

Variation in the Teeth of the Sand Shark, *Odontaspis taurus* (Rafinesque) Taken from the East China Sea

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Abstract The teeth of the sand shark, *Odontaspis taurus* (Rafinesque) taken from the East China Sea show wide range of variation. The presence or absence of lateral denticles and the proportion of the tooth length in hundredths of total length change with growth and differ from specimen to specimen. The number of anterior and intermediate teeth in the upper jaw varies greatly among the specimens. Since variation in the teeth is marked within a single species of *Odontaspis*, these tooth characters are not reliable in distinguishing some species of the genus.

Bigelow and Schroeder (1948) made an attempt to separate six species of *Odontaspis* (Odontaspidae, Lamniformes), i. e., *O. taurus* (Rafinesque), *O. ferox* (Risso), *O. tricuspidatus* (Day), *O. arenarius* (Ogilby), *O. owstoni* (Garman), and *O. platensis* Lahille, although

O. kamoharai (Matsubara, 1936) was omitted from their key. After their work, *O. herbsti* Whitley, 1950, *O. noronhai* (Maul, 1955), *O. yangi* (Teng, 1959), *O. madagascariensis* Fourmanoir, 1961, and *O. pelagicus* (Cadenat, 1963) have been added to the members of

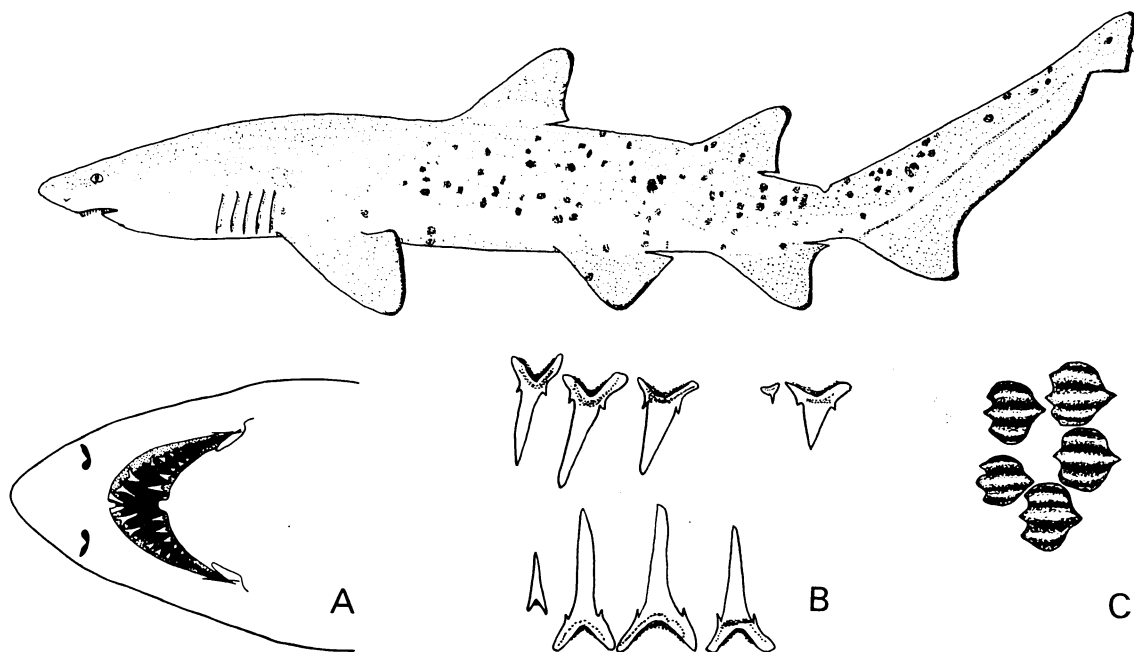


Fig. 1. *Odontaspis taurus*, young female, 1293 mm in total length, taken from the East China Sea (SCUM 509). A. ventral view of head of same. B. teeth on left side of both jaws of same, about 1.5 \times . C. dermal denticles below origin of first dorsal of same, about 30 \times .

the genus. In almost every case, the teeth have been considered to be one of the most important characters in discriminating the species of *Odontaspis*.

The odontaspid shark taken from the East China Sea was reported as *O. taurus* by Teng (1958) and Abe et al. (1968). Except for some of tooth characters that have been used, the specimens of the East China Sea studied here also agree with the description of *O. taurus* by Bigelow and Schroeder (1948: 100–106) in having the following characters: short and pointed snout with rounded tip; labial furrow at corners of mouth; origin of first dorsal fin nearer to uppercaudal origin than to tip of snout; second dorsal and anal fin nearly as large as first dorsal; upper caudal about 30 percent of total length; well-marked pit on the dorsal side of caudal peduncle but none on the ventral (Table 1 and Fig. 1). If tooth characters are employed, most specimens fall into *O. taurus* whereas others to *O. owstoni* or to other species of *Odontaspis*.

The present study intends to report great variation in the teeth of *O. taurus* collected from the East China Sea and to discuss what characters of the teeth are useful for the taxonomy of *Odontaspis*.

Material and methods

Eight whole specimens and 16 jaws of *O. taurus* ranging from 95 cm to ca. 300 cm in total length, preserved in the Shark Collection of the University Museum, University of Tokyo (SCUM) and Faculty of Fisheries, Nagasaki University (FFNU) were studied: SCUM509, 29°N., 125°E., Dec. 12, 1967; SCUM516 and 517, 29°50'N., 126°40'E, Mar. 6, 1968; SCUM518 and 519, 27°30'N., 122°50'E., Mar. 6, 1968; SCUM520 and 521, 28°00'N., 122°50'E., Mar. 10, 1968; FFNU (1116 mm in total length), East China Sea, Oct. 29, 1966; SCUM617 (jaw), East China Sea ?, Oct. 17, 1966; SCUM618 (jaw), East China Sea, July. 7, 1967; SCUM619 (jaw), East China Sea, Oct. 17, 1967; SCUM620

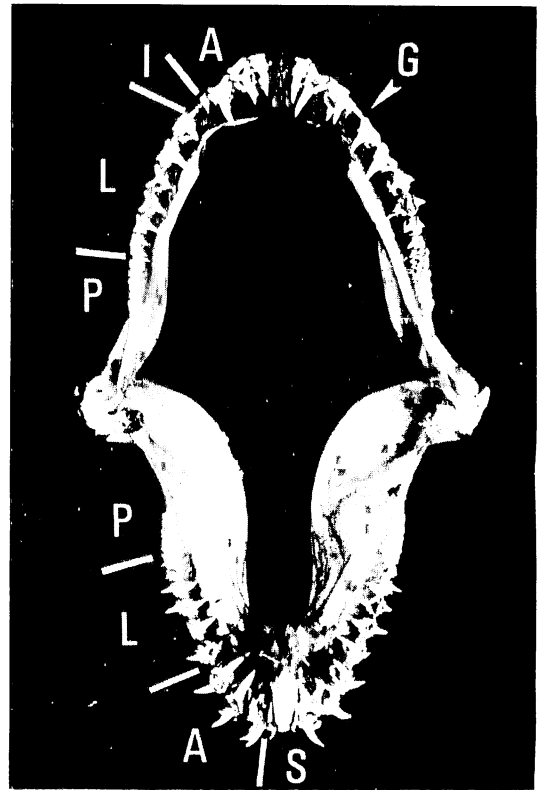


Fig. 2. A jaw of *O. taurus*, female, 218 cm in total length (SCUM 621), showing tooth names. A = anteriors, I = intermediate, L = laterals, P = posteriors, S = symphyseal. G shows a gap.

(jaw), East China Sea, Nov. 20, 1967; SCUM-621, 622, and 623 (jaws), East China Sea, Dec. 25, 1967; SCUM641 and 642 (jaws), 28°20'N., 122°30'E., Mar. 8, 1968; SCUM643 (jaw), 26°53'N., 121°26'E., May 20, 1968; other specimens of FFNU, East China Sea, Dec, 1967. Two specimens were discarded after their dental formulae were counted.

Tooth terminology used here is represented in Fig. 2, and is identical with that of Applegate (1965). Body length is defined here as the distance from tip of snout to upper caudal origin when total length is not measured.

Results

Dental formulae for each tooth type are shown in Table 2, with the tooth length of the second anterior of the lower jaw and the

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Table 1. Proportional dimensions in percent of total length of *Odontaspis taurus* taken from the East China Sea. Measurements followed Springer (1964).

Cat. No.	SCUM 518	SCUM 519	FFNU —	SCUM 516	SCUM 521	SCUM 520	SCUM 509	SCUM 517
Sex	♂	♀	♀	♀	♂	♂	♀	♂
Total length (mm)	950*	958*	1116	1151*	1211*	1242*	1293*	1311*
Snout tip to:								
outer nostrils	2.8	2.3	3.1	2.5	3.1	2.5	2.6	2.7
eye	5.8	5.1	6.0	4.8	5.9	5.1	4.5	5.1
spiracle	10.5	9.0	11.3	11.3	11.0	9.9	11.9	10.0
mouth (upper lip)	3.6	4.0	3.8	4.1	3.7	3.7	4.2	3.4
1st gill opening	18.3	17.1	19.1	18.6	19.8	17.7	17.3	17.4
5th gill opening	21.7	20.8	22.9	20.2	23.0	21.9	21.0	21.7
pectoral origin	22.3	21.7	23.4	23.6	23.5	22.3	22.0	21.9
pelvic origin	46.7	48.1	47.4	48.1	49.0	48.2	46.4	46.5
1st dorsal origin	37.7	37.6	37.2	37.7	39.5	37.8	37.5	37.8
2nd dorsal origin	55.2	56.5	54.8	56.6	57.5	57.4	55.5	57.4
anal fin origin	61.8	62.0	61.2	60.9	63.2	62.6	61.0	62.2
upper caudal origin	69.1	69.8	68.9	69.2	70.8	70.3	68.9	70.3
lower caudal origin	71.9	72.0	71.5	71.8	73.2	72.9	72.1	73.0
Nostrils:								
distance between inner corners	3.3	2.9	2.9	3.3	3.1	3.0	2.8	2.9
Mouth:								
width	10.3	9.7	—	9.0	9.9	9.7	8.1	8.8
length	4.3	3.8	—	4.5	4.2	4.1	3.9	4.2
Gill opening lengths:								
1st	5.5	5.0	4.7	5.7	5.0	4.8	4.3	4.6
3rd	6.4	6.3	5.4	6.7	6.3	6.4	5.2	5.7
5th	5.5	5.1	4.6	5.7	4.9	5.6	4.7	5.0
Eye:								
horizontal diameter	1.3	1.3	1.3	1.3	1.4	1.1	1.2	1.2
1st dorsal fin:								
length of base	8.4	7.7	7.6	7.4	8.0	8.9	7.2	8.7
length of post. margin	2.6	2.6	2.9	2.8	2.9	3.3	2.2	2.7
height	6.1	6.3	6.0	6.3	7.1	7.4	6.7	6.6
2nd dorsal fin:								
length of base	7.8	7.4	6.8	7.0	7.0	6.9	7.0	6.9
length of post. margin	2.3	2.4	2.2	2.4	2.5	2.7	2.2	2.4
height	5.9	5.7	5.8	6.7	6.5	7.1	6.2	6.4
Anal fin:								
length of base	7.4	7.0	7.2	6.9	7.1	7.0	7.4	7.0
length of post. margin	2.3	2.6	2.2	2.4	2.6	2.7	2.3	2.4
height	5.7	5.5	5.4	6.6	6.2	5.8	6.4	6.3
Pectoral fin:								
length of base	6.3	5.6	5.2	6.9	7.5	7.0	7.0	6.7
length of ant. margin	13.8	13.9	14.1	13.7	14.3	15.4	13.8	14.0
length of dist. margin	9.2	9.9	9.2	10.1	10.8	10.7	8.9	10.2
Pelvic fin:								
length of base	6.5	7.6	7.7	7.9	5.9	6.6	7.8	6.6
length of ant. margin	8.8	8.5	8.2	8.6	8.0	9.5	8.3	9.0
length of dist. margin	6.8	7.2	7.4	7.7	7.5	8.5	7.3	7.7
length of claspers	2.6				1.5	1.4		2.0
Caudal fin:								
length of upper lobe	32.8	32.2	31.4	33.0	32.8	32.8	31.3	31.7
length of lower lobe	11.3	10.3	10.6	9.8	9.7	10.9	10.8	10.0
depth of notch	4.5	4.0	3.5	3.6	4.1	4.5	4.1	4.1

* The specimen was measured in fresh state.

Table 2. Variation in the number of teeth in *O. taurus* for each tooth type. A = anterior, I = intermediate, L = lateral, P = posterior, S = symphyseal. *—specimens without denticles, **—specimens partly with a denticle, ***—specimens partly with two denticles. Specimens without asterisks always have a denticle on each side of the base.

Cat. No.	T.L. (cm)	B.L. (cm)	Sex	Dental formula												Total		Length of 2nd A. of lower jaw	in of T.L.
				Left upper jaw			Right upper jaw			Left lower jaw			Right lower jaw						
				A.	I.	L. & P.	A.	I.	L. & P.	S.	A.	L. & P.	S.	A.	L. & P.	upper	lower		
SCUM518	95	66	♂	3	1	15	3	1	15	1	3	14	1	3	14	38	36	8 mm	0.84
SCUM519	96*	67	♀	3	2	16	3	1	16	1	3	14	1	3	15	41	37	9	0.95
FFNU—	112**	77	♀	4	2	14	4	1	17	1	3	13	1	3	14	42	35	—	—
SCUM516	115**	80	♀	3	1	17	3	2	17	1	3	14	1	3	14	43	36	17	1.48
SCUM521	121**	86	♂	3	1	17	3	1	17	1	3	14	1	3	16	42	38	16	1.31
SCUM520	124**	87	♂	3	1	16	3	1	16	1	3	13	1	3	14	40	35	18	1.45
SCUM641	127**	—	♀	3	1	18	3	1	16	1	3	15	1	3	15	42	38	17	1.34
SCUM509	129**	89	♀	3	1	15	3	1	16	1	3	13	1	3	13	39	34	16	1.24
SCUM517	131**	92	♂	3	1	18	3	1	16	1	3	16	1	3	15	42	39	18	1.39
SCUM642	138	—	♂	3	1	17	3	3	15	1	3	13	1	3	13	42	34	18	1.30
FFNU—	180	148	♂	3	1	19	3	1	16	1	3	16	1	3	15	43	39	—	—
SCUM621	218***	157	♀	3	1	21	3	1	20	1	3	17	1	3	19	49	44	25	1.15
— —	226	163	♀	3	1	16	3	1	19	1	3	15	1	3	14	43	37	—	—
SCUM620	238	175	♂	3	2	17	3	1	17	1	3	14	1	3	13	43	35	37	1.55
— —	248	180	♂	3	1	16	3	1	17	1	3	16	1	3	15	41	39	—	—
SCUM622	261	187	♂	3	4	17	3	5	19	1	3	17	1	3	19	51	44	34	1.30
SCUM643	266	—	♂	3	1	17	3	1	16	1	3	14	1	3	14	41	36	34	1.28
SCUM623	—	192***	♀	3	2	18	3	2	16	1	3	16	1	3	16	44	40	37	—
FFNU—	—	192	♂	3	1	19	3	2	19	1	3	17	1	3	19	47	44	—	—
SCUM618	—	ca.200	♂	3	1	20	3	1	20	1	3	16	1	3	17	48	41	37	—
SCUM617	—	205	♂	3	1	14	3	1	18	1	3	16	1	3	15	40	39	39	—
SCUM619	ca.300	—	—	3	2	22	3	2	21	1	3	15	1	3	19	53	42	31	—
FFNU—	—	—	—	3	1	21	3	1	20	1	3	17	1	3	19	49	44	—	—
FFNU—	—	—	—	3	1	17	3	1	15	1	3	13	1	3	13	40	34	—	—

number of lateral denticles.

The number of lateral denticles in the shark is closely correlated with the size of the specimens. In small specimens less than 100 cm in total length, none of the teeth have a lateral denticle (Fig. 3A), whereas a small denticle usually exists on each side of the base of teeth in the specimens more than 110 cm in total length. In large specimens over 140 cm, all the teeth except posteriors always have denticles (Fig. 2). In some specimens, the first to fourth laterals possess two denticles on each side of the base (Fig. 3B), as observed by Bigelow and Schroeder (1948: 102).

Similarly, the length of the second anterior of the lower jaw (measured from tip of the

longest root) appears to be a growth-dependent character. In small specimens below 100 cm, the proportion of the tooth length in hundredths of total length is less than 1.0 %, whereas in specimens over 110 cm the value exceeds 1.1%. It is also variable from specimen to specimen.

Of 24 specimens examined, 15 have one intermediate followed by a broad gap on each side of the upper jaw (Fig. 2). Six have one intermediate on one side of the upper jaw and two on the other side (Fig. 4A). In this case, each last intermediate is followed by the first lateral without a broad gap, which is also found in two specimens (SCUM619 and 623) that have two intermediates on each side of the upper jaw (Fig. 4B). These

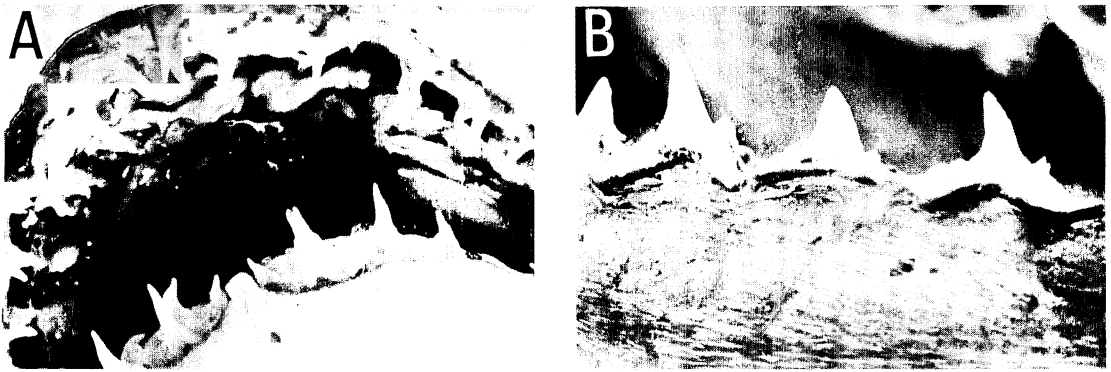


Fig. 3. Teeth of *O. taurus*. A. teeth without denticles. B. teeth with two denticles on each side of the base.

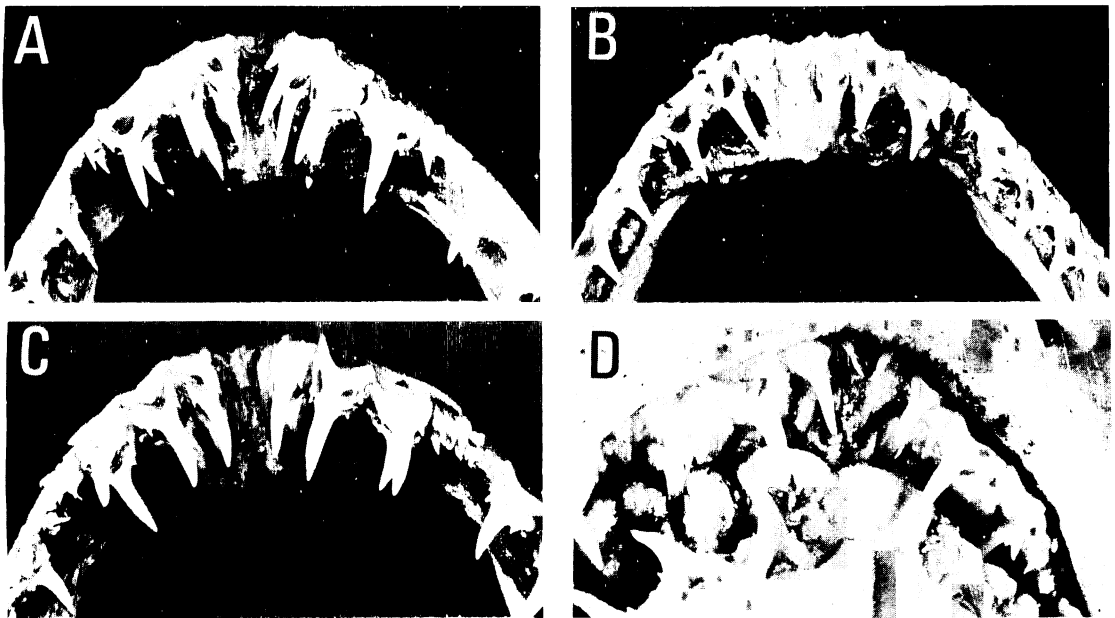


Fig. 4. Upper jaws of *O. taurus*, showing variation in the number of intermediates and anteriors. A. jaw with one intermediate on one side and two on the other. B. jaw with two intermediates on each side. C. jaw with four intermediates on left side and five on right side. D. jaw with four anteriors on each side.

facts seem to indicate that the presence or absence of a broad gap depends upon the occurrence of the second intermediate. However, it is not the case, because a large specimen (SCUM622) has four intermediates on left side and five on right side of the upper jaw with a gap between each last intermediate and the first lateral (Fig. 4C). One specimen (112 cm-T. L. Specimen of FFNU) has a peculiar tooth type that has not been reported yet. It has four anteriors on each side of

the upper jaw, and its first anterior is much smaller than others (Fig. 4D).

The total number of teeth varies from 38 to 53 in the upper jaw and 34 to 44 in the lower jaw. Variation in the total number of teeth is mainly due to numerical variability in laterals and posteriors, as reported in the Atlantic specimens of *O. taurus* by Applegate (1965). In every case, the total number of teeth in the upper jaw is higher than that in the lower jaw.

So far as examined, there is no variation in the number of symphyseal and anteriors on each side of the lower jaw. All the specimens have one symphyseal and three anteriors.

Discussion

The specimens studied here are divisible into eight groups on the basis of tooth characters (Table 3). According to the key by Bigelow and Schroeder (1948: 99), group A corresponds to *O. owstoni*, group D to *O. taurus*, and Group F to *O. platensis* and *O. arenarius*. Groups B, C, E, G, and H do not fall into any species in their key.

Cadenat (1956) reported that basal denticles were present in the teeth of the foetus of *O. taurus* (110 cm T.L.) but absent in the teeth of the primary rows in the uterus during the gestation. From the results of the present study and Cadenat's report, it is very probable that denticles occur with growth in *O. taurus*. Bigelow and Schroeder (1948: 102) also observed that there was numerical variation in the lateral denticle of *O. taurus* in the Western Atlantic. The tooth length does not appear to be an allometric character, especially of young specimens ranging from 95 cm to 130 cm. Although Applegate (1965) stated that in *O. taurus* tooth length was directly proportional to total length, his figure seems to indicate that increment of

the tooth length in young specimens is greater than that in large specimens and that there is individual variation in the ratio of tooth length to total length as seen in the present study. The number of intermediates varies from one to five and frequently shows numerical difference between the two sides of the upper jaw even in the same specimen. Such a numerical variation in the intermediate is also found in *O. arenarius*, because Ogilby (1911) stated that the species had one or two intermediates and Whitley (1937) reported that a specimen of *O. arenarius* had one intermediate on each side of the upper jaw. The number of anteriors is a fairly stable character, but one more anterior is found in a specimen in the present study. Variations in tooth characters due to the differences of growth stage, sex, locality, and individuals have been reported in many other groups of sharks, e. g., carcharhinids (Springer, 1964), sphyrnids (Gilbert, 1967), and alopiids (Kato et al., 1967). Therefore, it is better to consider that the differences in the tooth characters among the specimens are due to developmental and individual variation within a single species.

In consequence, presence or absence of lateral denticles, tooth length, and number of anteriors and intermediates in the upper jaw are not reliable specific characters but variable ones subject to growth or individual variation. On the other hand, the number of lateral denticles in adults may be

Table 3. Grouping of the specimens by the presence or absence of lateral denticles and the number of anteriors and intermediates. In case of one intermediate on one side of the upper jaw and two on the other side, No. of I. is expressed as 1 and 2. In this case, \pm in Gap indicates that a gap is present on the side with one intermediate but absent on the side with two intermediates.

Group	No. of specimens	Denticles	No. of A	No. of I.	Gap
A	1	—	3	1	+
B	1	—	3	1 and 2	\pm
C	1	+	4	1 and 2	\pm
D	14	+	3	1	+
E	3	+	3	1 and 2	\pm
F	2	+	3	2	—
G	1	+	3	1 and 3	\pm
H	1	+	3	4 and 5	+

useful in distinguishing *O. taurus* from *O. ferox*, *O. herbsti*, *O. kamoharai*, *O. yangi*, and *O. pelagicus*, because adult specimens of *O. taurus* usually have a denticle on each side of the base. The total number of teeth, the number of symphyseal and anteriors in the lower jaw also may be useful for the separation of *O. taurus* from *O. kamoharai*, *O. yangi*, and *O. pelagicus*.

In any way, there is great need for the revision of the genus *Odontaspis* by means of effective characters such as vertebral numbers.

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東支那海産シロワニの歯の形質における変異

谷内 透

東支那海で漁獲される シロワニ *Odontaspis taurus*

(Rafinesque) の歯の形質における変異は顕著である。側尖頭の有無と歯の大きさの全長に対する比は成長につれて変化するし、また、個体変異も大きい。各歯型ごとの歯数、とくにミズワニ属の分類で重要な前方歯数と中間歯数にはかなりの変異がみられる。このように、歯の形質における変異は同種内でも著しいので、上述の形質はミズワニ属においては種の特性になりえないことが解った。

(東京都文京区弥生 東京大学農学部水産学科)