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Resurrection of *Notoraja* Ishiyama, 1958 and description of a new species of deep-water skate from the South China Sea *Notoraja subtilispinosa* sp. nov. (Pisces, Batoidea, Rajidae)

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RÉSUMÉ

Résurrection du genre *Notoraja* Ishiyama, 1958 et description d'une nouvelle espèce de raie d'eau profonde de mer de Chine du Sud, *Notoraja subtilispinosa* sp. nov. (Pisces, Batoidea, Rajidae).

Après une étude plus détaillée de son squelette, l'espèce japonaise *Bathyraja tobitukai* (Hiyama, 1940) est transférée au genre *Notoraja* Ishiyama, 1958. Ce dernier taxon, originellement établi comme sous-genre de *Bathyraja* Ishiyama, 1958 est élevé au rang de genre. Un spécimen adolescent unique, recueilli en 1980 dans les eaux profondes, au nord-ouest des Philippines, pendant la campagne MUSORSTOM 2, est décrit comme l'holotype de *Notoraja subtilispinosa* sp. nov. C'est la seconde espèce de ce genre jusqu'à présent monotypique.

ABSTRACT

After a more detailed investigation of its skeletal anatomy, the Japanese *Bathyraja tobitukai* (Hiyama, 1940) is removed from its genus and is considered as a species of *Notoraja* Ishiyama, 1958. The latter taxon is elevated to generic rank from its original status as a subgenus of *Bathyraja* Ishiyama, 1958. A single early adolescent specimen, obtained in 1980 during the MUSORSTOM 2 expedition from deep water off the northwestern Philippines, is described as the holotype of *Notoraja subtilispinosa* sp. nov. which is the second species of this, so far, monotypic genus.

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INTRODUCTION

Originally all species of skate in the Western North Pacific, i.e. mainly Japanese waters, were in the traditional way classified under *Raja* Linnaeus. BIGELOW & SCHROEDER (1948) were the first who introduced the use also of characters of the skeletal anatomy (mainly snout and pelvic fin skeletons) to better distinguish between the numerous rajid taxa on a supraspecific level. Initiated by the latter study, ISHIYAMA (1952) in his first revision of Japanese rajids grouped these species into three genera, namely *Raja* L., *Breviraja* Bigelow & Schroeder, 1948 and *Rhinoraja* gen. n. based on even further distinctive characters, e.g. vertebral counts. Among other species, the latter author assigned also *Raja tobitukai* Hiyama, 1940 to the ' soft-snouted ' skates of *Breviraja*, with the remark that this was the smallest species among its Japanese representatives in growing to about 500 mm TL only. ISHIYAMA (1958) in his fundamental revision of Japanese rajids greatly extended the scope of characters he considered as relevant for taxonomic distinctions and phylogenetic interpretations, mainly e.g. through the inclusion of clasper morphology and skeleton, as well as detailed cranial anatomy. The splitting of Japanese rajids into the three genera of the 1952 revision was retained and was still better supported. Furthermore *Raja* was subdivided into the two new subgenera *Okamejei* and *Tengujei*. *Breviraja* was also subdivided into the three new subgenera *Notoraja, Bathyraja* and *Arctoraja*. Of these latter, *Notoraja* was defined monotypically for *B. tobitukai* with the remark that this " subgenus differs rather widely from *Bathyraja* and *Arctoraja* " mainly in having the least number of trunk vertebrae, a specialized clasper, an obviously long tail of more than 50 % TL and one exceeding the width of the disc, deeply incised pelvic fins with slender anterior lobe, a blunt process at the tip of the snout, an entirely prickly upper side, and a very slender rostral cartilage with long appendices extending about half its length rearward.

ISHIYAMA's (1967) rajid contribution to " Fauna Japonica " mainly summarized his revisional results of 1958 without alterations in the supraspecific classification and nomenclature.

However shortly afterwards, ISHIYAMA & HUBBS (1968) concluded that species in the Central Western Atlantic grouped into *Breviraja* by BIGELOW & SCHROEDER (1948 etc.) were distinct from Northwestern Pacific species assigned to this genus by ISHIYAMA (1952 etc.). This conclusion was based mainly on characters of the snout skeleton and claspers. Consequently, these authors assigned all former Japanese *Breviraja* species to *Bathyraja* Ishiyama, 1958 in elevating the latter taxon to generic rank, and they also synonymized *Notoraja* and *Arctoraja* with the latter. It should be mentioned here that subsequent workers, incl. ISHIYAMA and the present author, mistakenly referred *Bathyraja* as a genus to ISHIYAMA & HUBBS (1968) and not to ISHIYAMA (1958) as is naturally the case.

ISHIYAMA & ISHIHARA (1977) in their interspecific comparison of the descriptions of five new species of *Bathyraja*, again characterize *B. tobitukai* as distinct from all Japanese congeners in that it lacks clear thorns dorsally and has a very low Vtr count.

Recently, MCEACHRAN (1984) rearranged a number of supraspecific taxa within the Rajidae in combining these under the newly introduced tribe Pavorajini. He considered *B. tobitukai* to play an important role for the nomenclature of the subgeneric divisions of *Pavoraja* Whitley, 1939 in the following way : should the New Zealand species *P. asperula* and *P. spinifera* and *B. tobitukai* be consubgeneric, then all three species would make up the subgenus *Notoraja* ; should this not be the case, then *B. tobitukai* would form an additional subgenus *Notoraja*, the two New Zealand species falling into his, as yet unnamed subgenus " A ". However, although most of the relevant, incl. anatomical characters of *B. tobitukai* were described already by ISHIYAMA (1958), except for some neurocranial details and scapulocoracoid and pelvis, MCEACHRAN (1984) felt the necessity for his further and complementing examination of *B. tobitukai* before coming to a final decision upon the assignment of this species and its relationships.

In the course of the present author's investigation of the MUSORSTOM 2 skate specimen, it soon

became apparent that *B. tobitukai* is the closest and so far only known relative of the species described below. Because of the availability of only the holotype, an early adolescent male, the detailed dissection to obtain every skeletal information was not possible, and although the very poor calcification of the specimen did not provide much more through the use of radiographs, the comparison with *B. tobitukai* resulted nevertheless in the conclusion that both species are congeners and do not fit into McEachran's (1984) characterization of *Pavoraja* and its subgenera. As a consequence, *Notoraja* Ishiyama, 1958 is resurrected and elevated to generic rank from its original status as a subgenus.

It is by no means the intention of the present paper to be in competition with McEachran with regards to *B. tobitukai*, or here to publish in advance the latter's results. On the contrary, the present writer does not know more about McEachran's findings than were published in 1984 and has informed him personally about the results presented here, and he will leave to him the detailed full reinvestigation of *B. tobitukai*, as well as the interpretation of the interrelationships of *Notoraja* within the Rajoidei, resp. the Pavorajini.

MATERIAL AND METHODS

Bathyraja tobitukai (Hiyama, 1940) : ISH 30/84 — an immature male of 371 mm TL ; 33°13.6′ N, 133°46.6′ E, 12.V.1972, Tosa Bay Japan, 650-700 m.

Measurements, meristic counts and terminology follow Hubbs & Ishiyama (1968), Stehmann (1970, 1985) and McEachran & Compagno (1979).

Notoraja subtilispinosa sp. n.

Holotype

MNHN 1985-134. Early adolescent male of 415 mm TL. RV *Coriolis*, Stat. 56, 28.XI.1980 ; 13°53.7′ N, 119°56.3′ E, 970 m ; obtained by beam trawl during the Musorstom 2 expedition off Manila in the South China Sea.

Diagnosis

A small deep-water species with an adult size most probably not exceeding about 500 mm TL. Assigned to the genus *Notoraja* Ishiyama, 1958 due to a combination of characters of its squamation, snout skeleton, scapulocoracoid and body proportions.

Both surfaces uniformly dark greyish-brown. Entire upper surface very densely set with extremely fine spinules of even size and shape. No thorns dorsally other than a rudimentary one in front of each orbit. Lower side of disc smooth, but underside of tail completely and densely set with fine spinules of the type of the upper side. Anterior pelvic lobes slender and pointed, as long as or even somewhat longer than posterior lobes. Rear margins of nasal curtain smooth, but a fringed or serrated thin and low fold running across the posterior surface of each nasal curtain apex. Scapulocoracoid of subquadrangular shape, its height 85 % of its length, with distinct bridge across anterior fenestra, large postdorsal fenestra of equal height and length, and three small postventral foramina.

Etymology

Subtilis (lat.) = very fine, *spinosus* (lat.) = spinulose ; referring to the extraordinarily fine, velvet-like spinulation.

DESCRIPTION OF THE HOLOTYPE

Detailed measurements and counts given in table 1.

Shape

Disc an almost regular inverted heart-shape, 1.1 times as wide as long, the axis of maximum width at 66 % of disc length clearly posterior of shoulder girdle. Anterior disc margins very weakly undulated in being concave at sides of snout tip over short distance, convex at level of orbits, concave again at level of nape and convex again towards the broadly rounded outer corners. Posterior disc margins much shorter than anterior ones, evenly convex and broadly rounded into the pectoral axils. Snout relatively long and pointed, with angle 94°, its tip marked off as a

TABLE 1. — *Notoraja subtilispinosa* sp. nov. (Columns I-II) and *N. tobitukai* (Columns III-IV). Actual measurements in millimeters and as percentage of total length, of nasobasal cranial length and maximum scapulocoracoid length respectively of external morphology and skeletal structures. Not clearly obtainable values marked with asterisk.

	Holotype MNHN 1985 - 134		ISH 30/84	
	I	II	III	IV
Total length	415.0	100.0	372.0	100.0
Disc, width	192.0	46.3	193.0	51.2
Disc, length	182.0	43.9	167.0	44.9
Snout, preorbital length	48.3	11.6	40.0	10.8
Snout, preoral length	51.3	12.4	43.0	11.6
Snout, prenasal length	37.4	9.0	33.0	8.9
Orbit diameter	16.7	4.0	17.3	4.7
Interorbital width	13.8	3.3	10.0	2.7
Spiracle length	9.0	2.2	10.5	2.8
Interspiracular width	25.7	6.2	21.7	5.8
Orbit + spiracle	20.7	5.0	21.3	5.7
D1, height	6.0	1.5	7.8	2.1
D1, base length	14.0	3.4	16.0	4.3
D2, height	6.0	1.5	9.0	2.4
D2, base length	12.8	3.1	15.4	4.1
Distance D1-D2	0	0	3.4	0.9
C, base length	17.7	4.3	22.2	6.0
Tail, postdorsal length	20.9	5.0	26.4	7.1
Tail, height at V-tips	8.0	1.9	10.0	2.7
Tail, width at V-tips	12.0	2.9	13.6	3.7
Tail, height at D1 origin	3.2	0.8	4.0	1.1
Tail, width at D1 origin	4.1	1.0	6.0	1.6
Lateral tail folds, length	217.0	52.3	186.5	50.1
Head length, ventrally	98.4	23.7	89.5	24.1
Mouth width	24.0	5.8	22.0	5.9
Internasal width	28.3	6.8	22.0	5.9
Nasal curtain, length	20.7	5.0	15.0	4.0
Nasal curtain, width of each lobe	8.0	1.9	7.0	1.9
Nasal curtain, distance between lobes	18.7	4.5	16.8	4.5
Length gill slits, 1st	6.0	1.5	4.3	1.2
Length gill slits, 3rd	6.3	1.5	5.3	1.4
Length gill slits, 5th	3.8	0.9	3.7	1.0
Interbranchial width, 1st'	47.5	11.5	damaged	
Interbranchial width, 5th'	29.4	7.1	24.6	6.6
V, length anterior lobe	59.3	14.3	52.3	14.1
V, length posterior lobe	58.0	14.0	52.5	14.1
Clasper, postanus length	42.0	10.1	32.8	8.8
Snout-middle of anus	162.4	39.1	149.0	40.1
Snout-max. disc width	120.0	28.9	105.0	28.2
Middle of anus - D1	202.0	48.7	161.0	43.3
Middle of anus - D2	215.7	52.0	178.5	48.0
Middle of anus - tip of tail	248.0	59.8	220.7	59.3
Angle of snout	94°		117°	
Tooth rows upper jaw	35		43	
Pseudobranchial folds, l./r.	9/9		9/9	
Vtr	not obtainable		26	
Vprd	not obtainable		66	
P-radials, l./r.	not obtainable		67/67	
Cranial length	73.0	190.6	66.4	189.7
Nasobasal length	38.3	100.0	35.0	100.0
Rostrum length	33.6	87.7	31.7	90.6
Max. cranial width	45.5	118.8	35.7	102.0
Interorbital width	13.2	34.5	10.0	28.6
Width rostral base	6.0*	15.7	6.6*	18.9
Rostral appendix length	19.3*	50.4	19.0*	54.3
Rostral appendix, width of each	1.5*	3.9	2.0*	5.7
Rostral cleft length	12.2*	31.9	13.5*	38.6
Least width basal plate	11.6	30.3	9.6	27.4
Internasal width	4.7	12.3	4.6	13.1

	Holotype MNHN 1985 - 134		ISH 30/84	
	I	II	III	IV
Scapulocoracoid length	21.3	100.0	22.9	100.0
Scapulocoracoid max. height	18.0	84.5	16.2	70.7
Height at rear corner	13.6	63.9	11.0	48.0
Premesocondyle length	8.5	39.9	8.6	37.6
Postmesocondyle length	13.0	61.0	14.3	62.5
Postdorsal fenestra, length	6.6	31.0	7.8	34.1
Postdorsal fenestra, height	6.6	31.0	5.0	21.8
Anterior fenestra, length	3.7	17.4	3.0	13.1
Anterior fenestra, combined height	6.0	28.2	5.0	21.8
Postventral foramina, number	3		4	

triangular short process ; the preorbital length 3.5 times the interorbital width, which is 0.8 times the orbit diameter. Spiraculum with nine pseudobranchial folds, its length roughly 50 % of the orbit diameter ; distance between spiracula 1.9 times the interorbital width. Snout area soft and vertically flexible, the anteriormost propterygia extending almost to snout tip. (Fig. 1).

Preoral snout length 2.1 times the mouth width, which is 64 % of the prenasal snout length and 85 % of the internasal width. Nasal flaps extending laterally as narrow trapezoids with 3-4 distinct long fringes at the narrow outer margin. Oronasal pits lacking. Nasal curtain with an undulated left margin, where a step-like incision is obvious, whereas the right one evenly weakly convex. Apices of nasal curtain evenly rounded and continuous with short posterior margins, which are directed forward. Outer and rear margins of nasal curtain smooth, but a low and thin fold with serrated and shortly fringed upper margin originating from junction with the isthmus and running across the posterior nasal curtain surface parallel to its smooth rear margin (Fig. 3). Ventral head length 1.9 times the preoral, 2.6 times the prenasal snout length and 4.1 times the mouth width. Distance between first gill slits 1.6 times that between fifth gill slits and 2.0 times the mouth width.

Mouth and jaws moderately angled (Fig. 2). The small teeth arranged in quincunx ; closely set in median, more widely spaced in outer thirds of the jaw, where they also appear to be set in very oblique parallel rows. 35 tooth rows in upper and lower jaws. Individual tooth flat and rhomboid, those in median third tending to an ovoid shape. Only the teeth in the median 3/5 of the jaw show a short, almost horizontally oriented conical cusp at inner corner.

Pelvic fins distinctly bilobed, but with continuous outer margin. Anterior lobe slender and tapering towards pointed tip, as long as or even slightly longer than the posterior lobe, which shows a convex outer margin, narrowly angled tip and a weakly concave long inner margin. The claspers, still in an early adolescent stage with their still undeveloped terminal region already exceeding tips of pelvic fins, are very slender rods with a long basal portion and a short, somewhat widening glans.

The obviously long and slender tail gradually tapering rearwards, somewhat depressed only at base, but almost circular in cross-section over remaining length. Its length to D1 already nearly 50 %, to the extreme tip 60 % of the total length and 1.3 times the disc width. Lateral tail folds distinct from their origin at pelvic axils to their end at about half the postdorsal tail length ; relatively wide along most of the tail, becoming wider in the dorsal fin section as is usual. Postdorsal tail section obviously long, 1.6 times the base length of D2. The small dorsal fins at the very end of tail, almost equal in size and shape, their bases confluent above upper surface of tail ; their height roughly 50 % of their base length only. Their continuous anterior and upper margins somewhat convex and rising at a shallow angle, the narrow apex truncate and frayed, the rear margin greatly angled forward. A distinct upper caudal fold arising about 1/2 of D2-base length behind the latter, its even height roughly 50 % of the D2-height and greater than depth of tail in this section. A distinct lower caudal fold present, its length equal to, but the height only half of that of the upper fold.

Sensory pores along upper anterior disc margins rather large and somewhat bulbous, those along posterior margins even more obvious in

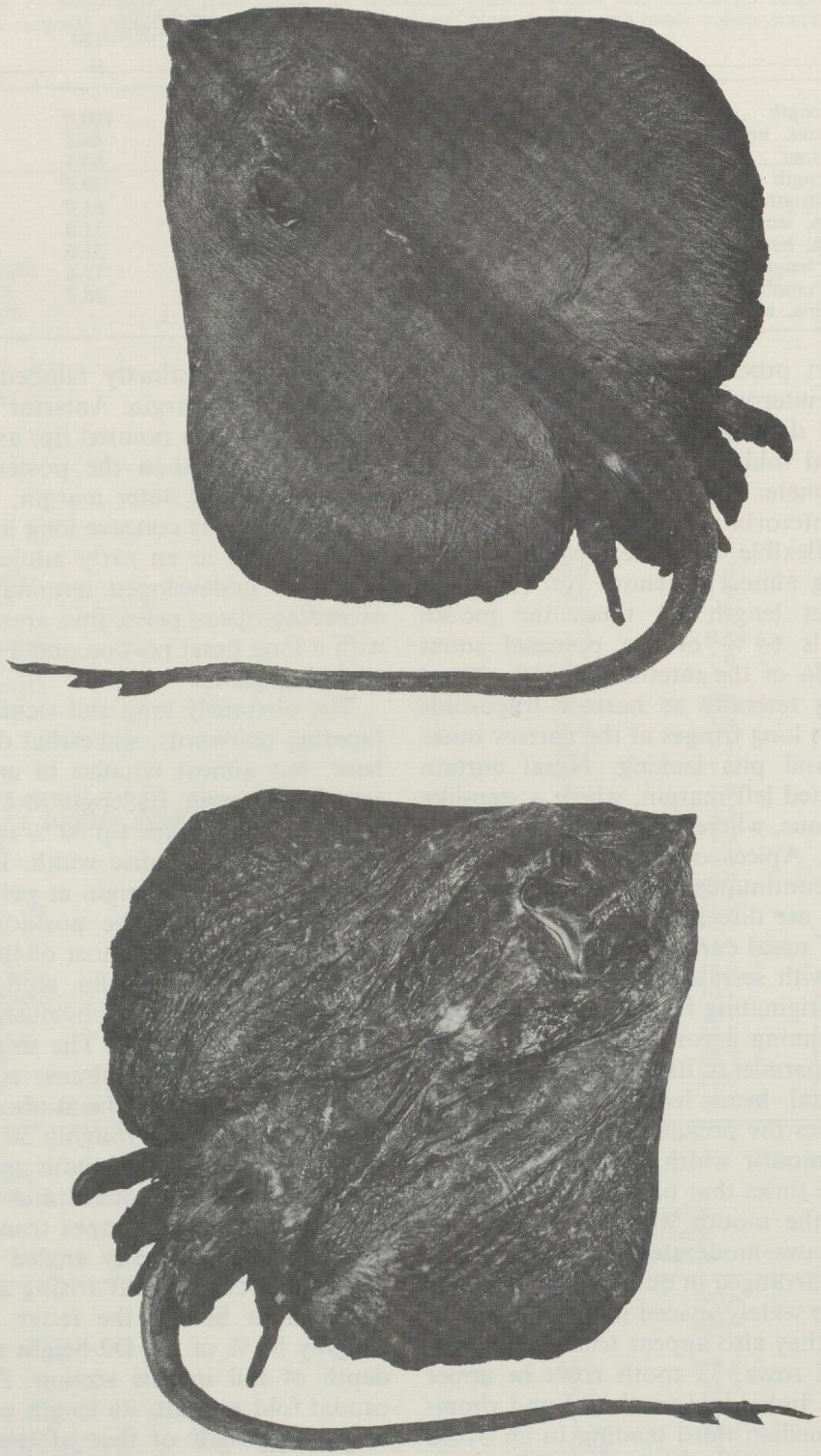

FIG. 1. — *Notoraja subtilispinosa* sp. nov.; holotype MNHN 1985-134 in dorsal and ventral view.

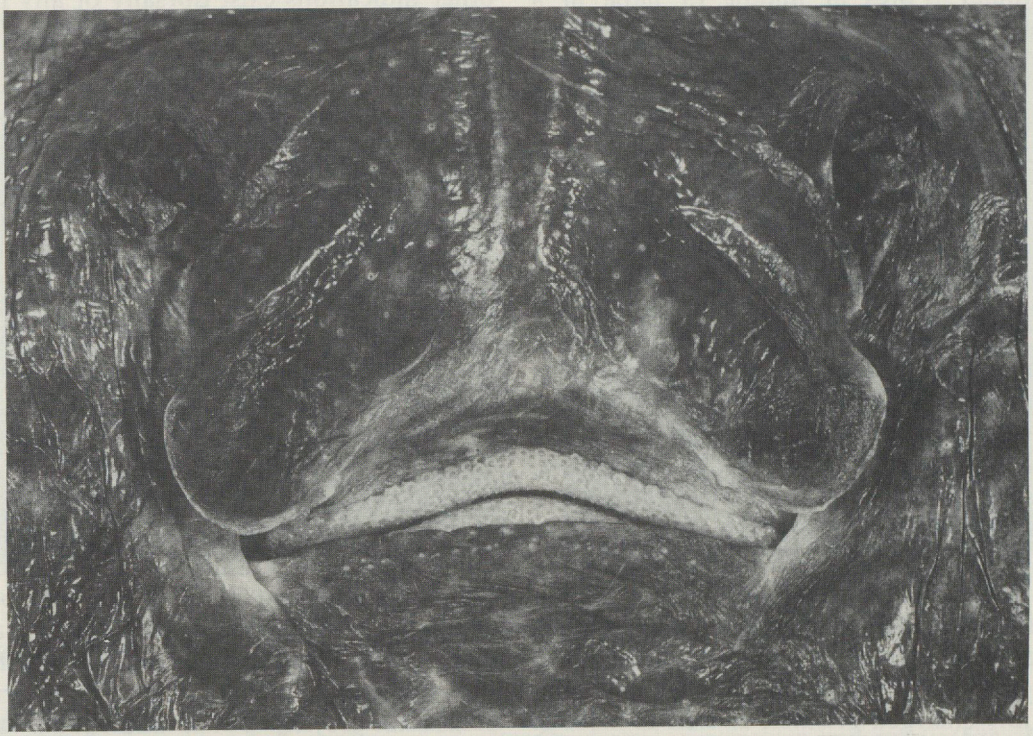

FIG. 2. — *Notoraja subtilispinosa* sp. nov. ; mouth and nasal region of the holotype.

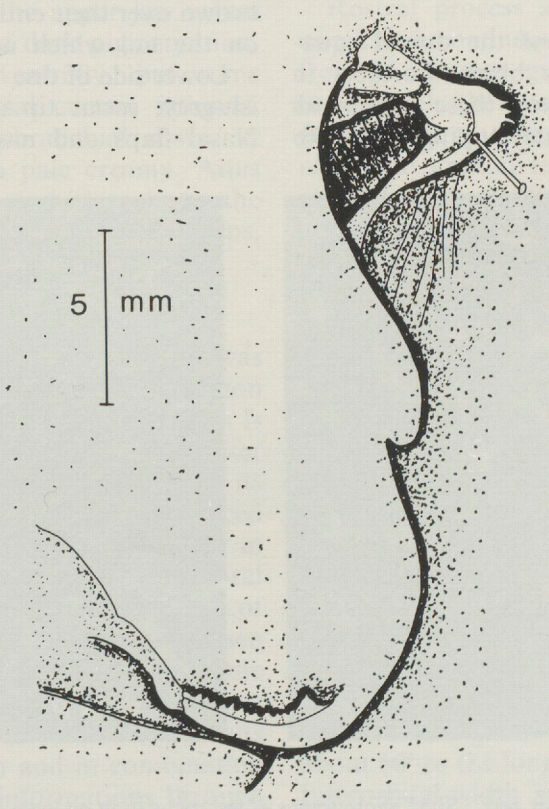

FIG. 3. — *Notoraja subtilispinosa* sp. nov. ; left nostril and nasal curtain of the holotype with separate fringed fold across apex.

being tubular. Pores at middle of nape in a single, somewhat irregularly arranged median line, which however is roughly crescentic and not evenly continuous ; pores of the line grouped rather in three separate fields, each of which appears somewhat bulbous and elevated from the surface (Fig. 1).

Squamation

Entire upper surface of disc, including orbits, very densely set with extremely fine, erect, needle-like spinules, which are macroscopically almost indiscernible and velvet-like to the touch (Fig. 4). Only the extreme tip of snout, i.e. the process, a very narrow edge along anterior, and a somewhat wider edge along posterior disc margins smooth, as well as the entire anterior pelvic lobes. Furthermore, a broad outer margin around posterior pelvic lobes, which however show a large central area of the velvet-like spinulation, and claspers smooth. Upper surface and sides of tail over its entire length equally densely and finely spinulose as the disc but without any enlarged prickles, as well as most of the dorsal fins and the upper caudal fold are spinulose.

Only enlarged elements of the dorsal squamation are a pair of tiny blunt thornlets in front of the orbits, but even these appear as being reduced rather than developing ones. No other indications exist dorsally of any thorns or thornlets, neither as scars, nor in some developmental stage.

Underside of disc, pelvics and claspers completely smooth. Ventral side of the tail entirely set with spinules as above, except for a small median smooth spot at the very base of the tail between the pelvic axils. Very exceptionally, the spinules encroach from the sides and underside of the tail onto the lateral tail folds dorsally and ventrally in the posterior half of the tail.

Colour

Upper side of disc, including orbits and the rostral triangle, of the alcohol preserved holotype, plain dusky greyish-brown with a bluish-metallic shade. Posterior disc margins blackish-brown at smooth outer edge. Back of trunk a somewhat darker shade as also the entire tail. Sensory canals not marked off, only pores and integument of the crescentic field on nape pale. Both pelvic lobes and claspers blackish-brown, the spinulose central area of posterior lobe somewhat greyish. Dorsal and caudal fins dusky greyish. Lateral tail folds marked off blackish-brown over their entire length since the only part on the tail which is not completely spinulose.

Lower side of disc " wishy-washy " dark brownish-grey, snout tip and edges of fins blackish. Nasal flaps and nasal curtain blackish-brown,

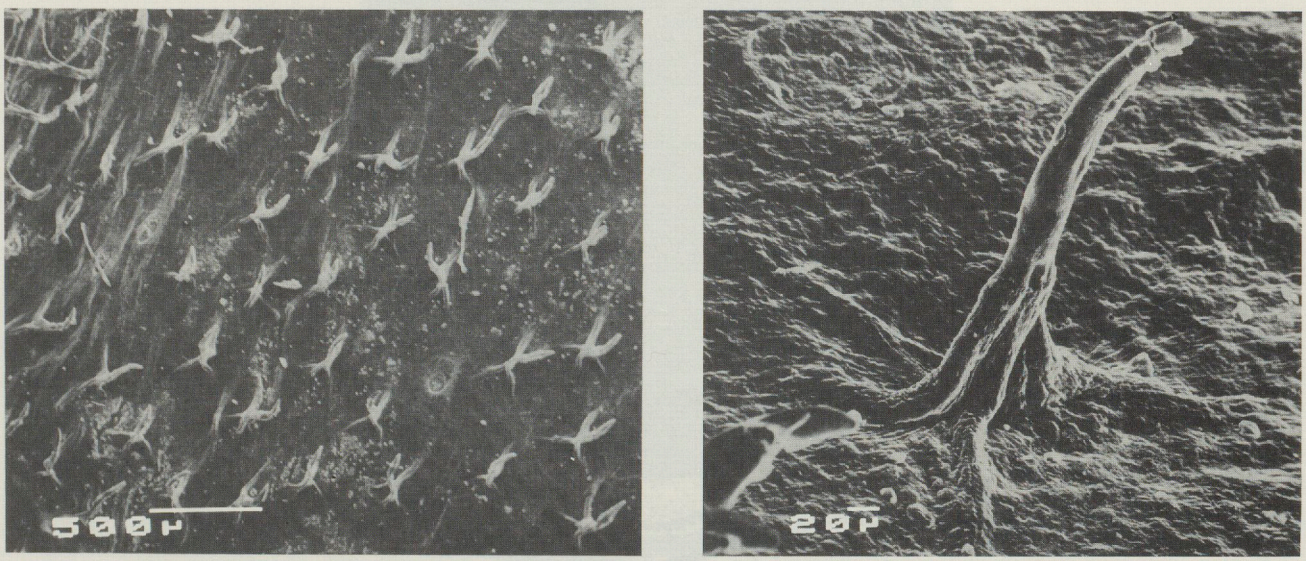

FIG. 4. — *Notoraja subtilispinosa* sp. nov. ; SEM photographs of the spinulation on inner left scapula of the holotype (a) and individual spinule in semilateral view (b).

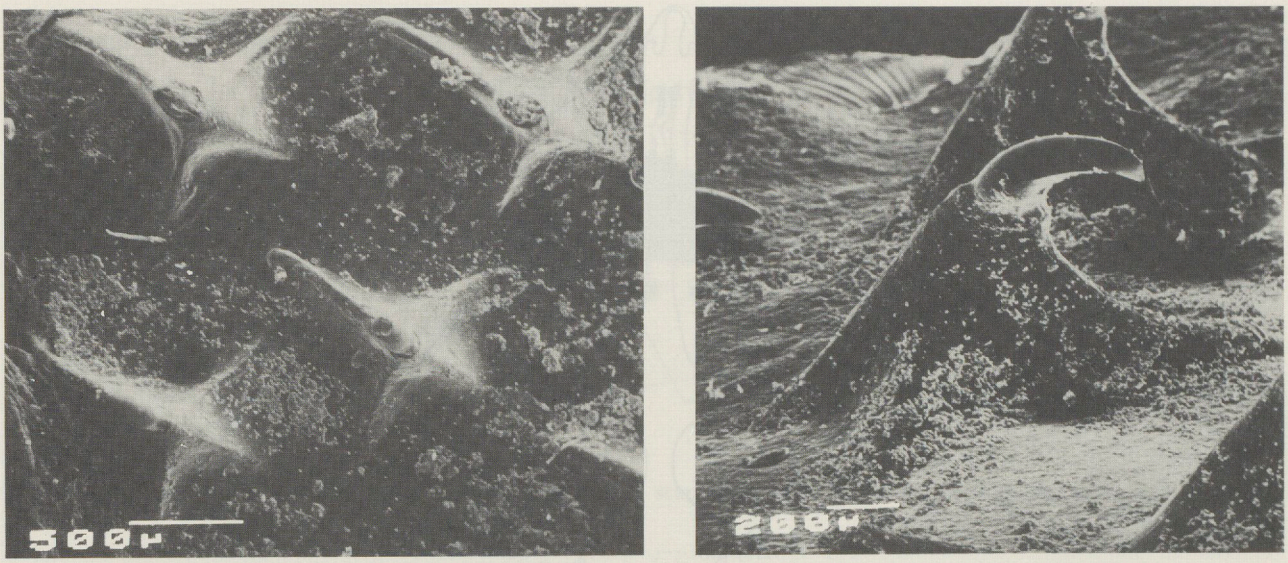

FIG. 5. — *Notoraja tobitukai*; SEM photographs of the spinulation on inner left scapula of specimen ISH 30/84 (a) and individual spinule in semilateral view (b).

the latter with pale narrow edges. Inner surface of nasal curtain as dark as the outer. Roof of mouth cavity and edge of the upper jaw velum with vague to partly spotted dark pigmentation. No real light markings ventrally, but some irregular pale areas at nasal curtain isthmus, medially on posterior interbranchial space, at angles of mouth, and jaws pale creamy. Anus edged blackish. Pelvic fins and claspers as the disc, but blackish towards their margins or tips, as well as the tail.

SKELETAL ANATOMY

Although every possibility in x-raying was tried, the results did not offer much information as apparently the calcification of the skeleton is too insufficient, either because this deep-water specimen has such a low calcification only, or its poor natural calcification has been reduced to almost Zero through long-term storage in strong formalin. Hence, on this basis, vertebral and fin ray counts, as well as an illustration of the pelvis were impossible, and the specimen could not be dissected in order to obtain the informations. Where possible without serious damage to the holotype, the following results were gathered by dissection and in combination of the latter with the few informations through radiographs.

CRANIUM AND SNOUT SKELETON (Fig. 6)

Rostral process slender, flexible and almost uncalcified, continuous without segmentation from front of cranium, gradually tapering towards its fusion with the rostral node. Its length about 46 % of the total cranial and about 88 % of the nasobasal cranial length. Rostral base narrow, about 16 % in width of the nasobasal length and about 13 % of the maximum cranial width, which is about 1.2 times the nasobasal length. Rostral process laterally undulated a short distance in front of rostral node; its appendices plate-like, somewhat vertically undulated and not fused to sides of the rostral process. Rostral node with a distinct process and deep incisions at its sides; free rear ends of appendices closely parallel to rostral shaft and terminating at 54 % of entire rostral length without curving away laterally. Shape of neither anterior, nor posterior fontanelle discernible in radiographs, but nasobasal fenestrae indicated and their presence confirmed by dissection. Ovoid-shaped nasal capsules large, greatly expanded laterally, with strongly convex anterior and almost straight posterior margins, which are set at an angle of about 60° to the longitudinal axis of the cranium. Interorbital width 34 % of the nasobasal length, of which the internasal width is about 12 % and

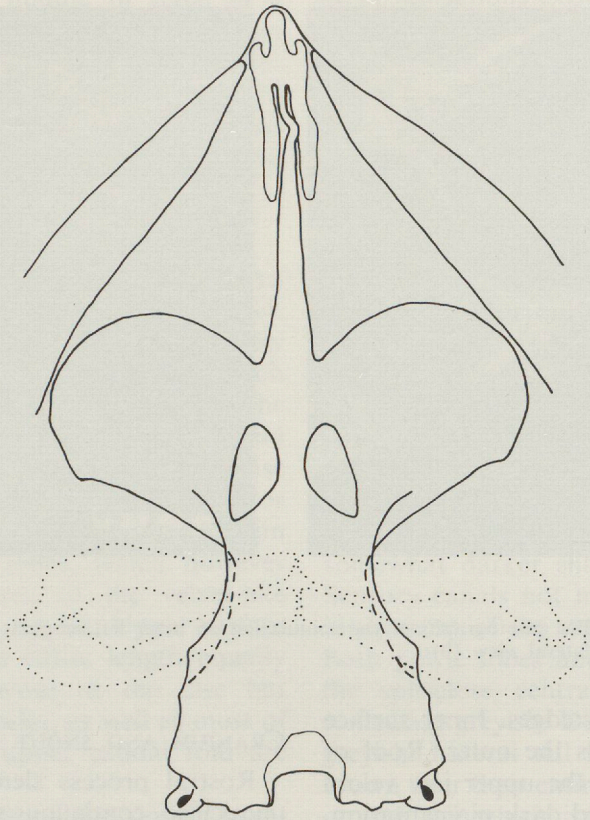

FIG. 6. — *Notoraja subtilispinosa* sp. nov. ; cranium and snout skeleton of the holotype semischematically reconstructed in combination of radiographs and dissected snout, about 1.5 times nat. size.

the least width of the basal plate about 30 %. Orbital region deeply and evenly concave, with anterior processes poorly and posterior ones moderately developed. Otic region massive, its width about 60 % of the nasobasal length, jugal arches moderately developed.

SCAPULOCORACOID (Fig. 7)

A high and relatively short element of subquadrangular shape, the maximum height 85 %, the height at rear corner 64 % of its length. Height at rear corner 76 % of the maximum height. Relation pre-msc-length : post-msc-length = 1 : 1.5. The straight anterodorsal margin gently sloping towards rear corner, which is marked but not elevated ; posterodorsal margin also straight but sloping steeply towards metacondyle. Anterior fenestra divided by a horizontal bridge into a larger, roundish dorsal and a smaller, oval ventral fenestra. The combined height of both anterior fenestrae somewhat less than that of the very large postdorsal fenestra. This as high as long and of subtriangular shape. The three small postventral foramina of rearward increasing size, the smallest anterior one placed almost underneath the postventral edge of the mesocondyle. The element is almost uncalcified.

PELVIS

Radiographs did not give any indication of its shape. A full dissection of the element could not be undertaken as the holotype is the only specimen available. However, in a partial dissection and in comparison with the pelvis of *N. tobitukai* (Fig. 9) it was confirmed, that *N. subtilispinosa* also has very short anterior processes, but in contrast to *N. tobitukai* appears to have a pelvis with evenly concave anterior contour of the bar.

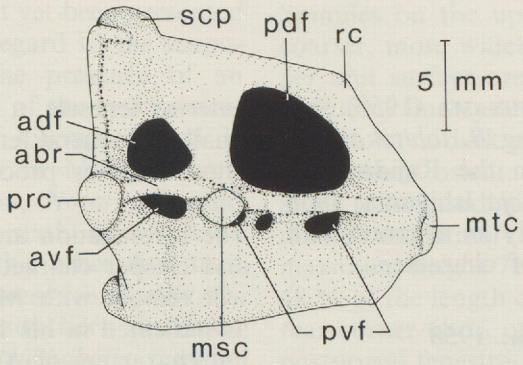

FIG. 7. — *Notoraja subtilispinosa* sp. nov.; left scapulocoracoid of the holotype in lateral view.

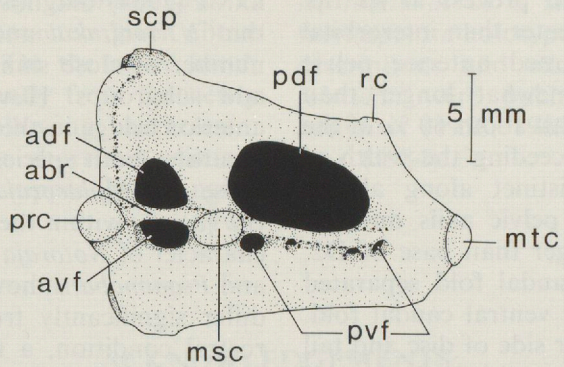

FIG. 8. — *Notoraja tobitukai*; left scapulocoracoid in lateral view of specimen ISH 30/84.

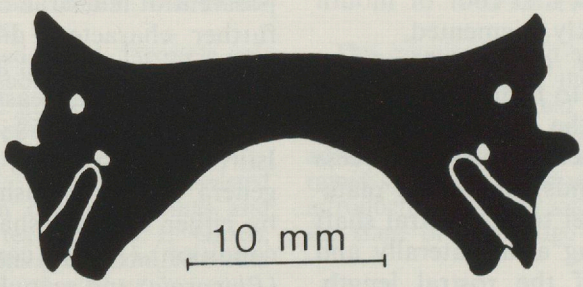

FIG. 9. — *Notoraja tobitukai*; pelvic girdle in dorsal view, somewhat schematized after radiograph of specimen ISH 30/84.

INTERSPECIFIC COMPARISONS AND CONCLUSIONS

Including references to ISHIYAMA (1958) and MCEACHRAN (1984), regarding *B. tobitukai* and supraspecific grouping within the Rajidae, the here resurrected taxon *Notoraja* Ishiyama, 1958 can be described preliminarily as a genus with the following combination of characters :

Notoraja Ishiyama, 1958

Type species. — *Raja tobitukai* Hiyama, 1940 by original designation.

Disc of inverted heart-shape, snout moderately elongated and with a small process at its tip. Orbit diameter distinctly greater than interorbital distance. Slender and pointed anterior pelvic lobes as long as, or somewhat longer than posterior lobes. Length of tail about 60 % of the total length and greatly exceeding the width of the disc. Lateral folds distinct along almost entire length of tail from pelvic axils onward. Postdorsal part of tail longer than base of D2, with a prominent upper caudal fold separated from D2-base and a lower ventral caudal fold. Oronasal pits absent. Upper side of disc and tail completely and evenly set with spinules. If present at all, thorns indistinct or rudimentary only and placed in preorbital position or medially along tail. Underside of disc and pelvics smooth, but tail almost entirely prickly. Upper and lower surfaces uniformly dark coloured. Inner side of nasal curtain and roof of mouth cavity at least partly darkly pigmented.

Rostral process slender and flexible, continuous from narrow base to fusion with rostral node, about as long as the nasobasal length. Rostral appendices with medial anterior process and very long free rear ends, which are plate-like and run closely parallel to the rostral shaft with their ends not curving away laterally and terminating at about half the rostral length. Nasal capsules greatly expanded laterally, ovoid-shaped and with basal fenestrae. Anteriormost propterygia of pectoral skeleton extending almost to snout tip at lateral edges of rostral node. Scapulocoracoid with anterior bridge dividing anterior fenestra, a large postdorsal and several small postventral fenestrae. Pelvis with short and blunt anterior processes.

The investigation and evaluation of neurocranial and clasper characters in detail of *N. tobitukai* will remain with MCEACHRAN's further studies as indicated in his 1984 paper. The corresponding characters of *N. subtilispinosa* could not be investigated, or were not available in the immature male holotype.

The above mentioned characteristics of *Notoraja* summarized and compared with MCEACHRAN's (1984) diagnoses and descriptions reveal, that *N. tobitukai* and *N. subtilispinosa* show a number of close similarities with the Pavorajini and subgroups. However, the presence of an anterior bridge in their scapulocoracoids already separates both species of *Notoraja* sharply from those of *Malacoraja, Neoraja, Pavoraja* and *Gurgesiella* within the Pavorajini. This particular character of *Notoraja* is shared with *Sympterygia* and *Psammobatis*, however both the latter genera differ significantly from *Notoraja* in, e.g. their rostral condition, a number of cranial features and the development of a dorsal thorn pattern (MCEACHRAN, 1982, 1983). The presence of an anterior bridge in the scapulocoracoid of *Notoraja* is shared furthermore by *Bathyraja*, in which the element however is greatly expanded horizontally and has multiple postdorsal, as well as postventral fenestrae or foramina. *Bathyraja* has further characters differing significantly from *Notoraja*, e.g. rostral and cranial conditions and distinct thorns at least on the upper side of the tail (ISHIYAMA, 1958 ; STEHMANN, 1970, 1985 ; ISHIYAMA & ISHIHARA, 1977). The remaining rajid genera are distinguished from *Notoraja* mainly by either external shape (*Dactylobatus*), rostral condition (*Raja*), conditions of the cranium (*Rhinoraja*) and scapulocoracoid (*Breviraja*), or a combination of these and additional characters (BIGELOW & SCHROEDER, 1953 ; STEHMANN, 1970 ; HULLEY, 1972 ; ISHIYAMA, 1958 ; MCEACHRAN & COMPAGNO, 1982).

The above comparison of *Notoraja* with

other supraspecific taxa does not fully consider McEachran's (1984) preliminary grouping of the rajoids for wich investigational results of the relevant specific taxa have not yet been presented completely. However, with regard to the scapulocoracoid condition, i.e. the presence of an anterior bridge, which is one of the synapomorphies for the separation of Groups I and II (considered of family rank) in McEachran's (1984) proposed classification, *Notoraja* would have to be grouped as the sixth supraspecific taxon within group I. Of the other five taxa within the latter group, *Psammobatis, Sympterygia* and *Bathyraja* have already been discussed above. *Pseudoraja* and *Arhynchobatis* remain, and there is hardly any risk of confusing these with *Notoraja*, as their representatives either lack, or have at most a single dorsal fin.

As a consequence, only *B. tobitukai* remains for comparison with *Notoraja subtilispinosa*. It shares with the latter the characters given above in the generic description. On the other hand, *N. tobitukai* differs significantly from the newly described species in the following characters : dorsal fins separated by a short but distinct interspace. Tooth rows in upper jaw ranging from 38 to 50 with an average of 44 (Ishiyama, 1958). Rear margins of nasal curtain smooth to fringed, separate fold across apex surface absent. Spinules on the upper surface distinctly larger, coarser, more widely spaced and thus much less per unit surface area (Fig. 5). Canals and pores of lateral line system on upper disc marked off whitish from dark ground colour. Nasal capsules of cranium orientated less forward at a larger angle to longitudinal axis of cranium. Scapulocoracoid moderately expanded horizontally, its maximum height 71 %, the height at rear corner 48 % of the length of the element only ; height at rear corner 68 % of the maximum height ; large postdorsal fenestra horizontally oval-shaped, 1.6 times as long as high ; four small postventral foramina of rearward decreasing size, the anteriormost one being the largest.

Detailed measurements of an immature male *N. tobitukai* of a size comparable to the *N. subtilispinosa* holotype are given in table 1. Good descriptions and excellent illustrations of *N. tobitukai* were published by Hiyama (1940), Ishiyama (1958, 1967) and Okamura & Kitajima (1984).

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NOTE (while in press)

This manuscript had been submitted in March 1985 already, but printing the volume took much longer than originally expected. In the meantime, alterations or updating were not possible. The author is aware of advances in knowledge and research since, regarding rajoid systematics, but under given circumstances the introductory remarks and conclusions can only reflect the stage of knowledge in 1984/85.

REFERENCES

BIGELOW, H. B. & SCHROEDER, W. C., 1948. — New Genera and Species of Batoid Fishes. *J. mar. Res.*, **7** : 543-566, figs 1-9.

BIGELOW, H. B. & SCHROEDER, W. C., 1953. — Sawfishes, Guitarfishes, Skates and Rays ; Chimaeroids. — *In* : Fishes of the Western North Atlantic (Eds TEE-VAN, J. et *al.*). *Mem. Sears Fdn mar. Res.*, **1** (2) : I-XV, 1-588, figs 1-127.

HIYAMA, Y., 1940. — Description of two new species of fish, *Raja tobitukai* and *Chlorophthalmus acutifrons*. *Jap. J. Zool.*, **9** (1) : 169-173, figs 1—2.

HUBBS, C. L. & ISHIYAMA R., 1968. — Methods for the Taxonomic Study and Description of Skates (Rajidae). *Copeia* 1968 (3) : 483-491, 1 fig.

HULLEY, P. A., 1972. — The origin, interrelationship and distribution of Southern African Rajidae (Chondrichthyes, Batoidei). *Ann. S. Afr. Mus.*, **60** (1) : 1-103, figs 1-59.

ISHIYAMA, R., 1952. — Studies on the Rays and Skates Belonging to the Family RAJIDAE, Found in Japan and Adjacent Regions. 4. A Revision of Three Genera of Japanese Rajids, with Descriptions of One New Genus and Four New Species Mostly Occured in Northern Japan. *J. Shimonoseki Coll. Fish.*, **2** (1) : 1-34, figs 1-7, pls 1-4.

ISHIYAMA, R., 1958. — Studies on the Rajid Fishes (Rajidae) found in the Waters around Japan. *J. Shimonoseki Coll. Fish.*, **7** (2, 3,) : 193-394, figs 1-86, pls 1-3.

ISHIYAMA, R., 1967. — Rajidae (Pisces). — *In* : Fauna Japonica. Biogeographical Society of Japan, Tokyo : VI + 84 pp., figs 1-23, pls 1-32.

ISHIYAMA, R., & HUBBS C. L., 1968. — *Bathyraja*, a genus of Pacific skates (Rajidae) regarded as phyletically distinct from the Atlantic genus *Breviraja*. *Copeia*, 1968 (2) : 407-410, figs 1-2.

ISHIYAMA, R. & ISHIHARA, H., 1977. — Five New Species of Skates in the Genus *Bathyraja* from the Western North Pacific, with Reference to Their Interspecific Relationships. *Jap. J. Ichthyol.*, **24** (2) : 71-90, figs 1-15.

MCEACHRAN, J. D., 1982. — Revision of the South American Skate Genus *Sympterygia* (Elasmobranchii : Rajiformes). *Copeia*, 1982 (4) : 867-890, figs 1-15.

MCEACHRAN, J. D., 1983. — Results of the research cruises of FRV " Walther Herwig " to South America. LXI. Revision of the South American skate genus *Psammobatis* Günther, 1870 (Elasmobranchii : Rajiformes, Rajidae). *Arch. FischWiss.*, **34** (1) : 23-80, figs 1-20.

MCEACHRAN, J. D., 1984. — Anatomical Investigations of the New Zealand Skates *Bathyraja asperula* and *B. spinifera*, With an Evaluation of Their Classification Within the Rajoidei (Chondrichthyes). *Copeia*, 1984 (1) : 45-58, figs 1-7.

MCEACHRAN, J. D. & COMPAGNO, L. J. V., 1979. — A further description of *Gurgesiella furvescens* with comments on the interrelationships of Gurgesiellidae and Pseudorajidae (Pisces, Rajoidei). *Bull. mar. Sci.*, **29** (4) : 530-553, figs 1-10.

MCEACHRAN, J. D. & COMPAGNO, L. J. V., 1982. — Interrelationships of and within *Breviraja* based on anatomical structures (Pisces : Rajoidei). *Bull. mar. Sci.*, **32** (2) : 399-425, figs 1-18.

OKAMURA, O. & KITAJIMA, T., (Eds), 1984. — Fishes of the Okinawa Trough and the adjacent waters. I. Japan Fisheries Resources Conservation Association, Tokyo : 414 pp., 8 + 205 figs.

STEHMANN, M., 1970. — Vergleichend morphologische und anatomische Untersuchungen zur Neuordnung der Systematik der nordostatlantischen Rajidae (Chondrichthyes, Batoidei). *Arch. FischWiss.*, **21** (2) : 73-164, fig. 1, pls 1-27.

STEHMANN, M., 1985. — Ergebnisse der Forschungsreisen des FFS « Walther Herwig » nach Südamerika. LXIV. *Bathyraja papilionifera* sp. n. (Pisces, Batoidea, Rajidae), eine weitere neue Rochenart aus dem Südwestatlantik vom nordargentinischen Kontinentalabhang. *Arch. FischWiss.*, **36** (1/2) : 195-211, figs 1-7.