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HYPORHAMPHUS MEEKI, A NEW SPECIES OF HALFBEAK (TELEOSTEI: HEMIRAMPHIDAE) FROM THE ATLANTIC AND GULF COASTS OF THE UNITED STATES

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Abstract.—*Hyporhamphus meeki* is described from the Atlantic and Gulf of Mexico coasts of the United States. It has been confused previously with *H. unifasciatus* (Ranzani) which occurs from southern Florida, Bermuda, the West Indies, and Mexico south to southern Brazil. *Hyporhamphus meeki* has more gill rakers, usually 33–39 on the first gill arch and 26–29 on the second arch compared to 28–32 on the first arch and 19–25 on the second arch in *H. unifasciatus.* Pectoral-fin rays are usually 11 or 12 vs. 10 or 11 in *H. unifasciatus.* The ratio of preorbital length to orbit diameter is usually greater than 0.70 in *H. meeki,* less than 0.70 in *H. unifasciatus.*

There has been considerable confusion regarding the taxonomy and systematics of the New World halfbeaks (Meek & Goss 1884, Miller 1945). Although the status of some species has been clarified, that of *Hyporhamphus unifasciatus* (Ranzani, 1842), the common inshore halfbeak, has been questioned for more than 100 years (Meek & Goss 1884, Collette 1978) but not resolved. The name *Hyporhamphus unifasciatus* (Ranzani) has been used for inshore halfbeaks in the western Atlantic, eastern Atlantic, in several parts of the Indo-West Pacific, and the eastern Pacific. The eastern Atlantic *Hyporhamphus* were shown to be *H. picarti* (Valenciennes, 1846) by Collette (1965); the Indo-West Pacific halfbeaks *H. limbatus* (Valenciennes, 1846) by Parin et al. (1980). This paper presents morphometric and meristic analysis of western Atlantic populations of halfbeaks referred to *H. unifasciatus,* with the description of a new species. Our objective is to describe this new species of *Hyporhamphus,* and compare it with the true *H. unifasciatus.* The new species will be included in further study of New World halfbeaks and other publications, particularly the halfbeak section for "Fishes of the western North Atlantic."

Populations referred to *H. unifasciatus* range in the western Atlantic from Uruguay in the south, northward along the coast of the Americas, through the Caribbean (Jordan & Evermann 1896), Gulf of Mexico (Hoese & Moore 1977), and around Bermuda (Beebe & Tee-Van 1933) to Cape Cod, Massachusetts. Strays have been collected as far north as Chamcook, Passamaquoddy Bay, New Brunswick (Leim & Day 1959). In the eastern Pacific they range from Peru (Hildebrand 1946) to Baja California and around the Galapagos Islands (Meek & Hildebrand 1923). The range of *H. unifasciatus* s. s. (type locality, Brazil) is from Bermuda and peninsular Florida southward through the Caribbean to Uruguay. Those populations referred to as *H. unifasciatus* from outside this range constitute superficially similar undescribed species of *Hyporhamphus* (Collette 1978). This paper deals only with the western Atlantic populations of the *H. unifasciatus* species group. The eastern Pacific populations will be addressed in future publications.

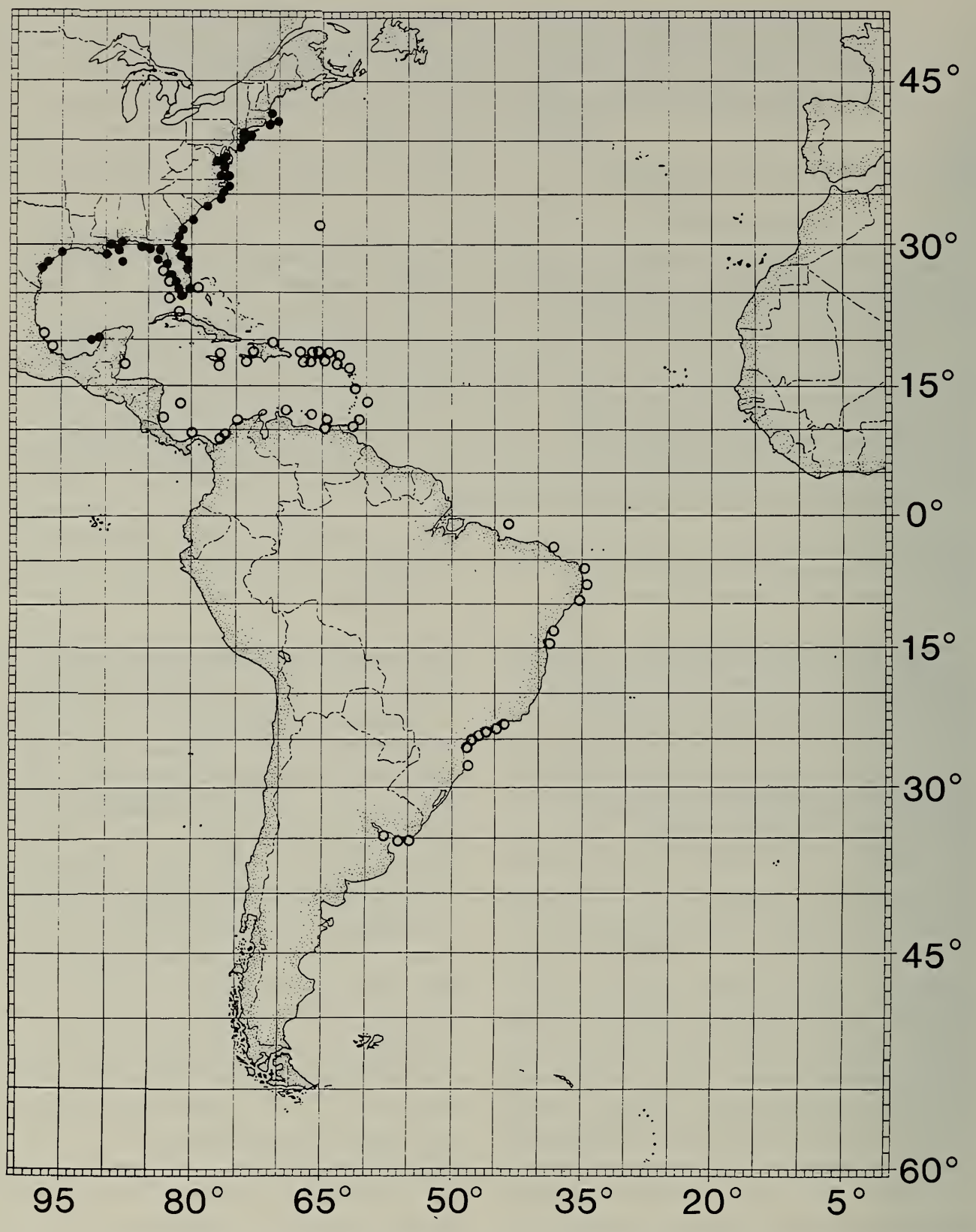

Fig. 1. Distribution of *Hyporhamphus meeki,* n. sp. (closed circles) and *H. unifasciatus* (open circles) based on material examined.

Materials and methods.—A total of 568 specimens of western Atlantic *Hyporhamphus* was examined for 24 morphometric and meristic characters; an additional 1088 specimens were examined only for meristic characters. The number of specimens examined for each character varies due to the condition of material. Due to the poor con-

dition of some specimens only some characters could be observed reliably. Material was chosen to represent the entire geographical range of what has been considered *H. unifasciatus* in the western Atlantic (Fig. 1). The majority of material examined was obtained from the following institutions (abbreviations from Leviton et al. 1985): AMNH, ANSP, CBL (Chesapeake Biological Laboratory, specimens now at VIMS), CAS, MCZ, MZUSP, SIO, UF, VIMS, UMMZ, and USNM. Additional material was collected by the first author in the York River at Gloucester Pt., Virginia, and is housed at VIMS. Following the description of the new species only the material that was examined for both morphometrics and meristics is listed.

Most characters examined follow Collette (1965) and Parin et al. (1980). Measurements were made to the nearest tenth of a millimeter (mm). Abbreviations and descriptions of characters examined are as follows: SL (standard length); LJL (lower jaw length, tip of upper jaw to tip of lower jaw); HDL (head length, from tip of upper jaw to posterior margin of opercle membrane); UJL (upper jaw length, from tip of upper jaw to where upper jaw bends); UJW (upper jaw width, where upper jaw bends); P_1-P_2 (distance from base of upper pectoral ray to base of anterior pelvic ray); P_2-C (distance from base of anterior pelvic ray to caudal base); P_2-CX (P_2-C distance extended anteriorly from base of anterior pelvic ray to a point on the body or head); BD-P_1 (body depth at origin of pectoral fin); BD-P_2 (body depth at origin of pelvic fin); ABASE (length of anal-fin base); DBASE (length of dorsal-fin base); P_1L (pectoral-fin length, distance from base of uppermost pectoral ray to tip of longest ray); ORB (soft orbit length); PREORB (preorbital length, from corner of mouth to anterior margin of orbit); ANA (number of anal-fin rays); DOR (number of dorsal-fin rays); P_1 (L, R, number of pectoral-fin rays); PRED (number of predorsal scales in median row in front of dorsal fin); RGR_1 (number of gill rakers on first arch (upper + lower = total); RGR_2 (number of gill rakers on second arch (upper + lower = total). VERT (number of precaudal plus caudal vertebrae, including the hypural plate = total number of vertebrae).

Statistical analyses utilized SAS software (SAS Institute, Inc. 1985). Frequency distributions of counts were compared between geographic populations and are presented in summary tables. If two populations in close geographic proximity did not have significantly different counts, counts were combined to form a single population in subsequent statistical analysis. Infraspecific geographic variation is discussed herein. Analysis of Variance (ANOVA) was performed on five data sets of meristic characters. If the F value for an ANOVA was significant ($P < .05$), Tukey's Studentized Range Test (Tukey-Kramer method) (SAS Institute, Inc. 1985) was performed to determine which means were significantly different from the others.

Values of morphometric characters were first plotted against SL, and then plotted against one another to inspect visually for separation between populations. Only those plots that proved to be diagnostic for the species are presented. Regression equations were generated for the plots of morphometric characters. Residual plots were inspected for homogeneity of variance. Due to heteroscedasticity of variance, all morphometric data were log transformed for regression analysis.

Hyporhamphus meeki, new species
Fig. 2A

Synonymy.—At least 10 different combinations of names have been used for this species. A complete synonymy will be included in the halfbeak section of "Fishes of the western North Atlantic." The commonest names used have been *Hyporhamphus* (or *Hemiramphus*) *roberti* (about 30 refer-

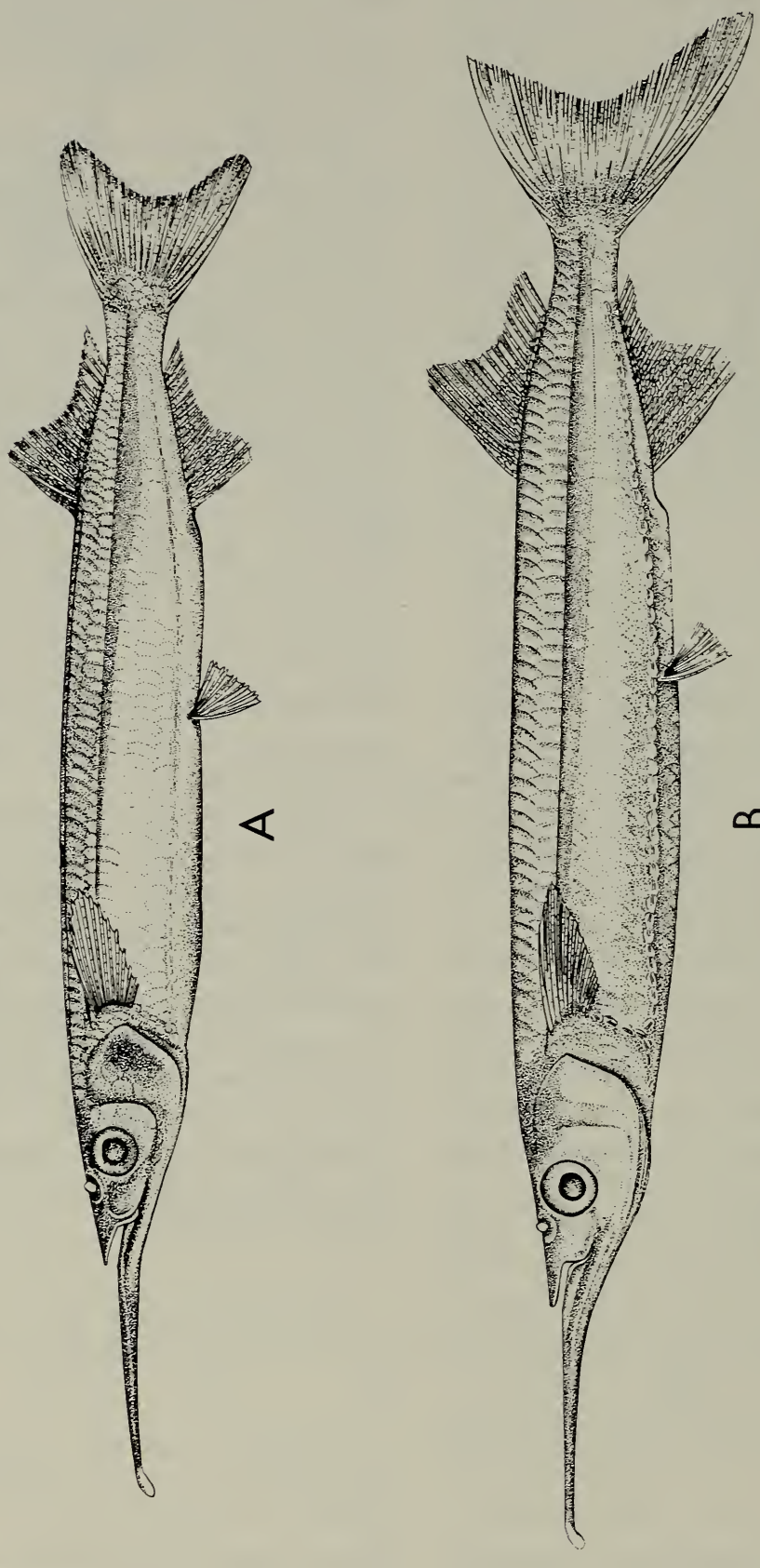

Fig. 2. A: *Hyporhamphus meeki*, new species, holotype, USNM 294369 (160 mm SL). B: *H. unifasciatus*, Colon, Panama, USNM 79666 (164 mm SL).

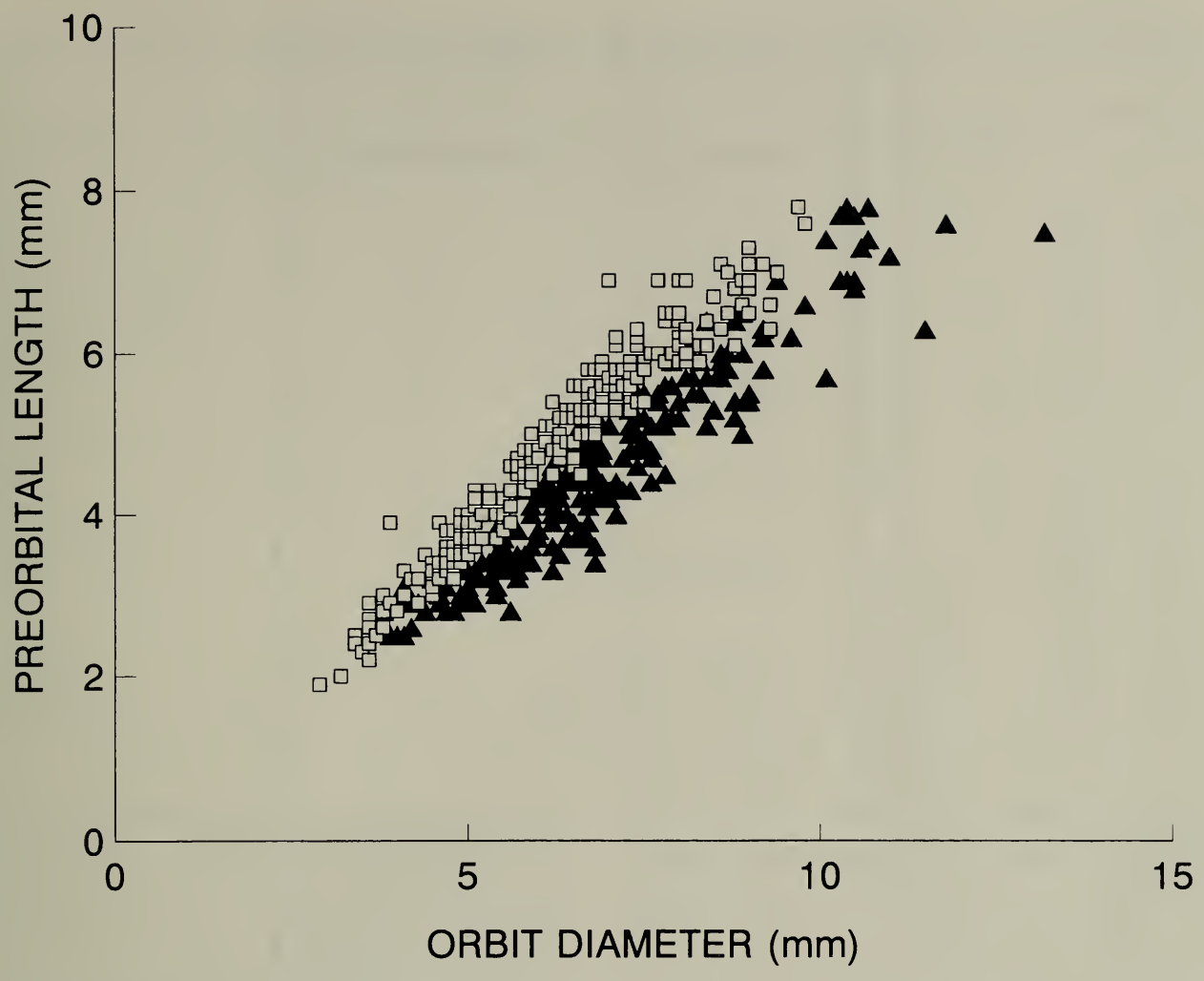

Fig. 3. Relationship of preorbital length to orbit length in *Hyporhamphus meeki* (squares) and *H. unifasciatus* (triangles).

ences, mostly 1862 to 1892) or *unifasciatus* (about 95 references, 1870 up to the present). Bruce (1986) prematurely used the name *H. meeki* as a nomen nudum in his treatment of isopod parasites of the genus *Mothocya*.

Diagnosis.—A member of the subgenus *Hyporhamphus* distinguished from *H. roberti* (Valenciennes) by having the dorsal and anal fins covered with scales. This species is distinguished by the following combination of characters: gillrakers on the first arch 31–40 (Table 1); gill rakers on the second arch 20–30 (Table 2); pectoral-fin rays 10–13 (Table 5); ratio of preorbital length to orbit diameter is usually greater than 0.70 (>0.70 in 92% of 265 specimens examined; Fig. 3).

Description.—Gill rakers on upper limb of first arch 8 to 12, usually 9 to 11, mean 9.8; lower limb 20 to 29, usually 24 to 27, mean 25.1; total of upper and lower limbs 31 to 40, usually 33 to 37, mean 34.6 (Table 1). Gill rakers on upper limb of second arch 2 to 6, usually 4 or 5, mean 4.3; lower limb 20 to 26, usually 22 or 23, mean 22.3; total 20 to 30, usually 25 to 28, mean 26.2 (Table 2). Dorsal-fin rays 12 to 17, usually 14 or 15, mean 14.5 (Table 3); anal-fin rays 14 to 18, usually 15 to 17, mean 15.9 (Table 4); and pectoral-fin rays 10 to 13, usually 11 or 12, mean 11.4 (Table 5). Predorsal scales (n = 87) 34 to 39, usually 35 to 37, mean 36.1. Vertebrae (n = 88) 31–35 precaudal + 16–19 caudal = 49–53 total.

Morphometric data for *H. meeki* is summarized in Table 6, for *H. unifasciatus* in Table 7. Lower jaw length 0.79 to 1.54 of

Table 1.—Numbers of total gill rakers on first arch in populations of *Hyporhamphus meeki* and *H. unifasciatus*.

Population	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	*n*	$\bar{X}$
H. meeki																	
MA to GA						2	7	43	64	77	43	13	1	1		251	34.5
E. coast FLA							3	10	15	39	19	9	4	2		101	35.1
W. penin. FLA						5	31	61	54	28	12	3				194	33.6
FLA pan. to TX						2	14	28	23	51	32	32	21	3	1	207	35.2
Yucatan									8	6	9	3	1			27	35.3
Species total						9	55	142	164	198	115	60	27	6	1	780	34.6
H. unifasciatus																	
Bermuda	1	3	13	39	43	11	3									113	29.5
Florida		1	4	15	30	11	4	–	1							66	30.0
West Indies		1	7	16	41	35	44	14	7	5						170	31.1
Yucatan				3	6	3										12	30.0
Cent. America			2	9	17	14	6	4	1							53	30.5
Carib. S. Am.			1	17	26	34	20	12	6	3						119	31.1
South America		3	3	15	26	40	28	8	1							124	30.8
Species total	1	8	30	114	189	148	105	38	16	8						657	30.6

Table 2.—Numbers of total gill rakes on second arch in populations of *Hyporhamphus meeki* and *H. unifasciatus*.

Population	19	20	21	22	23	24	25	26	27	28	29	30	*n*	$\bar{X}$
H. meeki														
MA to GA		2	–	–	–	2	11	53	80	33	8		189	26.8
E. coast FL		2	4	8	2	2	11	29	40	10	6		114	25.9
W. penin. FL						12	50	60	40	14	1		177	26.0
FLA pan. to TX				1	4	11	26	44	53	10	5	2	156	26.2
Yucatan					1	3	6	10	5	2			27	25.5
Species total		4	4	9	6	30	104	196	218	69	20	2	662	26.2
H. unifasciatus														
Florida		2	7	10	18	17	5						59	22.9
West Indies	2	–	3	11	25	46	37	11	5	1			141	24.1
Cent. America			2	5	10	11	6	–	1				35	23.5
Carib. S. Am.				6	27	33	23	24	1				114	24.3
South America			5	16	31	33	21	2	1				109	23.5
Yucatan			1	1	5	4	1						12	23.3
Bermuda		5	34	37	17	5	2						100	21.9
Species total	2	7	52	86	133	149	95	37	8	1			570	23.5

head length with 83% of 240 specimens greater than or equal to 1.0. Ratio of LJL to SL 0.20 to 0.35 with 95% of 240 specimens 0.22 to 0.30. PREORB to ORB ratio 0.61 to 1.0, usually 0.70 to 0.90 (92% of 265 specimens). Distance from base of anteriormost pelvic ray to caudal base extends anteriorly to mid-eye, usually between posterior portion of eye and posterior margin of opercular membrane. Dorsal- and anal-fin bases about equal, ratio of ABASE to DBASE 0.83 to 1.07, mean of 0.96 for 265 specimens. Origin of dorsal fin over that of anal fin. Bases of dorsal and anal fins covered with scales. Distance from anteriormost pectoral ray to origin of pelvic fin less

Table 3.—Numbers of dorsal-fin rays in populations of *Hyporhamphus meeki* and *H. unifasciatus*.

Population	12	13	14	15	16	17	*n*	$\bar{X}$
H. meeki								
MA to GA		2	100	56	1	1	160	14.4
E. coast FL		8	40	34	3		85	14.4
W. penin. FL			52	95	10		157	14.7
FL pan. to TX	1	5	90	65	4		165	14.4
Yucatan			15	12			27	14.5
Species total	1	15	297	262	18	1	594	14.5
H. unifasciatus								
Florida			14	28	6		48	14.8
West Indies		1	42	77	7		127	14.7
Cent. America			6	35	3		44	14.9
Carib. S. Am.			16	92	10		118	14.9
South America		1	32	76	11		120	14.8
Yucatan			1	9	2		12	15.1
Bermuda		5	48	27	2		82	14.3
Species total		7	159	344	41		551	14.8

Table 4.—Numbers of anal-fin rays in populations of *Hyporhamphus meeki* and *H. unifasciatus*.

Population	14	15	16	17	18	*n*	$\bar{X}$
H. meeki							
MA to GA	1	18	107	36	1	163	16.1
E. coast FL	1	31	43	10		85	15.7
W. penin. FL		13	98	45	1	157	16.2
FL pan. to TX	10	59	80	16		165	15.6
Yucatan		3	21	3		27	16.0
Species total	12	124	349	110	2	597	15.9
H. unifasciatus							
Florida			25	22	1	48	16.5
West Indies		15	83	29	1	128	16.1
Cent. America		4	27	13		44	16.2
Carib. S. Am.		8	63	47		118	16.3
South America	1	9	63	45	1	119	16.3
Yucatan			10	2		12	16.2
Bermuda		2	21	46	12	81	16.8
Species total	1	38	292	204	15	550	16.4

than the distance from the pelvic fin origin to the caudal base. Median pore of preorbital canal usually posterior, rarely medial.

Color.—Coloration in life is a silvery light tan-green. The fleshy tip of the lower jaw is a bright orange red.

Size.—Adults attain a maximum size of 179 mm SL (USNM 90798, Cape Charles, Virginia).

Habitat.—All specimens observed were collected near the surface of inshore or estuarine waters. Specimens collected by the first author in Chesapeake Bay and the Gulf of Mexico (Florida) were in areas with a sandy substrate and in proximity of submerged aquatic vegetation (eel grass, *Zostera*). As is often the case in estuarine conditions, the water inhabited by *H. meeki* is generally turbid.

Early life history.—Larvae of *H. meeki*

Table 5.—Numbers of pectoral-fin rays in populations of *Hyporhamphus meeki* and *H. unifasciatus*.

Population	9	10	11	12	13	*n*	$\bar{X}$
H. meeki							
MA to GA		2	75	59	3	158	11.4
E. coast FL		19	70	17		106	11.0
W. penin. FL			49	98		147	11.7
FL pan. to TX		1	77	41	1	120	11.4
Yucatan			18	9		27	11.3
Species total		22	289	224	4	558	11.4
H. unifasciatus							
Florida		19	45	5		69	10.8
West Indies		39	94	3		136	10.7
Cent. America	2	2	35	2		41	10.9
Carib. S. Am.		9	108	3		120	11.0
South America		14	104	4		122	10.9
Yucatan			11	1		12	11.1
Bermuda	3	104				107	10.0
Species total	5	187	397	18		607	10.7

Table 6.—Summary of morphometric data in percent standard length in populations of *Hyporhamphus meeki*, except for SL in mm.

Character % SL	Atlantic						Gulf					
	n	Min	Max	Mean	*SD*	*SE*	*n*	Min	Max	Mean	*SD*	*SE*
SL	169	48.1	179	96.7	27.16	2.09	124	63.6	176	128.9	23.81	2.14
P_1-P_2	169	31.8	37.8	34.5	1.01	0.08	124	31.7	38.1	34.6	1.09	0.10
P_2-C	169	39.2	46.2	43.0	1.04	0.08	124	41.3	45.7	43.6	0.91	0.08
LJL	161	20.6	35.1	27.0	2.32	0.18	107	20.5	29.8	23.9	1.88	0.18
HDL	169	19.1	34.4	24.4	1.27	0.10	124	21.9	26.0	23.7	0.76	0.07
UJL	169	2.2	4.8	4.2	0.32	0.02	124	3.7	4.8	4.3	0.23	0.02
UJW	169	4.3	6.2	5.2	0.32	0.02	124	4.7	5.8	5.2	0.21	0.02
BD-P_1	169	8.6	13.1	11.7	0.79	0.06	124	10.1	13.3	11.9	0.62	0.06
BD-P_2	169	7.2	15.9	11.4	1.62	0.12	124	9.0	15.3	12.9	1.20	0.11
ABASE	169	12.3	17.3	14.4	0.79	0.06	124	12.5	16.0	13.9	0.72	0.06
DBASE	169	13.3	16.9	14.8	0.67	0.05	124	13.2	16.4	14.6	0.67	0.06
P_1L	161	12.3	16.4	14.6	0.72	0.06	109	13.1	16.3	14.5	0.64	0.06
ORB	169	4.8	7.1	5.9	0.41	0.03	124	5.0	6.9	5.7	0.39	0.03
PREORB	169	3.4	6.1	4.5	0.28	0.02	124	3.4	5.2	4.2	0.30	0.03

have been described (as *Hyporhamphus* sp.) from Chesapeake Bay, which may indicate utilization of estuarine waters as nursery areas (Hardy & Johnson 1974). Larvae were collected along the Gulf coast of Florida most frequently during spring and summer in less than 30 m of water (Houde et al. 1979). The particulars of spawning are unknown. Eggs have been attached to floating *Zostera* blades (by their adhesive filaments) over vegetated habitats during summer months in Chesapeake Bay (Olney and Boehlert 1988).

Distribution.—Atlantic coast of the United States from Miami, Florida to Cape Cod, Massachusetts and rarely north to Chamcook, Passamaquoddy Bay, New Brunswick (Leim & Day 1959), and in the Gulf of Mexico from the Everglades to Galveston, Texas (Fig. 1). Also occurs in Yucatan. The observed water temperature range is 13.7 to 34.9°C, so *H. meeki* has a subtropical to temperate distribution. Sympatric with *H. unifasciatus* on the east coast of Florida from St. Lucie Inlet south to Miami and on the west coast from the Everglades to Tampa Bay.

Etymology.—Named after Seth E. Meek who first separated the two species we recognize here (Meek and Goss 1884:223) . . . "all the specimens . . . thus far taken on the Atlantic coast of the United States north of the Florida Keys . . . belong to a species differing from the West Indian *unifasciatus*, in the slenderness of body and in the greater length of the lower jaw," but misapplied the name *H. roberti* to the northern species.

Comparisons.—Meristic characters allow for statistical separation of *H. meeki* from *H. unifasciatus* (alpha = 0.05; Tables 8–12), though infraspecific variation exists within populations of both species. *Hyporhamphus meeki* is discernable from the southern species *H. unifasciatus* in usually having more gill rakers on both the first and second arches (Tables 1 and 2). Ninety two percent of the 780 *H. meeki* specimens examined have total RGR_1 counts from 33 to 40, whereas in *H. unifasciatus* 91% of 657 specimens examined have total RGR_1 counts from 28 to 32. Second arch gill rakers in 76% of 662 specimens of *H. meeki* range from 26 to 29, whereas 92% of 570 specimens of *H. unifasciatus* range from 19 to 25. Pectoral fin usually with 11 or 12 rays, 10 or 11 in *H. unifasciatus*.

Regressions of morphometrics also allow us to distinguish the two species. This is best

Table 7.—Summary of morphometric data in percent standard length in populations of *Hyporhamphus unifasciatus*, except for SL in mm.

Character % SL	West Indies and Florida						Central and South America						Bermuda					
	n	Min	Max	Mean	*SD*	*SE*	*n*	Min	Max	Mean	*SD*	*SE*	*n*	Min	Max	Mean	*SD*	*SE*
SL	76	73.5	195	119.4	32.55	3.73	86	62.4	205	129.4	33.62	3.63	69	79.7	168	109.3	19.57	2.36
P_1-P_2	76	30.8	38.2	35.4	1.50	0.17	86	32.6	40.6	35.4	1.20	0.13	69	34.7	39.0	36.7	0.86	0.10
P_2-C	76	40.1	47.2	43.7	1.33	0.15	86	38.9	45.8	43.2	1.11	0.12	69	39.5	44.7	41.7	0.91	0.11
LJL	59	15.0	31.0	23.0	3.03	0.39	81	19.8	29.5	23.8	1.86	0.21	50	19.7	30.9	25.3	2.72	0.39
HDL	76	19.6	26.0	22.6	1.06	0.12	86	21.0	25.6	23.1	0.96	0.10	69	19.5	24.7	22.8	0.86	0.10
UJL	76	2.9	4.6	3.8	0.31	0.04	86	3.4	4.9	4.1	0.27	0.03	69	3.1	4.5	3.8	0.27	0.03
UJW	76	4.2	5.8	5.3	0.40	0.05	86	4.4	6.8	5.5	0.53	0.06	69	4.0	5.8	5.1	0.37	0.04
BD-P_1	76	7.9	13.8	11.6	1.22	0.14	86	9.4	15.6	12.2	1.31	0.14	69	8.4	11.6	10.3	0.71	0.09
BD-P_2	76	6.5	15.3	12.0	2.05	0.24	86	7.6	17.2	12.5	2.41	0.26	69	5.7	12.7	9.9	1.38	0.17
ABASE	76	12.0	17.1	14.3	1.01	0.12	85	12.1	16.8	13.9	0.99	0.11	69	11.9	16.4	14.8	0.78	0.09
DBASE	76	13.4	16.3	14.7	0.65	0.07	86	13.1	17.6	14.7	0.77	0.08	69	12.7	16.8	14.5	0.78	0.09
P_1L	58	11.9	16.5	14.4	0.94	0.12	82	11.9	16.1	14.7	0.91	0.10	64	12.4	15.6	14.4	0.52	0.07
ORB	76	5.1	6.7	5.8	0.39	0.04	86	4.9	7.0	5.8	0.37	0.04	69	5.0	6.7	5.8	0.39	0.05
PREORB	76	3.1	4.2	3.8	0.22	0.03	85	2.9	4.5	3.9	0.24	0.03	69	3.2	4.3	3.7	0.19	0.02

illustrated in the preorbital on orbit relationship (Fig. 3). The slopes of the regressions are significantly different ($P > F > .001$). Ratio of preorbital length to orbit diameter is usually greater than 0.70 in *H. meeki* (92% of 265 specimens examined), but less than 0.70 in *H. unifasciatus* (75% of 224 specimens). Lower jaw length on standard length tends to be greater in *H. meeki* (Fig. 4), however, there is considerable infraspecific variation within populations of the two species especially in *H. unifasciatus.*

Geographic variation in morphology is not reported in detail herein. Analysis to date indicates that morphology of Atlantic and Gulf populations of *H. meeki* differs slightly. Southern Florida and Yucatan appear to be areas of sympatry between *H. meeki* and *H. unifaciatus.* Collection data indicate that sympatry of the two species in Florida may be largely avoided temporally, because both species migrate northward up the Florida coasts when the waters warm during summer and autumn; consequently *H. unifasciatus* moves into areas occupied by *H. meeki* in the winter. The dynamics of their sympatry in Yucatan is probably different than in peninsular Florida. Individual collections from Yucatan (UMMZ 143085 and MCZ 32881) contain both species. Yucatan *H. meeki* have a preorbital/orbit ratio typical of *H. unifasciatus.* Yucatan may be an area of hybridization or introgression, and needs further study.

Comparisons of meristic means by the Tukey-Kramer method indicate some geographic variability in populations of both *H. meeki* and *H. unifasciatus.* There appears to be little consistency in trends in *H. meeki* populations across the different meristic characters. The only trend with any consistency is the position of the west coast of the peninsula of Florida population. It is usually at the extreme of the range of means, being closest to mean values of *H. unifasciatus* populations. The one trend that stands out in populations of *H. unifasciatus* is that

Table 8.—Comparison of means for dorsal-fin ray counts for populations of *Hyporhamphus meeki* and *H. unifasciatus*, and between *H. meeki* and *H. unifasciatus*. Populations joined by the same line are not significantly different by the Tukey-Kramer method, alpha = 0.05.

Population	*n*	$\bar{X}$	TK
H. meeki			
West peninsula of FL	157	14.7	|
Yucatan	26	14.5	| |
FL panhandle to TX	165	14.4	|
Atlantic coast of FL	85	14.4	|
MA to GA	160	14.4	|
H. unifasciatus			
Yucatan	12	15.1	|
Caribbean South America	118	14.9	| |
Central America	44	14.9	| |
Florida	48	14.8	| |
South America (Brazil)	120	14.8	| |
West Indies	127	14.7	|
Bermuda	82	14.3	|
H. meeki	594	14.5	|
H. unifasciatus	551	14.8	|

Bermuda is always at an extreme of the range of means, usually at the lower extreme.

Material examined.—338 specimens of *H. meeki* (48.1–179 mm SL) from 50 collections, and 230 specimens of *H. unifasciatus* (62.4–205) from 54 collections, with almost complete morphometric and meristic data are listed. Additional specimens used mainly for meristic data are in the second author's files.

Table 9.—Comparison of means for anal-fin ray counts for populations of *Hyporhamphus meeki* and *H. unifasciatus*, and between *H. meeki* and *H. unifasciatus*. Populations joined by the same line are not significantly different by the Tukey-Kramer method, alpha = 0.05.

Population	*n*	$\bar{X}$	TK
H. meeki			
West peninsula of FL	157	16.2	|
MA to GA	163	16.1	|
Yucatan	26	16.0	| |
Atlantic coast of FL	85	15.7	| |
FL panhandle to TX	165	15.6	|
H. unifasciatus			
Bermuda	81	16.8	|
Florida	48	16.5	| |
Caribbean South America	118	16.3	|
South America (Brazil)	119	16.3	|
Central America	44	16.2	|
Yucatan	12	16.2	|
West Indies	128	16.1	|
H. meeki	597	15.9	|
H. unifasciatus	550	16.4	|

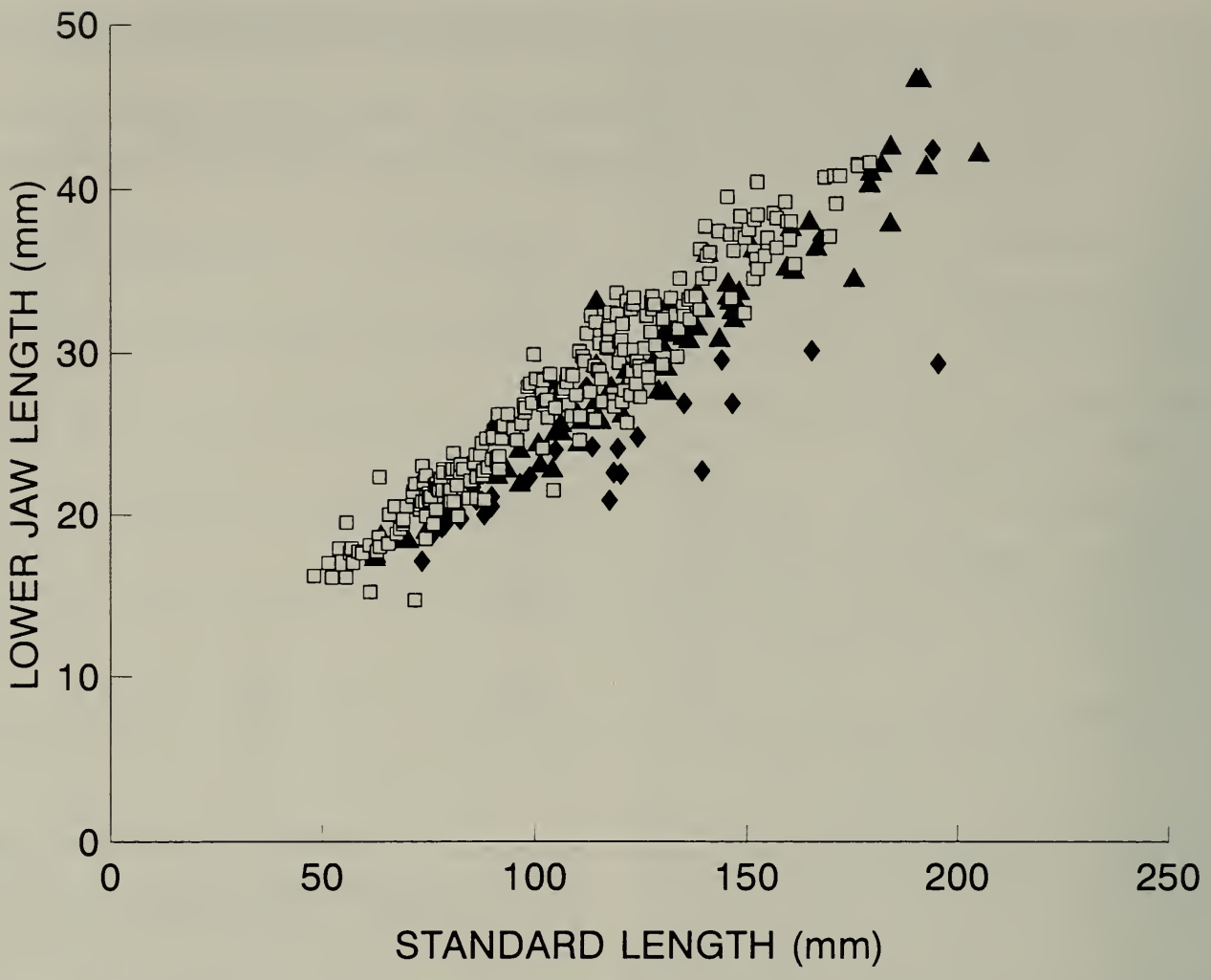

Fig. 4. Relationship of lower jaw length to standard length in *Hyporhamphus meeki* (squares) and two populations of *H. unifasciatus,* Central and South America (triangles) and West Indies (diamonds).

Hyporhamphus meeki

Holotype.—USNM 294369 (1, 160) Morehead City, NC; 5 Sept 1964.

ATLANTIC U.S. (paratypes): USNM 132257 (4, 55.7–115) Woods Hole, MA; 2 Sep 1876. USNM 68368 (5, 54–65.8) Great South Bay, NY; 1898. USNM 187214 (2, 73.6–98.9) Deep Cove, Indian R., DE; 7 Sept 1956. VIMS-CBL 173 (2, 108–123) CBL Pier, MD; 21 Jul 1936. VIMS-CBL 1523 (11, 73.6–91.1) Broomes I., Patuxent R., MD; 13 Aug 1958. USNM 90798 (1, 179) Cape Charles, VA. VIMS 61 (21, 87.6–123) Lynnhaven Inlet, Broad Bay, VA; 29 Sept 1954. VIMS 607 (7, 78.5–159) York R., VA; 18 Jul 1970. USNM 131146 (1, 147) Cape Charles, VA. USNM 131146 (4, 102–117) Morehead City, NC; 5 Sept 1964; taken with the holotype. VIMS-CBL 3571 (1, 51.5) Morehead City, NC; 9 Jul 1967. USNM 51878 (1, 153) Beaufort, NC. VIMS 7873 (3, 71.9–115) Carteret Co., Atlantic Ocean beach, NC; 12 Sept 1976. USNM 294396 (1, 150) SC, 32°26′N, 79°50′W; 6 Aug 1953. USNM 149969 (1, 107) Georgia coast. USNM 294377 (2, 99.7–104) St. Simons I., GA; 15 Mar 1956. USNM 294426 (1, 119) St. Simons I., GA; 14 Apr 1960. USNM 294427 (1, 105) St. Simons I., GA; 16 Nov 1955. USNM 294441 (1, 160) St. Simons I., GA; 11 Nov 1956. USNM 294435 (1, 55.6) off Savannah, GA, 31°41′N, 80°35′; 21 Oct 1953.

Other material examined: ATLANTIC U.S.: VIMS uncat. (56, 48.1–146), Gloucester Pt., York R., VA; 19 Jul 1989 to 17 Sept 1989.

Table 10.—Comparison of means for pectoral-fin ray counts for populations of *Hyporhamphus meeki* and *H. unifasciatus*, and between *H. meeki* and *H. unifasciatus*. Populations joined by the same line are not significantly different by the Tukey-Kramer method, alpha = 0.05.

Population	*n*	$\bar{X}$	TK
H. meeki			
West peninsula of FL	147	11.7	|
MA to GA	158	11.4	| |
FL panhandle to Texas	120	11.4	|
Yucatan	26	11.3	|
Atlantic coast of FL	106	11.0	|
H. unifasciatus			
Yucatan	12	11.1	|
Caribbean South America	120	11.0	| |
South America (Brazil)	122	10.9	| |
Central America	41	10.9	| |
Florida	69	10.8	|
West Indies	136	10.7	|
Bermuda	107	10.0	|
H. meeki	558	11.4	|
H. unifasciatus	607	10.7	|

ATLANTIC FLORIDA: UF 62140 (1, 125) 4.5 miles N. of Jupiter Inlet; 21 Aug 1964. UF 77037 (2, 111–127) Matheson Hammock; 11 Jul 1970. UF 83999 (20, 59.4–97.8) Indian R., Brevard Co.; 16 Aug 1976. USNM 294365 (4, 55.8–141) off New Smyrna Bch., 29°00′N, 80°32′W; 14 Oct 1953. USNM 294397 (19, 52.3–119) 29°40′N, 81°06′W; 15 Oct 1953. USNM 294494 (16, 91.4–145) 27°52′N, 80°26′W; 20 Jan 1961.

GULF COAST FLORIDA: UF 1010 (9,

Table 11.—Comparison of means for total first arch gill raker counts for populations of *Hyporhamphus meeki* and *H. unifasciatus*, and between *H. meeki* and *H. unifasciatus*. Populations joined by the same line are not significantly different by the Tukey-Kramer method, alpha = 0.05.

Population	*n*	$\bar{X}$	TK
H. meeki			
Yucatan	26	35.3	|
FL panhandle to TX	207	35.2	|
Atlantic coast of FL	101	35.1	| |
MA to GA	255	34.5	|
West peninsula of FL	194	33.6	|
H. unifasciatus			
Caribbean South America	119	31.1	|
West Indies	170	31.1	|
South America (Brazil)	124	30.6	| |
Central America	53	30.5	| |
Yucatan	12	30.0	| |
Florida	66	30.0	| |
Bermuda	113	29.5	|
H. meeki	780	34.6	|
H. unifasciatus	657	30.6	|

Table 12.—Comparison of means for total second arch gill raker counts for populations of *Hyporhamphus meeki* and *H. unifasciatus*, and between *H. meeki* and *H. unifasciatus*. Populations joined by the same line are not significantly different by the Tukey-Kramer method, alpha = 0.05.

Population	*n*	$\bar{X}$	TK
H. meeki			
MA to GA	189	26.8	|
FL panhandle to TX	156	26.2	|
West peninsula of FL	177	26.0	|
Atlantic coast of FL	114	25.9	|
Yucatan	38	25.5	|
H. unifasciatus			
Caribbean South America	114	24.3	|
West Indies	141	24.1	|
South America (Brazil)	109	23.5	| |
Central America	35	23.5	| |
Yucatan	12	23.3	|
Florida	59	22.9	|
Bermuda	100	21.9	|
H. meeki	662	26.2	|
H. unifasciatus	570	23.5	|

63.6–88.1) Cedar Key; 24 Jul 1948. UF 51083 (5, 71.8–135) Alligator Harbor; 7 Sept 1954. UF 52066 (5, 146–170) Alligator Harbor; 16 May 1954. UF 68483 (6, 114–148) St. Andrew's Bay, Panama City; 8 Oct 1968. UF 76904 (24, 50.1–74.2) 1 mile N of Lee-Collier Co. line; 18 Jun 1966. USNM 125446 (2, 139–153) Tarpon Springs; 5 Nov 1896. USNM 184268 (4, 133–146) Johns Pass, Madeira Bch.; 29 Sept 1958. USNM 294431 (5, 103–136) Sarasota; 24 Aug 1967. USNM 294452 (16, 119–134) Sanibel I.; 11 Aug 1959. USNM 294489 (6, 149–171) Sanibel I.; 8 Aug 1964.

GULF COAST U.S., ALABAMA-TEXAS: USNM 187122 (2, 151–152) S. Mobile, AL; 7 Jul 1960. VIMS 5095 (1, 113) Pelican Bay, Dauphin I., AL; 29 Aug 1974. USNM 147781 (1, 176) Mississippi Gulf coast; 1948. USNM 187120 (2, 123–128) inside Chandeleur Sound, LA; 19 Aug 1959. USNM 187123 (1, 73.9) Grande Isle, LA; 21 Jul 1930. USNM 94546 (1, 141) Corpus Christi, TX. USNM 103390 (1, 69.1) near Corpus Christi, TX; 1937. USNM 120056 (2, 128–155) Galveston, TX; 1941. USNM 187119 (2, 168–172) Corpus Christi, Shamrock Cove, TX; 7 Apr 1927. USNM 294440 (26, 100.5–152) Aransas Pass, Institute of Marine Science pier, TX; Mar 1959.

YUCATAN: UMMZ 143085 (28, 94.2–145) west of Progreso; 28 Mar to 1 Apr 1936. UMMZ 143087 (15, 64.2–152) Chicxulub, near Progreso; 1 Apr 1936. MCZ 32881 (3, 142–183) Yucatan; 1906.

Hyporhamphus unifasciatus

FLORIDA: UF 56209 (1, 143) Virginia Key; 26 Nov 1959. UF 62140 (11, 108–134) N. of Jupiter Inlet; 21 Aug 1964. USNM 34999 (4, 182–192) Key West; Dec 1883. USNM 158069 (3, 108–129) Snipe and Content Keys; June 1956. USNM 38544 (3, 138–144) Key West; 15–27 Apr 1884. USNM 187121 (4, 75.0–79.9) St. Joseph's Bay; 2 Feb 1959.

WEST INDIES: USNM 5802 (2, 146–186) Barbados. USNM 5847 (1, 103) Jamaica. USNM 8803 (1, 111) Jamaica. USNM 10730 (2, 79.5–89.9) Bahia Honda, Cuba. USNM 34938 (2, 118–123) St.

Thomas. USNM 38537 (2, 120–127) Jamaica; 1–11 Mar 1884. USNM 38601 (6, 119–158) Curacao; 10–18 Feb 1884. USNM 50111 (1, 194) San Juan Mkt., Puerto Rico; 14 Jan 1899. USNM 82366 (3, 77.2–86.3) Los Arroyos, Cuba; 19 May 1914. USNM 94077 (4, 112–139) Jamaica. USNM 107428 (2, 135–165) Bahia Honda Anchorage, Cuba; 5 Apr 1937. USNM 130652 (1, 195) Cuba. USNM 132524 (3, 109–147) Port-au-Prince, Haiti; 22 Oct 1945. USNM 294364 (5, 90.5–129) Sable Bay, Dominica; 13 Nov 1964. USNM 294493 (6, 78.6–119) Jobes Harbor, Greater Antilles; 20 Feb 1966. USNM 294515 (11, 81.9–167) 17°56′30″N, 66°13′12″W; 18 Feb 1966.

BERMUDA: AMNH 18711 (2, 87.3–90.2) Bermuda. ANSP 96626 (2, 114–117) Somerset, Bermuda; 12 Jun 1952. ANSP 109562 (15, 82.5–135) Somerset, Bermuda; 4 Jun 1952. ANSP 123715 (4, 100–141) Bermuda; Jun 1930. MCZ 34890 (5, 110–168) Bermuda. MCZ 40757 (6, 106–118) Bermuda; 1872. UMMZ 172321 (3, 99.2–154) Reach at Bio. Sta., Bermuda; 31 May 1951. UMMZ 172369 (3, 81.6–97.9) St. George's I., Bermuda; 5 Jun 1951. UMMZ 172418 (13, 87.9–145) St. George's I., Bermuda; 8 Jun 1951. UMMZ 175957 (2, 85.9–108) Reach at Bio. Sta., Bermuda. UMMZ 175967 (3, 124–140) Jetty at Bio. Sta., Bermuda; 19 Mar 1957. UMMZ 175974 (1, 105) Ferry Reach at Bio. Sta., Bermuda; 21 Mar 1957. UMMZ 175981 (1, 79.7) Ferry Reach at Bio. Sta., Bermuda; 24 Mar 1957. UMMZ 176014 (1, 148) Ferry Reach at Bio. Sta., Bermuda; 14 Apr 1957. UMMZ 176154 (1, 114) Ferry Reach at Bio. Sta., Bermuda; 4 Jun 1957. USNM 294439 (7, 87.7–110) Bermuda Harbor, Bermuda; 9 Mar 1963.

CENTRAL AMERICA: MCZ 32881 (1, 183) Yucatan, Mexico; 1906. UF 7107 (2, 165–181) Veracruz, Mocambo, Mexico; 20 Jan 1958. UMMZ 143085 (10, 94.2–140) W. of Progreso, Yucatan, Mexico; 28 Mar–1 Apr 1936. UMMZ 143087 (1, 71) Chicxulub, Yucatan, Mexico; 1 Apr 1936. USNM 79658 (1, 160) Colon Mkt., Panama; 23 Jan 1912. USNM 187843 (9, 62.4–85.5) off Bluefields, Nicaragua; 3–4 Jun 1962.

SOUTH AMERICA: USNM 203826 (11, 104–121) Gulf of Uraba, Colombia; 11 Jul 1966. USNM 206658 (17, 121–205) Baru I., Colombia; 26 Sept 1969. USNM 38574 (1, 135) Sabanilla, Colombia; 16–22 Mar 1884. USNM 94764 (1, 188) near Puerto Colombia, Barranquilla, Colombia. USNM 128286 (3, 121–129) Gulf of Venezuela, Venezuela; 5 Apr 1925. USNM 198404 (3, 86.1–108) off French Guiana; 30 Jul 1956. MZUSP 5206 (7, 131–148) Ubatuba, Brazil; 1967. MZUSP 41092 (3, 184–191) Praia de Itapenia, Brazil; Jul 1965. MZUSP 41094 (12, 131–179) Pontal, Ilheus, Brazil; 25 Oct 1971. USNM 107220 (1, 151) Recife, Brazil; 1932.

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