A new species of wedgefish, *Rhynchobatus springeri* (Rhynchobatoidei, Rhynchobatidae), from the Western Pacific

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ABSTRACT.— A new species of wedgefish, *Rhynchobatus springeri* sp. nov. is described from specimens collected from the Indo–Malay region, with a confirmed range extending from the Gulf of Thailand south to Java, and possibly westward to at least Sri Lanka. It is a medium-sized species to about 215 cm TL, with males reaching adulthood at about 110 cm TL. *Rhynchobatus springeri* closely resembles *R. palpebratus* in body shape and having a dark, eye-brow like marking on its orbital membrane, but differs from this species in having a lower vertebral count (113–126 vs. 130–139 total free centra), a broader preorbital snout, and more rows of white spots on the tail of adults. Other *Rhynchobatus* species in the region attain a much larger adult size, and have a relatively narrower snout and much higher vertebral counts. A revision of the group is needed to find more useful field characters.

Key words: Rhynchobatidae – *Rhynchobatus springeri* – Broadnose Wedgefish – new species – Western Pacific

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INTRODUCTION

The genus *Rhynchobatus* Müller & Henle, 1837 comprises several species of moderate-sized to giant (attaining between 0.8 and more than 3 m total length) shark-like batoids. They belong in the monotypic family Rhynchobatidae, according to the classification of McEachran *et al*. (1996), removing them from family Rhinidae and a single species *Rhina ancylostoma* Bloch & Schneider, 1801. Following FAO usage (Stehmann, 1981; Compagno & Last, 1999), *Rhynchobatus* species are termed 'wedgefishes' because of their distinctive wedge-shaped discs; other names include giant guitarfishes, white-spotted guitarfishes, and, significantly, sharkfin guitarfishes. Wedgefishes are widespread and common in inshore tropical waters of the Eastern Atlantic, Indian Ocean, and Western Pacific.

Members of the genus *Rhynchobatus* include some of the largest species of rays, with *Rhynchobatus djiddensis* attaining a total length of 3 m and *R. luebberti* reaching a weight of at least 227 kg. Two other *Rhynchobatus* species grow to at least 2–3 m length. Müller & Henle (1837, 1841) recognized only a single species in the genus *Rhynchobatus*, *R. laevis* (Bloch & Schneider, 1801). Eleven species and a subspecies have been referred to *Rhynchobatus* by various authors, but only two, the West African *R. luebberti* Ehrenbaum, 1914 and the Indo–West Pacific *R. djiddensis* (Forsskål, 1775), are generally recognised as valid and most of the remaining taxa have been synonymised with *R. djiddensis* (Garman, 1913; Fowler, 1941). Compagno & Last (1999) gave a brief review of the Western Central Pacific species as members of the family Rhinidae, including a key to species in the area and brief accounts and illustrations of *R. australiae* (Whitley, 1939), *R.* cf. *laevis* (Bloch & Schneider, 1801), and two undescribed species, referred to as *R.* sp. 1 and *R.* sp. 2. More recently, Compagno & Last (2008) described a new species, *Rhynchobatus palpebratus*, from the Indo–Malay Archipelago, and provisionally recognised 6 other taxa as valid: *Rhynchobatus australiae* Whitley, 1939 from Australia, Thailand, Philippines, Singapore, Taiwan, and Indonesia; *Rhynchobatus djiddensis* (Forsskål, 1775) from the western Indian Ocean, including southern Africa, Mozambique and the Red Sea; *Rhynchobatus laevis* (Bloch & Schneider, 1801) from Zanzibar, the Arabian Sea, Oman, the Persian Gulf, India, Sri Lanka, and Bangladesh; *Rhynchobatus luebberti* Ehrenbaum, 1914 from tropical West Africa, including Mauritania to Congo and Angola; *Rhynchobatus* sp. 1 (Compagno & Last, 1999), only known from Singapore and Java; and *Rhynchobatus* sp. 2 (Compagno & Last, 1999) found in

the Western Pacific, including the Philippines, Thailand, Sarawak, Singapore, and Java.

Wedgefishes are commonly caught as bycatch of demersal inshore fisheries wherever they occur and are important commercially for their excellent flesh and very valuable fins, which are currently important in the oriental shark-fin trade. The intense fisheries pressure on wedgefishes, and minimal biological data on any of the species, makes for concern about their conservation status; currently no species in the family is protected and fisheries are largely unregulated. In southern Africa and tropical Australia, wedgefishes are sought as game fishes by sports anglers because of their great size and strength, and powerful response when hooked.

The following paper describes one of the undescribed wedgefishes *Rhynchobatus* sp. 2, a broad snouted form with a low vertebral count.

METHODS

Proportional dimensions, expressed as percentages of total length, are given in Table 1. External measurements of *Rhynchobatus* specimens are based on batoid measurements proposed by Bigelow & Schroeder (1953), Hubbs & Ishiyama (1968), Compagno & Roberts (1982), Compagno & Randall (1987) and Randall & Compagno (1995), and the shark measurements of Compagno (1984, 2001). Terminology for enlarged dermal denticles or thorns is based on Hubbs & Ishiyama (1968). Vertebral centra, pectoral-fin radials, and crania were examined and meristic details counted from radiographs including all paratypes and 8 non-types (see also Compagno & Last, 2008). The vertebral column of *Rhynchobatus* is more differentiated than in sharks and is clarified herein: a group of vertebrae behind the cranium are fused to form a large cervical synarcual element (Garman, 1913; Compagno, 1973, 1988, 1999, 2003) containing from 25–34 segments; the synarcual element has an anterior centrum-free region of 13–21 segments and a posterior region with 11–16 embedded centra. The number of synarcual segments is determined by counting the synarcual centra and the corresponding spinal nerve foramina and canals in the anterior centrum-free region on properly exposed, high-resolution radiographs; it is often not possible to count the centrum-free region in some specimens, particularly newborn and poorly calcified individuals, although synarcual centra are usually visible. Posterior to the synarcual, the vertebral column can be subdivided into monospondylous precaudal (MP) centra in the trunk, diplospondylous precaudal (DP) centra in the precaudal tail, and diplospondylous caudal (DC) centra in the caudal fin. The MP centra have very long ribs that are reduced posteriorly before the transition to DP centra, in which the centra suddenly become smaller and two per myomere. The DC centra have strongly expanded neural and haemal arches modified as pterygiophores for the caudal fin but, for purposes of consistency, counts are delimited anteriorly at the upper caudal-fin origin as in sharks (Springer & Garrick, 1964). Counts presented here include the numbers of centra in the synarcual element, and the MP centra, DP centra, DC centra, total free centra, and total centra; centrum-free segments and total segments were not included as some of these counts proved difficult to obtain.

In *Rhynchobatus*, as in most modern elasmobranchs or neoselachians (Compagno, 1973, 1977, 1988, 1999, 2003), there are three basal cartilages to the pectoral-fin skeleton: the anterior propterygium, intermediate mesopterygium, and posterior metapterygium, which bears most of the pectoral-fin radials. *Rhynchobatus* (and various other batoids) have a space between the mesopterygium and metapterygium where `neopterygial' radials articulate directly with the synarcual. The propterygium of *Rhynchobatus* is a single, unsegmented cartilage with its front end terminating behind the nasal capsules; anterior to the propterygium are 1–8 free propterygial radials suggesting that a segmented propterygial axis, such as that present in other batoids, may have been lost in *Rhynchobatus*. The propterygium itself has 16–26 radials, the mesopterygium about 5–7 radials, the neopterygial space on the scapulocoracoid about 4–6 radials, and the metapterygium 21–29 radials. Counts presented include free, propterygial, mesopterygial, neopterygial, metapterygial, total basal radials (excluding free radials), and total radials. Cranial morphology of the new *Rhynchobatus* species is not considered in detail here but we note that *Rhynchobatus* species differ in the shape of their rostral appendices, and by the position of the anterior ends of the antorbital cartilages relative to the anterior ends of the nasal capsules.

Morphometric data in the description includes information on 6 specimen lots that were not included in the type series as their whereabouts is presently unknown, while another two lots (SU 69893 and SU 69894) still require resolution as they contain multiple specimens. Also, USNM 72480 (apparently cited by LJVC in his data files as USNM 75877 but matching USNM 72480 in size, sex and locality data) is confirmed to be a specimen of the new species (by PL), based on photos facilitated by Jerry Finan, Jeffrey Williams and Sandra Raredon at the USNM.

Material discussed in this manuscript is deposited widely in ichthyological collections following Leviton *et al*. (1985): Australian National Fish Collection (CSIRO), California Academy of Sciences (CAS), Hokkaido University Museum (HUMZ), Marine Reference Collection at Institut Penyelidikan Perikanan Sarawak (IPPS), Natural History Museum of Los Angeles County (LACM), Rijks Museum voor Natuurlijke History (now = National Museum of Natural History, Naturalis (RMNH), National Museum of Natural History (USNM), and Zoological Museum Hamburg (ZMH). Also includes two

subcollections: GVF (= George Vanderbilt Foundation collection, which was incorporated into the CAS in 1967) and SU (= Stanford University collection, which was incorporated into the CAS in 1969).

Rhynchobatus springeri sp. nov.

Figs 1–3, Table 1

Rhynchobatus sp. 2: Compagno & Last, 1999, 1422, fig.

Holotype. RMNH PISC 35839, female 410 mm TL, Jakarta (as Batavia), Indonesia, 1924.
Paratypes. 22 specimens: CAS 229747, immature male 501 mm TL, Gulf of Thailand, Thailand, 12°19′ N, 100°27′ E, 33 m, Aug. 1960; CAS 229748, immature male 600 mm TL, Gulf of Thailand, Thailand, 05 Apr. 1960; CAS 229749, female 780 mm TL, Gulf of Thailand, Thailand, 26 Jun. 1960; CAS 229750, female 561 mm TL, Gulf of Thailand, Thailand, 11°51′ N, 100°30′ E, 36 m, Aug. 1960; CAS 229751, immature male 490 mm TL, Gulf of Thailand, Thailand, 12°13′N, 100°07′E, 26 m, Jul. 1960; CAS 229752, immature male 482 mm TL, Gulf of Thailand, Thailand, 33 m, 01 Jul. 1960; CAS 229754, immature male 497 mm TL, Gulf of Thailand, Thailand, 12°15′ N, 100°17′ E, 36 m, Mar./Apr. 1961; CAS 229755, female 379 mm TL, Gulf of Thailand, Thailand, 12°23′ N, 100°33′ E, 36 m, Dec. 1960; CAS 229757, immature male 443 mm TL, Gulf of Thailand, Thailand, 12°19′ N, 100°27′ E, 33 m, Aug. 1960; CAS 229758, female 486 mm TL, Gulf of Thailand, Thailand, 12°11′ N, 100°41′ E, 37 m, Jan. 1961; CAS 229759, immature male 469 mm TL, Gulf of Thailand, Thailand, 12°13′N, 100°07′ E, 26 m, Jul. 1960; CAS 229760, female 900 mm TL, Gulf of Thailand, Thailand, 05 Apr. 1960; CSIRO H 7113–01, female 413 mm TL, Gulf of Thailand, Thailand, 16 m, 27 Jun. 1960; CSIRO H 7113–01, immature male 388 mm TL, Gulf of Thailand, Thailand, 12°06′ N, 101°11′ E, 37 m, Dec. 1960/Jan. 1961; HUMZ 96569, immature male 466 mm TL, off Kuching, Sarawak, Malaysia, 03°39′ N, 110°42′ E, 12 Dec. 1971; HUMZ 96570, adolescent male, South China Sea, Nov./Dec. 1971; HUMZ 117525, adolescent male 711 mm TL, off Kuching, Sarawak, Malaysia, Dec 1966; IPPS 2009–338, adult male 1126 mm TL, near Kuching Marine Labs (Sarawak), Malaysia, 06 Nov. 2009; RMNH PISC 35840, immature male 390 mm TL, Java Sea, Indonesia, Jan. 1911; SU 13330, female 480 mm TL, Manila, Philippines; ZMH 10259, immature male 447 mm TL, Java, Indonesia, 1855; ZMH 101280, female 567 mm TL, Gulf of Thailand, Thailand, 20–40 m, Aug./Sep. 1961.
Other material. 9 specimens: CAS - GVF 2125 unreg, female 2130 mm TL, Gulf of Thailand, Thailand, 05 Apr. 1960; CAS - GVF 2239 unreg, immature male 743 mm TL, Gulf of Thailand, Thailand, 26 Jun. 1960; CAS - GVF 2361 unreg, adult male 1250 mm TL, Gulf of Thailand, Thailand, 12°20′ N, 100°36′ E, 25 m, Aug. 1960; CAS – GVF unreg, immature male 450 mm TL, Philippines; LACM unreg, female 498 mm TL, LACM unreg, immature male 430 mm TL, Singapore; SU 69893, female 450 mm TL, Manila, Philippines, 31 May 1931; SU 69894, immature male 395 mm TL, Singapore, Mar. 1934; USNM 72480, female 610 mm TL, Java, Indonesia.

DIAGNOSIS.— A moderate-sized species of the genus *Rhynchobatus* with the following combination of characters: a broadly wedge-shaped snout; preoral snout 16–22% of total length; eye small, length 3.1–4.0 in preorbital snout; interorbital space 2.2–2.7 in preorbital snout; mouth hardly bowed, with a strong indentation on upper jaw near symphysis and strong protuberance on lower jaw; tooth rows in upper jaw about 52 (based on holotype); no spines on dorsal snout; no rostral spines or spines at dorsal tip of snout; supraorbital spines small but well differentiated, extending from preorbit to end of spiracle; spines of mid-dorsal row relatively well developed; two obvious rows of small scapular spines on each side; origin of first dorsal fin over origin of pelvic-fin bases; predorsal space 42–48% of total length; colour pale greyish green above with 3–4 rows of large, white spots extending along the tail; black pectoral marking prominent, usually closely surrounded with 4 white spots (occasionally 3); anterior pectoral disc with a narrow whitish margin; orbital membrane with a pair of dark, widely spaced, recurved lines; no alternating light and dark markings on interorbital space; propterygial radials 1–8 + 20–23, mesopterygial radials 4–6, neopterygial radials 4–7, metapterygial radials 23–29, total radials 57–68 (inc. free radials); vertebrae with 12–14 synarcual centra, 18–28 monospondylous precaudal centra, 78–88 precaudal free centra, 33–40 diplospondylous caudal (free) centra, 113–126 total free centra, 127–139 total centra (including synarcual centra).

DESCRIPTION.— Body relatively robust; snout in front of eyes bluntly angular to obtusely wedge-shaped, angle of about 50° in holotype. Lateral margin of anterior half of snout almost straight, then becoming distinctly convex between eye and origin of pectoral fin. Preorbital length about 3.2 in holotype (2.9–3.4 in paratypes) times interorbital width. Preoral length 3.5 (3.0–3.4) times mouth width. Disc width across pectoral-fin apices 73% (69–84%) of disc length from snout tip to pectoral-fin free rear tips. Head strongly depressed, trowel-shaped, disc thickness 1.2 (1.4 in one paratype) times in interorbital space; ventral head length 3.2 (3.1–3.7) times in total length; surface between eyes and spiracles almost flat. Precloacal length 87% (74–92%) of length of tail from anterior vent to caudal-fin tip. Tail depressed (somewhat dehydrated in holotype); in cross section, rounded dorsally, less so ventrally, angular laterally, tapering evenly from pelvic-fin insertions. Width of tail at first dorsal-fin insertions of holotype 1.3 times interspiracular distance. Lateral keels of tail extended forward as a thick angular edge along precaudal tail, almost reaching first dorsal insertion; strongly differentiated on caudal fin.

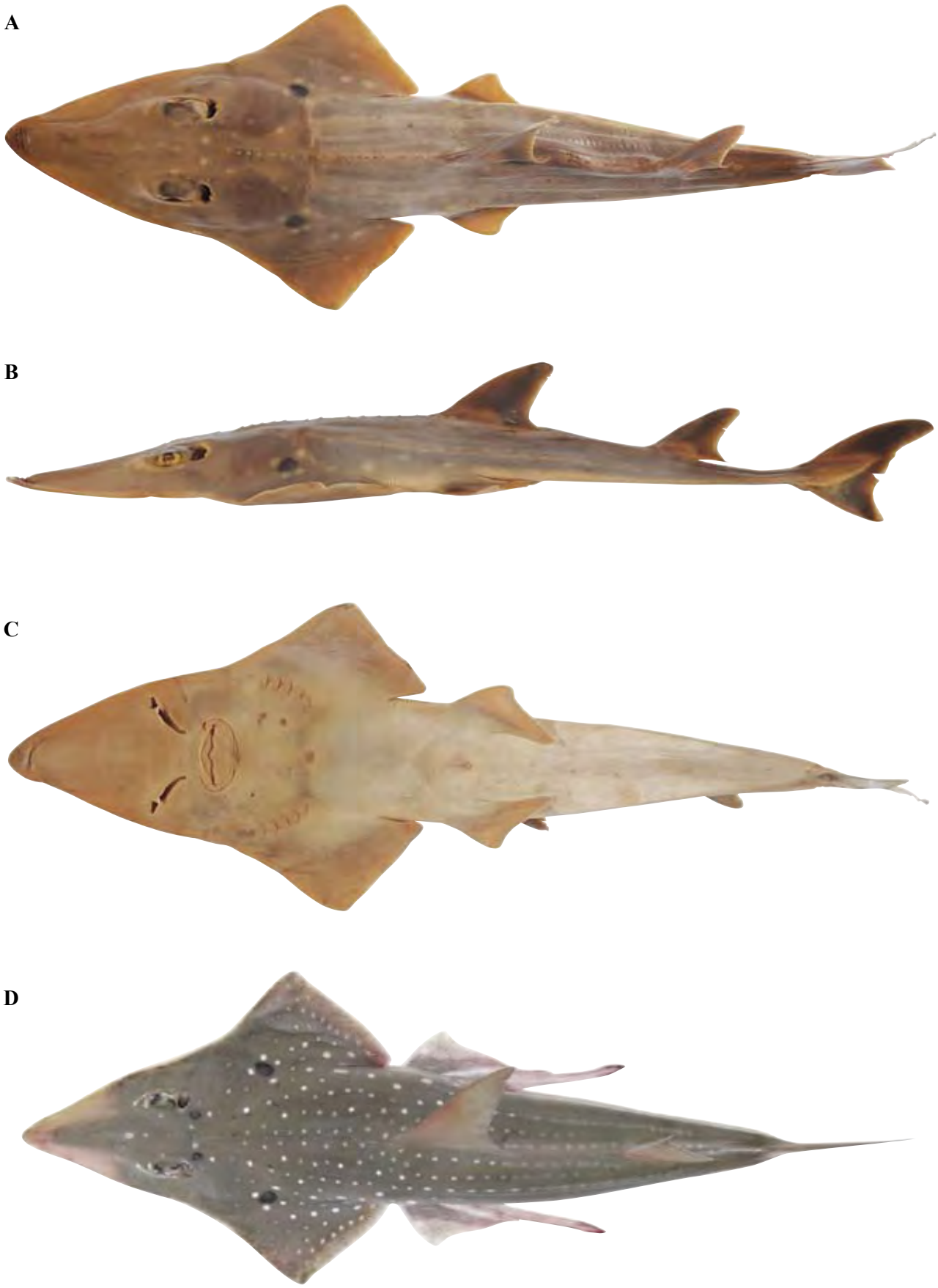

Figure 1. *Rhynchobatus springeri* sp. nov.: A. dorsal view of female holotype (RMNH PISC 35839, 410 mm TL, preserved); B. lateral view of holotype; C. ventral view of holotype; and D. reconstructed dorsal view of adult male paratype (IPPS 2009–338, 1126 mm TL, fresh), specimen missing dorsal fins and part of right pelvic fin.

Horizontal eye (eyeball) diameter about 76% (64–79%) of interspiracular width, distance from anterior margin of orbit to posterior margin of spiracle subequal to interspiracular width; greatest dimension of spiracles 46% (39–57%) of horizontal eye diameter; distance between spiracle and eye about half horizontal eye diameter, membrane of orbit almost continuous with spiracular opening. Spiracle dorsolateral, anterior margin with a strong valve, posterior margin with two anteriorly directed spiracular folds; outer fold slightly taller and larger than the inner fold.

Nostrils diagonal, forming about a 45° angle with body axis, anterior ends more lateral. Nasal cavity fully exposed, without dividing flaps; aperture straight anterolaterally, recurved posteromedially. Anterior nasal flap narrow, low, anteromedial on nasal aperture, inserted near midlength of nasal aperture; anterior process short, bilobed, its base length about twice as long as its width. Posterolateral nasal flap low, narrow and elongated, weakly lobate; originating just behind anterior lateral edge of incurrent aperture, extending posteriorly to about midlength of nasal aperture. Posterior nasal flap low, short based; joined to undersurface of posterolateral flap at about anterior third of its length, junction concealed beneath posterolateral nasal flap; inserted near midlength of nostril. Nostril width 1.2 (1.1–1.5) times in internarial width. Mouth opening somewhat arcuate, weakly undulating to nearly straight laterally; strong medial depression on upper jaw corresponding to a very prominent anterior extension at symphysis of lower jaw; much weaker corresponding depressions and convexities laterally. Labial folds and furrows short, but well developed at corners of mouth. Shallow pockets, circumoral grooves, and low folds and depressions, surround jaws laterally to labial folds; depressions most prominent on lower jaw. Teeth in differentiated serial rows, about 52 in upper jaw of holotype. First four gill openings subequal in length, the fifth slightly shorter. Third gill opening 3.2 (1.9–2.9) in internarial width, 3.8 (2.6–3.6) times in nostril length, 1.2 (1.1–1.8) times length of fifth gill opening.

Dermal denticles covering all of body surface (based on holotype and paratype RMNH PISC 35840), varying in shape across different parts of body; on dorsal surface, minute, dense but not imbricate, no obvious skin exposed between them; those on orbital membrane slightly smaller than those on interorbit; an indistinct patch of enlarged denticles present in front of eyes, length of patch about half length of eye. Dorsal denticles with slender pedicels and flat elevated crowns; crowns on trunk flattened, broad, subcircular, irregularly rounded anteriorly, unicuspidate or weakly tricuspidate posteriorly, usually with low medial and lateral ridges. Ventral denticles usually lacking cusps, strongly imbricate; subequal in size to those of dorsal surface.

Small, variable-sized thorns present on dorsal surface of body and tail; present on orbital margin, along dorsal midline, and in scapular region, those between nuchal and mid-scapular regions largest; rostral thorns absent. Thorns on midline of disc and tail long based, narrow, strongly oblique, bases partially embedded in skin; their surface mostly smooth, with corrugated anterior margins; largest thorns keel-like, posterior outer edges forming a sharp point, bases surrounded by a narrow naked perimeter. Orbit with continuous series of variably sized thorns; series extending along inner margin of orbit from anterior mid-eye to posterior margin of spiracle; mostly in a single row, approximately 12 on each side in holotype; row partly interrupted above anterior spiracle (partially subdivided into orbital and spiracular groups of thorns). Mid-dorsal series of thorns present before first dorsal fin (predorsal series) and between dorsal fins (interdorsal series); absent behind second dorsal fin. Predorsal thorns on a low dermal ridge in a single row, extending from anterior nuchal region to end of free rear tip of pectoral fin; more or less evenly spaced; about 14 thorns of varying size in holotype. Interdorsal thorns poorly defined, partly naked dermal ridge, extending in a single feeble row from free rear tip of first dorsal fin to about half eye diameter anterior to second dorsal-fin origin; much smaller than predorsal thorns, 4 in holotype (paratype RMNH PISC 35840 with about 14 thorns). A row of two short, disjunct patches (rows) of scapular thorns on each side of disc in holotype; positioned just forward of level of apices of pectoral fins; anterior patch with 3–4 thorns, its length about half of eye diameter; posterior patch with 2–3 thorns, short, less than half eye diameter; lateral patches absent in holotype.

Dorsal fins similar in shape, raked, shark-like, with strongly convex anterior margins (shallowly concave at base), bluntly pointed apices, deeply concave posterior margins, sharply acute free rear tips, and straight inner margins. Inner margin of first dorsal fin 67% (65–119%) of its base length. First dorsal fin considerably larger than second; origin about over origins of pelvic fins; free rear tip opposite or slightly behind free rear tips of pelvic fin. Interdorsal space 2.1 (1.9–2.9) times length of first dorsal base, about 3.0 (2.9–4.4) of length of second dorsal-fin base. Caudal fin rather short; dorsal caudal margin 6.3 (5.8–6.8) in total length, subequal to interdorsal space. Dorsal caudal margin moderately convex, slightly concave near its origin; tip bluntly pointed. Preventral caudal margin weakly convex, less so anteriorly; ventral lobe well developed, strong, angular (relatively shorter and less well-defined in juveniles). Lower postventral caudal margin short, weakly concave, 3.1 (3.0 in one paratype) in length of upper. Upper postventral margin weakly concave. Caudal axis elevated slightly, forming a narrow angle to body axis. Pectoral fins originating at about spiracles, with almost straight anterior margins; apices broadly pointed, posterior margins almost straight; free rear tips narrowly rounded, extending 77% (83–104%) percent of distance between pectoral and pelvic-fin bases (pectoral–pelvic space); inner margins straight to weakly convex. Pelvic fins small, with weakly convex anterior

Table 1. Morphometric data for the holotype of *Rhynchobatus springeri* sp. nov. (RMNH PISC 35839), with ranges and means for specimens <700 mm TL and >700 mm TL. Measurements are expressed as a percentage of total length.

		Paratypes (<700 mm TL) n=20			Paratypes (>700 mm TL) n=5		
	Holotype	Min.	Max.	Mean	Min.	Max.	Mean
TOT – Total length (mm)	410	374	610		748	1270	
FOR – Fork length	92.7	–	–	–	–	–	–
PCL – Precaudal length	84.1	78.9	84.5	82.4	82.1	84.6	83.9
PD2 – Pre-second dorsal length	68.6	66.7	69.3	68.2	66.6	68.7	67.6
PD1 – Pre-first dorsal length	47.3	43.9	48.1	45.6	41.5	44.5	43.4
PP2 – Prepelvic length	46.9	43.1	46.4	44.5	42.1	43.3	42.7
SVL – Snout–vent length	46.5	44.2	50.1	46.1	42.4	43.9	43.4
PSP – Prespiracular length	21.6	–	–	–	18.9	20.5	19.7
PG1 – Prebranchial length	27.3	26.1	27.4	26.8	22.8	25.4	24.1
HDL – Head length	31.5	29.2	32.6	30.9	26.8	29.5	28.5
POB – Preorbital length (direct)	17.8	15.1	17.5	16.3	12.4	15.5	14.4
POR – Preoral length	21.3	19.2	21.9	20.6	15.9	18.6	17.8
PRN – Prenarial length	15.4	13.1	15.8	14.3	11.0	14.5	12.8
IDS – Interdorsal space	15.0	14.4	16.7	15.8	15.4	18.2	16.5
DCS – Dorsal–caudal space	10.5	8.3	14.4	10.5	9.9	12.6	10.8
PPS – Pectoral–pelvic space	6.0	4.5	7.7	5.9	4.7	7.2	5.7
PCS – Pelvic–caudal space	33.9	31.2	35.7	33.6	34.4	37.8	35.3
PDS – Pelvic–dorsal space	-0.5	-0.6	1.0	0.1	-0.3	0.4	0.1
DW – Disc width	32.8	30.0	34.8	33.1	32.6	35.9	33.4
DL – Disc length	44.9	41.3	46.0	43.3	39.1	43.1	41.1
DT – Disc thickness	7.0	–	–	–	7.1	7.7	7.4
Snout – Greatest width	36.3	33.2	37.5	35.2	29.6	33.2	32.2
SWB – Snout width at base	16.2	14.9	16.5	15.8	13.6	14.8	14.3
COL – Corneal/eye length	3.3	2.3	3.2	2.7	1.5	2.1	1.8
COH – Corneal/eye height	1.8	–	–	–	1.0	1.4	1.2
EYL – Eye [eyeball] length	5.1	4.2	5.3	4.7	3.5	4.1	3.8
EYH – Eye (eyeball) height	2.3	–	–	–	2.4	2.4	2.4
INO – Interorbital space	5.6	5.0	5.7	5.2	4.6	5.2	5.0
SPL – Spiracle length	1.6	–	–	–	1.6	1.6	1.6
SPH – Spiracle height	2.4	1.8	2.5	2.2	2.0	2.2	2.1
ESL – Eye–spiracle space	6.4	–	–	–	5.2	5.2	5.2
INS – Interspiracular space	6.7	5.9	7.0	6.5	5.5	6.1	5.9
NOW – Nostril width	5.1	5.1	5.9	5.4	4.6	5.0	4.9
INW – Internarial space	4.3	3.8	4.6	4.1	3.4	3.9	3.8
ANF – Anterior nasal flap length	1.1	–	–	–	1.0	2.0	1.5
NSE – Nostril to snout edge	1.6	–	–	–	1.2	1.2	1.2
MOL – Mouth length	0.4	–	–	–	0.7	0.7	0.7
MOW – Mouth width	6.1	6.0	7.2	6.4	5.9	6.1	6.0
ULA – Upper labial furrow length	0.7	–	–	–	1.2	1.2	1.2
LLA – Lower labial furrow length	0.7	–	–	–	0.8	0.8	0.8
GS1 – First gill slit height	1.4	1.2	1.9	1.6	1.6	1.8	1.7
GS2 – Second gill slit height	1.4	1.6	1.9	1.7	1.7	1.9	1.8
GS3 – Third gill slit height	1.4	1.5	2.0	1.7	1.7	1.9	1.8

Table 1. cont'd.

		Paratypes (<700 mm TL) n=20			Paratypes (>700 mm TL) n=5		
	Holotype	Min.	Max.	Mean	Min.	Max.	Mean
GS4 – Fourth gill slit height	1.3	1.4	1.7	1.5	1.7	1.7	1.7
GS5 – Fifth gill slit height	1.1	0.9	1.4	1.2	1.0	1.3	1.1
ING1 – Inter 1st gill	14.1	12.5	15.3	14.1	12.9	14.1	13.4
ING5 – Inter 5th gill	10.4	9.8	10.6	10.2	9.6	10.4	9.9
HDH – Head height	5.2	4.1	5.0	4.7	3.8	7.5	4.8
TRH – Trunk height	7.1	3.7	8.5	7.1	8.2	9.0	8.5
TRW – Trunk width	12.6	11.8	13.9	13.2	13.6	14.3	13.9
ABH – Abdomen height	5.3	–	–	–	7.5	7.5	7.5
ABW – Abdomen width	11.0	–	–	–	12.9	12.9	12.9
CPH – Caudal peduncle height	1.6	–	–	–	1.6	1.6	1.6
CPW – Caudal peduncle width	3.2	–	–	–	3.7	4.1	3.9
VNL – Vent length	2.5	–	–	–	2.5	3.0	2.8
TFL – Tail fold length	35.1	–	–	–	34.6	35.8	35.2
P1L – Pectoral-fin length	21.9	–	–	–	20.6	22.9	21.8
P1A – Pectoral-fin anterior margin	14.2	–	–	–	13.9	15.3	14.6
P1B – Pectoral-fin base	16.4	–	–	–	16.6	17.1	16.9
P1H – Pectoral-fin height	9.0	–	–	–	10.2	10.3	10.2
P1P – Pectoral-fin posterior margin	12.3	–	–	–	12.9	15.1	14.0
P1I – Pectoral-fin inner margin	4.6	5.5	5.7	5.6	4.5	5.3	4.9
P2L – Pelvic-fin length	12.5	11.7	13.1	12.5	12.6	15.5	13.6
P2A – Pelvic-fin anterior margin	7.2	7.1	7.6	7.3	7.5	8.4	8.0
P2B – Pelvic-fin base	5.1	4.9	5.9	5.3	5.5	6.0	5.7
P2H – Pelvic-fin height	5.3	4.4	6.2	5.4	5.3	7.1	6.0
P2P – Pelvic-fin posterior margin length	8.0	–	–	–	8.4	11.9	10.2
P2I – Pelvic-fin inner margin length	7.6	6.3	8.1	7.2	7.4	10.0	8.1
P2S – Pelvic-fin span	17.0	–	–	–	19.9	19.9	19.9
CLO – Clasper outer length	–	2.0	3.0	2.6	6.5	11.5	9.4
CLI – Clasper inner length	–	–	–	–	15.7	19.9	17.8
CLB – Clasper base width	–	–	–	–	0.7	1.8	1.3
D1L – First dorsal-fin length	12.0	11.5	15.0	13.6	12.4	16.4	14.6
D1A – First dorsal-fin anterior margin	13.7	14.1	15.2	14.7	14.6	14.6	14.6
D1B – First dorsal-fin base	7.2	5.4	8.1	7.0	7.5	8.0	7.8
D1H – First dorsal-fin height	8.3	8.4	10.9	9.8	10.4	11.2	10.7
D1P – First dorsal-fin posterior margin	8.3	–	–	–	11.1	11.1	11.1
D1I – First dorsal-fin inner margin	4.8	4.9	8.8	6.6	4.9	8.4	6.5
D2L – Second dorsal-fin length	9.3	8.4	11.5	10.4	9.1	11.4	10.6
D2A – Second dorsal-fin anterior margin	10.9	10.8	10.9	10.8	11.3	11.3	11.3
D2B – Second dorsal-fin base	4.9	3.7	5.6	4.9	4.9	5.3	5.1
D2H – Second dorsal-fin height	6.1	6.1	8.1	7.0	7.1	8.9	7.9
D2P – Second dorsal-fin posterior margin	6.2	–	–	–	7.3	7.3	7.3
D2I – Second dorsal-fin inner margin	4.2	4.2	6.8	5.5	4.2	6.1	5.2
CDM – Dorsal caudal margin	15.9	14.8	17.3	15.9	15.5	17.4	16.4
CPV – Preventral caudal margin	11.1	8.8	12.0	10.6	11.0	12.4	11.6
CPL – Lower postventral caudal margin	2.9	–	–	–	3.4	3.4	3.4
CPU – Upper postventral caudal margin	9.2	–	–	–	10.3	10.3	10.3

margins, broadly pointed apices, concave posterior margins (more so anteriorly), elongate and very narrowly rounded free rear tips, and concave inner margins; inner margin very long, 1.5 (1.1–1.6) times lengths of pelvic bases; fin bases 1.2 (0.9–1.5) in pectoral–pelvic space; height of pelvic fins about 2.4 (2.1–2.9) in their lengths. Distance between pelvic-fin insertions much longer than pelvic-fin base length. Vent with well-developed folds laterally; well separated from pelvic-fin inner margins. Clasper very elongate, slender, weakly expanded distally at glans, extending almost to origin of second dorsal fin.

Vertebral column with 136 (127–139; n=30, including 8 non-types) total centra; 12 (13–19) synarcual centra, 26 (18–28) monospondylous centra, 87 (78–88) precaudal free centra, 37 (33–40) diplospondylous caudal (free) centra, 124 (113–126) free centra. Total synarcual segments 8.8% (8.8–11.6)%; monospondylous 19.1% (13.6–20.6)%; diplospondylous precaudal centra 44.9% (42.6–49.2)%, and precaudal free centra 64.0% (60.3–65.2)% of total centra count. Total pectoral radials 59–60 (57–68): 4 (1–8) free radials before propterygium, 20–21 (20–23) propterygials, 5–6 (4–5) mesopterygials, 4–5 (4–7) neopterygials, 25 (23–29) metapterygials, 55–56 (54–62) total basal radials (excluding free radials).

COLOUR.— When fresh (based on IPPS 2009–338, adult male 1126 mm TL): Dorsal surface of body pale greyish green (becoming more greenish brown well after death), with well-defined blackish pectoral spots (and dark spots and markings on orbital membranes), and a dense pattern of large, diffuse-edged white spots. Pectoral disc with narrow, weakly defined whitish border dorsally, broadest mid-anteriorly beside spiracle. Pelvic fins and clasper whitish. Orbital membrane with two curved black markings; anterior marking diverging posteriorly, abutted anteriorly by white blotch; posterior marking diverging anteriorly, larger than anterior marking, bordered ventrally by white membrane and almost abutting spiracle posteriorly; preorbit with an oblique white line (length subequal to eye diameter), directed medially. Posterior margin of spiracle and spiracular folds greyish. Black pectoral markings well defined, sharp edged, large (exceeding length of spiracle); closely surrounded by 4 white spots, lateral pair closer together than medial pair. Well defined, blackish spot posteromedial to each spiracle (diameter smaller than spiracle). White spots covering most of trunk and tail, their size subequal to pupil width or slightly smaller, bordered by faint greyish rings; in more than 3 rows on posterior part of pectoral fin; in 3–4 rows beneath first dorsal fin, spots on ventralmost row largest; in 3 well-defined, closely spaced rows along each side of tail to caudal-fin base, partly coalescing posteriorly to form a pale line; a few white spots on mid-snout and supraorbit. Ventral surface uniformly white; no irregular blackish blotch on anterior snout. In preservative (holotype): Yellowish brown above, uniformly paler yellowish white ventrally (white area appearing on tail when dry a likely

Figure 2. *Rhynchobatus springeri* sp. nov.: View of oronasal region of female holotype (RMNH PISC 35839, 410 mm TL, preserved).

Figure 3. Orbito-spiracular and scapular regions of *Rhynchobatus springeri* sp. nov, adult male paratype (IPPS 2009–338, 1126 mm TL, fresh).

artifact of preservation); unpaired fins similar to body coloration, small pale areas at base of dorsal fins. Black pectoral marking large (about ¾ orbit diameter), closely surrounded by four large, diffuse-edged white spots; two outer spots closer together than two inner spots; white spots less than half their diameter from black pectoral marking. Similar white spots present on anterior snout, interorbit, pectoral fin and in 2 main rows along side of trunk (ending beneath first dorsal fin). Orbital membrane with dark recurved markings; discontinuous, extending from near front of eye to level of spiracle; no evidence of dark postspiracular blotches. Two lines on preorbit; anterior line oblique, extending anteromedially from anteroventral edge of eye, its length slightly longer than eye; posterior line along anterior margin of orbit.

SIZE.— Females reaching at least 213 cm TL (CAS-GVF 2125 unreg); a suggested maximum size of 250–300 cm TL, based on specimens seen by one of us in Thailand (LJVC in Compagno & Last, 1999), needs confirmation; two male paratypes from Sarawak (IPPS 2009–338, adult male 1126 mm TL) and Thailand (CAS-GVF 2361 unreg) were fully mature at 113 and 125 cm TL respectively, suggesting that this species is a moderate-sized wedgefish rather than a large species.

DISTRIBUTION.— Indo–Malay region from Java (Indonesia) to Thailand, including Borneo, Singapore and the Philippines. Possibly more widespread in the Indo-Pacific, north to the East China Sea and west to Sri Lanka, but needing positive confirmation. Appears to be confined mainly to brackish coastal and estuarine habitats in shallow water.

ETYMOLOGY.—This wedgefish is named in honour of the late Stewart ("Stew") Springer who, internationally respected for his research on sharks, is hereby recognised for his contribution to the systematics of the genus *Rhynchobatus*. Vernacular: Broadnose Wedgefish.

REMARKS.— The Broadnose Wedgefish, *Rhynchobatus springeri* differs from other wedgefishes primarily in vertebral counts, but also in coloration and morphology of the snout. It has the second lowest vertebral count range of any member of the genus. Of species occurring in the region, *R. springeri* has 113–126 free vertebral centra vs. 130–139 in *R. palpebratus* (Compagno & Last, 2008), and 160–182 in *R. australiae*, 149–158 in *R.* cf. *laevis*, and 113–116 in *R.* sp. 1 (Compagno & Last, 1999). It also has a relatively broader snout than most other wedgefishes occurring in the region, with the exception of *R.* cf. *laevis*. Other species typically have either a bottle-shaped snout or the snout margin is almost straight. *Rhynchobatus* sp. 1, which has a dark body covered with large white spots, lacks a dark pectoral marking, and has rows of enlarged thorns along the rostral ridges, has characters unique within the genus. The black pectoral marking in *R. springeri* is usually surrounded by four white spots (less commonly with 3), but lacks a row of three well-defined spots adjacent its inner margin; of the other Indo–Malay species, *R. australiae* has three spots aligned in a straight row adjacent the inner margin of the pectoral marking, whereas *R. palpebratus* lacks this row of spots (also typically has four spots arranged around the pectoral marking).

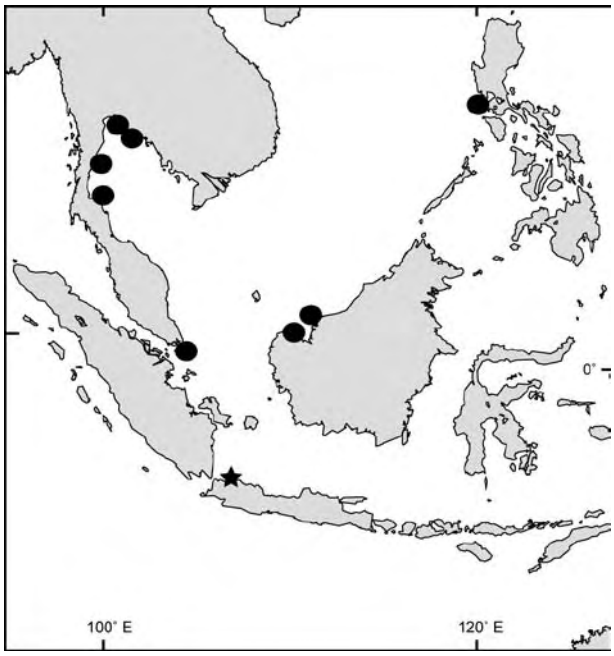

Figure 4. Distribution of *Rhynchobatus springeri* sp. nov. in the Western Central Pacific. Solid star represents holotype, solid circles represent paratypes.

Rhynchobatus springeri and *R. palpebratus* are very similar to each other. Additional to differences in vertebral counts, *R. palpebratus* has fewer, less well-developed rows of white spots along the sides of adults; the adult male holotype (CSIRO H 3384–01) of *R. palpebratus* is similar to its juvenile paratypes having two short rows of spots on each flank that terminate beneath the first dorsal fin posteriorly (the uppermost row of which sometimes continues along the mid-dorsal tail as a pale, faint line). In adult *R. springeri* (based on paratype IPPS 2009–338 and images of two discarded specimens from Sarawak), the tail is more heavily spotted, with 3–4 postdorsal rows of spots on each side that continue to the caudal fin; spots on the posterior parts of these rows sometimes coalesce to form pale lines). *Rhynchobatus springeri* also has slightly better developed thorns in the predorsal row and above the scapulocoracoid, and a marginally broader snout, but otherwise, no other obvious morphometric differences were found. However, these species have different sequences for the mitochondrial Cytochrome Oxidase 1 (COI) gene. A molecular barcode was resolved for one paratype of *R. springeri* (IPPS 2009–338, adult male 1126 mm TL) and compared with 11 *R. palpebratus* specimens (including the holotype and two paratypes).

Kimura 2-parameter corrected sequence divergence between *R. springeri* and *R. palpebratus* ranged from 2.6% to 3.0%, compared with an intraspecific range of 0.0%–0.3% for *R. palpebratus*. There may also be differences in habitat preference between these species. It appears as if *R. springeri* is found mainly in brackish coastal and estuarine waters rather than the more typical habitat of wedgefishes, the open sea; specimens observed in fish markets were associated with catches containing inshore/estuarine teleosts (e.g. *Otolithoides*, *Muraenesox* and polynemids).

The holotype of *R. springeri*, which has remained in surprisingly good condition, was collected almost a century ago from Java, eastern Indonesia. Its appearance is typical of other type specimens, although the dorsal fins (first dorsal-fin height 8.3% vs. 8.4–11.2, mean 10.0% TL) are slightly shorter than in most paratypes. Allometric patterns were not explored in the study, although changes in growth appear to be likely for some characters (see Table 1). Also, the morphometric data for the type series is more intraspecifically variable than in other rhinobatoid species. Perhaps the combination of some old and often bent material with fresh material in better condition has added unwanted variability to the data. The extent of intraspecific variability in colour and shape needs further investigation.

Compagno & Last (1999) considered *Rhynchobatus yentinensis* Wang, 1933 to be a possible synonym of their *R*. sp. 2, but later considered it more likely to be synonymous with *R. laevis* (Bloch & Schneider 1801) (Compagno & Last 2008; Eschmeyer, 2010). Wang's account of the male holotype (1010 mm TL) gives an upper tooth row count of 27 (well below the 52 rows in the holotype of *R. springeri*), a dark spot on the snout (vs. absent), first dorsal fin inserted above or slightly behind ventral-fin origin (vs. first dorsal-fin origin over pelvic-fin origin), and only 2 series of white spots (vs. 3–4 series of spots) along the tail of adult males (ca. 120 cm TL).

Comparative material.
Rhynchobatus palpebratus: CSIRO H 3384–01, adult male 1025 mm TL, north-west of Wessel Islands, Arafura Sea, Northern Territory, 10°11′ S, 137°17′ E, 50 m, 09 Feb. 1993.

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REFERENCES

Bigelow, H.B. & Schroeder, W.C. (1953) Fishes of the western North Atlantic. Part two. Sawfishes, guitarfishes, skates and rays. *Memoirs of the Sears Foundation of Marine Research* 1: 1–514.

Bloch, M.E. & Schneider, J.G. (1801) *M. E. Blochii, Systema Ichthyologiae iconibus cx illustratum. Post obitum auctoris opus inchoatum absolvit, correxit, interpolavit Jo. Gottlob Schneider, Saxo. Berolini. Sumtibus Auctoris Impressum et Bibliopolio Sanderiano Commissum*. Systema Ichthyologie, 584 pp.

Compagno, L.J.V. (1973) Interrelationships of living elasmobranchs. *In*: P.H. Greenwood, R.S. Miles & C. Patterson (eds). Interrelationships of fishes. *Journal of the Linnean Society (Zoology)* 53(Suppl. 1): 1–37.

Compagno, L.J.V. (1977) Phyletic relationships of living sharks and rays. *American Zoologist* 17: 302–322.

Compagno, L.J.V. (1984) FAO Species Catalogue. Vol. 4, Sharks of the World. An annotated and illustrated catalogue of shark species known to date. *FAO Fisheries Synopsis* No. 125. vol. 4, pt. 1 (Hexanchiformes to Lamniformes), pp. vii, 1–250, pt. 2 (Carcharhiniformes), pp. 251–655.

Compagno, L.J.V. (1988) *Sharks of the Order Carcharhiniformes*. The Blackburn Press, New Jersey, 486 pp.

Compagno, L.J.V. (1999) Chapter 3. Endoskeleton, pp 69–92. *In*: W.C. Hamlett (ed.). *Sharks, skates and rays. The biology of elasmobranch fishes*. Johns Hopkins

Press, Baltimore, USA.

Compagno, L.J.V. (2001) *Sharks of the World: an annotated and illustrated catalogue of shark species known to date. Volume 2. Bullhead, mackerel and carpet sharks (Heterdontiformes, Lamniformes and Orectolobiformes)*. FAO, Rome, 269 pp.

Compagno, L.J.V. (2003) *Sharks of the Order Carcharhiniformes*. Reprint of the 1988 Princeton book, with new introduction. Blackburn Press, Massachusetts, 572 pp.

Compagno, L.J.V. & Last, P.R. (1999) Rhinidae (=Rhynchobatidae), Wedgefishes, pp 1418–1422. *In*: Carpenter, K.E. & Niem, V.H. (eds). *FAO species Identification Guide for Fishery Purposes. The living marine resources of the Western Central Pacific. Volume 3. Batoid fishes, chimaeras and bony fishes part 1 (Elopidae to Linophrynidae)*. FAO, Rome, 1466 pp.

Compagno, L.J.V. & Last, P.R. (2008) A new species of wedgefish, *Rhynchobatus palpebratus* sp. nov. (Rhynchobatoidei: Rhynchobatidae), from the Indo–West Pacific, pp 227–240. *In*: P.R. Last, W.T. White & J.J. Pogonoski (eds). Descriptions of New Australian Chondrichthyans. *CSIRO Marine and Atmospheric Research Paper 022*, 358 pp.

Compagno, L.J.V. & Randall, J.E. (1987) *Rhinobatos punctifer*, a new species of guitarfish (Rhinobatiformes: Rhinobatidae) from the Red Sea, with notes on the Red Sea batoid fauna. *Proceedings of the California Academy of Sciences (Series 4)* 44: 335–342.

Compagno, L.J.V. & Roberts, T.R. (1982) Freshwater stingrays (Dasyatidae) of southeast Asia and New Guinea, with description of a new species of *Himantura* and reports of unidentified species. *Environmental Biology of Fishes* 7: 321–339.

Ehrenbaum, E. (1914) Ueber Fische von Westafrica, besonders von Kamerun. *Der Fischerbote* 6(11–12): 401–409.

Eschmeyer, W.N. (ed.) (2010) *Catalog of Fishes electronic version (19 February 2010)*. http://research.calacademy.org/ichthyology/catalog/fishcatmain.asp

Forsskål, P. (1775) *Descriptiones animalium, avium, amphibiorum, piscium, insectorum, vermium / quae in itinere orientali observavit Petrus Forskål. Post mortem auctoris edidit Carsten Niebuhr. Adjuncta est material medica kahirina atque tabula maris Rubri geographica*. Hauniæ: ex officina Mölleri, 1–20 + i–xxxiv + 1–164.

Fowler, H.W. (1941) The fishes of the groups Elasmobranchii, Holocephali, Isospondyli, and Ostariophysi obtained by United States Bureau of Fisheries Steamer Albatross in 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. *Bulletin of the United States National Museum* (100) 13: 1–879.

Garman, S. (1913) The Plagiostomia (sharks, skates, and rays). *Memoirs of the Museum of Comparative Zoology* 36: i–xii + 1–515.

Hubbs, C.L. & Ishiyama, R. (1968) Methods for the taxonomic studies and description of skates (Rajidae). *Copeia* 1968: 483–491.

Leviton, A.E., Gibbs, R.H., Jr., Heal, E. & Dawson, C.E. (1985) Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985: 802–832.

McEachran, J.D., Dunn, K.A & Miyake, T. (1996) Interrelationships of the batoid fishes (Chondrichthyes: Batoidea), pp 63–84. *In*: M.L.J. Stiassny, L.R. Parenti & G.D. Johnson (eds). *Interrelatioships of Fishes*. Academic Press, New York.

Müller, J. & Henle, F.G.J. (1837) *Gattungen der Haifische und Rochen nach einer von ihm mit Hrn. Henle unternommenen gemeinschaftlichen Arbeit über die Naturgeschichte der Knorpelfische.* Bericht Akademie der Wissenschaften zu Berlin 1837: 111–118.

Müller, J. & Henle, F.G.J. (1841) *Systematische Beschreibung der Plagiostomen*. Berlin. Plagiostomen i–xxii + 103–200.

Randall, J.E. & Compagno, L.J.V. (1995) A review of the guitarfishes of the genus *Rhinobatos* (Rajiformes: Rhinobatidae) from Oman, with description of a new species. *The Raffles Bulletin of Zoology* 43: 289–298.

Springer, V.G. & Garrick, J.A.F. (1964) A survey of vertebral numbers in sharks. *Proceedings of the United States National Museum* 116: 73–96.

Stehmann, M. (1981) Batoid Fishes. *In*: W. Fischer, G. Bianchi & W.B. Scott (eds). *FAO Species Identification Sheets for Fisheries Purposes, Eastern Central Atlantic, Batoid Fishes. Fishing Area 34 and Part of 47*. FAO, Rome. 240 pp.

Wang, K.F. (1933) Preliminary notes on the fishes of Chekiang (Elasmobranches). *Contributions from the Biological Laboratory of the Science Society of China. (Zoological Series)* 9: 87–117.

Whitley, G.P. (1939) Taxonomic notes on sharks and rays. *Australian Zoologist* 9: 227–262.

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