Studies on the Rays and Skates Belonging to the Family *Rajidae*, Found in Japan and Adjacent Regions. 6. *Raja macrocauda*, a New Skate※

By

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In 1936 Matsubara referred an immature specimen from off Kochi to *Raja oxyrinchus* Linnē. This identification has been accepted by contemporary Japanese ichthyologists without any criticism. Yet subsequent accumulation of samples which have been considered conformable to Matsubara's determination has led to elucidation of several characters which are either lacking or obscure in the aforementioned material. Things turned up in such a way as to throw doubt on identity of the Japaneses specimen with Linnē's material so far as the species category goes.

Suspicion may be said plausible considering remoteness of the two localities and poorness of skates as swimmers.

A considerable number of specimens ranging younger to older and referable to Matsubara's were obtained by motor trawlers from off Miyazaki, Kochi, Aichi, Shizuoka and Chiba Prefectures, about 180—200 fathoms in depth. They were closely examined with the same method as employed by the present author in 1952, and induced him to erect a new species, *Raja macrocauda*.

It is a pleasure to record here a debt of gratitude to Dr. K. Matsubara, Professor of Kyoto Univ. for his kindness in putting his valuable specimens and important literatures at the author's disposal, and also in readig the manuscript. Further, he wishes to express his hearty thanks to Mr. I. Furukawa of the Fishery Research Laboratory of Southern Region, and also to Mr. T. Kurakake of the Fisheries Experimental Station, Aichi Prefecture, who kindly sent him many useful specimens.

Raja macrocauda, sp. nov.

Fig. 1, A.

Japanese name : Kitune-Kasube, after Matsubara (1936)

Raja oxyrinchus Linne……Matsubara, 1936, p. 30, fig. 22 (Kochi); 1938, p. 25……Kamohara, 1938, p. 10 (Kochi);……Kuroda, 1952, p. 7 (Suruga Bay).

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Holotype : 997mm, ♂, Miya fish market, Mar. 19, 1952.

Paratypes : 23 specimens (226—1250mm), offings of Miyazaki, Kochi, Owase and Chosi.

External : Disc broad, width 1.46, length 1.69, tail 2.26 into total length; head 1.74, snout 3.19, precaudal 1.95 and procaudal 2.46 into disc length; interorbital space flat, the width 4.30, diameter of eye 5.55, 1st dorsal 2.89, the 2nd 3.30, caudal 7.12 and ventral incision 3.19 into snout.

Width of disc is much greater than lengths of disc and tail. Snout broad, projecting with a hard rostral axis, strongly undulating in the anterior oblique margins. Interorbital space slightly concave, 1.27 times as long as the diameter of rather large eye, which is 1.54 times the length of spiracle. Stumpy tail slightly thickened in its middle part, giving a peculiar feature to the tail. Two dorsals rather large, terminated together, followed by a small flap of reduced caudal fin. Ventral fin moderately notched between rather broad anterior and elongated posterior lobes. Clasper rather large and stout, extending half way to tip of caudal. Membranous folds along sides of the tail cleary developed, arising near the portion of emergence from inner sides of the posterior lobes of ventral fins, and gradually broadened backward.

Body almost entirely smooth on both sides of disc with exceptions of the following portions armoured with spines or spinules, which are supposed to be generalized character in the spination among the species referred to the present genus. Two large nuchal spines, and an irregular row of rather obvious 12 spines developed above and in front of eye; 3 rows of erectile hooks as buckler spines, arranged irregularly near the exterior angles of pectorals; a patch of minute prickles scattered on both surfaces of the top of snout, and fringing anterior oblique marginal portion, distending rearward from the middle part of snout to the lateral angle of disc; the prickles also sparsely covering posterior oblique portion of the disc. A row of caudal spines arising in opposition to the cloaca, running rearward, intermitted by lst dorsal; two dorsals coated with many prickles (Fig. 1, A).

Internal : Rostral cartilage very long and stout, bearing obvious rostral appendices on lateral sides of the anterior portion, accompanied by deep notches anteriorly between the axial bar and the wings, but there is neither the notch nor the crest posteriorly between them, fused throughout their edges. The length of rostral cartilage amounts to about 1.8 and 1.5 times the length and width of the cranium, respectively. The length of rostral appendices is slightly shorter than one-third the length of rostral cartilage, or somewhat longer than half the width of cranium. Nasal capsule slightly domed forward. Anterior fontanella large, elongated like a leaf in shape, making excavated anterior portion pointed; posterior one also

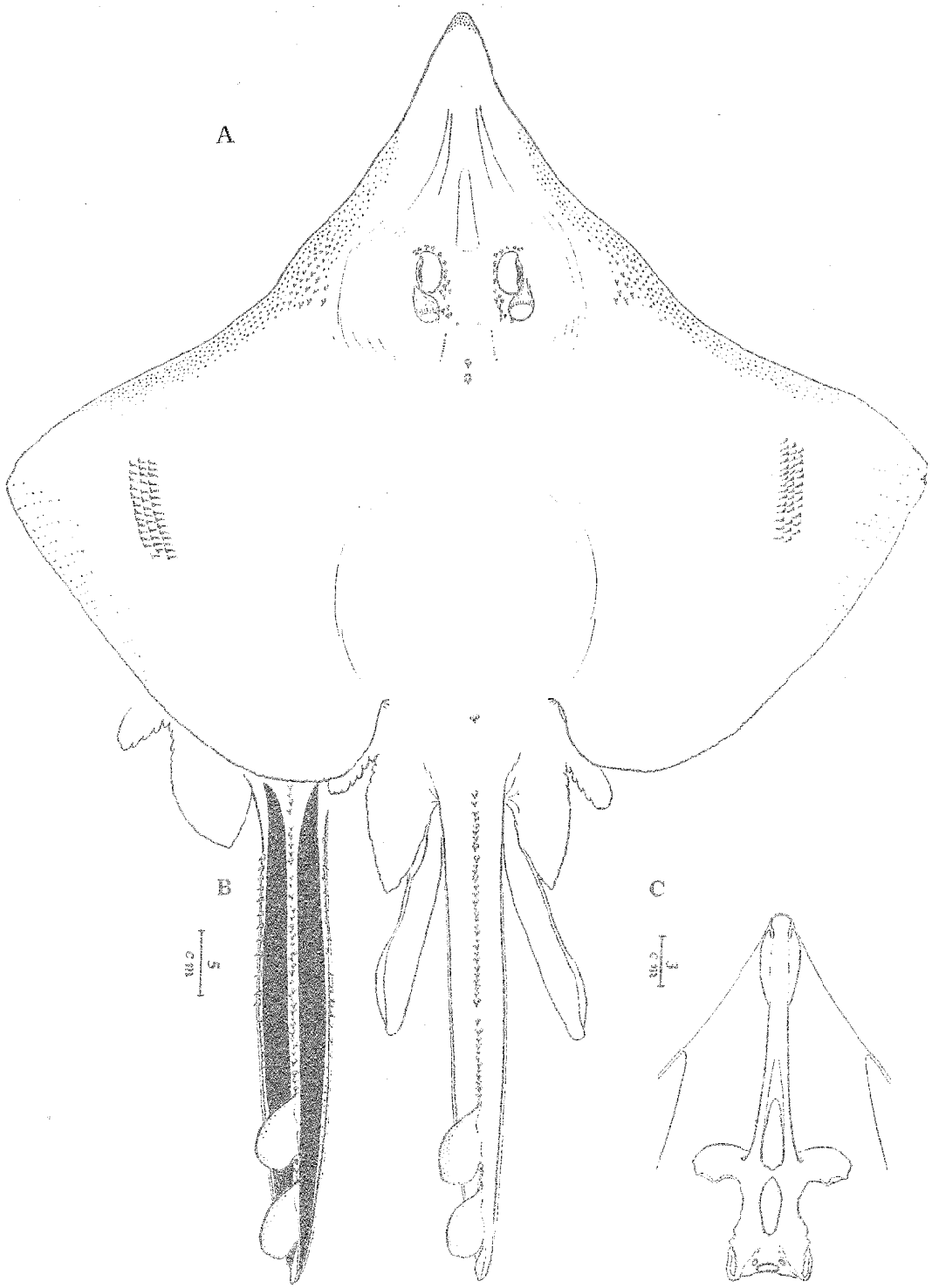

Fig. 1. *Raja macrocauda*, sp. nov. A, holotype; B, tail of adult female, especcially showing arrangement of the spines and the electric organ in dorsal aspect, respectively; C, cranium and rostral cartilage.

large, divided by a cartilage bridge from the anterior one, elipsoid or slightly constricted in the middle part. Foramen for superficial opthalmicus nerve very small and roundish in shape (Fig. 1, C).

The electric organ enormously large, spindle shape in dorsal aspect, or cylindrical in its main portion, but is gradually tapering toward both ends, extending along both sides of the tail from near the root to the near end of the tail (Fig. 1, B). The organ is considered to add the tail a noticeable feature, and to serve as a powerful armature of the tail as will be discussed in the forthcoming paper (ISHIYAMA, 1955), in which a conception for the natural function of the organ may be given.

Vertebral counts : 26 to 29+55 to 60

Turns of intestinal valves : 11

Coloration prior to formalin preservation lead-grey in both sides of the body coated with thicker mucous slime.

Supplementary diagnosis of paratypes : Morphometries within two sexes of paratypes, coupled with those in the holotype, are shown in Table 1.

Table 1. Proportional measarments in both holotype and paratypes of *Raja macrocauda*, sp. nov. Number in parenthesis denotes number of specimens examined.

Measurement	Holotype Adult male	Paratypes	
		male (12)	famale (11)
Total length, mm	997	235—1000	226—1250
Into total length : disc, width	1.46	1.31—1.67	1.41—1.95
〃, length	1.69	1.63—1.97	1.55—2.01
cloaca to tip of tail	2.26	1.87—2.30	1.83—2.69
Into disc length : snout, length	3.19	2.78—3.25	2.69—3.18
head, length	1.74	1.65—1.86	1.66—1.76
precaudal, length	1.95	1.54—2.09	1.48—2.56
procaudal, length	4.28	2.55—4.96	2.55—5.15
Into snout length : interorbital space	4.30	4.00—5.00	4.33—5.47
orbit, length	5.55	3.45—5.96	3.72—6.25
1st dorsal fin, basal length	2.89	2.53—3.91	2.44—6.89
2nd dorsal fin, basal length	3.30	2.67—3.88	2.78—4.37
caudal fin, length	7.12	2.21—7.50	2.78—4.37
ventral incision, length	3.19	2.35—4.22	2.16—4.57

Proportional ratios of those dimensions of both length and width of disc against total and head lengths were found to cover rather short ranges in regard to variations with growth of the body. But, other characters display either considerable variations or sexual dimorphisms which may or may not be taken as biometric constants. Relative growth in respective bodily parts, such as, length and width of disc against total length, and lengths of head and snout against disc length, showed

more or less decrease to some extent. But other parts as tabulated above were distinguished as the increase or decrease in their ratios. Thus, such changes in proportinal measurments between various bodily parts in accordance with growth of the body were found very complex. These matters will be dealt with from consistent examinations in a forth coming revision of the relatives.

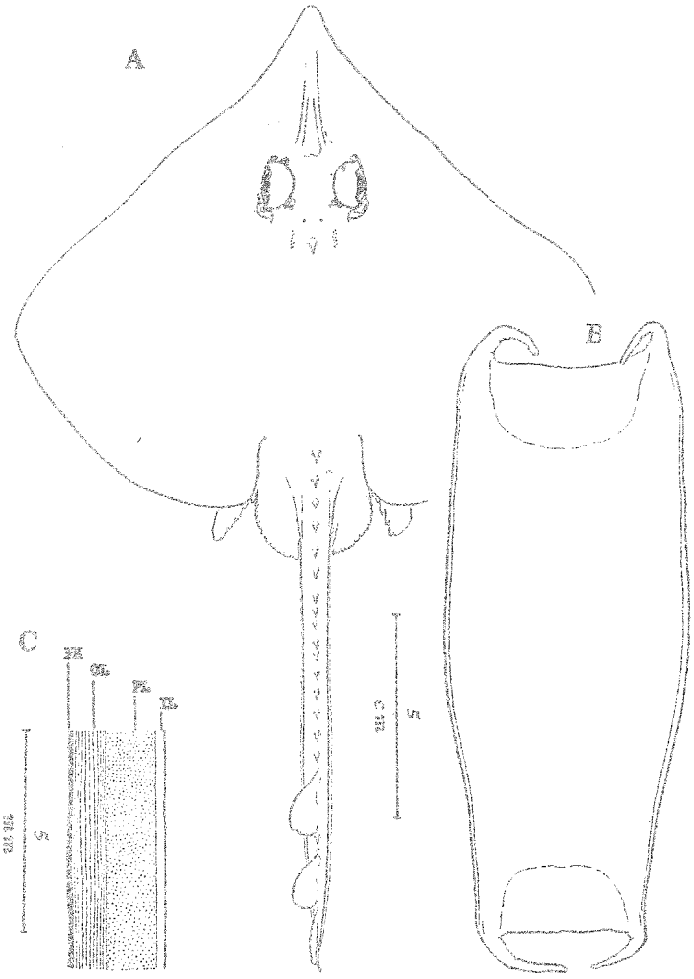

Fig. 2. A, young female, total length 240mm ; B, outline of the egg-capsule ; C, a cross section of the capsule. FH, fibroid hair ; IL, internal layer ; OL, outer layer; PL, pulpy layer.

Spinations in the young, measuring up to about 300mm in total length evade differences from sexes, viz., three distinct hooked spines occurring on the orbital ridge, the two of these bearing as preorbital and the rest postorbital one, and a large spine developing on nuchal. There is a row of caudal spines, numbering 15 to 17, of which there may be 1—2 between dorsals (Fig. 2, A). The outstanding development of the armatures which reveal sexual dimorphisms starts to sppear when the fish attains its maturation with body length about 1000 mm. The orbital spines of adult female are somewhat more numerous than in male, setting about as twice as those of the latter, and besides, three rows of caudal spines developing in female instead of one in male. The buckler spines on pectoral of male were about 2 to 3 in longitudinal and 13 in transverse broadest series (Fig. 1, A, B).

Egg-capsules were frequently obtained from the fishes procured in the spring, measuring from 1150 to 1230mm in total length. The coloration of the own capsule was yellow when extruded, and was covered with a felty mass of tightly packed fibers. The average sizes of seven capsules were 140mm in length, ranging 133 to 146mm, along the median line without horns, and greatest width 64mm, ranging 60 to 68 mm. The horns are very short, and somewhat longer in the posterior ones than the anterior, measuring about 30 to 40mm and 24 to 28mm, respectively (Fig.

2, B). The wall of the capsule (Fig. 2, C) is formed of three layers as is the case with that of *R. kenojei* (ISHIYAMA, 1950).

On the basis of these characteristics the capsule should belong to Kenojei-type, but it is much larger and the horns are shorter, which are all specific representations of the capsule.

Habitat : The present species is a deepest representative, inhabiting bathymetric waters of 180—200 fathoms in depth off the Pacific coast of our main island. The fish rather rarely occurs in the landings by the motor trawler.

The males appear to attain maturity when a little over 1000mm in total length, but the females grow larger, attaining about 1300mm. The species may be a spring breeder.

Comparisons and Relationship : The present species was first added to Japanese fauna by Matsubara (1936), and he referred, with some doubts in its identification, to a European species, *Raja oxyrinchus*.

Examination of a considerable number of specimen of the present species including Matsubara's collections from the Pacific coast, coupled with a critical study of the literatures, has led the author to conclude that there are no convincing ground for the recognition of agreement between the present species and the European's, though several resembling forms have been described from both the Pacific of America and the Atlantic coasts. Further, it appears that there is no form maintaining world-wide distribution among the skate within the southern members which inhabiting Japan and adjacent waters.

Five species (*pulchra, tengu, rhina, binoculata* and *oxyrinchus*) come under the author's detailed comparison with this new species. These relatives have some features in common in general physiognomy such as, longer snout, larger size, spination on dorsal surface of disc and of their young form. But, the present new species may readily be distinguished from not only the typical form of *R. oxyrinchus*, but also from those other closely resembling ones at least by having : 1) relatively larger eye and narrower interorbital space; 2) shorter tail, especially in adult, which retains enormous electric organ, so that the tail is soft and flexible when touched, and thickened in its middle portion.

From *R. pulchra* this new species differs in having characters other than two categories aforementioned : 1) color uniformly grey without pectoral ocellus instead of orange brown patterns with dark rings at the base of pectoral, which becomes obscure with age ; 2) the egg-capsule belonging to Kenojei-type inststead of showing peculiar feature (ISHIYAMA, 1950).

R. macrocauda is also clearly distinct from *tengu*, though they may belong to the same group in our skates, in having : 1) the sonut much shorter and blunter instead of sharply acuminate; 2) both interorbital space and tail being, as noted above, instead of the one always longer than the diameter of eye and of tail, much

slender and stout.

From *rhina* the present new species is distinguished at least in having : 1) the interorbital space narrower, which is 4.00 to 5.00 and 4.33 to 5.47 times in snout of males and females respectively, instead of broader in *rhina*, being the ratios, 3.25 to 3.75; 2) the long diameter of eye-ball greater than the interorbital space in young, but somewhat smaller in adult instead of one usually smaller than that of the interorbital space; 3) the grey colored disk instead of dark sienna brown with irregular black blotches and a ring form spot, which are always present in young, but often present in adult of *rhina*.

From *binoculata*, which was also described from the Pacific coast of America, *macrocauda* may be distinguished in having : 1) narrower interorbital space as compared with relatively wider one in *binoculata*, in which the ratio of it against length of snout runs from 2.1 to 3.0 ; 2) the length of disc somewhat greater, the ratios of it against the length of snout varying 2.69 to 3.25 times instead of being 3.80 to 4.60 times in *binoculata*, which has dark olive-brown or drabs, with a large dusky spot at base of the pectoral of young specimens ; 3) the egg-capsule with short horns at four angles but not quadrangular without horn.

R. macrocauda is distinct from *oxyrinchus* in having : 1) the broadly elongated snout instead of long acuminate and sharply pointed at tip; 2) the snout relatively shorter than that of the latter, with the ratio of it against the width of disc, 2.9 to 4.0 times the snout instead of 2.6 to 3.1 times, in the latter; 3) the under surface of disc almost smooth instead of entirely spinulose ; 4) color uniformly grey instead of with or without a few pale oval or circular white spots, which are usualy present in the young.

The author expressed his view on the relations within the rajids which are supposed to have been divided into two main stocks, northern and sorthern forms (ISHIYAMA, 1952). The characteristic features distinguished as specialization or degeneration are largely viewed in their external as well as internal character, among which those of such relations in characteristic of snout and of tail would apparently be recognized as antagonical ones. Namely, as in case of the northern form, the extreme specialization takes parts with their snout, but the significant specialization in its tail would be prevented, retaining more primitive state. Such relations thus antagonizing each other between the specialization of snout and tail would generally be confirmed within those of southern forms as the reversal trend when compared with the case of northern ones.

The strikingly shoter tail with distinguishing features in this new species may supposedly be of aberrant nature and, it may be taken as remarkable specialization as far as the tail is concerned.

Basing some other important characters, such as larger eye and uniform coloration, and spination, on dorsal border of the tail, and number of the precaudal

vertebrae, degree of development in the electric organ, number of turns of the intestinal valves, and features of the egg-capsule, the new species may probably be deep-sea representative among the allied ones, and may have arisen at least from forms dwelling rather less deep. In these respects *tengu* seems to be nearer their congener.

Raja pulchra, on the other hand, may be distinguished as shallower inhabitant, which would have been adapted as the surviver to the niche.

Conclusively, *macrocauda* and *pulchra* may respectively be of deep-sea and of shallow-water representatives, and *tengu* is intermediate in habitat. Furthermore, in its radiation, particularly toward long-snouted forms accompanied by the specialized tail with large electric organ, these skates may be included in a subgeneric series, and beside, world widely distributed skates having such common diagnostic features in both tail and snout may be included in the same stem of the fish referable to the genus *Raja*.

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