BOTHUS THOMPSONI (FOWLER) 1923, A VALID SPECIES OF FLATFISH (PISCES:BOTHIDAE) FROM THE HAWAIIAN ISLANDS

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ABSTRACT

Bothus thompsoni (Fowler) 1923 is resurrected from the synonymy of *B. bleekeri* Steindachner and redescribed. *B. thompsoni* differs from all other recognized species of the genus in possessing 11-17 gill rakers on the lower limb of the first gill arch and 115-147 lateral line scales. *B. thompsoni* is endemic to the Hawaiian Islands where it inhabits the outer shelf in depths of 70-115 m.

Fowler (1923) proposed *Platophrys thompsoni* on the basis of a single specimen obtained by John W. Thompson. Although no exact locality data were given, we assume the specimen was from the Honolulu market. *Platophrys* is now considered a synonym of *Bothus*, while Norman (1934), without comment, relegated *Bothus thompsoni* to the synonymy of *B. bleekeri* Steindachner. Gosline and Brock (1960) followed Norman in listing *B. bleekeri* from the Hawaiian Islands. Previously, only the holotype of *B. thompsoni* was available for study. Our examination of numerous specimens collected by the National Marine Fisheries Service (NMFS) during recent bottom trawling surveys in the 60-700 m depth range of the Hawaiian Islands demonstrates that *B. thompsoni* should be recognized as a valid species.

MATERIAL AND METHODS

All specimens were collected with 12.5-m (headrope) shrimp trawls during bottom trawling surveys in the Hawaiian Islands with the NMFS RV *Townsend Cromwell*. Sampling effort and general ichthyological results of these surveys are given by Struhsaker (1973). Most specimens examined (one exception from Maui) were from the north coast of the island of Oahu.

The following description is based on a series of 29 male (55.8-114.4 mm SL) and 31 female (39.1-103.7 mm SL) specimens all of which are housed in the National Museum of Natural History (USNM) and Bernice P. Bishop Museum (BPBM). Additionally, 33 uncatalogued specimens cleared and stained by the method described by Taylor (1967) were utilized in vertebral and gill raker counts, and more uncatalogued specimens were examined, obtaining supplementary dorsal, anal, and caudal ray counts.

Measurements and counts are usually as defined by Norman (1934), Hubbs and Lagler (1958), and Gutherz (1967). Standard length was taken from tip of snout to end of hypural plate on the blind side. Horizontal eye diameter was taken between edges of the bony orbits. Snout to axis of greatest depth was taken from the snout to a vertical line at the greatest body depth. The last two dorsal and anal rays are each associated with pterygiophores and are counted as two. Lateral line scale rows just above the lateral line and pored lateral line scales were counted. Vertebral counts were taken from radiographs and from cleared and stained specimens. Gill rakers were counted as discussed below.

To evaluate morphometric characters, measurements in original units and as percent of standard length were plotted as functions of standard lengths.

RESULTS

Description

Although a figure of *B. thompsoni* did not accompany the original description, Fowler (1928), in listing the species for Oceania, provided a figure of the type (P1. IV, C) which is

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housed in the BPBM (3398). Measurements of the 106.8 mm SL male holotype (Fowler gave an undefined length of 134 mm) expressed as percent of standard length are given in Table 1. We obtained the following counts on this specimen: dorsal rays 86; anal rays 62; caudal rays 16; pectoral rays (both sides) 12; lateral-line scale rows 130; pored lateral-line scales 83; gill rakers 19 (5 + 14). Fowler (1923) gave counts of 132 scale rows and 20 gill rakers (6 + 14). Otherwise, our counts agree with his.

Photographs of recently collected female (106.4 mm SL) and male (114.4 mm SL) specimens (both BPBM 14102) are shown in Figures 1 and 2.

Counts

Dorsal and anal ray counts, expressed as bivariate relations, for 101 specimens are given in Table 2. Dorsal rays ranged from 84 to 95 ($\bar{X}$ = 87.9) and anal rays ranged from 64 to 70 ($\bar{X}$ = 66.3). Although the dorsal ray counts are skewed to the right, the distribution does not deviate significantly from a normal distribution ($P > 0.2$; Kolomogorov-Smirnov test for goodness of fit, $D = 0.0702$).

There were considerably fewer pored lateral-line scales (Table 3) ($\bar{X}$ = 80.9) than the number of vertical scale rows above the lateral line ($\bar{X}$ = 131.6).

There was a tendency towards more pectoral rays (Table 3) on the ocular side ($\bar{X}$ = 12.24) than on the blind side ($\bar{X}$ = 11.49). The upper pectoral ray on the ocular side is reduced and sometimes inconspicuous. The upper pectoral ray on the blind side is also reduced, but easily visible.

Bothus thompsoni appears to be unique among species of *Bothus* in usually possessing 16 caudal rays. Of 163 specimens examined (Table 3), 2 (1.2%) had 15 rays, 157 (96.3%) had 16 rays, and 4 (2.5%) had 17 rays. The caudal rays are usually associated with the four hypural elements. Of 31 cleared and stained specimens having 16 rays, 11 had a caudal ray formula of 4-4-4-4 (dorsal element counted first). Other formulae obtained and number of specimens are as follows (rays articulating between elements are enclosed by parentheses): 4-4-3-(1)-4, (6 specimens); 4-4-3-5, (5 specimens); 3-(1)-4-4-4, (4 specimens); 3-(1)-4-3-(1)-4, (2 specimens); 3-(1)-4-3-5, (1 specimen); 3-(1)-4-3-5, (1 specimen); 4-4-3-5, (1 specimen). Two specimens with 15 rays had formulae of 4-4-3-4 and 3-(1)-4-4-3.

None of the caudal rays of *B. thompsoni* was associated with the neural and haemal spines of the penultimate vertebra or articulated in the space between the spines and hypural elements. Thus, *B. thompsoni* differs from certain other species of *Bothus* which have rays associated with the neural and haemal spines of the penultimate vertebra or which occur in the interspace between the spines and hypural elements. Gutherz (1970) gives a formula of 1-4-4-3-4-1 for larval *Bothus* (species not determined) from the western North Atlantic. We obtained the same formula for 12 cleared and stained specimens of *B. pantherinus* (Rüppell) from the Hawaiian Islands. In these specimens the first and last rays most often articulated in the interspace between the spines and hypural elements. These

TABLE 1.—*Bothus thompsoni*: Measurements of 13 characters for holotype, 29 males, and 31 females expressed as percent of standard length. Holotype excluded from regression statistics (a = ordinate intercept, b = regression coefficient).

Characters measured	Holotype BPBM 3398 percent of standard length	Range percent standard length for males	a	b	r^2	Range percent standard length for females	a	b	r^2
Head length	28.5	25.7-29.5	0.646	0.270	0.965	26.0-29.6	1.100	0.264	0.983
Snout length: to upper eye	23.9	14.0-21.5	−5.865	0.252	0.961	13.0-16.6	−1.022	0.162	0.968
to lower eye	6.3	4.4- 6.2	0.315	0.048	0.821	4.8- 6.8	−0.171	0.569	0.857
Orbit diameter: upper	11.6	9.1-12.6	2.255	0.084	0.828	8.2-12.4	1.656	0.087	0.896
lower	9.6	7.6-10.9	2.222	0.071	0.811	8.0-11.5	2.263	0.067	0.874
Interorbital distance	14.9	7.7-13.5	−5.856	0.182	0.958	5.1- 8.6	−1.112	0.088	0.949
Length of upper jaw	10.3	8.0-10.6	1.102	0.081	0.856	8.2-10.4	0.770	0.084	0.943
Greatest body depth	60.8	57.7-66.0	−1.046	0.629	0.968	57.0-67.3	−0.057	0.632	0.973
Least depth caudal peduncle	11.2	9.7-11.4	0.042	0.107	0.970	9.2-11.6	0.195	0.104	0.981
Length of pectoral fin: ocular side	21.7	19.0-24.7	4.661	0.159	0.912	18.8-24.9	4.925	0.153	0.924
blind side	18.4	15.3-18.7	2.294	0.141	0.928	14.0-18.5	0.826	0.155	0.930
Length of anal fin base	75.2	73.4-77.4	2.373	0.734	0.958	71.9-84.8	−3.634	0.814	0.966
Snout to greatest body depth	46.3	41.6-48.6	−4.156	0.497	0.959	41.4-50.0	0.341	0.452	0.961

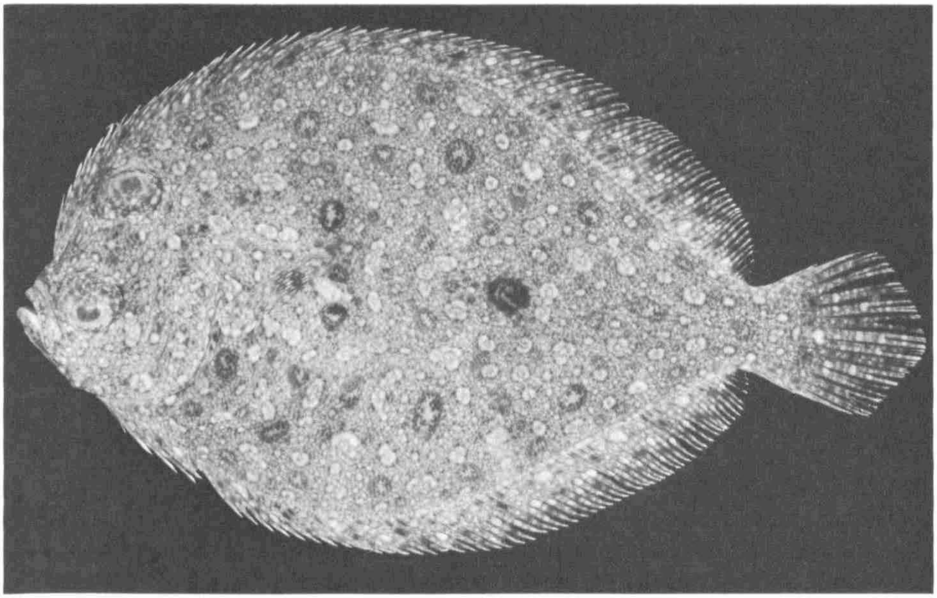

FIGURE 1.—A 106.4 mm SL female *Bothus thompsoni*.

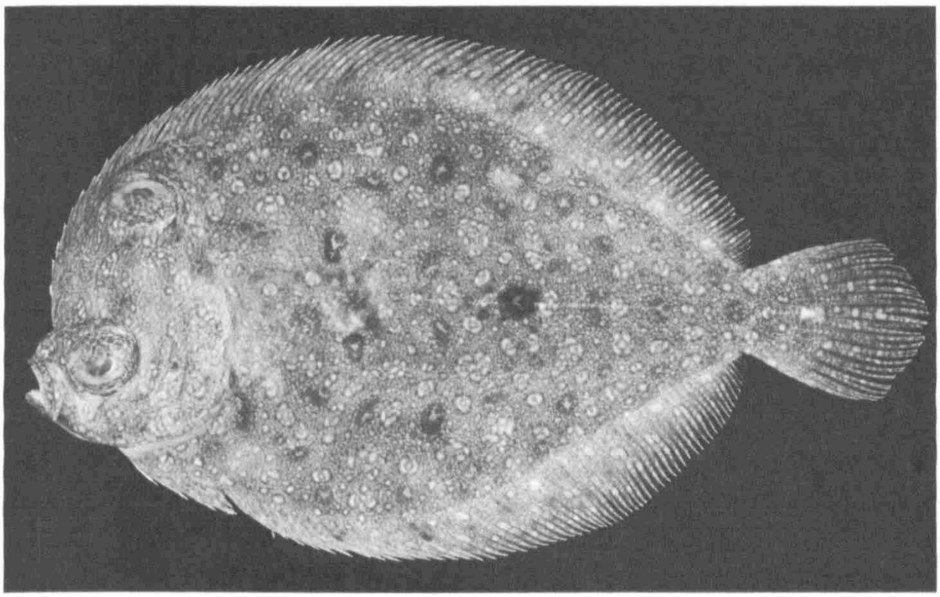

FIGURE 2.—A 114.4 mm SL male *Bothus thompsoni*.

data indicate that *B. thompsoni* exhibits a more variable caudal ray formula than *B. pantherinus*.

The first two and last two caudal rays of *B. thompsoni* are usually simple. Of a sample of 20 specimens, only 2 (10%) had either the second or penultimate ray divided.

The arrangement of gill rakers in *B. thompsoni* is shown in Figure 3, and counts are given in Table 3. There are 3-9 reduced gill rakers associated with the epibranchial and 1-4 reduced gill rakers associated with the hypobranchial. A series of 9-14 well-developed gill rakers is principally associated with the ceratobranchial. The reduced gill rakers associated with the epibranchial comprise the counts for the upper limb of the gill arch. The first well-developed

TABLE 2.—Dorsal and anal ray counts for 101 specimens of *Bothus thompsoni*.

Number of anal rays	Number of dorsal rays 84	85	86	87	88	89	90	91	92	93	94	95	Total number of specimens
70							1					1	2
69						1		1					2
68					1	3	1	4	1				10
67			2	5	7	7	5	3	1				30
66		3	7	3	9	8							30
65	2		8	7	3								20
64	2	1	2	1	1								7
Total number of specimens	4	4	19	16	21	19	7	8	2			1	101

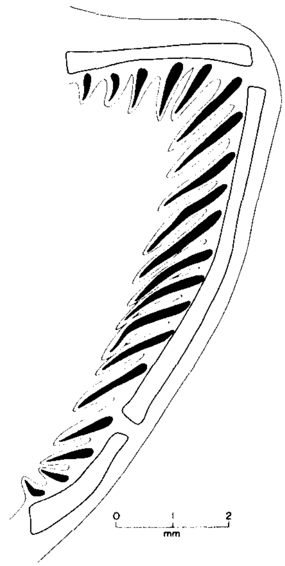

FIGURE 3.—A typical first gill arch from the ocular side of *Bothus thompsoni*.

raker occurs at the angle of the arch and is included in the counts for the lower limb, although stained material reveals this raker to be more closely associated with the epibranchial. The last one or two well-developed rakers are associated with the hypobranchial.

The number of gill rakers in the size range examined is apparently independent of size. A regression coefficient calculated for 28 females was not significant ($P > 0.4$).

Vertebral counts were obtained from 96 specimens. There are usually 10 abdominal vertebra (94 specimens), but two individuals had 11 (28 caudal vertebrae in both cases). Counts of caudal vertebrae (including urostyle) were 27 (7), 28 (69), and 29 (18), while total vertebral counts were 37 (7), 38 (69), and 39 (20).

Measurements

The measurements obtained from 29 male and 31 female specimens for 13 characters are summarized in Table 1. Linear regressions were calculated in original units of measurement (mm) with standard length as the independent

TABLE 3.—*Bothus thompsoni:* Counts for eight characters.

Characters	Frequency of occurrence 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	N	$\overline{X}$
Caudal rays	-	-	-	-	-	-	-	-	-	-	-	-	2	157	4	-	-	-	-	-	-	-	163	16.01
Pectoral rays (ocular side)	-	-	-	-	-	-	-	1	7	32	22	1	-	-	-	-	-	-	-	-	-	-	63	12.24
Pectoral rays (blind side)	-	-	-	-	-	-	-	2	29	31	1	-	-	-	-	-	-	-	-	-	-	-	63	11.49
Gill rakers (upper limb)	1	5	29	29	21	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	91	5.92
Gill rakers (lower limb)	-	-	-	-	-	-	-	-	1	3	21	22	27	13	4	-	-	-	-	-	-	-	91	14.38
Gill rakers (total)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	11	13	24	9	17	6	5	91	20.30
	70-71	72-73	74-75	76	78	80	82	84	86	88	90-91	92-93												
Pored lateral line scales	1	-	-	5	6	8	3	4	2	1	-	1											31	80.9
	114-115	116-117	118-119	120-121	122-123	124	126	128	130	132	134	136	138	140	142	144	146-147							
Lateral line scale rows	1	-	-	-	4	2	6	6	17	5	6	8	5	-	1	-	2						63	131.6

variable. Plots of all regressions are linear and exhibit high r^2 values.

The regressions obtained for the 13 measured characters were subjected to analysis of covariance to test for sexual dimorphism. Highly significant differences ($P<0.001$) were found between the regression coefficients for two characters (which are related): interorbital distance (Figure 4) and snout to upper eye. Juvenile and adult male specimens of *B. thompsoni* are similar to many *Bothus* spp. males in possessing a much greater interorbital distance than females of the same species. Male *B. thompsoni* exhibit positive allometric growth of the interorbital distance, this measurement being about 7.5%-9.0% of standard length at a length of 50-60 mm and about 12%-14% of standard length at a length of 100-115 mm. In female specimens longer than 50 mm the interorbital distances were 6.0%-8.6% of standard length. Interorbital distances of 5.3% and 5.1% of standard length were noted in two specimens 39 mm and 48 mm long. As expected, male *B. thompsoni* exhibited positive allometric growth of the snout to upper eye distance.

Among the remaining 11 characters subjected to analysis of covariance, there were no significant differences between regression coefficients. There were significant differences ($P<0.05$) in the elevations of the regressions between sexes for four characters. Both the upper and lower orbit diameters of males tend to be larger than for females; the differences in adjusted means for the two characters are 0.35 and 0.40 mm, respectively. Females tend to have a greater body depth and a greater snout to greatest body depth distance. The differences in adjusted means for these two characters are 1.1 and 1.0 mm, respectively.

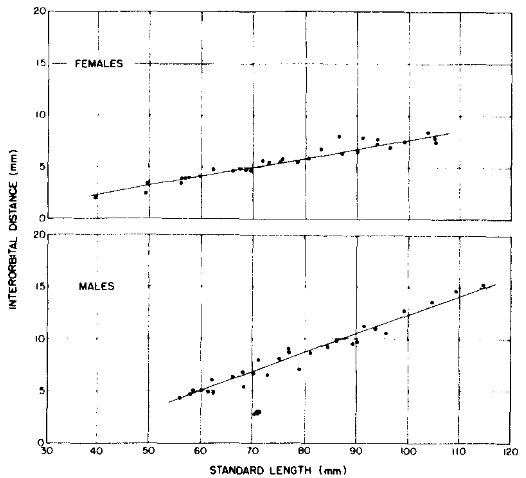

FIGURE 4.—Plots of the interorbital distance of 29 male and 31 female specimens of *Bothus thompsoni*.

In both sexes, the pectoral fins of the ocular side tend to be longer than those of the blind side (Table 1). The pectoral fins of both sexes exhibit negative allometric growth. This is most pronounced on the ocular size where the pectoral length is about 24%-25% of standard length at 40-60 mm and about 18%-21% of standard length at a length of 100-115 mm. There is only slight negative allometric growth of the pectoral fin on the blind side where this structure varies from 14.0% to 18.7% of standard length.

All other morphometric characters examined exhibited approximately isometric growth.

Two of the measurements we obtained for the holotype (Table 1) do not fall within the ranges we obtained from our study series: interorbital distance and snout to upper eye.

Other morphological characters

Bothus thompsoni has cycloid scales on the blind side and on most of the ocular side (Figure 5A). Ctenoid scales occur on the proximal portions of the dorsal and anal rays. There are 2-3 rows of ctenoid scales at the bases of the dorsal and anal fins (Figure 5B). Fowler (1923) stated that the holotype had ctenoid scales on the cheeks and postorbital region. In addition, we find that there is a patch of about 15 ctenoid scales below the curved portion of the lateral line in the holotype. A scale from this region is shown in Figure 5C. The occurrence of ctenoid scales on the cheek and in the vicinity of the curved portion of the lateral line is a variable character. Of 25 specimens (67.5-106.4 mm SL) from our study series, six had ctenoid cheek scales, three had ctenoid scales on the cheek and near the lateral line, and one had ctenoid scales near the lateral line only. The presence of ctenoid scales in these two regions does not appear to be related to size or sex. The cycloid scales are small and nonimbricated, but the ctenoid scales at the dorsal and anal fin bases overlap to a slight degree. The ctenii of the ctenoid scales generally occur in two rows: a primary row of well-developed ctenii and a secondary row of smaller ctenii basal to the

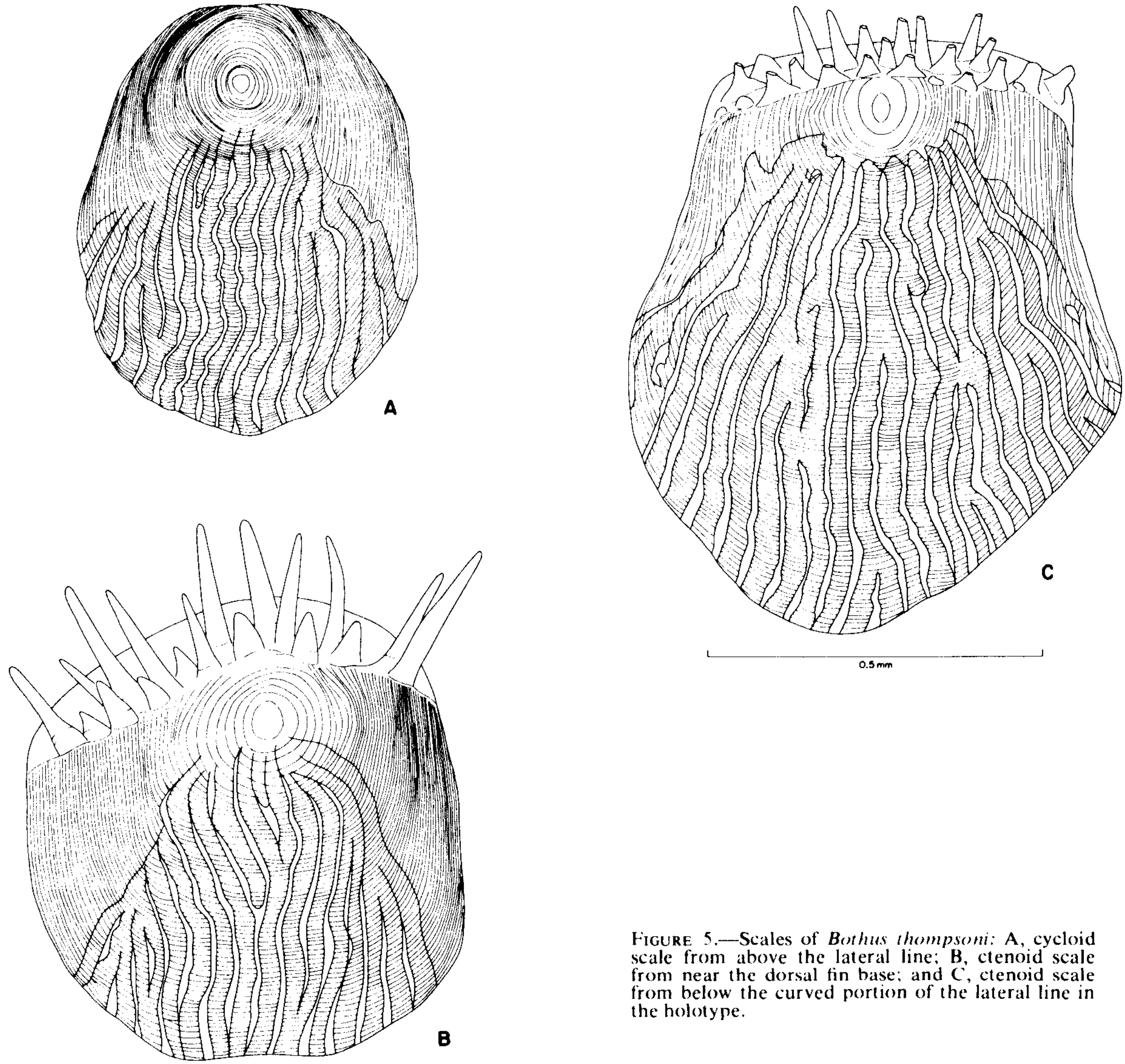

FIGURE 5.—Scales of *Bothus thompsoni:* A, cycloid scale from above the lateral line; B, ctenoid scale from near the dorsal fin base; and C, ctenoid scale from below the curved portion of the lateral line in the holotype.

primary row (Figure 5B and C). The number of ctenii on cheek scales varies from 5 to 8, while scales from the dorsal and anal fin bases at the greatest body depth have 15 to 25 ctenii.

The general arrangement of teeth in the upper and lower jaws is shown in Figure 6. There are usually three rows of teeth. The outer row consists of a few, stout conical teeth in the anterior portion of the jaws. The middle row consists of more numerous, but less stout, conical teeth. The inner row consists of depressed, poorly ossified conical teeth subequal in number to those in the middle row (except on the blind side of the upper jaw). The inner row of teeth are movable, being held in place by flesh and not inserted in the jaw bones.

The number of outer teeth, and, to a lesser extent, the middle teeth, vary according to jaw bone and size of specimen. This is illustrated in Figure 7 where the number of teeth are plotted by standard length for 10 females 49.2-106.4 mm SL and 10 males 55.8-114.5 mm SL. The increase in number of outer teeth with size is apparent for all jaw bones except the dentary on the ocular side. There also appear to be more outer teeth in the premaxillary of the ocular side of the males.

The teeth in the middle row also exhibit a general, but less well-defined, increase in numbers with size.

There are no fleshy papillae along the edges of the eyes such as reported for male *B. pantherinus* (Norman, 1934). There is a single prominent, blunt protuberance on the snout of males greater than 60 mm SL. This structure is represented in females by a small knob. The anterior edge of the lower orbit tends to be more developed and rugose in males than in females.

Coloration of fresh specimens

The blind side of both sexes is white, but tending to dusky white in males greater than about 80 mm SL, especially on the cheek and above the cheek. The ground color of the ocular side is light olive green. There is a single prominent dark spot on the lateral line posteriad about 60% of the standard length. There are two secondary dark ocelli near the pectoral fin. There are 14-15 olive green ocelli broadly distributed along the dorsal and ventral borders of the trunk. There are numerous light blue ocelli and spots distributed over the trunk, head, and dorsal, anal, caudal, and ventral fins. The pectoral fins are almost clear. In males, the light blue spots are more numerous and elongated along the anterior profile and between the eyes.

Comparison with Other Species of *Bothus*

A definitive discussion of the relation of *B. thompsoni* to other species of *Bothus* must await further study of the genus on a worldwide basis. *B. thompsoni* differs from all recognized species of *Bothus* (Fowler, 1933; Norman, 1934; Chabanaud, 1942; Stauch, 1966; Gutherz, 1967; Amaoka, 1969; Topp and Hoff, 1972) in possessing 11-17 gill rakers on the lower limb of the first arch (11 or fewer in other species) and 115-147 scale rows above the lateral line (apparently 100 or fewer in other species: Norman, 1934). It may also be unique in that it usually has only 16 caudal rays as opposed to 17 in other species. This character, however, apparently has been examined only rarely by earlier authors and few data on the numbers and arrangements of the caudal rays are available (Chabanaud, 1942; Amaoka, 1969; Gutherz, 1970). The figures given by Norman (1934) for *B. leopardinus* (Günther) and *B. bleekeri* indicate

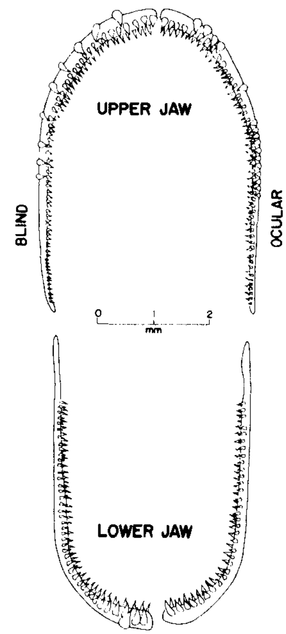

FIGURE 6.—The arrangement of teeth in *Bothus thompsoni*.

caudal ray counts of 16. However, a count of 16 is also indicated for *B. ovalis* (Regan) which Amaoka (1964) has shown to be the young of *B. myriaster* (Temminck and Schlegel). *B. myriaster* has 17 caudal rays (Amaoka, 1969). Chabanaud (1942) described *B. budkeri* from the Red Sea and gave caudal ray counts of 16 for the holotype and 17 for the two paratypes. A sample of 368 adult and larval specimens of *B. pantherinus* from the Hawaiian Islands had the following caudal ray counts: 16 (2.7%), 17 (95.7%), 18 (1.6%). Further examination of this character is required.

We have not examined specimens of *B. bleekeri*, and we separate this species from *B. thompsoni* on the basis of the description given by Norman (1934). In addition to the differences in gill raker and lateral line scale row counts discussed above, *B. thompsoni* has more pectoral rays on the ocular side (10-14 vs. 8-9). Adult male specimens of *B. thompsoni* do not have elongated pectoral rays (ocular side), whereas male *B. bleekeri* have elongated pectoral rays.

Two other species of *Bothus*, *B. pantherinus* and *B. mancus* (Broussonet), occur in the Hawaiian Islands. Adult specimens of *B. thompsoni* may be separated from similar life history stages of the former two species on the basis of body profile alone. Other useful characters for distinguishing *B. thompsoni* from *B. pantherinus* and *B. mancus* (in addition to counts of the lateral line scale rows, lower gill rakers, and caudal rays) are as follows. Cycloid scales are present on the ocular side of *B. thompsoni* (except at the bases of the dorsal and anal fin, and occasionally on the cheeks and in the vicinity of the lateral line) as opposed to ctenoid scales on the ocular side for *B. pantherinus* and *B. mancus*. Adult males of the latter two species have elongated pectoral fin rays on the ocular side, while male specimens of *B. thompsoni* do not. *Bothus mancus* possess more dorsal and anal fin rays than do *B. thompsoni* and *B. pantherinus* (97-102 vs. 84-96 and 77-82 vs. 64-74, respectively; Hawaiian Island

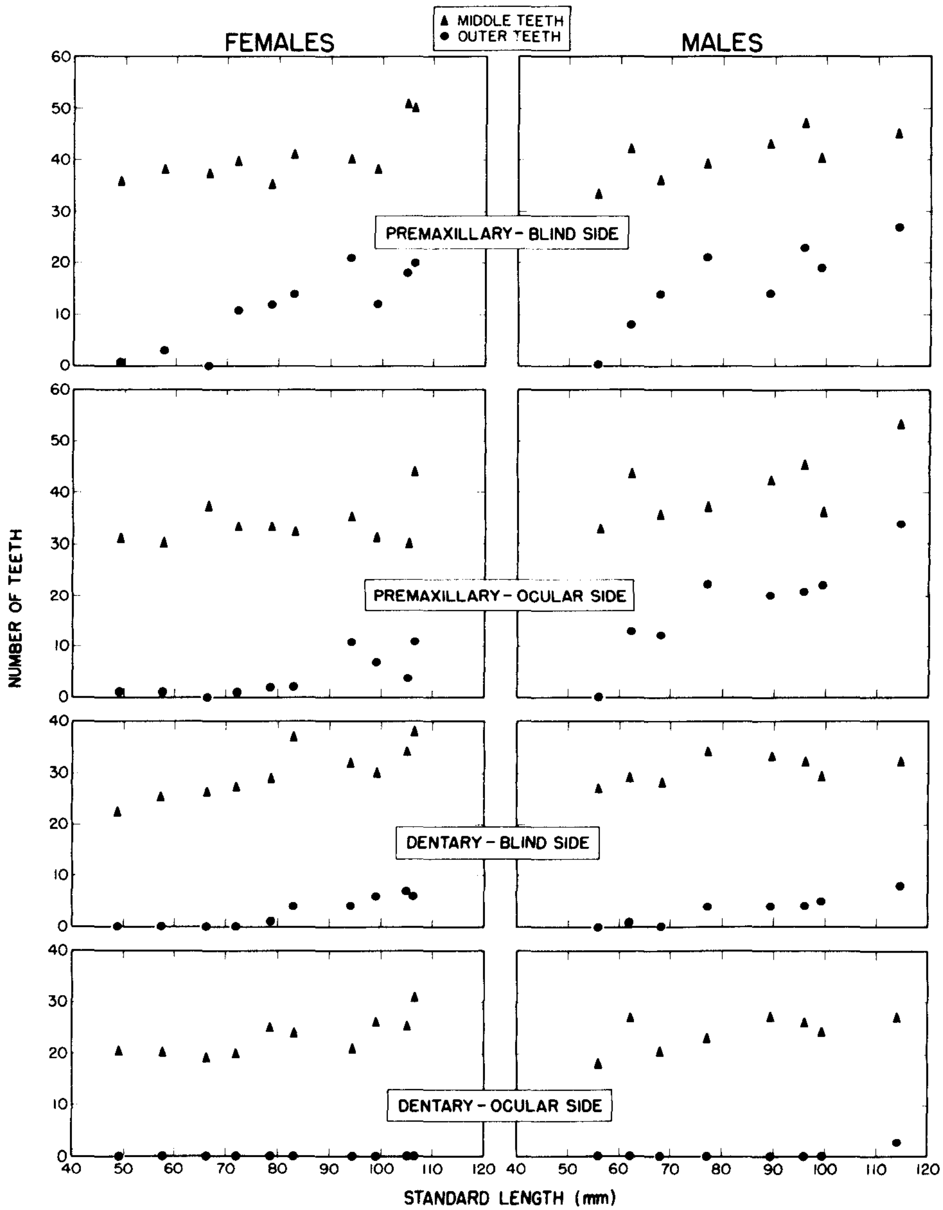

FIGURE 7.—Numbers of teeth in the outer and middle tooth rows in *Bothus thompsoni*.

specimens). *Bothus thompsoni* has 10-14 pectoral rays, whereas this count is 9-11 for both *B. pantherinus* and *B. mancus*.

With regard to other Indo-Pacific species recognized by Norman (1934), *B. thompsoni* differs from *B. myriaster* in that the pectoral fins of males are not elongated in the former species. The combination of cycloid and ctenoid scales on the ocular side of *B. thompsoni* differentiates it from *B. assimilis* (Günther) which has only cycloid scales and from *B. leopardinus* (Günther) which has only ctenoid scales on the ocular side (Norman, 1934). Norman (1934) considers also that *B. constellatus* (Jordan, *in* Jordan and Goss) is very doubtfully distinct from *B. leopardinus*.

Although no illustration was given of *B. budkeri* (Chabanaud, 1942) from the Red Sea, it differs from *B. thompsoni* in having a lesser body depth, fewer dorsal and anal rays, fewer gill rakers on the lower limb of the first arch, and only ctenoid scales on the ocular side.

Fowler (1933) described five species of *Bothus* from the Philippines and China Sea. The generic placement of several of these species is questionable. At any rate, none of them could be confused with *B. thompsoni*.

Ecology

With the exception of one specimen caught at a depth of 72 m off Maui, all specimens of *B. thompsoni* taken to date have come from depths of 90-113 m off the north coast of Oahu where bottom temperatures ranged from 24.5° to 26.0°C. About 580 specimens (32-107 mm SL) have been obtained at 13 stations where catches ranged up to 275 individuals per haul. An analysis of dispersion for this species (Struhsaker, 1973) shows it to have a highly clumped distribution. The type of bottom in the area of capture is primarily muddy sand interspersed with patches of sponge, broken shell, and rubble. *Bothus thompsoni* was often taken with 20-30 other species of fishes; it usually comprised less than 8% of the total catch, but occasionally ranged up to 30%. Numerically dominant species taken with *B. thompsoni* include *Trachinocephalus myops*, *Priacanthus* spp., *Antigonia eos*, *Parupeneus chrysonemus*, and *Lagocephalus hypselogeneion*. Struhsaker and Higgins (manuscr.[2]) have shown that *B. thompsoni* is the third most abundant larval flatfish (after *Engyprosopon xenandrus* Gilbert and *B. pantherinus*) taken in offshore midwater hauls near Oahu. They also presented evidence that *B. thompsoni* may spawn throughout the year.

ACKNOWLEDGMENTS

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MATERIAL EXAMINED

USNM 208494: TC-33-52 (R/V *Townsend Cromwell*, cruise 33, station 52); 1 male (109.2 mm SL); lat. 19°58.3′ N, long. 156°28.5′ W; depth 72 m, 13 Nov. 1967. USNM 208495: TC-36-15; 4 females (93.7-99.1 mm SL); lat. 21°37.7′ N, long. 158°08.8′ W; depth 113 m, 2 May 1968. USNM 208496: TC-36-20; 7 females (39.5-72.8 mm SL), 12 males (55.8-81.2 mm SL); lat. 21°36.8′ N, long. 158°12.5′ W; depth 110 m, 3 May 1968. USNM 208497: TC-40-115; 10 females (56.9-87.3 mm SL), 5 males (70.0-84.5 mm SL); lat. 21°36.8′ N, long. 158°08.2′ W; depth 102 m, 8 Nov. 1968. USNM 208498: TC-40-116; 4 females (56.0-105.4 mm SL), 3 males (58.6-104.5 mm SL); lat. 21°36.8′ N, long. 158°11.6′ W; depth 112 m, 1 Dec. 1968. USNM 208499: TC-40-119; 5 females (78.6-91.2 mm SL), 7 males (86.2-99.2 mm SL); lat. 21°36.8′ N, long. 158°11.2′ W; depth 96 m, 1 Dec. 1968. BPBM 14102: TC-40-125; 1 female (106.4 mm SL), 1 male (114.4 mm SL); lat. 21°36.8′ N, long. 158°11.6′ W; depth 102 m, 10 Nov. 1968.

[2] Struhsaker, P., and B. E. Higgins. Unpubl. manuscr. Post-larval flatfishes (Pisces:Pleuronectiformes): Observations on the identity and ecology of 11 Hawaiian species. Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, Hawaii 96812.

LITERATURE CITED

AMAOKA, K.

1964. Development and growth of the sinistral flounder, *Bothus myriaster* (Temminck and Schlegel) found in the Indian and Pacific Oceans. Bull. Misaki Mar. Biol. Inst., Kyoto Univ. 5:11-29.

1969. Studies on the sinistral flounders found in the waters around Japan—taxonomy, anatomy and phylogeny. J. Shimonoseki Univ. Fish. 18:65-340.

CHABANAUD, P.

1942. Notules ichthyologiques. Bull. Mus. Natl. Hist. Nat. Paris 14:395-402.

FOWLER, H. W.

1923. New or little known Hawaiian fishes. Occas. Pap. Bernice Pauahi Bishop Mus. 8(7), 20 p.

1928. Fishes of Oceania. Mem. Bernice P. Bishop Mus. 10, 540 p.

1933. Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. Proc. Acad. Nat. Sci. Phila. 85:233-367.

GOSLINE, W. A., AND V. E. BROCK.

1960. Handbook of Hawaiian fishes. Univ. Hawaii Press, Honolulu, 372 p.

GUTHERZ, E. J.

1967. Field guide to the flatfishes of the family Bothidae in the western North Atlantic. U.S. Fish Wildl. Serv., Circ. 263, 47 p.

1970. Characteristics of some larval bothid flatfish, and development and distribution of larval spotfin flounder, *Cyclopsetta fimbriata* (Bothidae). U.S. Fish Wildl. Serv., Fish. Bull. 68:261-283.

HUBBS, C. L., AND K. F. LAGLER.

1958. Fishes of the Great Lakes region. Revised ed. Cranbrook Inst. Sci., Bull. 26, 213 p.

NORMAN, J. R.

1934. A systematic monograph of the flatfishes (Heterosomata). Vol. I. Psettodidae, Bothidae, Pleuronectidae. Br. Mus. (Nat. Hist.), Lond., 459 p.

STAUCH, A.

1966. Quelques données sur les Bothus de l'Atlantique et description d'une espèce nouvelle Bothus guibei: n. sp. (Pisces Teleostei, Heterosomata). Bull. Mus. Natl. Hist. Nat. Paris 38:118-125.

STRUHSAKER, P.

1973. A contribution to the systematics and ecology of Hawaiian bathyal fishes. Ph.D. Diss., Univ. Hawaii, Honolulu, 482 p.

TAYLOR, W. R.

1967. An enzyme method of clearing and staining small vertebrates. Proc. U.S. Natl. Mus. 122(3596), 17 p.

TOPP, R. W., AND F. H. HOFF, JR.

1972. Flatfishes (Pleuronectiformes). Mem. Hourglass Cruises, Fla. Dep. Nat. Resour., Mar. Res. Lab. 4(2):1-135.