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Taxonomical Consideration on Japanese Carangid Fishes
of the Genus *Decapterus* BLEEKER

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Although seven species of *Decapterus* are distributed in Japan and its adjacent waters, the classification of these species is not so clear since the intraspecific variations of diagnostic characters are very large. We, therefore, made careful observations with special reference to coloration, upper jaw, opercular membrane, *HL-L* ratio, *BD-L* ratio, *Lp-Ld* ratio, gill raker, dorsal and anal soft rays, scale and fleshy lateral keel for seven species of Japanese *Decapterus*, and gave a new key to them on the basis of these characters.

Keywords : morphology, taxonomy, *Decapterus*

The fish belonging to the genus *Decapterus* are clearly distinguishable from the other carangids by having a single detached finlet behind the dorsal and anal fins, and having scutes on the straight portion of the lateral line. Seven species of the genus are known to occur in Japan and its adjacent waters and for the most part are valuable as food.

The keys to the species of Japanese *Decapterus* were previously given by WAKIYA (1924), OSHIMA (1925), MATSUBARA (1955), SUZUKI (1962) and GUSHIKEN (1976). In these keys except GUSHIKEN's, some of the species are confused with others since they recognized only five or six species. Moreover, the key given by SUZUKI (1962) is not practical for the identification of the species because it is mainly based on skeletal characters. GUSHIKEN (1976), making a revision of the genus distributed in Japan proper and the Ryukyu Islands, recorded seven species and proposed the key to them. This is a valuable contribution to the classification of Japanese *Decapterus*, but there are some discrepancies between his descriptions and our specimens examined in the present study with respect to the relative length of pectoral fin of *D. maruadsi*, scutes of *D. russellii* and so on.

Besides, it is not easy to identify the species of *Decapterus* by using the keys previously provided, since the intraspecific variations of meristic characters are very large and the proportion of body changes with growth of the fish.

We, therefore, made detailed observations of some morphological characters for seven species of Japanese *Decapterus* in order to give a new key to them.

Materials and Methods

The specimens used in this study were taken from the Pacific coast of Shima Peninsula, Mie prefecture, by set net and hook and line from 1978 to 1980. Counts and measurements were made generally in accordance with the methods proposed by HUBBS and LAGLER (1958) except body depth and lateral line scale count. The former was measured at the origin of the second dorsal fin and the latter was counted only for scales which are present on the straight portion of the lateral line before the posterior end of the hypural plate. Scientific and Japanese names follow Ichthyological Society of Japan (1981).

Decapterus kurroides BLEEKER "Akaaji" : FRLM (Fisheries Research Laboratory, Mie University) 1863 (230.0mm in standard length), 2447 (209.2mm), 2782 (252.0mm), 2783 (236.5mm), 2784 (247.0mm), 2785 (248.0mm), 2786 (244.5mm), 2939 (245.0mm), 2940 (254.2mm).

D. maruadsi (TEMMINCK et SCHLEGEL) "Maruaji" : FRLM 1818 (272.0mm), 1834 (123.0 mm), 1836 (129.2mm), 1873 (266.0mm), 2037 (216.0mm), 2038 (278.0mm), 2039 (265.0 mm), 2514 (165.0mm), 2517 (142.0mm), 2518 (143.0mm), 2519 (173.0mm), 2521 (136.0 mm), 2522 (141.0mm), 2523 (135.0mm), 2573 (143.2mm), 2574 (135.7mm), 2575 (139.0 mm), 2580 (137.0mm), 2581 (132.5mm), 2582 (141.5mm).

D. kiliche (CUVIER) "Indomaruaji" : FRLM 2715 (126.6mm).

D. russellii (RÜPPELL) "Oakamuro" : FRLM 2810 (261.2mm), 2941 (264.5mm), 2942 (254.0mm).

D. muroadsi (TEMMINCK et SCHLEGEL) "Muroaji" : FRLM 1750 (321.0mm), 1751 (293.0mm), 1752 (330.0mm), 1753 (332.0mm), 1874 (266.0mm), 1875 (239.0mm), 1876 (239.2mm).

D. lajang BLEEKER "Mcro" : FRLM 1740 (236.0mm), 1741(244.5mm), 1742 (212.5mm), 1877 (242.0mm), 2042 (212.0mm), 2583 (208.0mm), 2584 (233.5mm), 2585 (203.5mm), 2586 (203.0mm), 2653 (208.0mm, 203.0mm, 170.3mm, 162.8mm, 147.5mm, 140.2mm, 139.8mm), 2813 (270.0mm), 2814 (252.0mm), 2815 (261.0mm), 2816 (273.0mm).

D. macrosoma BLEEKER "Kusayamoro" : FRLM 1646 (242.0mm), 1647 (239.0mm), 1648 (233.0mm), 1649 (239.0mm), 1650 (246.0mm), 1651 (229.5mm), 1743 (231.0mm), 1820 (249.0mm), 1821 (256.0mm), 1822 (233.2mm), 1823 (245.0mm), 2041 (321.0mm), 2180 (220.0mm), 2182 (207.0mm), 2183 (212.0mm), 2184 (226.0mm), 2185 (191.0mm), 2186 (198.5mm), 2889 (286.0mm), 2890 (246.5mm).

Results

Coloration Color in life is dark green above and silvery below for all species. In *D. kurroides* and *D. russellii* the tip of soft dorsal fin, dorsal finlet, caudal fin and pectoral fin are reddish. These two species, therefore, are clearly distinct from other species by the coloration of fins in life. In *D. maruadsi* and *D. muroadsi* the tip of

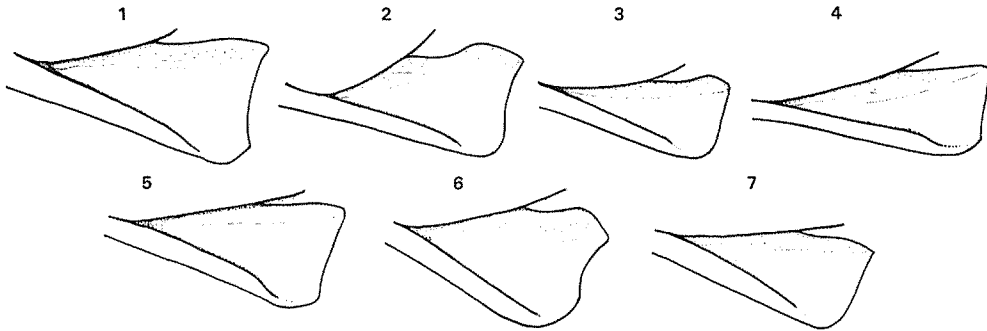


Fig. 1. Posterior part of upper jaws for seven species of Japanese *Decapterus*. 1, *D. kurroides*; 2, *D. maruadsi*; 3, *D. kiliche*; 4, *D. russellii*; 5, *D. muroadsi*; 6, *D. lajang*; 7, *D. macrosoma*.

second dorsal fin is white.

Scaled area on top of head Scaled area on top of head extends to a point between posterior margin and middle of eye in *D. kiliche* and *D. lajang*, whereas the area extends beyond the middle of eye and reaches to anterior margin of pupil or eye in others.

Upper jaw The posterior part of upper jaw of seven species are shown in Fig. 1. Posterior end of upper border of the jaw is rounded in *D. maruadsi*, *D. kiliche* and *D. lajang*. In other species the upper border of the jaw is almost flat. *D. lajang* makes an exception, since the lower corner of posterior margin of the jaw is produced backward and rounded. Although the shape of posterior part of upper jaw is characteristic, it is difficult to identify based on this character because the intraspecific variation of the shape is considerable.

Opercular membrane Posterior margin of opercular membrane is sharply serrated in adult of *D. russellii*. *D. macrosoma* resembles *D. russellii* in having serrate opercular membrane, but serration of the former is more indistinct than that of the latter. In other species the opercular membrane is smooth.

HL-L ratio The ratio of head length (HL) against standard length (L) generally decreases with growth of the fish (Fig. 2). Although *D. kurroides*, *D. kiliche* and *D. russellii* have slightly larger head than other species, it is hard to distinguish these three species from others clearly by the ratio of head length.

BD-L ratio The ratio of body depth (BD) against standard length generally increases with growth of the fish (Fig. 3). Seven species of Japanese *Decapterus* are divided into two groups by the ratio. One of them, having higher body, contains *D. kurroides*, *D. maruadsi* and *D. kiliche*. Another, having lower body, includes *D. muroadsi*, *D. russellii*, *D. lajang* and *D. macrosoma*. From Fig. 3, these two groups are able to be divided from each other by the following formula, $Rd=0.0002L+0.165$; Rd , $BD-L$ ratio. However, it may be impossible to discriminate between *D. maruadsi* and *D. muroadsi* by the ratio of body depth, since the ratios of these species are close to each other.

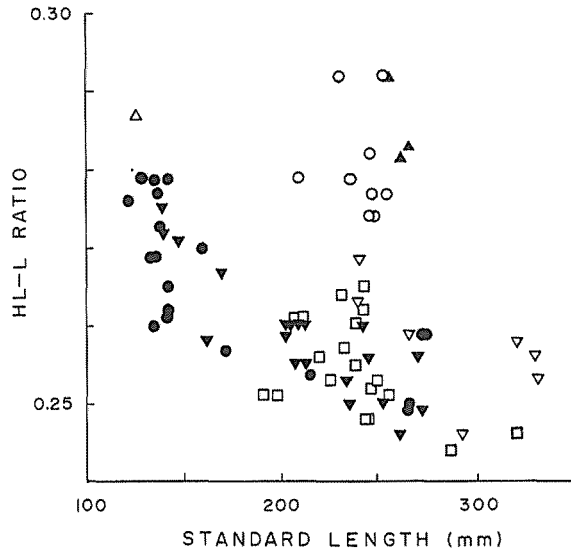


Fig. 2. Relations between *HL-L* ratio (head length/standard length) and standard length in seven species of Japanese *Decapterus*. \circ , *D. kurroides*; \bullet , *D. maruadsi*; \triangle , *D. kiliche*; \blacktriangle , *D. russellii*; ∇ , *D. muroadsi*; \blacktriangledown , *D. lajang*; \square , *D. macrosoma*.

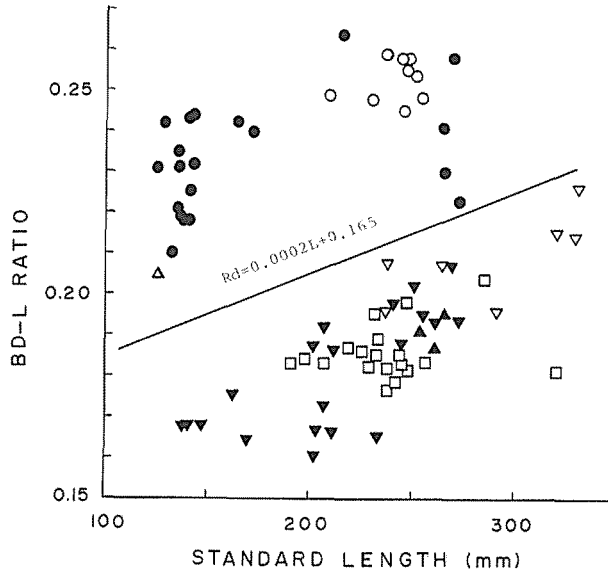


Fig. 3. Relations between *BD-L* ratio (body depth/standard length) and standard length in seven species of Japanese *Decapterus*. Marks in the figure are the same as Fig. 2.

***Ld-Ld* ratio** The ratio of distance from snout to posterior tip of pectoral fin (*Lp*) against the same from snout to origin of second dorsal fin (*Ld*) decreases with

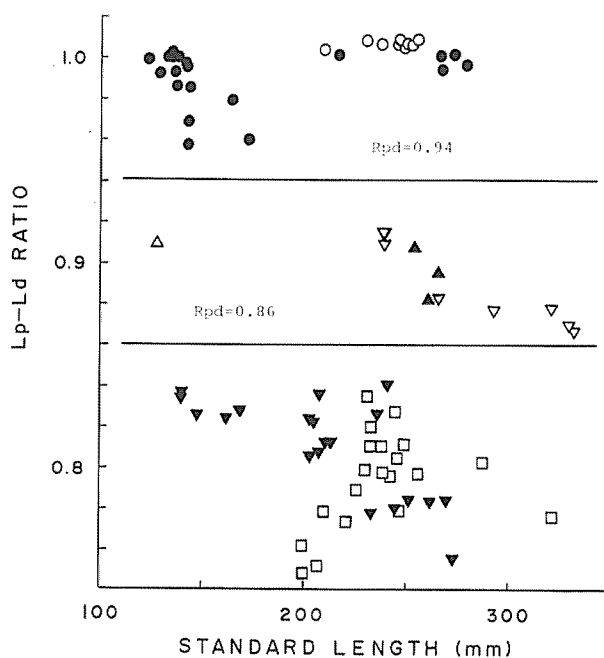


Fig. 4. Relations between $Lp-Ld$ ratio (distance from snout to posterior tip of pectoral fin/distance from snout to origin of second dorsal fin) and standard length in seven species of Japanese *Decapterus*. Marks in the figure are the same as Fig. 2.

growth of the fish in *D. muroadsi* and *D. lajang* (Fig. 4), whereas it does not change with growth in *D. kurroides*, *D. maruadsi* and *D. macrosoma*. Seven species of Japanese *Decapterus* are divided into three groups by this ratio. The first group which shows more than 0.94 in the ratio includes *D. kurroides* and *D. maruadsi*, having long pectoral fin. The second one, showing the ratio between 0.86 and 0.94, is represented by *D. kiliche*, *D. russellii* and *D. muroadsi*. The last one which shows less than in the ratio comprises *D. lajang* and *D. macrosoma*, having short pectoral fin. In *D. kurroides* and some specimens of *D. maruadsi* the pectoral fin extends distally beyond origin of the second dorsal fin, whereas in other species and the greater part of *D. maruadsi* it terminates before origin of the second dorsal fin.

Gill raker The number of gill rakers on the lower limb was shown in Table 1. Japanese *Decapterus* are clearly divided into two groups by the number of gill rakers. One of them having less than 33 gill rakers includes *D. kurroides*, *D. kiliche* and *D. russellii*. Another group having more than 34 gill rakers contains *D. maruadsi*, *D. muroadsi*, *D. lajang* and *D. macrosoma*.

Dorsal and anal soft rays The numbers of dorsal and anal soft rays were shown in Tables 2 and 3. Though the numbers of *D. kurroides* are slightly fewer than those of other species, it may be difficult to identify the species by the numbers of dorsal

Table 1. Frequency distribution of number of gill rakers on the lower limb in seven species of Japanese *Decapterus*.

No. of gill rakers	29	30	31	32	33	34	35	36	37	38	39	40	41
<i>D. kurroides</i>	2	4	3										
<i>D. maruadsi</i>							9	7	3	1			
<i>D. kiliche</i>				1									
<i>D. russellii</i>		3											
<i>D. muroadsi</i>									3	3	1		
<i>D. lajang</i>						2	7	6	4	1			
<i>D. macrosoma</i>								2	2	10	3	2	1

Table 2. Frequency distribution of number of dorsal soft rays in seven species of Japanese *Decapterus*.

No. of dorsal soft rays	27	28	29	30	31	32	33	34	35	36	37
<i>D. kurroides</i>	1	3	4	1							
<i>D. maruadsi</i>				2	6	6	5	1			
<i>D. kiliche</i>			1								
<i>D. russellii</i>			1	1	1						
<i>D. muroadsi</i>			1	1	3	1	1				
<i>D. lajang</i>							2	11	4	2	1
<i>D. macrosoma</i>						4	6	6	3	1	

Table 3. Frequency distribution of number of anal soft rays in seven species of Japanese *Decapterus*.

No. of anal soft rays	22	23	24	25	26	27	28	29	30
<i>D. kurroides</i>	4	2	3						
<i>D. maruadsi</i>				1	2	5	8	2	2
<i>D. kiliche</i>					1				
<i>D. russellii</i>		1	2						
<i>D. muroadsi</i>				1	1	3	2		
<i>D. lajang</i>						4	7	7	2
<i>D. macrosoma</i>						3	5	9	3

and anal soft rays because their intraspecific variations are very large and their ranges overlap each other.

Scales on the straight portion of lateral line There are the following types of scale on the straight portion of lateral line before the posterior end of hypural plate: 1, cycloid scale (Fig. 5-1), thin without any spine on the posterior margin, located on the anterior part of the straight portion of lateral line; 2, pseudo-scute (Fig. 5-2), showing intermediate form between cycloid scale and scute, *i. e.*, thin but with feeble spine, or thick and hard but without spine; 3, scute (Fig. 5-3), thick and hard with a

very stout spine, located on the posterior part of the straight portion of lateral line. Some species of *Decapterus*, ex. *D. kurroides*, *D. maruadsi* and *D. kiliche*, have scutes which are present on almost entire length of the straight portion of lateral line.

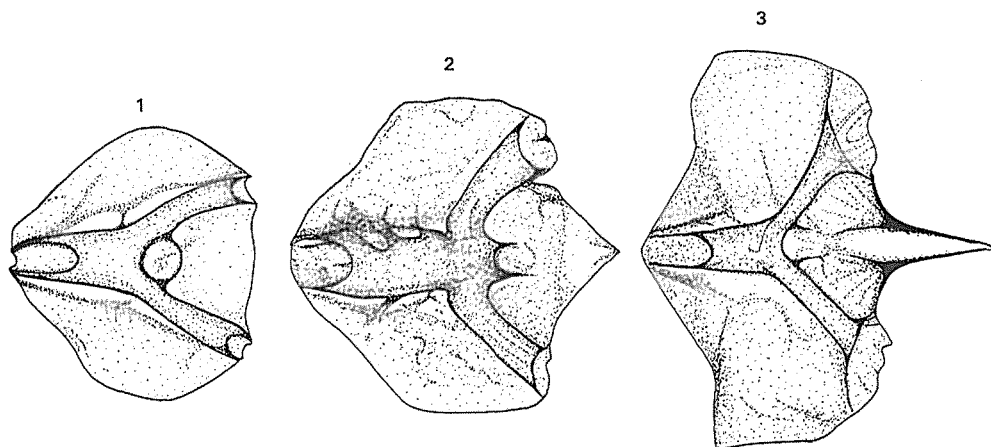


Fig. 5. Three types of lateral line scale. 1, cycloid scale; 2, pseudo-scute; 3, scute.

Table 4. Frequency distribution of number of scutes in seven species of Japanese *Decapterus*.

No. of scutes	25	26	27	28	29	30	31	32	33	34	35	36	37	38
<i>D. kurroides</i>								4	2	2	1			
<i>D. maruadsi</i>						1	1	4	6	1	3	2	2	
<i>D. kiliche</i>											1			
<i>D. russellii</i>							1		1	1				
<i>D. muroadsi</i>									1	2	2		1	1
<i>D. lajang</i>			1	1	1	3	2	2	3	2	3	2		
<i>D. macrosoma</i>	2		2	3	4	4	3	1			1			

Table 5. Frequency distribution of total number of cycloid scales and pseudo-scutes in seven species of Japanese *Decapterus*.

Total no. of cycloid scales and pseudo-scutes	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
<i>D. kurroides</i>	9																		
<i>D. maruadsi</i>	5	9	3		1	2													
<i>D. kiliche</i>	1																		
<i>D. russellii</i>										2	1								
<i>D. muroadsi</i>												1	1	1		2			1
Total no. of cycloid scales and pseudo-scutes	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
<i>D. muroadsi</i>	1																		
<i>D. lajang</i>	1	2	3	1	1	2	2	4	1	2	1								
<i>D. macrosoma</i>							1	1	2	3	1	4		2	3	1	1	1	

The number of scutes and the total number of cycloid and pseudo-scutes were shown in Tables 4 and 5. The numbers of scutes of *D. lajang* and *D. macrosoma* are slightly fewer than those of other species. However, it is impossible to classify the species by the number of scutes because differences of the number among seven species are very trifle. The total numbers of cycloid scales and pseudo-scutes of *D. kurroides*, *D. maruadsi* and *D. kiliche* are fewer than those of other species, in which the total number increases according to the order of *D. russellii*, *D. muroadsi*, *D. lajang* and *D. macrosoma*.

Fleshy keels on caudal base *D. macrosoma* more than 250 mm in standard length is peculiar in the possession of two fleshy keels on each side at the base of caudal fin. The keels, however, are indistinct or completely absent in the fish less than 250 mm.

Conclusion

As stated above, on account of the close resemblance of the specific character among seven species of Japanese *Decapterus*, it may be impossible to identify the species based on one character except the adult of *D. macrosoma* having two fleshy keels on each side at the base of caudal fin. Therefore, we could not help identifying the species by using the combination of some characters.

Key to seven species of Japanese *Decapterus*

- a¹ Scaled area on top of head not extending to the middle of eye.
 - b¹ Scutes present on almost entire length of the straight portion of lateral line *D. kiliche*.
 - b² Scutes present on less than entire length of the straight portion of lateral line *D. lajang*.
- a² Scaled area on top of head extending beyond the middle of eye.
 - c¹ $N_s > 22$ (N_s , total number of cycloid scales and pseudo-scutes on the straight portion of lateral line). A pair of fleshy lateral keels present on caudal base in adult *D. macrosoma*.
 - c² $N_s < 22$.
 - d¹ $N_g < 33$ (N_g , number of gill rakers on lower limb). Pectoral and caudal fins red in life.
 - e¹ $Rpd > 0.94$ ($Rpd = Lp/Ld$; Ld , distance from snout to origin of second dorsal fin; Lp , distance from snout to posterior tip of pectoral fin). Posterior margin of opercular membrane smooth *D. kurroides*.
 - e² $Rpd < 0.94$. Posterior margin of opercular membrane sharply serrate in adult *D. russellii*.
 - d² $N_g > 34$.
 - f¹ $Rpd > 0.94$. $N_s < 8$ *D. maruadsi*.
 - f² $Rpd < 0.94$. $N_s > 8$ *D. muroadsi*.

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