



Title	Review of the genus <i>Syacium</i> (Paralichthyidae) with the description of a new species from Ecuador and Columbia
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Review of the genus *Syacium* (Paralichthyidae) with the  
description of a new species from  
Ecuador and Columbia

Tsuyoshi MURAKAMI\* and Kunio AMAOKA\*\*

Abstract

Some two hundred and sixty male, female and juvenile specimens of the genus *Syacium* from the Pacific and Atlantic coasts of tropical America, and the Atlantic coast of Africa were examined externally. In addition, some osteological observations were made for clarification of specific and generic characters. Results were as follows: 1) eight species of *Syacium*, including one new species from Ecuador and Columbia, were recognized and described, and a key was provided: *S. guineensis* (Bleeker) from the eastern Atlantic, *S. gunteri* Ginsburg, *S. micrurum* Ranzani and *S. papillosum* (Linnaeus) from the western Atlantic, and *S. longidorsale* sp. nov., *S. ovale* (Günther), *S. maculiferum* (Garman) and *S. latifrons* (Jordan et Gilbert) from the eastern Pacific; 2) *S. guineensis*, and *S. latifrons*, formerly considered as synonyms of *S. micrurum* and *S. ovale*, respectively, are valid species; 3) *Citharichthys maculifer* Garman is transferred to the genus *Syacium*; and 4) sexual dimorphism in each species (absent in *S. ovale*) was described, based on growth patterns.

Introduction

Fishes of the paralichthyid genus *Syacium* are characterized by the lateral line lacking a distinct curve above the pectoral fin, biserial tooth rows in the upper jaw, and the vent and urogenital papilla opening on the blind side. They inhabit the continental shelves of tropical America and western Africa.

These fishes have been subject to a number of taxonomic studies (Jordan and Gilbert, 1883; Jordan and Goss, 1889; Jordan and Evermann, 1898; Garman, 1899; Norman, 1934; Guthertz, 1967; Fraser, 1971), but some confusion has occurred at both the specific and generic levels, because no attempt, except for that of Norman (1934), has been made to treat the genus overall. Norman (1934) revised the genus, giving short descriptions for each species, but admitted to the persistence of some problems, and the necessity of a further revision, based on a lot more material. After Norman's (1934) work on the Atlantic species of *Syacium*, they were studied by Guthertz (1967) and Fraser (1971) in detail, but some systematic problems still remained. Pacific species have not been revised since Norman (1934), and consequently, their morphology, taxonomy and distribution have remained poorly known.

In addition, sexual dimorphism, which occurs with growth in most species, has

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neither been fully understood nor taken into consideration in taxonomic studies, resulting in difficulties of identification and taxonomic confusion.

The present study is a taxonomic review of the genus *Syacium* on the basis of external morphology of as many male, female and young specimens as possible, and some internal characters.

Eight species of *Syacium*, including one new species, are recognized and described, along with notes on sexual dimorphism. A key to the species is given.

### Materials and methods

Terminology and measurements of external features generally follow Norman (1934) and Hubbs and Lagler (1958). Unless otherwise indicated, counts and measurements were made on the ocular side of the body.

Vertebral counts were taken from radiographs. Abbreviations used in the text are SL (standard length) and HL (head length).

Sex was determined from the external appearance of the gonads. The testes did not extend beyond the abdominal cavity, unlike the ovaries, which extended into the body musculature.

Osteological observations were made on specimens cleared and stained with Alizarin Red "S" and Alcian Blue, and the bones were drawn using a Wild M-8 stereomicroscope. Terminology of the bones follows Amaoka (1969) and Sakamoto (1984). Specimens examined osteologically are listed in Table 1.

Abbreviations for material depositories are as listed by Leviton et al. (1985).  
Synonymies of genera and species are cited only from the original references.

Table 1. Specimens used for the osteological study of *Syacium*.

Species	Catalog No.	Number	SL (mm)	Sex	Locality
<i>S. guineensis</i>	FSFL EI577	1	184.0	Male	Guinea
<i>S. gunteri</i>	HUMZ 103188	1	123.2	Male	Gulf of Mexico
<i>S. micrurum</i>	HUMZ 101910	1	201.6	Male	Caribbean Venezuela
	HUMZ 103183	1	126.7	Male	Caribbean Sea
	HUMZ 105572	1	169.0	Male	Atlantic Colombia
<i>S. papillosum</i>	HUMZ 32679	1	185.4	Male	Surinam
	NSMT-P 40921	1	163.0	Male	French Guiana
	NSMT-P 40938	1	189.5	Male	French Guiana
<i>S. longidorsale</i>	HUMZ 121140 (paratype)	1	112.6	Female	Pacific Colombia
<i>S. ovale</i>	HUMZ 103241	1	131.3	Male	Pacific Colombia
	HUMZ 105066	1	106.6	Male	Gulf of California
<i>S. latifrons</i>	HUMZ 121145	1	142.6	Male	Ecuador

Genus *Syacium* Ranzani

*Syacium* Ranzani, 1840, p. 18 (type-species *Syacium micrurum* Ranzani).

*Hemirhombus* Bleeker, 1862, p. 425 (type-species *Hemirhombus guineensis* Bleeker).

*Aramaca* Jordan and Goss in Jordan, 1885, p. 921 (type-species *Hemirhombus paetulus* Jordan and Gilbert).

**Diagnosis.** A paralichthyid genus with the lateral line lacking a distinct curve above the pectoral fin; teeth on upper jaw biserial (Fig. 1C); mouth rather large, maxillary extending to below middle of lower eye; pelvic fin on ocular side on ventral median line, slightly behind that on blind side; gill rakers short and stout, strongly serrated on posterior margin (Fig. 4C); genital papilla on blind side.

**Description.** Body ovate or somewhat elongate, compressed, highest just anterior to midpoint of body; tip of isthmus behind posterior margin of lower eye; dorsal and ventral outlines equally arched except for head. Caudal peduncle moderate in depth. Nostrils two on each side; those on ocular side in front of upper margin of lower eye, anteriormost with a flap posteriorly; those on blind side below origin of dorsal fin, similar in shape and structure to those on ocular side, but anteriormost very small. Eyes sinistral, separated by concave space. No spines on head.

Mouth oblique, moderate in size; maxillary extending to below middle of lower eye. Teeth on upper jaw biserial, some outer series stronger than inner ones, canine-like; teeth on lower jaw uniserial, similar to outer series on upper jaw (Fig. 1). Gill rakers short, stout, strongly serrated on posterior margin (Fig. 4C). Scales large, ctenoid on ocular side, cycloid on blind side, snout and tips of both jaws on ocular side naked. Supplementary scales present on both sides, particularly in region of lateral line. Lateral line lacking a distinct curve above pectoral fin. Origin of dorsal fin above posterior nostril on blind side. Anal fin origin behind pelvic fin on ocular side. All rays of dorsal and anal fins scaled. Pectoral fin on ocular side larger than that on blind side. Pelvic fins equal in size, that on ocular

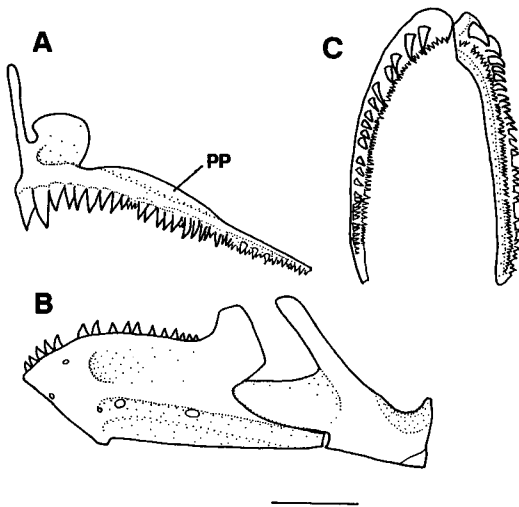


Fig. 1. Lateral view of premaxilla (A) and mandible (B), and ventral view of premaxillary (C) in *Syacium micrurum*. PP, postmaxillary process. Scale indicates 5 mm.

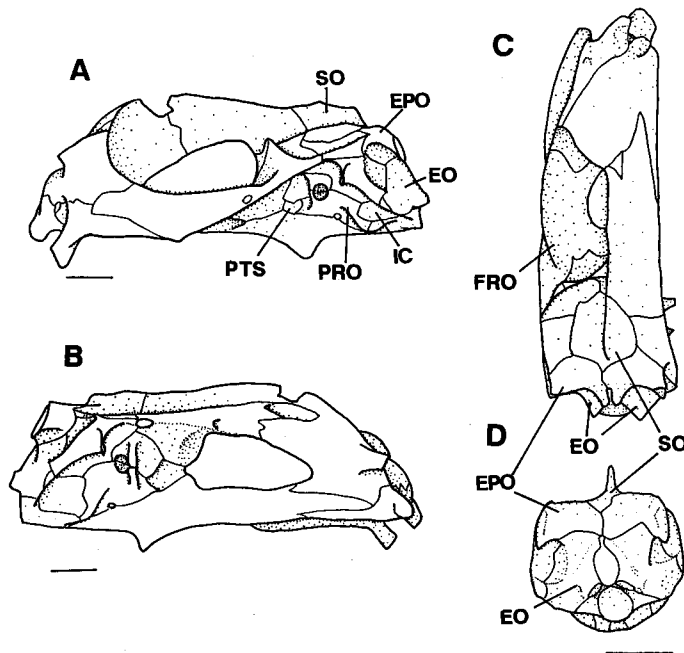


Fig. 2. Lateral (A: ocular side; B: blind side), dorsal (C) and rear (D) views of cranium in *S. micrurum*. So, supraoccipital; EPO, epiotic; EO, exoccipital; IC, intercalar; PRO, prootic; PTS, pterosphenoid; FRO, frontal. Scales indicate 5 mm.

side on ventral median line, slightly behind that on blind side. Caudal fin doubly truncate, middle rays longest, inner 11 (rarely 10 or 12) rays branched; other rays simple. Vent opening on blind side above origin of anal fin. Genital papilla located just behind vent.

**Osteological characters.** Interorbital process of frontal on blind side reduced (Fig. 2B, C). Pterosphenoid on ocular side small, not included in orbit; that on blind side moderate in size, forming a posterior part of orbit. Exoccipital separated from prootic by intercalar (Fig. 2A, B). Supraoccipital separated from exoccipital by epiotics meeting in midline (Fig. 2). Three sensory canal openings on anterior part of dentary (Fig. 1B). Postmaxillary process of premaxillary developed (Fig. 1A). Basihyal not directly connected with basibranchial owing to insertion of dorsal hypohyal (Fig. 3A). Cardiac apophysis of urohyal bifurcate (Fig. 3B, C). Tubular supratemporal "T"-shaped (Fig. 3D). Preorbital on ocular side bar-like or bar-like with a dorsal flange (Fig. 8A, B). One infraorbital on ocular side and five or six on blind side (Fig. 4A, B). First neural spine reduced (Fig. 4D). Transverse apophysis present on both sides of anterior caudal vertebrae (Fig. 4E). Epural fused with fifth hypural; caudal skeleton consisting of 4 plates (Fig. 5).

**Remarks.** In *Syacium*, all species, except for *S. ovale*, exhibit sexual dimorphism. This is especially so in *S. gunteri*, *S. papillosum* and *S. latifrons*, in which species adult males differ considerably from females and juveniles in general appear-

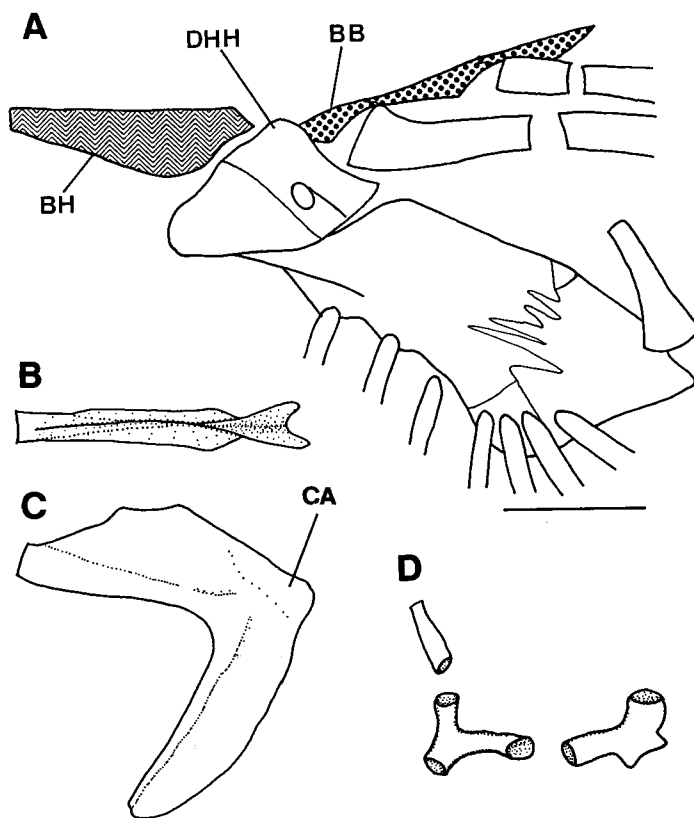


Fig. 3. Lateral views of hyoid arch (A), urohyal (C) and supratemporal (D), and dorsal view of urohyal (B) in 3 species of *Syacium*. A, *S. papillosum*; B, C, *S. micrurum*; D, *S. latifros*. BH, basihyal; DHH, dorsal hypohyal; BB, basibranchial; CA, cardiac apophysis. Scales indicate 5 mm.

ance. However, most of the species of this genus have been described from adult specimens only, and morphological differences owing to sexual dimorphism have received little attention. This has resulted in taxonomic confusion. For the identification of species in this genus it is necessary to consider both the sex and stage of development.

#### Key to species of *Syacium*

- 1a Eastern Atlantic species ..... *S. guineensis* (Bleeker)
- 1b Western Atlantic species ..... 2
- 1c Eastern Pacific species ..... 4
- 2a Length of pectoral fin on blind side more than 50% HL; body depth more than 48% SL .....  
..... *S. gunteri* Ginsburg
- 2b Length of pectoral fin on blind side less than 50% HL; body depth less than 47% SL ..... 3
- 3a Lateral line scales 57-69; interorbital width less than 11% HL; in males larger than 150 mm SL,

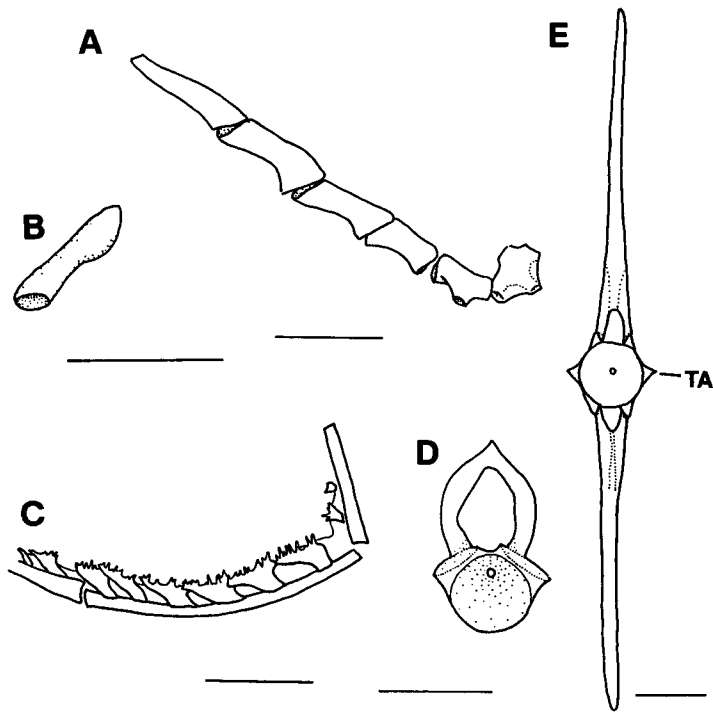


Fig. 4. Lateral views of infraorbitals (A, blind side; B, ocular side), and gill rakers of first arch (C) and front views of first vertebra (D) and anterior caudal vertebra (E) in *Syacium micrurum*. TA, transverse apophysis. Scales indicate 5 mm.

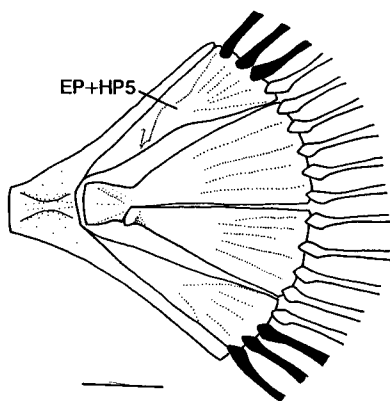


Fig. 5. Lateral view of caudal skeleton in *S. micrurum*. EP+HP5, epural fused with hypural 5. Solid rays show unbranched rays. Scale indicates 5 mm.

- interorbital width less than 11% HL; in males of 100–150 mm SL, interorbital width less than 8% HL; in females, interorbital width less than 8% HL ..... *S. micrurum* Ranzani
- 3b Lateral line scales 44–57; interorbital width 5–25% HL; in males larger than 150 mm SL, interorbital width greater than 14% HL; in males of 100–150 mm SL, interorbital width greater than 9% HL; in females of more than 100 mm SL, interorbital width greater than 7% HL ..... *S. papillosum* (Linnaeus)
- 4a Upper profile of head evenly curved or with a slight notch; interorbital width less than 6% HL; anterior margins of eyes at about same level; length from snout tip to anterior margin of upper eye less than 24% HL ..... 5
- 4b Upper profile of head with a distinct notch in front of upper eye or interorbital space; interorbital width 4–31% HL; anterior margin of lower eye in advance of that of upper eye; length from snout tip to anterior margin of upper eye greater than 23% HL ..... 6
- 5a Length from snout tip to anterior margin of upper eye less than eye diameter; length of 4th dorsal fin ray 23–53% HL; anterior rays of dorsal fin and one or two upper rays of pectoral fin on ocular side extended in male ..... *S. longidorsale* sp. nov.
- 5b Length from snout tip to anterior margin of upper eye equal to or greater than eye diameter; length of 4th dorsal fin ray 19–28% HL; pectoral fin rays and dorsal fin rays not extended ..... *S. ovale* (Günther)
- 6a Depth of caudal peduncle 31% HL; length of lower jaw on blind side 44% HL; gill rakers on lower limb 10 ..... *S. maculiferum* (Garman)
- 6b Depth of caudal peduncle 33–48% HL; length of lower jaw on blind side 37–41% HL; gill rakers on lower limb 7–8 ..... *S. latifrons* (Jordan et Gilbert)

*Syacium guineensis* (Bleeker)

Fig. 6

*Hemirhombus guineensis* Bleeker, 1862, p. 425.*Syacium ovale*: Pauca, 1930, p. 37.*Syacium micrurum*: Norman, 1934, p. 132, fig. 86 (in part).*Syacium guineensis*: Cadenat and Marshall, 1963, p. 1247.

**Material examined.** FSFL S201, male, 230.5 mm SL, 20° 21, 2'N, 17°22.6'W, off Mauritania, depth 37 m, Dec. 17, 1971; FSFL EI577, EI594, 2 males, 184.0–189.4 mm, 11°26.7'N, 17°07.7'W, off Guinea, 45 m, July 30, 1975; FSFL EI640, male, 219.2 mm, 5°45'N, 10°19' W, off Liberia, 73 m, Aug. 1, 1975; FSFL EI652, EI653, EI656, EI659, EI668, 3 males, 2 females, 214.6–228.0 mm, 10°39'N, 16°34'W, off Guinea, 49 m, Aug. 1, 1975; FSFL Q716, male, 209.7 mm, 10°58'N, 16°58'W, off Guinea, 56 m, Nov. 15, 1974; FSFL Q722, male, 164.1 mm, 11°21'N, 17°10'W, off Guinea, 50 m, Nov. 12, 1974; FSFL B1885, female, 231.1 mm, Atlantic coast of Africa; USNM 270657, 2 males, 3 females, 172.0–205.6 mm, 9°24'N, 15°26'W, off Guinea, 50 m, Nov. 29, 1963; USNM 270658, 4 males, female, 148.1–167.2 mm, 6°41'N, 11°23'W, off Liberia, 40 m, Nov. 11, 1963; HUMZ 48734, male, 238.5 mm, data unknown.

**Diagnosis.** An elongate species of *Syacium* with body depth 38–42% SL; small head, its length 24–28% SL; limited sexual dimorphism exhibited by interorbital space and pectoral fin on ocular side.

**Description.** Dorsal fin rays 84–93; anal fin rays 62–73; pectoral fin rays 11–12 on ocular side, 10 on blind side; lateral line scales 52–60; gill rakers 2–3+7–9; vertebrae 10+24–26.

Head length 3.6–4.2 in SL; body depth 2.4–2.7. Snout length 4.5–5.1 in HL; upper eye diameter 3.9–5.6; lower eye diameter 3.7–6.3; interorbital width 10.1–18.9; length of upper jaw 2.5–2.9 on ocular side, 2.5–2.7 on blind side; length of lower jaw 2.1–2.3 on ocular side, 2.0–2.2 on blind side; depth of caudal peduncle 2.1–2.6; length of pectoral fin 0.7–1.5 on ocular side, 2.1–2.6 on blind side; length



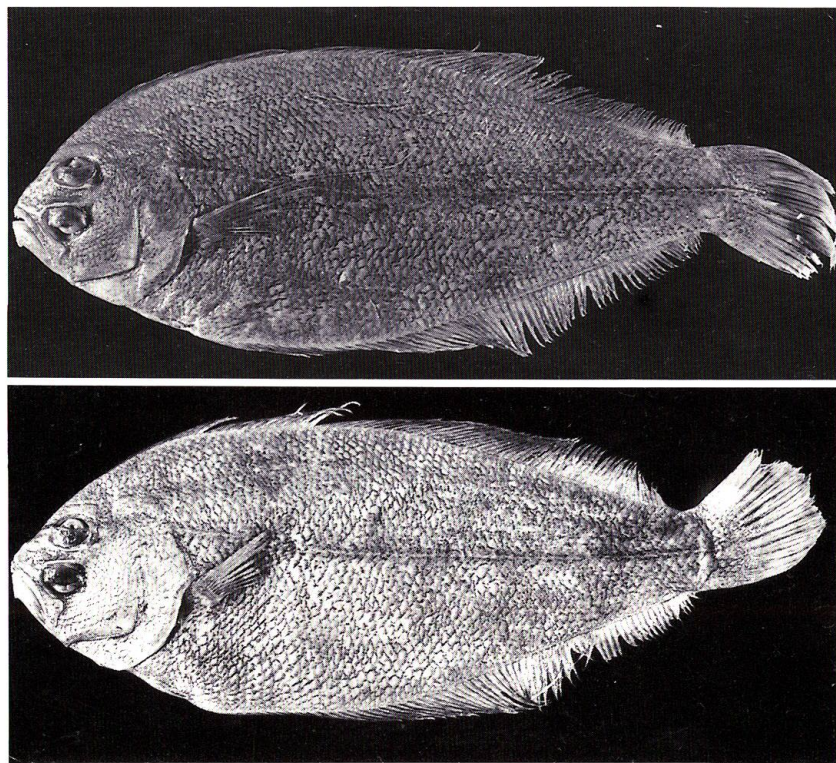


Fig. 6. *Syacium guineensis*. Above; FSFL EI659, male, 228.0 mm SL, from Guinea; below: FSFL EI652, female, 226.2 mm SL, from Guinea.

of pelvic fin 2.6–3.9 on ocular side, 2.4–3.0 on blind side; length of pelvic fin base 8.7–13.2 on ocular side, 7.6–12.5 on blind side; length of longest dorsal fin ray 2.1–2.7; length of longest anal fin ray 2.2–2.8; length of middle caudal fin ray 1.2–1.4.

Body elliptical, highest at midpoint; dorsal and ventral outlines equally arched. Caudal peduncle moderate in depth.

Head somewhat small; upper profile with a small notch in front of upper eye. Snout blunt and long, nearly equal to eye diameter. Eyes moderate in size, separated by a concave space. Interorbital space rather narrow, equal to or less than pupil. Lower eye slightly in advance of upper eye.

Origin of dorsal fin above posterior nostril on blind side, on horizontal line through lower margin of upper eye. Anal fin origin behind pelvic fin on ocular side. Pectoral fin on ocular side larger than that of blind side, middle five rays branched, all rays on blind side simple.

**Color of preserved specimens.** Body on ocular side uniformly brownish. Fins paler than body; dorsal and anal fins with a regular series of dark blotches; pectoral fin on ocular side with dark bars; caudal fin scattered with indistinct dark blotches. Blind side of body yellowish-white.

**Distribution.** Atlantic coast of tropical Africa, from Western Sahara to

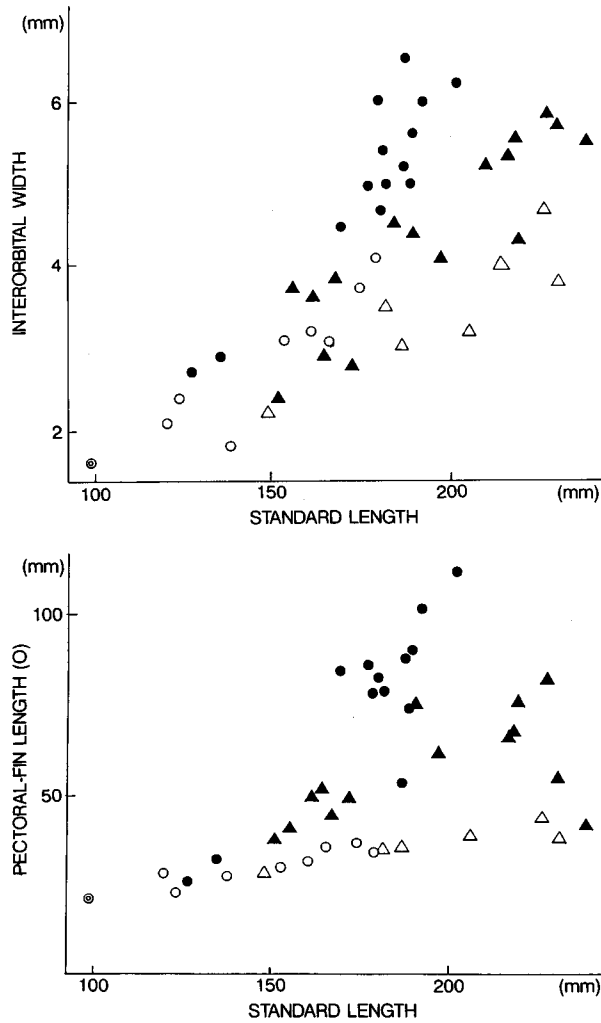


Fig. 7. Relationships between SL and interorbital width (above) and between SL and length of pectoral fin on ocular side (below) in 2 species of *Syacium*. *S. guineensis* (triangles) and *S. micrurum* (circles). Male (closed), female (open).

Angola.

**Sexual dimorphism.** This species exhibits sexual dimorphism in both the width of the interorbital and the shape of the pectoral fin on the ocular side. In mature males, the interorbital width is greater than in females (Fig. 7) and the upper one or two pectoral fin rays on the ocular side are extended and filamentous (Fig. 7).

**Remarks.** This species is most similar to *S. micrurum* in its meristic counts and proportional measurements.

Norman (1934) considered *S. guineensis* to be a synonym of *S. micrurum* Ranzani, although he recognized a few differences, viz. the number of lateral line

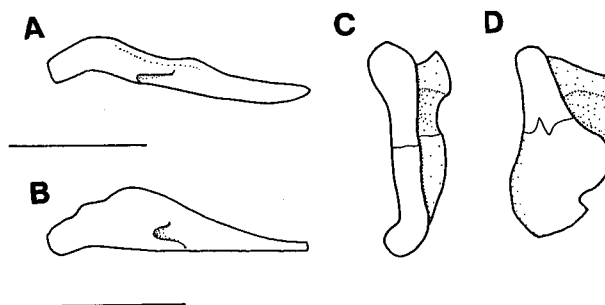


Fig. 8. Lateral views of preorbital (A, B) and front views of hypohyal (C, D) in 2 species of *Syacium*. A, C: *S. micrurum*; B, D: *S. guineensis*.

Table 2. Comparison of proportional measurements of *S. guineensis* and *S. micrurum*.

	<i>S. guineensis</i>			<i>S. micrurum</i>		
	Range	Mean (n)	SD	Range	Mean (n)	SD
SL (mm)	148.1-238.5			99.0-201.6		
% of SL:						
HL	24-28	26 (23)	1.0	27-32	29 (23)	1.0
Body depth	38-42	40 (23)	1.0	39-42	40 (23)	0.8
% of body depth:						
Length of upper jaw (o)	22-27	25 (23)	1.5	26-23	29 (23)	1.5
Length of lower jaw (o)	26-32	29 (23)	1.6	31-37	34 (23)	1.5
% of HL:						
Length of caudal fin	74-85	77 (20)	3.3	59-73	67 (19)	3.3

scales and differing interorbital widths in specimens of the same size and sex. His opinion has been followed by many authors (Chabanaud, 1949; Poll, 1959; Nielsen, 1961; Gutherz, 1967; Gutherz et al., 1981).

On the other hand, Cadenat and Marshall (1963) and Abousouan (1968) recognized *S. guineensis* as a valid species. In addition, Fraser (1971) examined many specimens of both species and distinguished the former from *S. micrurum* mainly on differences in the number of lateral line scales.

In the present study, the following differences between the species were found: somewhat smaller number of lateral line scales (52-60 in *S. guineensis* versus 57-69 in *S. micrurum*), somewhat narrower interorbital width in specimens of the same size and sex (Fig. 7), shorter pectoral fin on the ocular side in mature males (Fig. 7), shorter head, shorter jaws and longer middle caudal fin ray (Table 2). Moreover, there were also some osteological differences. *S. guineensis* had a dorsal flange on preorbital of the ocular side (bar-like in *S. micrurum*) (Fig. 8A, B), a thickened ventral hypohyal (this in *S. micrurum*) (Fig. 8C, D) and the interhyal with a posterior process (process absent in *S. micrurum*). Accordingly, it is considered that *S. guineensis* is distinct from *S. micrurum*.

*Syacium gunteri* Ginsburg

Fig. 9

*Syacium gunteri* Ginsburg, 1933, p. 7.

*Syacium longreyi* Norman, 1933, p. 201.

**Material examined.** USNM 92800, male, 98.3 mm SL, off Louisiana, Gulf of Mexico, Apr. 4, 1933, holotype; USNM 117043, 5 males, female, 100.3-132.9 mm, Dry Tortugas, Florida, Gulf of Mexico, Jul. 22, 1932; USNM 214344, 2 males and 4 females, 82.0-121.5 mm, 28°34.5'N, 91°11.7'W, off Louisiana, Gulf of Mexico, depth 27 m, Jan. 26, 1970; USNM 266478, 6 males, 88.7-121.3 mm, 20°00'N, 91°47'W, Golfo de Campeche, Gulf of Mexico, 48 m, Nov. 21, 1958; USNM 266488, 4 males, 5 females, 100.9-119.7 mm, 11°25' N, 65°49'W, Caribbean Venezuela, Sept. 24, 1965; HUMZ 101911, female, 89.8 mm, 12°29'N, 70°09'W, Caribbean Venezuela, 70 m, Oct. 3, 1965; HUMZ 103186, 103187, 2 males, 116.7-124.3 mm, same data as USNM 117043; HUMZ 103188-103191, 3 males, 1 specimen of unknown sex, 76.1-123.2 mm, same data as USNM 266478; NSMT-P40934, male, 104.7 mm, 6°56'N, 54°05'-54°10'W, off Surinam, 64-65 m, Mar. 16, 1981.

**Diagnosis.** An ovate species of *Syacium* with considerable body depth, 48-54% SL; length of pectoral fin on blind side 51-62% HL; lateral line scales 41-50.

**Description.** Dorsal fin rays 75-85; anal fin rays 58-66; pectoral fin rays 10-12 on ocular side, 8-10 on blind side; lateral line scales 41-50; gill rakers 2-3+4-8; vertebrae 10+23-24.

Head length 3.1-3.8 in SL; body depth 1.9-2.1. Snout length 4.2-5.8 in HL; upper eye diameter 3.9-4.8; lower eye diameter 3.7-4.7; interorbital width 3.5-16.4; length of upper jaw 1.8-2.8 on ocular side, 1.9-2.7 on blind side; length of lower jaw 2.0-2.3 on ocular side, 1.9-2.2 on blind side; depth of caudal peduncle 2.1-2.7; length of pectoral fin 0.8-1.4 on ocular side, 1.6-2.0 on blind side; length of pelvic fin 1.7-3.0 on ocular side, 2.1-2.3 on blind side; length of pelvic fin base 8.4-10.8 on ocular side, 7.6-12.9 on blind side; length of longest dorsal fin ray 1.6-2.6; length of longest anal fin ray 1.8-2.4; length of middle caudal fin ray 1.1-1.5.

Body deeply ovoid, highest anterior to midpoint, depth about half of SL; dorsal and ventral outlines equally arched, except for head. Caudal peduncle moderate in depth.

Head moderate in size; upper profile with a deep concavity in front of interorbital space or upper eye. Snout blunt and short, length less than eye diameter. Eyes moderate in size, separated by concave space. Interorbital space wide, exhibiting considerable sexual dimorphism. Lower eye in advance of upper eye.

Origin of dorsal fin above posterior nostril on blind side. Anal fin origin behind pelvic fin on ocular side. Pectoral fin on ocular side larger than that on blind side, inner four or five rays branched; all rays on blind side simple.

**Color of preserved specimens.** Body on ocular side brownish or dusty brown, sometimes with indistinct blotches. Fins paler than body; dorsal and anal fins with a regular series of dark blotches; pectoral fin on ocular side faintly marked with darker bars; caudal fin with distinct dark blotches. Blind side of body yellowish or greyish-white.

**Distribution.** Atlantic coast of Central and South America, from Florida to French Guiana.

**Sexual dimorphism.** This species shows sexual dimorphism in the interorbital width and length of the pectoral fin on the ocular side. In mature males, the



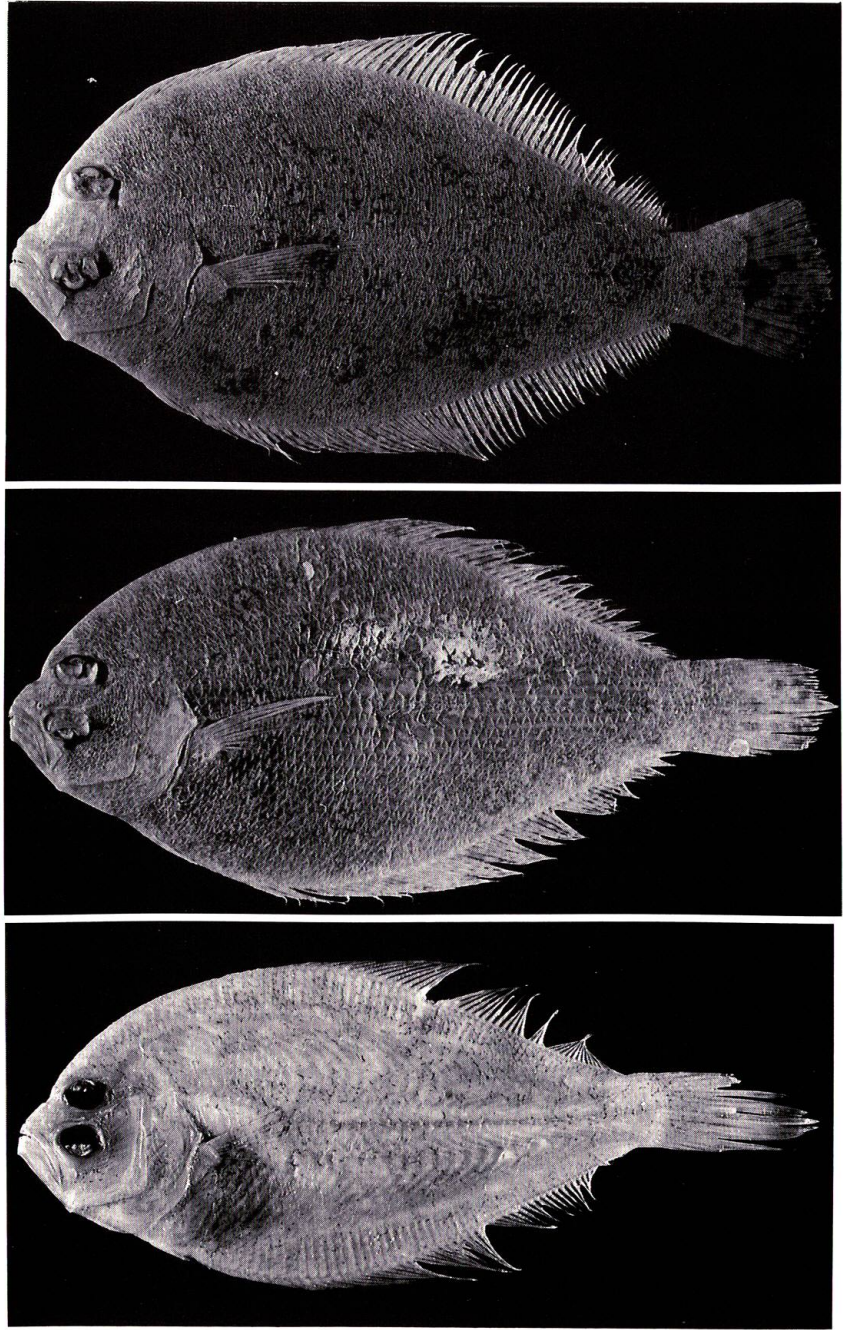


Fig. 9. *Syacium gunteri*. Above: HUMZ 103187, male, 123.4 mm SL, from Gulf of Mexico; middle; USNM 117043, female, 105.3 mm SL, from Gulf of Mexico; below: USNM 214344, young male, 82.0 mm SL, from Gulf of Mexico.

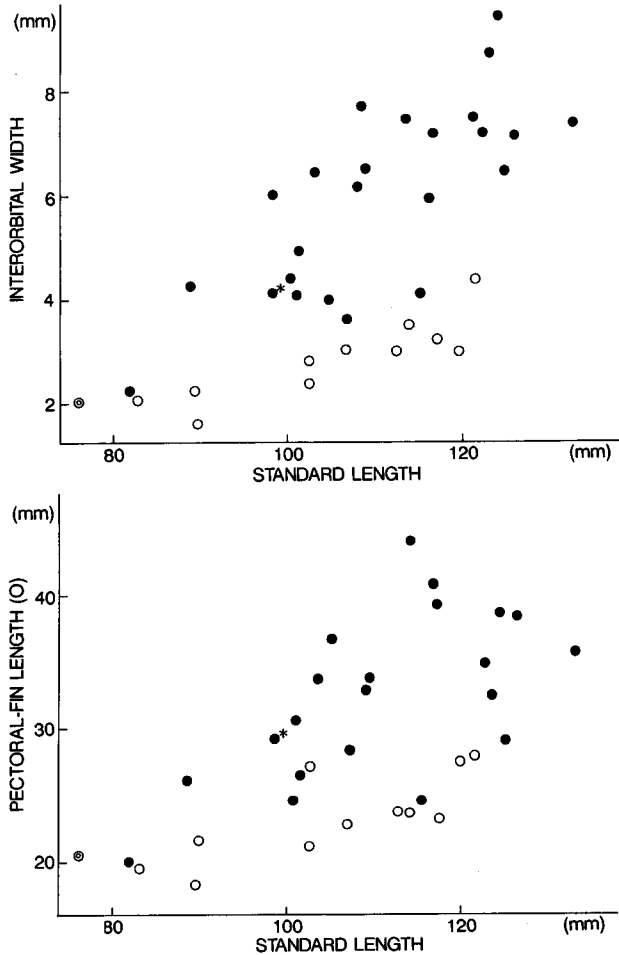


Fig. 10. Relationships between SL and interorbital width (above) and between SL and length of pectoral fin on ocular side (below) in *Syacium gunteri*. Male (closed circles), female (open), sex unknown (double), holotype (asterisk).

interorbital width is broader than in females (Fig. 10) and the pectoral fin on the ocular side is slightly longer (Fig. 10).

**Remarks.** Three species of *Syacium* have been recorded from the Atlantic coast of Central and South America (*S. gunteri*, *S. papillosum* and *S. micrurum*). Identification is very difficult owing to their close similarity to one another in general appearance, especially in specimens less than 100 mm SL. Fraser (1971) distinguished *S. gunteri* from the other species by the following characters: deeper body depth, 46–50% SL (less than 46% in the others), and lower number of lateral line scales (43–50 versus more than 50).

The most useful character for separation between *S. gunteri* and the above species was found to be the length of the pectoral fin on the blind side, in combina-

Table 3. Comparison of body depth and length of blind side pectoral fin (b) in three western Atlantic species of *Syacium*. Holotype shown in parentheses.

	<i>S. gunteri</i> (n=36)			<i>S. papillosum</i> (n=44)			<i>S. micrurum</i> (n=23)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
SL (mm)	76.1-132.9 (98.3)			62.5-243.0			99.0-201.6		
% of SL:									
Body depth	48-54 (50)	51	1.8	39-47	43	2.0	39-42	40	0.8
% of HL:									
Pectoral-fin length (b)	51-62 (62)	56	3.5	36-48	41	3.3	39-49	44	2.4

tion with the body depth (Table 3). In addition, it was found that the number of dorsal and anal fin rays, and lateral line scales were comparatively fewer in *S. gunteri* than in *S. papillosum*, although some overlap occurred (Table 4).

### *Syacium micrurum* Ranzani

Fig. 11

*Syacium micrurum* Ranzani, 1840, p. 18, pl. 5.

*Hippoglossus ocellatus* Poey, 1860, p. 314.

*Hemirhombus aramaca* Günther, 1862, p. 422.

*Hemirhombus micrurus*: Bleeker, 1863, p. 26.

*Hemirhombus ocellatus*: Poey, 1868, p. 407.

*Citharichthys ocellatus*: Jordan and Gilbert, 1883, p. 964.

*Citharichthys aethalion* Jordan, 1887a, p. 52.

*Hemirhombus aethalion*: Jordan, 1887b, p. 602.

**Material examined.** USNM 266482, 8 males, 5 females, 159.1-189.1 mm SL, 12°27'N, 70°06'W, Caribbean Venezuela, depth 73 m, Oct. 3, 1965; USNM 266485, male, 178.5 mm, 8°47'N, 79°09'W, Caribbean Colombia, 79 m, Oct. 17, 1965; HUMZ 32649, 32680, 1 male and 1 female, 152.7-192.2 mm, 7°50.5'N 57°54.5'W, Guiana, 51 m, Dec. 10, 1973; HUMZ 101549, female, 137.9 mm, 7°50'N, 77°36'W, Caribbean Sea, 20-22 m, Apr. 11, 1968; HUMZ 101910, male, 201.6 mm, 12°29'N, 70°09'W, Caribbean Venezuela, 70 m, Oct. 3, 1965; HUMZ 103181-103184, 3 males, 1 female, 1 sex unknown, 99.0-134.7 mm, 17°50'N, 77°36'W, Caribbean Sea, 20-22 m, Apr. 11, 1968; HUMZ 105572, male, 169.0 mm, 12°12'N, 72°26'W, Atlantic Colombia, 70 m, Oct. 12, 1965.

**Diagnosis.** An elongate species of *Syacium*, with body depth 39-42% SL; large head, 27-32% SL; narrow interorbital width, less than 11% HL; lateral line scales more than 57.

**Description.** Dorsal fin rays 84-91; anal fin rays 66-73; pectoral fin rays 10-12 on ocular side, 9-10 on blind side; lateral line scales 57-69; gill rakers 1-3+7-8; vertebrae 10+23-25.

Head length 3.2-3.7 in SL; body depth 2.4-2.6. Snout length 4.4-5.1 in HL; upper eye diameter 4.2-5.1; lower eye diameter 4.2-5.0; interorbital width 8.1-21.8; length of upper jaw 2.4-2.8 on ocular side, 2.3-2.7 on blind side; length of lower jaw 2.0-2.2 on ocular side, 1.8-2.1 on blind side; depth of caudal peduncle 2.5-3.0; length of pectoral fin 0.5-1.6 on ocular side, 2.1-2.6 on blind side; length



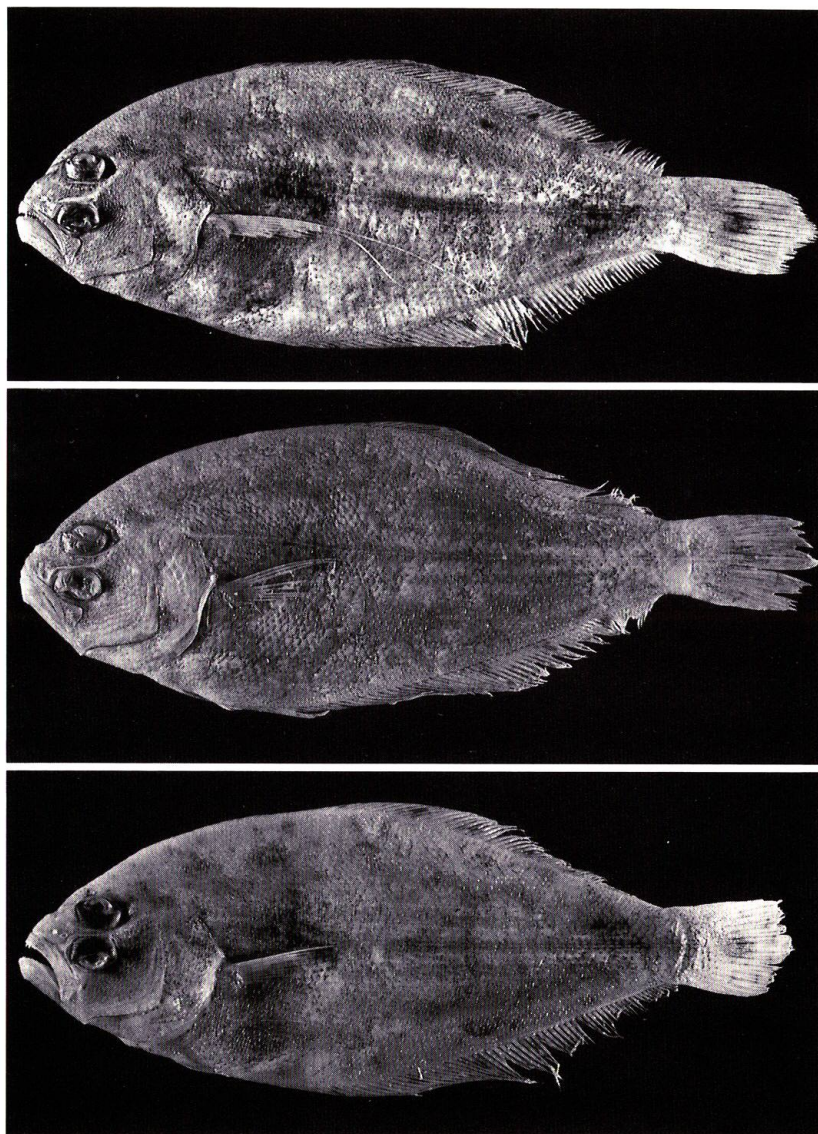


Fig. 11. *Syacium micrurum*. Above: USNM 266482, male, 181.7 mm SL, from Caribbean Venezuela; middle: USNM 266482, female, 178.7 mm SL, from Caribbean Venezuela; below: HUMZ 103182, sex unknown, 99.0 mm SL, from Caribbean Sea.

of pelvic fin 2.6-3.3 on ocular side, 2.3-3.1 on blind side; length of pelvic fin base 7.3-11.5 on ocular side, 7.2-12.2 on blind side; length of longest dorsal fin ray 2.2-2.9; length of longest anal fin ray 2.2-2.9; length of middle caudal fin ray 1.4-1.7.

Body elliptical, highest at midpoint; dorsal and ventral outlines about equally



arched. Caudal peduncle moderate in depth.

Head rather large; upper profile with a notch in front of upper eye. Snout blunt and long, nearly equal to eye diameter. Eyes rather large, separated by narrow concave space. Lower eye slightly in advance of upper eye.

Origin of dorsal fin above posterior nostril on blind side, on horizontal line through lower margin of upper eye. Anal fin origin behind pelvic fin on ocular side. Pectoral fin on ocular side larger than that on blind side, middle four or five rays branched, all rays on blind side simple.

**Color of preserved specimens.** Body on ocular side brownish with large, dark blotches on lateral line near base of pectoral fin and anterior part of caudal peduncle; indistinct darker blotches sometimes scattered on body. Fins paler than body; dorsal and anal fins with a regular series of dark blotches; pectoral fin on ocular side faintly marked with darker bars; caudal fin with a dark blotch centrally, scattered with indistinct, darker blotches. Blind side of body yellowish-white.

**Distribution.** Atlantic coast of Central and South America, from Florida to Rio de Janeiro.

**Sexual dimorphism.** This species exhibits sexual dimorphism in the interorbital width and length of the pectoral fin on the ocular side. In mature males, the interorbital width is greater than in females (Fig. 12) and the upper one or two pectoral fin rays on the ocular side are extended and filamentous (Fig. 7).

**Remarks.** *S. micrurum* is very similar to *S. guineensis* in both meristic counts

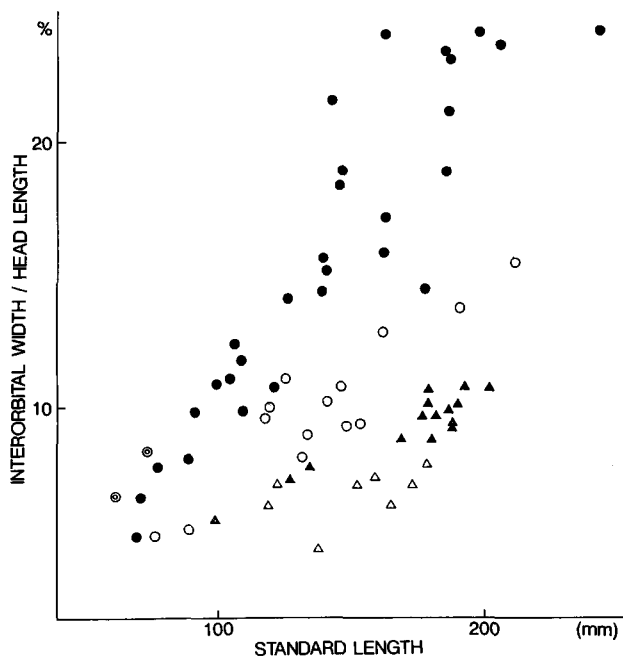


Fig. 12. Relationships between SL and interorbital width in %HL in 2 species of *Syacium*. *S. micrurum* (triangles), *S. papillosum* (circles). Male (closed), female (open), sex unknown (double).

and proportional measurements, but differs from the latter in having the head and both jaws longer, a shorter middle caudal fin ray (Table 2) and in some osteological characters as discussed in the remarks under *S. guineensis* (Fig. 8).

Among western Atlantic species of *Syacium* it is most similar to *S. papillosum*, in having a comparatively elongate body and similar sexual dimorphism of the interorbital space and the pectoral fin on the ocular side. In large specimens, *S. micrurum* is clearly distinguishable from *S. papillosum* because of its narrower interorbital width (Fig. 12), but in smaller specimens, the similarly narrow interorbital spaces (Fig. 12) make separation very difficult.

In previous studies (e.g., Norman, 1934; Gutherz, 1967), the number of lateral line scales was not considered as a useful character for separation of *S. micrurum* and *S. papillosum*, because of overlap. However, it was found here that the number of lateral line scales of the former was different (being greater than in *S. papillosum*) (Table 4). Moreover, it was recognized that the body outline of smaller specimens differed between the two species. In *S. micrurum*, the dorsal outline formed a gentle slope anteriorly, with its peak being behind that of the ventral outline, whereas in *S. papillosum* the dorsal outline was steep anteriorly, with the peaks of

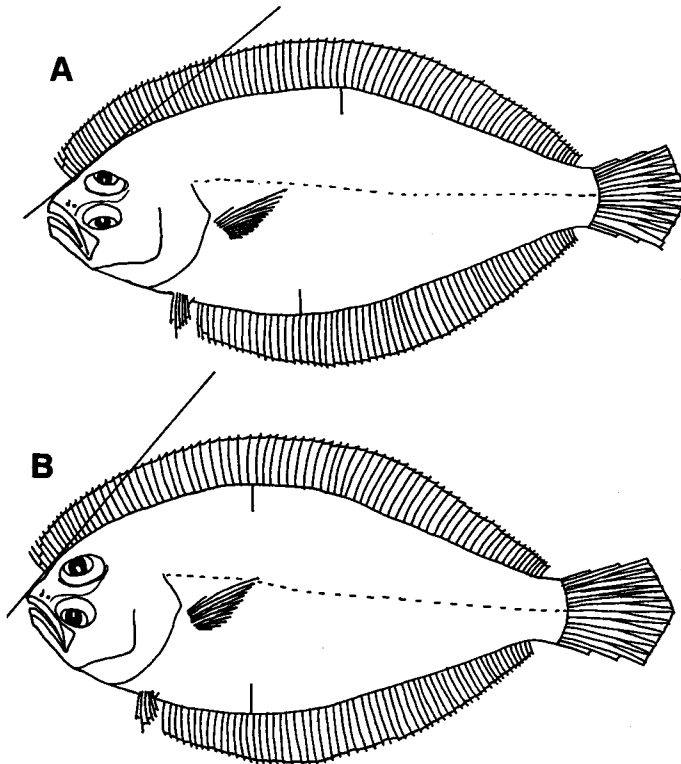


Fig. 13. Body outline of young of *S. micrurum* (A) and *S. papillosum* (B). Specific differences in head outline, and peaks of dorsal and ventral outlines are shown by oblique line and vertical lines respectively.

Table 4. Frequency distributions of numbers of lateral line scales (LLS), dorsal fin rays (DFR) and anal fin rays (AFR) in three western Atlantic species of *Syacium*. Asterisks indicate holotype.

No. of LLS	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	
<i>S. gunteri</i>	1	1	3	9*	4	5	6	4		2																				
<i>S. papillosum</i>				1		4		2	2	2	5	10	7	5	1	3	1													
<i>S. micrurum</i>																	1		3	2	3	2	5	2	4				1	
No. of DFR	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93											
<i>S. gunteri</i>	1	3	6	6*	5	5	6	2	2		1																			
<i>S. papillosum</i>				1	1	2	1	1	2	3		2	6	6	4	4	3	7	1											
<i>S. micrurum</i>										1	2	1	3	4	6	3	2		1											
No. of AFR	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74													
<i>S. gunteri</i>	1		3	6*	7	7	6	4	1																					
<i>S. papillosum</i>					2	2	4	2	5	4	7	5	4	5	3	1														
<i>S. micrurum</i>										1	1	5	8	5	2	1														

both dorsal and ventral outlines being on about the same vertical line (Fig. 13).

*Syacium papillosum* (Linnaeus)

Fig. 14

- Pleuronectes papillosus* Linnaeus, 1758, 271.
- Pleuronectes aramaca* Walbaum, 1792, p. 121.
- Rhombus soleaeformis* Agassiz in Spix, 1831, p. 86, pl. 67.
- Hippoglossus intermedius* Ranzani, 1840, p. 14, pl. 4.
- Hemirhombus soleaeformis*: Günther, 1862, p. 423.
- Hemirhombus paetulus* Jordan and Gilbert, 1882b, p. 304.
- Citharichthys aramaca*: Jordan and Gilbert, 1883, p. 816.
- Citharichthys paetulus*: Jordan and Gilbert, 1883, p. 964.
- Aramaca papillosa*: Jordan, 1887b, p. 602.
- Aramaca soleaeformis*: Jordan, 1887b, p. 602.
- Syacium papillosum*: Jordan and Goss, 1889, p. 269.
- Syacium micrurum*: Gilbert, 1900, p. 182.
- Syacium guineensis*: Fowler, 1936, p. 502 (in part).

**Material examined.** HUMZ 31143, HUMZ 31147, HUMZ 31149-31151, HUMZ 31153, HUMZ 31158, HUMZ 31161, 4 males, 2 females, 2 sex unknown, 62.5-108.9 mm SL, 6°32.9'N, 53°59.5'W, Surinam, depth 42 m, Dec. 7, 1973; HUMZ 31431, HUMZ 31486, 2 males, 186.6-187.0 mm, 6°57'N, 56°35.5'W, Surinam, 45 m, Dec. 9, 1973; HUMZ 32677, HUMZ 32679, 2 males, 185.0-185.4 mm, 7°50.5'N, 57°54.5'W, Surinam, 51 m, Dec. 10, 1973; HUMZ 101729, HUMZ 101733, HUMZ 101735, HUMZ 101736, 4 males, 99.0-142.5 mm, mouth of the Amazon R., Brazil, Dec. 1981; NSMT-P 40860, female, 146.7 mm, 7°22'N, 54°35'-54°42'W, Surinam, 94 m, Sept. 22, 1979; NSMT-P 40863-40866, NSMT-P 40870-40872, NSMT-P 40875, NSMT-P 40902, NSMT-P, 40904, NSMT-P 40906, 6 males, 5 females, 91.0-205.4 mm, Surinam; NSMT-P 40916-40922, 5 males, 2 females, 118.4-198.4 mm, 5°38'-5°39'N, 51°39'-51°41'W, French Guiana, 76 m, May 10, 1981; NSMT-P 40939, male, 139.0 mm, 6°32'-6°33'N, 52°45'-52°46'W, French Guiana, 71 m, May 1, 1981; NSMT-P 40940, male, 205.4 mm, 6°37'-6°38'N, 56°09'-56°12'W, Surinam, 41 m, Apr. 25, 1981; USNM 30180, male, 243.0 mm, Pensacola, Florida, Jan. 7, 1882, holotype of *Hemirhombus paetulus*; USNM 190429, female, 211.6 mm, 32°51'N, 78°32'W, Atlantic South Carolina, 35-38 m, Oct. 20, 1959; USNM 190430, male, 120.5 mm, 32°32'N, 78°40'W, Atlantic South Carolina, 73-92 m, Oct. 26, 1959; USNM 190431, male, 161.2 mm, 32°51'N, 78°32'W, Oct. 26, 1959; USNM 190432, female, 190.9 mm, 32°32'N, 79°42'W,

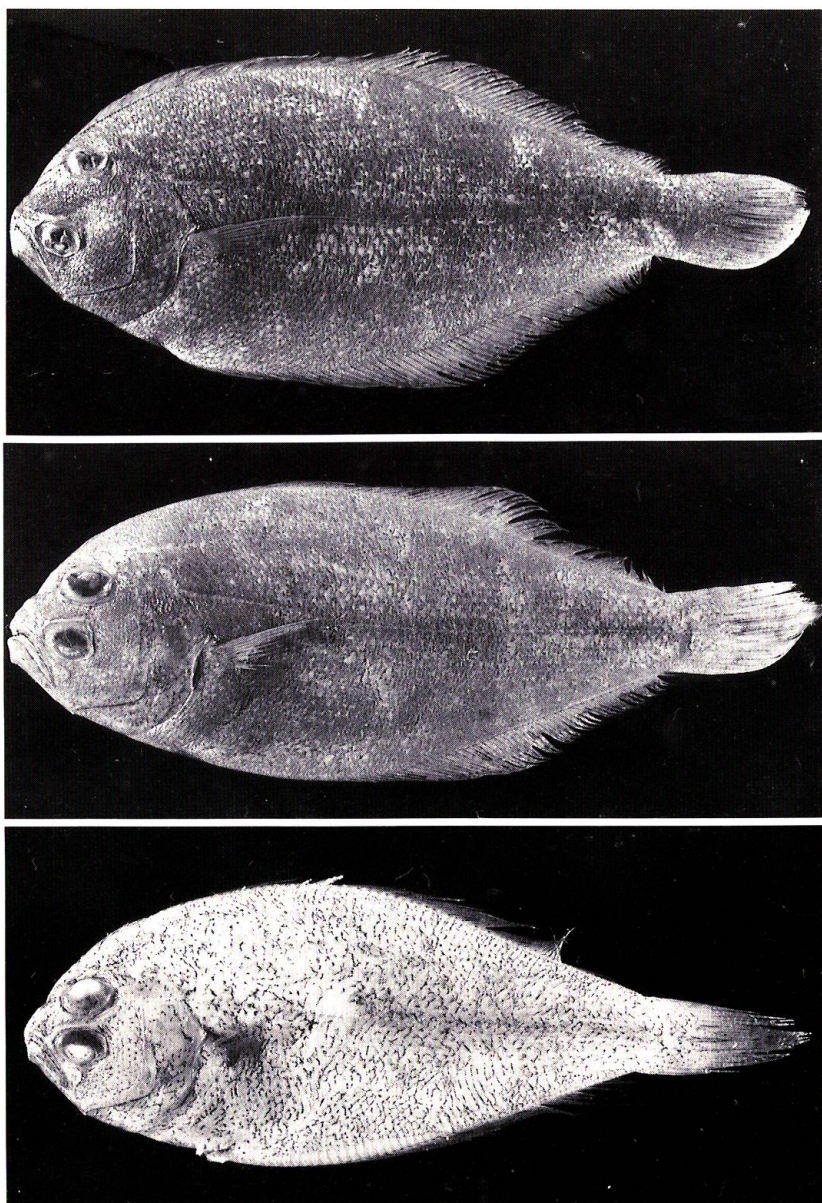


Fig. 14. *Syacium papillosum*. Above: NSMT-P 40919, male, 198.4 mm SL, from French Guiana; middle: NSMT-P 40922, female, 141.7 mm SL, from French Guiana; below: NSMT-P 40942, young, sex unknown, 87.3 mm SL, from Surinam.

Atlantic South Carolina, 13 m, Oct. 24, 1959; USNM 190434, male and female, 161.3-177.7 mm, 31°13'N, 80°10'W, Atlantic Georgea, 40 m, Jan. 14, 1960.

**Diagnosis.** An elongate species of *Syacium* with body depth 39-47% SL; upper orbit without a distinct concavity posteriorly in large males; lateral line scales 44-57; mature males with one or two dark lines from the anterior margin of the upper eye to the snout tip and a series of dark blotches along the upper profile of the head.

**Description.** Dorsal fin rays 81-93; anal fin rays 64-74; pectoral fin rays 10-12 on ocular side, 8-10 on blind side; pelvic fin rays 6 on ocular side, 5-6 on blind side; lateral line scales 44-57; gill rakers 2-4+5-10; vertebrae 10+23-25.

Head length 3.2-3.8 in SL; body depth 2.1-2.5. Snout length 4.3-5.8 in HL; upper eye diameter 3.3-5.5; lower eye diameter 3.5-5.2; interorbital width 4.1-18.8; length of upper jaw 2.4-2.7 on ocular side, 2.1-2.8 on blind side; length of lower jaw 2.0-2.3 on ocular side, 1.9-2.4 on blind side; depth of caudal peduncle 1.9-2.9; length of pectoral fin 0.6-1.6 on ocular side, 2.1-2.8 on blind side; length of pelvic fin 2.6-3.9 on ocular side, 2.3-3.3 on blind side; length of pelvic fin base 7.6-13.6 on ocular side, 8.1-11.8 on blind side; length of longest dorsal fin ray 1.9-3.0; length of longest anal fin ray 2.2-3.0; length of middle caudal fin ray 1.2-1.8.

Body elongate, ovate, highest anterior to midpoint; dorsal and ventral outlines equally arched, except for head. Caudal peduncle moderate in depth.

Head rather large; upper profile with a notch in front of interorbital space or upper eye. Snout blunt and long, as long as eye diameter. Eyes moderate in size, separated by concave space, interorbital space wide, exhibiting considerable sexual dimorphism. Lower eye in advance of upper eye.

Origin of dorsal fin above posterior nostril on blind side. Anal fin origin behind pelvic fin on ocular side. Pectoral fin on ocular side larger than that on blind side, inner four or five rays branched; all rays on blind side simple.

**Color of preserved specimens.** Body on ocular side brownish over all. Fins paler than body; dorsal and anal fins with a regular series of dark blotches; pectoral fin on ocular side with faint, dark bars; caudal fin scattered with indistinct darkish blotches. Blind side of body yellowish-white.

**Distribution.** Atlantic coast of Central and South America, from South Carolina to Rio de Janeiro; Ascencion Island.

**Sexual dimorphism.** This species is sexually dimorphic with regard to the interorbital space, pectoral fin length on the ocular side and snout pigmentation. The interorbital space becomes much broader with growth in males than in females (Fig. 15), and the upper one or two pectoral fin rays on the ocular side are extended and become filamentous with growth in males (Fig. 15). In addition, only mature males have one or two dark lines from the anterior margin of the upper eye to the snout tip and a series of dark blotches along the upper profile of the head (Fig. 14).

**Remarks.** This species is similar to *S. gunteri* and *S. micrurum*, but differs from the former in having a shorter pectoral fin on the blind side and a shallower body (Table 3), and from the latter in having a lower number of lateral line scales (Table 4).

*S. papillosum* is also very similar to *S. latifrons*, distributed in the eastern Pacific, in both meristic counts and proportional measurements, and in the consider-

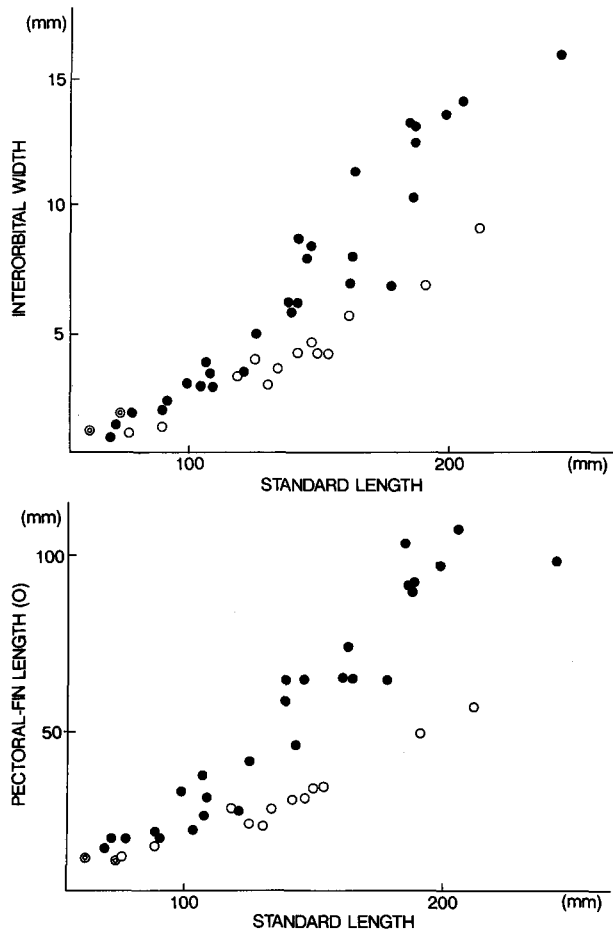


Fig. 15. Relationships between SL and interorbital width (above) and between SL and length of pectoral fin on ocular side (below) in *Syacium papillosum*. Male (closed circles), female (open), sex unknown (double).

able sexual dimorphism seen in the interorbital width, length of pectoral fin on the ocular side and snout pigmentation. Norman (1934) separated the two species only on the form of the anterior, upper jaw teeth (forming distinct canines in *S. papillosum*, but not so in *S. latifrons*). However, distinct differences were not found in this character during this study. In mature males, *S. papillosum* can be distinguished from *S. latifrons* only on account of the upper orbit lacking a distinct, posterior concavity (in *S. latifrons*, such a concavity can be seen in male specimens longer than 150 mm SL, and becomes more obvious with growth). Females and small specimens are difficult to separate.

*Syacium longidorsale* sp. nov.

Figs. 16, 17

**Material examined.** Holotype: USNM 317825, male, 109.1 mm SL, 3°39'S, 80°41'W, Gulfo de Guayaquil, Ecuador, depth 13 m, collected by Dr. Leslie W. Knapp, *Anton Bruun*, otter trawl, Sept. 10, 1966. Paratypes: USNM 317826, 4 males, 73.0-85.0 mm SL, 6 females, 81.8-110.7 mm SL, 1 unknown sex, 49.6 mm SL, same data as holotype; HUMZ 121131-121134, 3 males, 86.6-91.0 mm SL, female, 87.6 mm SL, same data as holotype; USNM 317827, 6 males, 85.8-121.6 mm SL, 8 females, 86.6-100.8 mm SL, HUMZ 121137-121140, 2 males, 116.0-116.1 mm SL, 2 females, 111.0-112.6 mm SL, 3°01'N, 77°50'W, Pacific Colombia, 35-38 m, Dr. Leslie W. Knapp, *Anton Bruun*, otter trawl, Sept. 16, 1966.

**Diagnosis.** A species of *Syacium* with the interorbital width narrow, less than 6% HL, and not subject to sexual dimorphism; length from snout tip to anterior margin of upper eye shorter than eye diameter; anterior dorsal fin rays extended in mature males.

**Description of holotype.** Paratypes are shown in parentheses. Dorsal fin rays 88 (82-92); anal fin rays 71 (65-74); pectoral fin rays 11 (11-12) on ocular side, 9 (8-11) on blind side; pelvic fin rays 6 (6) on ocular side, 6 (6) on blind side; caudal fin rays 3+11+3 (3+10-11+3); lateral line scales 54 (50-57); gill rakers 4+9 (2-5+7-9); vertebrae 10+26 (10+24-26).

Head length 3.7 (3.6-3.9) in SL; body depth 2.1 (2.1-2.4). Snout length 4.7 (4.7-6.4) in HL; upper eye diameter 4.2 (4.0-5.0); lower eye diameter 4.5 (3.9-5.0); interorbital width 18.3 (15.9-36.7); length of upper jaw 2.8 (2.7-3.2) on ocular side, 2.8 (2.7-3.0) on blind side; length of lower jaw 2.3 (2.1-2.4) on ocular side, 2.3 (2.2-2.3) on blind side; depth of caudal peduncle 2.5 (2.2-2.7); length of pectoral fin 0.9 (0.9-1.6) on ocular side, 1.9 (1.9-2.4) on blind side; length of pelvic fin 2.7 (2.5-3.2) on ocular side, 2.6 (2.2-2.7) on blind side; length of pelvic fin base 12.2 (8.6-14.6) on ocular side, 9.8 (7.9-13.8) on blind side; length of longest dorsal fin ray 1.7 (1.7-2.4); length of longest anal fin ray 2.1 (1.8-2.4); length of middle caudal fin ray 1.2 (1.2-1.4).

Body ovoid, highest at midpoint of body; dorsal and ventral outlines equally arched. Caudal peduncle moderate in depth.

Head somewhat small; upper profile evenly curved (evenly curved or with a slight notch). Snout blunt and short, shorter than eye diameter. Nostrils on ocular side two; those in front of upper margin of lower eye, anteriormost with a flap posteriorly; those on blind side below origin of dorsal fin, similar in shape and structure to those on ocular side, but anteriormost very small. Eyes rather large, separated by a very narrow space. Anterior margins of eyes at about same level.

Mouth oblique and rather large, slightly arched anteriorly. Maxilla extending to below middle of lower eye. Teeth on upper jaw biserial, those of outer series becoming gradually stronger anteriorly, those of inner series smaller than outer series, lower jaw uniserial. Gill rakers short and stout, serrated on posterior margin. Scales large, ctenoid on ocular side, cycloid on blind side; snout and tips of both jaws on ocular side naked. Lateral line lacking a distinct curve above pectoral fin.

Origin of dorsal fin above posterior nostril on blind side. Anal fin origin behind pelvic fin on ocular side. Pectoral fin on ocular side larger than that on blind side, about equal to head length; four (four or five) middle rays on ocular side branched, all rays on blind side simple. Pelvic fins equal in size, that on ocular side



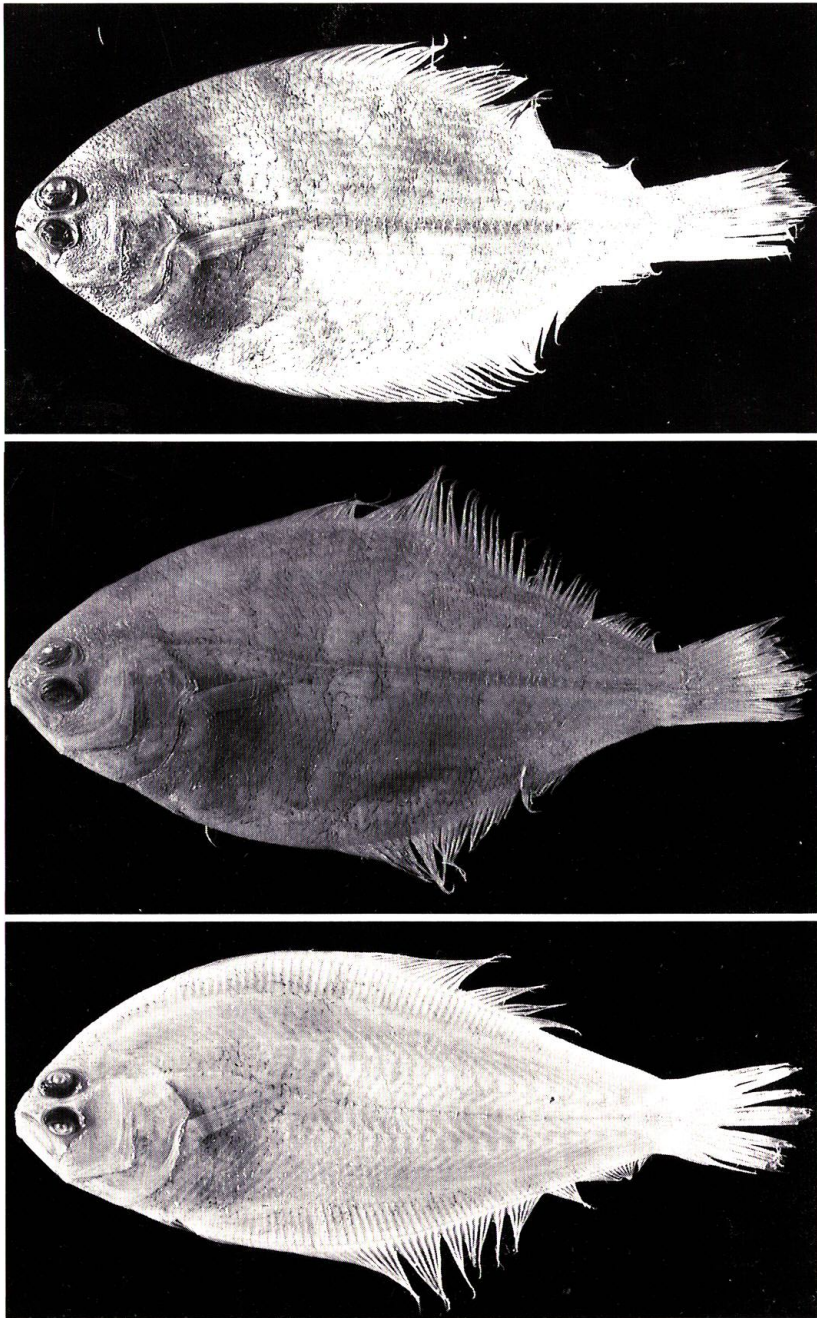


Fig. 16. *Syacium longidorsale* n. sp. Above: holotype, USNM 317825, male, 109.1 mm SL, from Ecuador; middle: paratype, USNM 317826-7, female, 110.2 mm SL, from Ecuador; below: paratype, USNM 317826-2, young, 73.0 mm SL from Ecuador.



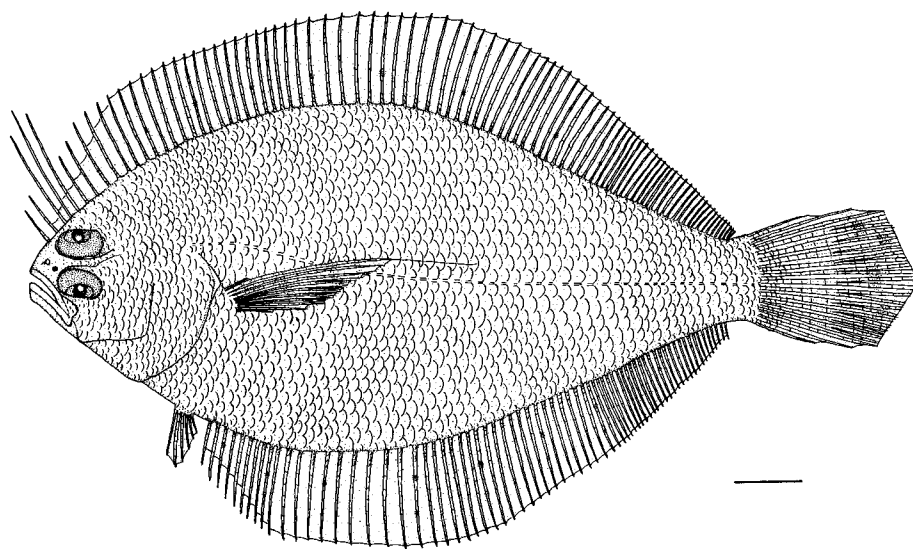


Fig. 17. *Syacium longidorsale* n. sp. holotype (USNM 317825), 109.1 mm, male, from Ecuador.  
Scale indicates 10 mm.

on ventral median line, slightly behind that on blind side; Caudal fin doubly truncate, inner 11 rays branched, other rays simple.

Vent opening on blind side above anal fin origin. Genital papilla just behind vent.

**Color of preserved specimens.** Ocular side of body uniformly brownish. Fins paler than body; dorsal and anal fins with a regular series of slightly darker blotches; pelvic fin on ocular side with slightly darker pigmentation; posterior part of caudal fin mottled. Blind side of body yellowish-white.

Table 5. Comparison of proportional measurements of *S. longidorsale* sp. nov. and *S. ovale*.

	<i>S. longidorsale</i>		<i>S. ovale</i>
	Holotype	Paratypes	
Number of specimens	1	27	34
SL (mm)	109.1	49.6-121.6	82.0-177.0
% SL:			
Head length	27	26-28	26-31
Upper eye diameter	6	5-6	5-6
% of upper eye diameter:			
Length from snout tip to upper eye	86	72-94	97-124
% HL:			
Pectoral-fin length (ocular side)	115	68-114 (male) 67-78 (female)	59-74
Fourth dorsal-fin ray length	56	30-54 (male) 23-33 (female)	19-28

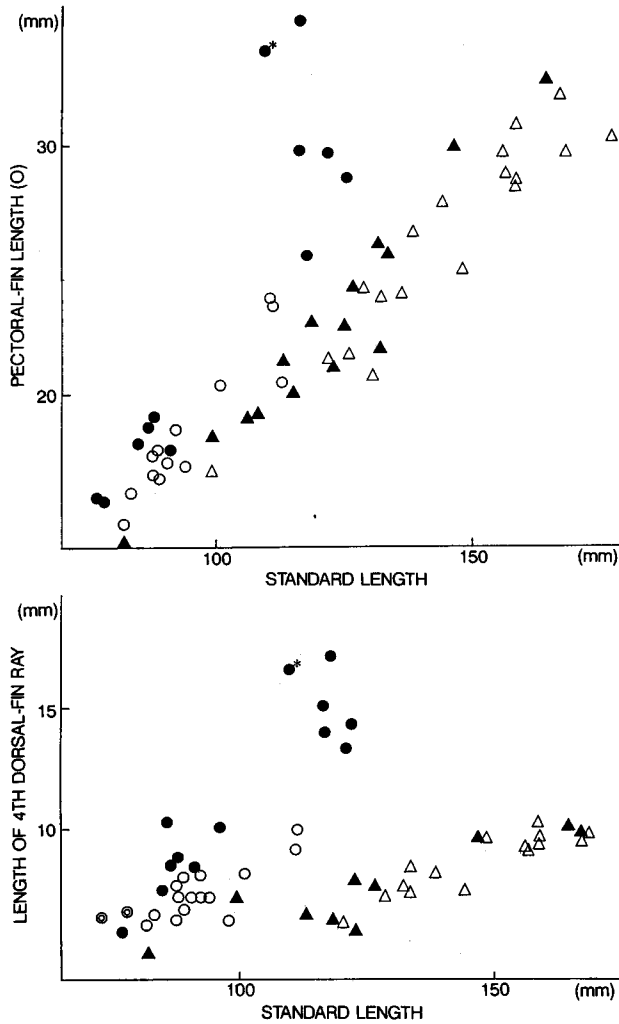


Fig. 18. Relationships between SL and length of pectoral fin on ocular side (above) and SL and length of 4th dorsal fin ray in 2 species of *Syacium*. *S. longidorsale* (circles), *S. ovale* (triangles). Male (closed), female (open), sex unknown (double), holotype of *S. longidorsale* (asterisk).

**Distribution.** Pacific coast of Ecuador and Colombia.

**Sexual dimorphism** In mature males, the anterior third to fifth rays of the dorsal fin and the upper one or two pectoral fin rays on the ocular side are extended (Fig. 18).

**Etymology.** From the Latin *longus* (long) and *dorsalis* (pertaining to the back) in reference to the extended anterior dorsal fin rays in mature males.

**Remarks.** This species exhibits no sexual dimorphism of the interorbital space, the width being very narrow throughout growth in both sexes. It is very

similar to *S. ovale*, not only in lacking such dimorphism, but also in meristic counts and proportional measurements. However, the present species is distinguishable from *S. ovale* by its shorter length from the snout tip to the anterior margin of the upper eye (Table 5) and the occurrence of sexual dimorphism in the length of the anterior dorsal fin rays and upper pectoral fin rays on the ocular side (Fig 18).

*Syacium ovale* (Günther)

Fig. 19

*Hemirhombus ovalis* Günther, 1864, p. 154.

*Citharichthys ovalis*: Jordan, 1886, p. 391.

*Syacium ovale*: Jordan and Goss, 1889, p. 271.

**Material examined.** USNM 317829, female, 158.6 mm SL, 0°51'S, 80°39'W, Ecuador, depth 37 m, Sept. 11, 1966; USNM 317830, 2 males, 112.9-118.4 mm SL, female, 168.4 mm, 3°15'S, 80°25'W, Ecuador, 32 m, Sept. 11, 1966; USNM 317828, 3 males, 133.3-164.3 mm SL, 9 females, 99.1-177.0 mm, 3°01'N, 77°50'W, Pacific Colombia, 35-38 m, Sept. 16, 1966; HUMZ 103241-103243, 2 males, 1 female, 124.9-132.0 mm, 2°57'N, 77°48'W, Pacific Colombia, 9 m, Sept. 20, 1966; HUMZ 105066-105068, 3 males, 82.0-106.6 mm, Mouth of Rio Colorado, Gulf of California, Mexico, Mar. 19, 1956; LACM W53-74, 2 males, 4 females, 107.9-144.0 mm, Puerto Refugio, Angele de la Guarda, Gulf of California, Apr. 24, 1953; LACM 33808-7, 3 males, 3 females, 115.0-140.9 mm, Pacific Costa Rica, Jun. 12, 1973.

**Diagnosis.** A species of *Syacium* with the interorbital width very narrow, less than 6% HL; no obvious sexually dimorphic characters.

**Description.** Dorsal fin rays 83-91; anal fin rays 64-71; pectoral fin rays 10-13 on oculr side, 9-11 on blind side; caudal fin rays 3+10-11+3; lateral line scales 52-58; gill rakers 2-4+7-9; vertebrae 10+25-26.

Head length 3.3-3.8 in HL; body depth 2.1-2.6. Snout length 5.0-6.1 in HL; upper eye diameter 4.3-5.7; lower eye diameter 4.2-5.5; interorbital width 15.7-32.5; length of upper jaw 2.6-3.1 on ocular side, 2.6-2.9 on blind side; length of lower jaw 2.1-2.5 on ocular side, 2.1-2.4 on blind side; depth of caudal peduncle 2.2-3.0; length of pectoral fin 1.4-1.7 on ocular side, 1.7-2.9 on blind side; length of pelvic fin 2.3-3.4 on ocular side, 2.3-2.9 on blind side; length of pelvic fin base 7.3-14.8 on ocular side, 7.7-13.2 on blind side; length of longest dorsal fin ray 2.1-2.9; length of longest anal fin ray 1.9-2.6; length of middle caudal fin ray 1.1-1.6.

Body elliptical, highest at midpoint, dorsal and ventral outlines about equally arched. Caudal peduncle moderate in depth.

Head rather large; upper profile with a shallow concavity in front of upper eye. Snout blunt and somewhat long, shorter than eye diameter. Eyes rather large, interorbital space very narrow. Anterior margins of eyes about same level.

Origin of dorsal fin above posterior nostril on blind side, on a horizontal line through lower margin of upper eye. Anal fin origin behind pelvic fin on ocular side. Pectoral fin on ocular side larger than that on blind side, middle 4 or 5 rays branched, all rays on blind side simple.

**Color of preserved specimens.** Body on ocular side brownish, sometimes completely covered with dark blotches. Fins paler than body; dorsal and anal fins with a regular series of darker blotches; pectoral fin on ocular side faintly marked with darker bars; caudal fin scattered with dark blotches. Blind side of body yellowish-white.

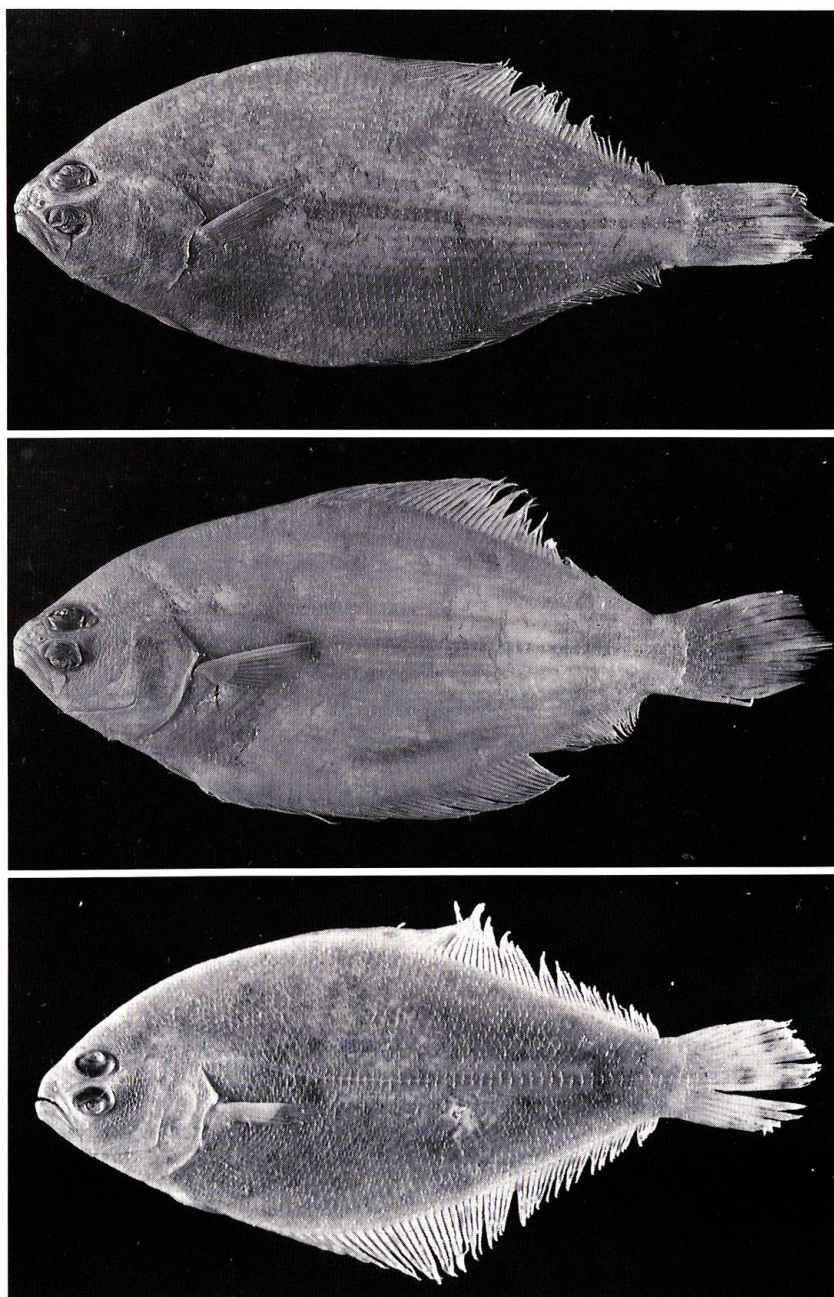


Fig. 19. *Syacium ovale*. Above: USNM 317828-1, male, 164.3 mm SL, from Pacific Colombia; middle: USNM 317829, female, 158.6 mm SL from Ecuador; below: young male, 82.0 mm SL, from Gulf of California.

**Distribution.** Pacific coast of Central and South America, from Gulf of California to southern Peru.

**Sexual dimorphism.** This species shows no sexual dimorphism (Fig. 18).

**Remarks.** This species is most similar to *S. longidorsale* in having a very narrow, non-sexually dimorphic interorbital space, but is distinguished from the latter by its longer snout, shorter rays in the anterior part of the dorsal fin and lack of sexual differences in the anterior dorsal fin rays and pectoral fin on the ocular side (Fig. 18, Table 5).

*S. ovale* is also similar to *S. latifrons* in its meristic counts, but is distinguished from the latter mainly by the absence of sexual dimorphism of the interorbital space and pectoral fin on the ocular side (Fig. 22).

*Syacium maculiferum* (Garman)

Fig. 20

*Citharichthys maculifer* Garman, 1899, p. 224.

*Cyclopssetta (Azevia) maculifera* : Norman, 1934, p. 139, fig. 92.

**Material examined.** MCZ 28546, male, 132.1 mm SL, 5°32'N, 86°54'W, Bay of Panama, depth 121 m, Feb. 28, 1891, syntype.

**Diagnosis.** A species of *Syacium* with a shallow caudal peduncle, 31% HL ; long upper jaw on blind side, 44% HL ; 10 gill rakers of lower limb on first gill arch.

**Description.** Dorsal fin rays 85 ; anal fin rays 68 ; pectoral fin rays 12 on ocular side, 10 on blind side ; lateral line scales 54 ; gill rakers 4 + 10 ; vertebrae 10 + 25.

Head length 3.3 in SL ; body depth 2.3. Snout length 4.8 in HL ; upper eye diameter 3.8 ; lower eye diameter 3.6 ; interorbital width 12.1 ; length of upper jaw 2.5 on ocular side, 2.3 on blind side ; length of lower jaw 2.0 on ocular side, 2.0 on blind side ; depth of caudal peduncle 3.2 ; pectoral fin on ocular side damaged, 2.2 on blind side ; length of pelvic fin 2.9 on ocular side, 2.6 on blind side ; length of



Fig. 20. *Syacium maculiferum*. MCZ 28546, syntype, male, 132.1 mm SL, from Bay of Panama.



Table 6. Comparison of number of gill rakers, depth of caudal peduncle and length of upper jaw on blind side in *S. maculiferum* and *S. latifrons*.

	<i>S. maculiferum</i>	<i>S. latifrons</i>
Number of specimens	(MCZ 28546: syntype)	67
SL (mm)	132.1	67.7-236.8
Number of gill rakers	4 + 10	1-4 + 7-8
% HL:		
Depth of caudal peduncle	31	33-48
Length of upper jaw (b)	44	37-41

pelvic fin base 8.7 on ocular side, 9.1 on blind side; length of longest dorsal fin ray 2.4; length of longest anal fin ray 2.5; length of middle caudal fin ray 1.5.

Body elongate, ovoid, slightly slender, highest anterior to midpoint; dorsal and ventral outlines equally arched. Caudal peduncle shallow.

Head somewhat large; upper profile with a notch in front of upper eye. Snout blunt and long, shorter than eye diameter. Eyes rather large, separated by concave space. Interorbital space somewhat narrow, its width equal to pupil. Lower eye slightly in advance of upper eye.

Origin of dorsal fin above posterior nostril on blind side. Anal fin origin behind pelvic fin on ocular side. Pectoral fin on ocular side larger than that on blind side (upper longest ray damaged); inner six rays branched; all rays on blind side simple.

**Color of preserved specimens.** Body on ocular side brownish, scattered with indistinct, whitish blotches. Fins paler than body, without distinct pigmentation. Blind side of body yellowish-white.

**Distribution.** Bay of Panama.

**Sexual dimorphism.** No female specimens have ever caught in this species.

**Remarks.** Garman's (1899) description of *Citharichthys maculifer* was based on 2 specimens from Bay of Panama. Norman (1934) later removed the species to the genus *Cyclosetta* for the reason that it had palmate gill rakers, the diagnostic character of *Cyclosetta*. Our examination of a syntype of *Citharichthys maculifer* disclosed the gill rakers to be short and stout, with serrations on their posterior margins, rather than palmate, and also that the upper jaw had biserially arranged teeth. Accordingly, the species is transferred to *Syacium* since the aforementioned conditions are diagnostic of this genus as defined by Norman (1934).

*S. maculiferum* is very similar to *S. latifrons* in both meristics and proportional measurements. However, it differs from the latter in the depth of the caudal peduncle, the length of the upper jaw and the number of gill rakers on the upper limb of the first gill arch (Table 6).

### *Syacium latifrons* (Jordan et Gilbert)

Fig. 21

*Citharichthys latifrons* Jordan and Gilbert, 1882a, p. 334.

*Syacium latifrons*: Jordan and Goss, 1889, p. 271.

*Syacium ovale* : Norman, 1934, p. 133, fig. 87 (in part).

*Citharichthys xanthostigmus* : Hiyama in Kumada, 1937, p. 60, pl. 96.

**Material examined.** USNM 317831, 5 males, 136.3-236.8 mm SL, female, 193.4 mm SL, HUMZ 121144-121145, 2 males, 177.1-142.0 mm SL, 2°43'S, 80°33'W, Ecuador, depth 20 m, Sept. 11, 1966; USNM 317832, 2 females, 121.5-121.8 mm SL, HUMZ 121146, male, 133.0 mm SL, 3°20'N, 77°40'W, Pacific Colombia, 52-60 m, Sept. 16, 1966; SIO 63-524-64, 4 males, 2 females, 109.1-148.3 mm, 15°50'N, 90°50.5'W, Golfo de Tehuantepec, Pacific Mexico, Nov. 3, 1966; SIO 65-277-64, 1 male, 5 females, 115.4-167.4 mm, 25°00.6'-24°57'N, 110°43.0'-110°41.6'W, Canal de San Jose, Baja California, Jul. 8, 1965; SIO 84-72, male, 147.3 mm, 23°29.2'N, 109°24.5'W, Gulf of California, Jun. 15, 1984; SIO 84-79, 2 males, 3 females, 118.6-189.1 mm, 23°07.65'N, 110°08.35'W, La Tinaja, Baja California, Jul. 16, 1984; LACM W53-74, 2 males, 174.9-182.1 mm, Puerto Refugio, Angele de la Guarda, Gulf of California, Apr. 24, 1953; LACM W63-142, 3 males, 3 females, 102.1-198.5 mm, off Cape Velas, Pacific Costa Rica, Mar. 1, 1963; LACM 24103, 1 sex unknown, 94.0 mm, 22°52'N, 109°50'W, Caleza Ballena, Pacific Mexico, 55 m, Mar. 11, 1949; LACM 32554-5, 5 males, female, 99.0-160.2 mm, Isla del Cano, Pacific Costa Rica, Mar. 16, 1972; LACM 38094-18, 2 females, 173.1-176.0 mm, Magdalena Bay, Baja California, Feb. 4, 1974; CAS 4747, male, 138.8 mm, Chiapas, Pacific Mexico, Jul. 11, 1932; CAS 30844, male, 129.1 mm, Bay of Panama, Apr. 20, 1973; CAS 36624, 6 males, 5 females, 79.3-168.9 mm, south of Los Frailes, Baja California, 27-37 m, Apr. 27, 28, 1976; CAS SU 46243, 1 male, 3 females, 1 sex unknown, 67.7 mm-127.6 mm, 9°19.32', 84°29.30'W, Pacific Costa Rica, Mar. 1, 1938; CAS SU 47208, female, 124.9 mm, 22°53'N, 109°53'W, San Lucas Bay, Baja California, May 19, 1952; MCZ 28547, 1 male, 1 sex unknown, 68.5-102.7 mm, off Acapulco, Pacific Mexico, mid-April, 1891.

**Diagnosis.** An elongate species of *Syacium* with the lower eye slightly in advance of the upper eye; upper profile of head with a distinct notch in front of upper eye or interorbital space; upper orbit with a distinct concavity posteriorly in large males; considerable sexual dimorphism of the interorbital width, length of pectoral fin on ocular side and snout pigmentation.

**Description.** Dorsal fin rays 81-93; anal fin rays 63-74; pectoral fin rays 11-12 on ocular side, 7-10 on blind side; caudal fin rays 2-3+10-12+3; lateral line scales 50-58; gill rakers 1-4+7-8; vertebrae 10+24-25.

Head length 3.1-3.8 in SL; body depth 2.0-2.4. Snout length 4.3-5.5 in HL; upper eye diameter 3.5-5.4; lower eye diameter 3.5-5.3; interorbital width 2.8-26.5; length of upper jaw 2.4-2.8 on ocular side, 2.4-2.7 on blind side; length of lower jaw 2.0-2.6 on ocular side, 1.9-2.7 on blind side; depth of caudal peduncle 2.2-3.0; length of pectoral fin 0.5-2.1 on ocular side, 2.1-3.3 on blind side; length of pelvic fin 2.2-3.4 on ocular side, 2.1-2.9 on blind side; length of pelvic fin base 7.4-14.1 on ocular side, 6.2-12.5 on blind side; length of longest dorsal fin ray 2.0-2.8; length of longest anal fin ray 1.8-2.7; length of middle caudal fin ray 1.3-1.6.

Body elongate, ovoid, highest anterior to midpoint; dorsal and ventral outlines equally arched, except for head. Caudal peduncle moderate in depth.

Head moderate in size; upper profile with a notch in front of interorbital space or upper eye. Snout blunt and long, as long as eye diameter. Eyes moderate in size, separated by concave space. Interorbital space wide showing considerable sexual dimorphism. Lower eye in advance of upper eye.

Origin of dorsal fin above posterior nostril on blind side. Anal fin origin behind pelvic fin on ocular side. Pectoral fin on ocular side larger than that on blind side, inner 4 or 5 rays branched; all rays on blind side simple. Pelvic fins equal in size, that on ocular side on ventral median line.

**Color of preserved specimens.** Body on ocular side brownish, sometimes with indistinct, darker blotches. Fins paler than body; dorsal and anal fins with



Fig. 21. *Syacium latifrons*. Above: LACM 63-142, male, 198.5 mm SL, from Costa Rica; middle: USNM 317831-4, female, 193.4 mm SL, from Ecuador; below: LACM 32488-1, young female, 83.8 mm SL, from Pacific Costa Rica.



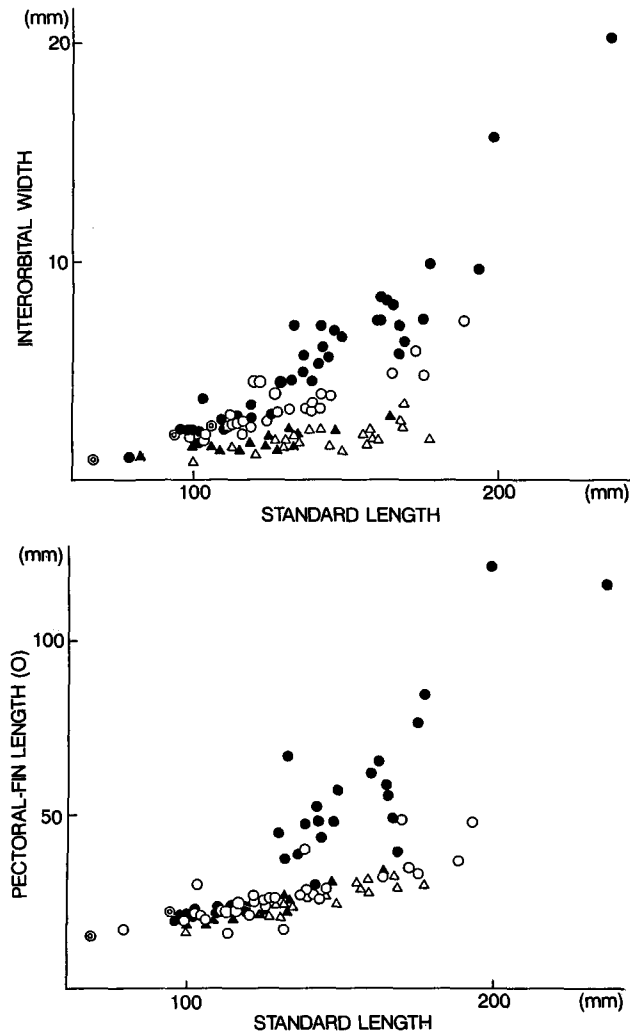


Fig. 22. Relationships between SL and interorbital width (above) and SL and length of pectoral fin on ocular side (below) in 2 species of *Syacium*. *S. latifrons* (circles), *S. ovale* (triangles). Male (closed), female (open), sex unknown (double).

a regular series of dark blotches; pectoral fin on ocular side faintly marked with darker bars; caudal fin with scattered indistinct, darker blotches. Blind side of body yellowish-white.

**Distribution.** Pacific coast of Central and South America, from Baja California to Ecuador.

**Sexual dimorphism.** This species exhibits sexual dimorphism of the interorbital width, length of pectoral fin on the ocular side and snout pigmentation. In males, the interorbital space becomes much broader with growth than in females (Fig. 22), and the upper one or two pectoral fin rays are extended, becoming

filamentous (Fig. 22). In mature males, one or two dark lines run from the anterior margin of the upper eye to the snout tip and a series of dark spots appear along the upper head profile (Fig. 21).

**Remarks.** *S. latifrons* is very similar to *S. ovale* in meristic counts, female and young specimens especially often being confused with each other because of their comparatively narrow interorbital space and normal length of pectoral fin rays on the ocular side.

The species was originally described by Jordan and Gilbert (1882) as *Citharichthys latifrons*, based on specimens having very broad interorbital spaces and extended pectoral fins on the ocular side, whereas *S. ovale*, described by Günther (1864) as *Hemirhombus ovalis*, was based on a specimen which had a very narrow interorbital space and normal length pectoral fin on the ocular side. Jordan and Evermann (1898) later noted in their description of *S. latifrons* that that species should be regarded as the adult male of *S. ovale*. Norman (1934) placed *latifrons* under the synonymy of *S. ovale*, based on a personal communication from Col. Tenison, who, after examining the type specimen of *Citharichthys latifrons*, also regarded it as a male of *S. ovale*. Clearly the differences in interorbital space and pectoral fin on the ocular side between the specimens were believed to represent sexual dimorphism in *S. ovale*.

In the present study, the sex of specimens of *S. latifrons* and *S. ovale* was verified by examination of the gonads. This confirmed that the interorbital widths of adults of both sexes of *S. latifrons* are much broader than in *S. ovale* (Fig. 22). Sexual dimorphism of the pectoral fin on the ocular side in *S. latifrons* was also confirmed, whereas *S. ovale* showed no dimorphism in this character (Fig. 22).

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Literature cited

- Abousouan, A. (1968). Oeufs et larves de téléostéens de l'ouest africain. 7. Larves de *Syacium guineensis* (Bleeker) (Bothidae). *Bull. Inst. Fond. Afr. Noire*, Ser. A, **30**, 1188-1197.
- Amaoka, K. (1969). Studies on the sinistral flounders in the waters around Japan. Taxonomy, anatomy and phylogeny. *J. Shimonoseki Univ. Fish.* **18**, 65-340.
- Bleeker, P. (1862). Sur quelques genres de la famille des Pleuronectoides. *Versl. Akad. Amsterdam* **13**, 422-429.
- Bleeker, P. (1863). Mémoire sur les poissons de la côte de Guinée. *Nat. Verh. Holl. Maatsch. Wetensch.* Haarlem (Ser. 2), **18**, 1-136.
- Cadenat, J. and Marshall, E. (1963). Resultat des campagnes oceanographiques de la Rein-Pokou aux îles Sainte-Helene et Ascencion. Poissons. *Bull. Inst. Fond. Afr. Noir*, Ser. A. **25**, 1235-1366.
- Chabanaud, P. (1949). Teleosteens dissymetrique (Heterosomata). Resultats scientifiques des croisières du navire-école belge "Mercator". *Mem. Inst. Roy. Sci. Nat. Belg.*, Ser. 2, Fasc. **33**, **4**, 3-120.
- Fowler, H. W. (1936). The marine fishes of West Africa. *Bull. Amer. Mus. Nat. Hist.* **70**, i-viii+1-605.
- Fraser, T. H. (1971). Notes on the biology and systematics of the flatfish genus *Syacium* (Bothidae) in the straits of Florida. *Bull. Mar. Sci.* **21**, 491-509.
- Garman, S. (1899). Reports on an exploration of the west coast of Mexico, Central and South America and off the Galapagos Islands, in charge of Alexander Agassiz, by the U. S. Fish Commission steamer "Albatross" during 1891. The fishes. *Mem. Mus. Comp. Zool. Harv. Coll.* **24**, 1-431.
- Gilbert, C. H. (1900). Results of the Branner-Agassiz Expedition to Brazil. III. The fishes. *Proc. Wash. Acad. Sci.* **2**, 161-184.
- Ginsburg, I. (1933). Descriptions of new and imperfectly known species and genera of gobioid and pleuronectid fishes in the United States National Museum. *Proc. U. S. Natn. Mus.* **82**, 1-23.
- Günther, A. (1862). *Catalogue of the Fishes in the British Museum. Vol. 4. Anacanthopterygii, Pharyngognathi and Anacanthini.* xxii+534 p. British Museum, London.
- Günther, A. (1864). Report of a collection of fishes made by Messers. Dow, Godman and Salvin in Guatemala. *Proc. Zool. Soc. London* **1864**, 144-154.
- Gutherz, E. J. (1967). Field guide to the flatfishes of the family Bothidae in the western North Atlantic. *U. S. Fish Wildl. Serv. Circ.* **263**, 1-47.
- Gutherz, E. J. (1981). Bothidae. In Fisher, W., Bianchi, G. and Scott, N. B. (eds.), *FAO species identification sheets for fishery purpose. Eastern Central Atlantic fishing area 14 and part of 47*, **1**, FAO, Rome.
- Hubbs, C. L. and K. F. Lagler (1958). Fishes of the Great Lakes region. *Bull. Cranbrook Inst. Sci.* **26**, i-xii+1-213.
- Jordan, D. S. (1885). A catalogue of fishes known to inhabit the waters of North America, north of the tropic of Cancer, with notes on the species discovered in 1883 and 1884. *Rept. U. S. Fish. Comm.* **13**, 789-973.
- Jordan, D. S. (1886). A list of the fishes known from the Pacific coast of tropical America, from the tropic of Cancer to Panama. *Proc. U. S. Natn. Mus.* **8**, 361-394.
- Jordan, D. S. (1887a). List of fishes collected at Havana, Cuba, in December 1883, with notes and descriptions. *Ibid.* **9**, 31-55.
- Jordan, D. S. (1887b). A preliminary list of the fishes of the West Indies. *Ibid.* **9**, 554-608.
- Jordan, D. S. and B. W. Evermann. (1898). The fishes of North and Middle America. A descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama. Part III. *Bull. U. S. Natn. Mus.* **47**, i-xxiv+2183-3186.
- Jordan, D. S. and C. H. Gilbert. (1882a). Descriptions of nineteen new species of fishes from the bay of Panama. *Bull. U. S. Fish. Comm.* **1**, 306-335.
- Jordan, D. S. and C. H. Gilbert. (1882b). Notes on fishes observed about Pensacola, Florida, and Galveston, Texas, with description of new species. *Proc. U. S. Natn. Mus.* **5**, 241-307.
- Jordan, D. S. and C. H. Gilbert. (1883). A synopsis of the fishes of North America. *Bull. U. S. Natn.*

- Mus.* (16), i-lvi+1-1081.
- Jordan, D. S. and D. K. Goss. (1889). A review of the flounders and soles (Pleuronectidae) of America and Europe. *Rept. U. S. Fish. Comm.* 14, 225-342.
- Kumada, T. (1937). *Marine Fishes of the Pacific Coast of Mexico*. 68 p, Nissan Fish. Inst., Odawara.
- Leviton, A. E., R. H. Gibbs, Jr., E. Heal and C. E. Dawson. (1985). Standards in herpetology and ichthyology: part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985, 802-832.
- Linnaeus, C. (1758). *Systema naturae per regna tria naturae*, ed. 10. Laurentii Salvii Holmiae, 824 p.
- Nielsen, J. G. (1961). Psettodoidea and Pleuronectoidea (Pisces, Heterosomata). *Atlantide Rep.* 6, 101-128.
- Norman, J. R. (1933). Notes on flatfishes (Heterosomata). 5. Four new species from the Atlantic coast of America. *Ann. Mag. Nat. Hist.* 12, 201-204.
- Norman, J. R. (1934). *A Systematic Monograph of the Flatfishes (Heterosomata)*. Vol. I. *Psetto-  
dididae, Bothidae, Pleuronectidae*. viii+459 p. Brit. Mus. Nat. Hist., London.
- Paucă, M. (1930). Fische aus der Walfischbay, Südwestafrika. *Ann. Naturh. Mus. Wien* 44, 33-37.
- Poey, F. (1860). Poissons de Cuba. *Memoiras sobre la Historia Natural de la Isla de Cuba* 2, 115-356.
- Poey, F. (1868). Synopsis piscium cubensium. *Repertorio Fisconatural de la Isla de Cuba* 2, 279-484.
- Poll. M. (1959). Poissons. V. Téléostéens Acanthoptérygiens (deuxieme partie). Expedition oceanographique belge dans les eaux cotieres africaines de l'Atlantique sud (1948-49). *Inst. Roy. Sci. Nat. Belg.* 4, 1-417.
- Ranzani, C. (1940). De novis speciebus piscium. *Novi. Comm. Akad. Sci. Inst. Bonon.* 5, 3-22.
- Sakamoto, K. (1984). Interrelationships of the family Pleuronectidae (Pisces: Pleuronectiformes). *Mem. Fac. Fish., Hokkaido Univ.* 31, 95-215.
- Spix, J. B. (1831). *Selecta genera et species piscium quos in itinere per Brasiliam annos. . Monachii*. Part 2, 83-138 p.
- Walbaum, J. J. (1792). *Perti Artedi Sueci Genera Piscium*. In quibus systema totum ichthyologiae proponitur cum classibus, ordinibus, generum characteribus, specierum differentiis, observationibus plurimis. *Ichthyologiae Pars III.* 723 p. (Reprint 1966 by J. Cramer).