon* (Figure 10) separable from all other species of the genus, except *S. berryi*, by the following combination of characters: segmented rays in anal fin 7, tubed lateral-line scales 50, total gillrakers on first gill arch 35–38 (10 or 11 + 25–27), sum of lateral-line scales and gillrakers on individual specimens 85–88, depth of body 20.6–24.8% SL (4.0–4.9 times in SL), length of depressed anal fin 21.8–23.9 % SL, length of anal-fin base 12.6–14.8% SL, length of first anal-fin spine 3.0–4.8% SL, hypurals 1 & 2 autogenous, hypurals 3 & 4 represented by a single plate, and first caudal vertebra without parapophyses. It can be separated from the Atlantic species *S. berryi* by a number of morphometric characters (see Table 4 and Figures 11–15). It also differs slightly from *S. berryi* in counts of pectoral-fin rays (17 or18, mean = 17.33, for *S. rhax* vs. 16–18, mean = 16.99, for *S. berryi*).

TABLE 4. Comparisons of morphometric data for specimens of *Symphysanodon berryi* and *S. rhax*. Standard lengths are in mm; other measurements, in percentages of standard length; > = slightly damaged.

	Symphysanodon berryi		*Symphysanodon rhax*	
Character	*n*	Range	*n*	Range
Standard length	164	36–160	6	65–144
Head, depth	51	19.0–23.3	6	17.7–20.3
Lower jaw, length	51	12.4–15.9	6	15.2–16.1
Bony interorbital width	53	7.2–9.0	6	6.6–7.3
Caudal peduncle, depth	51	9.5–11.9	6	7.1–9.7
Anal-fin length	127	22.8–30.3	6	21.8–23.9
First dorsal spine, length	32	5.0–8.5	6	4.3–5.9
Second dorsal spine, length	26	9.1–12.3	4	8.6–9.8
Third dorsal spine, length	29	12.1–16.5	4	11.5–12.6
Fourth dorsal spine, length	19	14.2–18.9	5	13.1–15.3
Last dorsal spine, length	26	ca. 12–>15	4	11.2–12.8
Second anal spine, length	129	9.9–13.4	6	7.5–9.2
Third anal spine, length	122	11.1–15.0	5	9.3–11.9

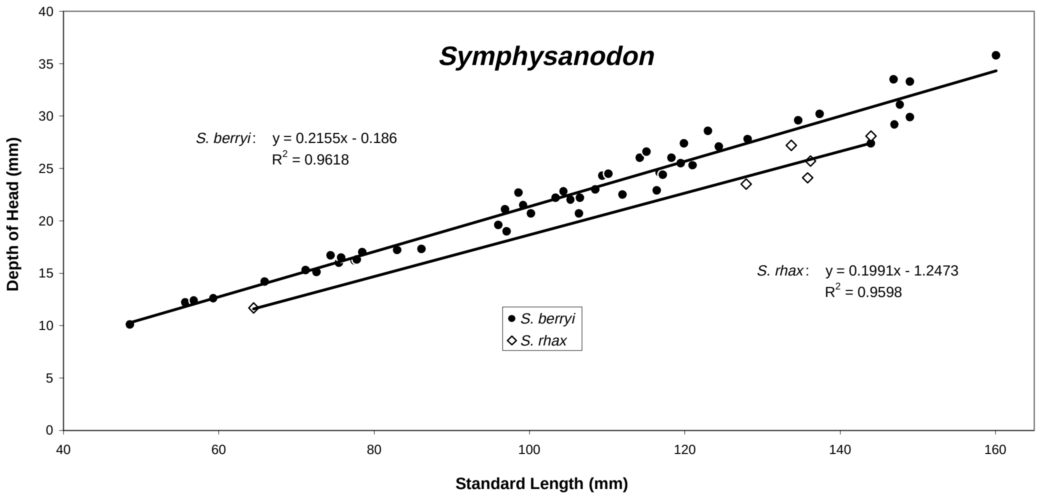

FIGURE 11. Comparison of depth of head versus standard length in *Symphysanodon berryi* and *S. rhax*.

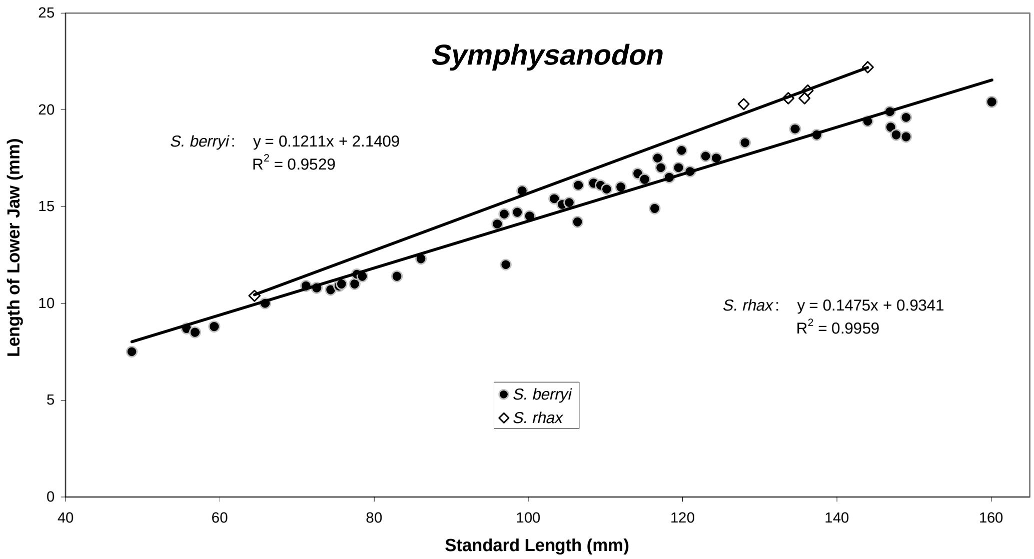

FIGURE 12. Comparison of length of lower jaw versus standard length in *Symphysanodon berryi* and *S. rhax.*

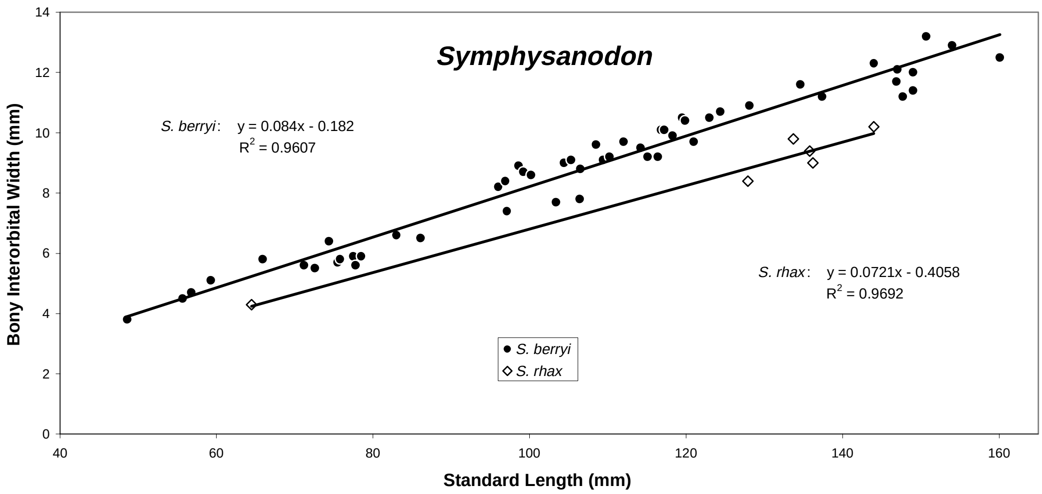

FIGURE 13. Comparison of bony interorbital width versus standard length in *Symphysanodon berryi* and *S. rhax.*

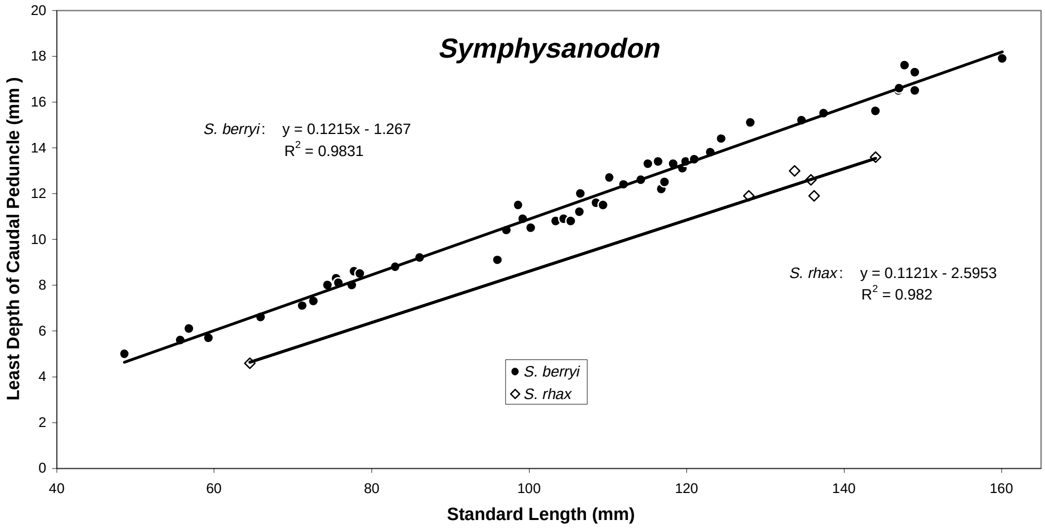

FIGURE 14. Comparison of least depth of caudal peduncle versus standard length in *Symphysanodon berryi* and *S. rhax*.

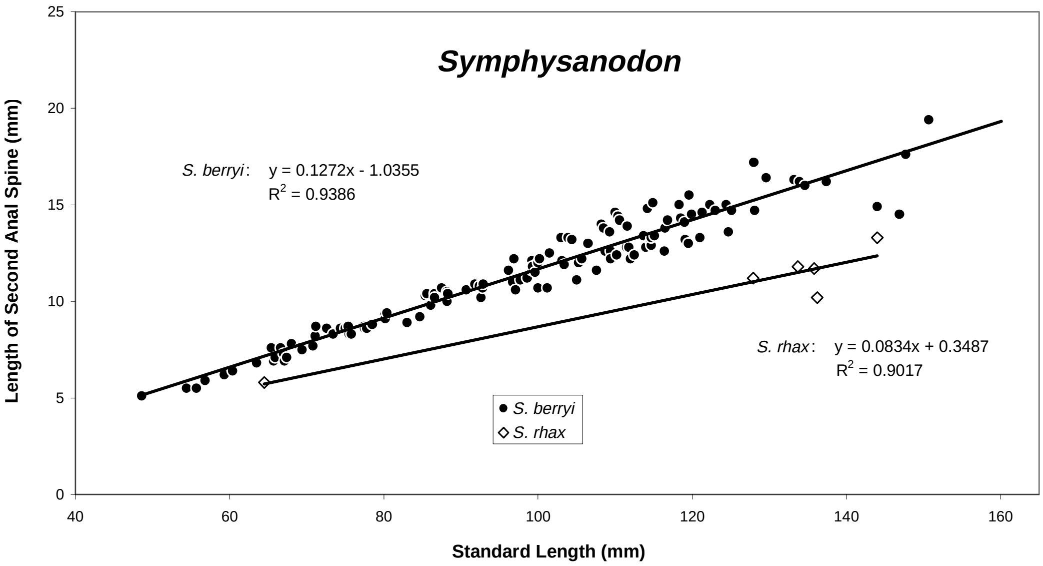

FIGURE 15. Comparison of length of second anal-fin spine versus standard length in *Symphysanodon berryi* and *S. rhax*.

Description. The characters included in the combined description of *S. mona*, *S. parini*, and *S. rhax* and those presented in the species diagnosis form part of the species description. Counts for the holotype are indicated by asterisks. Dorsal-fin rays IX, 10.*

Pectoral-fin rays 17 or 18*. Procurrent caudal-fin rays 13 or 14 dorsally, 12 or 13 ventrally. Trisegmental pterygiophores 2 or 3* associated with dorsal fin, 2 or 3 with anal fin. Epineurals associated with first 8* or 9 vertebrae (first 9 vertebrae in 5 of 6 specimens). Uroneurals 2 pairs*. Caudal-fin lobes damaged on all available specimens. Internarial distance contained 4–6 times in snout length; other morphometric data are presented in percentages of SL in Table 5.

TABLE 5. Morphometric data for specimens of *Symphysanodon rhax*. Standard lengths are in mm; other measurements, in percentages of standard length; > = slightly damaged.

Character	Holotype BMNH 2003.1.5.1	Paratype BMNH 2003.1.5.2	Other specimens	
			n	Range
Standard length	144	134	4	64–136
Head, length	33.2	32.2	4	33.1–35.5
Head, depth	19.5	20.3	4	17.7–18.9
Snout, length	6.7	7.2	4	5.4–6.3
Fleshy orbit, diameter	10.8	11.2	4	9.9–10.8
Postorbital head, length	15.8	15.0	4	16.3–18.1
Suborbital width	0.4	0.6	4	0.3–0.7
Cheek, height	6.0	6.4	4	5.1–6.2
Upper jaw, length	15.1	15.6	4	14.7–15.5
Lower jaw length	15.4	15.4	4	15.2–16.1
Bony interorbital width	7.1	7.3	4	6.6–6.9
Body, depth	23.5	24.8	4	20.6–23.8
Caudal peduncle, depth	9.4	9.7	4	7.1–9.3
Caudal peduncle, length	27.8	25.6	4	24.6–27.3
Anal-fin base, length	12.9	14.8	4	12.6–13.9
Anal fin, length	21.8	23.4	4	22.1–23.9
Pectoral fin, length	>22	>23	4	23.3–26.0
Pelvic fin, length	>67	>26	4	ca. 20–>64
First dorsal spine, length	5.1	5.6	4	4.3–5.9
Third dorsal spine, length	11.5	12.3	2	11.7–12.6
Fourth dorsal spine, length	13.8	14.2	3	13.1–15.3
Last dorsal spine, length	broken	12.8	3	11.2–12.4
Longest dorsal spine, length	13.8 (4th)	14.4 (7th)	3	13.4–15.3 (4th or 5th)
First anal spine, length	4.8	3.7	4	3.0–4.3
Second anal spine, length	9.2	8.8	4	7.5–ca. 9
Third anal spine, length	>10	11.9	3	9.3–11.2

Comparisons of *S. rhax* with other Indian Ocean species of *Symphysanodon*. *Symphysanodon rhax* can be distinguished from *S. andersoni* in having fewer gillrakers (total on first gill arch 35–38 vs. 41or 42) and lateral-line scales (50 vs. 60 or 61), from an undescribed species from the Comoros in having more gillrakers (total on first gill arch 35–38 vs. 28), and from *S. maunaloae* (assuming that species occurs in the Indian Ocean) in having more lateral-line scales (50 vs. 42–47).

Sexuality and sexual dimorphism. Histological examination of the gonads of two specimens of *S. rhax* (134 & 136 mm SL) showed both to be females with no evidence of hermaphroditism. Four specimens have short pelvic fins (20 – >26% SL) and two have produced pelvic fins (>64 & >67% SL). Because both specimens known to be female by histological examination have short pelvic fins and because females of the apparent closest relative of this species, *S. berryi*, have short pelvic fins (in contrast with males which frequently have very well-produced pelvic fins), it is reasonable to assume that the individuals of *S. rhax* with produced pelvic fins are males. *Symphysanodon berryi* is also sexually dimorphic with regard to lengths of caudal-fin lobes. Unfortunately, both caudal-fin lobes are damaged on all six specimens of *S. rhax*, leaving the question of sexual dimorphism in this character unanswered.

Distribution. Known only from the northern Indian Ocean off the Maldive Islands (Figure 9). Depth of capture, 218 m, is available for only one collection.

Remarks. Two of the six specimens of *S. rhax* (i.e., the type specimens) examined were reported under an account of *S. berryi* by Anderson (2003:1306), who wrote “2 specimens (134 and 144 mm standard length), indistinguishable from this species [*S. berryi*], have been obtained off the Maldives, southwest of Sri Lanka in the Indian Ocean.” Three other specimens (BMNH 1997.9.17:6–8, 128–136 mm SL) reported herein, along with another two (MRS 0455/97, 118 & 146 mm total length) from the Maldives, are listed under *Symphysanodon* sp. in Adam et al. (1998). Meristic and much of the morphometric data for *S. rhax* agree closely with those for specimens of *S. berryi*, but ranges for some measurements do not overlap or overlap only slightly with those of *S. berryi* (see Table 4).

It can be argued that the differences noted in Table 4 are artifacts of the small sample size from the Maldives and not sufficient to recognize those specimens as representing a species distinct from *Symphysanodon berryi*, but when the data for the measurements shown in Table 4 are plotted (see Figures 11–15), it is obvious that the Atlantic and Indian Ocean populations belong to different species. Also, closure of the Tethys Sea by Late Miocene (Smith et al., 1994) would have provided the long-term geographic isolation necessary for allopatric speciation to occur. Gill and Kemp (2002) addressed the problem of the taxonomy of widely distributed Indo-Pacific shore fishes, maintaining “that well-diagnosed geographic forms and subspecies should be awarded full-species status” (p. 165). We concur with their thinking and believe that it applies also to fishes, such as species of *Symphysanodon*, that occur over the continental shelf, upper continental slope, and submarine ridges and in insular waters of similar depths. Consequently, we have chosen to describe the Maldive form as a new species.

Etymology. The name *rhax* (berry or grape) is from the Greek and is an allusion to the similarity of this new species to *S. berryi*. The new name is a feminine noun in apposition to *Symphysanodon*.

Other species of *Symphysanodon*

***Symphysanodon typus* Bleeker, 1878.** Anderson (1970) reported 12 specimens (50–165 mm SL) of *S. typus* from Hawaii, New Guinea, Kai Islands, and Philippine Islands in depths of 119–236 m. We have examined 12 additional specimens (44–127 mm SL) not reported in the revision of the genus (Anderson, 1970): they are from the Hawaiian Islands (BPBM 24753; 93 mm SL.—BPBM 33426; 110 mm SL; taken from the stomach of a specimen of *Pristipomoides* [Lutjanidae]); off the island of Rotuma in the southwest Pacific (USNM 279253; 65 mm SL; taken from the stomach of a specimen of *Seriola* [Carangidae]; reported by Zug et al. 1989); off Papua New Guinea in the Gulf of Papua (WAM P.26769-003; 5: 84–107 mm SL); off Lombok, Indonesia (GMBL 81–162; 91 mm SL); the Philippines (GMBL 80–379; 2: 97–127 mm SL); and the South Pacific (presumably, actual locality of capture not known; GMBL 72–399; 44 mm SL). G. David Johnson examined 10 specimens of *S. typus* at the MNHN; they were collected off Wallis and Futuna at 14°19'08"S, 178°04'08"W (MNHN 1995-0775; 9: 46–74 mm SL.—MNHN 2001-3339; 72 mm SL). Mark McGrouther and Sally Reader provided data on nine specimens of *S. typus* collected north of Townsville, Queensland, Australia (AMS I.25800-006; 110 mm SL.—AMS I.25811-009; 6: 104-132 mm SL.—AMS I.25828-002; 103 mm SL.—AMS I.25829-003; 109 mm SL). Depths of collection for the additional material range from 50 (50–100) – 440 (245–440) m.

Three earlier references to *S. typus* (Kamohara and Katayama, 1959; Katayama, 1960, 1968) are to specimens collected off Kashiwajima, Kochi Prefecture, Japan; all of which appear to be *S. katayamai* (see Anderson, 1970). Masuda et al. (1975, plate 51-K) presented an illustration labeled *Symphysanodon typus* that is of a specimen of *S. katayamai*. Fourmanoir (1981) identified two specimens collected by bottom trawl in 183 m in Philippine waters as *S. typus* and provided enough information for verification of his identification. On a note with two Philippine specimens (GMBL 80-379), Fourmanoir wrote "dorsal fin, inf. caudal lobe, opercular flap yellow." Gloerfelt-Tarp and Kailola (1984:172–173) included a color photograph of this species in their book on southern Indonesian and northwestern Australian fishes and described the coloration as: "Scarlet-orange, paler below; head and lower caudal fin lobe bright yellow, dorsal fin bright yellow, membrane olive." Seki and Callahan (1988) noted that *Symphysanodon typus* and *S. maunaloae* were among the fishes most frequently consumed by the lutjanid *Pristipomoides zonatus* at Pathfinder Reef, Mariana Archipelago, in April and May 1984. Lee (1989) presented a table comparing morphological characters of *S. typus*, *S. katayamai*, and *S. maunaloae*. Chave and Mundy (1994) and Chave and Malahoff (1998) reported *S. typus*, based on photographs made from submersibles, from depths of 80–245 m over hard substrates in waters of the Hawaiian Archipelago, and published a photograph (figure 31 in Chave and Mundy, 1994; figure 176 in Chave and Malahoff, 1998) taken in 153 m of an aggregation of fish identified by them as *S. typus*. Chave and Mundy (1994: 396) wrote of *S. typus* : “Aggregated in midwater near holes in cliffs. Darted into overhangs, holes, or caves when approached.” Myers (1999) reported *S. typus* in a tabular checklist of Micronesian fishes as occurring in the southern Marianas, which he defined as Guam to Saipan, and Myers and Donaldson (2003) included it in their checklist of Marianas fishes. Kimura et al. (2003) presented a short account and a color photograph of *S. typus* and reported the species from off Bitung, northeastern Sulawesi, Indonesia. The photograph in Kimura et al. (2003) shows a specimen of 110 mm SL that is mostly pink with posterior part of operculum yellow, dorsal fin greenish yellow, upper lobe of caudal fin pink, and lower lobe of caudal fin yellow. *Symphysanodon typus*, then, is widely distributed from the Hawaiian Islands to Indonesia and the Phillipines. Locality data for *S. typus* are plotted in Figure 9.

***Symphysanodon katayamai* Anderson, 1970.** Anderson (1970), based on the holotype (ZIKU 8206, 163 mm SL) and one extensively dissected nontype specimen (YU uncatalogued; >145 mm SL, head removed), reported *S. katayamai* from off Kashiwajima, Kochi Prefecture, Japan. We have examined two additional specimens that have not been reported in the literature; they are from the Palau Islands (BPBM 37711; 72 mm SL) and the Hawaiian Islands (BPBM 30603; 111 mm SL; taken from the stomach of an *Epinephelus* [Serranidae]). Depths of collection for the additional material are 91 m and 165–183 m. Counts and measurements for the holotype and the new material are presented in Table 6.

TABLE 6. Counts and measurements for three specimens of *Symphysanodon katayamai*. Counts of lateral-line scales are of tubed scales. Counts of gillrakers are of total on first gill arch. Counts for pectoral-fin rays and lateral-line scales are from both sides of each specimen, where possible; left side count presented first. Standard lengths are in mm; other measurements, in percentages of standard length; R = right side; L = left side; > = slightly damaged; holotype--ZIKU 8206. *Broken when examined, but note with specimen states “caudal filaments prolonged.”

Character	BPBM 37711	BPBM 30603	ZIKU 8206
Dorsal-fin rays	IX, 10	IX, 10	IX, 10
Anal-fin rays	III, 7	III, 7	III, 7
Pectoral-fin rays	16, 16	17 L	16, 16
Tubed lateral-line scales	52, 50	ca. 52 L	50, ca. 50
Gillrakers	36 R	ca. 40 R	35 R
Standard length	72	111	163

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TABLE 6 continued

Character	BPBM 37711	BPBM 30603	ZIKU 8206
Head, length	29.9	25.4	27.2
Head, depth	17.9	18.0	21.8
Snout, length	5.4	5.5	7.3
Fleshy orbit, diameter	9.1	7.7	7.4
Postorbital head, length	14.1	12.0	13.9
Suborbital width	1.1	1.0	1.3
Cheek, height	5.4	5.6	7.3
Upper jaw, length	12.9	13.1	13.5
Lower jaw, length	13.3	12.8	13.6
Bony interorbital, width	7.2	7.2	8.1
Body, depth	27.6	26.7	31.1
Caudal peduncle, depth	10.9	11.3	14.0
Caudal peduncle, length	24.8	26.0	26.4
Anal-fin base, length	17.2	18.0	18.1
Anal-fin, length	ca. 37	ca. 34	38.9
Pectoral fin, length	30.2	ca. 33	28.2
Pelvic fin, length	24.7	ca. 25	26.6
Upper caudal-fin lobe, length	>53	broken*	ca. 58
Lower caudal-fin lobe, length	>46	broken*	ca. 56
First dorsal spine, length	broken	6.6	6.2
Third dorsal spine, length	10.8	11.6	>11.4
Fourth dorsal spine, length	12.5	11.4	>11.8
Last dorsal spine, length	10.5	broken	>12.0
Longest dorsal spine, length	12.5 (4^{th})	13.0 (8^{th})	13.0 (6^{th})
First anal-spine, length	5.0	7.3	>5.5
Second anal-spine, length	10.4	10.2	9.8
Third anal-spine, length	10.7	11.3	>10.5

Three earlier references to *S. typus* (Kamohara and Katayama, 1959; Katayama, 1960, 1968) refer to specimens collected off Kashiwajima; all of those specimens appear to be representatives of *S. katayamai* (see Anderson, 1970). One of the three specimens (ZIKU 8206, 163 mm SL) identified by Kamohara and Katayama (1959) as *S. typus* is the holotype of *S. katayamai* (see Anderson, 1970). Katayama (1984:138) noted that this species is “collected from southern Japan” being “rarely caught by hand-line in fairly deep water over rocky bottoms” and mentioned that it reaches 200 mm SL. Konishi (1988) provided descriptions and illustrations of 3.8 and 10.5 mm larvae of *Symphysanodon* that were identified as *S. katayamai*. Lee (1989) reported three specimens (118–164 mm SL) of *S. katayamai* obtained off southern Taiwan (Kaohsiung and Hengchun) in 1975 and 1988, provided a color photograph, and presented a table comparing morphological characters of *S. katayamai*, *S. typus*, and *S. maunaloae*. Senou (2002:733) provided a brief account that includes diagnostic data and the following comments on habitat and geographic range: "Rocky reefs of coastal shallow and deep waters. Pacific coast of southern Japan; Taiwan." Kimura et al. (2003) presented a short account and a color photograph of *S. katayamai* and reported the species from off Bitung, northeastern Sulawesi, Indonesia. *Symphysanodon katayamai*, then, has been reported in the literature only from collections made off southern Japan, off southern Taiwan, and off northeastern Sulawesi. The new material examined represents a considerable extension of the known range of the species to the Palau Islands (Augulpelu Reef) in the western Pacific and eastward to the northwestern Hawaiian Islands (South Gardner Pinnacles) in the central Pacific. Locality data for *S. katayamai* are plotted in Figure 9.

Kamohara and Katayama (1959:3) wrote the following about the three specimens they described under *Symphysanodon typus*: "Coloration: In preservative reddish, a broad longitudinal orange band on the side of body; dorsal yellowish; tip of each lobe of caudal yellowish." Masuda et al. (1975, plate 51-K) presented an illustration labeled *Symphysanodon typus* that is of a specimen of *S. katayamai*; this illustration closely resembles that in Masuda et al. (1984, plate 124-I; see below). Katayama (1984:138) wrote: "Body reddish-pink, with a broad longitudinal orange band on side of body." Masuda et al. (1984, plate 124-I) published a color photograph of a 200-mm specimen. The fish depicted by Masuda et al. (1984) is mainly rosy with a broad yellow band extending from near the orbit to caudal-fin base and onto upper lobe of caudal fin. Lee (1989:70) described the coloration when fresh as "rosy-red with a broad yellowish lateral band from posterior margin of orbit toward the base of caudal fin" and related (p. 70): "The species previously misidentified as *Scolopsis eriomma* in Chang et al., 1979 (p. 85, Pl. 31-D) is in fact *Symphysanodon katayamai* Anderson." The specimen shown in Chang et al., 1979 (Pl. 31-D) has the following coloration: head rosy dorsally and ventrally, mostly pallid laterally; iris mostly yellow; body rosy dorsally, pink midlaterally, and pallid ventrally; bright yellow spot at posterior end of opercle; dorsal fin mostly dull yellow; distal margin of anal fin rosy gray; upper caudal-fin lobe purplish, lower caudal-fin lobe greenish with ventralmost elements yellow; pectoral fin pinkish; pelvic fin not seen clearly. The individual (90 mm SL) in the photograph in Kimura et al. (2003) is mostly pink with a pale yellow band from posterior end of operculum to near the base of the caudal fin (band narrowing and becoming fainter posteriorly).

A note on coloration accompanying one of the recently examined specimens of *S. katayamai* (BPBM 30603, 111 mm SL) states: "Pale orange with diffuse yellow stripe mid-laterally; yellow on opercular flap, around pupil (on 'eye ring'), on preopercle below and posteriad to eye, and on snout. Principal caudal rays yellow; uppermost and lowermost rays pale orange; caudal filaments prolonged, pale orange." A photograph of *S. katayamai* (BPBM 37711, 72 mm SL), available at *http://www.bishopmuseum.org/research/treks/palautz97/fish29.html* (last visited, 28 February 2005), shows the head and body to be mainly rosy, darker dorsally; iris of eye yellow dorsally and to a slight degree ventrally; yellow stripe from posterior end of opercle to a point near the posterior end of the caudal peduncle—stripe diffuse posteriorly; dorsal fin mostly yellowish green suffused in part by pale pink; anal, pectoral, and pelvic fins pink; upper lobe of caudal fin mostly yellow, dorsalmost elements rosy proximally, gray distally; lower lobe of caudal fin mainly rosy, ventralmost elements gray distally; area encompassing fork of caudal fin pallid.

***Symphysanodon maunaloae* Anderson, 1970.** When originally described (Anderson, 1970), this species was known only from the Hawaiian Islands (30 specimens, ca. 42–86 mm SL). We have examined 48 specimens (45–162 mm SL) not reported in the original description; they are from Tuamotu Archipelago (BPBM 37136; 71 mm SL.—BPBM 37145; 58 mm SL); Society Islands (GMBL 84–110; 55 mm SL.—GMBL 85–93; 61 mm SL.—Both taken from stomachs of specimens of *Etelis*, a lutjanid); Hawaiian Islands (BPBM 19651; 2: 122–128 mm SL.—BPBM 21049; 2: 133–141 mm SL.—BPBM 28121; 2: 48–61 mm SL; LACM 46041-4; 10 [of 47]: 77–111 mm SL.—USNM 279252; 2: 127–162 mm SL); Johnston Atoll (BPBM 29266; one [of 5, others identified as *Symphysanodon* sp.], 49 mm SL.—BPBM 29371; 53 mm SL); Jumeaux Seamount, New Caledonia (NMNZ P.29249; 102 mm SL); Condor Reef, Caroline Islands (GMBL 72-455; 3: 73–80 mm SL); Kyushu-Palau Ridge (HUMZ 79145–79147; 3: 134–142 mm SL.—HUMZ 79261–79262; 2: 117–128 mm SL.—HUMZ 80341; 134 mm SL); Philippines (GMBL 80-378; 87 mm SL.—GMBL 80-379; 10: 45–62 mm SL); off Lombok, Indonesia (GMBL 81–158; 2: 74–120 mm SL.—SAIAB [RUSI] 20017; 128 mm SL).

Fourmanoir (1973, figure 4) provided a description and illustration of a postlarva (20 mm SL) of this species collected in the South Pacific at 12°33'S, 170°02'E between the surface and 165 m. Later Fourmanoir (1981:95) furnished data for two specimens (102 & 123 mm SL), writing: "Deux exemplaires de *Symphysanodon*, examinés après ceux des Philippines (provenance: W. Maleysia peninsula, 200 m, col. Fish. Res. Ins. Penang) paraissent identiques à *S. maunaloae* connu seulement d' Hawaï." (=Two specimens of *Symphysanodon*, examined after those from the Philippines [locality: W. Malaysian peninsula, 200 m, coll. Fish. Res. Ins. Penang] appear identical to *S. maunaloae* known only from Hawaii.). Based on data provided by Fourmanoir (1981), we identify those specimens as representatives of *S. maunaloae*. Tameka (1982) examined 50 specimens of *S. maunaloae* (111–150 mm SL) from the Kyushu-Palau Ridge in 326–500 m and presented a description of the species and illustrations (plate 144) in color of a male (132 mm SL) and a female (115 mm SL), describing the coloration (p. 372) as: "Body yellowish red, paler below. Dorsal and anal fins yellowish red. One paler darkish, vertical band from occiput to base of pectoral fin." Katayama (1984:138) mentioned that this species occurs on the Kyushu-Palau Ridge and in the Hawaiian Islands, that its body is reddish–yellow, and that it reaches 150 mm SL. Masuda et al. (1984, plate 124, figures G & H) published color photographs of a 130-mm male and a 120-mm female. Gloerfelt-Tarp and Kailola (1984:172–173) provided a short description and a photograph of *S. maunaloae* and related the coloration as: "Rosy, darker above; two or 3 dusky cross-bands below dorsal fin, the first from fin origin to above pectoral fin more noticeable." The specimen listed by Gloerfelt-Tarp and Kailola (1984:334) as *Symphysanodon* sp. (RUSI 20017), collected off the southeast coast of Lombok, is a representative of *S. maunaloae* (see above). Randall et al. (1985) reported six specimens (47–55.5 mm SL) of this species collected at Johnston Island in the central Pacific in depths of 274–305 m and observed it at depths of 230–366 m. Ralston et al. (1986) repeatedly observed individuals identified by them as *S. maunaloae* at Johnston Atoll in a series of dives in September/October 1983 from the submersible *Makalii* in depths of 230–365 m. Seki and Callahan (1988) noted that *S. maunaloae* and *S. typus* were among the fishes most frequently consumed by the lutjanid *Pristipomoides zonatus* at Pathfinder Reef, Mariana Archipelago, in April and May 1984. Lee (1989) presented a table comparing morphological characters of *S. maunaloae*, *S. typus*, and *S. katayamai*. Chave and Mundy (1994) and Chave and Malahoff (1998) reported this species based on photographs made from submersibles in depths of 131–398 m over a variety of substrates in waters of the Hawaiian Archipelago and at Johnston Atoll and published a photograph (figure 30 in Chave and Mundy, 1994) of two individuals identified by them as *S. maunaloae.* Chave and Mundy (1994: 396) noted that *S. maunaloae*: "Aggregated near the bottom. Darted downward into holes when approached, and two dark bands appeared behind the head." Myers (1999) reported *S. maunaloae* in a tabular checklist of Micronesian fishes as occurring in the northern Marianas, which he defined as Anatahan to Maug, and Myers and Donaldson (2003) included it in their checklist of Marianas fishes. Senou (2002:733) provided a brief account that includes diagnostic data and the following comments on bathymetric and geographic ranges: "From 300 to 500m depth. Kyushu-Palau Ridge; Hawaiian Isls."

S*ymphysanodon maunaloae*, then, ranges widely—from the Tuamotu, Society, and Hawaiian islands and Johnston Atoll westward through the Pacific to at least the Philippines and Lombok in Indonesia, and apparently, based on Fourmanoir's (1981: 95) brief note ("provenance: W. Maleysia peninsula"), to the Strait of Malacca off Malaysia. Locality data for *S. maunaloae* are plotted in Figure 9**.** Anderson (1970) gave the depth range for this species as 223–238 m, Tameka (1982) reported it from 326–500 m, and Katayama (1984:138) wrote that *S. maunaloae* has been caught in depths of 300–500 m. Depths of collection for the additional material reported herein range from 150 (150–280)–705 m. If observations from submersibles be included, the known depth range for specimens collected or observed near or on the bottom is 131–705 m.

Three color photographs of specimens of *Symphysanodon* are available at *http://www2.bishopmuseum.org/PBS/images/jer/images.asp?nm=Symphys&size=thumbnail* (last visited, 28 February 2005). They are from left to right in that presentation: BPBM 28121, BPBM 14181, and BPBM 19651. The specimen depicted in the middle photograph, BPBM 14181, has been misplaced and has not been identified to species. The other two are specimens of *S. maunaloae*. One of those (BPBM 28121, 61 mm SL) is mainly pink on head, body, and fins, with a dull reddish bar extending from dorsum to about pectoral-fin base just posterior to operculum. The other (BPBM 19651, 122 mm SL) has a very pale pink wash over head and body; fins with much white; considerable dull reddish pigment on many interradial membranes of dorsal fin; distal ends of both lobes of caudal fin dull reddish.

Anderson (1970:338) mentioned that seven (62–86 mm SL) of the 30 specimens of *S. maunaloae* that he examined in preparing the original description “have the pelvic fin well produced (with the medial branch of the first pelvic soft ray reaching anterior part of base of anal fin or beyond), whereas in the other specimens . . . the pelvic fin, although usually produced, falls short of the anal fin.” He tried to determine the sex of several individuals, but, because of the relatively small size of the specimens, was only partly successful. Nevertheless, he suggested that the well-produced pelvic fin is a male characteristic—as it is in *S. berryi* (see Anderson, 1970, and section below on *S. berryi*). Tameka (1982:372) observed that: “First soft ray of pelvic fin elongated in male, reaching backward beyond base of anal fin or to caudal fin. Pelvic fin of female not elongated.” In the specimens reported by Anderson (1970), the pelvic fin varies in length from ca. 22–>54% SL. In 16 of the additional specimens (79–141 mm SL) examined, the pelvic fin is appreciably elongated, ranging in length from ca. 42–>80 % SL. Based on gross examination of the gonads, two of those specimens (120 & 128 mm SL) are males.

Anderson (1970) gave the lengths of the caudal-fin lobes of *S. maunaloae* as ca. 31.2 – ca. 48.9 % SL (upper lobe) and ca. 30.0 – ca. 43.1 % SL (lower lobe). Measurements of the additional specimens expand those ranges to 29–ca.75 % SL (upper lobe) and ca. 28–ca.76 % SL (lower lobe). Two of the specimens (120 & 128 mm SL) with very long caudal fin lobes are males (based on gross examination of the gonads). In *S. maunaloae*, well-produced caudal-fin lobes appear to be characteristic of males, as they are in *S. berryi* (see Anderson, 1970, and section below on *S. berryi*).

Two of the three specimens of *S. maunaloae* caught off Lombok, Indonesia, are appreciably larger than those reported in the original description (120 & 128 mm SL vs. ca. 42–86 mm SL). In a number of morphometric characters (e.g., depth of body) those two Lombok specimens exhibit ranges that do not overlap or overlap only slightly with the ranges of the other material studied. Comparisons of the ranges for those characters for shallow-bodied vs. deep-bodied morphs are presented in Table 7. The two large specimens collected off Lombok are males, based on gross examination of gonads and lengths of pelvic fins and caudal-fin lobes (see above). We attribute the differences seen in Table 7 to allometric growth and sexual dimorphism.

TABLE 7. Comparisons of morphometric data for two morphs of *Symphysanodon maunaloae*: Shallow-bodied specimens compared with two deep-bodied specimens (GMBL 81-158, 120 mm SL; SAIAB (RUSI) 20017, 128 mm SL) collected off Lombok, Indonesia (see text for explanation). Standard lengths are in mm; other measurements, in percentages of standard length.

	Shallow bodied		Deep bodied
Character	*n*	Range	Range
Standard length	76	42–162	120–128
Head, length	37	32.0–35.8	35.6–36.6
Head, depth	36	17.9–25.4	26.3 (both)
Cheek, height	36	3.8–6.0	5.9–7.1
Upper jaw, length	36	12.5–15.3	16.6–16.7
Lower jaw, length	36	12.5–15.7	15.5–16.4
Body, depth	71	19.9–29.5	31.3–32.7
Pectoral-fin, length	36	23.6–28.1	29.2–30.6
Last dorsal spine, length	31	10.7–15.8	15.0–17.6

Symphysanodon berryi **Anderson, 1970.** This species was referred to as *Symphysanodon* sp. A by Anderson (1967). In describing *S. berryi*, Anderson (1970) examined 136 specimens (47–137 mm SL) collected in the western Atlantic off the Bahamas, Dominican Republic, Puerto Rico, Tobago, Mexico (Quintana Roo), Belize, Honduras, and Nicaragua. Anderson (1970) reported a specimen of this species collected off Grand Bahama Island along with one of *S. octoactinus*. We have examined 28 specimens (36–160 mm SL) since the publication of the original description; they are from North Carolina (MCZ 149604; 46 mm SL.—UF 38899; 61 mm SL; specimen reported by Rohde et al., 1996); Bermuda (USNM 326397; 53 mm SL.—USNM 372742; 36 mm SL); Bahamas, off Great Inagua Island (USNM 289921; 115 mm SL); Puerto Rico (CAS 61198; 96 mm SL.—CAS 61199; 74 mm SL—USNM 289922; 68 mm SL; caught with holotype of *S. mona*); Anguilla (FMNH 70768; 5 [of 18]: 74–99 mm SL); Dominica (FMNH 70769; 71 mm SL); Saint Lucia (MCZ 49899; 41 mm SL.—UF 230281; 74 mm SL); central Atlantic off Ascension Island (USNM 326396; 144 mm SL); eastern South Atlantic at 11º37’S, 05º13’W (HUMZ 100004–100005; 2: 148–160 mm SL.—HUMZ 100210–100214; 5: 97–149 mm SL); eastern South Atlantic, west of the Island of Pagalu (Annobón) at 03º01’S, 00º46’E (IIPB 405/1999; 154 mm SL.—IIPB 406/1999; 151 mm SL.—IIPB 407/1999; 147 mm SL.—IIPB 420/1999; 149 mm SL).

Karsten Hartel (pers. comm., 13 October 1999) informed us that there are numerous pelagic larvae and postlarvae of *Symphysanodon* in the collections of the Museum of Comparative Zoology, obtained from numerous localities along the Atlantic coast of North America from latitude 41º33’ N to southeastern Florida, in the West Indies, and throughout much of the Caribbean Sea. Two of those MCZ specimens (MCZ 81819, 9 mm SL, off Yucatán; MCZ 81820, 20 mm SL, off Louisiana) collected in the Gulf of Mexico were identified by Carole C. Baldwin as *Symphysanodon berryi*.

Trunov (1976) described *Planctanthias longifilis* (considering it to be a serranid) from a specimen of 115 mm SL collected from a depth of 150 m at a locality west of the Island of St. Helena in the South Atlantic Ocean. We have been unsuccessful in attempts to borrow that specimen (ZISP 42033). Nevertheless, the original description and illustration in Trunov (1976) indicate that *P. longifilis* is probably a junior synomym of *S. berryi*. This conclusion is supported by the examination of four IIPB specimens from the eastern South Atlantic, listed by Allué et al. (2000) as *P. longifilis*, that are representatives of *S. berryi* and is further supported by records of *S. berryi* from off Ascension Island and from a locality about 260 nautical miles north of St. Helena in the eastern South Atlantic (see above).

Cervigón (1993:157, fig. 69) mentioned five specimens (80–98 mm SL) of *S. berryi* from Venezuela (north of La Tortuga in about 265 m), and Cervigon et al. (1993) reported that this species was caught at some stations off Venezuela by a research vessel in 1988. Claro et al. (2000) reported the species from the southern coast of Cuba, based on observations and collections of specimens from the submersible *Johnson Sea Link II* (Harbor Branch Oceanographic Institution, Fort Pierce, Florida) in December 1997, and Claro et al. (2001) noted its presence off southern Cuba. Roa-Varón et al. (2003:14, fig. 8) examined three specimens collected off the Caribbean coast of Colombia (off Islas de San Bernardo) in 268–302 m.

Moore et al. (2003) reported two specimens of *S. berryi* in their annotated list of deep-water fishes occurring off New England, USA. One of those (MCZ 149604) is noted above. The other (MCZ 150975) on reexamination turns out to be a specimen of the epigonid genus *Epigonus* (pers. comm., Karsten E. Hartel, 12 August 2003).

Like *S. maunaloae, S. berryi* has a wide geographic range, viz.: western Atlantic from off North Carolina and Bermuda to northern South America (including the West Indies, Gulf of Mexico, and Caribbean Sea), central Atlantic (off Ascension Island), and eastern South Atlantic (from localities well north of the Island of St. Helena and west of the Island of Pagalu). The western Atlantic range is probably even more extensive because many of the MCZ larvae and postlarvae collected north of North Carolina (see above) are very likely representatives of *S. berryi*, suggesting that the adults may also range further to the north. Locality data for *S. berryi* are plotted in Figure 4**.** Anderson (1970) reported the depth range of *S. berryi* as 220–476 m. Depths of capture for the additional specimens cited above, with the exception of those collected off Bermuda, range from 101 (101–256) – 460 (163–460) m. The two Bermuda specimens (USNM 326397, USNM 372742) were caught between the surface and 950 m by midwater trawls over very deep water.

Symphysanodon berryi displays pronounced sexual dimorphism in development of the first segmented ray of the pelvic fin and lobes of the caudal fin; larger males have those fin elements greatly produced, but females do not (Anderson, 1970). Also, males have coarser and better developed dentition than do females (Anderson, 1970).

***Symphysanodon octoactinus* Anderson, 1970.** This species was referred to as *Symphysanodon* sp. B by Anderson (1967). *Symphysanodon octoactinus*, described originally from 19 specimens (58–108 mm SL), collected in the western Atlantic off the Bahamas, Puerto Rico, Nicaragua, and Panama in 156–293 m, was caught on one occasion with *S. berryi* off Grand Bahama Island (Anderson, 1970). We have examined five additional specimens (60–115 mm SL), collected in 183–640 (585–640) m; they are from Caribbean coast of Mexico, off Quintana Roo (UF 232079; 68 mm SL); off Belize (FMNH 70762; 2: 98–115 mm SL); off Caribbean coast of Nicaragua (FMNH 70763; 2: 60–66 mm SL). Claro et al. (2000) reported this species from off the southern coast of Cuba, based on observations and collections of specimens from the submersible *Johnson Sea Link II* in December 1997, and Claro et al. (2001) noted its presence off southern Cuba. Locality data for *S. octoactinus* are plotted in Figure 4.

***Symphysanodon andersoni* Kotthaus, 1974.** This species was described from a single specimen (ZMH 5170, 157 mm SL), collected in the western Indian Ocean southwest of Socotra Island near the entrance to the Gulf of Aden in a depth of 290–190 m (Kotthaus, 1974), and has been reported from the Gulf of Kutch, an inlet in the northeastern quadrant of the Arabian Sea on the west coast of India (Manilo and Bogorodsky, 2003) (see Figure 9). Three small specimens (USNM 326398, 40–47 mm SL) of *Symphysanodon*, collected by prawn trawl in 78 m off Somalia in the Gulf of Aden, may be representatives of *S. andersoni* (see Figure 9). Unfortunately, none of the small specimens is in good enough condition to accurately determine the most critical character (number of lateral-line scales) needed for identification as that species. Nevertheless, the presence of parapophyses on the first caudal vertebra in the holotype of *S. andersoni* and in the three small individuals suggests that the four specimens are conspecific (see below).

***Symphysanodon* sp. from the Comoros.** McCosker (1979) reported two partially digested specimens (7–8 cm) of *Symphysanodon* removed from a male coelacanth, *Latimeria chalumnae* (CAS 33111, 118 cm), collected in the western Indian Ocean off Grande Comore Island in ca. 225 m (pers. comm., David Catania, 14 November 2002; see Figure 9). G. David Johnson, who identified the specimens, informed McCosker that they probably represent an undescribed species (McCosker, 1979). The gillrakers on the more intact specimen of *Symphysanodon* number 8 + 20 (Johnson, pers. comm., 28 October 2002). A total count of 28 gillrakers on the first arch is appreciably lower than that from the only other described specimen of *Symphysanodon* from the western Indian Ocean, the holotype of *S. andersoni*, which has a total count of 41—right, 42—left (Kotthaus, 1974). Johnson appears to be correct in his appraisal of the status of the specimen on which he made a gillraker count.

***Symphysanodon* spp.** We have identified 26 specimens (10–119 mm SL) only to the genus *Symphysanodon*; data for them are: 13°07' S, 119°02' W (SIO 96–35; 25 mm SL); French Polynesia (BPBM 31670; 53 mm SL.—BPBM 37131; 54 mm SL.—GMBL 69-30; 35 mm SL.—GMBL 85–99; 57 mm SL); Hawaiian Islands (BPBM 24864; 52 mm SL.—BPBM 28856; 77 mm SL); Johnston Atoll (BPBM 29266; 4 [of 5, fifth identified as *S. maunaloae*]: 46–49 mm SL); Vanuatu, NE of Espíritu Santo Island (GMBL 66–13; 2: 10–19 mm SL); New Caledonia (GMBL 56–15; 6: ca. 40–>51 mm SL); South Pacific (presumably, actual locality of capture not known; GMBL 72–404; 37 mm SL); Papua New Guinea, Gulf of Papua (GMBL 71–238; 59 mm SL.—GMBL 71–239; 53 mm SL); Guam (GMBL 68–62; 119 mm SL); Somalia, Gulf of Aden (USNM 326398; 3: 40–47 mm SL; see above under *S. andersoni*). Most of the specimens (17) listed above were captured by midwater trawls or nekton net or were removed from the stomachs of other fishes (i.e., species of *Epinephelus, Seriola, Etelis, Thunnus*). While at the MNHN in October 2003, G. David Johnson identified an additional specimen collected off New Caledonia (St. Vincent) as a *Symphysanodon* (MNHN 1990-1473, 44 mm SL).

The larvae of *Symphysanodon* are quite distinctive, being "unique in their possession of hornlike frontal spines" (Johnson, 1984: 464, fig. 254A). Leis and Trnski (1989: 228–231, fig. 51; 2000: 394–398, fig. 100) described and illustrated larvae of *Symphysanodon* based on material collected in the Indo-Pacific and wrote (1989: 228; 2000: 394): "The remarkable head spination is extensive. The most obvious features are the massive, paired, serrate frontal and preopercular-angle spines." In fact, frontal spines or their remnants are frequently present on fairly large individuals. Consequently, even small specimens are relatively easy to identify to genus but often difficult to place in a species with confidence. Konishi (1988) provided descriptions and illustrations of 3.8 and 10.5 mm larvae of *Symphysanodon* that were identified as *S. katayamai* (see above under *S. katayamai*). The specimens illustrated by Konishi (1988) show the extremely well-developed head spination noted by other authors. There are many pelagic larval and postlarval specimens of *Symphysanodon* obtained from numerous localities in the western North Atlantic, mainly by midwater trawls, in the collections of the Museum of Comparative Zoology (pers. comm., Karsten Hartel, 13 October 1999); those localities are plotted in Figure 16.

Fourmanoir (1969) and Kami (1971) listed specimens, identified as *S. typus*, taken from the stomachs of predatory fishes (*Alepisaurus ferox* [Alepisauridae] caught in the southwest Pacific and *Seriola* sp. [Carangidae] taken off Guam, respectively), but provided no information that would allow verification of their identifications. Fourmanoir (1976) noted 10 specimens (18–30 mm, presumably SL), apparently postlarvae, identified as *Symphysanodon* sp., collected by "pelagic trawl" in the southwest Pacific, and Uchida and Tagami (1984) included *Symphysanodon* sp., *S. typus*, and *S. maunaloae* in their table 5, a list of fishes caught on the *Townsend Cromwell* northwest of the Hawaiian Archipelago by trawling over Hancock and other seamounts, but gave nothing that would substantiate the use of those names. Richards (1984) reported larvae of *Symphosanodon* [sic] spp. collected in the Caribbean Sea by bongo nets in the summer of 1972 and winter of 1973.

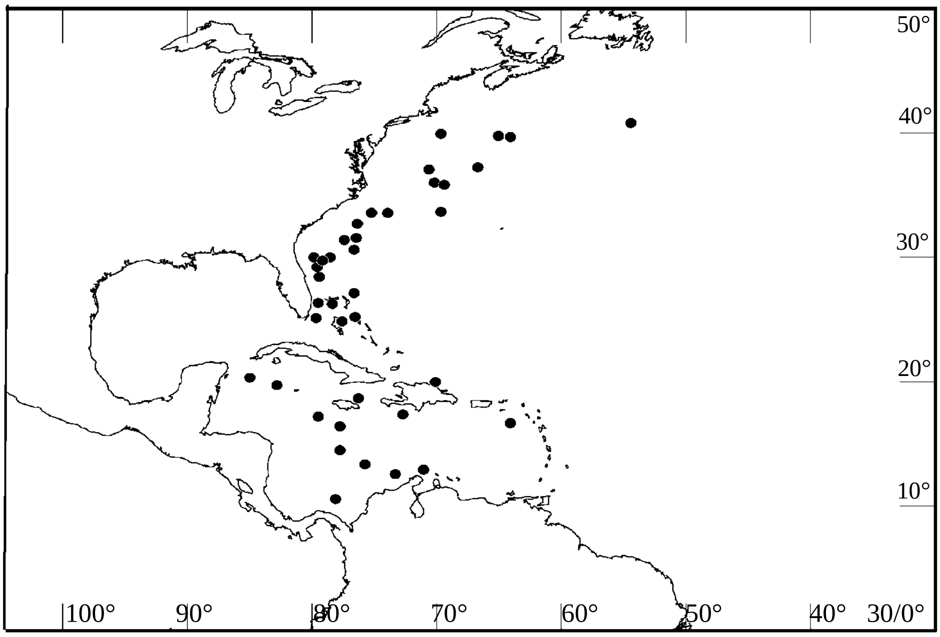

FIGURE 16. Localities of capture for specimens of Atlantic *Symphysanodon* identified only to genus. In most cases those specimens were not identified to species because of their small size, being larvae or postlarvae. Some symbols represent more than one collection.

Gloerfelt-Tarp and Kailola (1984:172–173) provided a photograph of a specimen and description of material identified as *Symphysanodon* sp., describing the coloration as: "Dusky red, darker above. Fins rosy, outer dorsal, caudal and ventral fins greenish." Further along those authors related: "First ray of ventral fin produced into a long, trailing filament; both caudal fin lobes produced into long filaments." The fish in the photograph labeled *Symphysanodon* sp. (p. 172) has the pelvic fin and upper lobe of the caudal fin well produced. Other data presented by Gloerfelt-Tarp and Kailola (1984: 173) are: "Body depth 3.8–3.9 in SL. . . . D IX, 9. A III, 7. Total GR 34. L. lat. 52–53. (voucher: 75 mm SL)." The counts of lateral–line scales fall within the range of those for *S. typus* but outside the range for *S. maunaloae*; however, the count of total gillrakers is lower than the lowest count recorded for *S. typus*, falling within the range of counts for *S. maunaloae*. Some specimens (presumably males) of *S. maunaloae* have well-produced pelvic fins and caudal-fin lobes, as do the above described specimens, but so far as is known the pelvic and caudal fins are not extensively produced in *S. typus*. Unfortunately the repository for the voucher specimen was not given, and as a consequence we can offer nothing on the species identification of this material.

In late November 2004, Richard Pyle observed numerous individuals of an unidentified species of *Symphysanodon* during two deep dives (ca. 120 m) off the southwest side of Gau Island, Fiji (lat. 18.05° S, long. 179.3° E). He took a number of photographs of that species and related (to VGS, in litt. 7 December 2004) that all of the individuals that he saw were “about 150 mm SL, purplish pink dorsally fading to pale pink ventrally. . . . Dorsal fin translucent yellow . . . caudal fin with distinct white tips. . . . Unlike the *Symphysanodon* that I have seen in Hawaii and elsewhere, this fish did not retreat by swimming through mid-water; rather, they would descend to the reef and hover in front of a hole, then disappear into the hole when approached too closely.” In a subsequent e-mail transmission (9 December 2004), Pyle reported that a video shows that this species has filamentous caudal-fin lobes and pelvic fins.

Locality data for specimens of *Symphysanodon* identified only to genus are plotted in Figures 16 and 17.

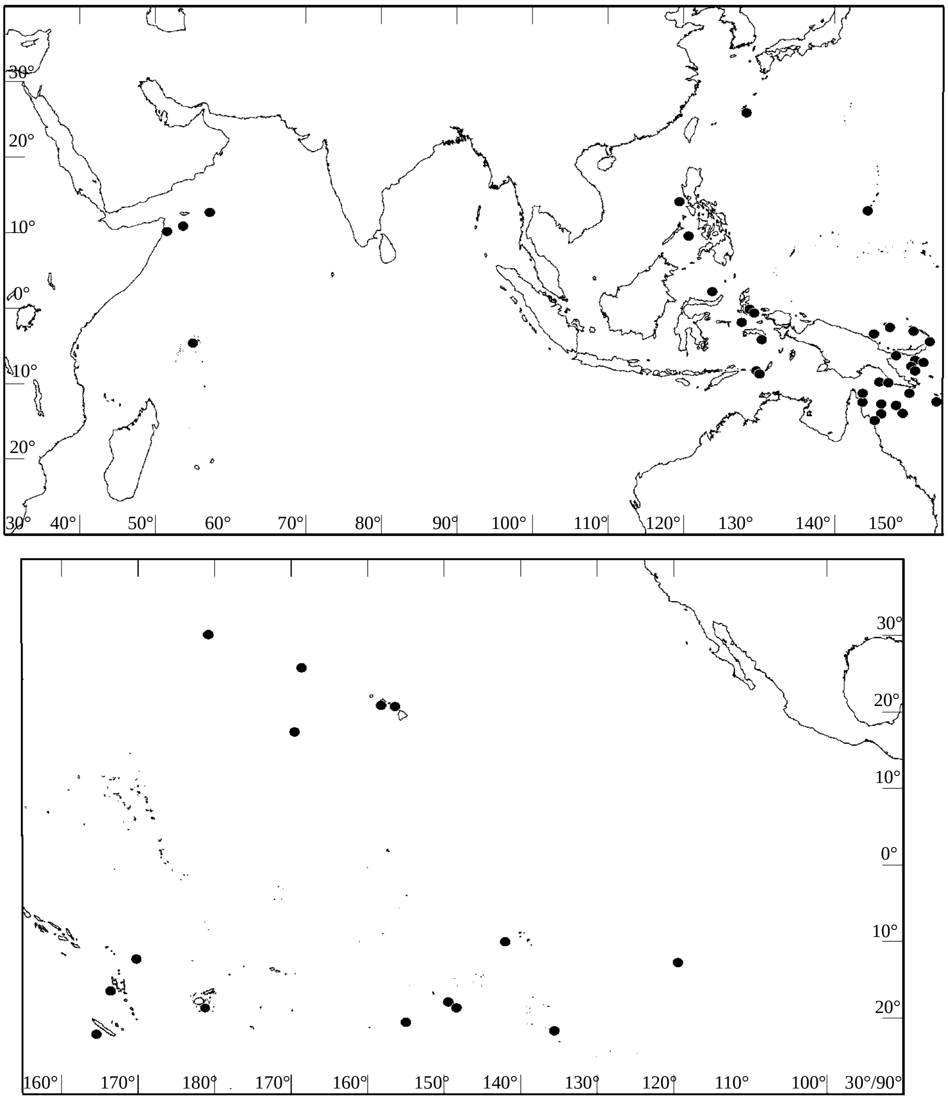

FIGURE 17. Localities of capture for specimens of Indo-Pacific *Symphysanodon* identified only to genus. In most cases those specimens were not identified to species because of their small size, being larvae or postlarvae. Some symbols represent more than one collection.

Osteological characters

In most specimens of all species of *Symphysanodon*, except *S. octoactinus*, the formula for configuration of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores is 0/0/0 + 2 + 1/1/1/. *Symphysanodon octoactinus* has a different configuration, i.e., 0/0/0 + 2/1 + 1/1/. Other configurations observed are: 0/0/0 + 2 + 1/1 + 1//1/ in one specimen of *S. berryi*, 0/0 + 0/2 + 1/1/ 1/ in one of *S. katayamai* and two of *S. maunaloae*, 0/0 + 0 + 2/1/1/ in one of *S. maunaloae*, and 0/0/2 + 1/1/1/ in one of *S. maunaloae.* See Table 8 for a summary by species of the configurations encountered.

TABLE 8. Frequency distributions of configurations of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores in species of *Symphysanodon.* In the formulae for the configurations, each"0" represents a supraneural bone, each slash a neural spine, and a "1" or a "2" indicates number of dorsal-fin spines supported (in a secondary association) by the first and subsequent pterygiophores of the dorsal fin (using notation of Ahlstrom et al., 1976). Other—refers to four other configurations found in a few specimens.

Species	0/0/0+2+1/1/1/	0/0/0+2/1+1/1/	Other
S. andersoni	1		
S. berryi	43		1
S. katayamai	3		1
S. maunaloae	28		4
S. mona	1		
S. octoactinus		13	
S. parini	10		
S. rhax	6		
S. typus	17		
S. sp.--Comoros	1		
S. sp.—Gulf of Aden	3		

Radiographs show that four of the species of *Symphysanodon* (*S. andersoni*—one specimen examined, *S. katayamai*—four, *S. typus*—17, *Symphysanodon* sp. from the Comoros—one) and the *Symphysanodon* sp. from the Gulf of Aden (three) have parapophyses on the first caudal vertebra (i.e., the eleventh vertebra) and that six species (*S. berryi*—44, *S. maunaloae*—33, *S. mona*—one, *S. octoactinus*—14, *S. parini*—10, *S. rhax*—six) lack those processes. In those species having parapophyses on the first caudal vertebra the haemal spine of that vertebra is displaced posteriorly as compared with its position in the other species.

We recorded data on hypural bones from examination of radiographs of 106 specimens, representing all of the previously described species of *Symphysanodon* and the three new species, and, at our request, G. David Johnson studied a radiograph of the two specimens of *Symphysanodon* removed from the CAS *Latimeria* (CAS 33111) collected in the

Comoros (McCosker, 1979). Unfortunately, the resolution on some radiographs makes it difficult to determine the extent of hypural fusions in a number of specimens. The parhypural and hypural five were found to be autogenous in all specimens in which they could be clearly seen, but considerable variation was observed among the species in fusions of the other hypural bones—from none in one species to partial in some specimens of other species to what may be complete fusion at first appearance in early development in other specimens. Data on hypural fusions (hypural one with two and hypural three with four) are summarized in Table 9. (In that table, partial fusions are considered as fusions.) *Symphysanodon octoactinus* is unique (in the genus), at least over the size range (60–115 mm SL) of the specimens examined, in having hypurals three and four autogenous, and *S. katayamai* and *S. typus* are distinctive in having relatively small specimens (<75mm SL) with hypurals one and two represented by a single plate. In *S. andersoni* only a single large specimen (157 mm SL) was available for radiography; consequently, the fusion of hypurals one and two displayed by it may be ontogenetic and not representative of the complete size range of the species. In summary, it seems that phylogenetic fusions of hypural bones have occurred in the genus and that ontogenetic fusions may occur in some of the species.

TABLE 9. Data on hypural fusions for species of *Symphysanodon*. Hypural one fused with two and hypural three fused with four. Fused denoted by + (partly fused considered as fused); autogenous by--; head missing from specimen by *. Parhypural and hypural five autogenous in all specimens in which they could be clearly seen. Standard lengths (SL) are in mm.

Species	*n*	SL	Hypurals 1& 2	Hypurals 3 & 4
S. andersoni	1	157	+	+
S. berryi	38	61-160	--	+
S. katayamai	4	72-163	+	+
S. maunaloae	19	45-142	--	+
S. mona	1	86	--	+
S. octoactinus	10	60-115	--	--
S. parini	10	81-114	--	+
S. rhax	6	64-144	--	+
S. typus	17	50-127	+	+
S. sp.--Comoros	1	ca. 68	--	+
S. sp.--Comoros	1	>56*	+	+

In *Symphysanodon*, configurations of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores, presence or absence of parapophyses on the first caudal vertebra, and presence or absence of hypural fusions may be useful in identification, particularly of small specimens, and may be helpful in determining relationships among the species.

Sexuality

William A. Roumillat examined histological sections of the gonads of specimens of three species of *Symphysanodon* (*parini*—10 specimens, *berryi*—three, and *rhax*—two) and found all of those individuals to be gonochoristic.

Relationships

Symphysanodon octoactinus is the most distinctive of the species of *Symphysanodon*, possessing a configuration of the supraneural bones, etc. (see Table 8) and a hypural morphology (see Table 9) that are unique within the genus. In addition, *S. octoactinus* usually has eight segmented rays in the anal fin (>90 % of specimens), whereas the other species almost always have seven, never eight. *Symphysanodon mona* has a gill arch morphology that is unlike that observed in the other species (gill arches of all species of *Symphysanodon* have been examined except S. *andersoni* and the species from the Comoros). Four of the species (*S. andersoni*, *S. katayamai*, *S. typus*, the species from the Comoros) possess parapophyses on the first caudal vertebra and the same type of hypural morphology (one of the two specimens from the Comoros differs; see Table 9), characters distinguishing them from other members of the genus. *Symphysanodon maunaloae* and *S. parini* are morphologically extremely similar, and based on available information it seems that they may be sister species. The same can be said for *S. berryi* and *S. rhax*. However, given that there are probably undescribed species of *Symphysanodon* yet to be collected, present in museums in unsorted collections, or represented by larvae or badly damaged specimens, it is premature to comment further on relationships.

Geographic distribution

Localities of capture are plotted in Figures 4, 9, 16, and 17. Many plotted localities are for specimens that we did not examine. Some points are based on literature reports that we consider reliable; others (mostly for larvae and postlarvae), on records from museum collections. As noted above, the larvae of *Symphysanodon* are quite distinctive. Consequently, even small specimens are relatively easy to identify to genus. Localities from museum records are included only for those specimens for which we could evaluate the quality of the identifications—either by knowing who made the determinations or by asking ichthyologists at the museums to check identifications. Many of the habitats, including rocky slopes, in which species of *Symphysanodo*n dwell are difficult to sample using dredges and trawls because those fishing gears frequently snag and are damaged or lost. Difficulty in collecting no doubt introduces an artifactual element of unknown degree into explanations of the distribution of these fishes.

Benthic stages (pre-adults, adults) of *Symphysanodon* species are mainly associated with moderately deep waters over rocky or coral-reef habitats in the vicinity of oceanic islands between latitudes 25° N and 25° S. Pelagic stages (larvae, post-larvae, pre-juveniles) appear to be similarly restricted, except in the western Atlantic (Figure 16). In that area, where considerable mid-water and plankton collections have been made, pelagic stages occur well north of 25° N, apparently transported by the Gulf Stream. Small, identifiable pelagic stages of *S. berryi* taken in the middle and southern Gulf of Mexico (Figure 4), where no adults have been reported, are probably waifs brought in from the south by the Caribbean Current. Specimens of *S. berryi* collected northeast of Bermuda, where the genus is unreported, are juveniles taken pelagically in trawls over deep water, and may be waifs from breeding populations on the deep slopes of Bermuda, which have been little sampled ichthyologically (W. F. Smith-Vaniz, pers. comm.).

The restricted distribution of *Symphysanodon mona*, known from a single specimen collected with a specimen of *S. berryi*, is probably a collecting artifact. Absences of *Symphysanodon* from the continental coasts of the southwestern Atlantic, eastern Atlantic, and eastern Pacific, most of the mainland coast of Asia (China west to the Persian Gulf), and much of the Indian Ocean (particularly the northwestern coast of Australia) probably reflect lack of suitable habitat. Such is not true of the western Indian Ocean island groups (Chagos, Mascarenes, etc.), where dearth of records may result from lack of slope collections. Absences of *Symphysanodon* from the continental coasts of the southwestern Atlantic, eastern Atlantic, and eastern Pacific do not appear to be collecting artifacts, as there has been considerable trawling in those areas. Absence from the continental coast of the eastern Pacific is duplicated bywarm-water coastally restricted pelagic forms such as *Rachycentron* (Springer, 1982:fig. 35) and *Sphyraena barracuda* (Springer, 1982:96; however, cool-temperate species of *Sphyraena* do occur in the eastern Pacific). A more general historical explanation is probably called for but is presently lacking. *Symphysanodon* may have been more continuously distributed in the past with former populations becoming extinct in the major areas where they are currently absent.

Molecular comparisons of specimens of *S. berryi* from the central and eastern South Atlantic islands with specimens of their geographically nearest conspecifics from the southern Lesser Antilles would be of interest in determining degree and age of divergence of those populations. We suspect that the insular central and eastern South Atlantic specimens of *S. berryi*, although just slightly differentiated morphologically (showing only minor morphometric differences) from Caribbean conspecifics, are probably well differentiated and represent one or two species distinct from *S. berryi*. Muss et al. (2001) found that populations of the blenniid genus *Ophioblennius* from the western, central, and eastern Atlantic, which Springer (1962), based on morphology, identified as a single species, apparently represent several species, which they refrained from describing. (Carole C. Baldwin has a manuscript in preparation describing those species, which she has been able to differentiate morphologically based on many more specimens than were available to

Springer.) Also, Moura and Castro (2002) have shown that populations of the tetraodontid genus *Canthigaster* from the western, central, and eastern Atlantic, usually considered as a single species, actually constitute a complex of six species.

Symphysanodon maunaloae is widely distributed in the Pacific (Figure 9). Some of the widely scattered and morphologically variable populations now considered conspecific with *S. maunaloae* may be recognized eventually at the specific level. Some of the variability (lengths of pelvic fin and caudal-fin lobes) shown by that species is apparently related to sexual dimorphism; some of the other differences are probably the result of allometric growth. In Tables 10 and 11, the geographic variation displayed by *S. maunaloae* in two characters, depth of body and total number of gillrakers on the first gill arch, is shown.

TABLE 10. *Symphysanodon maunaloae*. Variation in depth of body related to geography and size (standard length). Specimens are grouped by geography and depth of body and ordered by ascending depth of body (least measurement). Standard lengths are in mm; depths of body, in percentages of standard length.

Locality	*n*	Standard length	Depth of body
Hawaiian Islands and Johnston Atoll	39	47–111	19.9–26.0
Philippines	11	45–87	20.8–24.7
Tuamotu and Society islands	4	55–71	21.0–23.8
Lombok	1	74	25.2
New Caledonia	1	102	25.6
Hawaiian Islands	6	122–162	25.6–29.2
Caroline Islands	3	73–80	26.6–28.5
Kyushu-Palau Ridge	6	117–142	27.3–29.5
Lombok	2	120–128	31.3–32.7

TABLE 11. Frequency distributions of total numbers of gillrakers on first gill arch in populations of *Symphysanodon maunaloae*.

Locality	29	30	31	32	33	34	35	36	37	38	39	*n*	Mean
Tuamotu and Society islands	1	--	--	1	1							3	31.33
Caroline Islands			2	--	1							3	31.67
Kyushu-Palau Ridge			1	--	3	2						6	33.00
Philippines			1	4	4	1	1					11	32.73
Lombok				1	1	--	1					3	33.33
New Caledonia								1				1	36.00
Hawaiian Islands and Johnston Atoll			3	6	14	8	5	3	3	--	1	43	33.77

Conclusion

A reassessment of examined specimens and study of new material will likely lead to the discovery of additional species of *Symphysanodon*. There may be one or two undescribed species occurring off the islands of the central and eastern South Atlantic that are considered herein as populations of *S. berryi*, and *S. maunaloae* may be a species complex (see above under Geographic distribution). As noted by Gill and Kemp (2002) for widely distributed Indo-Pacific shore fishes (see above under *Symphysanodon rhax*), it seems that the diversity of shelf, slope, insular, and seamount fishes is presently underestimated.

Acknowledgments

Pierre Fourmanoir (ORSTOM) contributed many specimens of *Symphysanodon* to the GMBL collections; Conchita Allué (IIPB), David Catania (CAS), Richard F. Feeney (LACM), Karsten E. Hartel (MCZ), Mandy L. Holloway (BMNH), Hisashi Imamura (HUMZ), Leslie W. Knapp (USNM), Adolf Kotthaus (Hamburg, Germany), Jeffrey M. Leis (AMS), James MacLaine (BMNH), Mark McGrouther (AMS), Glenn Moore (WAM), Kazuhiro Nakaya (HUMZ), Lisa F. Palmer (USNM), N.V. Parin (IOAN), Patrice Pruvost (MNHN), Richard L. Pyle (BPBM), Sally Reader (AMS), Robert H. Robins (UF), Mary Anne Rogers (FMNH), Jeffrey A. Seigel (LACM), Andrew Stewart (NMNZ), Arnold Y. Suzumoto (BPBM), and H. J. Walker, Jr. (SIO) sent material on loan and/or furnished information on specimens; Phillip C. Heemstra allowed the first author, while in Grahamstown, to examine the SAIAB (RUSI) specimen of *S. maunaloae*; G. David Johnson (USNM) examined the specimens of *Symphysanodon* taken from the CAS *Latimeria* and specimens of *Symphysanodon* in the collections of the MNHN and furnished information on the caudal osteology of *Symphysanodon*; Carole C. Baldwin (USNM) identified the small MCZ specimens of *S. berryi* obtained in the Gulf of Mexico; Conchita Allué, Anthony C. Gill (BMNH), and Arnold Suzumoto gave permission to make dissections; William A. Roumillat (South Carolina Department of Natural Resources, Charleston) supervised the preparation of and examined the histological sections of gonadal tissues removed from specimens of *Symphysanodon*; Antony S. Harold (GMBL), Kristin Murphy (USNM), Sandra Raredon (USNM), Mary Anne Rogers, and Whitney Stahl (GMBL) helped with radiography; David G. Smith (USNM) clarified the locality of capture for a lot of *Symphysanodon* at the USNM; Kristin Murphy and Sandra Raredon contributed to the preparation of the maps; Sandra Raredon furnished photographic assistance; David D. Ramjohn (GMBL) advised on use of statistical software; Rebecca A. Anderson, the thirteen-year old granddaughter of the first author, guided him in using Microsoft Excel to plot data and determine regression statistics; Michelle A. Scioli (GMBL) assisted in the preparation of the tables; and Isaure de Buron (College of Charleston) verified our translation of a short section from Fourmanoir (1981). Funds in partial support of the first author's participation in this study were provided by the *L.P. Schultz Fund* of the Division of Fishes, National Museum of Natural History, Smithsonian Institution. Constructive comments on a presubmission draft of the manuscript were received from Carole C. Baldwin and Jeffrey T. Williams. This is contribution number 270 of the Grice Marine Biological Laboratory, College of Charleston.

References

Adam, M.S., Merrett, N.R. & Anderson , R.C. (1998) Additions to the fish fauna of the Maldive Islands. Part 1: An annotated checklist of the deep demersal fishes of the Maldive Islands. *J.L.B. Smith Institute of Ichthyology Ichthyological Bulletin*, 67, 1–19.

Ahlstrom, E.H., Butler, J.L. & Sumida, B.Y. (1976) Pelagic stromateoid fishes (Pisces, Perciformes) of the eastern Pacific: Kinds, distributions, and early life histories and observations on five of those from the northwest Atlantic. *Bulletin of Marine Science*, 26 (3), 285–402.

Allué, C., Lloris, D. & Meseguer, S. (2000) *Colecciones Biológicas de Referencia (1982–1999) del Instituto de Ciencias del Mar (CSIC): Catálogo de Peces*, Consejo Superior de Investigaciones Cientificas, Barcelona, 198 pp.

Anderson, W.D., Jr. (1967) Field guide to the snappers (Lutjanidae) of the western Atlantic. *United States Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Circular* 252, i–iv + 1–14.

Anderson, W.D., Jr. (1970) Revision of the genus *Symphysanodon* (Pisces: Lutjanidae) with descriptions of four new species. *Fishery Bulletin*, 68(2), 325–346.

Anderson, W.D., Jr. (2000) Symphysanodontidae. *In*: Carpenter, K.E. & Niem, V.H. (Eds), *FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific*. Vol. 4. *Bony Fishes Part 2 (Mugilidae to Carangidae),* Food and Agriculture Organization of the United Nations, Rome, 2438–2441. [Dated 1999, but actually published in 2000.]

Anderson, W.D., Jr. (2003) Symphysanodontidae. *In*: Carpenter, K.E. (Ed) *The Living Marine Resources of the Western Central Atlantic*. Vol. 2. *Bony Fishes Part 1 (Acipenseridae to Grammatidae).* FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Publication No. 5, Food and Agriculture Organization of the United Nations, Rome, pp. 1304–1307. [Dated 2002, but actually published in 2003.]

Bleeker, P. (1878) Quatrième mémoire sur la faune ichthyologique de la Nouvelle-Guinée. *Archives Néerlandaises des Sciences Exactes et Naturelles*, 13, 35–66, pls. 2–3.

Cervigón, F. (1993) *Los Peces Marinos de Venezuela*, (2nd ed.), Fundación Científica Los Roques, Caracas, Vol. II, 499 pp.

Cervigón, F., Cipriani, R., Fischer, W., Garibaldi, L., Hendrickx, M., Lemus, A.J., Márquez, R., Poutiers, J.M., Robaina, G. & Rodríguez, B. (1993) *FAO Species Identification Sheets for Fishery Purposes. Field Guide to the Commercial Marine and Brackish-water Resources of the Northern Coast of South America*. Food and Agriculture Organization of the United Nations, Rome, xv + 513 pp, 40 color plates.

Chang, K.H., Shao, K.T. & Lee, S.C. (1979) *Coastal Fishes of Taiwan (I)*, Institute of Zoology, Academia Sinica, Taipei, Taiwan, 150 pp., 56 color plates. [Text in Chinese.]

Chave, E.H. & Malahoff, A. (1998) *In Deeper Waters: Photographic Studies of Hawaiian Deep-sea Habitats and Life-forms*, University of Hawai`i Press, Honolulu, viii + 125 pp.

Chave, E.H. & Mundy, B.C. (1994) Deep-sea benthic fish of the Hawaiian Archipelago, Cross

Seamount, and Johnston Atoll. *Pacific Science*, 48(4), 367–409, 4 color plates.
Claro, R., Gilmore, R.G., Robins, C.R. & McCosker, J.E. (2000) Nuevos registros para la ictiofauna marina de Cuba. *Avicennia: Revista de Ecología, Oceanología y Biodiversidad Tropical* 12/13, 19–24.
Claro, R., Lindeman, K.C. & Parenti, L.R. (Eds) (2001) *Ecology of the Marine Fishes of Cuba*, Smithsonian Institution Press, Washington, D.C., xvi + 253 pp.
Fourmanoir, P. (1969) Contenus stomacaux d'*Alepisaurus* (poissons) dans le sud-ouest Pacifique. *Cahiers ORSTOM, Série Océanographie*, 7(4), 51–60.
Fourmanoir, P. (1973) Notes ichthyologiques (V). *Cahiers ORSTOM, Série Océanographie* 11(1), 33–39.
Fourmanoir, P. (1976) Formes post-larvaires et juvéniles de poissons côtiers pris au chalut pélagique dans le sud-ouest Pacifique. *Cahiers du Pacifique*, 19, 47–88.
Fourmanoir, P. (1981) Poissons (première liste). *Résultats des Campagnes MUSORSTOM. I-Philippines (18–28 Mars 1976)*, 85–102.
Gill, A.C. & Kemp, J.M. (2002) Widespread Indo-Pacific shore-fish species: A challenge for taxonomists, biogeographers, ecologists, and fishery and conservation managers. *Environmental Biology of Fishes*, 65, 165–174.
Gloerfelt-Tarp, T. & Kailola, P.J. (1984) *Trawled Fishes of Southern Indonesia and Northwestern Australia*, The Australian Development Assistance Bureau, The Directorate General of Fisheries (Indonesia), Deutsche Gesellschaft für Technische Zusammenarbeit, xx + 406 pp.
Hughes, D.R. (1981) Development and organization of the posterior field of ctenoid scales in the Platycephalidae. *Copeia*, 1981(3), 596–606.
Johnson, G.D. (1975) The procurrent spur: An undescribed perciform caudal character and its phylogenetic implications. *Occasional Papers of the California Academy of Sciences*, No. 121, 1–23.
Johnson, G.D. (1984) Percoidei: Development and relationships. *In*: Moser, H.G., Richards, W. J., Cohen, D.M., Fahay, M.P., Kendall, A.W., Jr., and Richardson, S. L. (Eds), *Ontogeny and Systematics of Fishes*, American Society of Ichthyologists and Herpetologists, Special Publication Number 1, Allen Press, Lawrence, Kansas, 464–498.
Kami, H.T. (1971) Check-list of Guam fishes, supplement I. *Micronesica*, 7(1 & 2), 215–228.
Kamohara, T. & Katayama, M. (1959) A new and a rare anthinid fishes from Kochi Prefecture, Japan. *Reports of the Usa Marine Biological Station*, 6(1), 1–5.
Katayama, M. (1960) *Fauna Japonica: Serranidae (Pisces)*, Biogeographical Society of Japan, Tokyo, viii + 189 pp., 86 pls.
Katayama, M. (1968) Notes on the osteology and systematic position of *Symphysanodon typus* Bleeker. *Bulletin of the Faculty of Education, Yamaguchi University*, 17(Pt. 2), 105–111.
Katayama, M. (1984) Family Symphysanodontidae. *In*: Masuda, H., Amaoka, K, Araga, C., Uyeno, T. & Yoshino, T. (Eds) *The Fishes of the Japanese Archipelago* (Text), Tokai University Press, Tokyo, 138.
Kimura, S., Peristiwady, T. & Suharti, S.R. (2003) Symphysanodontidae. *In*: Kimura, S. & Matsuura, K. (Eds) *Fishes of Bitung, Northern Tip of Sulawesi, Indonesia*. Oceanic Research Institute, The University of Tokyo, Tokyo, 45–46.
Konishi, Y. (1988) Symphysanodontidae. *In*: Okiyama, M. (Ed) *An Atlas of the Early Stage Fishes in Japan*, Tokai University Press, Tokyo, 421–423. [Text in Japanese.]
Kotlyar, A.N. & Parin, N.N. (1990) Otoliths and age of bottom and near-bottom fishes of the Nazca and Sala y Gómez submarine ridges. *In*: Parin, N.V. & Becker, V.E. (Eds) Seamount fishes. *Transactions of the P.P. Shirshov Institute of Oceanology*, 125, 97–126. (In Russian with English summary.)
Kotthaus, A. (1974) Fische des Indischen Ozeans. Ergebnisse der ichthyologischen Untersuchungen während der Expedition des Forschungsschiffes "Meteor" in den Indischen Ozean,

Oktober 1964 bis Mai 1965. A. Systematischer Teil, XI. Percomorphi (4). *“Meteor” Forschungsergebnisse*, Reihe D , No. 17, 33–54.

Lee, S.-C. (1989) Fish of the family Symphysanodontidae of Taiwan. *Bulletin of the Institute of Zoology, Academia Sinica*, 28(1), 69–71.

Leis, J.M. & Trnski, T. (1989) *The Larvae of Indo-Pacific Shorefishes*. University of Hawaii Press, Honolulu, xii + 371 pp.

Leis, J.M. & Trnski, T. (2000) Symphysanodontidae. *In*: Leis, J. M. & Carson-Ewart , B. M. (Eds) *The Larvae of Indo-Pacific Coastal Fishes: An Identification Guide to Marine Fish Larvae*, Brill, Leiden, 394–398.

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

Manilo, L.G. & Bogorodsky, S.V. (2003) Taxonomic composition, diversity and distribution of coastal fishes of the Arabian Sea. *Journal of Ichthyology*, 43, Supplement 1, S75–S149. [Original in Russian, *Voprosy Ikhtiologii*]

Masuda, H., Amaoka, K, Araga, C., Uyeno, T. & Yoshino, T. (Eds) (1984) *The Fishes of the Japanese Archipelago*, two volumes, Tokai University Press, Tokyo, xxii + 437 pp., 370 pls.

Masuda, H., Araga, C. & Yoshino, T. (1975) *Coastal Fishes of Southern Japan*, Tokai University Press, Tokyo, 379 pp., 143 pls.

McCosker, J.E. (1979) Inferred natural history of the living coelacanth. *In*: McCosker, J.E. & Lagios, M.D. (Eds) The biology and physiology of the living coelacanth. *Occasional Papers of the California Academy of Sciences*, No. 134, 17–24.

Moore, J.A., Hartel, K.E., Craddock, J.E. & Galbraith, J.K. (2003) An annotated list of deepwater fishes from off the New England region, with new area records. *Northeastern Naturalist*, 10(2), 159–248.

Moura, R.L. & Castro, R.M.C. (2002) Revision of Atlantic sharpnose pufferfishes (Tetraodontiformes: Tetraodontidae: *Canthigaster*), with description of three new species. *Proceedings of the Biological Society of Washington*, 115(1), 32–50.

Muss, A., Robertson, D.R., Stepien, C.A., Wirtz, P. & Bowen, B.W. (2001) Phylogeography of *Ophioblennius*: The role of ocean currents and geography in reef fish evolution. *Evolution*, 55(3), 561–572.

Myers, R.F. (1999) *Micronesian Reef Fishes: A Comprehensive Guide to the Coral Reef Fishes of Micronesia*, 3rd ed., Coral Graphics, Barrigada, Guam, vi + 330 pp.

Myers, R.F. and Donaldson, T.J. (2003) The fishes of the Mariana Islands. *Micronesica*, 35–36, 598–652.

Parin, N.V. (1990) Preliminary review of fish fauna of the Nazca and Sala y Gómez submarine ridges (southern east Pacific Ocean). *In*: Parin, N.V. & Becker, V.E. (Eds) Seamount fishes. *Transactions of the P.P. Shirshov Institute of Oceanology*, 125, 6–36. (In Russian with English summary.)

Parin, N.V. (1991) Fish fauna of the Nazca and Sala y Gomez submarine ridges, the easternmost outpost of the Indo-west Pacific zoogeographic region. *Bulletin of Marine Science*, 49(3), 671–683.

Parin, N.V., Gorelova, T.A. & Borodulina, O.D. (1990) Feeding and trophic relationships of fishes inhabiting the Nazca and Sala y Gómez submarine ridges. *In*: Parin, N.V. & Becker, V.E. (Eds) Seamount fishes. *Transactions of the P.P. Shirshov Institute of Oceanology*, 125, 37–57. (In Russian with English summary.)

Parin, N.V., Mironov, A.N. & Nesis, K.N. (1997) Biology of the Nazca and Sala y Gómez submarine ridges, an outpost of the Indo-west Pacific fauna in the eastern Pacific Ocean: Composition and distribution of the fauna, its communities and history. Advances in Marine Biology, 32, 145–242.

Ralston, S., Gooding, R.M. & Ludwig, G.M. (1986) An ecological survey and comparison of bottom fish resource assessments (submersible versus handline fishing) at Johnston Atoll. *Fishery Bulletin*, 84(1), 141–155.

Randall, J.E., Lobel, P.S. & Chave, E.H. (1985) Annotated checklist of the fishes of Johnston Island. *Pacific Science*, 39(1), 24–80.

Richards, W.J. (1984) Kinds and abundances of fish larvae in the Caribbean Sea and adjacent areas. *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, NOAA Technical Report NMFS SSRF-776*, i–vi + 1–54.

Roa-Varón, A, Saavedra-Díaz, L.M., Acero P., A., Mejía M., L.S. & Navas S., G.R. (2003) Nuevos registros de peces óseos para el Caribe Colombiano de los órdenes Beryciformes, Zeiformes, Perciformes y Tetraodontiformes. *Boletín de Investigaciónes Marinas y Costeras*, 32, 3–24.

Roberts, C.D. (1993) Comparative morphology of spined scales and their phylogenetic significance in the Teleostei. *Bulletin of Marine Science*, 52(1), 60–113.

Rohde, F.C., Ross, S.W., Epperly, S.P. & Burgess, G.H. (1996) Fishes new or rare on the Atlantic seaboard of the United States. *Brimleyana*, No. 23, 53–64. [Dated December 1995, but actually published 16 July 1996.]

Seki, M.P. & Callahan, M.W. (1988) The feeding habits of two deep slope snappers, *Pristipomoides zonatus* and *P. auricilla*, at Pathfinder Reef, Mariana Archipelago. *Fishery Bulletin*, 86(4), 807–811.

Senou, H. (2002) Symphysanodontidae. *In*: Nakabo, T. (Ed) *Fishes of Japan with Pictorial Keys to the Species*, English edition, I, Tokai University Press, Tokyo, 733.

Smith, A.G., Smith, D.G. & Funnell, B.M. (1994) *Atlas of Mesozoic and Cenozoic Coastlines*, Cambridge University Press, Cambridge, UK, x + 99.

Springer, V.G. (1962) A review of the blenniid fishes of the genus *Ophioblennius* Gill. *Copeia*, 1962(2), 426–433.

Springer, V.G. (1982) Pacific plate biogeography, with special reference to shorefishes. *Smithsonian Contributions to Zoology*, No. 367, i–iv + 1–182.

Springer, V.G. & Johnson, G.D. (2000) Use and advantages of ethanol solution of alizarin red s dye for staining bone in fishes. *Copeia*, 2000(1), 300–301.

Springer, V.G. & Johnson, G.D. (2004) Study of the dorsal gill-arch musculature of teleostome fishes, with special reference to the Actinopterygii. (Appendix by V.G. Springer and T.M. Orrell: Phylogenetic analysis of 147 families of acanthomorph fishes based primarily on dorsal gill-arch musculature and skeleton.) *Bulletin of the Biological Society of Washington*, No. 11, i–vi + 1–260, 205 pls.

Tameka , S. (1982) *Symphysanodon maunaloae* Anderson. *In*: Okamura, O., Amaoka, K. & Mitani, F. (Eds) *Fishes of the Kyushu-Palau Ridge and Tosa Bay: The Intensive Research of Unexploited Fishery Resources on Continental Slopes*, Japan Fisheries Resource Conservation Association, Tokyo, 218–219, 372. [In Japanese and English.]

Trunov, I.A. (1976) New species and species recorded for the first time in the pelagic area of the tropical Atlantic of the families Serranidae, Emmelichthyidae and Ariommidae. *Journal of Ichthyology*, 16(2), 229–238. [Original in Russian, *Voprosy Ikhtiologii*, 16 (2), 263–273.]

Uchida, R.N. & Tagami, D.T. (1984) Groundfish fisheries and research in the vicinity of seamounts in the North Pacific Ocean. *Marine Fisheries Review*, 46(2), 1–17.

Zug, G.R., Springer, V.G., Williams, J.T. & Johnson, G.D. (1989) The vertebrates of Rotuma and surrounding waters. *Atoll Research Bulletin*, No. 316, 1–25.