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Citation	北海道大學水産學部研究彙報, 4(4), 256-267
Issue Date	1954-02
Doc URL	https://hdl.handle.net/2115/22825
Type	departmental bulletin paper
File Information	4(4)_P256-267.pdf



REVISION OF *Hypomesus olidus* (PALLAS) AND *Hypomesus japonicus*
(BREVOORT) OF HOKKAIDO, JAPAN

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Hypomesus olidus has very generally been confused with *Hypomesus japonicus*. Some scholars have considered them to be a single species while others have differentiated them as two species.

According to HUBBS (1925), *H. olidus* differs sharply from *H. japonicus* in the smaller number of the scales, there being 54 to 62 rather than 63 to 68 in the course of the lateral line. According to BERG (1932), however, *H. olidus* has 53 to 68 scales in the course of the lateral line, and by him *H. japonicus*, *H. vercundus* and *H. olidus* are referred to a single species.

In consequence of the confusion in the classification of these species, as stated above, the present author has encountered difficulty in the synecological research of the pond smelt, *H. olidus*, which inhabits off the coast of Hokkaido, Japan. Therefore, he is faced with the urgent necessity of making a taxonomic revision of genus of *Hypomesus* taken from Hokkaido.

As results of the present research, it was confirmed that there are differences in the size of scales, the number of vertebrae and the position of pelvic insertions between *H. olidus* and *H. japonicus*, as was pointed out by JORDAN & HUBBS (1925), HUBBS (1925) and NOJIMA (1938). Moreover, it was found that the length and shape of the maxillary, the shape of the stomach and its appendage are different in the two different species.

1. Materials

With the exception of a few collections, all of the material used in this study was obtained off the coast of Hokkaido. Two series were taken in the Ishikari River. The specimens are shown in Tables 1 and 2. All specimens were preserved in 10 % formalin.

2. Ratio of head-length to body-length

So far as the small individuals are concerned the relative length of the head in proportion to the body length without caudal fin, is about the same in *H. olidus* as in *H. japonicus* (Fig. 1), but it is diverse in specimens larger than about 90 mm long. The head is about 23 % of body length in *H. olidus*, and about 22 % in *H. japonicus*. This difference is, however, too slight to establish two species. The relative length of the head to the body length is not sufficiently different in the present case to form a basis for classification in two species.

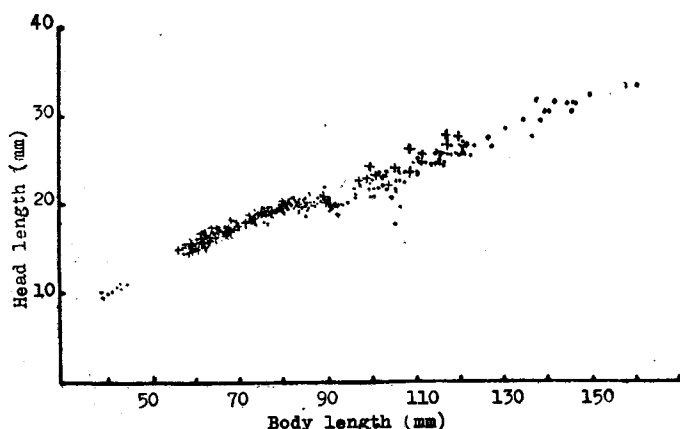


Fig. 1. Relation between the head length and the body length. The dots and the crosses show respectively *H. japonicus* and *H. olidus*

form, small in number and sometimes entirely lacking (Figs. 2, C and D).

4. Number of fin rays

The number of fin rays has been examined by many scholars, such as PALLAS (1811), SCHMIDT (1904), JORDAN & HUBBS (1925), SOLDATOV & LINDBERG (1930), BERG (1932), NOJIMA (1938) and others. The point was re-examined by the author but no clear differences were found. The detailed results of the re-examinations are as follows;

a) According to the older papers, the number of dorsal rays varied between 8 and 11 in *H. olidus*, and from 9 to 11 in *H. japonicus*. TARANETZ (1936) counted only the branched rays; therefore his data can not be compared with others. In the present research, the number of the dorsal rays varied from 9 to 11 in *H. olidus*, and from 10 to 13 in *H. japonicus*, with one abnormal specimen which has 17 rays, taken at Oshoro Bay on December 9, 1952 (Tables 5 and 6).

b) On the number of the anal rays, the older papers reported that *H. olidus* varied from 13 to 14, and *H. japonicus* from 13 to 17. In this re-examination, that number from 14 to 20 in *H. olidus*, and from 13 to 18 in *H. japonicus* as shown in Tables 7 and 8.

c) SCHMIDT (1904) and BERG (1932) say that the pectoral rays of *H. olidus* varied from 10 to 15 in number,

3. Length and shape of maxillary

H. olidus differs sharply from *H. japonicus* in the length of maxillary. Though the maxillary of *H. olidus* is 38 to 47 % of head length, it is no more than 29 to 39 % in *H. japonicus* (Tables 3 and 4). Canine-like teeth are always formed on the maxillary in *H. olidus* (Figs. 2, A and B). The corresponding teeth of *H. japonicus* are, however, modified in

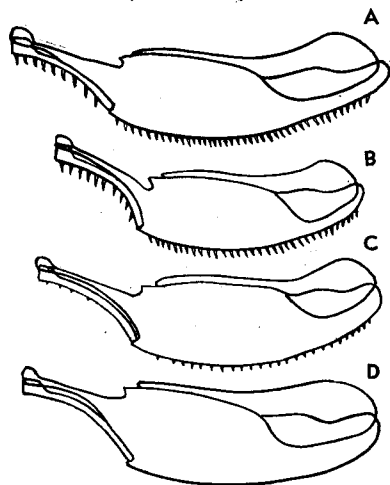


Fig. 2 A shows the maxillary of a female *H. olidus* obtained on October 30, 1934 in Akkeshi Bay; body length 119 mm, maxillary length 11 mm. B shows the maxillary of a male *H. olidus* obtained on November 10, 1952 off the coast of Mombetsu; body length 97.3 mm, maxillary length 9 mm. C shows the maxillary of a male *H. japonicus* obtained on May 6, 1953 in Oshoro Bay; body length 111 mm, maxillary length 9.5 mm. D shows the maxillary of a female *H. japonicus* obtained on October 6, 1934 in Akkeshi Bay; body length 110 mm, maxillary length 9.5 mm.

and according to GUENTHER (1866) the rays of *H. japonicus* number fourteen. As a result of the present re-examination, the number of pectoral rays was found to vary from 12 to 14 in *H. olidus*, and from 12 to 15 in *H. japonicus* as shown in Tables 9 and 10.

5. Number of scales in the course of the lateral line

According to HUBBS (1925), there are 54 to 62 scales in *H. olidus*, 63 to 68 scales in *H. japonicus*. JORDAN & HUBBS (1925), JORDAN & EVERMANN (1896) and NOJIMA (1938) also classified *H. olidus* and *H. japonicus* by the number of the scales. SCHMIDT (1904) reported that *H. japonicus* and *H. pretiosus* are local varieties of *H. olidus*. BERG (1932) and SOLDATOV & LINDBERG (1930) referred to *H. olidus* and *H. japonicus* as a single species, and they reported that the scales counted 53 to 68 in the course of the lateral line. In the present research, *H. olidus* was found to differ sharply from *H. japonicus* in the larger size of the scales, there being 54 to 60 rather than 61 to 69 in the course of the lateral line (Tables 11 and 12).

6. Position of pelvic fins

H. olidus is distinguished from *H. japonicus* in the more forward position of the pelvic fins in reference to the dorsal. The present specimens show the pelvic insertion to be usually in advance of, instead of a little behind, a vertical line from the origin of the dorsal, as was described by HUBBS (1925).

JORDAN & GILBERT (1899) reported that the position of the pelvic fins of *H. olidus* varied from slightly in advance of this point in the young to slightly behind in the adult. This variation, however, was found because they erroneously identified *H. japonicus*, which had been collected at Petropoulovsk, with *Mesopus olidus* (HUBBS 1925).

7. Number of vertebrae

The number of vertebrae is a striking taxonomic characteristic of genus *Hypomesus*. According to TARANETZ (1936), the vertebrae of *H. olidus* number 54 to 58, and those of *H. pretiosus* 61 to 64. NOJIMA (1938) counted 54 to 57 in *H. olidus*, and 61 to 64 in *H. japonicus* taken from Hokkaido. SATO, R. (1951) reported that the number of vertebrae of *H. olidus* in several lakes of Japan was 53 to 58. The number counted by the author, fluctuated from 52 to 58 in *H. olidus* and 59 to 66 in *H. japonicus* (Urostyle was included) as is shown in Tables 13 and 14. *H. pretiosus* described by TARANETZ (1936) had the same number of vertebrae as *H. japonicus* which was identified by the author. TARANETZ (1936) emphasized that *H. japonicus* is a synonym of *H. pretiosus*.

SOLDATOV & LINDBERG (1930) and BERG (1932) say that *H. japonicus* is a synonym of *H. olidus*, and that *H. pretiosus* is a different species.

Fortunately, by the courtesy of Asst. Prof. R. SATO of the Tohoku University, Sendai, Japan, the author had an opportunity to make a detailed examination of two specimens of the surf-smelt, collected from Puget Sound and presented to Asst. Prof. R. SATO by Dr.

WELANDER. These specimens were identified as *H. pretiosus* by American ichthyologists. The specimens differ from *H. japonicus* in respect to the small size of scales, there being 70 in the course of the lateral line. Therefore, the author maintains that *H. olidus* and *H. japonicus* are independent species respectively, as was proposed by HUBBS (1925). The possibility must be examined that *H. japonicus* may be a local variety of *H. pretiosus*, but it is a subject to be decided after ecological and embryological researches. *H. vercundus* may be a synonym of *H. japonicus*, for the description by JORDAN & METZ (1913) indicates no clear difference from *H. japonicus*.

8. Stomach and pyloric caeca

The stomach of *H. olidus* is V-shaped, and its bending portion is caecal approximately as the result of the swelling of the outside (Fig. 3,A). On the right side of the stomach, there are two finger-like and one to three small pyloric caeca, and one finger-like and one to two small pyloric caeca on the left side (Table 15). The distance from the bending portion of the duodenum, to the end of the finger-like pyloric caeca on the left side of the stomach is usually shorter than half of the distance to the posterior tip of the stomach. The stomach of *H. japonicus* is U-shaped or nearly so and siphonal. The stomach bends somewhat easily in the posterior portion and swells faintly. The pyloric caeca are the same as in *H. olidus* in number (Table 16), but they are longer than those of *H. olidus*. It is usual that the length from the duodenum to the end of the finger-like pyloric caeca on the left side of the stomach is longer, except in a case of overeating, than one half of the distance to the posterior tip of the stomach (Fig. 3,B).

9. Relative length of pectoral fins to length of way to pelvic insertion

According to HUBBS (1925), *H. olidus* differs from *H. japonicus* in the larger size of all the fins, the pectoral reaching more, instead of less, than halfway to the pelvic insertion. In the present research in *H. olidus*, the length of the pectoral fins was found to be 52 to 68 % of the distance to the pelvic insertion, and 43 to 60 % in *H. japonicus* (Tables 17 and 18). That is to say,

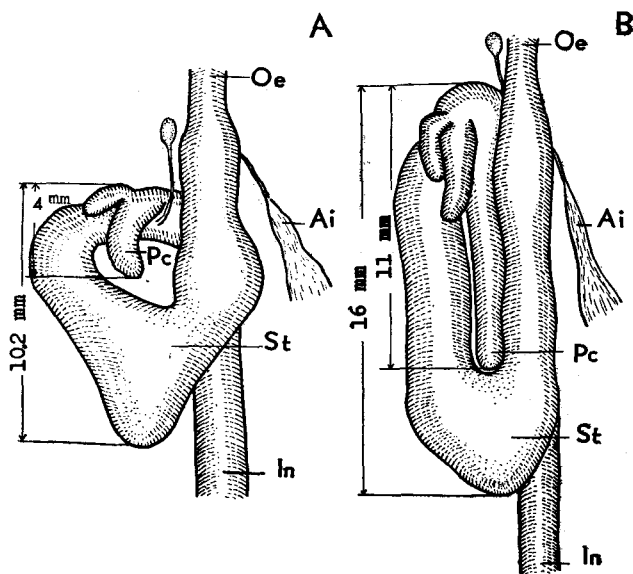


Fig. 3. View of the left-side of the stomach. A shows the stomach of a female *H. olidus* 69 mm long, obtained on October 30, 1934 in Akkeshi Bay. B shows the maxillary of a female *H. japonicus* 98 mm long, obtained on November 16, 1952 off the coast of Muroran.

Ai: air-bladder In: intestine Oe: oesophagus
Pc: pyloric caeca St: stomach

the pectorals of some specimens of *H. japonicus* reach more than half-way to the pelvic insertion. According to TARANETZ (1936), the length of pectoral fin of *H. olidus* is 61 to 80 % of the distance to the pelvic insertion and that of *H. pretiosus* (as mentioned before, this species is a synonym of *H. japonicus*) is 51.5 to 61.5 %. As stated above, the length of the pectoral fin of *H. olidus* is generally longer than that of *H. japonicus*. This point is however, not certain as a taxonomic characteristic to classify *H. olidus* and *H. japonicus*.

10. Conclusion

H. olidus differs evidently from *H. japonicus* in several characteristics. If *H. olidus* and *H. japonicus* are referred to a single species, as BERG (1932) has proposed, *H. japonicus* ought to be found in the ponds and the rivers. However, *H. japonicus* has never been found in ponds or rivers at any time of year. The morphological differences are summarized as the following Key.

- a₁. Maxillary 38 to 47 % of head, canine-like teeth on it.
- b₁. Scales larger than in *H. japonicus*, 54 to 60 along lateral line.
- c₁. Pelvic fins usually inserted a little before origin of dorsal.
- d₁. Vertebrae fewer in number than in *H. japonicus*, 52 to 58.
- e₁. Stomach V-shaped, and approximately caecal. Pyloric caeca shorter than in *H. japonicus*. *Hypomesus olidus*
- a₂. Maxillary 29 to 39 % of head, teeth smaller than in *H. olidus*, fewer in number, or lacking.
- b₂. Scales smaller, 61 to 69 along lateral line.
- c₂. Pelvic fins usually inserted behind origin of dorsal.
- d₂. Vertebrae more numerous than in *H. olidus*, 61 to 64.
- e₂. Stomach U-shaped, and siphonal or approximately so. Pyloric caeca longer than in *H. olidus*. *Hypomesus japonicus*

Acknowledgement

The writer wishes to express his gratitude to Prof. S. SAITO and to Asst. Prof. H. NIYAMA for their guidance throughout the work: to Prof. S. SATO for his advice and for his gift of valuable specimens. Appreciation is offered to Mr K. KUDO and Mr. H. OKESAKU, Hokkaido Regional Fisheries Research Laboratory, Yoichi, for the specimens collected off the coast of Muroran and Kiritappu.

The present work was carried out with the financial aid of a subsidy for Scientific Research from the Ministry of Education.

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(水産科学研究所業績 第197号)

Table 1. *H. olidus* used in the present study

Locality	Date	Number of Specimens		Body Length	Note
Akkeshi Bay	Oct. 1936	♂ 2	♀ 4	69—119 mm	
Oshoro Bay	May 8, 1953	♂ 1		101	
Coast of Mombetsu	Nov. 10, 1952	♂ 1	♀ 1	87.5—99.5	Mombetsu, Kitami
Coast of Abashiri	Sept. 21, 1950	♂ 35	♀ 17	58—80	Pyloric caeca were not counted. Length of pectoral fin was not measured.
Ishikari River	June 1, 1936	♂ 2	♀ 1	90—111	Fish ascending to spawn. Ebetsu
Ishikari River	May 22, 1949	♂ 3	♀ 3	99—108	Fish ascending to spawn.

Table 2. *H. japonicus* used in the present study

Locality	Date	Number of Specimens		Body Length	Note
Akkeshi Bay	Sept. 20—Oct. 30, 1934	♂ 2	♀ 6	66—141 mm	
Akkeshi Bay	Apr. 24, 1936	♂ 3	♀ 2	115—157	Spawning season
Oshoro Bay	June 1, 1949	♂ 2	♀ 4	102—120	After spawning Pyloric caeca were not counted.
Oshoro Bay	Dec. 9, 1952	♂ 9	♀ 11	112—127	
Oshoro Bay	May 6, 1953	♂ 1	♀ 2	111—136	After spawning
Coast of Kiritappu	Dec. 9, 1952	♂ 10	♀ 11	96—160	Pyloric caeca were not counted.
Coast of Muroran	Aug. 2, 1952	♂ + ♀ 7		39—44	Maxillary, fin, fin ray, scales were not measured or counted.
Coast of Muroran	Oct. 15, 1952	♂ 5	♀ 5	85—94	Pyloric caeca were not counted.
Coast of Muroran	Nov. 16, 1952	♂ 11	♀ 9	90—107	
Coast of Mombetsu	Nov. 10, 1952	♂ 3	♀ 1	86—115	
Coast of Abashiri	Sept. 21, 1950	♂ 22	♀ 25	74—87	Pyloric caeca were not counted. Pectoral fin length was not measured.

Table 3. Variation in percentage relationship of maxillary to head in *H. olidus*

Local.	Akkeshi	Mombetsu	Abashiri	Oshoro	Ebetsu	Ishikari	Total
Date	Oct. 1934	Nov. 10, 1952	Sept. 21, 1950	May 8, 1952	June 1, 1939	May 22, 1949	
Percentage of maxillary to head	38		1				1
	39	1	2				3
	40	1	10	1	1	1	15
	41		14			2	16
	42		5			1	6
	43	2	3		1	1	7
	44		13		1		14
	45	1				1	2
	46	1					1
	47		2				2

Table 4. Variation in percentage relationship of maxillary to head in *H. japonicus*

Local.	Kiri-tappu	Akkeshi	Akkeshi	Mom-betsu	Abashiri	Muroran	Muroran	Oshoro	Oshoro	Oshoro	Total
Date	Dec. 9, 1952	Sept.-Oct. 1934	Apr. 24 1936	Nov. 10 1952	Sept. 21 1950	Oct. 15 1952	Nov. 16 1952	June 1 1949	Dec. 9 1952	May 6 1953	
Percentage of maxillary to head											
29	1										1
30											
31	2										2
32	4						1		1		6
33	7			1	10		2	1	7		28
34	1	1	1		3	1	2			1	10
35	2	1		2	22	8	7	4	6		52
36	3	3	2	1	1	1	4	1	6		22
37		2	2		11		3			1	19
38	1				1		1			1	4
39		1									1

Table 5. Variation in number of dorsal rays in *H. olidus*

Local.	Akkeshi	Mombetsu	Abashiri	Oshoro	Ebetsu	Ishikari	Total
Date	Sept.-Oct. 1934	Nov. 10, 1952	Sept. 21, 1950	May 8, 1953	Jun. 1, 1939	May 22, 1949	
Number of dorsal rays							
9	2		13				15
10	4	2	39	1	2	4	52
11					1	2	3

Table 6. Variation in number of dorsal rays in *H. japonicus*

Local.	Kiri-tappu	Akkeshi	Akkeshi	Mom-betsu	Abashiri	Muroran	Muroran	Oshoro	Oshoro	Oshoro	Total
Date	Dec. 9, 1952	Sept.-Oct. 1934	Apr. 24, 1936	Nov. 10, 1952	Sept. 21, 1950	Oct. 15, 1952	Nov. 16, 1952	Jun. 1, 1949	Dec. 9, 1952	May 6, 1953	
Number of dorsal rays											
10	4	3	4	1	33	1		1	1	3	51
11	16	5	1	4	14	4	7	3	13		67
12	1			5		5	12	2	5		30
13							1		(17) 1		(17) 1

Table 7. Variation in number of anal rays in *H. olidus*

Local.	Akkeshi	Mombetsu	Abashiri	Oshoro	Ebetsu	Ishikari	Total
Date	Sept.-Oct. 1934	Nov. 10, 1952	Sept. 21, 1950	May 8, 1953	Jun. 1, 1939	May 22, 1949	
Number of anal rays							
14			2				2
15	1		9				10
16	3	1	23				27
17	1	1	17	1		1	21
18	1		1		3	3	8
19						1	1
20						1	1

Table 8. Variation in number of anal rays in *H. japonicus*

Local.	Kiri-tappu	Akkeshi	Akkeshi	Mom-betsu	Abashiri	Muroran	Muroran	Oshoro	Oshoro	Oshoro	Total
Date	Dec. 9, 1952	Sept.-Oct. 1934	Apr. 24, 1936	Nov. 10, 1952	Sept. 21, 1950	Oct. 15, 1952	Nov. 16, 1952	Jun. 1, 1946	Dec. 9, 1952	May 6, 1953	
Number of anal rays	13	1		1		1					3
	14	8				6		1	1		16
	15	10	2	1		26	3	6	9	1	58
	16	1	4	1	2	10	5	10	4	7	46
	17	1	2	2	2	4	2	1	1	3	17
	18						2	1			3

Table 9. Variation in number of pectoral rays in *H. olidus*

Local.	Akkeshi	Mombetsu	Abashiri	Oshoro	Ebetsu	Ishikari	Total
Date	Sept.-Oct. 1934	Nov. 10, 1952	Sept. 21, 1950	May 8, 1953	Jun. 1, 1939	May 22, 1949	
Number of pectoral rays	12	4		11	1	2	18
	13	2	2	41		3	50
	14					2	2

Table 10. Variation in number of pectoral rays in *H. japonicus*

Local.	Kiri-tappu	Akkeshi	Akkeshi	Mom-betsu	Abashiri	Muroran	Muroran	Oshoro	Oshoro	Oshoro	Total
Date	Dec. 9, 1952	Sept.-Oct. 1934	Apr. 24, 1936	Nov. 10, 1952	Sept. 21, 1950	Oct. 15, 1952	Nov. 16, 1952	Jun. 1, 1949	Dec. 9, 1952	May 6, 1953	
Number of pectoral rays	12				1						1
	13	13	1		1	18	4	7	2	5	51
	14	7	6	5	2	28	6	11	4	15	87
	15	1	1	1	1		2				6

Table 11. Variation in number of scales of *H. olidus* in the course of lateral line

Local.	Akkeshi	Mombetsu	Abashiri	Oshoro	Ebetsu	Ishikari	Total
Date	sept.-Oct. 1934	Nov. 10, 1952	Sept. 21, 1950	May 8, 1953	Jun. 1, 1939	May 22, 1949	
Number of scales	54			2			2
	55	1		9			10
	56		1	14			15
	57	2		13		2	20
	58	3		11	1	1	18
	59		1	3			4
	60					1	1

Table 12. Variation in number of scales of *H. japonicus* in the course of lateral line

Local.	Kiri-tappu	Akkeshi	Akkeshi	Mom-betsu	Abashiri	Muroran	Muroran	Oshoro	Oshoro	Oshoro	Total
Date	Dec. 9, 1952	Sept.-Oct. 1934	Apr. 24, 1936	Nov. 10, 1952	Sept. 21, 1950	Oct. 15, 1952	Nov. 16, 1952	Jan 1, 1949	Dec. 9, 1952	May 6, 1953	
Number of scales	61		1								1
	62		1		1						2
	63	7	1	1	5	1	2		1		18
	64	10	2	1	2	7	3		4		31
	65	3		2		10	1	7	3	5	33
	66	1	2	1	1	12	2	3		4	26
	67		2			11	3	5	3	4	28
	68							1		2	4
	69					1				1	1

Table 13. Variation in number of vertebrae in *H. olidus*

Local.	Akkeshi	Mombetsu	Akkeshi	Oshoro	Ebetsu	Ishikari	Total
Date	Sept.-Oct. 1934	Nov. 10, 1952	Sept. 21, 1950	May 8, 1953	June 1, 1939	May 22, 1949	
Number of vertebrae	52				1		1
	53						
	54						
	55	1		10			11
	56	5	1	23	1	1	31
	57		1	15		4	22
	58			4		1	5

Table 14. Variation in number of vertebrae in *H. japonicus*

Local.	Kiri-tappu	Akkeshi	Akkeshi	Mom-betsu	Abashiri	Muro-ran	Muro-ran	Muro-ran	Oshoro	Oshoro	Oshoro	Total
Date	Dec. 9, 1952	Sept.-Oct. 1934	Apr. 24, 1936	Nov. 10, 1952	Sept. 21, 1950	Aug. 2, 1952	Oct. 15, 1952	Nov. 16, 1952	June 1, 1949	Dec. 9, 1952	May 6, 1953	
Number of vertebrae	59		1				1					2
	60				2						1	3
	61					1						1
	62	1	3	1	14			1		4		24
	63	9	3	2	2	12	2	5	3	8	1	49
	64	8	1	1	2	11	5	4	11	1	8	52
	65	3	1			6		3	3	2		19
	66					2						2

Table 15. Variation in number of pyloric caeca in *H. olidus*

Local.		Akkeshi	Mombetsu	Oshoro	Ebetsu	Ishikari	Total
Date		Sept.-Oct. 1934	Nov. 10, 1952	May 8, 1953	June 1, 1939	May 22, 1949	
Number of pyloric caeca	4	4				2	6
	5	1	2		3	1	7
	6	1		1		1	3
	7					2	2

Table 16. Variation in number of pyloric caeca in *H. japonicus*

Local.		Akkeshi	Akkeshi	Mombetsu	Muroran	Oshoro	Oshoro	Total
Date		Sept.-Oct. 1934	Apr. 24, 1936	Nov. 10, 1952	Nov. 16, 1952	Dec. 9, 1952	May 6, 1953	
Number of pyloric caeca	4			3				3
	5	7	4		8	9	1	29
	6	1	1	1	12	10	2	27
	7					1		1

Table 17. Variation in percentage of length of pectoral fins to distance between pectoral and pelvic insertions in *H. olidus*

Local.		Akkeshi	Mombetsu	Oshoro	Ebetsu	Ishikari	Total
Date		Sept.-Oct. 1934	Nov. 10, 1952	May 8, 1953	June 1, 1939	May 22, 1949	
Percentage of length of pectoral fins to distance between pectoral and ventral insertions	52					1	1
	53						
	54					1	1
	55						
	56		1				1
	57						
	58						
	59	1				1	2
	60				1	1	2
	61	1					1
	62						
	63			1	1		2
	64	1	1				2
	65						
	66	1					1
	67	1			1		2
	68	1					1

Table 18. Variation in percentage of length of pectoral fins to distance between pectoral and pelvic insertions in *H. japonicus*

Local.	Kiri-tappu	Akkeshi	Akkeshi	Mom-betsu	Muroran	Muroran	Oshoro	Oshoro	Oshoro	Total
Date	Dec. 9, 1952	Sept.-Oct. 1934	Apr. 24, 1936	Nov. 10, 1952	Oct. 15, 1952	Nov. 15, 1952	June 1, 1949	Dec. 9, 1952	May 6, 1953	
Percentage of length of pectoral fins to distance between pectoral and ventral insertions	43	1								1
	44								1	1
	45	1					1			2
	46	2			1			1		4
	47	2		1			3			6
	48	4				3	1	3		11
	49								1	1
	50	1		2	1	2	3	1	6	16
	51	1				1		3		5
	52				1	4	6			11
	53	3	3		1	1		3		11
	54	2		2		2		2	1	9
	55	2	2			2		2		8
	56	1	1		1	2				6
	57	1				1				2
	58					1				1
	59		1							1
	60		1							1