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FLOUNDERS OF THE GENUS *PARALICHTHYS* AND RELATED GENERA IN AMERICAN WATERS

By Isaac Ginsburg

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FLOUNDERS OF THE GENUS *PARALICHTHYS* AND RELATED GENERA IN AMERICAN WATERS

By ISAAC GINSBURG, *Fishery Research Biologist*

This report is an account of the important group of flatfishes belonging to the genus *Paralichthys*, and the closely related genera *Hippoglossina* and *Pseudorhombus*, which occur in American waters and, in the aggregate, are food fishes of great economic importance. Three of the leading species, the summer flounder, the southern flounder, and the California halibut, add annually nearly 20 million pounds to the commercial catch of the United States. Statistics are not available for some other species which are of lesser economic importance or occur on the coasts of Central and South America. The combined catch of all the lesser species is probably considerable at present and will very likely increase with future advances in exploitation of the natural resources of the American continents. In view of the importance of these species, it is remarkable how little we know of their biology. Such knowledge is a prerequisite to the wise exploitation of any species. This report presents some basic knowledge of the species, derived from first-hand, accurately determined data, which is necessary to their further study.

In order to understand properly the species of *Paralichthys*, it is necessary to consider also those that belong to *Hippoglossina* and *Pseudorhombus*, as the species of these three genera form an interrelated, closely knit, and compact group. A serious drawback to a rational study of their life histories is the difficulty of properly distinguishing the species, which are so closely related that where two or more occur together considerable difficulty has been encountered in trying to refer specimens to their respective species. It is true that Jordan and Gilbert (Bull. U. S. Nat. Mus., 16: 822–823, 1883) long ago indicated in broad outline the structural characters by which the common species may be distinguished; but in *Paralichthys* that did not prove sufficient. Descriptions based on a few specimens may be of use in separating material in bulk, but they are insufficient to identify a considerable percentage of individual fish. The chief characters distinguishing the species are of a meristic nature. The extent of intraspecific variations in these characters is considerable. Moreover, the species are closely related and they approach one another or even intergrade somewhat in these characters. Consequently, when specimens at or near the border line with respect to one or more structural characters are examined, they appear to be inseparable specifically, and doubt is thus cast on the distinctness of the species.

The difficulties encountered in properly distinguishing the species concerned may be appreciated by a consideration of two treatises dealing with those species. Hildebrand and Cable (Bull. U. S. Bureau of Fisheries 46:464, 1930) state: ". . . the present writers are unable to separate the representatives of this genus [*Paralichthys*], occurring locally [at Beaufort, N. C.], into more than two groups (species?) . . ." The fact is that three common species are present at Beaufort. The data given by these authors on the chief differentiating characters nearly agree with those determined by me. Many of their specimens formed the basis of my studies. Their figures 79–81 representing the frequency distributions of the numbers of gill rakers and anal and dorsal rays evidently are bimodal polygons which, taken separately, would understandably lead to the statement quoted above. However, it is of the utmost importance to correlate the data on which the polygons are based. To illustrate, their figure 79 consists of two well-defined polygons which touch at a point, and seemingly it represents not more than two species. However, were the frequency distributions of the number of anal rays of the specimens represented in the left polygon graphed separately, the result would be a polygon similar to their figure 80. That is, the left polygon represents two species, *albigutta* and *lethostigma*, while the right polygon represents *dentatus*. Similarly we may use their figure 80

as the starting point of the correlation. It consists of two somewhat irregular polygons which, considered independently, might also be taken to represent two species. Were the number of gill rakers of the specimens represented by the right polygon graphed separately, the result would be a bimodal polygon similar to their figure 79, which would represent two species, *lethostigma* and *dentatus;* while the left polygon of figure 80 represents *albigutta.* A comparison of Hildebrand and Cable's figures 79–81 with figures 1–3 of this report will clarify the preceding discussion. The intraspecific variability and distribution of the three characters concerned, among the three common species, are such that when a mixture of specimens of the three species is studied and the mixed data graphed for each character separately, as was done by Hildebrand and Cable, the resulting polygons would be similar to their figures 79–81, leading to the conclusion that not more than two species are involved. But when the characters are correlated it becomes clear that three distinct and common species are represented. Moreover, after correlating the characters and dividing the mass of specimens into three rather well-defined species, other characters appear which although not sufficiently divergent to separate all the specimens will yet distinguish the great bulk of specimens of the three species, respectively.

Norman[1] states: "[*albigutta* is] perhaps identical with *P. lethostigma* . . ." (p. 75); and ". . . it is possible that *lethostigma, albigutta* and *squamilentus* will eventually have to be regarded as representing one variable species" (p. 76). However, when adequate samples of the three species about which Norman was in doubt are studied and the data correlated and tabulated, as is done in the following pages, all questions as to their distinctness disappear. While Norman tentatively did treat these three species as distinct, he did not properly separate all his western Atlantic specimens.[2]

In order to prove that the separate species are distinct, and to show how individual fish may be identified, it becomes necessary to investigate the chief distinguishing characters by statistical methods; in other words, it is necessary to determine in detail the variability of these characters of each species separately, showing precisely their limits and their normal frequency distributions, and to correlate them. That has been accomplished during the present study for the common species, as far as available material permits. It now becomes a comparatively easy matter to separate the species. There is seldom trouble in placing individual specimens, certainly not more so than in many other closely related species.

A study such as that reported in the following pages manifestly must precede any consistent study of the life history of each species. Besides studying their taxonomy, the known and scattered data regarding the biology and the economics of the species have been digested and condensed, and original observations included. This paper treats of those species that inhabit the Atlantic and Pacific coasts of North and South America. The species are so closely interrelated that it is necessary to treat them as a group in order to understand them fully.

In stating proportional measurements of certain parts throughout this paper, the figures given refer to percentage of the standard length. Statements of the size of specimens refer to the total length, including the caudal fin. Measurements of the eyeball and orbit are those of the upper eye. The stated number of scales refers to the number of rows over the straight part of the lateral line unless otherwise specified (p. 271). The diagnoses include only those characters which are of importance in distinguishing the species. Counts and relative proportions are mostly given in general statements in the diagnoses. More detailed data are in the tables which form part of and should be used in connection with the diagnoses.

In the following accounts of the species, the given numbers of specimens examined are those in the United States National Museum Catalog, unless otherwise indicated.

All illustrations accompanying this paper, executed with such obvious skill, were prepared by Louella E. Cable. Figures of specimens represent reworked photographs, which were made in the Smithsonian photographic laboratory.

[1] A systematic monograph of the Flatfishes (Heterosomata) vol. 1, Psettodidae, Bothidae, Plueronectidae, by J. R. Norman, British Museum, London, 1934.

[2] See Ginsburg, Jour. Washington Acad. Sci., vol. 26, pp. 130–133, 1936. In that paper I discuss briefly some of the differences between the present treatment of the species and that in Norman's work. Where necessary the discussions are here amplified under the accounts of some of the species.

COMMON NAMES

Since these flounders are common or abundant food fishes, it is especially desirable for each species to have a distinctive common name which may be uniformly applied to the same species throughout its range. An attempt is here made to introduce such common names for the species of *Paralichthys* that occur in the waters of the United States. It is well known to those who deal with the fishes of the country as a whole that the multitude of common names applied to a given species is confusing, especially with food fishes that enter the channels of trade. Not only are species often known by different names in different sections of the country, but frequently this occurs in adjacent communities of the same State. It is even more confusing when a name is applied in one locality to a particular species, and in another to an entirely different species. In this paper, therefore, a distinctive English name is suggested as a uniform common name for the species.

SAMPLING

The chief characters used for separating the species are of a meristic nature and vary within rather wide limits. The variations are of the usual frequency-distribution type and lend themselves readily to the ordinary methods of statistical studies of such variations. It is evident, therefore, that in any study of these characters it is important to sample the individuals examined in such a manner that the resulting frequency distribution, as tabulated, represents as nearly as possible the living population of the species in the water.

The importance of a representative sample in studies of fin ray counts for instance, is forcibly impressed after gaining considerable experience in such studies. It may be readily observed in species in which the number of fin rays varies within considerable limits that specimens obtained in the same haul of the net will sometimes tend to group themselves either near the beginning or near the end of the frequency distribution of the species as a whole. Therefore, in order to portray adequately the meristic characters for each species, the method of selecting the sample to be studied is of importance. If, let us say, the fin rays of one hundred specimens are enumerated and tabulated, and all the specimens are obtained in a single haul of the net, the result is apt not to present a true picture of the species. On the other hand, if the hundred specimens are taken at random, one each, from as many hauls in different localities, the result is apt to present a fairly good view of the normal variation of that character within the species as a whole. The individuals employed in this study represent specimens obtained by methods intermediate between these two extremes. They were those obtained in the ordinary course of extensive collecting, when the tendency on the part of the collector is to save a few specimens out of each haul as a sample, especially when any haul yields too many individuals of one species. All the individuals tabulated herewith are a composite of many such samples generally ranging from 1 to 10 specimens in each sample. Only three samples had more than 10 specimens, the highest number being 21. The frequency distributions thus obtained for the more common species probably represent fairly those of the respective species, at least near enough for practical purposes. (The question is further discussed on p. 276 in relation to the three common east-coast species.)

STRUCTURAL DIFFERENCES DISTINGUISHING THE SPECIES

For the practical purpose of the proper distinction of the three common eastern species, it is only necessary to enumerate correctly for any given specimen, the gill rakers, the anal rays, the dorsal rays, and the scales. The importance of the characters is in the order stated. These structural characters in combination with evident differences in the color pattern will serve to distinguish individual fish of the three common species of the east coast. Proportional measurements in the east coast species are generally of secondary importance. However, when all the species are taken into consideration these generalizations do not hold altogether, and the important differentiating characters are pointed out under each species. Also, when all the species of the genus are considered, the structure of the scales, whether cycloid or ctenoid, and the presence or absence of accessory scales is of much importance in classification.

In distinguishing the species in general, reliance must be placed to a large extent on the number of

gill rakers, fin rays, and scales. As these numbers vary within wide limits within the species, and individual fish of closely related species may approach or even overlap in these respects, it is evident that the course of the student in his attempt to properly distinguish the species is beset with many pitfalls. By way of illustration, it may be pointed out that a specimen of *lethostigma*, for instance, having 65 rays in the anal fin may be considered as conspecific with a specimen of *albigutta* having 62 rays, rather than with another specimen of *lethostigma* having 72 rays, as far as this one character is concerned. Of course, in the proper identification of any given specimen all the characters must be taken into account, but the student will be greatly aided in reaching the correct conclusion, if instead of the simple range of each meristic character, he has before him tables showing the frequency distributions of these characters. Such tables are therefore supplied here, as far as available material permitted. In addition to their practical value, the tables afford valuable evidence going to prove the distinctness of closely related species, where doubt may exist.

TABLE 1.—*Frequency distribution by number of oblique rows of scales over straight part of lateral line to end of hypural.*

Species	Number of scales																																		
	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	70	71	72	73	74	75	76	77	78	79	80	81
Hippoglossina																																					
bollmani	1		1	2	2																																
mystacium								1																													
stomata	1		2	1	1		3	1	1	2		1																									
oblonga																			1		1		2	2	2	1	4	3	1	2	1	1	2	1		2	1
tetrophthalmus																			2						1												
Pseudorhombus																																					
isosceles		2				1																															
Paralichthys																																					
patagonicus																																1					
schmitti																								1													
adspersus																			1		1	1			1	1	2	2	1	1	1	1	1	1	1		1
californicus																		2	3	2	4	4	7	5	3	6	2	4	5	1		1	1	1			
aestuarius																				2	2	4	6	5	1	2		3		1	2	2	1		1		
woolmani																		2	1	2	1	1	3	1	2	2	1										
brasiliensis																		1	2	1	3	2	3	1	2	1		1									
dentatus												1	2		1	2	2	8	11	8	16	11	5	7	8	7	4	3	1	3	2	1					
albigutta			2	1	5	5	7	18	16	10	9	8	6			2																				
vorax				1																																	
tropicus																							1														
lethostigma								1	1	1	3	12	11	15	17	20	8	7	11	8	5	5	5		1					1							
squamilentus																							1		1	1	1	2			2	1		2		1	

SCALES

The cycloid or ctenoid character of the scales is of primary importance in the major division of the species comprising the genus *Paralichthys* and is of much help in the identification of the species of this genus as well as of related genera. In the Fishes of North and Middle America, by Jordan and Evermann (Bull. U. S. Nat. Mus., No. 47, Pt. 3, 1898), a general work used by ichthyologists to identify American fishes, this character is inadequately treated. In the definition of the genus (ibid. p. 2624) the statement is made "scales small, weakly ctenoid or ciliated." This is not true of all the species; and in the descriptions of some of the species the scales are correctly described as "smooth" or "cycloid." It is interesting to note that in the same work, the two genera which are closely related to *Paralichthys*, namely, *Hippoglossina* (p. 2620) and *Lioglossina* (p. 2622), as limited by those authors, are distinguished by the scales, ctenoid in one and cycloid in the other. This character is also of importance in forming major divisions of the species comprising the genus *Paralichthys*. The presence or absence of spinules on the scales was found to be the most constant of all characters used in the distinction of the species, with the exception of *P. aestuarius* and *Hippoglossina oblonga* (the latter species being assigned to *Paralichthys* by Jordan and Evermann in the work cited). In *H. oblonga* the number of spinuliferous scales is highly variable, but a few are always present on the caudal peduncle of the blind side in specimens over 75 mm. long, and the eyed side of the head always has spinuliferous scales in large specimens. In *P. aestuarius*, it is an age character, the scales of the eyed side being all spinuliferous in fish less than about 160 mm. in length. The spinules are gradually lost after that length has been reached; the scales become cycloid in specimens over 220 mm. In the other

species, this character is constant at all ages, although in very large fish the spinules in the species having them sometimes are comparatively less marked. In very large specimens they sometimes change to coarsely granular asperities, but the distinguishing nature of the scales is still evident. The two exceptional species in this respect, and the change of the scales in very large specimens of other species perhaps explains the inadequate treatment this character has received in the study of the species of *Paralichthys*. However, the structure of the scales is of as much importance in interpreting the relationship of the species and in the practice of identification, as it is in related genera. Besides the presence or absence of spinules on the scales, another important character which may be used in generic division is the presence or absence of accessory scales (see p. 284).

Besides the structure of the scales, their size, which is usually expressed inversely as the number along certain lines of the body, is a valuable aid in distinguishing the species when used in connection with the other characters, although it usually shows much variability and considerable intergradation. One serious drawback to a precise use of this character is the difficulty of determining the number of scales with any reasonable degree of accuracy. The tubes in the lateral line are easiest to count in young fish, but the more or less clear-cut boundaries between the individual tubes disappear to a large extent with growth. Also, with increase in size the normal scales on either side gradually overlap more and more those in the lateral line, while the increasing numbers of accessory scales cover the surface of all the large scales more and more. Consequently, in large or medium-sized fish, it is almost impossible to count the individual scales in the lateral line with any reasonable degree of accuracy.

After testing different methods of expressing the scale count, the following procedure was adopted as yielding fairly accurate results with the least amount of labor. The count is made of the number of oblique rows over the straight part of the lateral line, beginning with the row standing directly over that canal in the lateral line which is entirely, or almost entirely, horizontal and ending with the row the lowest scale of which is at the end of the hypural as determined by flexing the caudal fin. In counting the scales the specimen is held with the back tilted down and away from the observer. When held in this position the reflection of light is such that the rows of scales appear fairly prominent, and the rows are counted rather than the individual scales. Sometimes the fish has to be turned somewhat at different angles until the rows become prominently visible so that they may be counted with any fair degree of accuracy. A check on a number of small specimens shows that the number of scales in the lateral line closely approximates the number of oblique rows placed over it.

The number of rows along the curved part of the lateral line cannot be determined with as much accuracy as along the straight part, because the rows in the anterior part of the body are more irregular, and because of the greater difficulty of fixing the point to begin the count. Had these rows been included in the count, the small increase in the degree of specific divergence would have been made at the sacrifice of greater accuracy. They were, therefore, omitted and the number of scales stated in the diagnoses in this paper and in table 1 uniformly refers to the number of oblique rows over the straight part of the lateral line.

In current descriptions, the number of scales is usually stated as so many or "about" so many in the lateral line. It seems desirable to have some conversion factor by which current descriptions may be correlated with the present paper, although it seems highly probable that counts hitherto recorded by different investigators are not comparable by a wide margin, because of the use of different methods. The number of scales in the curve was determined on a number of small specimens in which they may be counted with a fair degree of accuracy. It was found that, in general, that number closely approximates one-half of the number in the straight part. Therefore, by adding one-half to the number given in this paper, counts of scales are obtained which are approximately comparable with those given in current descriptions. In the short accounts of established species of which no specimens were examined the number of scales stated is that obtained by using the above conversion factor and subtracting the estimated numbers in the arch from the number in the entire lateral line.

GILL RAKERS

Next to the structure of the scales the number of gill rakers constitutes the most valuable character for separating the American species. It has been universally so used and its importance justly emphasized. For the three common species of the east coast, figure 1 shows unquestionably that *dentatus* is distinct from the other two. Frequency distributions of all the species studied are shown in tables 2 to 4. The number of gill rakers as recorded may vary somewhat with the observer. For instance, in *dentatus* the uppermost gill raker on the upper limb is sometimes very small. Less frequently, this is also true of the anteriormost gill raker of the lower limb. In this investigation the smallest gill rakers were included if they were large enough to be manipulated with a dissecting needle. In *albigutta* and *lethostigma*, slight discrepancies in the counts made by different investigators would be due chiefly to the variability in the uppermost gill raker of the upper limb. This gill raker is sometimes very small, later becoming closely adherent to the gill arch as a triangular piece of cartilage, and finally, seeming to merge with the gill arch. Frequently, when grown to the

TABLE 2.—*Frequency distribution by number of gill rakers on the upper limb of the first gill arch*

Species	Number of gill rakers on upper limb										
	1	2	3	4	5	6	7	8	9	10	11
Hippoglossina											
bollmani		3	3								
mystacium					1						
stomata				6	8	1					
oblonga [1]	3	23	1								
tetrophthalmus		4									
Pseudorhombus											
isosceles [1]	3										
Paralichthys											
patagonicus		1									
schmitti			1								
adspersus							12	5			
californicus							14	53	30	4	1
aestuarius					1		11	21	4		
woolmani				9	12	1					
brasiliensis			1	8	8						
dentatus			2	5	64	41	6				
albigutta		31	63	1							
vorax				1							
tropicus		1									
lethostigma		138	8								
squamilentus			7	6	2						

[1] The short stumps of gill rakers, 3 to 5 in number, on upper limb, not included in the count. Traces of 1 or more gill rakers in other species also not included (see text).

TABLE 3.—*Frequency distribution by number of gill rakers on the lower limb of the first gill arch*

Species	Number of gill rakers on lower limb																
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Hippoglossina																	
bollmani			3	3													
mystacium						1											
stomata					1		6	4	4								
oblonga	1	11	13	2													
tetrophthalmus			1	3													
Pseudorhombus																	
isosceles		1	2														
Paralichthys																	
patagonicus				1													
schmitti			1														
adspersus									1	2	4	7	3				
californicus												5	10	36	29	17	5
aestuarius												6	11	9	10		1
woolmani [1]					2	14	7	2									
brasiliensis							4	8	3	2							
dentatus						4	3	18	44	35	11						
albigutta			9	39	41	4											
vorax						1											
tropicus					1												
lethostigma		7	67	66	6												
squamilentus				5	5	5											

[1] The type specimen has 11 gill rakers on lower limb on eyed side and 13 on blind side, the latter number being included in the table, all the counts having been made on the blind side.

TABLE 4.—*Frequency distribution by number of gill rakers on the outer gill arch*

Species	Total number of gill rakers on outer arch																							
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Hippoglossina																								
bollmani			2	2	2																			
mystacium									1															
stomata							1		2	6	3	2	1											
oblonga	3	10	12	1	1																			
tetrophthalmus			1	3																				
Pseudorhombus																								
isosceles	1	2																						
Paralichthys																								
patagonicus				1																				
schmitti				1																				
adspersus														1	2	2	7	4	1					
californicus																	2	6	10	26	27	13	12	6
aestuarius																1	1	4	12	14	3	1	1	
wollmani								1	7	6	6	2												
brasiliensis										5	3	4	4	1										
dentatus								2	2	2	2	12	35	23	29	8								
albigutta			4	23	29	32	5																	
vorax								1																
tropicus					1																			
lethostigma		6	63	66	10																			
squamilentus					1	6	5	3																

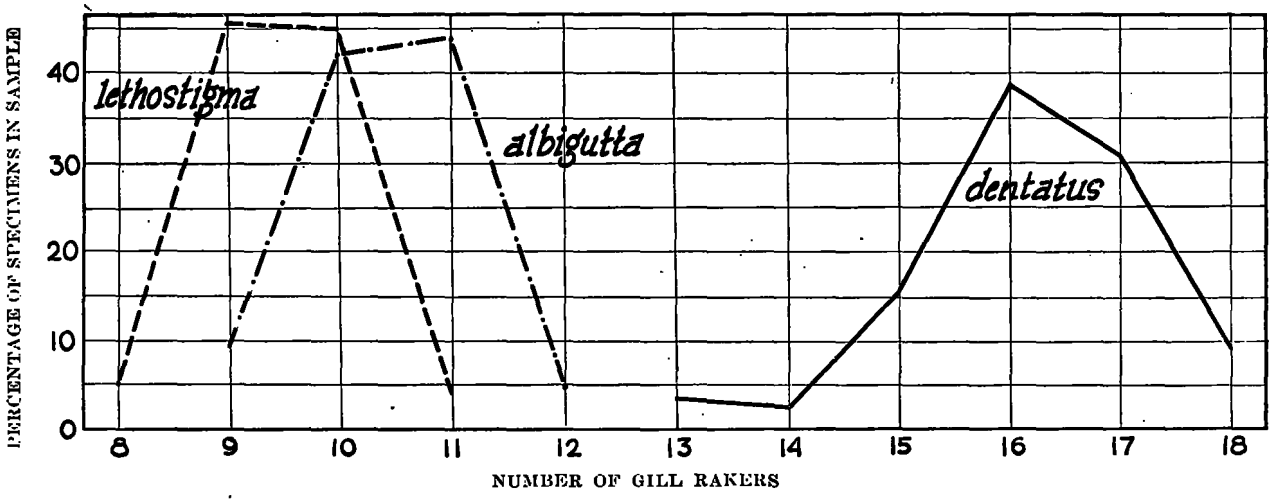

FIGURE 1.—Frequency distribution by number of gill rakers on lower limb of outer gill arch of three common east-coast species of *Paralichthys*. Number of specimens: 115 *dentatus*, 146 *lethostigma*, 93 *albigutta*.

gill arch its triangular outline may be readily traced, but often it is very faint. In this study the uppermost gill raker was arbitrarily included when it projected sufficiently above the surface of the gill arch so that it could be manipulated with a dissecting needle. When it was adherent to the arch even though its outline was evident it was not included in the count. It may also be stated that such specimens are comparatively few, and any slight differences in counts which may be made by different observers would have little effect on the final result when large numbers are studied. In this study all the counts were made by me. The counts of gill rakers as here recorded were all made on the blind side because of greater convenience in counting. The two sides sometimes vary slightly in number; but in the small number of specimens in which counts were made on both sides, as a test, there was no average difference in comparing both sides. The counts were then all made on the blind side for convenience and to insure uniformity.

ANAL RAYS

Next to the gill rakers the number of anal rays constitutes the most important character for separating the three common east coast species, the intergrading individuals being few. This character is especially valuable in separating *albigutta* from both *dentatus* and *lethostigma*. A glance at

TABLE 5.—*Frequency distribution by number of rays in the anal fin*

Species	Number of anal rays																													
	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
Hippoglossina																																
bollmani	1	1	1	2		1																										
mystacium										1																						
stomata		1			1	2	7	1	2	1																						
oblonga													1		1	2	6	1	4	4	1	2		2			1					
tetrophthalmus													1			1	1	1														
Pseudorhombus																																
isosceles																					1	1	1									
Paralichthys																																
patagonicus																					1											
schmitti																		1														
adspersus									1		3	5	6	2	2	1																
californicus				1	4	6	14	26	23	17	16	4	2	2																		
aestuarius												3	2		3	8	5	4	8	3	1	1									
woolmani										4	1	5	5	4	3																	
brasiliensis									2	2	2	5	3	1	1																	
dentatus																1	1		5	4	13	25	21	12	18	6	6	5				
albigutta								1	1	4	10	15	16	26	17	11	5	5														
vorax									1																							
tropicus													1																			
lethostigma																		2	5	10	15	25	27	31	13	14	9	1				1
squamilentus														1	3	3	6	1	2													

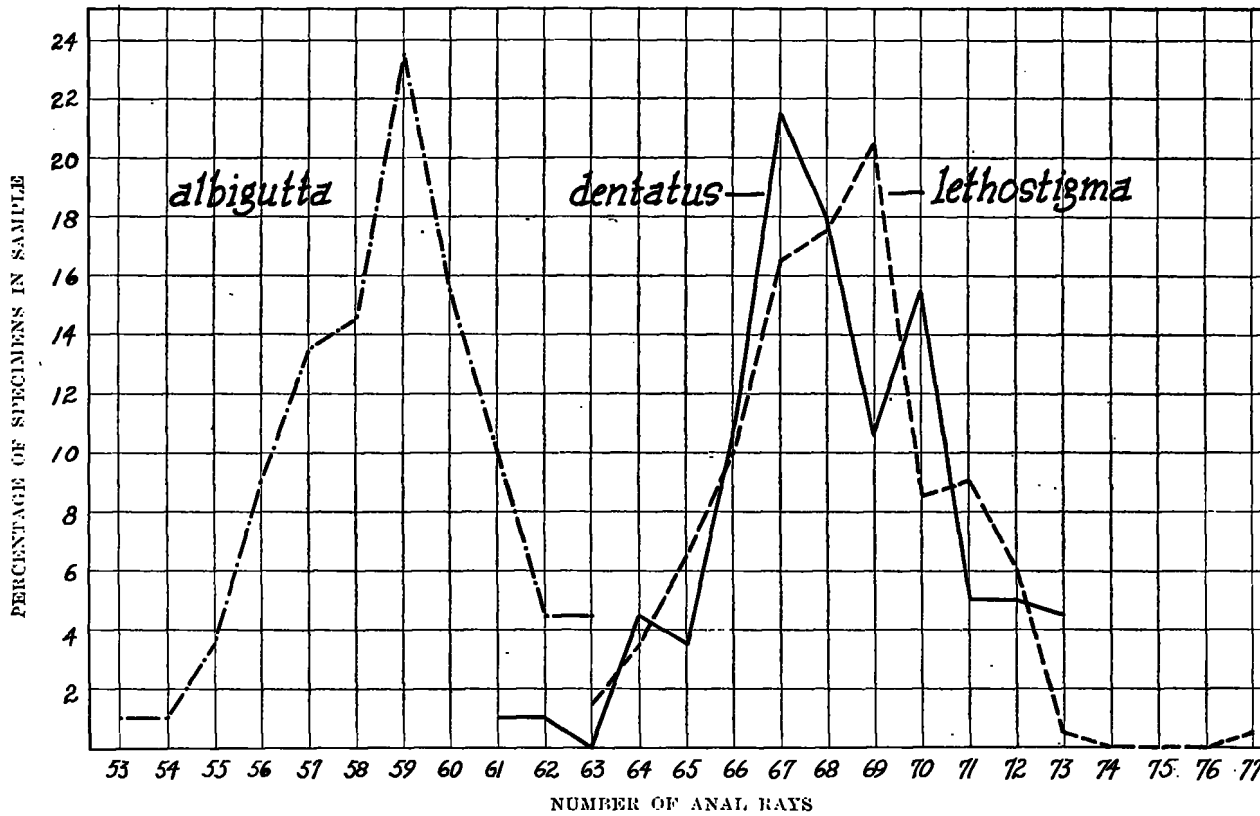

FIGURE 2.—Frequency distribution by number of anal rays of three common east-coast species of *Paralichthys*. Number of specimens: 117 *dentatus*, 153 *lethostigma*, 111 *albigutta*.

figure 2 shows the essential specific divergence of *albigutta* from those two closely related species.

Because the fin ray counts overlap more or less, while at the same time being of prime importance in separating the species, it is essential to make an accurate count when using this character. In this study every fin was counted twice, once on either side, as a check. Since the fin rays are many and the labor of counting tedious, great care and patience must be exercised to insure an accurate count. In practice, some means may suggest themselves to check the counts on both sides of part of the fin. For instance, most specimens have places where the interradial membrane is conspicuously broken. The number of rays up to such a point is jotted down and when the count is made on the other side this number is checked. Again the count may be made in groups of five or ten rays, a dissecting needle being used to point off the groups. By adopting some such means of facilitating the count accuracy is possible.

DORSAL RAYS

Although in the three common eastern species the number of dorsal rays intergrades to a considerable extent (fig. 3), it is a useful character, supplementing the two previous ones for distinguishing doubtful specimens. In the separation of *californicus* from *aestuarius*, the number of dorsal rays intergrades somewhat less than the number of anal rays. The methods of counting and recording the number of dorsal rays were the same as stated for the anal rays.

CORRELATION IN THE NUMBERS OF ANAL RAYS AND GILL RAKERS

Figures 1 to 3 show that the number of gill rakers and that of the anal rays constitute the two most divergent characters. By plotting these two counts, one against the other, in a correlation table (fig. 4), a striking proof of the essential specific divergence of the three common eastern species is obtained. Figure 4 has been prepared from the

TABLE 6.—*Frequency distribution by number of rays in the dorsal fin*

Species	Number of dorsal rays																																		
	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Hippoglossina																																					
bollmani	1		2	2		1																															
mystacium							1																														
stomata				1	1		3	3	3	3	1																										
oblonga													1	1		1	2	2	2	5	5	3		1		1	2										
tetrophthalmus																	1						1	1		1										
Pseudorhombus																																					
isosceles																							2		1												
Paralichthys																																					
patagonicus																							1														
schmitti																					1																
adspersus									1	3	2	1	3	3	5	1	1																				
californicus							4	7	13	18	15	18	20	7	6	2	1																				
aestuarius																1	3		6	3	5	4	6	5	2	2										
woolmani											2	1	2	3	5	2	2	1	2	1		1															
brasiliensis									1		1		1	2	2	1	3	4	1																		
dentatus																					1	1	1	4	3	9	8	13	21	21	15	5	5	4	3	1	1
albigutta												1	2	4	6	12	10	14	13	15	9	13	6		3	1											
vorax																1																					
tropicus																1																					
lethostigma																					1	4	2	6	15	11	20	18	22	14	11	5	13	2	1	1	
squamilentus																	2	1	1	5	3	2	1	1													

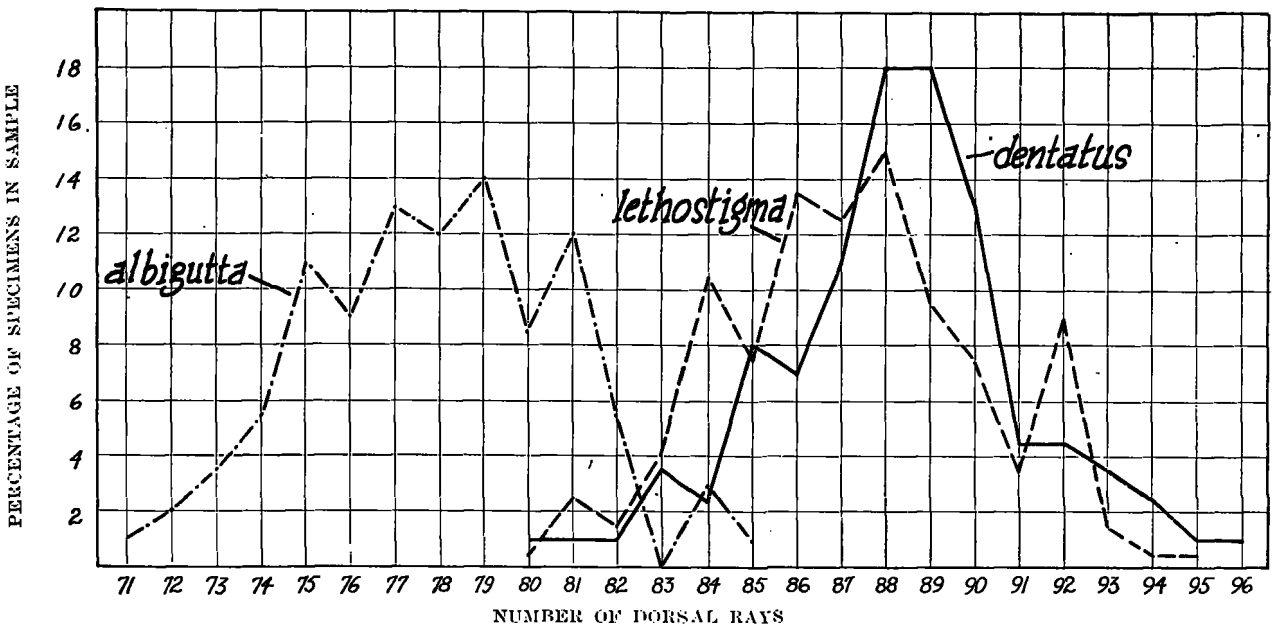

FIGURE 3.—Frequency distribution by number of dorsal rays of three common east-coast species of *Paralichthys*. Number of specimens: 116 *dentatus*, 146 *lethostigma*, 109 *albigutta*.

rough data before attempting to segregate the specimens into their respective species. A mere inspection of figure 4 shows convincingly how the specimens are massed into three fairly well defined groups. These three groups represent: (1) *albigutta* showing a correlation of low gill raker and fin ray counts; (2) *lethostigma* having a combination of relatively few gill rakers and many fin rays; (3) *dentatus* being characterized by relatively many gill rakers in correlation with many fin rays.

While the bulk of the specimens are concentrated at three well separated regions, smaller numbers of specimens radiate diffusely from the three centers of concentration and it is not possible to draw sharp lines of demarcation separating the three species by these characters alone. The proper placement of specimens at or near the border line is discussed on page 282. After such somewhat doubtful specimens are properly placed the boundaries may be drawn between the species with assurance, and they are indicated by a broken

line in the chart. In only one of the squares does the broken line cross. That is, of the total number studied only two specimens of *albigutta* and one of *lethostigma* have the same correlation of the number of gill rakers and anal rays. Such specimens must be assigned to their proper species by means of other characters.

In figure 4 is plotted the total number of gill rakers. Practically the same result is obtained by plotting the number on the lower limb only, except that in that case the lines are more densely grouped.

FREQUENCY POLYGONS

Three variable characters which are of importance in distinguishing the three common species from the east coast of the United States are represented graphically in figures 1 to 3. The polygons representing the number of dorsal rays are markedly irregular; those representing the gill rakers are fairly regular; those representing the anal rays are intermediate with respect to regularity of arrangement. The irregularities are apparently caused by imperfect sampling and may result from one or all of the following main factors. (1) The number of specimens studied may not be sufficient to form a representative sample in its respective species. (2) The method of sampling may be inadequate. (3) The samples do not represent altogether homogeneous populations. It will be shown hereafter (p. 320) that the populations of *dentatus* from Chesapeake Bay and from North Carolina differ appreciably in these three characters. To some extent this is also true of different populations of *lethostigma* (p. 332), and probably also of *albigutta*, although in the latter two species population differences are apparently not so marked. The irregularities in *dentatus* partly disappear when the data are tabulated separately for Chesapeake Bay and North Carolina.

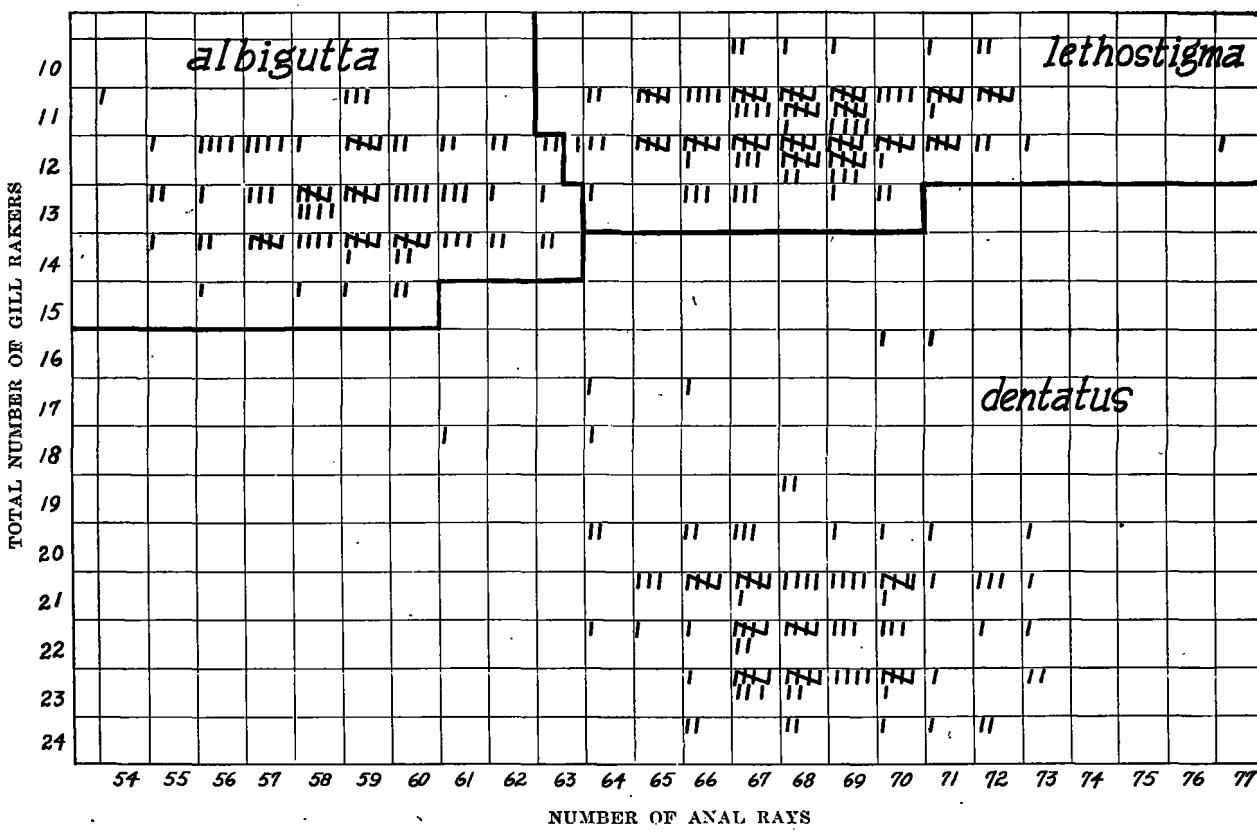

FIGURE 4.—Correlation between total number of gill rakers on first gill arch and number of anal rays, of three common east-coast species of *Paralichthys*. (See p. 274). Each mark represents one specimen; four marks with a cross line represent five specimens.

On the other hand, the marked regularity shown by the distribution of the gill-raker count of *lethostigma* is apparently due to the fact that it is based on material that is not entirely homogeneous. A combination of the somewhat heterogeneous data happened to result in a markedly regular distribution in this case. The more detailed analysis of the data for this count is given on page 332, which shows that the distribution for the combined populations of Texas and Louisiana is not quite so regular as that shown in figure 1. The same may also be true of *albigutta*.

The geographic origin of the specimens forming the basis of the graphs is as follows. The total number of specimens tabulated are *albigutta*, 111; *dentatus*, 120; and *lethostigma*, 159. The three characters were determined for nearly all these specimens; in a few exceptions one or another character was indeterminable on account of injury. The localities of capture of these specimens are: *albigutta*, 71 in a mixed lot from Beaufort, N. C. and Key West, Fla. (see footnote on p. 279), 26 from Texas, 13 from Florida, and 1 from South Carolina; *dentatus*, 71 from Chesapeake Bay, 45 from Beaufort, N. C., 2 from South Carolina, and 2 from Georgia; *lethostigma*, 100 from Louisiana, 34 from Texas, 15 from Beaufort, N. C., 4 from Georgia, and 2 each from Florida, South Carolina, and North Carolina. The great bulk of the specimens in every case thus came from two localities.

Figures 1, 2, and 3 show that we are dealing here with three entirely distinct species, although the samples studied apparently are not altogether representative, and somewhat insufficient as to number. The distributions based on the specimens examined are somewhat irregular and each species differs to some extent with the locality; but the data presented prove conclusively that each species has its own characteristic distribution and fairly well-defined limits. It is evident that a fairly good idea of the specific distributions and their limits may be gained from the determined data; but a study of more specimens and samples more nearly approaching perfection should serve in smoothing the distributions. It is of particular interest to determine further the differences with local stocks in the distributions of the variable characters.

COLOR PATTERN

A cursory examination of the species of *Paralichthys*, in general, shows them to be irregularly blotched. After handling these fishes for some time, however, one may see a definite generalized color pattern; differences in this pattern, on closer examination, are of some aid in distinguishing the species.

The generalized color pattern of the genus may best be discerned in some young fish, especially in those in which the pigment is of medium intensity, neither too dark nor too light. The fundamental, typical color pattern may be said to consist of five longitudinal rows of spots on a variably shaded background, one row along the midline, one under the base of the dorsal, one over the base of the anal and two intermediate rows, one between the median and upper rows and the other between the median and lower rows. (The spots are sometimes rather irregularly arranged and appear to be in 7 irregular rows, see pp. 306, 307, and 312.) The rows may be designated for convenience in discussion as subdorsal, upper intermediate, median, lower intermediate and supra-anal. The spots in the subdorsal and supra-anal rows are generally smaller than in the other three rows. The spots in the median row are generally diffuse, except one spot situated about three-quarters of the way from the gill opening to the base of the caudal fin. In many species this is the most conspicuous spot on the body and in the following discussions it will be designated as the prepeduncular spot.

The value of the color pattern in distinguishing species lies chiefly in the fact that certain spots in certain locations, depending on the species, are most prominent. For instance, in *dentatus*, usually, the three most prominent spots are ocellated and are situated at the angles of an imaginary triangle, the apex of which is formed by the prepeduncular spot, while the base is caudad of the apex and is formed by the two posterior spots of the subdorsal and supra-anal rows, respectively. This will be designated hereafter as the small triangle.

In *albigutta*, the three most prominent spots are also ocellated and form an imaginary triangle, the apex of which is also the prepeduncular spot, as in *dentatus*; the base, however, is situated cephalad of the apex and is formed by the two anterior spots of the upper and lower intermediate rows, respectively. This will be designated as the large triangle. Both of these imaginary triangles are present to a greater or lesser extent in both species.

In *albigutta*, the spots forming the large triangle are the most prominent and nearly always present; those forming the small triangle are less prominent, or faint, or absent altogether. In *dentatus*, the spots in the small triangle are usually the most prominent and nearly always present; those in the large triangle are usually well marked, but not so prominent as the others, often about as prominent, sometimes rather faint. In *lethostigma* all spots are usually rather faint; sometimes the spots in the large triangle are somewhat more prominent, but they are not ocellated. The difference in coloration in the three common species is thus not absolute, it consists of an unequal development in intensity of pigmentation of different parts of the same color pattern. This being the case, and considering also the variability of intensity of pigmentation with individual fish, it may readily be expected that specimens will frequently be encountered which could not be placed by color alone. However, the majority of specimens may be referred to their proper species by color differences. As an illustration, the following test may be cited. A mixed lot of fish consisting of *dentatus*, *albigutta*, and *lethostigma*, from Beaufort, N. C., were separated by color. After the structural differences were studied, it was found that out of a total of 125 individuals thus separated only 14 specimens had been referred to the wrong species; 11 *dentatus* were placed in *albigutta*, two of the latter were tentatively identified with the former, and one *lethostigma* was mistaken for an *albigutta*. It should be stated that this test was made before I had much experience in discerning the color differences of the various species. It may thus be seen that in practice, color is a valuable aid in the proper identification of the species when used in conjunction with the morphological differences, although it is not altogether reliable by itself.

The typical color of the other species could not be well determined with the available specimens, but notes on the color of these specimens are given under the separate accounts of the species.

The spots in the five rows, in general, appear to grow fainter with increased size. To a lesser extent this is also true of the most prominent spots, and in very large specimens the typical specific color pattern is often not discernible.

A similar generalized color pattern is probably present also in *Pseudorhombus* and possibly also in *Hippoglossina* and other related genera, but the material examined is insufficient to determine this definitely for those two genera. In *Hippoglossina* the most prominent spots are in two rows, two or three spots in a row depending on the subgenus, and appear to be situated in the subdorsal and supra-anal rows. In *Pseudorhombus* the location of the most prominent spots differs with the species.

TABLE 7.—*Proportional measurements of 3 species of* Hippoglossina

[Expressed as percentages of standard length]

Species and total length of specimens	Number of specimens	Depth		Maxillary length		Maxillary width		Head [1]		Orbit		Eyeball	
		Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
H. bollmani:													
140–167 mm	6	34.8–38.3	36.4	13.7–14.9	14.3	3.2–3.7	3.5	30.8–32.8	31.9	11.3–12.1	11.8	8.9–9.6	9.2
H. mystacium:													
183 mm	1	----------	39.8	----------	13.6	----------	3.0	----------	30.7	----------	10.4	----------	8.5
H. stomata:													
54–55 mm	2	39.3–40.9	40.1	14.8–15.3	15.1	3.3–3.6	3.5	30.7–32.6	31.7	12.3–14	13.2	10.5–10.5	10.5
116–125 mm	2	38.8–39.6	39.2	14.4–14.9	14.7	3.2–3.4	3.3	31.4–32.7	32.1	11.7–11.8	11.8	8.9–9.7	9.3
138–208 mm	7	36.8–40.7	39.2	14.6–16.1	15.4	3.6–4.2	3.8	31.5–33.7	32.3	10.9–11.7	11.3	7.8–8.9	8.4
240–332 mm	4	38.4–42.4	40.2	16.5–17.9	16.9	4.0–4.6	4.2	33.4–35.6	34.3	10.9–11.6	11.3	7.3–7.6	7.5

[1] Measurements not including the soft scaleless border.

TABLE 8.—*Proportional measurements of some species of* Paralichthys

[Expressed as percentages of standard length]

Species and total length of specimens	Number of specimens	Depth		Maxillary		Head [1]		Interorbital [2]	
		Range	Average	Range	Average	Range	Average	Range	Average
P. adspersus:									
37–45 mm	3	44.6–45.6	45.0	13.2–13.5	13.4	32.9–34.9	34.0		
74–86 mm	3	46.1–47.2	46.7	13.2–14.1	13.7	30.2–32.0	31.3	2.4–2.6	2.5
90–118 mm	6	44.5–48.0	46.7	12.9–13.9	13.5	29.1–31.3	30.1	2.1–2.6	2.4
205 mm	1		45.5		14.1		29.8		3.5
223–276 mm	5	44.2–47.1	45.9	13.3–14.5	13.8	28.4–30.2	29.4	2.9–3.4	3.2
388 mm	1		47.6		13.5		28.9		4.1
P. californicus:									
42–52 mm	3	40.2–41.5	40.7	13.3–15.0	14.3	30.8–33.8	32.7		
61–85 mm	23	37.2–42.3	40.2	13.3–15.2	14.3	27.9–31.9	30.3	1.6–2.5	2.0
94–120 mm	13	37.7–43.5	39.7	12.9–14.3	13.8	27.7–29.4	28.7	1.7–2.6	2.1
124–209 mm	41	37.2–41.7	39.5	12.6–14.9	13.7	26.4–29.8	28.1	1.9–3.0	2.5
226–302 mm	11	37.3–42.4	39.5	12.7–14.0	13.4	26.1–28.0	27.2	2.8–3.3	3.0
332–371 mm	3	38.0–40.8	39.2	12.6–13.7	13.0	26.0–27.4	26.8	2.9–3.4	3.1
473–570 mm	2	37.9–41.0	39.5	11.9–12.1	12.0	24.9–25.1	25.0	3.5–3.6	3.6
P. aestuarius:									
37 mm	1		42.1		17.9		36.5		
66–81 mm	10	41.1–44.2	43.0	14.8–15.3	15.0	29.7–31.9	30.7	1.8–2.7	2.1
90–119 mm	12	41.6–44.9	42.7	13.6–14.6	14.2	28.1–30.3	29.4	1.7–2.5	2.0
125–203 mm	12	39.9–44.5	42.5	13.2–15.1	14.1	26.9–29.8	28.6	1.8–2.3	2.0
220 mm	1		44.5		14.2		29.6		3.0
330–381 mm	2	44.4–44.9	44.7	13.2–14.3	13.8	26.5–28.7	27.6	3.1–3.1	3.1
P. woolmani:									
48–57 mm	2	46.7–47.8	47.3	15.4–15.9	15.7	32.6–32.8	32.7		
72–105 mm	7	44.5–49.6	46.9	14.0–16.3	15.4	29.6–32.8	31.4	1.9–2.3	2.1
143–195 mm	4	44.6–48.7	46.4	14.2–15.3	14.9	29.5–31.4	30.3	2.2–2.7	2.4
232–258 mm	5	44.8–46.7	45.8	13.3–14.2	13.8	26.9–28.4	27.9	2.2–2.6	2.4
300–306 mm	2	45.8–47.9	46.9	13.7–14.0	13.9	27.5–28.0	27.8	2.7–3.0	2.9
429 mm	1		45.0		13.9		28.3		3.3
P. brasiliensis:									
131–214 mm	15	40.2–45.6	44.2	12.9–14.2	13.4	27.2–28.7	27.8	2.2–3.1	2.8
264 mm	1		44.4		12.5		25.1		2.9
477 mm	1		45.4		11.8		25.1		3.4
P. dentatus from Chesapeake Bay:									
29–49 mm	5	40.5–42.8	41.7	13.3–15.9	14.2	30.5–33.7	31.8		
64–92 mm	5	42.4–43.7	42.9	12.9–14.4	13.7	28.4–31.2	29.9	1.8–2.6	2.2
102–130 mm	6	40.8–44.7	43.7	12.5–14.2	13.6	27.2–29.8	28.5	1.6–2.2	1.9
159–194 mm	10	41.2–45.1	43.3	12.3–13.7	13.0	25.7–27.9	26.9	2.0–2.6	2.2
208–255 mm	10	41.1–44.0	42.6	11.7–13.9	13.1	25.4–27.5	26.8	2.1–2.8	2.5
300–390 mm	10	41.4–45.4	42.8	11.9–13.8	13.0	24.3–27.5	26.3	2.5–3.3	2.7
400–432 mm	2	42.0–42.6	42.3	13.1–13.9	13.5	26.6–27.6	27.1	3.1–3.3	3.2
P. dentatus from North Carolina:									
33–52 mm	4	41.8–46.5	44.2	14.3–14.9	14.5	32.1–33.4	32.9		
75–93 mm	5	42.9–45.8	44.1	13.2–13.8	13.5	28.2–30.9	29.5	1.2–2.3	1.8
98–130 mm	7	41.5–44.0	42.8	13.2–14.0	13.5	28.1–30.2	28.8	1.4–2.0	1.8
149–192 mm	9	[3] 41.5–45.0	43.7	13.3–15.0	14.0	27.1–29.2	28.5	1.6–2.3	2.1
208–253 mm	8	42.2–45.1	43.8	12.7–14.1	13.6	26.2–28.8	27.5	2.2–2.5	2.3
310–390 mm	10	40.3–45.6	42.4	12.9–14.6	13.3	25.7–27.8	26.5	2.1–2.9	2.5
427–441 mm	2	42.5–46.5	44.5	13.7–14.2	14.0	27.3–27.7	27.5	2.6–3.2	2.9
P. albigutta: [4]									
29–47 mm	10	42.2–44.6	43.4	15.2–17.4	16.3	32.8–35.0	34.0		
58–95 mm	10	[5] 41.7–46.2	44.4	14.7–16.7	15.6	30.1–33.4	31.5	1.9–2.7	2.3
102–130 mm	13	42.7–47.5	45.1	14.2–15.7	15.1	28.3–31.2	29.8	1.6–2.3	2.0
143–201 mm	[6] 16	41.9–46.9	43.6	14.6–16.8	15.8	[7] 28.3–31.1	29.7	1.8–2.8	2.2
207–273 mm	12	43.1–46.1	45.0	14.5–16.5	15.2	28.1–30.8	29.0	2.3–3.0	2.5
311–389 mm	7	39.3–44.5	41.7	14.1–16.7	15.5	27.5–30.5	28.7	2.7–3.6	3.1
P. lethostigma: [8]									
29–47 mm	8	40.8–44.3	42.6	15.3–17.4	16.0	32.4–34.3	33.4		
59–95 mm	7	39.8–43.6	41.5	14.7–17.2	16.1	29.5–32.2	31.0	1.7–2.9	2.2
111–132 mm	16	38.5–43.8	41.2	14.7–16.8	15.9	27.2–31.1	29.2	2.4–3.1	2.8
134–200 mm	11	40.8–45.5	42.6	13.2–16.2	15.3	26.5–29.8	28.5	2.6–3.6	3.1
206–292 mm	15	42.0–45.4	44.3	13.0–15.9	14.2	24.7–28.4	26.6	2.8–4.1	3.4
310–383 mm	8	43.6–46.7	45.2	13.9–15.0	14.4	25.8–27.3	26.7	3.4–4.1	3.9
393–472 mm	4	43.4–46.1	44.7	14.4–16.0	15.2	26.5–27.6	27.0	3.7–4.7	4.2
497–659 mm	4	45.2–47.7	46.2	14.1–16.2	15.2	25.7–28.6	27.4	4.0–5.2	4.6
P. squamilentus:									
30–45 mm	5	46.7–50.6	49.3	15.5–17.2	16.2	32.3–36.1	33.9		
96–120 mm	7	46.6–52.3	49.7	14.6–15.8	15.3	28.9–30.9	30.0	1.8–2.2	2.0
333–370 mm	4	49.7–52.1	50.7	13.2–13.6	13.4	26.8–27.4	27.1	2.4–2.8	2.6

[1] Head length from tip of snout to margin of opercle, not including the posterior soft border.

[2] Measured between soft margins.

[3] One specimen, 189 mm., unusually slender, depth 38.5. This measurement is not included in the average.

[4] Specimens measured from the following localities: Texas, 10 specimens, 29–47 mm., and 4, 58–68 mm.; Cedar Keys, Fla., 1, 308 mm; all others in a mixed lot from Beaufort, N. C., and Key West, Fla., the labels of many of them lost and not separable definitely. The somewhat irregular changes in proportional measurements with growth may be caused by the mixed samples, perhaps the number of specimens from each locality unevenly represented in the different categories.

[5] One specimen, 95 mm., having an unusually deep body, 49.3. This measurement is not included in the average. Specimen has 54 scales and a number of accessory scales, and is evidently not *squamilentus*. It has the typical color of *albigutta*.

[6] One specimen not included in this table, 148 mm., an extreme variant, unusually slender and with a notably long head and maxillary: depth 37.7; maxillary 17.7; head 32.4; interorbital 2.2.

[7] Another specimen, 154 mm., having an unusually long head for its size, 32.1. This measurement is not included in the average.

[8] Specimens from following localities measured and included in the table: in category 29–47 mm. are 8 specimens from Texas; 59–95 mm., 7 from Texas; 111–132 mm., 3 from Texas, and 13 from Louisiana; 134–200 mm., 1 from Texas and 10 from Louisiana; 206–292 mm., 4, 8, and 3 from Texas, Louisiana and North Carolina, respectively; 310–383 mm., 2, 2, and 4, from Texas, Georgia and North Carolina, respectively; 393–472 mm., 4 from North Carolina; 497–659, 2 from Texas, and 2 from North Carolina.

PROPORTIONAL MEASUREMENTS

In conventional taxonomic accounts of the species of *paralichthys* and related species a prominent part of the description is usually comprised of statements of the proportional measurements of various parts, while the statements referring to gill raker, fin ray and scale counts are apparently based on a few specimens; and such important characters as the structure of the scales, ctenoid or cycloid, and the presence or absence of accessory scales are often left out. However, for the purpose of distinguishing the species properly, proportional measurements are of secondary importance, except in a very few cases, the essential requisites being frequency distribution tables of the numbers of gill rakers, fin rays and scales, and descriptions of the typical structure of the scales and the presence or absence of accessory scales. In this investigation four measurements, the greatest depth; the length of the maxillary, the length of the head, and the interorbital width, were studied in detail, in order to test the practical value of these characters in the proper distinction of the species. The length of the pectoral differs as between *woolmani* and *brasiliensis*, and it may possibly show average differences between some other species. However, it was not investigated in detail, since after a cursory examination it was decided that it would not be of a more decisive nature than the other four measurements. In the genus *Hippoglossina* the upper eyeball and orbit were also measured, because these measurements are of some importance in separating the subgenera; while in the subgenus *Hippoglossina* the greatest width of the maxillary is of some importance in distinguishing the species.

There may be other measurements showing average differences between the species, but if there are any, they are apparently not pronounced. It was noted, as was to be expected, that the proportions of the parts investigated differ greatly with size, and the data were consequently separated by size groups. Indeed, the intraspecific differences due to size are frequently greater than the interspecific differences. The results of these measurements, segregated by size groups, are conveniently presented in tables 7 and 8. Summarizing the results, it may be stated that they are of some value, as follows.

The greatest depth is useful in separating *adspersus* from *californicus* and *aestuarius*. This difference is of no practical value in the identification of specimens because the former species is geographically discontinuous with the latter two and occurs in a widely separated region. However, since the other specific characters separating *adspersus* from the other two species are now shown to intergrade to a very large extent, the difference in the greatest depth is useful in proving their distinctness. The relative depth is also useful in aiding the separation of *squamilentus* from *lethostigma* and *dentatus*. In this case it is especially important to compare specimens of approximately the same size, and the depth is not the only important distinguishing character. Other characters show nearly as much divergence as the relative depth, although there is more or less intergradation in every one of those characters.

The relative length of the head and that of the maxillary are useful in separating *woolmani* from *brasiliensis*. While there is some intergradation in this character between the two species, the degree of overlapping is apparently less than in the other characters separating them. Here again it is necessary to compare individuals of approximately like size, and this character is of no practical value in the identification of specimens, the two species being discontinuous geographically, the former occurring on the Pacific coast and the latter on the Atlantic coast.

The interorbital width is useful in separating *lethostigma* from *dentatus* in specimens over 100 mm. long. In this case, also, it is necessary to compare individuals of approximately like size; while, on the other hand, the difference in the number of gill rakers distinguishes these two species readily.

Briefly then, of the proportional measurements investigated in detail, namely, the depth, head, maxillary, and interorbital, the depth of body is of value in aiding the separation of *squamilentus* and *adspersus* from related species; while the length of the head and maxillary is useful in presenting evidence that *woolmani* and *brasiliensis* are distinct species. *H. mystacium* may be distinguished from *H. stomata* by differences in the length and width of maxillary and the head length. In other species, differences in these measurements are of lesser importance.

CHANGE OF FORM WITH SIZE

In connection with an attempt to use the different body proportions for the proper distinction of the species, some interesting observations bearing on change of form with size have been made, which may be profitably discussed here. Of course, it was not the primary object of this investigation to study in detail the change of form with change in size, and an insufficient number of specimens were measured to describe with exactitude the form of the curves representing these changes. However, measurements made seem to justify certain conclusions which are of interest and importance in these flounders and may perhaps find a wider application. Since so much stress is laid on measurements in extant descriptions and they are of some use for the distinction of the species in a few cases, it is important to point out some of the changes noted with size. Some tentative conclusions suggested by a close scrutiny of tables 7 and 8 seem to be as follows.

The curve representing relative depth apparently follows a sinuous course during the life cycle of most species. That is, with growth it alternately increases and decreases, or vice versa, the change taking place more than once. Thus, in *aestuarius*, *woolmani*, and *lethostigma* there is a gradual decrease in depth in the smaller fish up to about 150 or 200 mm. After that length is reached it increases again. In *adspersus* and *albigutta* there is an increase in relative depth up to about 100 or 125 mm. and then it decreases as in the preceding three species, in fish up to about 200 mm. After that length is reached the depth increases in these two species also; but surprisingly, in *albigutta* the relative depth undergoes another change and the largest specimens become slender in comparison. In *dentatus* the alternate changes are apparently about the same as in *adspersus* except that they occur at a somewhat larger size. In *californicus* there is apparently a gradual decrease in relative depth from the smallest to the largest specimens.

These alternate changes in relative depth in most species may be due to changes in the rate of growth in length. That is, in the smaller fish there possibly is a marked acceleration in the tempo of growth in length which increases at a greater rate than the depth, the particular length at which this takes place differing with the species. With increase in size the accelerated growth in length slows up and the relative depth increases.

The head in young fish, those under 50 mm., is notably long in all species of *Paralichthys*. Its rate of growth soon slows down very markedly, and in somewhat larger specimens, about 50 to 70 mm., it becomes almost abruptly and palpably shorter in comparison with the standard length. It then continues to decrease slowly in relative length as the fish grows. In two species, *lethostigma* and *dentatus*, it appears to increase again in the largest specimens; but those measured are not in sufficient number to be certain of this, and the increase, if any, is moderate. Changes in the relative length of the maxillary with size, in general, follow that of the head length. The interorbital gradually increases in width as the fish grows.

In striking contrast to the species of *Paralichthys*, the head in *H. stomata* (table 7) increases gradually in relative length from the small to the large specimens. The depth in that species changes little with size.

It is evident that, with size, changes in the form of any part often differ markedly with the species. This is very important to bear in mind in connection with the use of measurements in distinguishing species. A difference between two species based on proportional measurements may hold at a given size, but not at other sizes. A striking case showing that a difference between two species may be reversed at a certain size is furnished by *lethostigma* and *albigutta*. Small and medium-sized specimens of *lethostigma* are more slender on the average than large specimens; but in *albigutta* the body evidently becomes more slender in large fish. As a result we have the interesting condition when comparing *albigutta* with *lethostigma* that the smaller specimens are relatively deeper in the former; but the proportions are rereversed in large specimens, the former species being relatively more slender (table 8). The divergence between the two species with respect to depth is greater for the larger specimens.

It is to be noted that the length of the maxillary relative to the body length generally decreases in the larger specimens of *Paralichthys*. However, if the length of the maxillary is judged by the relation of its posterior extremity to the position of the eye, it seemingly increases with size, since its

hind margin reaches more and more posteriorly with respect to a vertical through the posterior margin of the eye, as the size of the fish increases. This is important to bear in mind, since species are sometimes distinguished on the basis of the position of the posterior margin of the maxillary with reference to the position of the eye. Again, the relation of the maxillary length is usually expressed as the number of times it enters into the head length. Since both the head and maxillary decrease relatively with size, at least up to a certain point, the numerical value of their ratio does not change much with the size, except in specimens under 50 mm. Anybody desiring to use this ratio may readily compute it by simple division of the averages given in the tables. However, this ratio does not always express specific differences, as for instance in the case of *woolmani* and *brasiliensis*. In these two species the measurement of the maxillary as compared with the standard length, shows a pronounced divergence; but when the maxillary length is compared with the head length the divergence disappears.

SPECIMENS AT THE BORDER LINE

Inspection of figures 1 to 4 afford sufficient proof that the three common eastern species are distinct. Since, however, there is often more or less intergradation when any single specific character is considered, it is of some importance and of considerable interest, to consider in greater detail how specimens at the border line were referred to their proper species in constructing the tables and graphs as presented in this report. After all, in identification it is individual fish that we are dealing with, and in such closely related species it is important that individual specimens are referred to other proper species.

First of all, it may be pointed out that the number of actually overlapping specimens are very few insofar as it relates to the counts of the gill rakers and the anal rays. In the case of the gill rakers (tables 3 and 4) there are no intergrading individuals between *dentatus* and *albigutta* or *lethostigma*. In the case of the anal rays (table 5) there would be no intergrades between *albigutta* and *lethostigma* or *dentatus* if only two individuals each of the latter two species are eliminated from the 381 specimens counted.

However, the number of actually overlapping specimens is not of primary interest. It is of greater interest to know, in such closely related species, just how all other specimens near the border line have been properly referred. For instance, two specimens having a total of 16 gill rakers have been referred to *dentatus*. What is the reason for placing them in that species and not in *albigutta*, since as far as the frequency distribution of that single character is concerned, it would be just as logical to refer them to the latter species (compare with table 4). Of these two specimens one has D. 89, A. 70, scales 67, and the other has D. 95, A. 71, scales 64. The color pattern is also that typical of *dentatus*. It is evident, therefore, that these other characters unmistakably remove these specimens from *albigutta*. They apparently belong to *dentatus* and are extreme specimens with respect to the gill-raker count. In the same way, other specimens at the border line with respect to any character may be referred with confidence to the proper species by at least one character falling outside the range of the most closely related species and at the mode or even the extreme outer end of its species.

Infrequently, no character is entirely decisive, but one character is sufficiently pronounced that the specimen may be placed with assurance. The following two fish from North Carolina are examples of such specimens. One has D. 83, A. 64: gill rakers 13+4, scales 63; the other, D. 80, A. 61, gill rakers 14+4, scales 59. They have ocellated spots, but the color pattern is somewhat intermediate between *dentatus* and *albigutta* and not typical of either species. It will be noted that in the anal ray count the former specimen is more like *dentatus* and the latter more like *albigutta*. The scales in the first specimen fall somewhat outside the range of *albigutta*, and considering also that the number of anal rays is just outside the range of that species, it would be more properly placed with *dentatus*. In the second specimen, the number of scales falls at the beginning or at the end of the frequency distributions of the two species, respectively. Both have been placed with *dentatus* largely on the basis of the gill-raker count. Reference to table 4 and figure 4 will show that this is the proper disposition of these two specimens.

After border-line individuals such as the preceding ones are placed, there remain a few speci-

mens none of the structural characters of which are decisively like their species. As examples of the latter, we may cite the case of two specimens from North Carolina here included with *albigutta*. One has D. 84, A. 63, the other D. 85, A. 62. The gill rakers in both are 10+2. It may be readily seen that so far as these characters are concerned, they may equally as well be referred to *lethostigma*. The number of scales is 54 and 53, respectively, this character being near the mode of *albigutta*, but it also falls at the extreme of variation of *lethostigma*. The two specimens, however, have the typical color pattern of *albigutta*, and it is evident that they are extreme specimens of that species with respect to the fin ray counts. A similar specimen from Cedar Keys, Fla. (U.S.N.M. 35085), likewise has all the structural characters examined close to the border line between *lethostigma* and *albigutta*, namely, D. 82, A. 63, gill rakers 2+11, scales 55, but the color pattern is strongly marked and, without a doubt, that of an *albigutta*. The last specimen is also of a size at which these two species show considerable differences in proportional measurements: length 376 mm.; depth 40.9; head 28.9; maxillary 15.3; interorbital 3. Comparing these measurements with those given in table 8 for specimens of similar size, it is found that they fall outside the range of *lethostigma*—the depth decidedly so—and within that of *albigutta*.

The preceding three specimens at the border line between *albigutta* and *lethostigma* showed the characteristic color pattern of the former sharply marked and could be placed with assurance in that species. The situation is more difficult when a similar border line specimen lacks ocellated spots. The question then may arise: Is it a *lethostigma* because of the lack of such spots, or is it an individual variant of *albigutta* with respect to color, since occasional specimens of the latter species, especially dark individuals, have the spots very faint? One such specimen from North Carolina was examined: it has D. 81, A. 63, scales 57, total number of gill rakers 12, and lacks ocellated spots. Every one of these important structural characters is about intermediate between *albigutta* and *lethostigma* and characteristic of neither species. The color is like *lethostigma*, but it may possibly be an individual variant of *albigutta*. This specimen, 330 mm. long, was placed with *lethostigma* on the basis of its proportional measurements, namely, depth 46.5, head 27.1, interorbital 3.4. Comparing these measurements with those given in table 8 for the group of specimens of similar size, it may be seen that the depth falls decidedly outside the range of *albigutta* and near the outer extreme of *lethostigma*. The head measurement also falls within the range of *lethostigma* and outside that of *albigutta*, but very near that of the latter. The color agrees with that of *lethostigma*.

By following the methods outlined, it was thus possible to place individual fish near the border line with their respective species. Out of a total of nearly 400 specimens studied in detail, only one was found, the last one described, about which some shade of doubt exists, and this is because specimens of similar size were not available in sufficient number to determine with entire assurance the difference in measurements. Even assuming that it is a doubtful specimen—which it hardly is—the proportion of doubtful specimens, one out of nearly 400, is low, probably less than is usually the case among closely related species.

It may be suggested that this last specimen is a hybrid, but this would be a mere assumption although within the realm of possibility. While some of the border-line specimens discussed in the preceding paragraphs may possibly be hybrids (p. 321), it would be necessary to make a much more detailed study to be able to identify any hybrid specimens with reasonable assurance. At any rate, it seems evident that hybrid specimens of these flounders, if present, are comparatively few in nature. The above placement of the border line specimens apparently is in accord with their specifically genotypic origin, except a very few possible hybrids, the existence of which it is not possible to prove definitely at present.

While the three common eastern species may be distinguished readily even to individual fish, soon after the rays and gill rakers become differentiated, in fish of about 15 mm., this is not the case with two common and geographically adjacent species of the west coast, namely, *californicus* and *aestuarius* (p. 308). Small specimens, up to about 175 mm., of these two species are sometimes not possible to place with confidence. The two west coast species differ also in the frequency distributions of the numbers of fin rays, but there is more inter-

gradation than in the eastern species, and furthermore, in the case of small specimens of the west coast species, there are no characters which may be correlated with the fin ray count, the number of gill rakers and scales and the color being nearly alike in those two species.

GENERIC LIMITS

External characters altogether satisfactory for the division of the species treated in this paper into major groups or genera have not been proposed hitherto. None were elaborated during the present investigation, except one which although not entirely satisfactory is apparently more so than those hitherto proposed. These characters are discussed in reverse order of their apparent importance.

The presence of an anterior accessory branch of the lateral line has been used for distinguishing *Pseudorhombus;* but this is the least important of all characters and is of very little usefulness in generic division. This character and the number of vertebrae are discussed at greater length on page 298.

The structure of the scales, cycloid or ctenoid, is of some moderate use. The known species which apparently belong to *Paralichthys* either have all scales cycloid or when ctenoid scales are present they are typically confined to the eyed side. Sometimes very few ctenoid scales are present on the blind side as a rather infrequent individual variation. If a species typically does have ctenoid scales on the blind side, it is highly probable that it does not belong to *Paralichthys*. In the known species of *Hippoglossina* ctenoid scales are either present on both sides or absent on both sides. In the known species of *Pseudorhombus* the scales are ctenoid on the eyed side and ctenoid or cycloid on the blind side. This character is useful for subgeneric division. The species of *Paralichthys* may be divided into two apparently natural groups by the presence or absence of ctenoid scales on the eyed side. In *Pseudorhombus* the same difference on the blind side may possibly be used for subgeneric division. In one subgenus of *Hippoglossina*, however, this difference is only of specific importance.

The structure of the scales is very constant intraspecifically with two exceptions. In *H. oblonga* the number of ctenoid scales differs greatly with the individual (p. 294). In *P. aestuarius* the ctenoid scales lose their spinules with growth and all scales are cycloid in large specimens. However, in spite of the relative constancy of this character it is of limited use for generic division. It is evident that the disappearance of ctenoid scales occurred independently in all three genera. (The presence of cycloid scales appears to represent a more recent development in the species concerned.) Consequently, to use this character by itself for the major division of the species into genera would run counter to their natural relationship and lead to the formation of polyphyletic genera.

The size of the eye and the interorbital width are of importance in separating the species placed in *Hippoglossina*, but the transition between extreme species in these respects is rather gradual. The same is true of the size of the teeth. The species placed in *Paralichthys* have markedly long, fanglike teeth, while those placed in *Hippoglossina* have rather small teeth; but here also there is a gradual transition, some of the species placed in *Pseudorhombus* having the teeth intermediate in size. No sharp lines may be drawn between the major groups, or genera, on the basis of these three characters.

The position of the dorsal origin is of considerable importance. In the species of *Hippoglossina* the dorsal begins approximately over the middle of the eye, while in nearly all other species it begins over the anterior margin of the eye or a little more forward. However, this character does not separate all the species. In *microps* (p. 301) which, judged by other characters, apparently belongs to *Paralichthys*, the dorsal origin is over about the middle of the eye.

The presence or absence of accessory scales was found to be a good criterion for the generic separation of the species concerned. All the species of *Hippoglossina* examined lack accessory scales. All those of *Paralichthys* have such scales. (They are very few in *squamiltentus*, p. 333). The following exotic species of *Pseudorhombus*, labeled as such or under their synonyms in the National Museum, were examined for this character, namely, *arsius*, *javanicus*, *jenynsii*, *pentophthalmus*, *cinnamoneus*, *oligodon* and *oligolepis* (Norman, Monogr., 1934). These identifications were made by a number of previous workers from time

to time, but their authenticity was not checked. All the numerous specimens examined lacked accessory scales. Of the American species, *isosceles* lacks accessory scales and it is apparently a *Pseudorhombus* (p. 299); but in the species described as *Paralichthys triocellatus* by Miranda Ribeiro, which is possibly also a *Pseudorhombus*, this character may vary with individual fish (p. 335).

The accessory scales appear rather late in the life of the fish and this character is probably a late evolutionary acquisition. In *P. dentatus* and *P. albigutta* they appear only after the fish has attained a length of about 75–90 mm., and in these two species they seem to develop at a smaller size than in the others. In *P. brasiliensis* they seem to develop first in specimens between 130 and 155 mm. On account of their late appearance the practical usefulness of this character is limited. The relative development of this character also differs much with the species. For instance, the accessory scales are profuse in large specimens of *dentatus* and *albigutta*, while in *brasiliensis* they are rather few in number. This character, therefore, is seemingly also not of transcendent importance in generic separation.

This character was neglected by authors in general and it is difficult to appraise its true value. Norman (Monogr., p. 46, 1934) states: ". . . the presence of supplementary scales . . . provide features of taxonomic importance." He includes this character in the definition of some genera but fails to mention it in others. Later, in discussing *Paralichthys isosceles*, Norman (Disc. Rept. vol. 16, p. 135, 1937) states: ". . . I am not convinced of the value of this character [the absence of supplementary scales] in the definition of genera." However, irrespective of the value of this character in the family as a whole, it is evident that in the species concerned it is of at least as much value as the other character employed in the delimitation of genera. Judged by the species studied by me, it seems likely that it will prove to be of greater value than the other characters for the major divisions of the species, in showing relationship and in the separation of genera. Of course, a final solution of the question must wait until this character is determined in all the species involved, its development with size, and its individual variability, especially in *triocellatus* which possibly forms an exception.

The foregoing consideration of the generic characters makes it evident that the three genera as now constituted are not sharply distinguished. With the possible exception of the accessory scale character, no other single character will delimit any one of the three genera concerned. The delimitation of the genera depends rather on a combination of characters and the lines drawn between them are more or less arbitrary. As far as our present knowledge of the morphology of the species studied is concerned there are substantial reasons for placing them in a single genus, *Paralichthys*, divisible into a number of subgenera. However, they evidently form groups of related species and in view of the comparatively large number of species involved, it is desirable to split them up into convenient genera. Another cogent reason for adopting this course is that by doing so the current nomenclature of the species will be least disturbed. It is also possible that a further, intensive study of the species will reveal satisfactory internal characters to separate the genera.

KEY TO AMERICAN SPECIES OF HIPPOGLOSSINA, PSEUDORHOMBUS, AND PARALICHTHYS [3]

A. Accessory scales absent in large as well as small fish.[4] Anterior teeth only slightly or not enlarged, sometimes moderately enlarged.

B. Origin of dorsal behind anterior margin of eye; eyeball and orbit very large to moderately large; interorbital reduced to a mere ridge; the three characters occurring together. Accessory branch of lateral line rather poorly developed, not reaching dorsal profile. Ctenoid scales either present on both sides or absent on both sides. Most prominent spots either 4 or 6, depending on the subgenus, in two longitudinal rows, occupying nearly the same positions in all the species; prepeduncular spot obsolescent or absent ---------- genus *Hippoglossina* (p. 287)

a. Orbit and eyeball strikingly large, 10.4 to 12.1 and 7.3 to 9.6, respectively, in large specimens. Origin of dorsal usually over or nearly over middle of eye in large as well as in small specimens. Preanal spine (first interhaemal) usually well developed and visible externally. Typical color pattern with 6 prominent spots, incompletely ocel-

[3] Species of which no specimens were examined are placed in brackets. See also p. 334 for three species of doubtful relationship and position.

[4] Small specimens of all the species lack accessory scales, have a narrow interorbital, a comparatively large eye, and the dorsal origin is more or less behind the anterior margin of the eye. Consequently, this key should be used with care in placing small specimens.

lated. Scales 45 to 56. Anal rays 46 to 55. Dorsal rays 60 to 70. Ctenoid scales present on both sides. Anterior teeth hardly enlarged.....subgenus *Hippoglossina* (p. 288)

b. Ctenoid scales on blind side extending forward to middle of body or more anteriorly. Depth 42.4 or less.

c. Entire number of gill rakers on first arch 11 to 13. Ctenoid scales on blind side usually extending nearly to shoulder girdle, varying to about a vertical through middle of arch. Maxillary with 3 to 6 cycloid scales. Dorsal rays 60 to 65. Anal rays 46 to 51. Depth 34.8 to 38.3; length and width of maxillary 13.7 to 14.9 and 3.2 to 3.7, respectively; head 30.8 to 32.8 (6 specimens 140 to 167 mm. measured).

Hippoglossina (*Hippoglossina*) *bollmani* (p. 288)

cc. Entire number of gill rakers on first arch 15 to 21. Ctenoid scales on blind side usually not extending forward of posterior angle in lateral line, varying to about a vertical through middle of arch. Dorsal rays 63 to 70. Anal rays 47 to 55. Depth 36.8 to 42.4.

d. Three cycloid scales on maxillary. Length and width of maxillary, 13.6 and 3, respectively; head, 30.7 (1 specimen 183 mm. measured). Coast of Chile.....*Hippoglossina* (*Hippoglossina*) *mystacium* (p. 289)

dd. Maxillary with a small patch of 7 to 16 scales, all or at least some of them ctenoid. Length and width of maxillary 14.6–16.1 and 3.6–4.2, respectively; head 31.5–33.7 (range of 7 specimens 138–208 mm.) Coasts of California and lower California.....*Hippoglossina* (*Hippoglossina*) *stomata* (p. 289)

[bb. Ctenoid scales on blind side present only on posterior third. Depth 43–45.

Hippoglossina (*Hippoglossina*) *macrops*] (p. 291)

aa. Orbit rather large, 7.4 to 9.3 in large specimens; eyeball 6.1–7.6 in large specimens. Origin of dorsal usually over space between anterior margin of eye and that of pupil in large specimens, nearly over middle of eye in small fish. Preanal spine covered by skin, not visible externally. Typical color pattern with 4 very prominent ocellated spots. Scales, 63–81. Anal rays, 58–72. Dorsal rays, 72–86.....subgenus *Lioglossina* (p. 293)

e. Ctenoid scales present on both sides, their number highly variable (p. 294), but at least a few alway spresent on head of eyed side and caudal peduncle of blind side. Anterior teeth very moderately enlarged. Anterior two spots on a vertical nearer to head than base of caudal. Atlantic.

Hippoglossina (*Lioglossina*) *oblonga* (p. 293)

ee. Scales all cycloid on both sides. Anterior teeth but slightly enlarged. Anterior two spots on a vertical about midway between posterior margin of head and base of caudal. Pacific.

Hippoglossina (*Lioglossina*) *tetrophthalmus* (p. 297)

BB. Origin of dorsal over or in front of anterior margin of eye; eyeball and orbit varying from comparatively small to rather large; interorbital varying from medium width to a mere ridge. Accessory branch of lateral line rather well developed, usually, but apparently not always, reaching dorsal profile. Ctenoid scales present on eyed side (except possibly in *tenuirastrum* (Norman Monogr., p. 95), present or absent on blind side depending on the species. Color pattern differing with the species, prepeduncular spot prominent in some. Includes one American species, *isosceles* (p. 299), possibly also *triocellatus* of Miranda Ribeiro (p. 334).....*Pseudorhombus* (p. 298)

AA. Accessory scales present (very few in *squamilentus*); usually beginning to develop on the fish reaching a length of about 75 to 150 mm.; their first appearance with respect to length differing with the species and to some extent with individual fish. Anterior teeth strongly enlarged in most species, caninoid, sometimes moderately enlarged, never subequal. Eye rather small. Most prominent spots usually forming a triangle including the prepeduncular spot.

Paralichthys (p. 300)

f. Scales on eyed side ctenoid, at least in fish up to about 160 mm.[5].....subgenus *Paralichthys* (p. 301)

[g. Origin of dorsal nearly on a vertical through middle of eye. Gill rakers on lower limb 18 to 23.

Paralichthys (*Paralichthys*) *microps*] (p. 301)

gg. Origin of dorsal approximately over anterior margin of eye, except in the young.

h. Gill rakers on lower limb not more than 11.

i. Dorsal of blind side not spotted. Pectoral approximately 2 in head.

j. Pectoral rays 12. Scales 76. Sinistral. Atlantic.....*Paralichthys* (*Paralichthys*) *patagonicus* (p. 301)

[jj. Pectoral rays 11. Scales 62. Dextral. Pacific.....*Paralichthys* (*Paralichthys*) *hilgendorfii*] (p. 304)

ii. Dorsal of blind side spotted. Pectoral 2.3 to 2.4 in head. Sinistral.

k. Scales 68. Gill rakers on lower limb 9.....*Paralichthys* (*Paralichthys*) *schmitti* (p. 305)

[kk. Scales 94. Gill rakers on lower limb 11.....*Paralichthys* (*Paralichthys*) *fernandezianus*] (p. 305)

hh. Gill rakers on lower limb not less than 15.

l. Depth 44–48 and scales ctenoid in large as well as in small specimens. Sinistral. Total number of gill rakers 22–27. D. 68–76. A. 54–61. Pacific Coast of South America.

Paralichthys (*Paralichthys*) *adspersus* (p. 306)

ll. Depth 37–45, when more than 43.5 (in *aestuarius*) scales becoming cycloid with growth. Very often dextral.

m. Scales retaining their ctenoid character at all ages. Dorsal rays 66 to 76. Anal rays 49 to 59. Total

[5] In *aestuarius* the scales lose their ctenoid character on reaching a length between 160 and 220 mm. Larger specimens of this species may be separated from others having cycloid scales by the many gill rakers, 24 or more in total number. In very large specimens of some other species the spinules on the scales may change to coarse granular asperities, but their early ctenoid condition and distinguishing nature is still evident.

number of gill rakers 25 to 32, the greatest concentration of individuals at 28 to 29. Depth 37 to 43.5. California and west coast of lower California---------- *Paralichthys* (*Paralichthys*) *californicus* (p. 307)

mm. Scales becoming cycloid with age (the change from ctenoid to cycloid scales taking place in fish between 160 and 220 mm.) Dorsal rays 75 to 85. Anal rays 57 to 67. Total number of gill rakers 24 to 31, the greatest concentration at 27 and 28. Depth 40 to 45. Gulf of California and west coast of Lower California---------- *Paralichthys* (*Paralichthys*) *aestuarius* (p. 310)

ff. Scales without spinules at all ages---------- subgenus *Chaenopsetta* (p. 312)

n. Gill rakers on lower limb of first gill arch 13 or more (except *woolmani* from the Pacific occasionally having 12 or 11).

o. Anal rays 54 to 60. Dorsal rays 68 to 81. Total number of gill rakers 17 to 21 in nearly all specimens, varying 16 to 22.

p. Head 29.5 to 31.4; maxillary 14.2 to 15.3; depth 44.6 to 48.7 (in 4 specimens 143 to 195 mm.). Pectoral rays predominantly 12, often 11; pectoral of eyed side usually reaching lateral line. Origin of dorsal usually over anterior margin of eye in medium-sized specimens. Pacific coast *Paralichthys* (*Chaenopsetta*) *woolmani* (p. 312)

pp. Head 27.2 to 28.7; maxillary 12.9 to 14.2; depth 39.8 to 45.6 (in 15 specimens 131 to 214 mm.). Pectoral rays predominantly 11, sometimes 10 on one or both sides; pectoral of eyed side usually falling short of lateral line. Origin of dorsal in medium-sized as well as large fish more or less in front of anterior margin of eye. Atlantic coast of South America---------- *Paralichthys* (*Chaenopsetta*) *brasiliensis* (p. 314)

oo. Anal rays 61 to 73. Dorsal rays 80 to 96. Total number of gill rakers nearly always 20 to 24, varying 16 to 24. Pectoral rays predominantly 12. Atlantic coast of the United States. *Paralichthys* (*Chaenopsetta*) *dentatus* (p. 316)

nn. Gill rakers on lower limb not more than 12. Atlantic.

q. Scales in not more than 60 rows over straight part of lateral line. Anal rays not more than 63.

r. Pectoral rays predominantly 11, varying 10 to 12. Ocellated spots present. East coast of United States. *Paralichthys* (*Chaenopsetta*) *albigutta* (p. 324)

rr. Pectoral rays 10. No well-marked ocellated spots. Brazil---------- *Paralichthys* (*Chaenopsetta*) *vorax* (p. 327)

qq. Scales usually in more than 60 rows; when less (in *lethostigma*) anal rays nearly always 64 or more (63 in 2 specimens of *lethostigma* out of 153).

s. Body moderately deep, not more than 43.8 in specimens 59 to 132 mm. (23 *lethostigma* measured), not more than 46.7 in specimens 134 to 472 mm. (36 *lethostigma* and 1 *tropicus* measured). Entire number of gill rakers on first arch 10 to 13. Accessory scales in rather moderate numbers or profuse.

t. Anal rays 58. Dorsal rays 75. Vertebrae 10+26. Interorbital 2.2. Accessory scales profuse (1 specimen 321 mm. studied). Trinidad---------- *Paralichthys* (*Chaenopsetta*) *tropicus* (p. 327)

tt. Anal rays 63 to 77. Dorsal rays 80 to 95. Vertebrae 10 to 11+27 (in 2 specimens). Interorbital 3.4 to 4.1 (in 8 specimens 310–383 mm.). Accessory scales usually in moderate numbers. East coast of United States---------- *Paralichthys* (*Chaenopsetta*) *lethostigma* (p. 328)

ss. Body notably deep, 46.6 to 52.3 in specimens 96 to 120 mm. (7 measured); 49.7–52.1 in specimens 333 to 370 mm. (4 measured). Entire number of gill rakers 13 to 16. Accessory scales very few. Anal rays 59 to 64. Dorsal rays 76 to 82. Vertebrae 10+28 (in 1 specimen). East coast of United States. *Paralichthys* (*Chaenopsetta*) *squamilentus* (p. 332)

HIPPOGLOSSINA

This genus is distinguished from *Paralichthys* (for definition see p. 300) and *Pseudorhombus* chiefly by the following combination of characters. Accessory scales absent. Origin of dorsal on space over pupil. Interorbital reduced to a mere ridge in large as well as in small specimens. Eye large. Teeth small. Scales either ctenoid on both sides or cycloid on both sides. Accessory branch of lateral line rather poorly developed, not reaching dorsal profile. Prepeduncular spot obsolescent; most prominent spots 4 or 6, depending on the subgenus, in two longitudinal rows. This genus is divisible into two subgenera.

The boundary between *Hippoglossina* and *Paralichthys* is not sharp. The accessory scales are sparse in some species of *Paralichthys*. In the dorsal origin and in the size of the eye and the teeth, the subgenus *Lioglossina* is rather intermediate between *Paralichthys* and the typical subgenus of *Hippoglossina*. One or two species of *Paralichthys* have a backward insertion of the dorsal (p. 301). One species, *coeruleosticta* (p. 335), apparently shows a combination of a number of characters common to both genera. However, the contained species apparently form, on the whole, two fairly distinct though not sharply divergent groups. But, if the two groups of species are recognized as distinct genera, *oblonga* which has been placed in *Paralichthys* by all recent authors must be placed in *Hippoglossina*.

Hippoglossina is even nearer to *Pseudorhombus*, both genera agreeing in the absence of accessory scales. They differ slightly in the origin of the

dorsal, over anterior margin of pupil or a little more backward in *Hippoglossina*, over anterior margin of eye or a little more forward in *Pseudorhombus*. The typical subgenus of *Hippoglossina* diverges in a more pronounced manner from *Pseudorhombus* in this respect, but the subgenus *Lioglossina* is rather intermediate. The accessory branch of the lateral line is poorly developed in *Hippoglossina;* it is usually well developed in *Pseudorhombus* reaching the dorsal profile in most, but apparently not in all the species. The interorbital is reduced to a mere ridge in *Hippoglossina;* in most species of *Pseudorhombus*, but apparently not in all, it is wider than a mere ridge. The eye in the typical subgenus of *Hippoglossina* is markedly large, but in the subgenus *Lioglossina* it is nearly the same as in some species of *Pseudorhombus*. In *Hippoglossina* ctenoid scales are present on both sides or absent on both sides; in *Pseudorhombus* ctenoid scales are present on the eyed side and present or absent on the blind side. No other characters than the foregoing are now known by which the two genera may be distinguished. They are hardly adequate as generic characters, and the separation of the two genera is now largely a matter of convenience.

Subgenus Hippoglossina

Hippoglossina STEINDACHNER, Sitzb. Akad. Wiss. Wien 74 (1): 161 (Ichthy. Beit. 5: 13) 1876 (genotype *Hippoglossina macrops* Steindachner by monotypy).

A comparative discussion of the differences between this subgenus and *Lioglossina* is given under the latter (p. 293). The four known species of this subgenus are confined to the Pacific Coast of North and South America, in rather deep water.

HIPPOGLOSSINA BOLLMANI

(PLATE 1)

Diagnosis.—Scales on eyed side ctenoid on head and body; on blind side cycloid on head, ctenoid on body, the ctenoid scales extending forward to within 3 to 8 rows of gill opening, sometimes to about a vertical through middle of arch in lateral line. Maxillary of eyed side with 3 to 6 cycloid, more or less embedded scales, usually in one row, sometimes in two irregular rows. Scales 45 to 49. No accessory scales. Gill rakers 11 to 13 in total number; 2 or 3 on upper limb; 9 or 10 on lower. Anal rays 46 to 51; dorsal rays 60 to 65. Pectoral rays on eyed side usually 11 (in 5), sometimes 10 (in 1); on blind side usually 10 (in 5), sometimes 11 (in 1). Origin of dorsal very nearly over middle of eye (specimens 140—167 mm. examined). Teeth nearly equal, the anterior ones slightly enlarged. Maxillary extending to a vertical through middle of eye or posterior margin of pupil. Eye conspicuously large; body slender; head and maxillary of medium length. Sinistral.

Color.—Specimens examined faded. Six conspicuous spots evident, 3 in a longitudital row below dorsal profile and a similar row above ventral profile, nearer to profiles than to a median line. Smaller spots evident on caudal peduncle, one each at base of caudal rays, at upper and lower angles, continued on blind side. A row of small white spots close to dorsal profile, and a similar row at ventral profile. Margins of caudal, dorsal and anal on blind side, blackish posteriorly.

Specimens examined and geographic distribution.—Panama Bay; Albatross Station 2805; lat. 07°56′ N., long. 79°41′30″ W.; 51.5 fathoms; March 30, 1888 (41143, the type; 41147, 41156, 41187, 41216, 41250). Number of specimens studied 6, 140 to 167 mm. Jordan and Bollman (1889) state on page 176, "Numerous specimens were dredged at station 2805," and on page 183 they record it from station 2804 as well. The latter station is a little north and east of 2805, namely, lat. 08°16′30″ N., long. 79°37′45″ W., 47 fathoms; but no specimens from that station are now present in the U. S. National Museum.

Distinctive characters and relationship.—This species differs from *stomata* chiefly in the smaller number of gill rakers as pointed out under the latter (p. 291), where the other characters distinguishing the two species are also discussed. Its relationship to *mystacium* and to *macrops* is discussed under the latter two species (pp. 289 and 292). What may prove to be a unique feature of this species is that the number of pectoral rays on the blind side is predominantly one less than on the eyed side. In all species of *Paralichthys* the numbers are predominantly the same on both sides, while *H. stomata* is rather intermediate in that respect.

Hippoglossina macrops JORDAN and BOLLMAN (not Steindachner), Proc. U. S. Nat. Mus. 12: 175, 1889 (Albatross Station 2805).—JORDAN and BOLLMAN, ibid., p. 183 (recorded from Albatross Stations 2805 and 2804).

Hippoglossina bollmani GILBERT, Proc. U. S. Nat. Mus. 13: 123, 1890 (based on Jordan and Bollman's account).—

JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 (3) : 2621, 1898 (No. 41143 designated as type).

Hippoglossina vagrans GARMAN, Mem. Mus. Comp. Zool. 24: 221, 1899 (off the coast of Colombia, 66 fath.; the structural characters given in original description agree with *bollmani*, but color somewhat different; needs further investigation).

Hippoglossina bollmani MEEK and HILDEBRAND, Field Mus. Nat. Hist. Chicago (zool. ser.) 15 (3) : 973, 1928 (compiled account).—NORMAN, Monogr. Flatfishes, p. 68, fig. 36, 1934 (reviewed).

HIPPOGLOSSINA MYSTACIUM

Diagnosis.—Scales on eyed side ctenoid on body, mostly cycloid on head, but many weakly ctenoid scales present; on blind side ctenoid scales present on posterior part of body, extending on midline to a distance behind arch about equal to half its chord, scales on head and on body anteriorly cycloid. Maxillary with 3 cycloid embedded scales in one row. Scales 52; 28 perforate scales in arch. Accessory scales absent. Gill rakers 3 comparatively long ones on upper limb, with 2 widely spaced and very small ones above; 12 on lower limb. Anal rays 55; dorsal rays 66. Pectoral rays 11 on eyed side, 10 on blind side. Origin of dorsal nearly over middle of eye. Anterior teeth but slightly enlarged. Maxillary extending to a vertical through posterior margin of pupil. Eye notably large; body rather slender; head and maxillary short, the maxillary conspicuously narrow distally. Sinistral.

Color.—Nearly faded; traces of 6 spots in 2 lengthwise rows present, as in other species of the subgenus, somewhat nearer to upper and lower profiles than to straight part of lateral line; every spot in either row placed on a transverse line with its fellow in the other row, first pair of spots on a transverse line through about middle of arch in lateral line, second pair on a vertical somewhat nearer to head than to base of caudal, third pair not far from ends of dorsal and anal fins; traces of smaller spots on caudal peduncle, near upper and lower posterior angles, at base of caudal rays, these two spots being continued to a slight extent on blind side.

Specimen examined and geographic distribution.—The above account is based on the type specimen (77393) 183 mm., taken near Taita Peninsula, Chile; Albatross Station 2787, 46°47′30″ S, 75°15′ W; in 61 fathoms. The two specimens examined by Günther and by Norman (see synonymy) extend the range of this species to the Straits of Magellan.

Distinctive characters and relationship.—In the number of gill rakers and dorsal and anal rays, the single specimen studied is more like *stomata* than *bollmani*. The extent of ctenoid scales on the blind side is less than in most specimens of *stomata*, but some individuals of the latter species approach *mystacium* closely. The ctenoid scales on the eyed side of the head are fewer, and in general, the ctenoid character of the scales is weaker than in *stomata*, but there is considerable variation in those respects in the latter species. A striking difference shown by the type specimen which attracts immediate attention is the narrow maxillary. This species also has a shorter head and maxillary than *stomata* (table 7). It further differs from *stomata* in having fewer scales on the maxillary, which are cycloid instead of ctenoid.

This species is apparently more remotely related to *bollmani*. It differs from the latter which occurs nearer to its range, in having more numerous gill rakers and dorsal and anal rays and in the ctenoid scales not extending so far forward. It agrees with *bollmani* in having cycloid scales on the maxillary. In the number of scales on the maxillary, the length and width of the maxillary and the length of the head, *mystacium* will most probably be found to intergrade with *bollmani*.

As compared with the original description of *macrops*, this species differs in having a more slender body, a shorter head, and the ctenoid scales on the blind side evidently extend more forward.

Hippoglossina macrops GÜNTHER, Proc. Zool. Soc. London 1881: 21 (Trinidad Channel, listed).—Thompson, Proc. U. S. Nat. Mus. 50: 424, 1916 (specimen from off Taita Peninsula forming type of *mystacium*).—NORMAN, Monogr. Flatfishes, p. 67, 1934 (account based on specimens recorded by Günther).

Hippoglossina mystacium GINSBURG, Jour. Washington Acad. Sci. 26: 130, fig. 1, 1936 (based on specimen recorded by Thompson).—Norman, Disc. Rep. 16: 132, 1937 (identification of specimens from Trinidad Channel corrected).

HIPPOGLOSSINA STOMATA

(PLATE 2)

Diagnosis.—Eyed side having nearly all scales on body ctenoid, those on head variable, usually nearly all ctenoid, sometimes the majority cycloid, but some ctenoid scales always present; on blind

side cycloid on head, ctenoid on greater posterior part of body, the ctenoid scales usually extending on midline to about posterior end of arch, in lateral line, varying with individual fish, with that point as a center, from a vertical about through the middle of the arch to an equal distance behind; broad wedge shaped areas of cycloid scales usually extending backward above and below the median ctenoid scales for variable distances, sometimes the ctenoid scales ending everywhere on the same, nearly straight, transverse line (above description applying to specimens 116 mm. or more; in two small specimens, 54 and 55 mm., ctenoid scales present only on posterior half of body, the spinules probably not having as yet developed on the more anterior scales; compare with account of *oblonga*, p. 294). Maxillary of eyed side with a small patch of 7 to 16 scales, usually in 3, sometimes in 2 or 4 irregular rows, all or nearly all ctenoid in medium-sized specimens (116–208 mm.) with the spinules rather well developed, sometimes a few of them cycloid; in larger specimens (240–313 mm.) most of them apparently cycloid but early ctenoid nature of a few at least always evident by rather weak spinules or granular asperities (in 2 specimens 54 to 55 mm. scales on maxillary rather small, cycloid and embedded apparently not far from beginning of development). Scales 45 to 56; accessory scales absent. Gill rakers on first arch modally 18 in total number, varying 15 to 21; 4 or 5, sometimes 6 on upper limb; modally 13 on lower limb, varying 11 to 15. Anal rays 47 to 55; dorsal rays 63 to 70. Pectoral rays nearly always 11 on eyed side (in 12 specimens), sometimes 12 (in 1); on blind side 10 (in 5), or 11 (in 8). Origin of dorsal very nearly over middle of eye in small and also large specimens, sometimes nearer to anterior margin of pupil than middle of eye in large fish. Teeth nearly equal, the anterior ones slightly enlarged. Maxillary extending to a vertical through middle of eye in 2 specimens 54 and 55 mm., generally to posterior margin of pupil in specimens 116 to 208 mm., to about posterior margin of eye or below the space between the posterior margin of pupil and posterior margin of eye in specimens 240 to 334 mm. Eye conspicuously large; depth medium; head and maxillary long, gradually increasing in length with growth up to largest specimens (compare with discussion on page 281). Sinistral.

Color.—Most specimens examined are faded, where color is present it may be described as follows: Ground color a light brownish yellow, irregularly speckled with darker; many ring-like spots of a dark brown on body and head, often the inside area of the ring becoming more or less pigmented like the periphery, except a small area near the margin, thus forming a rounded dark spot with a small lighter area on one side, the lighter area sometimes in form of a short curved band, the spot then suggesting an incomplete ocellus; 6 spots especially conspicuous and persisting in nearly all faded specimens, forming a longitudinal row of three spots below dorsal profile and a similar row over ventral profile; the pair of anterior spots usually less prominent than other 4 on a transverse line dividing an imaginary chord of the arch into two unequal parts, about three-fifths anteriorly and two-fifths posteriorly; middle pair of spots on a vertical somewhat nearer to head than base of caudal; posterior pair of spots near ends of vertical fins, extending partly on the fins. A pair of smaller spots on caudal peduncle, one above and one below, at base of caudal rays, more or less evident, these spots continued for a short distance onto blind side. Caudal of blind side, and to a lesser extent also anal and dorsal, shaded with dark in some specimens. In the two smallest fish, 54 and 55 mm., a faint lighter bar, bordered faintly with a diffuse darker pigmentation extending across the fish between each of the posterior two pairs of spots. The color in life, according to Eigenmann, is strongly tinged with blue, with numerous spots of light blue and with five pairs of dark brown ocelli, the alternate ones more conspicuous. The latter spots are evidently those which persist in preserved specimens, but their ocellate character disappears or becomes faint after preservation.

Lectotype.—Two specimens were described by Eigenmann without designating a holotype. One of these, U.S.N.M. 41905, 315 mm. in total length, is hereby designated as the lectotype.

Specimens examined.—Santa Barbara Channel, off Santa Barbara, Calif.; Albatross Station 2961; lat. 34°22′45″ N. long. 119°40′30″ W; 21 fathoms; Feb. 11, 1889 (47289). Santa Barbara Channel, off Ventura, Calif.; Albatross Station 2971; lat. 34°20′23″ N. long. 119°37′50″ W; 29 fathoms; Feb. 11, 1889 (46324). Nearly same position as

preceding; Albatross Station 2970; lat. 34°20′20″ N. long. 119°37′30″ W; 29 fathoms; Feb. 11, 1889 (46420). Off Avalon, Dakins Cove, Santa Catalina I., Calif., Albatross Stations 3662 and 3663; 47 fathoms, April 8, 1897 (77967). San Pedro Channel, Calif.; Albatross Station 2939; lat. 33°36′ N. long. 119°09′30″ W; 27 fathoms; Feb. 5, 1889 (46331; 46344). San Diego, Calif.; Albatross, 1897–8 (59545). Off Point Loma, San Diego, Calif.; in deep water; Nov. 7, 1889 (41905; the lectotype). Off the southern boundary of California; Albatross Station 2934; lat. 32°33′30″ N. long. 117°16′ W; 36 fathoms; Jan. 26, 1889 (46421). Off Bahia de Ballenas, Lower California; Albatross Station 3044; lat. 26°16′15″ N, long. 113°42′15″ W; 58 fathoms; Apr. 10, 1889 (46419); Albatross Station 3039; lat. 24°27′ N. long. 111°59′ W; 47 fathoms; April 8, 1889. Off Cape Tepoca, Gulf of California; Albatross Station 3018; lat. 30°16′ N. long. 113°05′ W; 36 fathoms; Mar. 24, 1889 (46342). Total number of specimens studied 16, 54 to 332 mm.

Geographic and vertical distribution.—The geographic range of the species as established by the material examined extends from off Santa Barbara, Calif., to near the northern end of the Gulf of California; the range in depth being 21 to 58 fathoms. The record by Starks and Morris carries the distribution northward to Point Conception, Calif. Gilbert (1915) records a depth of 74 fathoms.

Size.—The largest specimen examined 334 mm. (13 inches), 275 mm. without the caudal, stands for the present as the record size of the species.

Distinctive characters and relationship.—This species differs from *bollmani* chiefly in the number of gill rakers, the total number on the first gill arch being 15 to 21 in *stomata* and 11 to 13 in *bollmani;* although it is possible that when larger series are counted the two species may be found to approach one another in that character or even to intergrade. It usually has more numerous scales on the maxillary than *bollmani*, and these scales are ctenoid instead of being cycloid as in that species. Most specimens of medium size may be distinguished by the extent of the ctenoid scales usually extending forward to the posterior end of the arch in the lateral line in *stomata*, and usually nearly to the gill opening in *bollmani*, but sometimes individual fish cannot be distinguished on that basis. Other important differences are found in *stomata* having, on the average, more numerous dorsal and anal rays, a deeper body and longer maxillary than *bollmani*, but there is considerable intergradations in those characters, although the two species will no doubt prove to have distinct modes even after much greater numbers are studied. This species is evidently more closely related to *mystacium* than to *bollmani*, as far as shown by the structural characters. The relation of *stomata* to *mystacium* and to *macrops* is discussed under the accounts of the latter two species.

Hippoglossina stomata Eigenmann, Proc. California Acad. Sci. (2) **3**: 22, 1893 (off San Diego, Calif.; in deep water).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47 (3) : 2620, 1898 (after Eigenmann).—Gilbert, Rept. U. S. Comm. Fish. 1898 : 28, 1899 (off Catalina Island, Calif.; 47 fathoms).—Starks and Morris, Pub. Univ. California (Zool.) **3**: 242, 1907 (off southern part of Lower California, north to Point Conception).—Metz, First Ann. Rept. Laguna Lab., p. 60, 1912 (Newport, Calif.; recorded under *Hippoglossoides*).—Gilbert, Proc. U. S. Nat. Mus. **48**: 377, 1915 (Point Conception to Ballenas Bay; 21—74 fathoms).—Hubbs, Pub. Univ. Calif. (Zool.) **16**: 168, 1916 (San Diego Market).—Starks, California Fish and Game **4**: 168, fig. 87, 1918 (brief general account).—Ulrey and Greeley, Bull. Southern California Acad. Sci. **28** (1) : 26, 1928 (Catalina I., Long Beach, Newport, Point Firmin, Venice, San Diego, all localities in California).—Norman, Monogr. Flatfishes, p. 66, fig. 34, 1934 (reviewed).

Hippoglossina bollmani Hiyama, Marine Fishes of the Pacific coast of Mexico, edited by T. Kumada, p. 59, pl. 92, fig. A, 1937 (Mexico, no definite locality given; the inadequate account agrees most nearly with *stomata* and is probably based on specimens of this species).

HIPPOGLOSSINA MACROPS

This species was described from Mazatlan, the Pacific Coast of Mexico, based on specimens "11–12 Zoll" long. The most essential characters as stated in the original description are as follows: Scales on eyed side of body all ctenoid, on blind side ctenoid scales present only on posterior third, about 52, A. 52, D. 66 to 67, P. 10–12. Dorsal origin over middle of eye. The figure shows a very large eye and narrow interorbital. Teeth small. Maxillary extending to a vertical slightly behind middle of eye. Depth 43 to 45; head 33 or a little shorter; maxillary 13. Steindachner's figure shows a dextral flounder, but some statements in the original description are evidently based on a sinistral fish.

No specimens are available for comparison and the relation of this species to the other three described above must remain somewhat doubtful for the present. An important character, namely, the number of gill rakers is omitted from the original description. It apparently differs from the other three species in that the ctenoid scales on the blind side do not extend as far forward, being present only on the posterior third of the body, and in having a deeper body. It further differs from *stomata* in having a shorter maxillary.

The taxonomic status of this species which is the genotype of *Hippoglossina* is uncertain. The use of the name *macrops* has an interesting history which has a bearing on the status of the species, and the different authors are discussed here in chronological order, omitting the four references cited in the synonymy which are based on Steindachner's orginal account. The original specimens were stated by Steindachner to have been taken at Mazatlan, but later authors ascribed it to the coast of Chile, apparently without comparing their specimens with the types.

Günther (1881) merely lists this species from Trinidad Channel without describing his specimens. They were later described by Norman as discussed below.

Abbott (Proc. Acad. Nat. Sci. Philadelphia, 1899, p. 475, 1900) records a specimen from Valparaiso Harbor, Chile, which he states "agrees with the description of *H. macrops* so exactly in every detail as to leave no doubt whatever of its identity." This author concludes that the locality, Mazatlan, given in the original description, is an error. Abbott's specimen is dextral, has 6+11 gill rakers and a well developed, antrorse, preanal spine.

Lönnberg (Ergeb., Hamburger Magalh., Sammelr., Fische, p. 14, 1907) records two specimens under *H. macrops* without describing them, one from Smyth Channel, Straits of Magellan, and one from Coronel, Chile. Later, Norman (1937, see below) cites Lönnberg's record, with a query, under two species, evidently suggesting that the two specimens mentioned possibly belong to one or two species, *mystacium* and *macrops*.

Norman (Monogr., p. 67, 1934) gives a description of two of Günther's specimens under the name of *H. macrops*. Later, Norman (Discovery Rept. vol. 16, p. 132, 1937) examined another specimen from the coast of Chile which proved to differ specifically from the two specimens he previously (1934) referred to *macrops*. Norman now concludes that the two specimens previously recorded by him and by Günther as *macrops* belong to *mystacium* while his later specimen, taken at lat. 38°22′, represents *macrops*. Its essential characters are as follows: Scales about 51; ctenoid scales on blind side only on posterior part of the body. Gill rakers 12 on lower limb. A. 56; D. 69. Pectoral of eyed side with 12 rays. Maxillary extending to below middle of eye. Head about 33; depth 42.

It is not possible to surmise what Abbott's and Lönnberg's specimens represent. They must be restudied and their pertinent characters established. As to Norman's specimen, it evidently is different from any of the three species examined by me; but whether it represents *macrops* is another question. The fish fauna of Mazatlan, the offshore fishes in particular, are not well enough known to be sure that a certain species does not occur there. Considering that *stomata* which seems to be closely related, has been taken on the Pacific Coast of Mexico, it is altogether within the realm of possibility that a species corresponding to the description of *macrops* will also be found to exist on that coast, and that two closely related species of the same genus live side by side. Should this surmise prove to be true, the probabilities are that none of the 4 specimens examined by the last-named three authors represent *macrops*, because nearly all of the species treated here have a comparatively restricted geographic distribution. Another possibility is that the original account of *macrops* is not quite accurate and that the species here described as *stomata* represents Steindachner's *macrops*. This suggestion is fortified by the fact that *stomata* is a common species and that it has apparently been taken on the Pacific coast of Mexico as recorded by Hiyama p. 291).

Hippoglossina macrops STEINDACHNER, Sitzb. Ak. Wiss. Wien 74 (1) : 161 (Ichth Beit. 5: 13), pl. 3, 1876 (Mazatlan, Mexico).—JORDAN and Goss Rept. U. S. Comm. Fish. 1886: 242, 1889 (after Steindachner).—JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 (3) : 2621, 1898 (after Steindachner).—JORDAN and others, Rep. U. S. Comm. Fish. 1928: 223, 1930 (listed).

Subgenus Lioglossina

Lioglossina Gilbert. Proc. U. S. Nat. Mus. 13: 122, 1891 (genotype *Hippoglossina tetrophthalmus* (Gilbert) = *Lioglossina tetrophthalmus* Gilbert by original designation).

This subgenus differs structurally but slightly from *Hippoglossina*. The most striking difference is in the size of the eye which is notably large in the species of the subgenus *Hippoglossina* and not so large in the two species here placed in the subgenus *Lioglossina*. Combined with this difference is the somewhat more anterior position of the dorsal origin with respect to the anterior margin of the eye in medium-sized and large specimens of *Lioglossina*, and the weakly developed preanal spine which does not project exteriorly. Still another difference is found in the number of scales which is greater in the two known species of *Liogossina;* but since the number of available specimens in most species of these two subgenera is limited, the value of this character is uncertain. Quite probably, counts of more specimens will show a certain degree of intergradation. Other differences are given in the key. While these differences are hardly sufficient for subgeneric division, the species of *Hippoglossina* have a markedly distinctive physiognomy, due chiefly to their strikingly large eye and the 6 conspicuous spots. A consideration of all the characters makes it seem desirable to maintain *Lioglossina* as a subgenus distinct from *Hippoglossina*.

Lioglossina was originally based on, and distinguished from *Hippoglossina* by its cycloid scales. This seems adequate as far as the genotype, *tetrophthalmus*, is concerned. However, *oblonga*, which is obviously most nearly related to *tetrophthalmus* (p. 297), always has at least some ctenoid scales. Their number in that species is subject to great individual variability and some specimens have very few ctenoid scales (p. 294). It would seem to do violence to a natural arrangement of the species to place *oblonga* and *tetrophthalmus* in separate subgenera. The presence or absence of ctenoid scales in this subgenus is, therefore, regarded as of specific importance only, although in *Paralichthys* where this character clearly distinguishes two groups of related species, it is used for subgeneric division. The two known species are American.

HIPPOGLOSSINA OBLONGA
Fourspotted flounder
(PLATE 3)

Common name.—The four prominent spots on the eyed side of this species, usually surrounded by a ring of lighter color, suggests an appropriate common name for it, as given above. This name is generally employed in accounts of the species, and is here adopted. This common name conflicts with that of another species, *Ancyclopsetta quadrocellata*, which occurs in shallow water on the coast of the southern States. In order to distinguish the shallow water species, the name "fourspotted shoal flounder" is suggested for the latter fish, and since the present species is the more important one from an economic point of view, the shorter name is adopted for it.

Diagnosis.—At least a few ctenoid scales present on blind side of caudal peduncle in fish between 60 and 75 mm. or longer; ctenoid scales present on eyed side of head in large specimens, usually present also on posterior part of body on both sides; the number of spinuliferous scales highly variable; scales 63 to 81. No accessory scales. Gill rakers on lower limb of first arch rather short and stumpy, usually 8 or 9 in number, sometimes 7 or 10; on upper limb usually 2 gill rakers at angle somewhat similar to those of lower limb, and 3 to 5, usually 4, tuberosities above; tuberosities rarely becoming somewhat elongate, resembling short chunky gill rakers; sometimes the uppermost one of the two gill rakers at the angle shortened resembling the tuberosities; total number of gill rakers, not including the tuberosities, usually 10 or 11, sometimes 9, infrequently 12 or 13. (The structure and number of gill rakers, as described, is the same in the smallest specimens examined, 44 mm.; the tuberosities, therefore, not representing the stumps of gill rakers of young fish, but being the normal condition in this species, probably representing a remnant of a more remote phylogenetic condition.) Anal rays 58 to 72; dorsal rays 72 to 86. Pectoral rays usually 11, frequently 12, sometimes 10 (11 on both sides in 5 specimens, 12 on both sides in 3, 10 on blind side and 11 on the other in 1, 11 on blind side, and 12 on the other in 3). Origin of dorsal usually over anterior margin of pupil in small fish, generally over space between anterior margin of eye and that of pupil in medium-sized and large specimens. Teeth subequal in small fish,

a few anterior maxillary teeth becoming moderately enlarged in large individuals, more so than in other species of *Hippoglossina*. End of maxillary falling on a vertical through middle of eye at 50 mm., generally under posterior margin of pupil at 75 mm., under space between posterior margin of pupil and that of eye in large specimens. Interorbital a mere ridge; eye medium large; depth 39.5 to 43.5; head 25 to 29; maxillary 11.7 to 13.6; upper orbit 7.4 to 9.3; upper eyeball 6.1 to 7.6 (measurements of 11 specimens 244 to 328 mm.). Sinistral.

Development and variability of spinules on the scales.—The spinules begin to appear first on the scales of the blind side when the fish reaches a total length of about 60 mm., as a rule, sometimes not appearing until 70 or 75 mm. The scales at the base of the caudal are the first ones to develop spinules. In fish of that length the spinules are visible as well marked, tiny, and somewhat rounded points clearly and cleanly projecting beyond the margin of the scale. As the fish continues to grow the spinules appear successively on the more anterior scales. At the beginning a single conspicuous spinule appears on any one of the scales, the number of spinules increasing with size. During the process of development, therefore, the posterior scales, at the base of the caudal may have several conspicuous spinules, the anteriormost ctenoid scales, one spinule each, the numbers on each scale gradually decreasing from behind anteriorly. The spinules on the scales of the eyed side appear much later, sometimes in fish of about 100 to 110 mm., and quite often not appearing in fish as long as 135 mm. or longer. The spinules on any one scale of the blind side are generally more numerous and somewhat stronger than on the eyed side.

While the ctenoid scales increase gradually in number with size, their numbers are also highly variable with individual fish. In large fish they are nearly always present on the caudal peduncle of both sides, infrequently on the blind side only, and are also nearly always present on the eyed side of the head. Sometimes the spinuliferous scales extend over the posterior half or even two-thirds of the body, rarely over nearly the entire body. The spinuliferous scales are usually more numerous, and the spinules are somewhat better developed on the blind side, but sometimes they are more numerous on the eyed side. The spinules sometimes become visible only after drying the specimen, especially in those which are thickly covered with mucus, but they may always be felt by passing the sensitive tip of the finger forward over the surface of the fish.

Color.—Body always having 4 strongly marked ocellated spots in the same and characteristic positions; one each near the ends of the dorsal and anal fins, respectively; and one each near the dorsal and ventral profiles, on a vertical a little nearer to the head than the base of the caudal. Body and head otherwise variously mottled with lighter and darker shades. Ventral of eyed side with a small black spot at its distal margin; small specimens having this spot diffuse, or with three diffuse spots side by side. The caudal, dorsal, and anal on blind side characteristically peppered with minute dark chromatophores, distally.

The 4 characteristic ocellated spots are present in the smallest specimens examined, 40 mm. In small fish, 40 to 50 mm., the eyed side is thickly and uniformly spotted with small specks which may be more or less confluent, while the blind side is more or less profusely, but not thickly, sprinkled with minute clear cut dots which do not coalesce. The chromatophores on the blind side, except for the fins as described above, become more diffusely scattered at 60 mm. and entirely disappear at 75 mm.

Size.—This is a comparatively small species. The bulk of the specimens captured are about 12 inches or less. The maximum length on record is that given by Storer (1863), 16 inches. The largest examined is 13½ inches (340 mm.). Nichols and Breder (1927) record a maximum length of 15 inches, and a weight of 13 ounces.

Distinctive characters and relationship.—There is no trouble in properly identifying specimens belonging to this species. The characteristic position of the four prominent ocellated spots is unlike that of any other related American species found in the Atlantic. Also, the spots are unusually well marked, even in preserved specimens, as compared with the other related species. In rare cases, when the spots become faint in preserved fish, they may be identified by a combination of structural characters, namely, the absence of accessory scales, the presence of ctenoid scales, the comparatively small scales, and the few gill rakers. Its nearest relative

is evidently *P. tetrophthalmus* from the Pacific. The latter species besides agreeing with *oblonga* in nearly all the essential characters also has the same color pattern.

Specimens examined.—Provincetown, Mass. (24365). Cape Cod Bay, Mass. (24334; lat. 41°55′ long. 70°07′, 6 fathoms). Off Nantucket, Mass. (33359, lat. 40°43′ long. 70°45, 31 fathoms). Woods Hole, Mass. (10731; 45601). Vineyard Sound, Mass. (54905, 54910, 54916, 54927, 54933, and 54890). Menemsha Bight, Martha's Vineyard, Mass. (16552; 28702). Katama Bay, Martha's Vineyard, Mass. (58859). Buzzards Bay, Mass. (28861). West Bay, Newport, R. I. (25853, 12.5 fathoms; 25893, 5 fathoms). Noank, Conn. (14036). Long Island Sound at Milford (67600) and Stratford (67613; 676618; 67628), Conn. Long Island Sound, N. Y. (70207; 73413). Orient, Long Island, N. Y. (7061 A. M. N. H.). Tompkinsville, N. Y. (15089). Off Long Island (31673, lat. 40°03′ long. 70°45′, 70 fathoms; 31672, lat. 40°02′ long. 70°45′, 89 fathoms; 31691, lat. 40°02′ long. 70°35′, 100 fathoms; 33023, lat. 40°02′ long. 70°27′, 239 fathoms; 28711, lat. 40°01′ 24″ long. 70°46′, 98 fathoms). Off New Jersey (33534, lat. 39°59′ 15″ long. 70°36′30″, 143 fathoms; 28752, lat. 39°54′ long. 69°51′30″, 134 fathoms; 35508, lat. 39°33′40″ long. 72°08′45″, 87 fathoms; 33022, lat. 39°29′ long. 72°19′55″, 74 fathoms). Off Virginia (32684, lat. 37°19′45″ long. 74°26′06″, 102 fathoms). Off North Carolina (32785 lat. 36°38′30″ long. 74°40′10″, 81 fathoms; 45600, lat. 35°38′ long. 74°53′, 49 fathoms). Off South Carolina (45669, lat. 32°53′ long. 77°53′, 99 fathoms). About 15 miles south of Tortugas, Longley (92042). Total number of specimens examined 113, 40 to 340 mm.

Geographic and vertical distribution.—Northward this species has been recorded from Gloucester Harbor and also from Salem Harbor, Mass., by Goode and Bean (1879), as *Chaenopsetta oblonga* and as *Pseudorhombus oblongus*. However, later (1896) the same authors state: "The northern limits of its range is marked by the capture of a single small individual in 1877, off the mouth of Salem Harbor." This would make it seem likely that their previous reference to Gloucester Harbor was an error, but the authors may have overlooked that record. There is also a record from farther north on the register of the National Museum, apparently unpublished heretofore, namely, off Nova Scotia, lat. 45°25′ N. long. 57°10′ W., 170 fathoms. This record (23905) entered in the register in 1880 as *Pseudorhombus oblongus* could not be verified as to the identification, since the specimen is not available at present. The southernmost record previously published is apparently that of Longley (1941) from off Tortugas. The specimens examined as listed in the preceding paragraph cover the range from Provincetown, Mass., to Tortugas, Fla.

The vertical distribution of the species is interesting in that it varies from north to south. Near the northern end of its range, between Massachusetts and New York, it is common in comparatively shallow water just off the coast and in the larger bays and sounds where it is sometimes taken in large numbers between 5 and 15 fathoms. South of New York, however, it appears to be essentially a deeper-water species, occurring in water beyond the 20-fathom line. This evidently explains the paucity of records for this species south of New York, since so little trawling is carried on farther south in deep water. (At the northern extreme end of its range it possibly also occurs in deep water only, judging by the record from off Nova Scotia mentioned in the preceding paragraph.) The greatest depth at which it was taken is 239 fathoms (33023).

Biology.—No comprehensive study of this flounder was ever published and very little is known about the life history of the species. Smith (1898) states that: "The fish spawns in May and its eggs have been experimentally hatched at Woods Hole. The eggs are buoyant, one-twenty-sixth of an inch in diameter, and hatch in eight days in water having a mean temperature of 51° to 56° F." Bigelow and Schroeder (1936) record the capture of ripe specimens in mid-July. Some pelagic larvae taken by Bigelow and Welsh (1924) off the coast of New Jersey on July 19 and August 1, 1913, 8 to 11 mm. have been tentatively identified by those authors as belonging to this species. Fish of about 40 mm. are taken on the bottom with dredges or trawls.

The National Museum has a number of young fish for some of which the dates of capture are known. Since it is quite likely that no extensive study of this species will be undertaken for some time to come, it seems desirable to work up the

data which are presented in table 9. The data are too meager for general conclusions. However, they seem to indicate that the young reach a length of 80 to 160 mm. (3 to 6 inches) by the end of September. It seems also that the variation from year to year in the length at a given date is rather moderate.

Economic importance.—Although this fish is sold in the market, there is no way of gauging its importance in the flounder fishery, since those marketed are not sold under a distinctive name but are lumped with other flounders. Because of the small size, its economic importance is probably not great. It sometimes occurs in quantity from New York to Massachusetts beyond the five fathom line and is taken in dredges, trawls, or weirs. At Woods Hole, Mass., it is most common during May and June, while off New York it is "common in rather deep water" in November (Nichols and Breder). Pearson (1932) found it to a small extent in the winter trawl fishery off Virginia and North Carolina. This author, however, does not state whether the species was taken off the coast of both States, or only off the coast of Virginia. Judging by the vertical distribution of this species (p. 295), it seems probable that it does not occur in any numbers in the shallower waters off North Carolina where the winter trawlers operate. Farther south it is seldom captured apparently because the usual fishing operations do not extend to the depths inhabited by this species in southern waters.

Pleuronectes oblongus MITCHILL, Trans. Litt. and Phil. Soc. New York 1: 391, 1815 (New York).

Platessa quadrocellata STORER, Proc. Boston Soc. Nat. Hist. 2: 242, 1848 (Provincetown, Mass.)

Platessa quadrocularis GILL, Cat. Fish. N. Amer. (supp. Proc. Acad. Nat. Sci., Philadelphia, 1861), p. 51, 1861 (no description, only a citation to Storer: change of name either a lapsus, or regarded more appropriate).

Platessa quadrocellata STORER, Mem. Amer. Acad. Arts Sci., Boston 8: 397, pl. 31, fig. 3, 1864; also in Hist. Fish. Mass., p. 203, 1867 (Provincetown, Mass.).

Chaenopsetta oblonga GILL, Proc. Acad. Nat. Sci., Philadelphia, 1864: 218 and 223.

Pseudorhombus oblongus LYMAN, Sixth Ann. Rep. Comm. Inland Fish. Massachusetts, p. 47, 1872 (Waquoit, Mass.).

Chaenopsetta oblonga BAIRD, Rept. U. S. Comm. Fish. 1871–72, p. 824, 1873 (Woods Hole, Mass.).—GOODE AND BEAN, Amer. Jour. Sci. Art. (3) 17: 40, 1879 (Gloucester Harbor).

Pseudorhombus oblongus GOODE and BEAN, Bull. Essex Inst. 11: 7, 1879 (mouth of Salem Harbor).—Bean, Proc. U. S. Nat. Mus. 3: 79, 1880 (Noank, Conn.; Woods Hole and Provincetown, Mass.).

Paralichthys oblongus GOODE, Proc. U. S. Nat. Mus. 3: 472, 1881 (Station 873, off Martha's Vineyard, lat. 40°02′ N., long. 70°57′ W., 100 fath.).—JORDAN and GILBERT, Bull. U. S. Nat. Mus. 16: 824, 1883 (specimens from Woods Hole, Mass.).—BEAN, Rept. U. S. Comm. Fish., 1882: 340, 1884 (Woods Hole, Mass.).—GOODE, Fish. Ind. U. S., Sec. 1, p. 181, pl. 43, 1884 (Salem Harbor, Mass.; New York to New England).—JORDAN and Goss, Rept. U. S. Comm. Fish., 1886, p. 249, pl. 3, fig. 8, 1889.—GOODE and BEAN, Ocean. Ichth., p. 436, 1896 (mouth of Salem Harbor, Mass.; Buzzards Bay, Mass.: off Virginia, lat. 37°07′ N., long. 74°34′30″ W., 46 fath.; off N. Carolina, lat. 35°58′ N., long. 74°53′ W., 49 fath., lat. 35°42′ N., long. 74°54′30″ W., 43 fath.; off S. Carolina, lat. 32°53′ N., long. 77°53′ W., 99 fath.; general range given as Florida to Massachusetts).—JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 (3): 2632, pl. 374, fig. 924, 1898 (Woods Hole, Mass.).—SMITH, Bull. U. S. Bur. Fish. 17: 108, 1898 (Woods Hole, Mass.).—BUMPUS, Thirtieth Ann. Rept. Comm. Inland Fish. Rhode Island, p. 53, 1900 (Narragansett Bay, R. I.).—BEAN, 6th Ann. Rept. Forest Fish Game Comm. New York [Cat. Fish. Long Island], p. 473, 1901.—BEAN, 7th Rept. Forest Fish Game Comm. New York [Food and

TABLE 9.—*Length frequency distribution, by date of capture, of some young individuals of* Hippoglossina oblonga

Length	Aug. 16–23, 1880, Narragansett Bay, R. I.	Aug. 26, Buzzards Bay, Mass.	Aug. 29, 1879, Cape Cod Bay, Mass.	Sept. 3, 1875, Menemsha Bight, Mass.	Sept. 3–9, 1892, Vineyard Sound, Mass.	Sept. 10, 1874, Noank, Conn.	Sept. 17, 1890, Long Island Sound, N. Y.	Sept. 19, 1899, Katama Bay, Mass.	Sept. 25, Long Island Sound, N. Y.	Sept. 29, Long Island Sound, N. Y.	Sept. 29–30, 1892, Vineyard Sound, Mass.	Oct. 1–8, 1890, Long Island Sound, N. Y.
40 millimeters					1							
50 millimeters		3			1							
60 millimeters		2		2	2		1					
70 millimeters	1	1										
80 millimeters	2	3	2								1	
90 millimeters	2	3	2									
100 millimeters	2		5		3	1			1			1
110 millimeters			4		4					1	1	1
120 millimeters			1		3			1			1	1
130 millimeters	1		2									
140 millimeters												2
150 millimeters												
160 millimeters												1

Game Fishes of New York], p. 457, fig., 1902 (New York).—Bean, Cat. Fish. New York, p. 721, 1903.—Sharp and Fowler, Proc. Acad. Nat. Sci. Philadelphia 56: 512, 1904 (Nantucket, Mass.).—Kendall, Occ. Pap. Boston Soc. Nat. Hist. 7 (8): 147, 1908 (Gayhead, North Truro and Monomoy, Mass.; off Stratford, off Bridgeport, Middle Ground, off Faulkners Island, off South West Ledge and off Branford Beacon, Conn.).—Tracy, Fortieth Rept. Comm. Inland Fish. Rhode Island, p. 162, 1910 (R. I.).—Kendall, Rept. Comm. Fish. Game Massachusetts, 1910: 151, 1911 (Tisbury Great Pond, Mass.).—Sumner, Osburn, and Cole, Bull. U. S. Bur. Fish. 31 (1): 163, chart 208, 1913 (Woods Hole, Mass.).—Bigelow and Welsh, ibid. 40 (1): 494, fig. 205, 1925.—Nichols and Breder, Zoologica 9: 177, fig. 252, 1927 (Orient and Sandy Hook Bay, N. Y.).—Schroeder, Copeia, 1931: 45 (Off New Jersey, lat. 39°23′ N., long. 72°18′ W., 88 fathoms; lat. 40°04′ N., long. 73°14′ W., 28 fath. Off Rockaway, New York, 11 fath.).—Pearson, U. S. Comm. Fish., Inv. Rept. 1 (10): 24, 1932 (off Virginia and North Carolina, taken in the winter trawl fishery).—Norman, Monogr. Flatfishes, p. 79, fig. 45, 1934 (Woods Hole, Vineyard Sound, and Buzzards Bay, Mass.; off Long Island, N. Y.).

Hippoglossina oblonga Ginsburg, Jour. Washington Acad. Sci. 26: 131, 1936 (systematic position discussed).

Paralichthys oblongus Bigelow and Schroeder, Bull. U. S. Bur. Fish. 48 (20): 340, 1936 (southern half of Georges Bank; Virginia Capes; depth 10–112 fathoms).—Longley, Carnegie Inst. Washington Publ. 535: 39, 1941 (Tortugas, deep water).

HIPPOGLOSSINA TETROPHTHALMUS

(PLATE 4)

Diagnosis.—Scales all cycloid on both sides in small as well as large specimens; 63 to 69. No accessory scales. Gill rakers rather short, 2 on upper limb of first gill arch with 1 to 4 tubercles above, 9 to 10 on lower limb. Anal rays 58 to 63; dorsal rays 76 to 85. Pectoral rays 10 to 12 (10 on both sides in 1; 11 in another; 11 on eyed side, 10 on right in 1; 12 on eyed side, 11 on right in another). Origin of dorsal but slightly in front of anterior margin of pupil in large specimens, nearly over middle of eye in small fish. Teeth small and subequal, a few anterior ones in upper jaw but slightly enlarged. Maxillary reaching to a vertical through posterior margin of eye in large specimens, through posterior margin of pupil in small fish. Interorbital reduced to a mere ridge; eye large; depth 42 to 44.6; maxillary 13.9 to 14.1; head 29.5 to 30.1; upper orbit 8 to 9; upper eyeball 6.3 to 6.5 (measurements of 3 large specimens, 274 to 332 mm.; in 1 small specimen, 51 mm.; depth 38.8, maxillary 15.8, head 33.5, eyeball 10). Sinistral.

Color.—Four large, well-marked, ocellated spots on eyed side in approximately same position as in *oblonga*, but two foremost spots in a more posterior position, placed on a vertical about midway between hind margin of head and base of caudal. A large spot on ventral of eyed side at upper, distal angle, faintly ocellated in one specimen. Underside of vertical fins and caudal profusely sprinkled with minute dark dots, in one large specimen; blind side of body similarly sprinkled.

Lectotype.—Two specimens were described by Gilbert who did not designate a holotype, and U.S.N.M. 47290 is hereby designated as the lectotype.

Specimens examined and geographic distribution.—Gulf of California at Tiburon I., taken by the Albatross; 1 specimen 332 mm., Station 3014, lat. 28°28′ N., long. 112°04′30″ W., 29 fathoms, Mar. 23, 1889 (47290, the lectotype); 1 specimen 322 mm., Station 3016, lat. 29°40′ N., long. 112°57′ W., 76 fathoms, March 24, 1889 (47268). Gulf of California off Bahia de la Paz, Albatross Station 2822, lat. 24°16′ N., long. 110°22′ W., 21 fathoms, April 30, 1888, 1 specimen 51 mm. West coast of Lower California; Albatross Station 3038, lat. 24°24′30″ N., long. 111°53′ W., 31 fathoms, April 8, 1889; 1 specimen 274 mm. (47265). Total number of specimens studied 4, from localities ranging from off Tiburon I., at the northern end of the Gulf of California to off Magdalena Bay on the west coast of Lower California; the vertical distribution being 21 to 76 fathoms. Previous records apply to first two specimens, one from San Francisquito Bay not examined, and Hiyama's record of the west coast of Mexico without more definite locality.

Distinctive characters and relationship.—This species agrees with *oblonga* in all essential specific structural characters, except one. The origin of the dorsal is nearly the same in both species, and they have the same number of gill rakers, fin rays, and scales. The color pattern is also remarkably alike, there being but a slight difference in the position of the two anterior spots. This likeness appears to be a case of real affinity rather than parallelism. The only essential difference between the two species is that *tetrophthalmus* has all the scales cycloid while in *oblonga* some of the scales are ctenoid. However, in *oblonga* this character is highly variable, sometimes the greater number

980335°—52——5

of scales being ctenoid and in some individuals the ctenoid scales being very few. Indeed, if the four specimens of *tetrophthalmus* described above had been captured on the Atlantic coast, they readily might have been taken to be extreme variants of *oblonga* in which the ctenoid character of the scales was entirely lost, except for the difference in the position of the two anterior spots. The three large known specimens of *tetrophthalmus* have a somewhat deeper body and longer head and maxillary than average examples of *oblonga* of approximately the same size, but the latter species varies considerably in proportional measurements of the various parts, and when sufficient numbers are measured the two species very likely will be found to intergrade to a large extent in those respects. This species may readily be distinguished from all other related species on the Pacific coast of North and South America by its distinctive color pattern.

Lioglossina tetrophthalmus GILBERT, Proc. U. S. Nat. Mus. 13: 122, 1891 (Albatross Station 3014 and 3016; Gulf of California, off Tiburon I.).—JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 (3): 2622, 1898.—NORMAN, Monogr Flatfishes, p. 69, fig. 37, 1934 (based on U.S.N.M. 47268 and 47290).—BREDER, Bull. Bingham Ocean. Coll. 2 (3): 3, 1936 (San Francisquito Bay, Gulf of California).—HIYAMA, Marine Fishes of Pacific Coast of Mexico, edited by T. Kumada, p. 59, pl. 92, fig. B, 1937 (Mexico, definite locality not given).

PSEUDORHOMBUS

Pseudorhombus BLEEKER, Versl. Med. Akad. Wet. Amsterdam 13: 436, 1862 (genotype *Pseudorhombus arsius* (Hamilton-Buchanan)=*Rhombus polyspilos* Bleeker by monotypy).

Pseudorhombus is intermediate between *Hippoglossina* and *Paralichthys*. It lacks accessory scales like *Hippoglossina* and has the dorsal origin over the anterior margin of the eye or a little more forward like nearly all species of *Paralichthys*. The interorbital width and the size of the eye and teeth differ with the species which form the intermediate links in a series showing a gradual transition from *Hippoglossina* to *Paralichthys* in these three characters. The color pattern is either somewhat like one or like the other of these two genera, or like a combination of the two, depending on the species. The prepeduncular spot is prominent in some species; the other prominent spots on the body are in two longitudinal rows in some species. The differences between *Pseudorhombus* and *Hippoglossina* are discussed on page 287. As compared with *Paralichthys*, the species comprised in *Pseudorhombus* are generally of smaller size and they have a somewhat different physiognomy. Their general appearance is probably what induced most later authors to maintain the species in a genus distinct from *Paralichthys*. As far as I could find after a review of the literature, two characters have been proposed, hitherto, for separating *Pseudorhombus* from *Paralichthys*, but neither one is tenable.

One of these characters was proposed by Jordan and Evermann (Proc. U. S. Nat. Mus. vol. 25, p. 365, 1902) who distinguished *Pseudorhombus* from *Paralichthys* by the former having an accessory branch of the lateral line and the latter lacking it. These authors were followed by Jordan and Starks (Proc. U. S. Nat. Mus. vol. 31, p. 173, 1906), by Weber (*Siboga* Exped., p. 414, 1913), by Norman (Monogr., p. 61, 1934), and probably by other authors who recognized *Pseudorhombus* as distinct. However, this character apparently does not hold. In the Indo-Pacific species now placed by authors in the genus *Pseudorhombus* the accessory branch is usually more clearly marked and better developed, extending to the dorsal profile, but in some of those species it apparently fails to reach there (see Norman, Monogr., figs. 59, 61, 63, and 65). The American species under consideration also have an anterior accessory branch of the lateral line more or less developed, although it generally does not extend to the dorsal profile. It is best developed in *californicus*, the genotype of *Paralichthys*, in which species it generally falls short of the dorsal profile, but in individual fish it often plainly extends to the dorsal fin, to the base of the fifth to the seventh ray. It is evident that as far as the accessory branch of the lateral line is concerned, the Indo-Pacific species do not differ generically from *californicus* and should be placed in *Paralichthys*.

The other character is that used by Regan (Ann. Mag. Nat. Hist., ser. 8, vol. 6, p. 492, 1910) who divides the two genera on the basis of the number of vertebrae, 10+24 in *Paralichthys* and 10+27 in *Pseudorhombus*. He does not state how many species nor the number of specimens examined to see whether this character is subject to individual variation intraspecifically, or to specific differences

within the genus. Two dissected specimens of *lethostigma* examined by me give counts of 11+27 and 10+27; of three specimens of *dentatus*, two have 11+30 and one has 11+31; one *squamilentus* has 10+28 and one *tropicus* has 10+26. Jordan and Goss (Rept. U. S. Comm. Fish. 1886, pp. 243–245, 1889) report the number of vertebrae as: *californicus* 10+25, *dentatus* 11+30, *albigutta* and *lethostigma* 10+27, *H. oblonga* 11+30. Thompson (Proc. U. S. Nat. Mus., vol. 50, p. 411, 1916) records the vertebrae of *brasiliensis* as 11+23. The number of vertebrae is, therefore, subject both to individual variation and to specific differences, and the numbers found in the American species which are universally accepted as being congeneric, cover the range of both *Pseudorhombus* and *Paralichthys* as given by Regan. Consequently, no two genera can be distinguished on that basis.

This leaves the absence of accessory scales as the best character by which *Pseudorhombus* may be distinguished from *Paralichthys*. This character is discussed on page 284.

PSEUDORHOMBUS ISOSCELES

(PLATE 5)

Diagnosis.—Scales ctenoid on both sides, except those on cheek and opercle of blind side; 46 to 50 (counted on blind side in the three specimens examined, scales on eyed side largely fallen off); perforate scales 24 to 28 in arch and 50 to 51 in straight part to end of hypural. Accessory scales absent. Gill rakers on lower limb 8 or 9, comparatively short; upper limb with one gill raker at angle and 3 to 5 tuberosities above but slightly raised. Anal rays 66 to 68; dorsal rays 82 to 84. Pectoral 11, sometimes 10 (11 on both sides in two specimens, 10 on blind side, and 11 on the other in one specimen). Origin of dorsal in front of anterior margin of eye. Interorbital narrow, but wider than a mere ridge. Eyes rather large. Anterior teeth very moderately enlarged. Maxillary reaching posteriorly to a vertical through hind margin of eye or not quite that far. Depth 47 to 49.8, maxillary 13.9 to 14.3, head 26.9 to 29.3, upper eyeball 6 to 6.4, upper orbit 7.5 to 7.9, interorbital 1.3 to 1.6 (range of 3 specimens 243 to 260 mm.). Sinistral.

Color.—The color is nearly faded. Two large ocellated spots distinct, situated on a vertical almost midway between shoulder girdle and base of caudal, one at a short distance below the dorsal profile, and one at an equal distance from the ventral profile. A definite prepeduncular spot is not now present; but Jordan describes it in his original account, and a trace of such a spot is faintly perceptible. Ventral of eyed side with a small, oblong, rounded black spot at its distal margin.

Specimens examined and geographic distribution.—This account is based on three of Jordan's original specimens from Bahia, Brazil, 243–260 mm. (43335; 43368; 43371, herewith designated as the lectotype, 247 mm.). Norman's record (1937) extends the range of the species southward to latitude 45°05′.

Distinctive characters and relationship.—This species has ctenoid scales on the blind side, unlike any species of *Paralichthys*. It also lacks accessory scales. In these two characters it agrees with the species of *Pseudorhombus*. No other, more substantial characters, are now known by which the two genera may be delimited, and if they are recognized as distinct at all, *isosceles* should be placed in *Pseudorhombus*. In their general appearance, regularity of arrangement and sharply defined edges, the scales of *isosceles* resemble those of *Pseudorhombus oligolepis* (Bleeker) with which it was compared. This species is readily distinguished from all closely related species of the western Atlantic, except *Hippoglossina oblonga*, by the presence of ctenoid scales on both sides. It differs from *H. oblonga* in having fewer scales, in having nearly all scales ctenoid and more strongly so, in the color pattern and in other characters given in the key.

This species, *H. oblonga* and *H. tetrophthalmus* have a black spot on the ventral of the eyed side. Attention is here called to this fact; because the possession of certain color marks in common, is often a good indicator of close relationship in fishes.

Paralichthys isosceles Jordan, Proc. U. S. Nat. Mus. 13: 330, 1890 (Bahia, Brazil).—Norman, Monogr. Flatfishes, p. 80, 1934 (based on original account).

Pseudorhombus isosceles Ginsburg, Jour. Washington Acad. Sci. 26: 131, 1936 (systematic position discussed).

Paralichthys isosceles Norman, Discovery Rept. 16: 134, 1937 (from four stations off the coast of Argentina between latitudes 43°50′ and 45°05′).

PARALICHTHYS

Definition.—Mouth symmetrical, large, maxillary reaching a vertical through middle of eye or more posteriorly, position of posterior extremity of maxillary depending largely on size of fish. Ventrals symmetrically placed on both sides of abdominal ridge, the fins from both sides subequal in length and in width of base. Pectoral longer on eyed side, base subequal on both sides, none of the rays notably prolonged. Body sinistral in most species, in 2 species varies with individual fish being nearly as often dextral as sinistral (another species is known from 1 dextral specimen). Lateral line present on both sides; with a well marked curve in front over pectoral fin; with an anterior accessory branch more or less developed, usually more or less disconnected from main lateral line, extending forward and more or less upward, generally not reaching dorsal profile, sometimes reaching there as an individual variation. (The accessory branch of the lateral line is somewhat better developed in *californicus*, *aestuarius*, *adspersus*, and *woolmani*, where it sometimes reaches the dorsal profile, especially in the larger specimens; but is present to a greater or lesser extent in all the species, is highly variable with the individual in its extent, and is evidently of no importance in distinguishing the species.) Teeth in jaws in one row, similar on both sides; the anterior teeth more or less enlarged, caninoid, especially those of upper jaw, but no marked fangs present; no teeth on vomer or palatines. Scales medium or small; ctenoid on eyed side and cycloid on blind side (in subgenus *Paralichthys;* some ctenoid scales infrequently present on caudal peduncle of blind side in *adspersus* and *californicus*, while in *aestuarius* the scales on eyed side become cycloid in large specimens); or scales all cycloid on both sides at all ages (in the subgenus *Chaenopsetta*). Accessory scales present, usually beginning to develop in fish reaching a length of 75 to 155 mm., the first appearance of accessory scales with respect to length differing with the species and to a lesser extent varying with individual fish. Gill membranes united, free from isthmus. Dorsal origin over or in front of anterior margin of upper eye in medium-sized or large specimens, more or less behind anterior margin of eye in young fish, nearly over middle of eye in adults, also, of one species; anterior dorsal rays not markedly prolonged. Rays of vertical fins simple, except hindmost; posterior 1 to 3 rays first becoming split in fish reaching a length of 40 to 60 mm., the number of branched rays and the number of dichotomous branchings increasing with size; total number of branched rays in large fish 5 to 15, with the posterior 2 or 3 sometimes branched dichotomously 3 times, except sometimes as an individual variation the ultimate ray and less often also the penultimate remaining simple in large specimens as well. The interorbital wider than a mere ridge, except in young fish; its width not differing notably with sex. Eye medium or rather small, the eyeball usually 5 percent of standard length or less in large or medium specimens. Gill rakers always considerably longer than wide, pointed or narrowly rounded at apex; few and more or less short and broad, to many and quite long and slender. Vertebrae 10 to 11+23 to 31, the number differing interspecifically, and somewhat varying intraspecifically with the individual (p. 299). Caudal rounded in young fish, becoming more or less biconcave in specimens over 100 or 200 mm., the biconcave condition becoming more pronounced with growth, the upper and lower angles becoming more or less produced in large fish. (The size at which the gradual changes occur and the relative development of the biconcave condition differs somewhat with the species but the differences are not sufficiently pronounced to be used in specific distinction.) Typical color pattern in 5 longitudinal rows of spots, the most prominent spots occupying various positions within the typical pattern depending on the species (p. 277). The prepeduncular spot prominent in most species, forming part of either the large or the small triangle or both.

Paralichthys is most nearly related to *Hippoglossina* and *Pseudorhombus* as discussed under those two genera (pp. 287 and 298). It is divisible into two subgenera, *Paralichthys* and *Chaenopsetta*. The following account of the genus includes all the known species except *olivaceus* from the coasts of Japan and China.

Subgenus Paralichthys

Paralichthys GIRARD, U. S. Pac. R. R. Explor. Surv. Zool., 10 (Fish.) p. 146, 1858 (genotype *Paralichthys californicus* (Ayres)=*Paralichthys maculosus* Girard by monotypy).

Uropsetta GILL, Proc. Acad. Nat. Sci., Philadelphia, 1862, p. 330 (genotype *Paralichthys californicus* (Ayres)=*Hippoglossus californicus* Ayres by monotypy).

Uropsetta GILL, ibid., 1864; pp. 194 and 198, (genus characterized for first time).

This subgenus differs from *Chaenopsetta* in having ctenoid scales on the eyed side. The scales become ctenoid when the fish is small, the smallest specimens examined already having the scales on the upper side spinulose (37 mm., total length of *aestuarius* and *adspersus* and 42 mm., *californicus*). In one species, *aestuarius*, the scales gradually lose their ctenoid character in fish between 160 and 220 mm., larger specimens having all scales cycloid with no trace of their former ctenoid condition. This gives a clue as to how the subgenus *Chaenopsetta* originated from species having ctenoid scales on the eyed side. Also, occasional specimens of *adspersus* and *californicus* have the caudal peduncle of the blind side more or less with spinuliferous scales, thus forming a transition to those species having ctenoid scales on both sides. All the species of the subgenus *Paralichthys* are American, with the exception of *olivaceus*.

PARALICHTHYS MICROPS

The following essential characters are compiled from Norman's two accounts of the species. Scales ctenoid on eyed side, cycloid on blind side; 54 to 65. Accessory scales present. Gill rakers 18–23 on lower limb. A. 56–65; D. 68–80. Pectoral about 2 in head, with 11–12 rays. Dorsal origin over middle or anterior half of eye. Eye 4.5–5.5 in head. (Norman's figure shows a rather narrow interorbital.) Canines moderate. Maxillary extending nearly to posterior edge of eye. Depth 43–50, head 29–32, maxillary about 14, sinistral. Mottled and spotted with darker, median fins blackish towards their margins.

Norman places *Paralichthys jordani* Steindachner in the synonymy of *microps*, with a query. Steindachner's species is based on three specimens, 217–280 mm. The pertinent characters given in the original description agree with those given by Norman for *microps* and outlined above, with the following exceptions: Scales about 62–70. Pectoral almost 1⅔ in head. Eye about 6 in head. Most scales finely margined posteriorly with dark brown, with a central brown point. Three longitudinal rows of grayish blue spots, along a median line and near dorsal and anal bases.

According to the original description *jordani* appears to have more numerous scales than *microps*, a character which usually indicates specific divergence in this group of fishes. The color of *jordani* also appears to be distinctively different. The apparent difference in the scale count may be due to different methods of counting or may fall within the range of variation of a single species. While the specimens on which the two names are based may possibly represent the same species, the probabilities are equally as good that they represent distinct species. This question may be determined only by a direct comparison of the types, or better still, by frequency distribution studies of numbers of specimens. Steindachner's specimens appear to have also a somewhat smaller eye and longer pectoral. Nevertheless, Steindachner does not satisfactorily prove that *jordani* is distinct. Pending further studies, Norman's treatment is here continued and the two names are associated under one heading.

This species is distinctively different from all other species of *Paralichthys* in the posterior position of the dorsal origin with reference to the anterior margin of the eye, agreeing with or approaching to the species of *Hippoglossina* in this respect. The dorsal origin in young fish is behind the anterior margin of the eye in all the species, but in *microps* this condition evidently persists in grown specimens also.

Hippoglossina microps GÜNTHER, Proc. Zool. Soc. London, 1881: 21 (west coast of Patagonia).—JORDON and Goss, Rept. U. S. Comm. Fish., 1886: 242, 1889 (after Günther).

Paralichthys jordani STEINDACHNER, Faun. Chile 1: 325 [Zool. Jahrb. supp. bd. 4] 1898 (Puerto Montt, Rohalo River, Chile).—Delfin, Cat. Pec. Chile, p. 104, 1901 (listed).

Hippoglossina microps Delfin, ibid., p. 103 (listed).

Paralichthys microps NORMAN, Monogr. Flatfishes, p. 88, fig. 52, 1934 (Chile; west coast of Patagonia).—NORMAN, Disc. Rept. 16: 133, 1937 (coast of Chile, near Conception and at latitude 38°22′).

PARALICHTHYS PATAGONICUS

Diagnosis.—Scales ctenoid on eyed side, cycloid on blind side; 76. Accessory scales present, moderately profuse. Gill rakers 2+10. Anal rays

66; dorsal 82. Pectoral with 12 rays, not quite but almost reaching to lateral line on eyed side, considerably short of lateral line on right side. Origin of dorsal slightly in front of anterior margin of eye. Maxillary reaching a vertical slightly past posterior margin of eye. Depth 43, head 26, maxillary 13, interorbital 2.3, eye 4.4, snout 6.9, left pectoral 13.1, right pectoral 10.7. Sinistral. The single specimen studied irregularly shaded, not showing any definite color pattern.

Specimen examined and geographic distribution.—The preceding account is based on a single specimen collected in Uruguay by Dr. Waldo L. Schmitt (87778). Records in the literature give a range for this species extending from Montevideo, Uruguay, to Bahia Blanca, Argentina. If the uncertain locality, Fort Famine, given by Günther for his specimen is correct, and the specimen in fact belongs to the present species, it would extend its range far to the south, to Magellan Strait. Also, if *Paralichthys bicyclophorus* Miranda Ribeiro is in fact a synonym, the range of the species would extend northward to the coast of Brazil.

Size.—The specimen examined, 410 mm. (16 inches), evidently must stand for the present as the record size to which the species attains.

Distinctive characters and relationships.—This is the only species of the typical subgenus which is now known from the Atlantic coast, and it may be separated from all other species of *Paralichthys* found in the Atlantic by its ctenoid scales on the eyed side. From *Pseudorhombus isosceles* which occurs in the same region with it, the present species is easily separable by the cycloid scales on the blind side and its smaller scales.

Synonymy and identification.—*P. bicyclophorus* is based on two specimens 330 mm. long from the Rio de Janeiro market. The pertinent specific characters given in the original account are: Scales ciliated (not stated whether only on one or on both sides); 68. Accessory scales present. Gill rakers 2 + 11; A. 65; D. 84. Maxillary nearly attaining to under posterior border of eye. Two prominent ocellated spots, one in the approximate position occupied by the prepeduncular spot in related species, the other and somewhat larger spot under the posterior bend in the lateral line.

In their original description of *patagonicus* Jordan and Goss state: ". . . dorsal rays 76; anal rays 60 . . . gill rakers 3 + 11". These counts and those given for *bicyclophorus* may fall within the range of variation of a single species, judging by all the species in which the frequency distribution has been determined. The authors of *patagonicus* fail to mention the structure of the scales, an important character in *Paralichthys*. William C. Schroeder kindly examined the three cotypes at my request and found the scales to be ctenoid on the eyed side and cycloid on the blind side, in 82 rows over the straight part of the lateral line which also agrees or nearly agrees with the types of *bicyclophorus*.

Mr. Schroeder describes in a letter the color of the types as follows: "Although faded, the 187 mm. specimen shows an ocellated spot about the size of the eye on lateral line, about four-fifths the distance from eye to hypural. The 160 mm. specimen shows the same and, in addition, several other obscure spots, one of them opposite the origin of the pectoral and below the lateral line where the arch joins the straight part. The 165 mm. specimen is too faded to show any spots." These notes when compared with the photograph published by Miranda Ribeiro of his *P. bicyclophorus* strongly suggest the possibility that the types of *patagonicus* originally had the same two prominent spots as Miranda Ribeiro's fish. The types of *patagonicus* and *bicyclophorus* are thus in apparent agreement in all the more important characters which differentiate the species of *Paralichthys* and the two names are most probably synonymous.

The specimen forming the basis of this account agrees almost perfectly with the types of *bicyclophorus* in its structural characters and it apparently also belongs to the same species. However, there is a discordant note with respect to the color. This specimen does not have the two prominent spots present in the types of *bicyclophorus* and apparently also in those of *patagonicus*. This specimen is larger than the five types discussed above and it is possible that, as in other species of *Paralichthys*, the prominent spots disappear with age. On the other hand, there is the possibility that the types of *patagonicus*, those of *bicyclophorus* and the specimen examined represent more than one species. A definite solution of this question must wait until more abundant material is examined.

Nomenclature.—In naming this species Jordan and Goss (1889) were anticipated by Jenyns (1842) who describes a specimen that evidently belongs to the same species under the name of *Platessa orbignyana;* as shown by his statement which agrees with this species, as follows: "Upper or eye side of the body slightly rough, with the scales finely ciliated; under-side smooth, the scales on this side not ciliated." Norman (1937) re-examined Jenyns' specimen, found it to have 10 gill rakers on the lower limb, and he states that it "should most probably be placed here [under *patagonicus*]." The question now is, what is the status of the name *orbignyana?* Most authors following Jenyns and Valenciennes, who used the name *orbignyana*, either as a valid name or in synonymy, possibly employed it not in accordance with the international rules.

The generally accepted dates of publication of Jenyns' work (Zool. Voy. Beagle), and D'Orbigny's work (Voy. Amer. Mérid.) where Valenciennes describes his *orbignyana*, are those given on the title pages, namely, 1842 and 1847, respectively. However, Jenyns in his supposedly earlier work refers in several places to the atlas of D'Orbigny's work. Under his account of *Platessa orbignyana* which he ascribes to Valenciennes, with a query, and cites the plate of that author, Jenyns states: "This species agrees so well with the figure of the *P. Orbignyana* in D'Orbigny's Voyage, that I have little hesitation in considering it the same,—but as no description of this last has been yet published, it is still possible I may be mistaken." An explanation of this discrepancy is offered by Norman (Monogr., p. 71, 1934) who states: "The fact that Jenyns quotes Valenciennes' name in 1842 appears to be due to the earlier publication of the Atlas of D'Orbigny's voyage." Norman's interpretation is reasonable. However, there may be yet another explanation. Jenyns might have examined the originals or the proofs of the plates before they were formally issued in such manner as to reasonably constitute "publication" that may be used in determining priority. In that case, the name *orbignyana* as used by Jenyns is a manuscript name, and according to Opinion 4 of the International Commission must be dated from that author's work and applied to that species represented by the specimen described by him, regardless of the fact that he cites it with a query, thus: "Platessa Orbignyana. Val. ?"

It is of course well known that the date on the title-page of a work often does not represent the true date of its issue. But in practice we must assume the published date is correct, unless unmistakable proof to the contrary is adduced. Otherwise, any stability in nomenclature will be impossible to attain, in some cases. It may require considerable research to determine the correct date of publication of some works, and in some others, older works especially, a most extended search may prove to be a labor in vain.

The status of *Platessa orbignyana* of Valenciennes cannot be determined now. The entire description consists of a single sentence, as follows: "Nouvelle espèce de limande caractérisée par la force des dents antérieures." This is of course inadequate to determine the species. At the most, it shows that he probably had a species of *Paralichthys*. The figure shows that it was drawn from a specimen representing a species of *Paralichthys*, but it is not sufficient for a definite, specific identification. It shows 74 dorsal rays, 55 anal rays, and 73 oblique rows of scales over the lateral line. The dorsal and scale counts agree with the two species here designated as *patagonicus* and *brasiliensis*, and the anal count more nearly agrees with the latter; but this does not offer satisfactory evidence regarding the disposal of Valenciennes' name. Mr. Paul Chabanaud kindly replied to my inquiry regarding the type, stating that it cannot be located.

On the assumption that Jenyns' use of that name has priority, it is not of much importance to determine Valenciennes' later use of the same name, except with respect to the proper placement of the synonymy. But, should it be definitely proved that, as suggested by Norman, Valenciennes' use of the name *orbignyana* has priority, its proper disposition becomes a matter of importance. It may be taken to be what it practically is: representing an unidentifiable species. It may also be suggested that later revisers be followed; but there may be differences of opinion as to which one of the later revisers to follow.

Assuming that Valenciennes' plate was published earlier, Jenyns (1842) is the first reviser; but he cites Valenciennes' name with a query, and

there may be some question whether his restriction is to be accepted. The next reviser is Günther (1860) who places both Valenciennes' and Jenyns' references under his account of *Pseudorhombus dentatus* with a query (possibly his account is based primarily on a specimen of the present species, but Norman, 1937, is not certain regarding its placement). Since Günther doubtfully cites his synonymy, it may also be questioned whether his action constitutes a definite restriction of the name *orbignyana*. On the other hand, he associates both Valenciennes' and Jenyns' references under one heading, and he may be said to have restricted both accounts to one species. Since Jenyns' description includes statements pertinent to its identification and his specimen is still in existence enabling a definite determination of its status, this is probably the best disposition that may be made of Valenciennes' name *orbignyana*. That is, accept Günther's restrictions of both accounts to the same species, and restrict the name *orbignyana* to that species represented by Jenyns' specimen, the status of which is now determinable.

Still later revisers are as follows: Jordan and Goss, 1889 place *orbignyana* in the synonymy of *brasiliensis*, and the same course is followed by Jordan and Evermann, 1898. Norman (1934) applies the name *orbignyana* to that species here designated as *brasiliensis* and switches the name *brasiliensis* to another species. The conflicting use of that name by these authors is apparently not in consonance with all the facts in the case or with the most reasonable usage indicated on a consideration of the various points involved.

On the basis of the evidence now available Jenyns' use of that name should evidently have preference, his specimen becomes the type of this species, and the name *orbignyana* is to be properly applied to it. Even assuming that *orbignyana* of Valenciennes has priority, its apparent best disposition is also to apply it to this species. Nevertheless, I continue the use of the name *patagonicus* for the following reasons: (1) It is not altogether certain which one of the later revisers is to be followed in disposing of Valenciennes' *orbignyana*. (2) The status of the material here grouped under this name is not entirely certain as discussed above, and it seems best to postpone this change of name, which must be confusing at first, until the status of the species is thoroughly cleared. (3) The name *patagonicus* was more frequently used for this species than any other name. Also, that name apparently was used for no other species and its continued use for this species will not lead to confusion. (4) The name *orbignyana*, either as a valid name or as a synonym, was generally applied by authors to other species than the present one and its substitution for this species would lead to further confusion.

Platessa orbignyana JENYNS, Zool. Voy. Beagle 4: 137, 1842 (Bahia Blanca).—VALENCIENNES, Voy. Amer. Merid. D'Orbigny 5 (2, poiss.): 10, pl. 16, fig. 1, 1847 (Brazil).

Pseudorhombus dentatus GÜNTHER (not Linnaeus), Cat. Fish. British Mus. 4: 425, 1862 ("Probably brought by Capt. King from Port Famine"; specimen possibly belonging to this species; accounts of preceding two authors cited).

Paralichthys patagonicus JORDAN and GOSS, Rept. U. S. Comm. Fish. 1886: 245 and 248, 1889 (east coast of Patagonia, types in Museum of Comparative Zoology).—Berg, An. Mus. Nac. Buenos Aires 4: 77, 1895 (Bahia Blanca and Mar del Plata, Argentina; Montevideo, Uruguay).—EVERMANN and KENDALL, Proc. U. S. Nat. Mus. 31: 107, 1906 (Buenos Aires market).

Paralichthys bicyclophorus MIRANDA RIBEIRO, Arch. Mus. Nac. Rio de Janeiro 17 (Heterosomata): 14, photo., 1915 (Rio de Janeiro market).

Paralichthys patagonicus DEVINCENZI, An. Mus. Nac. Montevideo (2) 5: 278, 1924 (Uruguay).—MARINI, Rev. Soc. Argentina Cienc. Nat. 9: 454, 1929 (Puerto Quequen, Argentina).

Paralichthys brasiliensis NORMAN (in part), Monogr. Flatfishes, p. 77, fig. 44, 1934 (outline figure of type specimen of *patagonicus* published).

Paralichthys bicyclophorus NORMAN, ibid., p. 78 (after original account).—MCDONAGH, Rev. Mus. La Plata 34: 56, 1934 (Mar del Plata, Argentina).

Paralichthys patagonicus GINSBURG, Jour., Washington Acad. Sci. 26: 132, 1936 (stated to represent a distinct species and that *bicyclophorus* is probably the same).—NORMAN, Disc. Rept., 16: 133, 1937 (Buenos Aires).

PARALICHTHYS HILGENDORFII

This species is based on a single, malformed specimen, 273 mm., from Juan Fernandez, Chile. The original description gives the following pertinent specific characters. Scales ctenoid on eyed side, cycloid on blind side; about 62. Gill rakers 9 on lower limb of first gill arch; 6 on upper limb, the 4 anterior ones rudimentary. A. 61; D. 75; pectoral 2 in head with 11 rays. Dorsal origin over anterior margin of eye. Maxillary somewhat less than 2¼ in head; reaching to under posterior margin of orbit. Dextral. Eyed side grayish brown with a fine dark sprinkling.

This species apparently differs from both *schmitti* and *fernandezianus* in not having the blind side of the dorsal spotted and in having a shorter pectoral as compared with the head length. The single specimen known is apparently dextral while the other two species are sinistral. It further differs from *fernandezianus* in having fewer scales and possibly also fewer gill rakers, and from *schmitti* possibly in having fewer pectoral rays and a shorter maxillary.

Paralichthys hilgendorfii STEINDACHNER, Faun. Chilen. 3: 209 (Zool. Jahrb., supp., bd. 6) 1905 (Juan Fernandez, Chile).—NORMAN, Monogr. Flatfishes, p. 81, 1934 (after Steindachner).

PARALICHTHYS SCHMITTI

(PLATES 6 AND 7)

Diagnosis.—Scales ctenoid on eyed side, cycloid on blind side; 68. Accessory scales present on both sides, very numerous, nearly covering surface of many regular scales and massed in bands around edges of nearly all scales. Gill rakers short, 9 on lower limb of first gill arch, 3 on upper limb with 1 tubercle above. Anal rays 63; dorsal 80; pectoral 12. Origin of dorsal a little in advance of anterior margin of eye; maxillary extending posteriorly to a point a little behind a vertical through posterior margin of lower eye, 15. Body of medium depth, 44; head 30; interorbital rather wide, 3.2; pectoral 2.4 in head. Sinistral.

Color.—Blind side of head and body light-colored, like the normal condition in the species of *Paralichthys*, but unlike nearly all other species; the fins of underside, including the dorsal, anal, caudal and ventral, distinctly blotched. A narrow area along upper and lower margins of blind side, in front, speckled with small brown spots, the speckling continued, but less distinct on opposite side. Eyed side dark, irregularly shaded. Some diffuse spots of more or less greater intensity than the ground color; two or three faintly suggesting ocelli; no spots especially prominent. Pectoral and ventral of eyed side with irregular transverse rows of somewhat elongate spots. Two diffuse curved bands on caudal, against an irregularly shaded background.

Specimen examined.—This species is known from the single type specimen, 455 mm. (88831), taken at Juan Fernandez Island, off the coast of Chile.

Distinctive characters and relationship.—This species is apparently related to *fernandezianus* which also has the dorsal blotched on the blind side, an unusual color mark in a species of *Paralichthys:* but it differs in the less numerous scales. Although no material is available for comparison, it is to be noted that Steindachner who described *fernandezianus* also is the author of three other species of the subgenus *Paralichthys*, namely, *adspersus*, *jordani*, and *hilgendorfii* for which he gives the number of scales in the lateral line as 104, 92 to 105 and 94, respectively. These numbers closely agree with those found in the species of the subgenus *Paralichthys* studied by me (compare with table 6, taking into account the conversion factor given on p. 271). The scale count of *schmitti* also closely agrees with the majority of the species of its subgenus. On the other hand, the count of *fernandezianus* is given as, "L. l. c. 140." This is a number much greater than that found in *schmitti* as well as the three species described by Steindachner. From all the other American species of *Paralichthys*, except *fernandezianus*, *schmitti* may be distinguished by the fins being blotched on the blind side, and the other characters given in the key.

Paralichthys schmitti GINSBURG, Proc. U. S. Nat. Mus. 82 (20): 1, 1933 (Juan Fernandez Island, Chile).

PARALICHTHYS FERNANDEZIANUS

This species is based on a single specimen, 510 mm., from Juan Fernandez, Chile. The following important specific characters are taken from the original description: Scales ctenoid on eyed side cycloid on blind side; about 94. Accessory scales present. Gill rakers 3 on upper limb of first gill arch with 2 rudiments, 11 on lower limb. A. 60. D. 78. Pectoral slightly more than 2⅓ in head; with 11 rays. Origin of dorsal slightly in front of anterior margin of eye. Maxillary attaining past posterior margin of eye by a distance nearly equal to length of eye; 2⅕ in head. Sinistral. Dorsal on blind side marbled with irregular brown spots; eyed side with a fine dark sprinkling.

This species has the dorsal spotted on the blind side like *schmitti* differing in having more numerous scales, and possibly in having more gill rakers and the maxillary extending more backward with relation to the posterior margin of the eye.

Paralichthys fernandezianus STEINDACHNER, Faun. Chilen. 3: 208 (Zool. Jahrb. supp., bd. 6), 1905 (Juan Fernandez, Chile).—NORMAN, Monogr. Flatfishes, p. 87, 1934 (after Steindachner).

PARALICHTHYS ADSPERSUS

(PLATE 8)

Diagnosis.—Scales ctenoid on eyed side, typically cycloid on blind side (sometimes ctenoid scales present on caudal peduncle and adjacent hind part of body); 63 to 81. Accessory scales present; first occurring in specimens of about 100 mm.; appearance with respect to size varying individually, becoming very numerous with increase in size. Total number of gill rakers on outer arch 22 to 27, the majority having 25 or 26; 7 or 8 on upper limb, mostly 7; 15 to 19 on lower limb. Anal rays 54 to 61, 57 or 58 in the majority of individuals; dorsal rays 68 to 76. Pectoral rays usually 12 or 13, sometimes 11 (12 on both sides in 5 specimens, 13 in 3, 11 in 1, 12 on blind side and 13 on eyed side in 2, 13 on blind side and 12 on the other in 1, 11 on blind side and 12 on the other in 1). Origin of dorsal over space between anterior margin of eye and that of pupil in specimens 70 to 118 mm., over anterior margin of eye or nearly there in specimens 205 to 388 mm. Maxillary about reaching to a vertical through posterior margin of pupil in specimens 72 to 118 mm., to posterior margin of lower eye or slightly past that in specimens 205 to 388 mm. Head comparatively long. Body rather deep. Caudal usually becoming more or less biconcave in larger specimens, sometimes nearly rounded in large fish also. Sinistral.

Color.—Rows of spots more or less irregular, appearing like seven longitudinal rows in some specimens; many of the spots more or less ocellated; the three spots forming the larger triangle usually rather more prominent than the other spots. The ocellated spots are present in the largest specimen examined, 388 mm. Some of the spots frequently are more or less characteristically ring-like, the center being to some extent pigmentless or but sparsely pigmented. Underside of fins sprinkled with tiny dark dots, somewhat as in *H. oblonga* but not so profuse. White spots frequently present at bases of dorsal and anal fins, but not so well marked as in *californicus*.

Specimens examined.—Callao, Peru; P. O. Simmons, 2 specimens, 205–388 mm. (53490); R. E. Coker, 3 specimens, 239–276 mm. (77713 and 77715); R. C. Murphy, Callao market, 1 specimen 284 mm. (7273 A. M. N. H.). Chincha I., Peru, R. C. Murphy, 3 specimens 37–45 mm. (7911 A. M. N. H.); R. C. Murphy, Oct. 26, 1919, 1 specimen 275 mm. (7290 A. M. N. H.). Mollendo, Peru, R E. Coker, 1 specimen 245 mm. (77716). Tome, Chile, *Albatross*, 3 specimens 72–86 mm. (77390). Lota, Chile, Feb. 15, 1888, *Albatross*, 6 specimens 90–118 mm. (77391). Total number of specimens studied 20, 37 to 388 mm., in length.

Geographic distribution.—The material examined covers the range from Callao, Peru, to Lota, Chile; existing records also include this range and San Juan I. Extant records of "*Paralichthys adspersus*" from the Pacific coast of Mexico and Panama apparently are based on specimens of *Paralichthys woolmani* (p. 313).

Size.—The largest specimen examined, from Callao, Peru, is 388 mm. (15 inches) long, including the caudal fin. However, this may not represent the maximum for the species since those examined are museum specimens, and collectors usually select the smaller examples for preservation.

Distinctive characters and relationship.—Of the other species of the subgenus *Paralichthys* occurring on the coast of South America, *adspersus* may be distinguished from *fernandezianus*, *hilgendorfii* and *schmitti* by its more numerous gill rakers. From *microps* it differs in the more anterior insertion of the dorsal. This species is very near to *californicus* differing from the latter chiefly in having a deeper body, there being no intergrades between the two species in this character (table 8). The gill rakers in *adspersus* are less on the average than in *californicus*, and the fin rays are more numerous; but there is considerable intergradation in those characters (tables 1 to 5). *P. adspersus* is always sinistral, while *californicus* is often also dextral. This species intergrades with *aestuarius* in every character studied, except the structure of the scales in the larger specimens. Individual fish of these two species are separable only when they reach a size of about 200 mm., such specimens having the scales on the eyed side ctenoid in *adspersus* and all or almost all cycloid in *aestuarius* (p. 310).

Economic importance.—This is evidently a food fish on the coast of South America, and some of the

specimens studied have been obtained in the market at Callao, Peru; but there does not seem to be any data extant as to its abundance or the quantities marketed.

Pseudorhombus adspersus STEINDACHNER, Sitzb. Akad. Wiss. Wien 55 (1): 709, pl. 2 (Ichthyol. Notiz. 5: 9) 1867 (Chincha Islands, Peru).

Paralichthys adspersus JORDAN and GOSS (in part), Rept. U. S. Comm. Fish. 1886: 246, 1889 (Callao).—JORDAN (in part), Proc. California Acad. Sci. (2) 5: 503, 1895 (Callao, Peru).—JORDAN and EVERMANN (in part), Bull. U. S. Nat. Mus. 47 (3): 2627 and 2872. 1898 (Callao, Peru).—ABBOTT, Proc. Acad. Nat. Sci., Philadelphia, 1899: 363, 1900 (Coast of Peru).—STEINDACHNER, Fauna Chilensis 3: 208 (Zool. Jahrb. supp. bd. 6) 1905 (Juan Fernandez, Chile; specific name spelled *adspasus*).—STARKS, Proc. U. S. Nat. Mus. 30: 800, 1906 (Callao, Peru).—THOMPSON, Proc. U. S. Nat. Mus. 50: 411 and 468. 1916 (Tome and Lota, Chile; Callao, Peru).—EVERMANN and RADCLIFFE, Bull. U. S. Nat. Mus. 95: 140. 1917 (Callao and Mollendo, Peru).—NICHOLS and MURPHY, Bull. Amer. Mus. Nat. Hist. 46: 512. 1922 (Chincha Is., Peru).—NORMAN, Monogr. Flatfishes, p. 83, fig. 49, 1934 (Peru: Iquique, Lota, Pescadores Bay, and Juan Fernandez Island, Chile).

PARALICHTHYS CALIFORNICUS

California halibut

(PLATE 9)

Common names.—This species is commonly called halibut in California, a name which properly belongs to a distinct and quite different species of flatfish. It is also known as bastard halibut, Monterey halibut, chicken halibut, southern halibut, and alabato. "California halibut" has been adopted as a uniform common name for this species by the Division of Fish and Game of California.

Diagnosis.—Scales on eyed side ctenoid in large as well as in small fish, cycloid on blind side (the ctenoid scales sometimes extending in narrow bands at the dorsal and ventral edges of the caudal peduncle of the blind side; infrequently the spinuliferous scales spread over the entire surface of the caudal peduncle and the base of the caudal fin on the blind side); 62 to 78. Accessory scales present, first appearing on eyed side of head in specimens of about 100 mm., at about 135 mm. on eyed side of body and a little later on blind side; first appearance of accessory scales with respect to length varying with individual fish, becoming very numerous and nearly covering entire surface of normal scales with increasing size. Total number of gill rakes on outer arch 25 to 32, the majority having 28 or 29; usually 8 or 9 on upper limb, frequently 7, sometimes 10 or 11; lower limb with 18 to 23 gill rakers. Anal rays 49 to 59; dorsal rays 66 to 76. Pectoral rays usually 12, frequently 11 or 13 (12 on both sides in 15 specimens; 11 in 3; 13 in 2; 11 on blind side and 12 on eyed side in 4; 12 on blind side and 11 on other in 1; 12 on blind side and 13 on the other in 3). Origin of dorsal over anterior margin of pupil in specimens 50 to 85 mm., over space between anterior margin of eye and that of pupil in specimens 90 to 175 mm., generally over anterior margin of eye in specimens 175 to 300 mm., distinctly in front of eye in 1 specimen 473 mm., considerably in front in 1 specimen 570 mm. Posterior extremity of maxillary usually falling on a vertical through middle of eye or posterior margin of pupil in specimens 55 to 85 mm., through posterior margin of pupil to that of eye in fish up to about 150 mm., usually to posterior margin of eye in specimens 150 to 200 mm. and somewhat beyond eye in larger fish. Body rather slender or of medium depth; head and maxillary rather short. Often dextral. (Out of 123 fish examined, 77 were sinistral and 46 were dextral. It is to be noted that in lots of specimens of approximately the same size taken on the same date at the same locality, evidently from the same school having the same origin, the fish are preponderately either sinistral or dextral, suggesting that this character is of an hereditary nature).

Color.—Ocellated spots present in some of the small specimens examined, most of the others evidently faded from long immersion in preservative, and the frequency of occurrence of ocellated spots in fresh specimens is problematical. The rows of other spots, where present, are often more or less irregular. In those specimens in which the ocellated spots are present the three spots forming the larger triangle are often more prominent than the others, and sometimes present in specimens having no other ocellated spots than those three. A longitudinal, somewhat curved, row of six, white, small spots under and along the dorsal profile, beginning at a point over the preopercle and ending near the end of the dorsal; and a similar but usually less well-marked row over the base of the anal. These spots are frequently persistent in

preserved specimens which have otherwise nearly all faded. Sometimes numerous similar, white, small spots are scattered over the head and body, and in such specimens the longitudinal rows as described above are not as saliently marked, but even then the spots in the longitudinal rows stand out more prominently than the others. Most other species have white spots more or less developed, but they are usually most prominent in *californicus* and also in *aestuarius*.

Specimens examined.—San Diego, California (22 lots in Nat. Mus., 1 to 11 specimens in a lot, and one lot of 25 specimens, 18 of which are included in the tables). The following localities on the west coast of Lower California: San Quentin Bay (46561); San Bartolome Bay (47269: 59464); Puerto San Bartolome (A. M. N. H. 5460 and 5462); Ballenas Bay (A. M. N. H. 5452); Magdalena Bay (47286). Total number of specimens studied 123, 42 to 570 mm.; 15 from the west coast of Lower California; all others from San Diego.

Geographic distribution.—The specimens examined represent a range from San Diego Bay, Calif., to Magdalena Bay, Lower California. It has previously been reported from Tomales Bay, Calif., to Magdalena Bay, these two localities being the extremes of its range known at present. Its center of abundance is at San Diego; it is abundant at Monterey; at San Francisco it is not abundant although taken in moderate commercial quantities.

Size.—This is the largest species of *Paralichthys* in American waters. The largest fish of which there is any definite record is that reported by Lockington (1879), a specimen weighing 58 pounds, 4 feet 10 inches in length. The same author (1878–79) states that he was told that the fish reaches a weight of 70 pounds. Jordan and Gilbert (1881) record a fish of 55 pounds.

Distinctive characters and relationship.—This species is closely related to *aestuarius* and *adspersus*. From the latter it differs chiefly in the depth of body, there being no intergrading individuals in the many specimens examined although the extremes of the two species approach closely. The form of the frequency-distribution polygon for the number of gill rakers is different in the two species, but in this case there is considerable overlapping. *P. californicus* is most closely related to *aestuarius*, differing from the latter in that the scales retain their ctenoid character with age and in the smaller number of dorsal and anal rays, there being some intergrading in the latter characters. In practice, *californicus* may be readily distinguished from *adspersus* in its more slender body and also in their widely separated geographical ranges. From *aestuarius*, large specimens, those over 200 mm., may be distinguished by the character of the scales. Small specimens, however, may be distinguished only by the number of fin rays, and this is not reliable in every case (tables 5 and 6). Difficulty will, therefore, be experienced in identifying some isolated small specimens in the localities where the two species occur together. In fact this may prove impossible in the case of some individual small fish. If a fish has less than 74 dorsal and less than 56 anal rays, it is nearly always a *californicus*. The probability of its being an *aestuarius* is remote. Likewise, if a specimen has more than 77 dorsal and more than 60 anal rays it is most likely an *aestuarius;* the chance of its being *a californicus* is almost negligible. However, the identification of small specimens having 74 to 77 dorsal rays and 56 to 60 anal rays must be doubtful.

Biology.—Although it is a common and important species very little is known regarding its life history. Clark (1931) states that "spawning . . . occurs from February to July with its greatest intensity in May." According to this author, the fishermen think that when the fish become abundant in late winter or early spring they are migrating from greater depths to spawn nearer the coast. This would indicate a spawning migration in the opposite direction from that taken by the summer flounder on the east coast (p. 319). As to the rate of growth, Clark estimates a length of 1–5 inches for fish one year old; 4–9 inches at 2 years; 6–15 inches at 3 years; 10–16 inches at 4 years, and 11–17 inches at 5 years.

Fishery and economic importance.—The California halibut is one of the important food fishes on the coast of California and Lower California. The trammel net is an important gear by which this species is taken and is practically the only gear used around San Pedro due to legal restrictions (Clark 1931). The inner layer of the trammel nets used there has a mesh of 8 inches,

stretched. In other sections of the coast, it is also taken with trawl nets and with hook and line. The commercial catch is mostly obtained in water from 3 to 20 fathoms in depth. The California halibut is taken in commercial quantities the year-round, but the bulk of the catch on the American coast is taken between January and June, with the peak usually occurring during March. Of the total quantity obtained in Mexican waters and landed at American ports, the bulk is obtained between June and November with the peak of the catch during August (Whitehead 1929).[6]

The annual catch of the California halibut fluctuates from year to year, as does that of many other fishes. Superimposed on this annual fluctuation, a decline occurred in the commercial catch from more than 4 million pounds in 1916 to 1,787,901 pounds in 1947 (Calif. Bur. Mar. Fish., Bull. 74, p. 226, 1949). The value of the catch to the fisherman, for 1947, was $331,218.

Population differences.—The specimens examined make it seem possible that some population differences exist in this species with respect to the fin ray and gill raker counts, as shown by the following tabulation. These apparent differences may disappear when more specimens from the southern range of the species are examined. However, should they be found to exist in fact, differences in the fin ray counts will prove to be of some help in distinguishing this species from *aestuarius*. On account of the possible lower counts of *californicus* in the southern population the relative number of intergrades may largely or partly disappear where both species occur together. (Compare the following tabulations with tables 5 and 6.)

Anal rays

	49	50	51	52	53	54	55	56	57	58	59
Number											
San Diego frequencies	1	4	5	12	22	19	15	14	4	2	2
Lower California frequencies			1	2	4	4	2	2			

Dorsal rays

	66	67	68	69	70	71	72	73	74	75	76
Number											
San Diego frequencies	4	6	9	16	14	16	17	6	5	2	1
Lower California frequencies		1	4	2	1	2	3	1	1		

Gill rakers on upper limb

	7	8	9	10	11
Number					
San Diego frequencies	10	48	29	3	1
Lower California frequencies	4	5	1	1	

Gill rakers on lower limb

	18	19	20	21	22	23
Number						
San Diego frequencies	4	8	35	23	16	5
Lower California frequencies	1	2	1	6	1	

Pleuronectes maculosus GIRARD, Proc. Acad. Nat. Sci., Philadelphia, 7: 155, 1854 (San Diego, Calif. The name is a homonym of *Pleuronectes maculosus* CUVIER, Reg. Anim., nouv. ed., t. 2, p. 341, 1829; and may also prove to be a homonym of *Pleuronectes maculosus* GRONOW, in Cat. Fish. British Mus., edit. by Gray, p. 89, 1854, if the exact dates of publication could be ascertained).

Paralichthys maculosus GIRARD, U. S. Pacific R. R. Exp. Sur. (Zool.) 10 (Fish.): 147, 1858 (San Diego, Calif.).

Hippoglossus californicus AYRES, Proc. California Acad. Sci. 2: 29, 1859 and [p. 59] fig. 10, 1860 (San Francisco Bay).

Pseudorhombus californicus, GÜNTHER, Cat. Fish. British Mus. 4: 426, 1862 (after Ayres).

Paralichthys maculosus GÜNTHER, ibid., p. 431 (after Girard).

Uropsetta californica GILL, Proc. Acad. Nat. Sci. Philadelphia, 1862: 330 (listed).

Paralichthys maculosus GILL, ibid., 1864: 197 (listed).

Uropsetta californica GILL, ibid., p. 198 (listed).

Paralichthys maculosus LOCKINGTON, Rep. Comm. Fish. California, 1878–79: 41 (Tomales Bay to San Diego).—LOCKINGTON, Proc. U. S. Nat. Mus. 2: 79, 1879 (San Francisco, Calif.).—JORDAN and GILBERT, ibid. 3: 454, 1881 (San Francisco, Monterey Bay, San Luis Obispo, Santa Barbara, San Pedro and San Diego, Calif.).—JORDAN and GILBERT, ibid., 4: 66, 1881 (Tomales Bay to San Diego).

Paralichthys californicus JORDAN and GILBERT, Bull. U. S. Nat. Mus. 16: 821, 1883 (California).

Paralichthys maculosus JORDAN, Fishery Industries U. S. (by Goode and others), sec. 1, p. 182, 1884.

Paralichthys californicus JORDAN and Goss, Rept. U. S. Comm. Fish. 1886: 245, 1889 (Tomales Bay to San Diego, Calif.).—JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 (3): 2625, 1898 (Tomales Bay to Cerros I.).—GILBERT and SCOFIELD, Proc. U. S. Nat. Mus. 20: 490, 1898 (Magdalena Bay, Lower California).—STARKS and MORRIS, Pub. Univ. California (Zool.) 3: 242, 1907 (San Diego Bay).—METZ, First Ann. Rep. Laguna Lab., p. 60, 1912 (Newport, Calif.).—OSBURN and NICHOLS, Bull. Amer. Mus. Nat. Hist. 35: 180, 1916 (Port San Bartholome, Ballenas Bay

[6] This difference in the seasonal abundance as between American and Mexican waters may possibly be explained by the fishermen resorting to the more remote waters off the coast of Lower California during that part of the year, either because the fish become more scarce nearer at home or for some other reason. Another possible explanation which it may be well to check in any future studies of the flounders, is that the catch in Mexican waters may also contain quantities of *aestuarius*, a species which occurs at the southern end of the coast of Lower California and which greatly resembles the California halibut.

and Magdalena Bay, Lower California).—STARKS, California Fish and Game 4: 169, fig. 89, 1918.—WHITEHEAD, Bull. Div. Fish Game California 15: 35, 1920 (gives figures of commercial catch).—CLARK, ibid., 20: 54, 1930 (quantity of commercial catch).—CLARK, California Fish and Game 16: 315-317, 1930.—WALFORD, Bull., Div. Fish and Game California 28: 138, fig. 113, 1931.—CLARK, ibid., No. 32, 1931 (an account of the fishery).

Paralichthys maculosis ULREY and GREELEY, Bull. South. California Acad. Sci. 28: 31, 1928 (Santa Monica Bay, San Pedro Bay and Newport Bay, Calif.).

Paralichthys californicus NORMAN, Monogr. Flatfishes, p. 81, fig. 47, 1934 (San Francisco and San Diego, Calif.; Magdalena Bay).

PARALICHTHYS AESTUARIUS

Gulf flounder

(PLATE 10)

Common name.—Apparently this species has as yet no common name, and the term "gulf flounder" is proposed as its uniform common name. This name refers to its habitat, being the most common species of *Paralichthys* in the Gulf of California.

Diagnosis.—Scales ctenoid on eyed side in small specimens, cycloid in large, the gradual change in the character of the scales generally taking place in fish between 150 and 200 mm. in round figures (varies greatly with individual fish; one of the "cotypes" in the National Museum, 220 mm., still has a few weakly ctenoid scales under the bend in the lateral line, and in another fish 193 mm., no ctenoid scales could be found); scales on caudal peduncle usually the first ones to change; cycloid scales on blind side at all ages; 64 to 79. Accessory scales present, first beginning to appear in specimens of 75 to 100 mm., very numerous on both sides in specimens 200 mm. or longer. Total number of gill rakers 24 to 31, the greatest concentration of individuals at 27 or 28; 18 to 23 on lower limb; 6 to 9 on upper limb, the mode at 8. Anal rays 57 to 67; dorsal rays 75 to 85.[7] Pectoral rays predominantly 12, sometimes 13 or 11 (12 on both sides in 14 specimens, 13 in 2, 11 in 1, 12 on eyed side, and 13 on the other in 1). Origin of dorsal slightly behind anterior margin of eye in 1 specimen 78 mm.; generally over anterior margin of eye, sometimes slightly in front or somewhat behind in specimens 81 to 220 mm., a little in front of eye in 2 specimens 330 and 381 mm. Maxillary extending backward to a vertical through posterior margin of pupil in fish up to 80 or 100 mm., through hind margin of eye or slightly past in specimens 200 mm. or longer. Depth medium. Nearly as often dextral as sinistral in the specimens examined (16 fish having the eyes on the right side and 22 on the left).

Color.—In small specimens the three spots forming the large triangle are more or less ocellated in those fish having the color preserved. Other ocellated spots are frequently present, two ocellated spots, one each in the upper and lower intermediate rows, are often especially well marked, on a vertical about two-thirds the distance from the base to the apex of the large triangle; these two spots forming a quadrangle with the two anterior spots of the large triangle, and a triangle with the prepeduncular spot on the lateral line. Often spots are present in which the center of the ocellus is lacking, thus simulating "rings." The larger specimens examined, those of 185 mm. or longer, do not show any ocellated spots, but this may be due to their long immersion in preservative. The cotypes show longitudinal rows of white spots at the bases of dorsal and anal, and are also more or less profusely snowed over with smaller white spots. The other specimens examined do not show the white spots, but some have longitudinal rows of dark spots at the bases of the vertical fins in place of the white spots.

Specimens examined.—Shoal Point, at mouth of Colorado River, *Albatross*, 2 specimens, 193 and 220 mm. (48128, originally designated type), 3, 185–195 mm., same data (Stanford Univ. Zool. Coll. 195); 2, 66 and 76 mm., same locality, March 28, 1889. Gulf of California, *Albatross*: lat. 30°36′30″ N. long. 114°27′45″ W., Mar. 27, 1889, 24 fathoms, 1, 381 mm. (47280); lat. 30°58′30″ N. long. 113°17′15″ W., Mar. 24, 1889, 11 fathoms, 1, 330 mm. (47281); lat. 31°17′30″ N. long. 113°57′15″ W., Mar. 25, 1889, 10 fathoms, 1, 203 mm. (47284). The following specimens obtained by the *Pawnee* of the Bingham Oceanographic Foundation in 1926: San Felipe Bay, May 19, 3, 101–159 mm.; Gongago Bay, May 18, 9, 66–113 mm., and May 17, 10, 68–148 mm.; Angeles Bay, May 11, 1, 37 mm.; San Francisquito Bay, May 9, 3, 110–154 mm.; Conception Bay, May 1, 1, 81 mm., and May 2, 1, 80 mm. Total number of specimens studied 38, ranging 37 to 381 mm.

[7] One specimen from Gongago Bay has only 71 dorsal rays. The dorsal fin of this specimen apparently has been injured to its base, in part, and regenerated. This count was, therefore, neither included in the diagnosis nor in table 6.

Geographic distribution.—Besides the localities given above from which specimens were studied (all from the Gulf of California), the species has also been recorded from Magdalena Bay on the west coast of Lower California under the name of *Paralichthys magdalenae*. The present known range of the species is therefore from the mouth of the Colorado River to Magdalena Bay. In the latter locality it occurs together with *californicus*. It is possible that it extends further north on the west coast of Lower California and that it has been confused there with *californicus*.

Size.—The type of *magdalenae*, 17 inches, is the largest specimen known of this species. The largest specimen examined in this study is 15 inches (381 mm.).

Distinctive characters and relationship.—As far as the practical work of correctly identifying material is concerned, it is only necessary to consider the relation of the present species with *woolmani*, *californicus*, and *H. tetrophthalmus*, since these are the only known species which occur together with it in parts of its range, with which it may be confused. *P. aestuarius* may be distinguished from *woolmani* by the number of gill rakers (table 4). There is a wide gap in the ranges of the two species, and they may be separated without difficulty, at all ages, by that character alone. *H. tetrophthalmus* has a still smaller number of gill rakers. The situation becomes difficult, however, when we try to distinguish correctly *aestuarius* from *californicus*, as discussed under the account of the latter.

This species is evidently closely related to *californicus*, nearly agreeing with the latter not only in the number of gill rakers and the number of scales, but also in the almost invariably sinistral or dextral body. The change in the character of the scales of *aestuarius* with age, ctenoid in the small fish becoming cycloid in the larger individuals, furnishes evidence as to the probable phylogenetic development of some species of *Paralichthys*. Assuming that the loss of spinules on the scales is a more recent development in this genus, it may be stated that *aestuarius* is an offshoot of *californicus*. As a further development along this line of modification, *woolmani* has been derived from *aestuarius*, by the loss of scale spinules at all ages. We thus have evidence to show the derivation of the subgenus *Chaenopsetta* from typical *Paralichthys*.

Synonymy.—The species described under the name *Paralichthys magdalenae* was evidently based on a specimen of *aestuarius*. Abbott in describing his supposedly new species compared it with *californicus* and correctly pointed out the important differences, as far as the size of the specimen which he studied was concerned. However, these are the very differences which distinguish *aestuarius* from *californicus*. Gilbert and Starks, by a comparison of the types of *magdalenae* and *aestuarius* have already concluded that the former was based on a specimen of the latter. Notwithstanding that the edition of the check list by Jordan, Evermann and Clark (1930) lists *magdalenae* as a tenable species, this name should be relegated to the synonymy of *aestuarius*.

Economic importance.—No data are at present extant as to the economic importance of this flounder, if indeed, it enters the market at all. However, the species seems to be common where it does occur and it also reaches marketable size. Consequently, it seems to offer possibilities for exploitation, should it prove to occur in commercial quantities. Moreover, in view of its close resemblance to the California halibut, it is possible that it now enters the market mixed with that species in catches obtained southward, in Mexican waters.

Paralichthys aestuarius Gilbert and Scofield, Proc. U. S. Nat. Mus. 20 : 499, pl. 39, 1898 (Shoal Point, mouth of Colorado River, Mexico).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47 (3) : 2626, 1898 (Shoal Point, Mouth of Colorado River, Mexico).

Paralichthys magdalenae Abbott, ibid., p. 2871 (Magdalena Bay, Lower California).

Paralichthys aestuarius Gilbert and Starks, Mem. California Acad. Sci. 4: 198, 1904 (type compared with *magdalenae*).

Paralichthys magdalenae Jordan and others, Rept. U. S. Comm. Fish., 1928: 223, 1930 (listed).

Paralichthys aestuarius Jordan and others, ibid., 224 (listed).—Norman, Monogr. Flatfishes, p. 82, fig. 48, 1934 (based on a paratype).—Breder[8] Bull. Bingham Ocean. Coll. 2 (3): 1936 (San Francisquito Bay, Gongago Bay, Conception Bay, San Felipe Bay, Angeles Bay, all localities in Gulf of California).—Hiyama, Marine Fishes of the Pacific Coast of Mexico. Edited by T. Kumada, p. 58, pl. 91, 1937 (Mexico).

[8] The majority of specimens forming the basis of the present account are the same as those forming the basis of this record, and I wish to express my gratitude to Dr. Breder for the opportunity of studying these specimens.

Subgenus Chaenopsetta

Chaenopsetta GILL, Cat. Fish. E. Coast North America (supp. Proc. Acad. Nat. Sci. Philadelphia, vol. 13, 1861), p. 50, 1861 (genotype *Paralichthys dentatus* (Linnaeus) = *Platessa oblonga* Storer = *Platessa ocellaris* De Kay, by monotypy, both latter names cited in the original account being synonyms of *dentatus*).

Chaenopsetta GILL, Proc. Acad. Nat. Sci. Philadelphia, 1864: 216 (genus first defined).

This subgenus differs from typical *Paralichthys* in having cycloid scales on both sides in large as well as in small specimens. The species comprising this subgenus seem to form a natural and related group. Its possible derivation from the subgenus *Paralichthys* through *aestuarius* to *woolmani* is suggested above (p. 301). All the known species occur on the Atlantic and Pacific Coasts of North and South America.

PARALICHTHYS WOOLMANI

(PLATE 11)

Diagnosis.—Scales cycloid on both sides at all ages, 62 to 71. Accessory scales present, beginning to appear in specimens of about 150 mm., rather sparse at a comparatively large size, usually somewhat more numerous on blind side, on either side increasing in numbers somewhat with the size of the fish. Total number of gill rakers on outer arch 16 to 20, usually 17 to 19; usually 4 or 5 on upper limb, infrequently 6; usually 13 or 14 on lower limb, sometimes 12 or 15, infrequently 11. Anal rays 55 to 60; dorsal rays 70 to 81. Pectoral rays most often 12, commonly also 11 (12 on both sides in 14 specimens, 11 on both sides in 5, 11 on blind side and 12 on the other in 2). Origin of dorsal more or less behind anterior margin of eye in specimens 60 to 90 mm., generally over anterior margin of eye in specimens 90 to 250 mm., in front of anterior margin of eye in 1 specimen 429 mm. Maxillary extending backward to underneath the space between posterior margin of eye and that of pupil in specimens under 100 mm., to a vertical through posterior margin of eye or nearly there in specimens up to 200 mm., somewhat past eye in one specimen 429 mm. Maxillary and head longer and body somewhat deeper than in the closely related *brasiliensis* when specimens of like size are compared. Sinistral.

Color.—Color pattern more distinguishable in smaller specimens. Spots, where distinct, usually in 5 longitudinal rows, sometimes more or less irregularly arranged, faintly suggesting 7 rows. Ocellated spots present, frequently numerous. Spots forming the large triangle frequently rather more prominent than other spots. Other shadings on body variable as in related species, irregularly shaded, light and dark; the intensity of the shadings variable, sometimes light all over and often very dark; ocellated character of spots in darker specimens often not discernible, sometimes snowed over with many white spots; sometimes sprinkled profusely with small dark spots; longitudinal rows of white spots along dorsal and ventral profiles sometimes more or less evident.

Specimens examined.—Carmen Island, Gulf of California (46437). La Paz, Mexico, "cotype" of *Paralichthys sinaloae* (47486). Cape San Lucas, Lower California (7036). Panama (50334). Panama City Market (78103, 81052, 81054, 81055, 81056). Taboga I., Panama (81634). Perlas I. Panama (Bingham Ocean. Coll.). Chame Point, Panama (81635, 82698). Galapagos I., Albatross; type of *P. woolmani;* about 240 mm. caudal broken at tip (47575; as to authenticity of locality of the type see following discussion). Paita, Peru (77705). Total number of specimens studied 22, 48 to 429 mm.

Geographic distribution.—The species has been recorded hitherto from localities ranging from La Paz, Sinaloa, Mexico, to Paita, Peru, and the coast of Lower California at Cape San Lucas. The material studied confirms this range and carries the distribution somewhat northward and westward within the Gulf of California to Carmen Island. The range of this species is more extensive than that of any other related species from the American continents.

The locality where the type specimen was captured is doubtful. Jordan and Bollman (1889) who first listed the specimen stated that it came from Panama. Later, presumably this same specimen was described as a new species by Jordan and Williams (1896) who now ascribe it to the Galapagos Islands, and the locality is so entered on the National Museum register. Since the species without a doubt occurs as far as Paita, Peru, it is not impossible that it extends its range to the Galapagos Islands. In regard to this question, Gilbert and Starks (1904) state, "The type of this species was collected by the Albatross in 1888, at Panama . . . Later, when made the type of a new species, it was erroneously credited to the

Galapagos Islands." These authors, however, do not indicate whether their statement is based on the original record of Jordan and Bollman, or whether they had additional unpublished information showing that the later record of Galapagos Islands is erroneous.

Size.—Jordan (1895) records it as reaching an estimated length of "about three feet" and that most specimens are "much smaller." Outside of this estimated maximum length, the largest individual which appears to have been actually measured is given by the same author as 44 cm. (17½"), taken in the estuary at Mazatlan, Mexico. Meek and Hildebrand record a maximum length of 30.5 cm. The largest specimen examined by me, which was also studied by Evermann and Radcliffe (1917), is 43 cm., from Paita, Peru.

Distinctive characters and relationship.—This species may be distinguished from all others, except *aestuarius*, of the same genus occurring on the Pacific Coast of North and South America, by its cycloid scales. From *aestuarius* which occurs in part of its range and also has cycloid scales when large, it may be separated by the fewer gill rakers: 12 to 15 on the lower limb of the first arch of *woolmani*, 18 to 20 in *aestuarius;* the frequency distribution of the gill raker count in the two species being sufficiently discontinuous to enable one to distinguish individual fish with assurance. This species is apparently most closely related to *brasiliensis* from the Atlantic coast.

Synonymy.—P. sinaloae described by Jordan and Abbott and recognized in the new edition of the check list should be deleted and this name placed in the synonymy of *woolmani*. The authors in describing *P. sinaloae* have correctly indicated the differences between their supposedly new species and *adspersus*, except as to the width of the interorbital which is approximately the same when specimens of similar size are compared. However, the distinguishing characters as stated by these authors are the same which differentiate *woolmani* from *adspersus*. These authors further state that *woolmani* probably differs from their *sinaloae* because of the smaller number of gill rakers of the former. The type of *woolmani* has been studied. On the eyed side it has 11 well-developed gill rakers on the lower limb; and 4 well-developed ones on the upper limb with one short, stumpy gill raker above the 4. According to my method of counting it would be enumerated as 5+11, and this is the number given in the original description. On the blind side it has 12 well-developed gill rakers on the lower limb with one very short and small but plainly perceptible gill raker in front; and 4 well-developed gill rakers with one tuberosity above. According to my method of counting they would be enumerated as 4+13. Therefore, the gill rakers of the type specimen of *woolmani*, even when the eyed side is considered, fall within the regular frequency distribution for the species here described, which also evidently includes *sinaloae* stated to have 13 or 14 gill rakers on the lower limb. One of the paratypes of *sinaloae* (U.S.N.M. 47486) has been examined, and, except for its being somewhat more slender than the average specimen of *woolmani* at that length, it does not differ from that species. Gilbert and Starks who have reexamined the types of *sinaloae* also concluded that they represent specimens of the previously described *woolmani*.

Economic importance.—This species is a food fish of some importance where it occurs. Meek and Hildebrand (1928) state it to be "rather common at Panama, and it is of some commercial value," and Gilbert and Starks (1904) report it as "abundant at Panama." Jordan (1895) states it to be "very common . . . at Mazatlan [Mexico] . . . and is a food fish of some importance." However, no figures of the catch are available by which the commercial importance of the species may be definitely established.

Paralichthys dentatus Goode and Bean (in part) Proc. U. S. Nat. Mus. 2: 123, 1879 (The specimen recorded from Paraguay, U.S.N.M. 8436, Capt. Page, agrees more nearly with *woolmani* and the recorded locality is most probably in error although the characters of the specimen are not decisively indicative.)

Paralichthys adspersus Jordan and Gilbert (not Steindachner), ibid., 5: 370, 1882 (Cape San Lucas, Lower California).—Jordan and Gilbert, Bull. U. S. Fish. Comm. 2: 108, 1882 (Mazatlan, Mexico).—Jordan and Gilbert, ibid., p. 111 (Panama).—Jordan and Bollman, Proc. U. S. Nat. Mus. 12: 182, 1889 (the locality is given as Panama, but later changed to Galapagos Is. by Jordan and Williams, 1896).—Jordan, Proc. California Acad. Sci. (2) 5: 503, 1895, (Mazatlan and La Paz, Mexico).

Paralichthys woolmani Jordan and Williams, Proc. U. S. Nat. Mus. 19: 457, 1896 (apparently based on same specimen recorded by Jordan and Bollman, 1889, as coming from Panama, but now assigned to Galapagos Islands).

Paralichthys adspersus JORDAN and EVERMANN (in part), Bull. U. S. Nat. Mus. 47 (3): 2627, 1898 (specimens from Mazatlan and La Paz refer to this species).

Paralichthys woolmani JORDAN and EVERMANN, ibid., p. 2628 (redescription of type).

Paralichthys sinaloae JORDAN and ABBOTT, ibid., p. 2872 (Mazatlan and La Paz, Mexico).

Paralichthys woolmani GILBERT and STARKS, Mem. California Acad. Sci. 4: 107, 1904 (Panama).

Paralichthys adspersus THOMPSON (in part), Proc. U. S. Nat. Mus. 50: 411, 1916 (Mazatlan, Mexico).

Paralichthys woolmani EVERMANN and RADCLIFFE, Bull. U. S. Nat. Mus. 95: 140, 1917 (Paita, Peru).—MEEK and HILDEBRAND, Publ. Field Mus. Nat. Hist. Chicago (zool. ser.) 15 (3): 974, 1928 (Chame Point, Taboga I. and Panama City market, Panama).

Paralichthys sinaloae JORDAN and others, Rept. U. S. Comm. Fish., 1928 (2): 224, 1930 (listed).

Paralichthys woolmani JORDAN and others, ibid. (listed).—NORMAN, Monogr. Flatfishes, p. 86, fig. 51, 1934 (La Paz, Mexico; Panama).—BREDER, Bull. Bingham Ocean. Coll. 2 (3): 4, 1936 (Perlas Is., Panama Bay).

Paralichthys adspersus HIYAMA, Marine fishes of the Pacific Coast of Mexico, edited by T. Kumada, p. 58, colored plate 43, 1937 (Mexico).

PARALICHTHYS BRASILIENSIS

Diagnosis.—Scales cycloid on both sides at all ages; 62 to 72. (Posterior end of curve in lateral line often not continued rather abruptly into straight horizontal part, as in related species, but somewhat gradually merging with straight part along a short rather oblique line.) Accessory scales present, usually in somewhat larger numbers on blind side, comparatively not numerous on both sides, present in specimens as small as 131 mm. (the smallest examined), sometimes still absent in specimens as large as 155 mm. Total number of gill rakers on first arch 18 to 22; 4 or 5, sometimes 3, on upper limb; 14 to 17 on lower limb. Anal rays 54 to 60; dorsal rays 68 to 78. Pectoral rays 11 in most fish, sometimes 10 on one or both sides (11 on both sides in 10 specimens; 10 on both sides in 3; 10 on blind side and 11 on the other in 2; 10 on eyed side and 11 on the other in 2). (Vertebrae 11+23 according to Thompson 1916). Origin of dorsal more or less in front of anterior margin of eye in specimens 131 mm. or longer. Maxillary about reaching a vertical through posterior margin of orbit in specimens 131 to 214 mm., somewhat past eye in larger fish. Head and maxillary rather short. Body of medium depth. Sinistral.

Color.—More or less mottled with shadings of various intensity; traces of white rather diffuse spots at bases of dorsal and anal in some specimens. No evidence of ocellated spots in the specimens examined, but probably more or less faded from long immersion in preservative. The figure published by McDonagh of a young specimen shows some ocellated spots. (The prepeduncular spot appears to be doubled in his figured specimen.)

Specimens examined and geographic distribution.—Rio de Janeiro; U. S. Exploring Expedition (83404 and 83399, the type and paratype, respectively of *Xystreurys ribeiroi*). Montevideo, Uruguay; Albatross (77388). Buenos Aires, Argentina; Albatross (77389). Mar del Plata at Necochea, Argentina, Dr. T. L. Marini. Total number of specimens studied 17, 131 to 477 mm., the localities ranging from Rio de Janeiro to Mar del Plata. The northernmost record in the literature is also Rio de Janeiro; the southernmost record is that by McDonagh, namely, San Blas, Argentina.

Distinctive characters and relationship.—As compared with related species which are known at or near its range, *brasiliensis* may be distinguished from *Pseudorhombus isosceles* and *Paralichthys patagonicus* by its cycloid scales. Two species occurring through or near its range belong to the subgenus *Chaenopsetta* and also have cycloid scales, namely, *tropicus* and *voræ*, from both of which the present species may be distinguished by the greater number of gill rakers, and from *voræ* it may be distinguished also by its smaller scales. In the possession of cycloid scales it agrees with 4 species from the east coast of the United States. As compared with the latter it may be separated from *dentatus* by the lesser number of fin rays, from *albigutta* by the more numerous gill rakers and scales, from *lethostigma* by having fewer fin rays and more gill rakers, and from *squamilentus* by the more numerous gill rakers and more slender body.

The relationship of *brasiliensis*, as far as may be judged by the characters studied, is evidently nearest to *woolmani* from the Pacific coast. The two species differ in the frequency distributions of a number of characters, such as the number of rays in the pectoral fin and its length, the number of gill rakers, the relative measurement of the

maxillary, head and depth. However, there is more or less intergradation in all of these structural characters. In the comparatively few specimens studied the greatest divergence is shown by the relative length of the head and maxillary in the standard length, when specimens of like size are compared (table 8); but in view of the variation of this character with the size of the fish and the few specimens available for measurement, it is doubtful whether it will prove more divergent than the other characters, after measuring a large series. In fact, the two species are so closely related that they may be distinguished only when taken in bulk, in a group of specimens. The proper identification of individual specimens would often prove quite uncertain by a study of structural differences only, unless the locality of capture be known. The relation between *brasiliensis* and *woolmani* looks very much like another example of the numerous similar cases where two species from both sides of the isthmus of Panama show small and slightly overlapping differences. While *brasiliensis* is not now positively known to occur on the Atlantic coast of Panama, it is possible that it will eventually be found there.

Economic importance and size.—The material studied by me indicates that this is probably the most common species of *Paralichthys* on the Atlantic coast of South America, and the common commercial flounder, the linguado or lenguado, on the coasts of Brazil, Uruguay, and Argentina is quite likely the present species. Berg's (1895) record of a species of *Paralichthys* reaching one meter in length, probably refers to this species. However, in view of the fact that the several species on the coast of South America apparently have not been distinguished properly heretofore, the question of its economic importance as well as the maximum size to which the present species attains must be left for future determination.

Nomenclature and synonymy.—The original description of *brasiliensis* fails to take account of important characters, and the application of that name must be attended with considerable doubt when dependent only on the original account. From the figure and description it may be gathered that Ranzani's species is sinistral, of medium depth. It has rather low vertical fins; short, symmetrical ventrals; a short pectoral; a large mouth; large teeth; a well developed anterior curve in the lateral line. It is apparently a species of *Paralichthys*. Assuming it to belong to that genus, the only substantial characters, of those investigated in detail during this study and also mentioned in the rather lengthy original description, are the number of fin rays; D. 69, A. 53, P. 11. The figure disagrees with the description in that it shows only 48 anal rays. The numbers in the vertical fins may very readily fall within the range of variation of three species now known from that region, namely, the present species, *tropicus* and *vorax*. The number of pectoral rays is one more than in the single specimen of *vorax* examined by me, but one specimen is, of course, not of decisive importance in this case. Ranzani's figure shows rather large scales, in about 50 oblique rows over the straight part of the lateral line, rather like *vorax*, but the number of scales is not mentioned in the description and in view of apparent inaccuracies shown by Ranzani's figures in general, the size of the scales of the published figure of *brasiliensis* cannot be accepted as a reliable guide. As far as I know nobody ever redescribed the type.

In view of these uncertainties, the best we can do now is to follow later revisers. Jordan and Goss (1889) were the first authors to use the name *brasiliensis* in a definite sense. They gave a recognizable description of a species of *Paralichthys* to which they applied Ranzani's name. The species described by them is evidently the same as the one described herewith and I follow these authors in their nomenclature.

Norman (1934) substitutes the name *orbignyana* for this species and applies the name *brasiliensis* to the species described by Günther, under the name of *vorax* and here so designated. This creates an unfortunate confusion of names which is possibly unnecessary. The name *orbignyana* is apparently not available for this species as discussed on pages 303 to 304. Regarding the name *vorax*, Ranzani may have had specimens of that species when he described his *brasiliensis;* but judging by the specimens examined in the National Museum and those recorded by Norman in the British Museum, the present species appears to be much more common than the one described by Günther as *vorax*, and the probabilities are much greater that Ranzani had specimens of the present species. Furthermore, the authors presenting the best accounts of this species, in addition to that of

Jordan and Goss, before the appearance of Norman's monograph, have used the name *brasiliensis* to designate it. That name apparently was generally applied to this species, although in some cases accounts of "brasiliensis" may refer partly or wholly to other species as well. Probabilities and general usage, therefore, favor the use of the name *brasiliensis* for this species, and this course is adopted here. If the type of *brasiliensis* is still in existence and in good enough condition for study this question may be settled with finality by its examination, at least as far as the use of that name is concerned.

The type and paratype of *Xystreurys ribeiroi* Fowler and Bean were examined and proved to be specimens of the common species here described.

Attention may also be called here to the use of the name *brasiliensis* by Miranda Ribeiro (Arch. Mus. Rio de Janeiro, vol. 17, 1915). That author describes his *brasiliensis* as having ctenoid scales, 5 gill rakers on the upper limb and 10 to 15 on the lower. This combination of characters does not agree with any species studied by me. Ribeiro's material either represents a new species, or it consists of a composite of more than one species.

Hippoglossus brasiliensis Ranzani, Nuov. Anal. Sci. Nat. Bologna **3**: 290, 1840 (Brazil; nomen nudum).—Nov. Comm. Acad. Sci Inst. Bonon. **5**: 10, pl. 3, 1842 (Brazil).

Paralichthys brasiliensis Jordan and Goss, Rept. U. S. Comm. Fish. 1886: 246, 1889 (Rio de Janeiro, Brazil; Maldonado, Uruguay).

Pseudorhombus dentatus Perugia, An. Mus. Civ. Genova (2) **10**: 629, 1891 (Montevideo).

Paralichthys brasiliensis Berg, An. Mus. Nac. Buenos Aires **4**: 77, 1895 (Bahia Blanca and Mar del Plata, Argentina: Montevideo and Maldonado, Uruguay; gill raker count agrees with this species but scale count more like in *woræ*).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47 (3): 2626, 1898 (Rio de Janeiro; Maldonado).—Thompson, Proc. U. S. Nat. Mus. **50**: 411, 1916 (Montevideo; Buenos Aires).

Xystreurys ribeiroi Fowler and Bean, Proc. U. S. Nat. Mus. **63** (19): 26, 1923 (Rio de Janeiro; type reexamined).

Paralichthys brasiliensis Devincenzi, An. Mus. Nac. Montevideo (2) **5**: 278, 1924 (Uruguay; scale count more like that in *woræ*).—Fowler, Proc. Acad. Nat. Sci. Philadelphia **78**: 273, 1926 (Buenos Aires).—Marini, Rev. Soc. Argentina Cienc. Nat. **9**: 454, 1929 (Puerto Quequen, Argentina).

Paralichthys orbignyana Norman, Monogr. Flatfishes, p. 71, figs. 38 and 38a, 1934 (Rio de Janeiro; Rio Grande do Sul; Montevideo; Bahia Blanca).

Paralichthys brasiliensis MacDonagh, Rev. Mus. La Plata **34**: 52, pl. 5, 1934 (Atalaya, Costa Sur, Mar Chiquita, Bahia Blanca and San Blas, Argentina).—Ginsburg, Jour. Washington Acad. Sci. **26**: 132, 1936 (nomenclature discussed).

PARALICHTHYS DENTATUS

Summer flounder

(PLATE 12)

Common names.—Like other fishes this species is known by a number of common names. The early settlers, familiar with the common plaice of English waters, applied this name to the species. Thus, at about the middle of the eighteenth century, Dr. Garden who sent a specimen of the fish to Linnaeus used the name "plaise" to designate it, and that name is still in use in some sections. On the coast of New Jersey some fishermen call it splaice (Smith 1894) an evident variant of plaice. During the middle of the last century an attempt was made to introduce the name turbot for this fish on the Boston market in order to find a ready sale for it under that name which is used in England to designate another species of flatfish that is well esteemed. On Long Island it is generally called fluke, and this name is used by fishermen and especially by sportsmen in other sections also, but the same name is sometimes applied to other species of flatfishes. The name "summer flounder" is commonly used by fishermen in the more northern part of its range, because this is the common commercial flounder taken during the summer, as opposed to *Pseudopleuronectes americanus*, the common commercial species caught during the winter in the same region. The name "summer flounder" is most frequently used by writers and is here adopted as the uniform common name of the species. A summary of the other common names as compiled from the literature, and the locality in which the names are used, follows.

Summer flounder (New Jersey; New York; Rhode Island). Fluke (New York). Plaice (New York; Mass.). Chicken halibut (by some fishermen and dealers being either mistakenly or purposefully regarded as the young of the halibut which it resembles). Brail (Rhode Island). Puckermouth (Rhode Island). Turbot (Mass.). Flatfish (Long Island, New York; Chesapeake Bay; also generally applied). Flounder is applied throughout its range by many people who do not distinguish the different species of flat-

fishes. Book names applied to this species are: American turbot (Storer), long-toothed flounder (De Kay), flounder of New York (Mitchill), and common flounder (Baird).

Diagnosis.—Scales cycloid on both sides at all ages; 56 to 76, the greatest concentration of individuals between 62 and 70, the mode at 65. Numerous accessory scales present, usually beginning to appear in specimens of about 80 to 90 mm., their first appearance usually on eyed side. Total number of gill rakers on first arch ranging 16 to 24, but few specimens of those examined having less than 20; 3 to 7 on upper limb, the great majority having 5 or 6; 13 to 18 on lower limb, only a few having less than 15. Anal rays 61 to 73; dorsal rays 80 to 96. Pectoral rays mostly 12, sometimes 13 (in 10 specimens taken at random, 12 on both sides in 7, 13 in 2, and one having 8 rays on eyed side and 12 on blind side, the last probably abnormal with respect to this character). Vertebrae 11 + 30 or 31 (in 3 specimens). Origin of dorsal over or slightly in front of anterior margin of eye in large or medium-sized fish, usually slightly behind anterior margin of eye in specimens under 100 mm. Maxillary generally extending to a vertical through posterior margin of pupil in fish of 125 mm., through posterior margin of eye at 200 mm., past eye in fish over 300 mm., the backward extension of the maxillary with relation to the eye varying considerably with individual fish as well as with size. Sinistral.

Color.—Body on eyed side with numerous well marked ocellated spots in the great majority of individuals. Usually, most conspicuous ocellated spots, one each, at posterior ends of subdorsal and supra-anal rows and the prepeduncular spot on the lateral line (for terminology of spots see p. 277), the three forming the angles of an imaginary isosceles triangle. Two somewhat less conspicuous spots than the foregoing three, but more so than the other spots on body situated at anterior end of the upper and lower intermediate rows, these two spots forming with the prepeduncular spot another and larger triangle. Most spots in the 5 rows usually more or less ocellated. A number of smaller ocellated spots scattered on anterior part of body and head usually present. Specimens often quite dark in color, less frequently unusually light, the ocellated spots in such specimens, especially in the former, not so conspicuous, sometimes their ocellated character not evident altogether. The fish is capable of changing the relative intensity of the light and dark shadings in accordance with the shades of color of the background on which it rests, and this change in color shading may be induced experimentally (Mast 1916). However, the fundamental color pattern, that is, the distribution and relative intensity of the various ocellated spots may be discerned, in the great majority of cases, irrespective of the infinite variations in shadings which the fish may assume.

Young fish between 20 and 45 mm. have groups of chromatophores somewhat like those described for *lethostigma* (p. 329) overlaying the blotches on the body. The three blotches forming the large triangle are very prominent, rather more so than in *lethostigma*. These three blotches are not markedly ocellated, thus differing from specimens of *albigutta* of similar size. None of the spots in *dentatus* are distinctly ocellated in specimens between 20 and 40 mm.; although some of the spots, especially the two posterior spots which go to form the smaller triangle, in specimens between 30 and 40 mm., sometimes give a faint indication of being destined to become ocellated. These two spots at the posterior ends of the subdorsal and supra-anal rows are prominent, more so than in either *lethostigma* or *albigutta*, although they are more or less evident in the latter two species. The other blotches on the body are usually more or less diffuse. Specimens 55 mm. or longer generally show the characteristic color pattern of large fish.

Specimens examined.—Provincetown, Mass., August 1856, Putnam (5372). Mecox Bay, L. I., N. Y. (48990). Great South Bay, L. I., N. Y. (Blue Point Cove, 35907, 49029 and 49054; Fire Island, 35963). Sandy Hook Bay, N. J. (A. M. N. H. 7795). Beesleys Point, N. J. (789). Ocean City, Md. (45109). Hog Island, Va. (5885). Cape Charles, Va. (42485, 43208, 43142, and 43162). Chesapeake Bay (many localities in Maryland and Virginia). North Carolina (A. M. N. H. 5275). Hatteras, N. C. (88478). Beaufort, N. C. (15016, 51888, 51934 and many specimens in the collection of the U. S. Bureau of Fisheries). Charleston, S. C. (17121, 33168). Coosaw River, S. C. (59099). Parrot Creek, S. C. (59036). St. Simons Bay (outside), Ga. (collected by W. W. Anderson). Fernandina, Fla. (collected by the

Grampus). Total number of specimens studied in detail for the number of gill rakers, fin rays and scales, 120; many more examined in more or less detail to verify conclusions based on the above; sizes of specimens examined ranging 20 to 432 mm. Two lots of this species in the National Museum evidently were supplied with inaccurate or incomplete data as to locality, as follows: 35799, Mississippi, Lt. Wailes, 3 specimens, 193–248 mm. These specimens were possibly sent by the collector from Mississippi, but certainly not captured there. 5767, Jamaica, C. B. Adams, 1 specimen, 192 mm. The location of "Jamaica" is doubtful, but it probably refers to Jamaica Bay, Long Island, N. Y.

Geographic distribution and habitat.—The localities from which specimens were examined represent a range from Provincetown, Mass., to Fernandina, Fla. Around the northern end of Cape Cod, in Cape Cod Bay, it has been reported from North Truro (Kendall 1908) and Wellfleet (Storer 1864). In a review of the literature of the species, no authentic records north of Cape Cod were found. The distribution, Fernandina, Fla., to Provincetown, Mass., and around the point to Wellfleet, as based on material examined and on unquestionable records in the literature, must therefore stand for the present.

Kendall (1908, and Proc. Portland Soc. Nat. Hist., vol. 3, pt. 1, pp. 70 and 133, 1914) ascribes three records for Casco Bay, Maine, to the present species, one by Holmes and the other two from entries in the register book of the National Museum. The record by Holmes (in Second Ann. Rept. Nat. Hist. Geol. Maine, p. 61, 1862) as *Pomatopsetta dentata* Gill, most likely refers to the species now known as *Hippoglossoides platessoides*. At about the time when Holmes' report was published the leading American ichthyologists, such as Storer, De Kay, and Gill applied the specific name *dentata* to *Hippoglossoides platessoides*, and the type of Gill's genus *Pomatopsetta*, is that species. Moreover, *Hippoglossoides platessoides* is a common fish in the Gulf of Maine, although it is generally taken in deeper water, at 15 fathoms or beyond. Holmes lists three species of flatfishes from Maine, the other two being *Hippoglossus americana*, the halibut, and *Pleuronectes americanus*, the winter flounder, both common species. It is, therefore, much more likely that his *Pomatopsetta dentata* Gill was based on material of *Hippoglossoides platessoides* rather than on *Paralichthys dentatus*. As to the two records on the register of the National Museum, they probably also refer to some other common species of flatfish. During the seventies when the identifications entered on the register were presumably made, *Paralichthys dentatus* was known among the American ichthyologists under the specific name of *ocellaris* rather than *dentatus*. According to the data now extant, *Paralichthys dentatus* does not occur north of Cape Cod.

The species is very common and caught in commercial quantities from Cape Cod to North Carolina, and is abundant from southern Massachusetts to Chesapeake Bay. In Chesapeake Bay it is the most common flatfish marketed. In the summer it is found chiefly in shallow water, generally to about the 15 fathom line and, in the winter, on the coast of the northern States, it lives in deeper water, and has been recorded from a depth of 100 fathoms off the coast of Virginia, March 3, 1929 (Schroeder 1931). The species shows a preference for hard or sand bottom, but is also taken on mud or grass bottoms.

Size.—The usual sizes of this species which enter the market range from 12 to 25 inches, having a weight of ½ to 6 pounds. Fish more than 6 pounds are not common. The largest specimen on record weighed 30 pounds, taken off Fishers Island, N. Y. (Nichols and Breder 1927). Goode (1884) records the capture of a specimen weighing 26 pounds, landed at Noank, Conn. A half-pound fish measures about 12 inches; 1 pound, about 15 inches; 2 pounds, about 18 inches; 3 pounds, about 20 inches; 4 pounds, about 22 inches; 8 pounds, about 27 inches; 10 pounds, about 30 inches.

Distinctive characters and relationship.—The characteristic color pattern of this species enables one to identify the great majority of specimens at a glance. Near the northern end of its range, at Cape Cod, dark specimens in which the color pattern is not well marked, resemble somewhat *Hippoglosoides platessoides*, but this latter species may be readily distinguished by its eyes and color being on the right side, its lack of a high arch in the anterior part of the lateral line, its smaller

mouth, smaller teeth, ctenoid scales, and other salient differences. Some difficulty may be encountered in properly distinguishing scattered specimens of this species from *albigutta* or *lethostigma* where their ranges overlap. Doubtful specimens of *dentatus* in these localities may generally be properly placed by the more numerous gill rakers. For separating the residual few specimens in which the number of gill rakers approach the other two species see page 282. The three species are evidently quite closely related.

Bionomics

Spawning period.—The spawning period of this species is evidently the late fall and winter possibly extending to early spring in Chesapeake Bay, judging by available evidence. Hildebrand and Schroeder (1928: 166) found specimens taken in Chesapeake Bay during October, having comparatively large gonads. Hildebrand (op. cit.) found the gonads of fish taken at Beaufort, N. C., to be partly developed during fall and early winter while those taken in March and April were fully spent. Abundant data on the size of the fry and its bearing on the spawning season of the species is furnished by Hildebrand and Cable (1930: 470).[9] In the very extensive collections made at Beaufort, N. C., and reported on by these investigators, individuals 25 mm. (1 inch) or less in length were taken from September to May, the bulk of the specimens having been collected in November and December. As three common species occur at Beaufort, N. C., and no characters for separating the very young fry, before the fin rays and gill rakers become differentiated, are known at present, only the approximate spawning period for the separate species may be surmised. It is possible that the height of spawning varies with the different species. If that is the case, the spawning periods of the separate species probably overlap to a large extent, since the data published by Hildebrand and Cable do not show any dominant concentration of fry at different periods of time, when grouped by month intervals. (Perhaps, in a grouping of data by smaller intervals of time differing heights of spawning would show up to some extent.) In Chesapeake Bay spawning apparently takes place later, in the late winter or early spring, if we are to judge by the size of the fry in relation to the season of the year when taken. Thus, Hildebrand and Schroeder (op. cit.) report fry taken there in May and June to be approximately 25 mm. (0.9 to 1.1 inches). During 1892 the *Grampus* made some collections in Chesapeake Bay of young *Paralichthys dentatus* which are now preserved in the National Museum as follows: June 28, 3 specimens, 49, 58 and 83 mm.; June 29, 1 specimen, 40 mm.; July 4, 2 specimens, 38 and 50 mm.; July 6, 2 specimens, 42 and 45 mm.; July 16, 1 specimen, 57 mm. A comparison of the measurements of these few specimens with the extensive data given by Hildebrand and Cable seems to indicate that spawning occurs somewhat later in Chesapeake Bay.

Spawning places and distribution of fry.—In regard to particular situations where spawning takes place, Bigelow and Welsh (1925: 494) and Hildebrand and Schroeder (1928: 166) suggest the possibility of the fish going to deep water to spawn. There is evidence showing a general migration of the fish to deeper water with the advent of cold weather (p. 320). One of the objects of this migration may be spawning. That spawning takes place offshore is further indicated by the distribution of the fry as found by Hildebrand and Cable (1930: 474). Fry up to 3 mm. were taken only at sea; somewhat larger ones, up to 5 mm., were taken also within Beaufort Harbor, but they were much more numerous outside Beaufort inlet; while specimens 6 to 10 mm. are about equally distributed in the inner and outer waters, extending from 12 to 15 miles offshore into the estuaries of Newport and North Rivers. This furnishes evidence of a gradual movement of the fry to the inner waters from offshore where they hatch.

The type of eggs is unknown at present, but it is probably demersal, as recently hatched fry were taken by Hildebrand and Cable (1930: 475) chiefly on the bottom. If they hatch on the bot-

[9] The most extensive studies on the biology of *Paralichthys* which have been carried out so far, are those by Hildebrand and Cable to whose report the reader is referred for detailed accounts. These authors made their studies at Beaufort, N. C. Since, however, three closely related species of *Paralichthys* are common there, and it is difficult or impossible to separate the fry by species, Beaufort is not a favorable place to study the development of *dentatus*. The Chesapeake Bay region and localities farther north are more suitable because only this one species of *Paralichthys* occurs there.

tom, the young become distributed to some extent in the upper layers after hatching and are taken also at the surface with tow nets, but most of them remain on the bottom.

Growth.—The rate of growth of this species is as yet unknown, no special study having been made based on a sufficient amount of material. Hildebrand and Schroeder (1928: 166) by measuring a limited number of available specimens give tentative figures for growth as being 4½ to 7 inches at 1 year and about 10 inches at 2 years. The age at which the fish mature is likewise unknown. Hildebrand and Cable state (1930: 475) that individuals with roe which have been observed were large, 16½ to 29 inches. The age of specimens of that size is unknown at present.

Migration.—During the warmer months of the year, between April or May and November or December, depending on the latitude, this species is readily taken in comparatively shallow water, generally between 2 and 20 fathoms. With the advent of cold weather it becomes scarce in shallow water, indicating a general migration of the fish to deeper water. During the winter months it may be taken in large numbers beyond the 20 fathom line (Pearson 1932) and down to 100 fathoms (Schroeder 1931). This migration is evidently induced by the inability of the fish to withstand the colder temperature of the more shallow water. Fish sometimes are found torpid in shallow water during the winter (Baird 1855), probably being trapped by a sudden chill after being lured from greater depths by a spell of warm weather. The movement to deeper water during cold weather is a common habit of various species of fish. In the case of the summer flounder this is apparently also a spawning migration. The fish appear again in shallow water during the spring of the year, the time of appearance varying with the latitude, and most probably also with the temperature conditions during any given year. Other mass migrations of the adults are unknown, and it is unlikely that the species makes any other general migrations. The summer flounder is probably a comparatively immobile fish as a species. The young fry after hatching remain chiefly on the bottom, but they become also distributed in the upper layers to some extent, as stated. The fry undertake a movement from offshore to the inner waters. After the young fish exceed a length of 10 mm. they stay on the bottom and continue to move inshore, many going into the estuaries of rivers for considerable distances. The young evidently remain at the brackish-water zone and grow till they reach a length of about 125 mm. when they seem to gradually spread toward salt water.

Food and feeding habits.—The summer flounder is primarily a predaceous fish. Its food consists chiefly of such species of fish and small invertebrates as are readily accessible in the region which it inhabits. The following fishes have been reported as being preyed upon by the summer flounder, namely, mackerel, menhaden, tautog, sand launce, silversides, butterfish, and scup; of invertebrates, crabs, shrimp, squid, small mollusks, worms, and sand dollars. In the business of obtaining food it is aided by its ability of partial concealment; by simulating the color of the background, by partly burying itself in the bottom, and by the natural flat shape of the body. It lies flat on the bottom, often partly buried in the sand or mud, with the light and dark shades of color of the uppermost surface so varied in intensity on different parts of the body as to blend and harmonize with the background. The instinctive concealment is often so well accomplished that it is quite hard to detect the position of the fish even when keeping a sharp lookout in fairly clear water. It thus waits till some unwary victim chances its way when it strikes with swiftness and force. Sometimes it will pursue schools of small fish to the very surface.

Races.—While it is not the primary aim of this investigation to elaborate in detail the characters which may be used in separating races, and, moreover, the material at hand is not sufficient for a thorough racial analysis; it is yet desirable to point out the bearing of the characters investigated on the study of racial differentiation. The material examined yields evidence that the populations of *Paralichthys dentatus* from Chesapeake Bay and from Beaufort, N. C., belong to two distinct racial stocks. The frequency distributions of the meristic characters given in tables 2 to 6, segregated by locality, for *dentatus*, are as follows:

Gill rakers on upper limb

	3	4	5	6	7
Class					
Chesapeake Bay frequencies	--	--	31	35	5
North Carolina frequencies	2	4	29	6	1

Gill rakers on lower limb

	13	14	15	16	17	18
Class						
Chesapeake Bay frequencies	--	--	9	28	25	9
North Carolina frequencies	4	2	9	15	7	2

Total number of gill rakers on outer arch

	16	17	18	19	20	21	22	23	24
Class									
Chesapeake Bay frequencies	--	--	--	--	6	19	15	23	8
North Carolina frequencies	2	2	1	2	6	15	5	6	--

Anal rays

	61	62	63	64	65	66	67	68	69	70	71	72	73
Class													
Chesapeake Bay frequencies	--	--	--	1	3	6	17	12	6	11	3	6	5
North Carolina frequencies	1	1	--	2	1	7	6	8	6	7	3	--	--

Dorsal rays

	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Class																	
Chesapeake Bay frequencies	--	--	1	--	2	7	5	8	12	12	10	4	3	2	3	--	1
North Carolina frequencies	1	1	--	4	--	1	3	4	8	9	4	1	2	2	--	1	--

The data tabulated show that there is one consistent and statistically measurable character which may be used in racial studies, namely, the number of gill rakers. There is only a slight difference in the frequency distribution of the fin ray counts, which is somewhat more pronounced in the anal ray count. However, while the difference in the anal count is not very significant, it is of considerable practical value in identification, since overlapping specimens at the extreme end of the frequency distribution disappear in northern specimens, and *dentatus* from Chesapeake Bay is thus more readily separable from *albigutta*. There is practically no difference in the scale count which is, on that account, omitted from the preceding tabulations by locality. The racial difference in proportional measurements, shown in table 8, in groups of specimens of approximately like sizes, is not pronounced. The North Carolina population of *dentatus*, in general, is somewhat deeper bodied and has a slightly longer head and maxillary. These differences do not hold in all the size groups, and it is possible that curves representing the relative changes with size in these measurements will have somewhat different forms, but not enough specimens have been measured to draw any definite conclusions.

The divergence of the races of *dentatus* is such that the population from North Carolina more nearly approaches that of *albigutta* than specimens from Chesapeake Bay approach that species. When *dentatus* from Chesapeake Bay is compared with *albigutta* there is a comparatively wide gap between them as far as the total number of gill rakers is concerned, and individual specimens of the two species may be readily distinguished on that basis; but this structural gap disappears between the two species at North Carolina (compare the tabulated racial data of *dentatus* with tables 2 to 4). To a lesser extent this is also true of the anal rays.

It is to be noted, also, that there is a difference in the regularity of the frequency distributions of the number of gill rakers in the two populations of *dentatus*. The Chesapeake Bay population is more uniform in its structural characters, the spread and form of the frequency distribution is rather compact and regular; while the North Carolina population is more variable, the spread being more extensive, and the frequency polygon will assume a skewed form.

Hybridism.—The somewhat irregular frequency distribution of *dentatus* from North Carolina may possibly be due to the presence of hybrid specimens which are intermediate in some respects. This

would seemingly partly explain the cause of the difficulty of referring occasional individual specimens from that coast to their proper species. For instance, the two border-line specimens discussed above (p. 282) having a high fin-ray count, near the extreme of the distribution of the genus as a whole, and gill rakers in intermediate numbers, might be hybrids between *dentatus* and *lethostigma* (see also fig. 4). However, it is evident from the form of the frequency distributions that the number of hybrids, if indeed any do occur, are not numerous. In any case, it would require more detailed studies to prove the presence of hybrids and to show how they may be identified. It should be emphasized that the only substantial evidence showing the probable existence of hybridism consists of a rather slight irregularity in the frequency distributions of the characters studied. This evidence is certainly not conclusive. On the contrary, irregularity of frequency distributions appears to be the rule rather than the exception in nature. No evidence of hybridism between *lethostigma* and *albigutta* was found on the Gulf coast where those two are the only common species.

Economic importance.—The summer flounder is one of the important food fishes. The meat is of excellent quality and generally esteemed, resembling in flavor the halibut. It is taken chiefly during the warmer months of the year, between April and November, from shallow water to a depth of about 20 fathoms, the bulk of the commercial catch being captured between 5 and 15 fathoms. As may be expected from its bottom living habit, it is taken in the greatest numbers by the gear most suitable for taking bottom fish, by trawls. Large numbers are also taken in stationary gear, such as pound nets, fyke nets, weirs, and traps. Considerable quantities are taken by baited hook and line and to a lesser extent also by haul seines. As stated, the catch of this species had been confined chiefly to the months of April to November. Within recent years a special winter trawl fishery has developed off the coasts of Virginia and North Carolina which during the winter of 1930–31 produced a yield of this species of more than a million pounds (Pearson 1932).

The recent annual yield of this species, in round figures, is 13 million pounds, worth $2,156,000 to the fishermen. These figures are obtained by adding the statistics compiled by the Fish and Wildlife Service for "fluke" from Massachusetts to Delaware and those under the heading of "flounder" for Maryland and Virginia. The name "fluke" refers to the present species. The catch of "flounder" in the latter two States consists chiefly of *Paralichthys dentatus*, but includes a variable, an unknown percentage of *Pseudopleuronectes americanus*, which is greater in the Maryland catch and smaller in that of Virginia. The statistics used are those for 1945 for New Jersey and Delaware and for 1946 for the other States.

Synonymy.—The following involved synonymy of this species appears to be correct, as indicated by the accounts of authors. In a few cases, the specimens on which the records are based were examined. Attention may be called again to the fact that some early accounts by American writers employing the specific name *dentatus* for a flatfish (see, for instance, Storer in Hist. Fish. Mass., p. 197, pl. 30, fig. 3, 1867), refer to *Hippoglossoides platessoides*, and that the inclusion of such references by later writers in the synonymy of this species is erroneous.

Pleuronectes dentatus LINNAEUS, Syst. Nat., ed. 12, pt. 1, p. 458, 1766 (Carolina).

Pleuronectes lunatus LINNAEUS, ibid., p. 459 (not *Pleuronectes lunatus* L. of the tenth edition Syst. Nat., according to Günther 1861 and Goode and Bean 1885).

Pleuronectes dentatus WALBAUM, Gen. Pisc., p. 116, 1792 (Carolina).—BLOCH and SCHNEIDER, Sys. Ichth., p. 156, 1801 (North America).—MITCHILL, Tr. Lit. Phil. Soc. New York 1: 390, 1815 (New York).

Pleuronectes melanogaster MITCHILL, ibid. (New York, based on a teratological specimen).

Pleuronectes aquosus STORER (not Mitchill), Boston Jour. Nat. Hist. 1: 352, 1836 (Massachusetts).

Rhombus aquosus STORER (not Mitchill), ibid., 2: 484 (Rep. Fish. Mass., p. 146) 1839 (Boston market).

Platessa oblonga DE KAY (not Mitchill), Zool. New York, Fishes p. 299, pl. 48, fig. 156, 1842 (New York).

Platessa ocellaris DE KAY, ibid., p. 300, pl. 47, fig. 152, 1842 (New York).

Platessa oblonga LINSLEY (not Mitchill), Amer. Jour. Sci. Art. 47: 72, 1844 (Stratford, Conn.).—STORER, Proc. Boston Soc. Nat. Hist. 1: 194, 1844 (teratological specimen, no locality).—STORER Mem. Amer. Acad. Art. Sci. (n. s.) 2: 477, 1846; also in Syn. Fish. North America, p. 225, 1846.

Platessa ocellaris BAIRD, 9th Ann. Rep. Smithsonian Inst., p. 349 (1854) 1855.

Chaenopsetta oblonga GILL, Cat. Fish. North America (supp. Proc. Acad. Nat. Sc. Philadelphia 1862), p. 50, 1861.

Chaenopsetta oblonga var. *ocellaris* GILL, ibid.

Pseudorhombus dentatus GÜNTHER (in part), Cat. Fish. British Mus. 4: 425, 1862 (states that type of *dentatus* still in existence).

Pseudorhombus oblongus GÜNTHER, ibid., p. 426 (after De Kay).

Pseudorhombus ocellaris GÜNTHER, ibid., p. 430 (after De Kay).

Platessa oblonga STORER (not Mitchill), Mem. Amer. Acad. Art. Sci. Boston 8: 395, pl. 31, fig. 2 and 2b, 1864; also in Hist. Fish. Massachusetts p. 202, 1867 (Provincetown and Wellfleet, Mass.).

Chaenopsetta ocellaris GILL, Proc. Acad. Nat. Sci. Philadelphia, 1864: 218 (Beesleys Point, N. J.; New York; Norfolk, and Old Point, Va.).—ABBOTT, Geol. New Jersey by G. H. Cook, app. E. p. 817, 1868 (New Jersey).—VERRILL, Amer. Nat. 5: 399, 1871 (Great Egg Harbor, New Jersey).

Pseudorhombus melanogaster LYMAN, Sixth Ann. Rep. Comm. Inland Fish. Massachusetts, p. 47, 1872 (Waquoit, Mass.).

Chaenopsetta ocellaris BAIRD, Rept. U. S. Comm. Fish. 1871–72: 823, 1873 (Woods Hole, Mass.).—UHLER and LUGGER, Rep. Comm. Fish. Maryland, Jan. 1, 1876, p. 96, 1876 (Chesapeake Bay).

Chaenopsetta oblonga UHLER and LUGGER, ibid. (Chesapeake Bay).

Chaenopsetta ocellaris UHLER and LUGGER, ibid., January, 1876, p. 80, 1876 (Chesapeake Bay).

Chaenopsetta oblonga YARROW, Proc. Acad. Nat. Sci. Philadelphia 1877: 206 (North Carolina; states "occasionally taken of large size" and probably refers to *dentatus*, wholly or in part, the species of flounders not properly differentiated by this author).

Chaenopsetta ocellaris YARROW, ibid. (North Carolina, one specimen reexamined).

Pseudorhombus ocellaris JORDAN and GILBERT (in part), Proc. U. S. Nat. Mus. 1: 370, 1879 (Beaufort, N. C.).

Pseudorhombus dentatus JORDAN and GILBERT (in part), ibid. (Beaufort, N. C.).—GOODE and BEAN (in part), ibid. 2: 123, 1879 (four species confused in this account, the three common species of the east coast of the United States and one apparently erroneously said to have come from Paraguay).—GOODE and BEAN, Bull. Essex Inst. 11: 7, 1879.—BEAN (in part), Proc. U. S. Nat. Mus. 3: 79, 1880 (Noank, Conn.; Woods Hole, Mass.; Crisfield, Md. The other localities given probably contain more than one species, since this author did not properly differentiate the species).

Paralichthys ophryas JORDAN and GILBERT, Bull. U. S. Nat. Mus. 16: 822, 1883 (Charleston, S. C.).

Paralichthys ocellaris JORDAN and GILBERT, Proc. U. S. Nat. Mus. 5: 617, 1883 (Charleston, S. C.).

Paralichthys dentatus BEAN, Rept. U. S. Comm. Fish. 1882: 340, 1884 (Woods Hole, Mass.).—GOODE (in part), Fish. Ind. U. S., sec. 1, p. 178, 1884 (not the figure; an account of the fishery; includes more than one species, the geographical distribution given being erroneous).

Pleuronectes dentatus GOODE and BEAN, Proc. U. S. Nat. Mus. 8: 197, 1885 (type reexamined and described).

Pleuronectes lunatus GOODE and BEAN, ibid. (specimen described by Linnaeus as *Pleuronectes lunatus* in the twelfth edition of Systema Naturae reexamined and found to be a *dentatus*).

Paralichthys dentatus JORDAN, Proc. U. S. Nat. Mus. 9: 29, 1886 (Beaufort, N. C.).—BEAN, Bull. U. S. Fish. Comm. 7: 135 (1887) 1889 (Ocean City, N. J.).—JORDAN and GOSS, Rept. U. S. Comm. Fish. 1886: 246, 1889 (Cape Cod to Florida).—BEAN, Proc. U. S. Nat. Mus. 14: 85, 1891 (Cape Charles City, Va.; Point Lookout and St. Jerome, Md.).—BEAN, 19th Rept. Comm. Fish., New York, p. 246, pl. 2, fig. 2, 1891 (Long Island).—SMITH, Bull. U. S. Bur. Fish., 10: 72, pl. 20, 1892 (Potomac River, Md.).—RATHBUN, Rept. U. S. Comm. Fish., 1889–91: 161, 1893.—MOORE, Bull. U. S. Fish Comm. 12: 363, 1894 (Sea Isle City, N. J.).—SMITH, ibid., p. 379, 1894 (New Jersey).—BEAN, Bull. Amer. Mus. Nat. Hist. 9: 372, 1897 (Gravesend Bay, N. Y.).—JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 (3): 2629, pl. 373, fig. 922, 1898 (Cape Cod to Florida).—SMITH, Bull. U. S. Bur. Fish., 17: 108, 1898 (Woods Hole, Mass.).—BUMPUS, Thirtieth Ann. Rept. Comm. Inland Fish. Rhode Island, p. 53, 1900 (Narragansett Bay, R. I.).—BEAN, 52 Ann. Rept. New York State Mus., vol 1, p. 110, (1898) 1900 (Long Island, N. Y.).—BEAN, 6th Ann. Rept. Forest Fish Game Comm. New York [Cat. Fish. Long Island], p. 472, 1902 (Long Island, N. Y.).—BEAN, 7th Rept. Forest Fish Game Comm. New York [Food and Game Fish., New York], p. 455, 1903 (Long Island, New York).—BEAN (in part), Cat. Fish. New York, p. 717, 1903 (Long Island, N. Y., part of the description refers to *lethostigma*).—SHARP and FOWLER, Proc. Acad. Nat. Sci. Philadelphia 56: 512, 1904 (Nantucket, Mass.).—FOWLER, Ann. Rept. New Jersey State Mus., 1905: 393, 1906 (not the figure; New Jersey, many localities given).—LINTON, Bull. U. S. Bur. Fish. 24: 410, 1905 (parasites of the species at Beaufort, N. C. Author states that material probably not well differentiated as to species).—FOWLER, Ann. Rept. New Jersey State Mus., 1906: 341, 1907 (Sea Isle City, N. J.).—SMITH, Fish. North Carolina, p. 386, fig. 178, 1907 (Beaufort, N. C.).—KENDALL, Occasional Papers Boston Soc. Nat. Hist. 7 (8): 146, 1908 (Chatham, North Truro and Menemsha Bight, Mass.; off Stratford Point and Middle Ground, Conn.; regarding record from Casco Bay, see p. 318).—EVERMANN and HILDEBRAND, Proc. Biol. Soc. Washington 23: 163, 1910 (St. George Island and Hampton Creek, Potomac River).—TRACY, Rept. Comm. Inland Fish. Rhode Island, 1910: 161 (Rhode Island).—KENDALL, Rept. Comm. Fish Game Massachusetts, 1910: 151, 1911 (Tisbury Great Pond, Mass.).—SUMNER, OSBURN, and COLE, Bull. U. S. Bur. Fish. 31 (1): 163, chart 207, 1913 (Woods Hole, Mass.).—FOWLER, Occasional Papers, Mus. Zool. Univ. Michigan 56: 19, 1918 (Cape Charles City, Magothy Bay and Smith Island, Va.).—BREDER, Zoologica, 2: 350, 1922 (Sandy Hook Bay, New Jersey).—BIGELOW and WELSH, Bull. U. S. Bur. Fish. 40 (1): 491; fig. 249, 1925.—NICHOLS and BREDER, Zoologica 9: 176, fig., 1927 (New York).—HILDEBRAND and SCHROEDER, Bull. U. S. Bur. Fish, 43 (1): 165, fig. 86, 1928 (Chesapeake Bay, many localities).—HILDEBRAND and CABLE, Bull. U. S. Bur. Fish. 46: 464, figs., 1930. (an extensive account of natural history at Beaufort, N. C.).—SCHROEDER, Copeia, 1931: 45 (off Virginia, lat. 37°36′

N., long. 74°17′ W., 100 fathoms).—PEARSON, U. S. Bur. Fish. Invest. Rept. 1 (10): 24, 1932 (an account of the winter trawl fishery off Virginia and North Carolina; those obtained in N. C. most probably contain an admixture of *P. lethostigma*).—NORMAN, Monogr. Flatfishes, p. 72, fig. 39, 1934 (Woods Hole, Mass.; Hampton Roads; Charleston Harbor, S. C.; reviewed).

PARALICHTHYS ALBIGUTTA

Sand Flounder

(PLATE 13)

Common name.—This species is most generally termed "flounder" by fishermen and others without any qualifying adjective, not being distinguished from related flounders. However, some fishermen on the Gulf coast are able to distinguish this species from *P. lethostigma*, the other common species of the Southern States. When so distinguished the term "sand flounder" is sometimes applied to *albigutta* and "mud flounder" to *lethostigma*, evidently alluding, correctly, to the bottom on which the bulk of each species, respectively, is taken. This suggests an appropriate uniform common name for the species. In this connection it is also interesting to note that Smith (1907) gives the names "mud flounder" and "sand flounder" as being used by the fishermen at North Carolina for *P. dentatus*. It seems possible that some fishermen at North Carolina also distinguish between the species of *Paralichthys* under those names.

Diagnosis.—Scales cycloid on both sides at all ages; of medium size, 47 to 60, nearly all specimens have 49 to 57, the apex of the curve at 52 and 53. Accessory scales present on both sides, quite numerous in large fish, beginning to appear in specimens of about 85 mm. Total number of gill rakers on first arch ranging 11 to 15, 12 to 14 in the great majority of specimens; 2 or 3, rarely 4, on upper limb; 9 to 12 on lower limb, 10 or 11 in the large majority of specimens. Anal rays 53 to 63; dorsal rays 71 to 85. Pectoral rays usually 11, sometimes 10 or 12 (11 on both sides in 10 specimens; 10 in 1; 10 on blind 11 on eyed side in 1; 10 on eyed side 11 on blind side in 1; 11 on blind side 12 on eyed side in 3). Origin of dorsal usually somewhat in front of anterior margin of eye, over anterior margin in young fish, at about 80 mm. Posterior extremity of maxillary attains to a vertical through posterior margin of pupil in specimens under 75 mm., to the space beneath the posterior margin of pupil to posterior margin of eye in specimens up to 125 mm., usually to posterior margin of eye in specimens up to 250 mm., usually to somewhat behind posterior margin of eye in specimens over 300 mm., at any given size also varying considerably with individual fish. Sinistral.

The depth, and the length of the head and maxillary in this species is evidently subject to considerable individual variability and it requires the measurement of many specimens to definitely establish the normal change of form with age. Judging by the specimens measured (table 8, p. 279), it seems that unlike the condition in *lethostigma* fish under 50 mm. are relatively more slender than somewhat longer fish. The depth increases with length in fish up to about 125 mm. The tempo of increase in body-length is then greatly accelerated, and fish between 125 and 200 mm. in length become gradually more slender. Between 200 and 300 the depth again increases. Finally, what seems to be unlike the change of growth with size in most other species of the genus, fishes over 300 mm. again show a considerable decrease in relative depth of body. Comparing *albigutta* with *lethostigma* we have the surprising fact that whereas fish under 200 mm. are definitely deeper-bodied in the former species, those over 300 mm. are markedly deeper in the latter.

Color.—The typical 5 longitudinal rows of spots more or less evident, diffuse. Most prominent spots on body, three in number, the prepeduncular spot and two at anterior ends of the two intermediate rows, forming the angles of an imaginary scalene triangle; these three spots conspicuous and ocellated in the great majority of individuals, sometimes rather faint. Other spots on body fainter and mostly not ocellated; sometimes one or more ocellated spots at posterior end of subdorsal row, less frequently at posterior end of supra-anal row, and rarely at middle of intermediate rows. Body variously shaded with light and dark hues. Frequently quite light and sometimes notably dark, the ocellated character of the three spots in such specimens sometimes faint, but these spots nearly always rather more prominent than the other blotches on the body. Individuals frequently snowed over densely with white spots, tending to disappear after death but frequently persistent in preserved specimen. This species, like *dentatus*, is able to change the relative inten-

sity of the shadings on the body to accord with its background as has been shown experimentally by Mast (1916). However, the three characteristically placed, prominent, more or less ocellated spots are usually plainly evident as may be seen by examining some of the plates published by the author.

The color pattern of *albigutta* and *dentatus* are nearly alike. There is a difference in the color of the two species, but the difference is more a matter of relative intensity of pigmentation. In *dentatus* the ocellated spots are generally more numerous. In *albigutta*, in the great majority of specimens, only three ocellated spots are present forming the large triangle, the spots forming the small triangle being absent or faint. In *dentatus* the large triangle is also present, but the spots forming the small triangle are usually the most prominent.

In young fish examined, the three characteristic ocellated spots forming the large triangle are distinct in those as small as 17 mm. and resemble those of the adults. The aggregations of coarse chromatophores overlaying the blotches which are present in *lethostigma* and *dentatus* are absent or very sparsely developed in *albigutta*. The other spots on the body are already present in fish between 17 and 30 mm. in the form of small specks in five longitudinal rows, becoming large and diffuse in fish over 30 mm.

Specimens examined.—South Atlantic Coast (36892). North Carolina (A. M. N. H. 3296). Cape Lookout (A. M. N. H. 4381 and 5280) and Beaufort (93512; A. M. N. H. 1883; many specimens from the collection of the U. S. Bureau of Fisheries Biological Station), N. C. Coosaw River, S. C. (93513). Florida (4887; U. S. and Mexican Boundary Survey; the specimen recorded as *albigutta* in a table of measurements by Goode and Bean, 1879). Key West, Fla., (specimens collected by the staff of the Fisheries Biological Station; inseparably mixed with those from Beaufort). Southern Florida (A. M. N. H. 2897). Southwest Florida (A. M. N. H. 2445). West Florida (5156). Caxambas (A. M. N. H. 2544), Tampa Bay (84041), Cedar Keys (35085), Apalachicola Bay (collected by me), and Pensacola (30818 collected in Laguna Grande by S. Stearns, Jordan and Gilbert's type of *albigutta;* 30191; 30698; 30842; specimens collected by me), Fla. Off Breton Island, La. (collected by Stewart Springer). Harbor Island, Hog Island, and Corpus Christi Pass, Tex., (collected by John C. Pearson). Total number of specimens studied in detail for the meristic characters 111; many more examined to verify conclusions; those examined ranging 17–389 mm.

Geographic distribution and habitat.—The range of the specimens examined extends from Cape Lookout, N. C., to Corpus Christi Pass, Tex., and this represents the extremes of its range, as now established, having been known previously from Beaufort, N. C., to Pensacola, Fla. The range of the species is continuous with respect to geographico-zonal variations in the environment and includes the semitropical surroundings at the southern tip of Florida. On the other hand, its range seems to be discontinuous with respect to the nature of the bottom. This species prefers hard or sandy bottoms, and where long stretches of coast having a mud bottom occur, it is either absent or rare. For instance, in my investigations during 1930, in 5 weeks of intensive and almost daily collecting on the coast of Louisiana, chiefly in the immediate vicinity of Grand Isle and extending from Bastian Island to Isle Derniere, during late June, July, and early August, not a single specimen of *albigutta* was obtained, while, at the same time, *lethostigma* was abundant and the majority of trawl landings yielded some specimens of the latter species. Soon after leaving Grand Isle and going to Pensacola about the middle of August, the first three flounders obtained there while seining in Big Lagoon, were *P. albigutta*. The bottom in the latter body of water consists largely of fine white sand, while on the coast of Louisiana, between the points indicated above, the bottom is chiefly of blue mud. The apparent conclusion which may be drawn from these observations is that the species prefers a sandy bottom.

This conclusion was further corroborated during 1932 by observations made in Apalachicola Bay, Fla. That body of water has long stretches of hard or sand bottom alternated with a mud bottom, and is a favorable location for a study of the difference in habitat of *albigutta* and *lethostigma*. Specimens of *Paralichthys* obtained there on a hard bottom are chiefly *albigutta* and those on a mud bottom are largely *lethostigma*,

as may be illustrated by the following data from my note book of three drags with a commercial shrimp trawl on June 16, 1932, in Apalachicola Bay, just off St. George Island, near West Pass. The first drag of the trawl lasting 1 hour, on a muddy bottom with occasional patches of sand, yielded, among other fishes, 7 specimens of *Paralichthys lethostigma*, 20 to 28 cm., and 2 *P. albigutta* 14.5 and 15 cm. After the first trawl was landed it was immediately put overboard and the drag continued in the same direction but on a stretch where the bottom was chiefly hard. The second drag lasted 30 minutes and the yield of *Paralichthys* was 11 specimens of *albigutta*, 9 to 21.5 cm., and 2 *lethostigma*, 19.5 and 23.5 cm. A third drag lasting 45 minutes, begun approximately at the point where the preceding drag was ended and continued in the same direction, the bottom having changed again to mud, yielded 3 specimens of *P. lethostigma*, 22.5 to 29.5 cm. and none of *albigutta*. These observations made in Apalachicola Bay were corroborated, in a general way, on numerous other occasions. The species seems to be common throughout its range where the bottom is favorable for its existence.

Size.—This is a comparatively small species. The usual size is under 10 inches. The largest specimen known at present is that recorded by Jordan and Swain from Cedar Keys, Fla., 39 cm. (15 inches).

Distinctive characters and relationship.—The great majority of specimens may be readily recognized by the distinctive color pattern, the presence of three very prominent spots, considerably more prominent than the other spots on the body. These three spots form the angles of an imaginary scalene triangle, the apex of which is on the lateral line about three-quarters of the distance from the gill opening to the base of the caudal fin, the other two angles being above and below the lateral line, on a somewhat oblique base falling a little behind the posterior angle of the curve in the lateral line. This distinctive color pattern is present in specimens as small as 17 mm. Individual fish are frequently found in which the color pattern is not saliently distinctive, the three spots are either fainter and hardly ocellated approaching thus to the color of *lethostigma*, or there are supernumerary ocellated spots posteriorly somewhat as in *dentatus*. Such individual fish may be distinguished by the fin ray, gill raker and scale counts. For a discussion of the proper placement of infrequent specimens at the border line see page 282.

Biology.—No special investigation of the biology of this species has ever been made, and consequently there is little data extant in regard to it. Hildebrand and Cable (1931: 469) report that "a few female *Paralichthys albiguttus* with large roe were seen in October and November." Young fish taken by J. C. Pearson on the coast of Texas, during 1927, measured as follows: February 23, Laguna Madre, 4 specimens, 41, 42, 45, and 47 mm.; March 16, Hog Island, 5 specimens, 17, 29, 33, 42, and 52 mm.; March 30, Corpus Christi Pass, 2 specimens, 18 and 61 mm. The spawning season is, therefore, probably in late fall or in winter. The data given by Hildebrand and Cable in regard to young *Paralichthys* at Beaufort, and discussed in this paper under *dentatus*, also include the present species. As in the other species of *Paralichthys* it evidently spawns offshore.

Economic importance.—This species is evidently of minor economic importance in the southern States, the common commercial flounder there being *lethostigma*. Most specimens over 15 inches in length that are obtained by spears are of the latter species. While the relative quantities of the two species in the catch are unknown at present, not being distinguished by the fishermen or dealers when selling flounders, the numbers of *albigutta* entering trade channels are not large. On a visit to the French Market in New Orleans, only one specimen of the present species, about 15 inches long, was observed, although the stalls were then abundantly supplied with *lethostigma*. An examination of the catch brought in by the giggers in Apalachicola, Fla., for several days in succession, revealed only one small specimen of *albigutta* which was thrown away; all the others being *lethostigma*.

Pseudorhombus ocellaris JORDAN and GILBERT (in part), Proc. U. S. Nat. Mus. 1: 370, 1879 (Beaufort, N. C.).

Pseudorhombus dentatus JORDAN and GILBERT (in part), ibid. (Beaufort, N. C.).—Goode and Bean (in part), ibid. 2: 123, 1879 (U.S.N.M. 4887 from Florida belongs to this species. In their accompanying table of measurements and counts this specimen bears the heading, "*albigutta* type").

Paralichthys albigutta JORDAN and GILBERT, ibid. 5: 302, 1882 (Pensacola, Fla.; Beaufort, N. C.).—JORDAN and GILBERT, Bull. U. S. Nat. Mus. 16: 823, 1883 (South

Atlantic and Gulf Coasts).—Jordan and Swain, Proc. U.S.N.M. 7: 233, 1884 (Cedar Keys, Fla.).—Jordan, ibid. 9: 29, 1886 (Beaufort, N. C.).—Jordan and Goss, Rept. U. S. Comm. Fish. 1886: 248, 1889 (South Atlantic and Gulf coasts of the United States).—Henshall, Bull. U. S. Fish. Comm. 9: 382, 1891 (Marco, Gordon's Pass, Big Gasparilla, and Lemon Bay, Fla.).—Lönnberg, Ofvers. Svensk. Vet. Akad. Forh. 51: 130, 1894 (Clearwater Harbor, Hillsborough Co., Fla.).

Paralichthys lethostigma Evermann and Bean (in part), Rept. U. S. Comm. Fish., 1896: 248, 1898 (specimens from Indian River at Fort Pierce only, according to Evermann and Kendall, 1900).

Paralichthys albiguttus Jordan and Evermann, Bull. U. S. Nat. Mus. 47 (3): 2631, 1898 (Cedar Keys, Fla.).—Evermann and Kendall, Rept. U. S. Comm. Fish., 1899: 96, 1900 (Key West).—Linton, Bull. U. S. Bur. Fish. 24: 411, 1905 (food and parasites of the species at Beaufort, N. C.; probably not well distinguished as to species).—Smith, Fish. North Carolina, p. 388, 1907 (Bird Shoal, Point Lookout, and Fort Macon, N. C.).—Kuntz, Bull. U. S. Bur. Fish. 35: 1–30, 1918 (histological basis of color changes).—Hildebrand and Cable (in part), Bull. U. S. Bur. Fish. 46: 464–476, fig. 86–87, 1930 (Beaufort, N. C.).—Norman, Monogr. Flatfishes, p. 75, fig. 41, 1934 (North Carolina: Cedar Key, Fla.; Apalachicola Bay, Fla.).

PARALICHTHYS VORAX

Diagnosis.—Scales cycloid on both sides, 48; modified scales in lateral line 24 in arch, 49 in straight part. (The single small specimen examined without accessory scales.) Gill rakers short, 4 + 12 (3 + 11 on eyed side). Anal rays 54; dorsal 75; pectoral 10 on both sides. Origin of dorsal over anterior margin of upper orbit. Maxillary reaching a vertical through posterior margin of lower orbit. Depth 42.7, head 31, maxillary 15.8, interorbital 2.2. Sinistral.

Color.—Dark, mottled with shades of greater or lesser intensity; spots not conspicuous, some very faintly suggesting ocelli, but no definite ocellated spots present; jaws and snout of blind side blackish, the dark pigmentation continued along upper and lower profiles, gradually becoming more diffuse posteriorly, except upper and lower margins of caudal peduncle black; cheek of blind side dusky.

Specimen examined and geographic distribution.—The above account is based on a single specimen, 103 mm., from Recife, Brazil, collected by Dr. R. von Ihering (102370). This is the only definite locality which may be stated at present. The type locality is given as South America without further designation. This species was probably confused by some authors with *brasiliensis* and consequently its geographical distribution still remains to be determined. It is possible that some of the references given under *brasiliensis* refer partly or wholly to this species.

Distinctive characters and relationship.—In the essential diagnostic structural characters this species agrees closely with *albigutta* from the coast of the United States. The number of fin rays and scales and the proportional measurements are very nearly the same in both species. An examination of numbers of specimens may possibly reveal differences in the frequency distributions of the number of gill rakers and pectoral rays, the single specimen studied having these counts, at the upper and lower limits, respectively, of the frequency distributions as determined for *albigutta*. Specimens of *albigutta* of the same size as the one of *vorax* described above, already have accessory scales developed, whereas the present specimen shows no trace of such scales. This species does not have the ocellated spots characteristic of *albigutta*.

As compared with the known species of its subgenus occurring with it or near its geographical range, namely, *brasiliensis* and *tropicus*, this species may be readily distinguished by its larger scales. It further differs from *brasiliensis* in the smaller number of gill rakers. *P. vorax* evidently bears the same relation to *brasiliensis* as *albigutta* bears to *dentatus* on the east coast of the United States.

Rhombus aramaca Castelnau (not Cuvier), Anim. Nouv. Rar. Amer. Sud. Poiss., p. 18, pl. 40, fig. 3, 1855 (Bahia).

Pseudorhombus vorax Gunther, Cat. Fish. Brit. Mus. 4: 429, 1862 (South America).

Paralichthys brasiliensis Norman, Monogr. Flatfishes, p. 77, fig. 43, 1934 (based on types of *vorax*).

Paralichthys vorax Ginsburg, Jour. Washington Acad. Sci. 26: 132, 1936 nomenclature discussed).

PARALICHTHYS TROPICUS

(PLATE 14)

Diagnosis.—Scales cycloid on both sides; 67. Accessory scales present on both sides, numerous, except in an area along middle posterior part of body; most other scales on body having a complete circle of small accessory scales around their edges. Gill rakers rather short, 11 on lower limb (12 on eyed side of the single specimen studied) of first gill arch, 2 on upper limb at the angle with two tuberosities above. Anal rays 58; dorsal 75;

pectoral 11. Vertebrae 10+26. Origin of dorsal nearly over anterior margin of eye. Maxillary reaching slightly past a vertical through posterior margin of orbit. Depth 43.9, maxillary 13.6, head 28.1, interorbital 2.2. Sinistral. The single known specimen is now faded, and color pattern of the species is unknown.

Specimen examined.—The foregoing account is based on the type, 321 mm. (34919), taken at lat. 10°37′40″ N., long. 61°42′40″ W. (off Trinidad, West Indies), in 31 fathoms.

Distinctive characters and relationship.—In the structural characters studied *tropicus* is apparently near to *vorax* from Brazil differing in having smaller scales. Although only one specimen of each species was examined, the difference in the scale count (table 1) is so pronounced that there is hardly any question that they belong to distinct species. Other differences between the two species remain to be determined. Very likely *tropicus* will prove to have a more profuse development of accessory scales.

Two other apparent near relatives of this species are *lethostigma* and *squamilentus* from the east coast of the United States. It apparently differs from both in having fewer vertebrae, and possibly also in having the accessory scales more profuse. It differs further from *lethostigma* in having fewer rays in the vertical fins, the counts of the type of *tropicus* falling decidedly out of the frequency distribution based on approximately 150 specimens of the other species (tables 5 and 6). It probably differs from *squamilentus* also in having fewer rays on the average; but judging by the few specimens examined, it is evident that these two species will be found to overlap, possibly rather widely, in this respect. The interorbital is appreciably narrower and the maxillary somewhat shorter than in *lethostigma*. The depth is less than in *squamilentus*. Although the precise degree of divergence between *tropicus* and these other two species remains to be learned by a determination of the range of variability of the distinguishing characters, there seems hardly any question that the single type specimen belongs to a distinct species.

It is apparently more remotely related to *brasiliensis*, a common species of its subgenus occurring nearer its range, differing chiefly in the number of gill rakers on the first arch and the number of vertebrae; *tropicus* having a total of 13 gill rakers and 10+26 vertebrae, while the corresponding counts in *brasiliensis* are 18 to 22 and 11+23, respectively.

Paralichthys tropicus GINSBURG, Proc. U. S. Nat. Mus. 82 (20) : 4. 1933 (off Trinidad, West Indies).

PARALICHTHYS LETHOSTIGMA

Southern large flounder

(PLATE 15)

Common name.—This species is generally called "flounder" without any qualifying word to distinguish it from other flounders. Some fishermen distinguish it by the term "mud flounder" p. 324). Since, however, this is the only commercial flounder of value on the coast of the Southern States that designation is not deemed appropriate and the term "southern large flounder" is suggested as a uniform common name for the species to distinguish it from other flounders.

Diagnosis.—Scales cycloid on both sides at all ages; 52 to 74, nearly all individuals falling in the range between 56 and 67, the mode at 60. Accessory scales rather sparse, sometimes numerous in large specimens (although not quite so many as in *dentatus* or *albigutta*), usually beginning to appear in specimens 110 to 120 mm. in length, sometimes very few present in much larger fish. Total number of gill rakers on first arch ranging 10 to 13, nearly all having 11 or 12 (these two numbers occurring with approximately equal frequency); nearly always 2 on upper limb, infrequently 3; 8 to 11 on lower limb, nearly all specimens having 9 or 10. Anal rays 63 to 73, the mode at 69 (77 in one specimen); dorsal 80 to 95. Pectoral rays 12 in the majority of fish, frequently 11, sometimes 13 (12 on both sides in 6; 11 on both sides in 2; 12 on eyed side and 11 on the other in 2; 13 on eyed side and 12 on the other in 1; 9 on eyed side and 11 on blind side in 1, the last evidently being abnormal in this respect). Vertebrae 10 or 11+27 (in 2 specimens). Origin of dorsal usually somewhat in front of anterior margin of eye in large fish and somewhat behind anterior margin in specimens under 100 mm. Posterior extremity of maxillary reaching to a vertical through posterior margin of pupil in specimens of about 35 mm., through posterior margin of eye at about 50 to 100 mm., past eye in specimens over 100 mm. Interorbital rather wide, becoming markedly broad in large fish, conspicuously more

so than in related species. Body becoming deep in large individuals. Sinistral.

Color.—Body irregularly shaded with darker and lighter. The five longitudinal rows of spots more or less evident, usually diffuse, blending more or less with the darker shadings, and tending to disappear entirely in large individuals. None of the spots ocellated. Sometimes the spots are saliently distinct in specimens up to about 150 mm., and in such individuals the three spots forming the large triangle are most prominent as in *albigutta*, but they are not ocellated. The relative intensity of the shadings on the body is subject to great variation as in related species; some specimens being very light all over, especially in life, and others being very dark. After being landed, specimens of this species usually have whitish spots irregularly snowed over the body; these usually disappear after the death of the fish, but are sometimes present also in preserved specimens.

Small fish, between 20 and 45 mm., show characteristic groups of chromatophores, each group consisting of a blotch-like concentration of minute pigment dots interspersed with coarser chromatophores. This grouped concentration of chromatophores gives a gross appearance of blotches which may be somewhat coalescent. The coarser chromatophores may be also scattered between the blotches, but they are especially concentrated on them. The characteristic appearance of these groups is well shown in Hildebrand and Cable's figure 88, although in most specimens they are not so saliently prominent. One group on the midline, about two-thirds of the distance from the gill opening to the base of the caudal and two others near the angle of the curve in the lateral line, one above and one below, tend to be most prominent. The three most prominent groups are in the same position as the three ocellated spots in *albigutta*, that is they form the characteristic large triangle of related species, but these spots in the young of *lethostigma* are not ocellated. The young of *lethostigma*, of about 20 to 40 mm., have the color pattern very similar to those of *dentatus* of the same size; but after the material is properly separated some small differences become apparent which are typical of *lethostigma*. The two spots at the posterior ends of the subdorsal and supra-anal rows are not as prominent as in *dentatus;* the coarse chromatophores that overlay the dark blotches in groups, are characteristically more numerous in *lethostigma;* the other blotches on the body, in addition to the three most prominent ones, are usually more distinct than in *dentatus*. In *lethostigma* the other blotches are sometimes of nearly equal intensity as the three forming the large triangle.

In still smaller individuals, 13 to 20 mm., the groups of chromatophores are more diffuse and so arranged that they sometimes suggest broad cross bands. At about that size, specimens of *albigutta* resemble somewhat those of *lethostigma*. Specimens of 50 mm. or over generally have the color pattern of large fish.

Specimens examined.—Edenton, Albermarle Sound (collected by B. Schwartz); Avoca (23103); Beaufort (51898; also, many specimens from collection of U. S. Bur. Fish. Biological Station) and Cape Fear River (25591); N. C. Charleston, S. C. (17119 and 17120). St. Simons Sound, Ga. (collected by W. W. Anderson). St. Johns River (21279, the lectotype) and Apalachicola Bay (collected by E. Danglade and by me), Fla. Mississippi (8026). Biloxi Bay, Miss. (collected by Stewart Springer). Off Breton Island (collected by Stewart Springer); Bay Adams, off Grand Terre, Barataria Bay, Bay des Ilettes, Bayou Rigaud, Bayou Fifi, off Grand Isle, Caminada Bay and Callou Bay (collected by me); La. Galveston (31028 and 73590); Matagorda Bay (63652); Indianola (9388); Mission Bay, Mud I., Hog I., Oso Bay, Aransas Pass, Harbor I. and Corpus Christi Pass (collected by John C. Pearson); Tex. Specimens studied in detail 159; about 100 more examined to check one or another of the important characters; size of those examined ranging from 13 to 659 mm.

Geographic distribution and habitat.—The range of the specimens studied extends from Edenton, Albemarle Sound, N. C., to Corpus Christi Pass, Tex. This also represents the range of the records in the literature, which are based on specimens undoubtedly belonging to the present species. Extant records in the literature north of Albemarle Sound are evidently in error as pointed out later. It yet remains to be discovered whether the species is continuous in its range around the tip of the peninsula of Florida. The southernmost records of the species now extant are, Indian River on the east coast and Tampa Bay on the

west coast of Florida. It is common or abundant throughout its range.

This species has been recorded a number of times as occurring north of Albemarle Sound. Smith (1907) states that "It ranges as far north as New York, but is most common from Chesapeake Bay to the Gulf Coast." From New York it has been recorded by Jordan and Goss (1889), by Jordan and Evermann (1898) and by Bean (6th Ann. Rept. Forest Fish Game Commission, New York, p. 472, 1902; ibid., 7th Ann. Rep., p. 456, 1903; Cat. Fish New York, p. 720, 1903).

Smith does not state whether he actually examined specimens from Chesapeake Bay; while, on the other hand, the rather extensive collections of *Paralichthys* made by Schroeder in Chesapeake Bay and reported on by Hildebrand and Schroeder (Bull. U. S. Bur. Fish., vol. 43, pt. 1, p. 165, 1928) all represented *dentatus* and not a single specimen of *lethostigma* was taken. In this study also, no *lethostigma* was found among the extensive collections obtained by others in Chesapeake Bay. It is, therefore, safe to state that the species does not occur in Chesapeake Bay.

Likewise, the repeated records of this species from New York evidently are not based on the study of any specimens collected there. They have a common origin and may be traced to an erroneous interpretation of De Kay's work (Zool. New York, Fishes, pp. 299–300) by Gunther (Cat. Fish. Brit. Mus., vol. 4, pp. 426–430, 1862) and Jordan and Goss (1889). De Kay described two species of left-handed-flounders which he designated as *Platessa oblonga* and *Platessa ocellifer*. Both of these species are evidently referable to *Paralichthys dentatus* (Linnaeus), judging by De Kay's accounts. His *Platessa ocellifer* is without a doubt the same as *Paralichthys dentatus*, since his figure shows the typical color pattern of that species, while no other species is known from New York to which this figure may apply. It, therefore, only remains to consider what his *oblonga* represents. The author distinguishes his *oblonga* from his *ocellifer*, by the angulated shape of the caudal, the lesser number of rays in the dorsal and the lack of ocellated spots. These three characters, as distinguished by De Kay, are not tenable. The number of dorsal rays as given by De Kay, 88 and 95, fall within the range of variation of *dentatus* (table 6, p. 279). The lack of ocellated spots in De Kay's *oblonga* may well be ascribed to his having dark individuals in which the ocellated spots are faint; such individual specimens of *dentatus* occur sometimes. *P. dentatus* always has an angulated caudal, and the material on which De Kay based his *ocellifer* with a supposedly rounded caudal, either had the caudal frayed at the end or it was shrunken so that it appeared rounded. There is hardly a doubt that *ocellifer* and *oblonga* of De Kay refer to the same species, *dentatus* of Linnaeus. This was correctly pointed out long ago by Storer (1846 and 1863).

Besides the three characters pointed out by De Kay, his figure shows another difference which, however, is not mentioned in the description, namely, that his *oblonga* shows a much wider interorbital. Gunther who did not have any specimens but relied solely on De Kay's account, kept the two species separate, emphasizing the differences in the interorbital width shown by the figures. Jordan and Goss following Gunther, also state that *ocellifer* and *oblonga* of De Kay are distinct and that the latter species is the same as *lethostigma*. This is evidently the basis of the frequent reference of *lethostigma* to New York. While the combination of wide interorbital and the lack of ocellated spots generally does distinguish *lethostigma* from *dentatus* when specimens of like size are compared, the former character varies greatly with size in both species and the latter varies much with individual fish. The decisive difference, the character which would show without a doubt whether the *oblonga* of De Kay was based on specimens of *lethostigma*, namely, the number of gill rakers, is not given by that author. Furthermore, De Kay states in regard to his *oblonga* that it "is common along our sandy shores, and is procured abundantly in the months of September and October." This statement certainly can not apply to *lethostigma*. On the basis of the data now extant, therefore, the present species is not known to occur north of North Carolina.

The species prefers a mud bottom (p. 324), and is generally found along the shore, in bays, sounds and lagoons in comparatively shallow water where it is captured readily by spearing. This flounder also enters fresh water where it is sometimes taken in numbers. It has been reported from Lake George, St. John's River, and Ocklawaha River

in Florida (Goode 1884) and from Roanoke River in North Carolina (Smith 1893 and 1907). Specimens from Edenton and from Avoca, on Chowan River, N. C., were examined by me. I was told by fishermen that it is taken by spears along the banks of the Mississippi for considerable distances above the mouth.

Size.—This is the largest flounder on the coast of the Southern States. Fish brought to the market by giggers are usually between 12 and 20 inches. The largest examined is an individual 26 inches (660 mm.), including the caudal fin, from Beaufort, N. C. Jordan and Gilbert (1883, p. 617) report a maximum length of 30 inches at Charleston, S. C. However, in view of the paucity of records, it is quite possible that the species attains a considerably larger size.

Distinctive characters and relationship.—On the Gulf coast and the east coast of Florida where *albigutta* is common, this species may be readily distinguished, as a rule, by its distinctive color, all of the spots being diffuse, none especially prominent and not definitely ocellated. Doubtful specimens are separable by the combination of higher fin ray and scale counts (tables 1, 5, and 6). In the northern part of its range, North Carolina to northern Florida, where *dentatus* also occurs, *lethostigma* may be distinguished from that species by the lack of ocellated spots, and more especially by the fewer gill rakers there being no intergrading individuals with respect to this character, as between these two species. A count of the gill rakers on the first arch will positively distinguish *lethostigma* and *dentatus* in every case (tables 2 to 4). From the deep water *squamilentus*, this species may be distinguished by the depth of the body aided by the fewer gill rakers and other characters (p. 334). *P. lethostigma* also has a wider interorbital than the other three species, except in the small specimens.

Neotype.—Jordan and Gilbert in 1883 gave a recognizable description of this species under the name of *P. dentatus;* but the given synonymy and distribution do not apply altogether to it. Later, in 1885, they establish the name *lethostigma* based solely on their account of 1883. Since that account is based on more than one species it is necessary to fix definitely the status of *lethostigma* by the selection of a type. Jordan and Gilbert's account of 1883 does not contain any statements by which any of the specimens forming the basis of their description may be identified now. In their synonymy they cite Goode and Bean 1879, and the latter authors give museum numbers of the specimens examined by them. One of those specimens, 21279, from Indian River, Fla., 292 mm., is herewith designated as a neotype.

Biology.—No special study was ever made of this species and consequently very little is known regarding its habits and life history. Spawning probably takes place in late fall and early winter and the spawning season is possibly extended. John C. Pearson, in connection with his studies of the life history of the sciaenids on the coast of Texas obtained some young of this species as follows: In 1926, March 31, Corpus Christi Pass, 1 specimen 53 mm. In 1927, January 25, Harbor I., 3 specimens, 23, 24, and 31 mm.; February 15, Mud I., 4 specimens, 27, 28, 31 and 47 mm.; Feb. 23, Laguna Madre, 5 specimens 33, 36, 59, 62 and 65 mm.; March 11, Laguna Madre, 2 specimens 77 and 89 mm.; March 30, Corpus Christi Pass, 3 specimens, 89, 111, and 114 mm. These few individuals perhaps indicate that the spawning season is in late fall, and they show a fairly rapid growth to the end of March.

Fishery and economic importance.—A comparatively important fishery for this species exists on the coast of the Southern States from North Carolina to Texas. The most important method in commercial fishing is by means of spears, the operation being known as "gigging," "flounder-lighting" or "floundering." The fishermen's outfit is simple. Besides the spear or "gig," it consists of a flat-bottomed skiff having an iron rod attached to the stern in a nearly but not quite upright position and a wire basket suspended from the upper end of the rod. A flaring fire is lit in the basket by burning pine-knots, called "fat-wood." The skiff is poled along in the shallows, and as the bright flame divulges the position of a flounder it is speared. Fishing may be carried out by two men, one poling and the other spearing the fish; but often one man does all the work. Gigging is usually done on dark, calm nights, at the incoming tide with which the fish come into shallow water. On bright moonlight nights or when a wind is blowing, gigging is said not to yield very satisfactory results.

Besides gigging, a method of capture employed in the Southern States for taking flounders especially, this species is taken in considerable quantities in haul seines, trammel nets, gill nets, and, to a lesser extent, in shrimp trawls. The flounders taken with these types of gear are mostly obtained incidentally, while fishing for other species, or in general fishing operations.

The annual yield of this species, in round figures, is 3,232,000 pounds worth $440,000 to the fisherman. These figures are obtained from the published statistics of the Fish and Wildlife Service under the heading of "flounder" from North Carolina to Texas for the year 1945. The "flounder" catch of the Southern States consists chiefly of *Paralichthys lethostigma* with a small admixture of *Paralichthys albigutta*, except that the catch in North Carolina, consisting of 1,203,000 pounds, includes a considerable and unknown percentage of *Paralichthys dentatus*.

Racial differentiation.—The number of gill rakers in the population of *lethostigma* on the Atlantic coast apparently averages higher than that on the Gulf coast as shown below. Of the 6 specimens having 11 gill rakers on the lower limb, 5 came from North Carolina and Georgia and only 1 from Louisiana; although this character was determined in only 23 specimens from the Atlantic coast as compared with 121 specimens from the Gulf coast. All specimens having 8 gill rakers came from the Gulf coast. The modes apparently are at 9 and 10 on the Gulf and Atlantic coasts, respectively.

	Gill rakers on lower limb			
Number	8	9	10	11
North Carolina to Georgia frequencies		7	11	5
Louisiana and Texas frequencies	7	60	53	1

Chaenopsetta dentata GILL (not Linnaeus), Proc. Acad. Nat. Sci. Philadelphia, 1864: 218 (Charleston, S. C.).

Lophopsetta maculata YARROW, ibid., 1877: 205 (Beaufort, N. C.; judging by size recorded and by description of fishery probably relates to present species possibly including also *dentatus*).

Pseudorhombus ocellaris JORDAN and GILBERT (in part), Proc. U. S. Nat. Mus. 1: 370, 1879 (Beaufort, N. C.; according to Jordan, 1886).

Pseudorhombus dentatus JORDAN and GILBERT (in part), ibid. (North Carolina).—GOODE, ibid., 2: 110, 1879 (St. Johns River and St. Augustine, Fla.).—GOODE and BEAN (in part), ibid., p. 123, 1879 (South Carolina; Florida; Texas).—BEAN (in part), ibid., 3: 79, 1880.

Paralichthys dentatus JORDAN and GILBERT, Proc. U. S. Nat. Mus. 5: 302, 1882 (Pensacola, Fla.; Galveston, Texas; New Orleans, La.).—JORDAN and GILBERT, ibid., p. 617, 1883 (Charleston, S. C.).—JORDAN and GILBERT, Bull. U. S. Nat. Mus. 16: 822, 1883 (description only refers to this species not the synonymy nor distribution).—BEAN, ibid., 27: 431, 1884 (Galveston, Tex.).—GOODE (in part), Fish. Ind. U. S. Sec. 1, p. 179, pl. 42, 1884 (figure and part of account refer to this species).

Paralichthys lethostigma JORDAN and GILBERT, Proc. U. S. Nat. Mus. 7: 237, 1884 (species established on description of Jordan and Gilbert 1883, p. 822; no type specimen indicated).—JORDAN, ibid., 9: 29, 1886 (Beaufort, N. C.).—JORDAN and GOSS, Rept. U. S. Comm. Fish., 1886: 247, pl. 3, fig. 7, 1889 (part of synonymy and distribution in error).—SMITH, Bull. U. S. Fish. Comm. 11: 196 and 200, 1893 (Edenton Bay and Roanoke River at Plymouth, N. C.).—EVERMANN and KENDALL, ibid., 12: 119, 1894 (Galveston, Dickinson Bayou and Corpus Christi, Tex.).—HENSHALL, ibid., 14: 220, 1895 (Tampa, Fla.).—EVERMANN and BEAN (in part, Rept. U. S. Comm. Fish., 1896: 248, 1898 (specimens from Indian River at Stuart only, according to Evermann and Kendall 1900).—JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 (3): 2630, 1898 (part of synonymy and distribution in error).—EVERMANN and KENDALL, Rept. U. S. Comm. Fish. 1899: 96, 1900 (Tampa Bay, Fla.).

Paralichthys dentatus FOWLER (in part), Ann. Rept. New Jersey State Mus., 1905: pl. 87, 1906 (the figure evidently a copy of Goode (1884) from a specimen of this species, not the description).

Paralichthys lethostigmus SMITH, Fish. N. C., p. 388, 1907 (Avoca, Albemarle Sound and Roanoke River at Plymouth, N. C.).

Paralichthys albiguttus HILDEBRAND and CABLE (in part), Bull. U. S. Bur. Fish. 46: 473–474, figs. 88 and 89, 1930 (Beaufort, N. C.; fin rays correctly indicated on the figures, also part of account applies to this species).

Paralichthys lethostigma NORMAN (in part), Monogr. Flatfishes, p. 74, fig. 40, 1934 (North Carolina; Charleston Harbor, S. C.; Florida; Biloxi Bay to Horn I., Miss.; the specimen recorded from Beaufort is an *albigutta*, that from Tobago probably a *tropicus*).—GINSBURG, Jour. Washington Acad. Sci. 26: 133, 1936 (general notes).

PARALICHTHYS SQUAMILENTUS

Broad flounder

Common name.—This flounder is a deep water species, living out of reach of the usual fishery operations for flounders hitherto pursued in the Gulf. For this reason it is largely unknown to the fishermen and failed to receive a popular name. The above name is suggested as appropriate as a uniform common name for the species, referring to its deep body.

Diagnosis.—Scales cycloid on both sides, 67 to 80. Accessory scales in sparse numbers, appearing late in life. Total number of gill rakers on first arch usually 14 or 15, varying 13 to 16; upper limb

usually with 3 or 4 gill rakers, sometimes 5; lower limb with 10 to 12. Anal rays 59 to 64; dorsal rays 76 to 83. Pectoral rays usually 12, frequently 11 (12 on both sides in 8 fish; 11 on both sides in 2; 11 on blind side and 12 on eyed side in 3; 12 on blind side 11 on eyed side in 1). Vertebrae 10+28 (in 1 specimen). Origin of dorsal over anterior margin of pupil at 30 mm., over space between anterior margin of eye and that of pupil in specimens 36 to 45 mm., over anterior margin of eye, varying slightly both ways, in specimens 96 to 370 mm. Maxillary reaching posteriorly to a vertical through hind margin of pupil in specimens 30 to 45 mm., through posterior margin of eye or nearly there in fish 96 to 370 mm. Body conspicuously deep. Sinistral.

Accessory scales.—Twelve specimens 30–120 mm., and one specimen 333 mm. virtually have no accessory scales. After prolonged search with a magnifier one such scale was found on one specimen each of 118 and 333 mm. Three specimens 342–370 mm. have accessory scales, but they are few in number and rather widely spaced. Evidently in this species the accessory scales develop late in life and they are few in number. In this character then, *squamilentus* approaches the genus *Pseudorhombus*.

Color.—Small specimens, 30 to 36 mm., with five longitudinal rows of spots as described above in the discussion of the generalized color pattern (p. 277), fairly well outlined, not ocellated; body characteristically sprinkled with pigment specks, somewhat like the published figure of the type specimen, suggesting a "fly specky" appearance, the specks nearly confined to a broad area along dorsal and ventral profile, area along middle of body virtually devoid of specks; a specimen of 333 mm. faintly showing non-ocellated spots in the subdorsal and supra-anal rows, one of 370 mm. without a trace of spots (other available specimens faded); both large specimens having the specks more numerous and crowded than the small specimens, and the blind side moderately dusky.

As compared with specimens of similar size, the small specimens of *squamilentus* examined differ from *lethostigma* and *dentatus* in not having the well marked groups of chromatophores characteristic of those two species, and from *albigutta* in the spots not being ocellated.

Specimens examined.—Pensacola, Fla., one specimen 120 mm., the type (30862); 1 specimen 100 mm. (30762); 5 specimens 96 to 118 mm. (32585). Corpus Christi Pass, Tex.; collected by John C. Pearson; 3 specimens 30 to 36 mm., March 23, 1927 (152881); 2 specimens 39 and 45 mm., March 30, 1927 (152882). Off Santa Rosa Island, Fla.; 105 fathoms; Stewart Springer; 2 specimens 333–370 mm. (152883). Tortugas, Fla.; 39 fathoms; W. H. Longley; 2 specimens 242 mm. (117069).

Geographic distribution and habitat.—Besides the localities listed above from which specimens were examined and the records by Norman and by Longley, this species has also been recorded from Egmont Key and Biscayne Bay, Fla., and Charleston, S. C., as noted in the bibliography. However, in view of the facts brought out by this investigation, the latter records need verification, although the species quite possibly does occur in those localities. The chief character by which *squamilentus* has been distinguished heretofore, was by the increased number of scales, but a study of table 1 shows that while this character is sufficient to distinguish this species from *albigutta*, the frequency distribution of the number of scales nearly falls within the range of *dentatus*, although averaging higher in *squamilentus*, and that it also intergrades with *lethostigma*. Especially the record from South Carolina possibly might have been based on a specimen of *dentatus* or of *lethostigma* having a high scale count. Although this specimen was supposed to have been deposited in the National Museum it was not found there during this investigation. The proper distinction of *squamilentus* depends on a combination of characters which must be studied in detail and with exactitude, since each character when taken by itself closely approaches or overlaps that of *dentatus* or *lethostigma*.

Specimens of this species are scarce in collections for the evident reason that it lives in deep water. Stewart Springer who preserved two of the large specimens forming the basis of this account states in a letter that "it apparently is abundant in 80 to 120 fathoms and could possibly turn out to be of commercial importance." The 5 small specimens examined from Corpus Christi were obtained inshore by John C. Pearson. It may be tentatively concluded then, that the young fish

live in shallow water and migrate in deep water to attain growth.

Size.—The largest specimen on record appears to be that by Longley, 415 mm., taken off Tortugas.

Distinctive characters and relationship.—This species is not easily separable from the three common east coast species. The number of dorsal and of anal rays overlaps that of *dentatus* or *lethostigma* and *albigutta*, respectively. The apex of the curve for *squamilentus* falls at the region where the extremities of the curves of the other three species overlap, being somewhat nearer to those of *albigutta*. To a lesser extent this is also true of the gill rakers. In the specimens counted there is no intergradation between *squamilentus* and *dentatus* with respect to the number on the lower limb, and a slight intergradation between this species and *lethostigma* with respect to the total number. However, more intergrades may well be expected when more specimens of *squamilentus* are examined. The scale count of *squamilentus* is markedly high; it does not intergrade with *albigutta;* intergrades with *lethostigma* and is massed at the upper extremity of distribution of *dentatus*. The body is notably deep. When all the characters are considered there should be no trouble in distinguishing *squamilentus*. It is separable from *albigutta* by the number of scales (table 1), aided—in case of specimens near the border line—by its depth and to a lesser extent by the other meristic characters and by color. Its separation from *dentatus* and *lethostigma* may be best accomplished by the depth, the variation in this character in *squamilentus* being fairly discontinuous in the specimens measured (table 8), as compared with the other two species. The depth character is greatly aided by the number of gill rakers, to a lesser extent by the number of fin rays and to some slight extent by the number of scales. The interorbital is not as wide as in *lethostigma*. The differences between *squamilentus* and *tropicus* are discussed on page 328. It differs from the other four species in having notably few accessory scales.

The general physiognomy of *squamilentus* is such that specimens usually may be identified at a glance. The 5 small fish from Corpus Christi Pass were distinguished by sight as being different than either *lethostigma* or *albigutta*, on a preliminary identification, before a detailed study of the specific characters was made, and not having any idea at the time what species they may represent. The features which chiefly draw attention to the present species are the deep body and the distinctive color. They show a certain characteristic "fly specky" appearance. It should be noted, however, that medium sized specimens of *albigutta* and large specimens of *lethostigma* are also rather deep-bodied and hardly separable from *squamilentus* on sight. The color also is not radically different than in the related species.

On account of its intermediacy in some important characters, the precise relationship of *squamilentus* is rather obscure. It is probably most nearly related to *lethostigma*.

Paralichthys squamilentus JORDAN and GILBERT, Proc. U. S. Nat. Mus. 5: 303, 1882 (Pensacola, Fla.).—JORDAN and GILBERT, Bull. U. S. Nat. Mus. 16: 823, 1883 (West Coast of Florida to South Carolina).—BEAN, Bull. U. S. Nat. Mus. 27: 431, 1884 (Pensacola).—JORDAN and GOSS, Rept. U. S. Comm. Fish., 1886: 248, 1889 (South Atlantic and Gulf coasts of United States).—HENSHALL, Bull. U. S. Fish. Comm. 9: 382, 1891 (Egmont Key, Fla.).—McCORMICK, Rept. U. S. Comm. Fish., 1895: 176, 1896 (Biscayne Bay, Fla.).—JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 (3): 2631, pl. 374, fig. 923, 1898 (Pensacola, Fla.; Charleston, S. C.).—NORMAN, Monograph Flatfishes, p. 76, fig. 42, 1934 (Pensacola and Dry Tortugas, Fla.).—LONGLEY, Carnegie Inst. Washington Pub. 535: 39, 1941 (Tortugas, Fla.; 45–110 fathoms).

SPECIES OF DOUBTFUL RELATIONSHIP

No specimens are available of the following species. Judging by extant accounts the generic affiliations of these species are somewhat doubtful; but their names were associated by authors with *Paralichthys*. They are treated here under the original names pending further research and a definite decision regarding their generic status.

PARALICHTHYS TRIOCELLATUS

The essential characters in the original author's account (1915) based on a specimen from Ilha Rasa, Brazil, are as follows: Scales largely ctenoid (not stated whether on one only or on both sides), 48. Accessory scales absent. Gill rakers 1 on upper limb, 8 on lower limb. A. 69, D. 86. Dorsal origin over anterior margin of eye. Interorbital much reduced. Head 28.5; depth 44.5; maxillary 2 in head. Prepeduncular spot present, ocellated; two other ocellated spots on a vertical about midway between base of caudal and posterior margin

of head, forming an isosceles triangle with the prepeduncular spot.

All the essential characters given by Miranda Ribeiro agree with those of *Pseudorhombus isosceles*, except that the body is not quite so deep as in that species. Norman examined four specimens in the British Museum, from Cape Frio, Brazil, which he thinks are identical with *triocellatus*. Norman's description is adequate to distinguish his specimens specifically from all known related flounders on the coast of Brazil and should his specimens prove to be conspecific with the type of *triocellatus*, the species is distinct from *isosceles*.

The essential characters in Norman's description of these four specimens are as follows: Scales mostly feebly ctenoid on ocular side, cycloid on blind side; 40 ("about 60 in lateral line"). Very few accessory scales. Gill rakers 8 or 9 on lower limb. A. 67–69; D. 82–86. Dorsal origin in front of eye. Interorbital a narrow ridge. Teeth of moderate size, canines not much enlarged. Maxillary extending to a little beyond middle of eye, about 2 in head. Head 29–31; depth 40–43. Color same as above, except that prepeduncular spot sometimes lacking.

There are two important discrepancies in the accounts of the two authors. According to Miranda Ribeiro, *triocellatus* lacks accessory scales and the scale count is 48; while Norman's specimens have some accessory scales and the scale count is 40. These differences may possibly be due to individual variability, or to different methods of study followed by the two authors; but they may also indicate specific differences. A solution of these questions must wait until the range of variation of *triocellatus* is definitely established.

The interorbital in this species is reduced to a mere ridge, unlike that in any species of *Paralichthys*. Norman describes his specimens as having the teeth moderate which is also unlike that in most species of *Paralichthys*. Consequently, it is doubtful whether this species belongs to *Paralichthys*.

Paralichthys triocellatus Miranda Ribeiro, Bol. Soc. Agric. Rio de Janeiro 1904, p. 192 (citation not verified).—Miranda Ribeiro, Arch. Mus. Nac. Rio de Janeiro 17 (Heterosomata): 13, photo., 1915 (Ilha Rasa, Brazil).—Norman, Monogr. Flatfishes, p. 80, fig. 46, 1934 (Cape Frio, Brazil; 40 fath.).—Norman, Discovery Rept. 16: 135, 1937 (compared with *P. isosceles*).

PARALICHTHYS COERULEOSTICTA

This species was described from a single example 73 mm., from Juan Fernandez, Chile. The pertinent specific characters given in the original description are as follows: A slender spine at beginning of anal. Scales on eyed side thickly spinuliferous, esmooth on blind side; 50. Gill rakers on lower limb of first arch 20. A. 70; D. 87. Dorsal origin in front of eye. Eye 3 times in head. Interorbital very narrow. Teeth slender, pointed, gradually and not much increasing in length forward. Depth 45, head about 22, maxillary 7.3. Sinistral.

This species apparently shows characters of both *Paralichthys* and *Hippoglossina*, and if properly placed in the former largely destroys the boundary between those two genera. The dorsal origin is in front of the eye like *Paralichthys*: but the interorbital is narrow, the teeth are small and it has a preanal spine like *Hippoglossina*. Assuming it to be a *Hippoglossina*, it is to be noted further that the preanal spine, the short maxillary, the relatively many gill rakers and the rather large scales are like in the subgenus *Hippoglossina*, but the fin rays have a high count and the eye is medium large like in the subgenus *Lioglossina*.

On the basis of the original description it is not possible to place this species generically with confidence. It is very possible that it belongs to neither one of those two genera. This is further indicated by the unusually short head and maxillary, strikingly shorter than in any species of the two genera.

Paralichthys coeruleosticta Steindachner, Fauna Chilensis 1: 327 (Zool. Jahrbüch. supp. bd. 4) 1898 (Juan Fernandez I. Chile).—Delfin, Cat. Pec. Chile, p. 104, 1901 (listed).—Norman, Monogr. Flatfishes, p. 88, 1934 (after Steindachner).

HIPPOGLOSSUS KINGII

This name was based by Jenyns not on actual specimens, but on a drawing prepared by an officer of the *Beagle*. The figure published by Jenyns shows the following characters: Ventral short, with a short base, symmetrical. Interorbital wide, somewhat as in males of some species of *Syacium*, or in specimens of some other genera. A well

developed anterior curve in the lateral line. Scales large, in about 35 rows over straight part of lateral line. Pectoral short. Mouth rather large, maxillary extending approximately to under posterior margin of eye. Teeth comparatively large. Eye small. Body deep, sinistral. D. 66; A. 51; P. 11; ". . . fin-ray formula . . . computed from the recent fish." No spots or other distinctive color markings. Size unknown.

The figure further shows the first 18 dorsal rays subequal, rather abruptly lower than and separated from the succeeding rays, as though the dorsal was composed of two separate fins. This is unusual for a flounder, but not so far fetched as may appear. Some flounders now known from the coast of Chile, some species of *Paralichthys* for instance, have the anterior rays short, although the increase in length to the posterior rays is more gradual than represented in the figure. Assuming a tear in the interradial membrane in that position in the specimen from which the drawing was prepared, it may be readily conceived how this apparently misleading effect was produced by the artist.

It is impossible to determine with confidence the particular species of those now known from the coast of Chile, to which the original account may apply. Even its generic affiliation cannot be determined with assurance. The apparent best course to follow in this particular case would be to treat it as an unidentifiable species until the flounders from the coast of Chile are better known when it may possibly be placed with some measure of assurance.

The species was referred by later authors, generally with a query, to *Paralichthys* or *Pseudorhombus*, as shown in the bibliography. No author, except Fowler, assigned definite specimens to this species. Fowler described a specimen from the coast of Chile that he identifies with this species which he places in *Paralichthys*. The essential characters in his description, based on a mounted specimen, 740 mm., are as follows. Scales all cycloid, 80; A. 53; D. 66. Pectoral 12, "upper rays longest" . . . "large canines in lower jaw about equal each side; no upper canines and upper teeth best developed on blind side." Depth 43; head 28; maxillary 12, "reaches opposite front pupil edge." . . . "lower eye 10, 2 in interorbital". Sinistral.

Fowler's account also is inadequate to determine the genus to which his specimen belongs. Norman (Monogr., p. 84, 1934) suggests that Fowler's specimen may be a *Hippoglossina* on account of its comparatively few fin rays. However, it apparently has large teeth, a small eye and a wide interorbital, and consequently, can hardly belong to that genus. Also, the point at which the maxillary terminates is markedly more forward than in any species of *Paralichthys*, especially considering the large size of the specimen described, and it apparently does not belong to that genus either.

As compared with the figure published by Jenyns, the specimen described by Fowler apparently has smaller scales and a shorter maxillary. However, he is the first author to assign a definite specimen to *kingii*, and if no species which more nearly approaches Jenyns' figure is ever discovered on the coast of Chile, Fowler's restriction may be allowed to stand. But his specimen needs to be reexamined to definitely determine its status and generic affiliation.

Hippoglossus kingii JENYNS, Zool. Voy. Beagle, 4: 138, pl. 26, 1842 (Valparaiso).—GUICHENOT, in Hist. Fis. Pol. Chile, by Gay, Peces, p. 332, 1848.—GÜNTHER, Cat. Fish. Brit. Mus. 4: 423, 1862 (suggests that the species may possibly belong to Bleeker's genus *Pseudorhombus*).

Paralichthys adspersus JORDAN and GOSS, Rept. U. S. Comm. Fish. 1886: 246, 1889 (place under *adspersus* with a query).

Pseudorhombus kingii REED, An. Univ. Chile 98: 665 (Cat. Pec. Chilenos, p. 16) 1897 (listed).

Paralichthys kingii DELFIN, Cat. Pec. Chile, p. 104, 1900 (listed).—FOWLER, Proc. Acad. Nat. Sci. Philadelphia 78: 282, 1926 (Chile).

Paralichthys adspersus NORMAN, Monogr. Flatfishes, p. 83, 1934 (placed in synonymy of *adspersus* with a query).

Paralichthys microps NORMAN, Disc. Rep. 16: 133, 1937 (placed in synonymy of *microps* with a query).

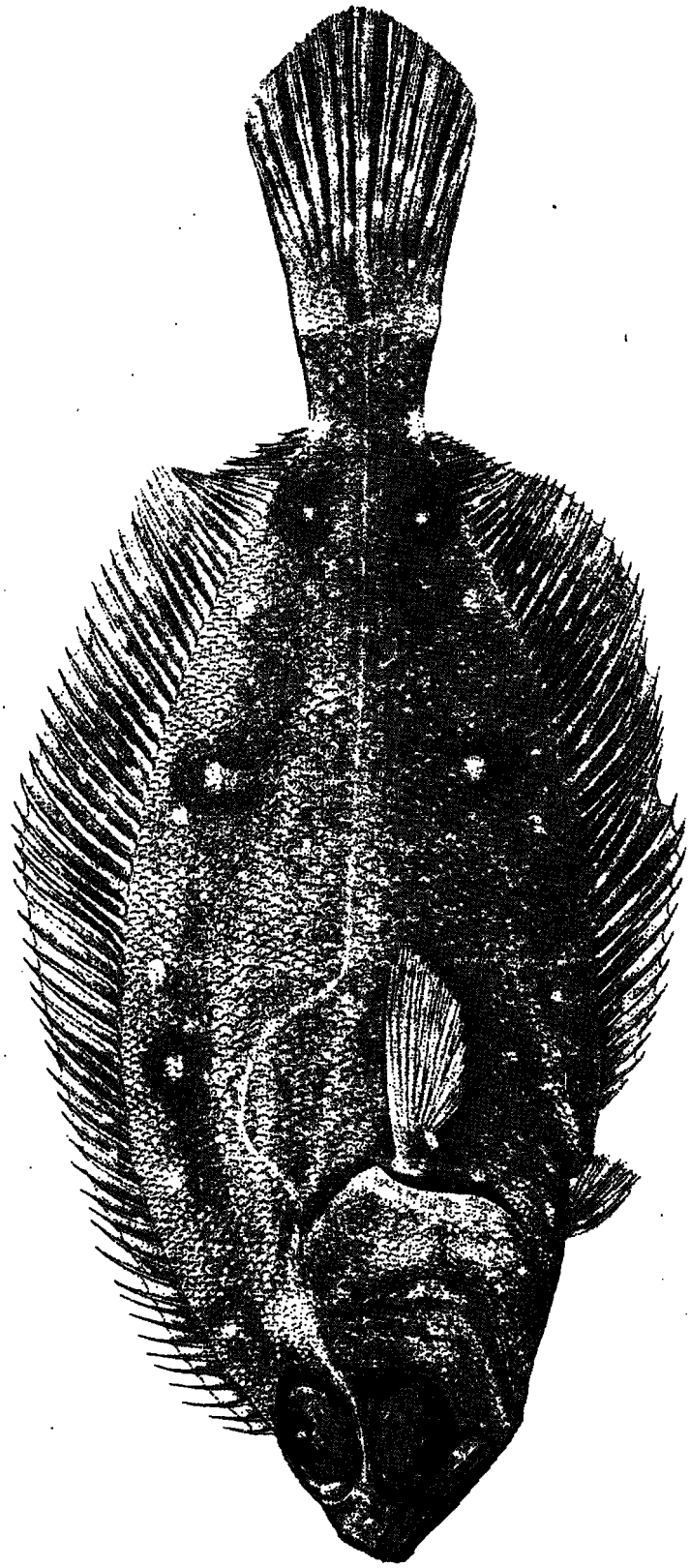

PLATE 1.—*Hippoglossina bollmani*, from a specimen 161 mm.; U. S. Nat. Mus. 41187; Panama Bay.

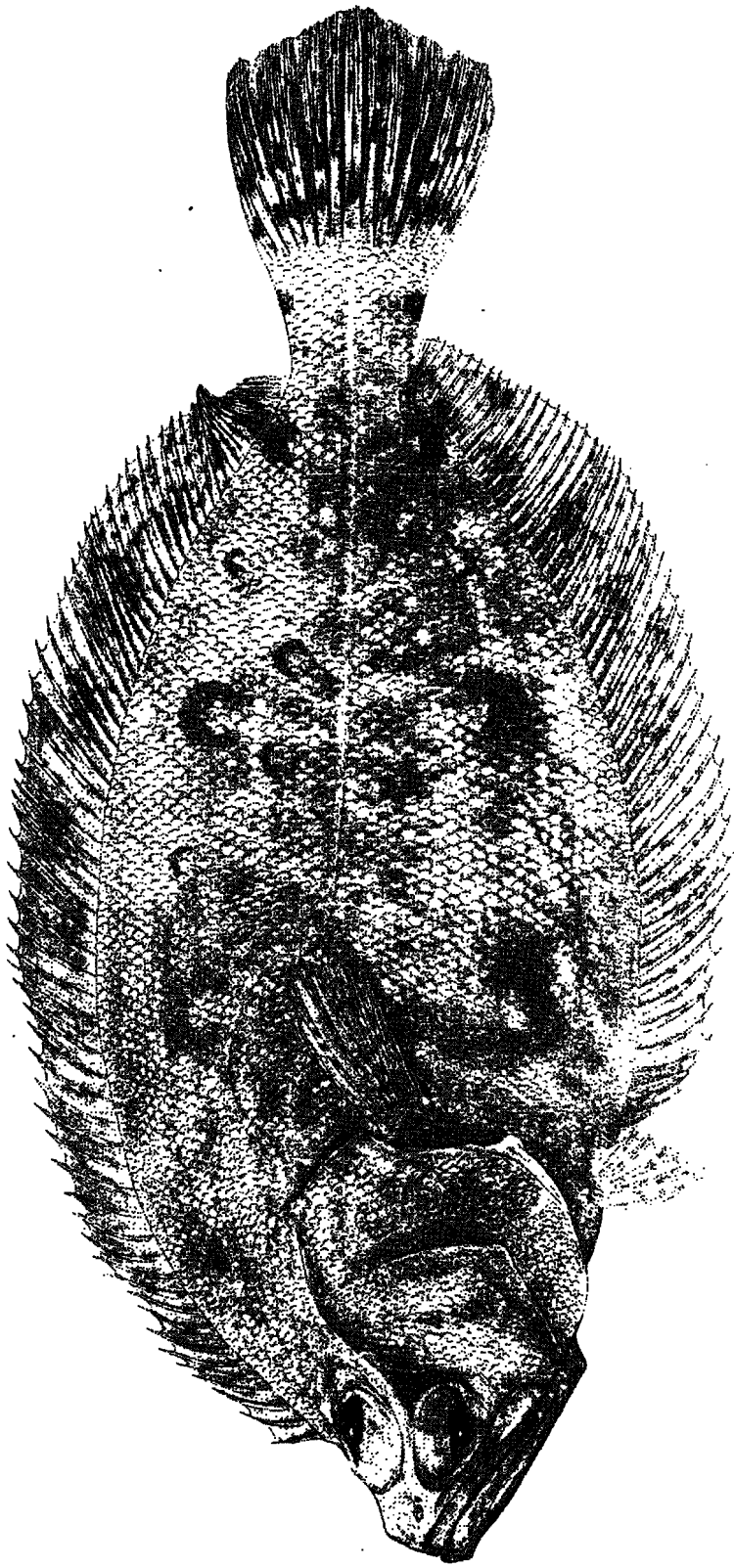

PLATE 2.—*Hippoglossina stomata*, from the lectotype; 315 mm.; U. S. Nat. Mus. 41905; San Diego, Calif., off Point Loma.

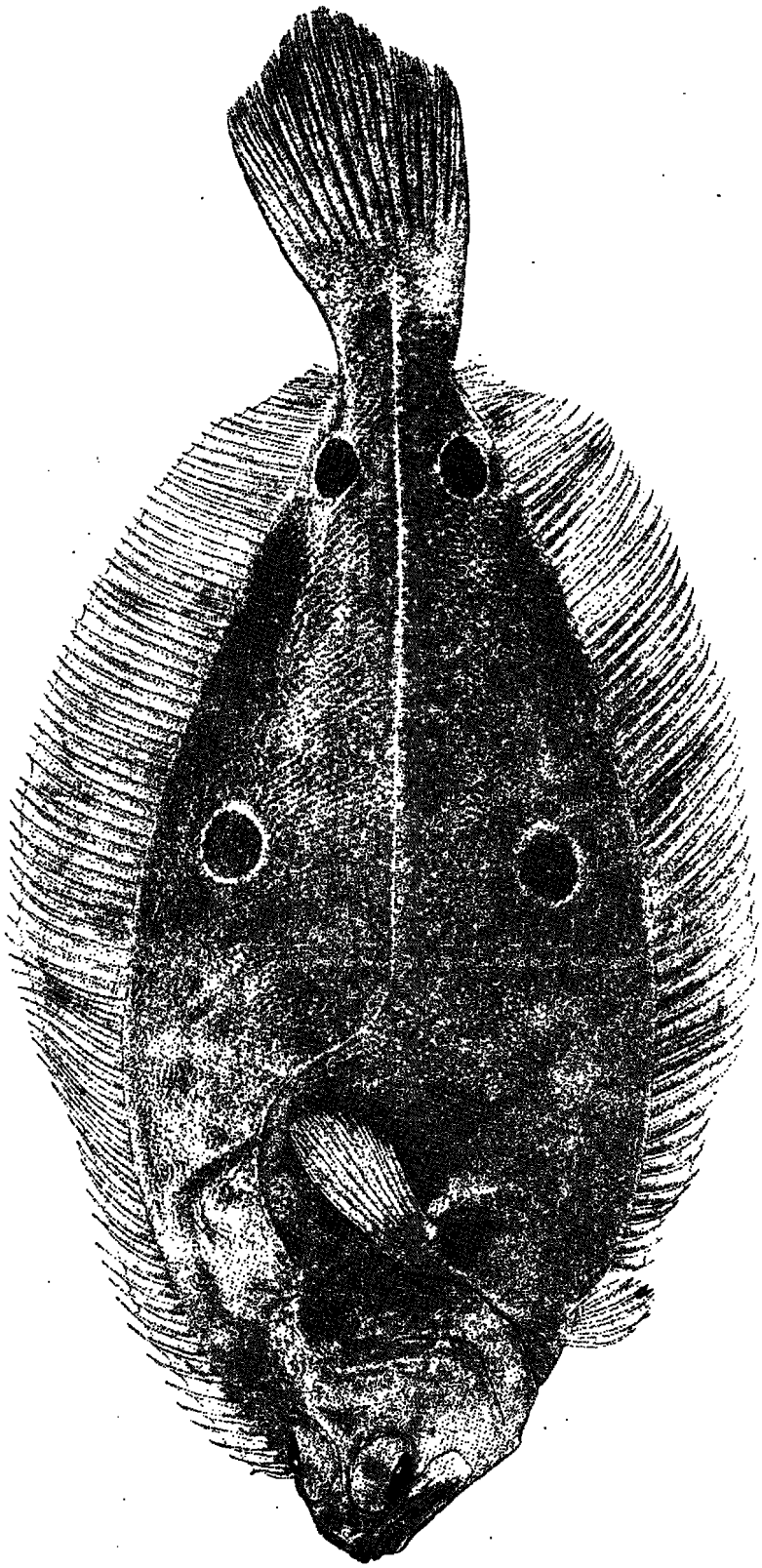

PLATE 3.—*Hippoglossina oblonga*, from a specimen 304 mm.; U. S. Nat. Mus. 33359; off Nantucket, Mass.

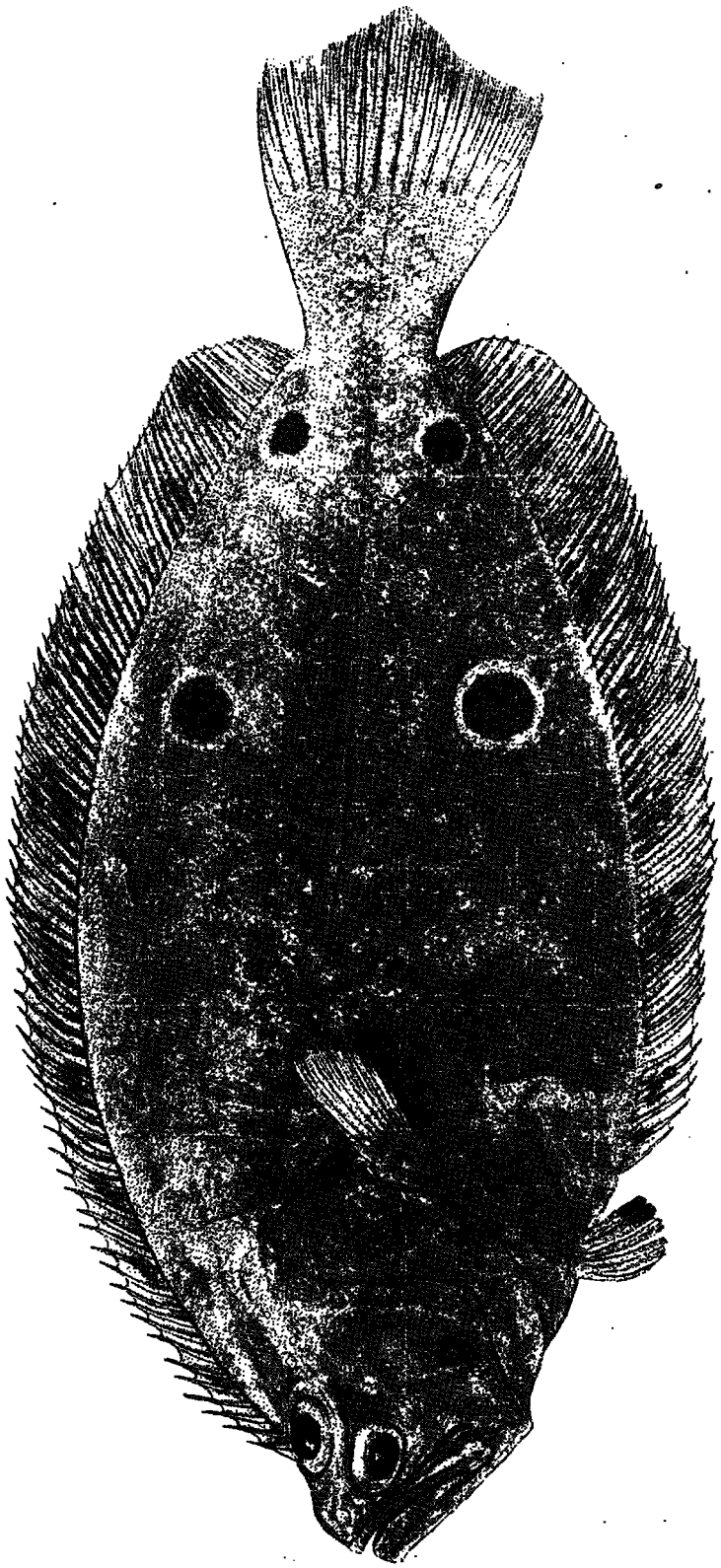

PLATE 4.—*Hippoglossina tetrophthalmus*, from the holotype, 332 mm.; U. S. Nat. Mus. 47290; Gulf of California at Tiburon Island.

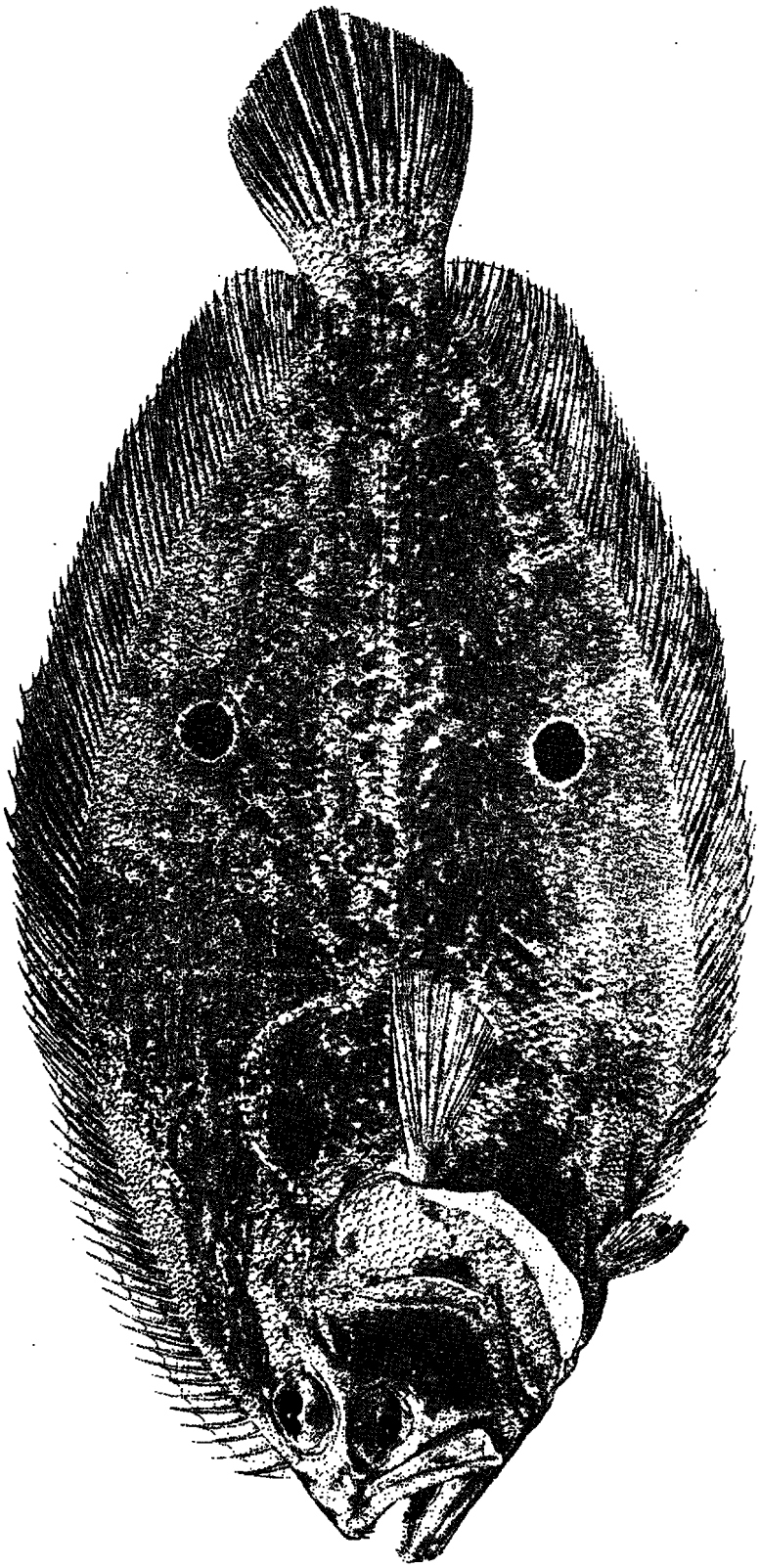

PLATE 5.—*Pseudorhombus isosceles*, from the lectotype, 247 mm., U. S. Nat. Mus. 43371; Bahia, Brazil; scales restored in large part; prepedunclular spot possibly partly faded in the three available specimens.

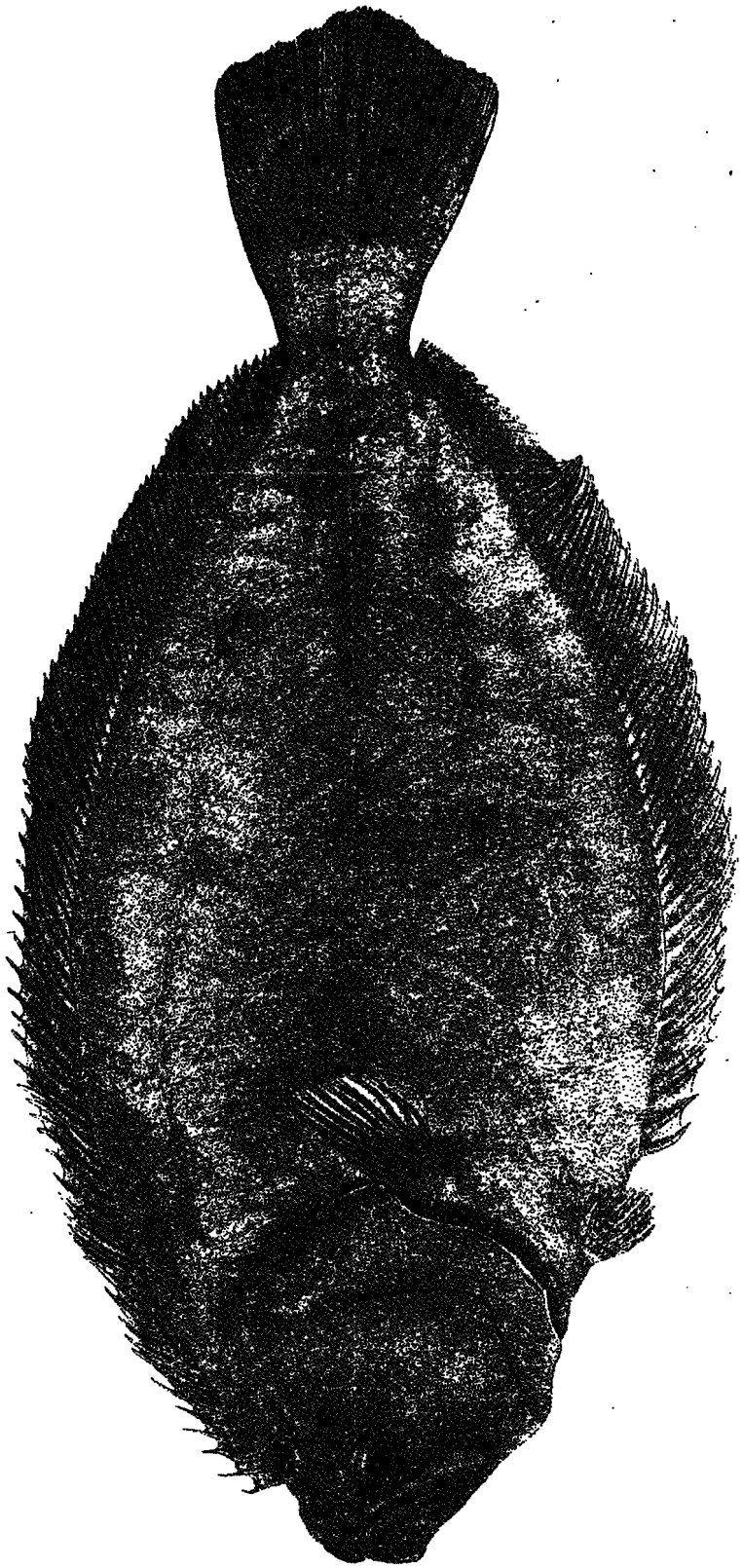

PLATE 6.—*Paralichthys schmitti*, from the type, 455 mm.; U. S. Nat. Mus. 88831; Juan Fernandez Island, Chile.

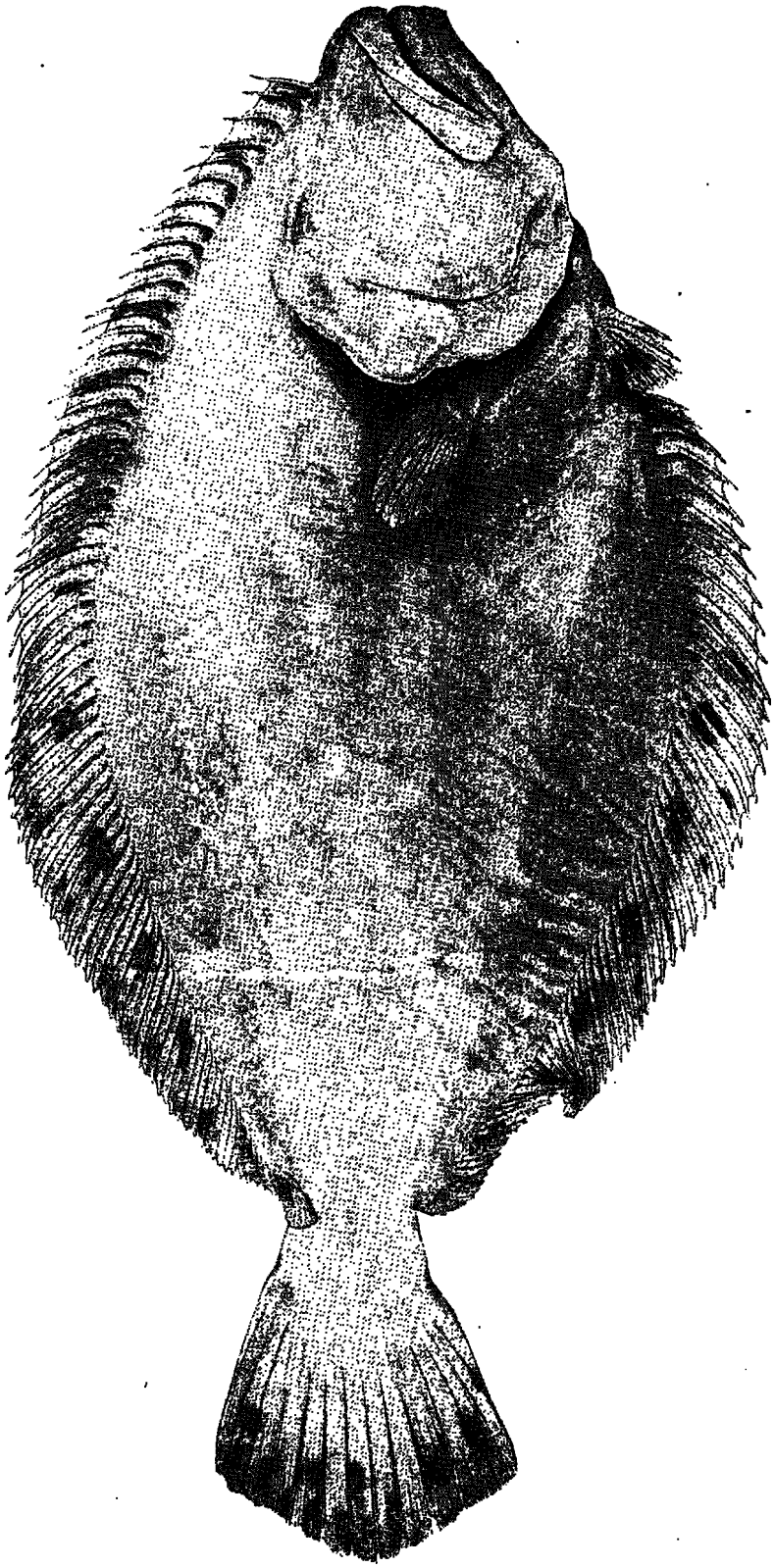

PLATE 7.—*Paralichthys schmitti*, blind side of same specimen as in plate 6, showing spots on fins and jaws.

PLATE 8.—*Paralichthys adspersus*, from a specimen 388 mm.; U. S. Nat. Mus. 53490; Callao, Peru; the prepedunc ular spot not plainly marked in the larger available specimens, possibly faded, well marked and ocellated in the smaller specimens.

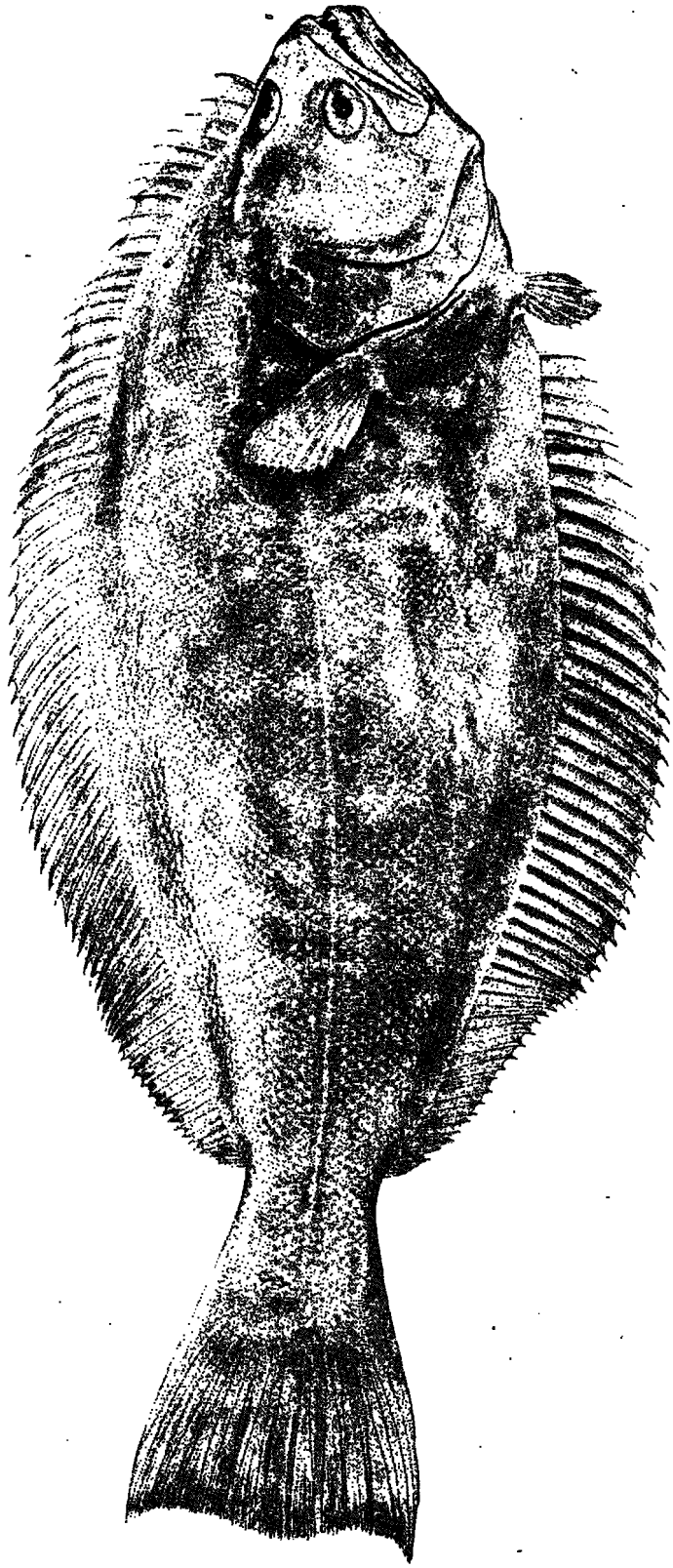

PLATE 9.—*Paralichthys californicus*, from a specimen 300 mm.; U. S. Nat. Mus. 26767, San Diego, Calif.; specimen evidently faded.

PLATE 10.—*Paralichthys aestuarius*, from a specimen 381 mm.; U. S. Nat. Mus. 47280; Gulf of California; specimen probably faded.

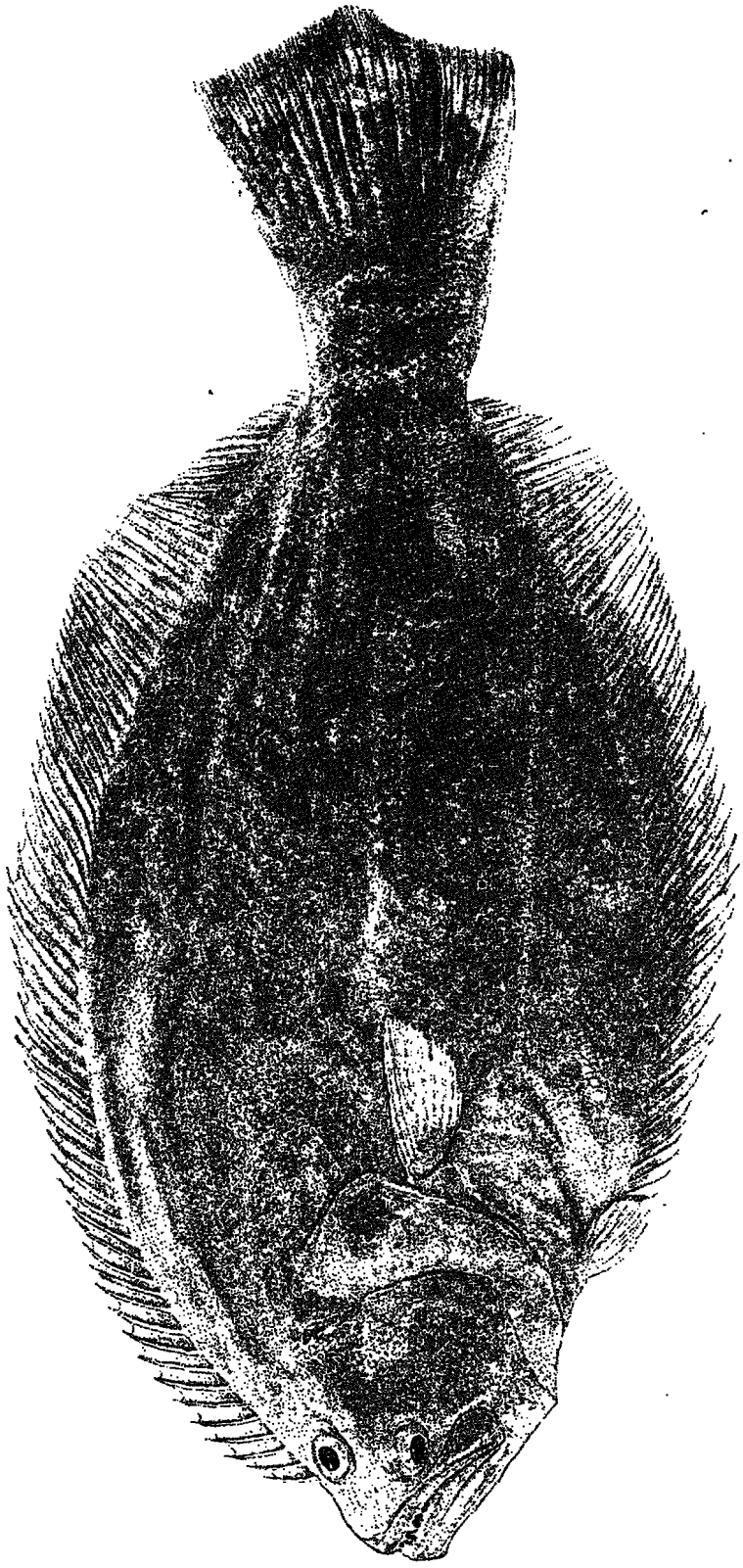

PLATE 11.—*Paralichthys woolmani*, from a specimen 429 mm.; U. S. Nat. Mus. 77705; Paita, Peru; specimen dark, ocellated spots not evident.

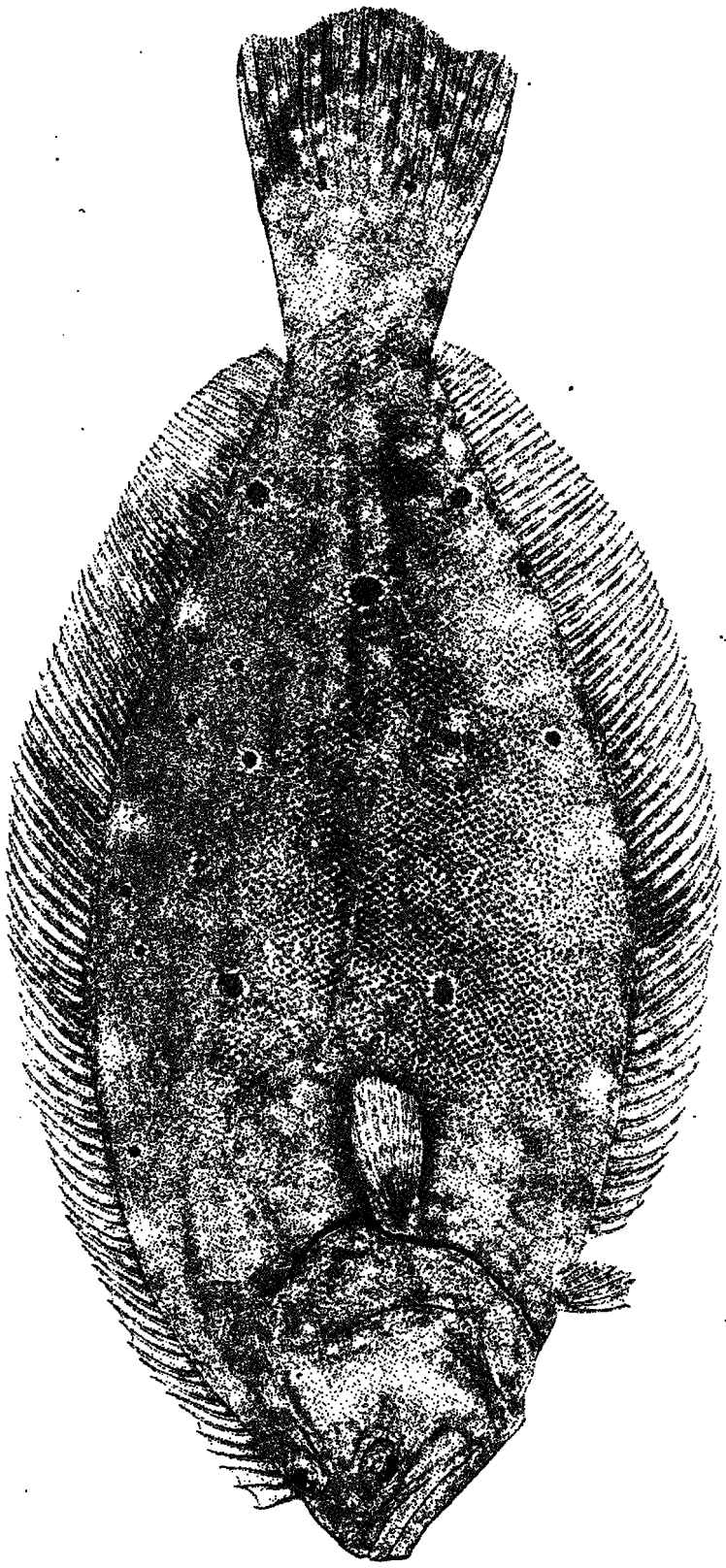

PLATE 12.—*Paralichthys dentatus*, from a specimen 390 mm.; Beaufort, N. C.; ocellated spots in the larger triangle and the others as well, except those in the smaller triangle, somewhat more prominent than usual.

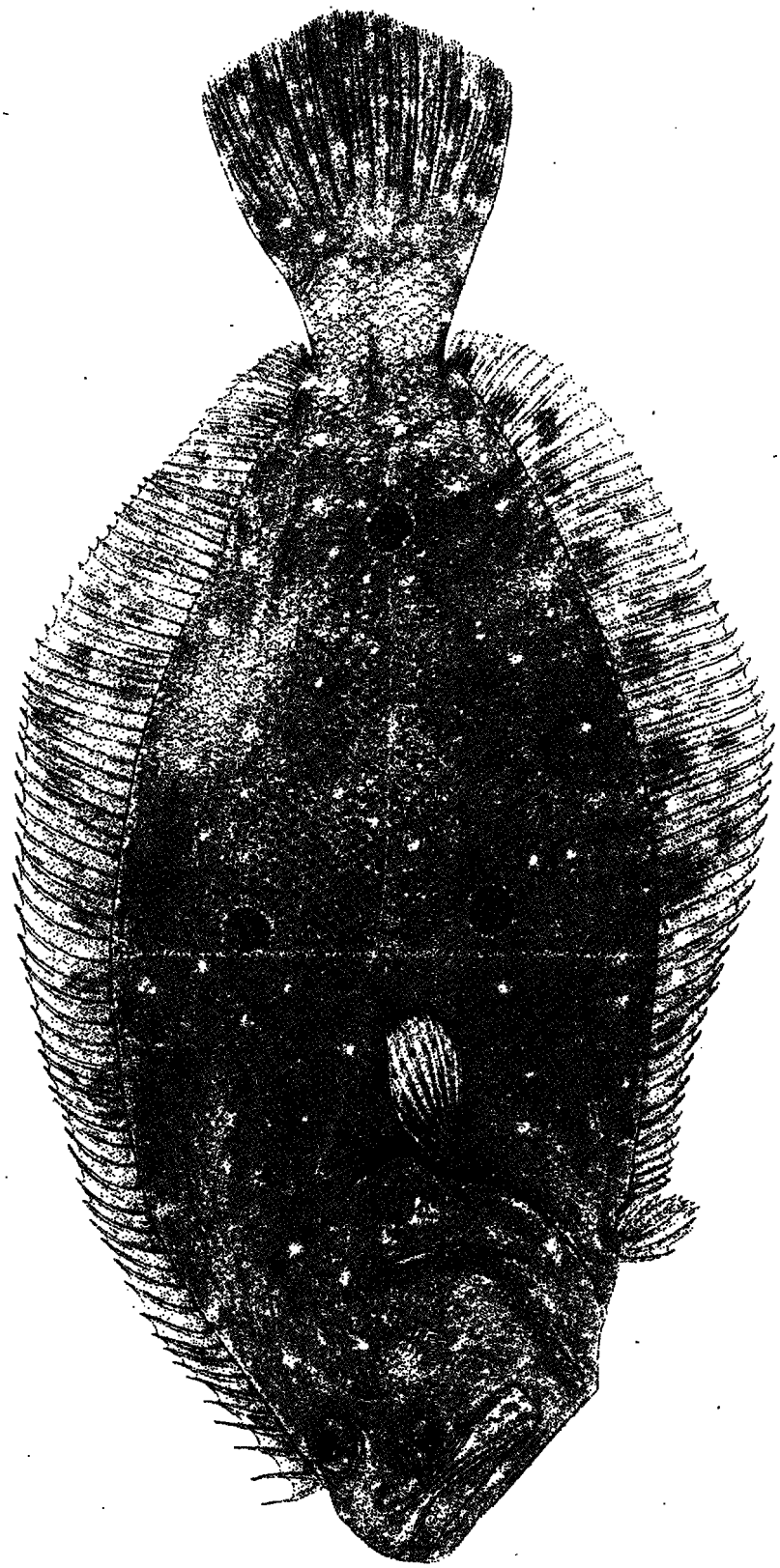

PLATE 13.—*Paralichthys albigutta*, from a specimen 373 mm.; Beaufort, N. C.; spots in large triangle nearly always present and prominent as in figure; spots in small triangle sometimes present, as in *dentatus*, but fainter than in the latter; scattered white spots rather more often present and more prominent in this species, but even in this species absent or obsolescent in most specimens.

PLATE 14.—*Paralichthys tropicus*, from the type, 321 mm.; U. S. Nat. Mus. 34919; off Trinidad, West Indies; specimen evidently faded.

PLATE 15.—*Paralichthys lethostigma*, from a specimen 393 mm.; Beaufort, N. C.