Rhinobatos jimbaranensis and *R. penggali*, two new shovelnose rays (Batoidea: Rhinobatidae) from eastern Indonesia

by

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ABSTRACT. - Two new shovelnose rays, *Rhinobatos jimbaranensis* sp. nov. and *R. penggali* sp. nov., are described from material collected at fish markets in eastern Indonesia during surveys to describe the commercial shark and ray fauna of the region. The two new species are superficially similar to each other and reach the same maximum size (about 100 cm TL), but they differ significantly in some body proportions and in colour. *Rhinobatos penggali* belongs to a subgroup of white-spotted *Rhinobatos* species that includes *R. punctifer* from the western Indian Ocean, but they differ in some body proportions and the configuration of spots. *Rhinobatos jimbaranensis* lacks white spots. *Rhinobatos penggali* is known from markets at Bali and south Java, whilst *R. jimbaranensis* is known only from Jimbaran Bay (southern Bali).

RÉSUMÉ. - *Rhinobatos jimbaranensis* et *R. penggali* (Batoidea ; Rhinobatidae), deux nouvelles raies guitares d'Indonésie orientale.

Rhinobatos jimbaranensis sp. nov. et *R. penggali* sp. nov. sont décrites à partir de spécimens récoltés sur des marchés aux poissons en Indonésie orientale, lors de missions de terrain effectuées dans le cadre d'un projet qui avait pour but de décrire les espèces commerciales de requins et de raies de la région. Les deux nouvelles espèces se ressemblent en apparence et elles ont des tailles maximales voisines de 100 cm, mais elles diffèrent significativement par certains caractères biométriques et par leur coloration. *Rhinobatos penggali* appartient au sous-groupe des espèces du genre *Rhinobatos* présentant des points blancs sur le corps, qui inclut *R. punctifer* de l'océan Indien occidental, de laquelle elle diffère par certaines proportions et par la distribution des points blancs. *Rhinobatos jimbaranensis* ne présente aucun point blanc. *Rhinobatos penggali* a été observée sur les marchés du sud de Bali et de Java, tandis que *R. jimbaranensis* n'est connue que de la baie de Jimbaran (sud de Bali).

Key words. - Rhinobatidae - *Rhinobatos jimbaranensis* - *Rhinobatos penggali* - ISW - Eastern Indonesia - Western Indian Ocean - Taxonomy - New species.

Surveys of the fish markets of eastern Indonesia between April 2001 and October 2004, as part of a collaborative Australian/Indonesian investigation of the chondrichthyan fishes of the region, led to the identification of approximately 139 species of sharks and rays. Many of these are commercially important but little is known of their distribution and biology, and some species are new to science. Included amongst the new taxa were two shovelnose rays of the genus *Rhinobatos* (Rhinobatidae). The new species are described and figured below and their possible affinities are discussed briefly.

The family Rhinobatidae is represented in the Western Central Pacific by 11 species (Compagno and Last, 1999), of which two, *Rhinobatos thouin* (Anonymous, *in* Lacepède, 1798) and *R. typus* Bennett, 1830, are known to occur in Indonesia. These two rays belong to a species complex, known as the '*granulatus*' group (Last *et al*., 2004), for which the genus-group name *Glaucostegus* Bonaparte, 1846 may be applicable. The new *Rhinobatos* species both belong to a larger unresolved group that includes the type species of the genus, *R. rhinobatos* (Linnaeus, 1758) from the Eastern Atlantic and Mediterranean Sea, and *R. sainsburyi* Last, 2004, from nearby northwestern Australia.

METHODS

Morphometric methodology follows a standard developed for the family Rhinobatidae at a FAO-funded workshop on batoid morphology and meristics (Paris, March 2002). Most of the measurements follow the existing convention for sharks and rays and are taken directly (point to point) unless otherwise stated. Measurements of the nasal region of *Rhinobatos* are outlined in Last *et al*. (2004). Fin measurements follow methods used for sharks by Compagno (1984). Refinements of shark morphometrics include: snout length - direct length from the snout tip to the firm nasal capsule adjacent the orbit (forward of eye socket);

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spiracle length - greatest length of the main cavity; preoral length - direct length from the snout to the posterior edge of upper jaw at its symphysis; mouth width - taken across the exposed width; pelvic-fin insertion to dorsal-fin origin - horizontal distance from the pelvic insertion to the origin of the first dorsal fin. Meristics were taken from radiographs; nasal lamellae counts were taken from the posterior half of the nasal capsule. Types are held in the collection of the Museum Zoologicum Bogoriense, Cibinong, Java, Indonesia (MZB) and the Australian National Fish Collection, Hobart, Tasmania, Australia (CSIRO).

RHINOBATOS JIMBARANENSIS SP. NOV.

(Figs 1, 2, 3A, Tab. I)
[English Name: Jimbaran shovelnose ray]

Holotype. - MZB 12905, male 579 mm TL, Kedonganan fish market (08°45'S, 115°10'E), Bali, Indonesia, 17 Jun. 2002.

Paratypes. - Five specimens collected at same locality as holotype: CSIRO H 5873-03, female, 544 mm TL; CSIRO H 5873-04, male, 654 mm TL, 16 Jun. 2001; CSIRO H 5888-04, female, 507 mm TL; CSIRO H 5888-05, female, 559 mm TL, 17 Jun. 2002; CSIRO H 6202-01, female embryo, 128 mm TL, 18 Apr. 2004.

Diagnosis

A species of the genus *Rhinobatos* distinguished by the following combination of adult characters: wedge-shaped disc, width 32-33% TL, disc length more than 1.3 (1.35-1.39) times width; moderately elongate snout, length 3.4-3.6 times interspiracular distance, 5-5.5 times interorbital width; medium-sized orbit, 1.5-1.6 times spiracle length; weakly oblique nostrils, their length 1.3-1.4 times internarial distance; preoral length 7.7-8.1 times internarial distance; anterior nasal flaps penetrating slightly into internarial space but well separated at their insertion; posterior nasal flaps broad; two spiracular folds, outermost fold only slightly taller than inner fold; ridges of rostral cartilage almost parallel, converging slightly anteriorly but not constricted medially; anterior cartilage sickle shaped, pointed posteriorly; distance between fifth gill slits 3.1-3.4 times in ventral head length; prebranchial sensory pore patch obvious, extending to first gill slit; postscapular sensory canal obscure, without exposed lateral pores, not grooved; thorn patches on supraorbit, scapular region, and dorsal midline rudimentary, inconspicuous; pelvic-fin inner margin slightly shorter than its base; interdorsal distance more than 2.5 (2.8-3.1) times first dorsal-fin base; dorsal caudal margin about 2.1 times preventral margin; upper jaw with 62-77 tooth rows; 176-180 post-synarcual centra; more than 50 (51-55) nasal lamellae; dorsal fin not distinctly bicolored; and no white spots on dorsal disc.

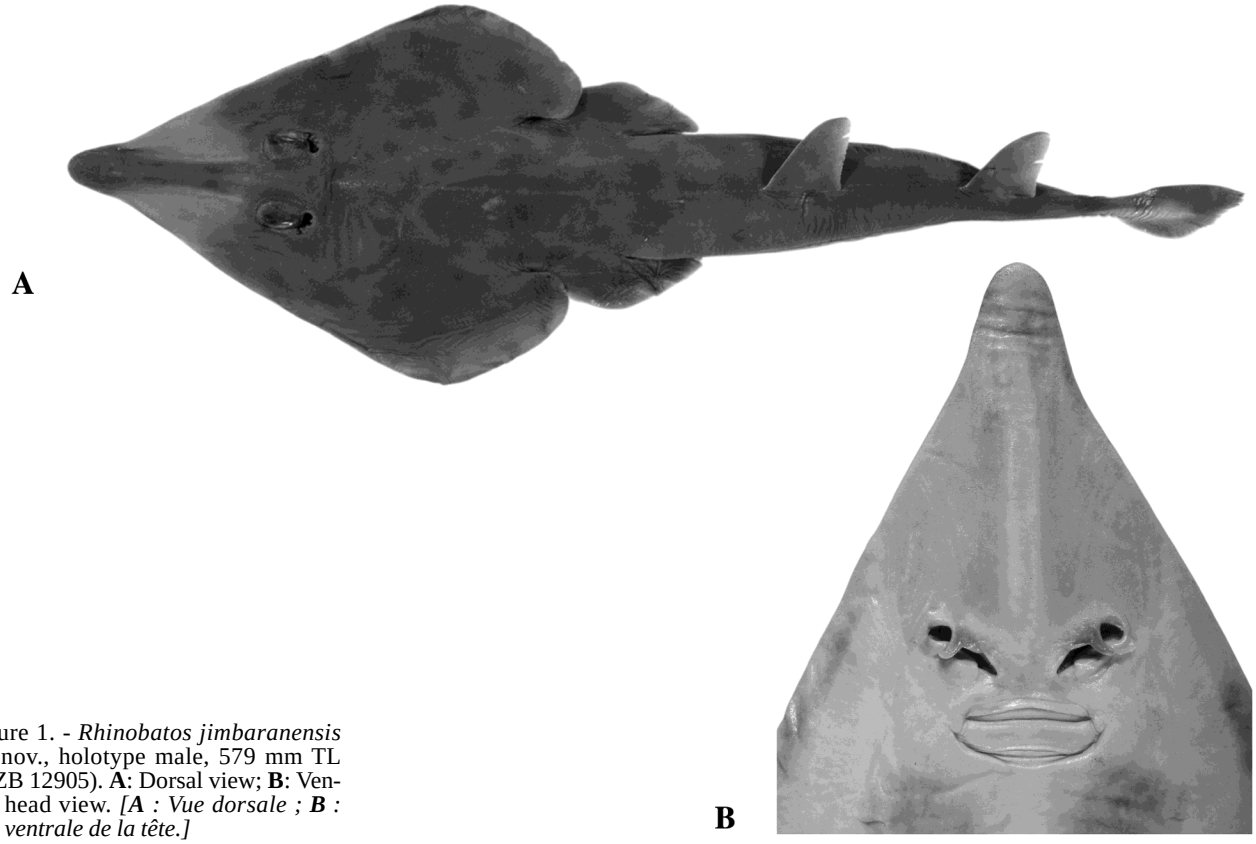

Figure 1. - *Rhinobatos jimbaranensis* sp. nov., holotype male, 579 mm TL (MZB 12905). **A**: Dorsal view; **B**: Ventral head view. *[**A** : Vue dorsale ; **B** : Vue ventrale de la tête.]*

Figure 2. - Radiograph of the chondrocranium of the holotype of *Rhinobatos jimbaranensis* sp. nov. (MZB 12905). *[Radiographie du chondrocrâne de l'holotype.]*

Description

Disc broadly wedge shaped, angular anteriorly, angle before eyes 59-60° (73° in late-term embryo CSIRO H 6202-01) outer margins broadly rounded, narrowly rounded distally, length 1.39 (1.35-1.38 in paratypes, excluding embryo) times width. Pelvic fins elongate, short-based, base length 0.91 (0.72-0.99) of inner margin length; total length 1.86 (1.60-1.86) times their base length, 2.24 (2.17-2.43) times width; anterior margin weakly convex anteriorly then becoming straight, apex broadly rounded, posterior margin convex. Tail moderately elongate, broad anteriorly, tapering; in cross-section nearly flat below, rounded above; tail length from anterior cloaca 1.34 (1.28-1.37) times precloacal length, 1.29 (1.25-1.35) times disc length, 5.87 (5.41-5.80) times its width at pelvic-fin insertions; tail width 2.19 (2.07-2.23) times depth at pelvic-fin insertions, 2.71 (2.63-2.82) at first dorsal-fin origin, 2.11 (2.09-2.19) at second dorsal-fin origin. Dermal fold lateral on tail, originating well anterior to free rear tip of pelvic fin, reaching just behind ventral caudal-fin origin; fold moderate, maximum width at interdorsal space about a half width of posterior nasal flap. Head moderately elongate, ventral length 29.3 (28.3-29.8)% TL; snout moderately long and bluntly pointed; preoral length 3.65 (3.68-3.74) times mouth width, 7.68 (7.67-8.07) times internarial distance, 1.51 (1.50-1.67) times dorsal caudal-fin margin, 4.96 (4.88-5.42) times distance from nostril to margin of disc; preorbital snout length (direct) 3.62 (3.44-3.61) times interspiracular length, 4.63 (4.51-4.80) times orbit, 5.34 (5.03-5.47) times interorbital width; interorbital space very slightly concave, almost flat, rather broad; eyes moderately large, not elevated or protruding, orbit relatively small, diameter 1.59 (1.54-1.62) times spiracle length, 1.15 (1.05-1.21) times interorbital distance. Spiracles narrowly bean-shaped, relatively large; two strongly compressed folds on posterior margin, length of innermost spiracular fold 0.6-0.9 of outer fold; distance between bases of folds 0.7-1 length of shortest fold. Nostril moderately large, oblique, nasal flaps well developed; anterior aperture subcircular, width only slightly exceeding length; nostril length 3.41 (3.27-3.68) times anterior aperture width, 1.47 (1.43-1.57) times anterior nasal-flap base length, 0.86 (0.83-0.91) times distance from nostril to edge of disc, 1.33 (1.31-1.36) times internarial distance. Anterior nasal flap narrow with long, slender process anteriorly; flap base 1.44 (1.46-1.68) times its width at process, 2.32 (2.27-2.42) times anterior aperture width; inserted slightly into internarial space, slightly lateral to nostril margin; distance between insertions of flaps 3.02 (3.05-3.33) in greatest distance across nostrils, 0.91 (0.89-0.97) in minimum internarial distance; process of flap about twice as long as wide, bluntly pointed distally, abutting posterolateral nasal flap and determining hind margin of anterior aperture. Posterolateral nasal flap lobe-like, broadest medially, length 3.97 (3.93-5.13) times width; originating just behind lateral extremity of anterior nasal aperture, extending posteromedially as a free fold to just behind level of insertion of anterior nasal flap. Posterior nasal flap strongly lobe-like, base length 1.91 (2.01-2.50) times its width, well short of innermost margin of nostril; width 1.09 (1.02-1.12) times anterior aperture width, 1.47 (1.28-1.74) times posterolateral nasal-flap width. Mouth width 1.58 (1.55-1.60) times nostril length, 7.75 (7.81-7.97) in precloacal length; positioned slightly forward of hind margin of orbit. Upper jaw weakly convex, upper lip arched; lower lip pronounced, separated from oral groove by ridges of strongly corrugated skin; strong, short lateral grooves around corners of mouth. Teeth

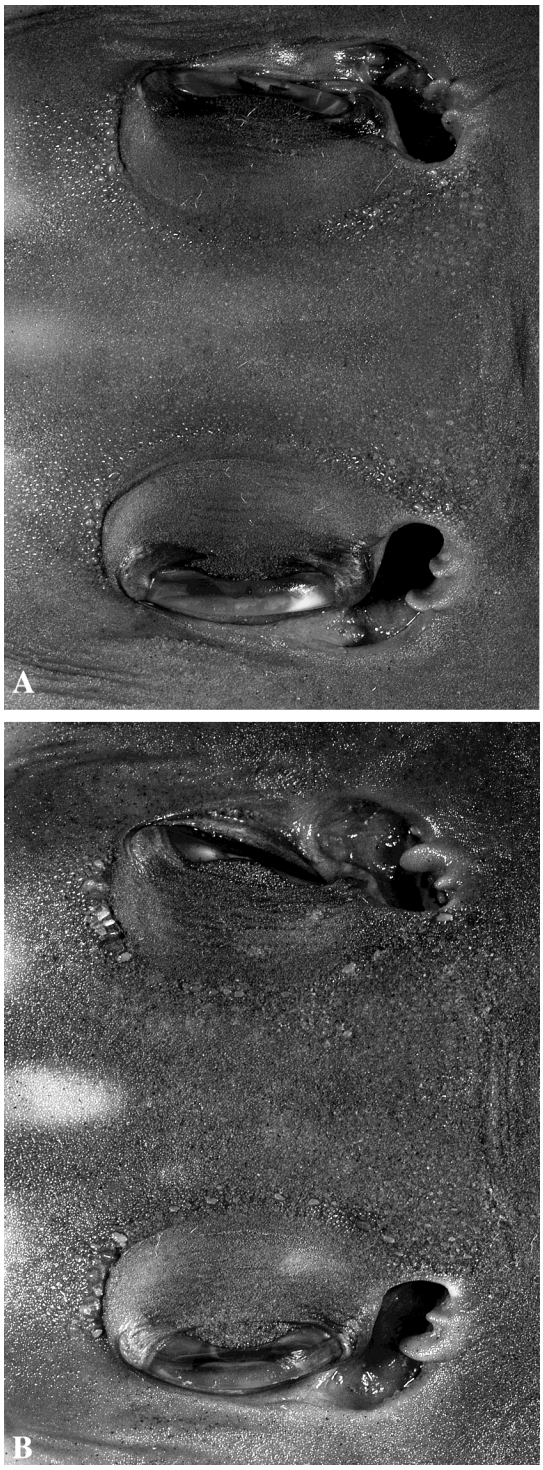

Figure 3. - Views of the orbital region of the holotypes of **A**: *Rhino - batos jimbaranensis* sp. nov. (MZB 12905), and **B**: *R. penggali* sp. nov. (MZB 12904), comparing the orbital squamation and shapes of the spiracular folds. *[Vues de la région orbitale des holotypes, com - parant l'écaillure orbitale et les formes des replis spiraculaires.]*

small, blunt, crowns rhomboidal with weak, pointed posterior cusps; teeth quincuncial, in 77 (60-72, mean 68) rows in upper jaw; upper and lower jaw teeth similar in shape and size. Gill openings distinctly s-shaped, fifth less so; length of third gill slit 2.59 (2.29-2.77) in nostril length, 6.46 (5.99-7.19) in distance between fifth gill slits; distance between first gill slits 1.42 (1.33-1.38) times distance between fifth gill slits; distance between fifth gill slits 3.32 (3.29-3.58) times internarial distance, 1.58 (1.60-1.69) times mouth width, 0.30 (0.29-0.32) of ventral head length. Dorsal fins relatively short, raked slightly; apices narrowly rounded rather than angular; anterior margins slightly convex; posterior margins straight to weakly concave, subfalcate; free rear tips almost forming right angle, produced slightly; first dorsal fin slightly taller than second, length of first 1.00 (0.86-1.01) times its height, base length 1.73 (1.86-2.17) times inner margin length; second dorsal-fin length 1.05 (1.00-1.19) times its height, base length 2.02 (2.19-2.30) times inner margin length. First dorsal fin well behind pelvic-fin insertion, interspace 0.83 (0.74-0.86) times interdorsal distance; interdorsal space moderate, 1.98 (2.06-2.30) times second dorsal-fin height, 2.93 (2.87-3.07) times base of first dorsal fin, 1.78 (1.64-1.92) times interspace between second dorsal-fin insertion and upper origin of caudal fin. Caudal fin relatively small, relatively deep and short; dorsal caudal margin 2.08 (2.06-2.14) times preventral margin length. Dermal denticles small, close-set, covering entire body and fins; surfaces uniformly coarsely granular, but becoming enlarged slightly along dorsal midline and infraorbit; slightly enlarged on midline of tail between dorsal fins, precaudal midline, snout tip, lateral margin of disc anteriorly, and on lateral fold; dense covering of denticles over nasal lamellae. Thorns minute, or rudimentary, often embedded, cusps low, blunt distally, rarely with sharp rear angle; weak around orbit, most pronounced on preorbit and near inner margin of spiracle, barely evident without magnification; similar on dorsal midline, somewhat globular, variable in shape and size, largest denticles in a single row; scapular patches with slightly enlarged embedded denticles, or weak thorns. Prebranchial sensory pore patch indistinct, extending to first gill slit. Postscapular sensory canals deeply embedded, not undulated anteriorly, termination indistinct, apparently extending well beyond halfway to pectoral-fin insertions; sensory pores not evident; sensory canal not forming a shallow groove. Rostral cartilage broad, its shaft increasing in width only slightly in a posterior direction; rostral node broadly expanded and elongate, rounded apically, not angular, axis at widest part of node 23.3% of length of rostral cartilage from snout tip; precerebral cavity relatively broad posteriorly, converging to a point anteriorly at rostral node, dorsolateral edges of cartilage surrounding cavity (rostral ridges on surface of snout) well separated posteriorly, not constricted medially; rostral cartilage about 67% of length of neurocranium, ventral edges of rostral cartilage united; nasal capsules large, their transverse axes anterolaterally directed;

Table I. - Morphometric data for the holotype of *Rhinobatos jimbaranensis* sp. nov. and *Rhinobatos penggali* sp. nov., with ranges provided for the paratypes. Measurements expressed as percentage of total length. *[Données morphométriques des holotypes avec les variations des paratypes. Les mesures sont données en pourcentage de la longueur totale.]*

	Rhinobatos jimbaranensis			*Rhinobatos penggali*		
	Holotype	Paratypes n = 4		Holotype	Paratypes n = 4	
	MZB 12905	min	max	MZB 12904	min	max
Total length	579	507	654	494	502	746
Disc width - maximum	31.8	31.8	32.8	36.8	36.5	37.3
Disc length	44.2	42.8	44.8	46.4	44.9	46.8
Head length - dorsal	23.1	23.0	24.0	23.1	22.5	24.8
Head length - ventral	29.3	28.3	29.8	31.2	29.5	32.0
Snout length - presocket	17.5	17.0	17.8	17.6	16.6	18.0
Orbit diameter	3.8	3.5	3.9	4.3	3.6	4.3
Spiracle length	2.4	2.2	2.5	2.8	2.6	2.8
Orbit and spiracle length	4.7	4.4	4.7	5.4	4.9	5.3
Interorbital width	3.3	3.2	3.4	3.9	3.9	4.3
Interspiracular width	4.8	4.7	5.1	5.7	5.4	5.9
Preoral length	20.2	19.8	20.7	20.6	19.4	21.4
Mouth width	5.5	5.4	5.6	6.3	6.0	6.7
Prenarial distance	16.5	15.8	16.8	16.2	15.2	16.7
Nostril length	3.5	3.5	3.5	4.2	3.8	4.1
Anterior aperture - width	1.0	0.9	1.1	1.4	1.3	1.4
Anterior nasal flap - base length	2.4	2.2	2.5	2.7	2.3	2.8
Anterior nasal flap - width	1.6	1.4	1.6	1.6	1.4	1.6
Posterolateral nasal flap - total length	3.0	3.0	3.2	3.4	3.3	3.7
Posterolateral nasal flap - width	0.8	0.6	0.8	0.7	0.6	0.8
Posterior nasal flap - base length	2.1	2.1	2.5	2.7	2.5	2.7
Posterior nasal flap - width	1.1	1.0	1.1	1.1	1.1	1.2
Distance across anterior nasal apertures	8.7	8.5	8.9	10.4	9.6	10.6
Internarial distance - minimum width	2.6	2.6	2.6	3.0	2.8	3.0
Distance between anterior nasal flaps	2.9	2.6	2.9	3.3	3.0	3.2
Distance from nostril to disc margin	4.1	3.8	4.2	3.6	3.5	3.7
Third gill opening - width	1.4	1.3	1.5	1.8	1.7	2.0
Distance between first gill openings	12.4	12.0	12.3	15.2	14.4	15.1
Distance between fifth gill openings	8.7	8.7	9.2	11.0	10.5	11.1
Pelvic fin - length	14.5	14.4	14.7	14.2	13.9	14.7
Pelvic fin - anterior margin length	8.5	7.8	8.4	8.4	7.9	8.5
Pelvic fin - width	6.5	5.9	6.8	6.0	5.7	6.2
Pelvic fin - base length	7.8	7.9	9.0	8.1	8.2	8.5
Pelvic fin - inner margin length	7.1	6.3	7.9	6.4	5.9	6.7
First dorsal fin - length	6.5	6.2	6.4	6.8	6.5	7.0
First dorsal fin - anterior margin length	9.3	8.5	9.4	10.2	9.5	9.7
First dorsal fin - height	6.5	6.4	7.3	6.8	6.2	7.2
First dorsal fin - base length	4.2	4.0	4.6	4.2	4.2	4.4
First dorsal fin - inner margin length	2.4	2.1	2.2	2.6	2.4	2.5
Second dorsal fin - length	6.5	6.2	6.4	6.8	6.3	7.1
Second dorsal fin - anterior margin length	8.8	8.1	8.6	9.2	8.8	9.1
Second dorsal fin - height	6.2	5.4	6.2	6.1	6.1	6.5
Second dorsal fin - base length	4.4	4.5	4.6	4.6	4.4	4.9
Second dorsal fin - inner margin length	2.2	2.0	2.1	2.3	2.0	2.2

Table I. - Continued. *[Suite.]*

	Rhinobatos jimbaranensis			*Rhinobatos penggali*		
	Holotype	Paratypes n = 4		Holotype	Paratypes n = 4	
	MZB 12905	min	max	MZB 12904	min	max
Caudal fin - dorsal margin	13.4	12.4	13.2	13.7	13.8	15.0
Caudal fin - preventral margin	6.4	6.0	6.2	6.4	5.8	6.5
Snout to first dorsal-fin origin	58.5	58.1	59.7	58.9	57.4	58.9
Snout to second dorsal-fin origin	75.0	75.3	76.1	74.9	73.3	74.6
Snout to upper caudal-fin origin	86.4	86.9	87.9	85.6	85.3	86.1
Snout to lower caudal-fin origin	88.3	88.4	89.3	86.6	87.7	88.1
Snout to pelvic-fin origin	38.7	38.5	40.0	42.8	41.0	42.9
Snout to anterior vent	42.8	42.3	43.9	45.9	43.5	45.4
Pelvic-fin insertion to dorsal-fin origin	10.1	9.0	10.5	8.5	7.0	8.1
Interdorsal distance	12.2	12.1	12.9	11.3	11.1	12.1
Caudal peduncle length (dorsal)	6.9	6.8	7.5	6.9	6.9	7.2
Body width - pelvic insertion	9.8	10.0	10.4	10.7	10.4	10.9
Disc width - anterior orbit	18.9	18.6	19.2	21.1	19.7	20.9
Body width - first dorsal-fin origin	9.4	9.3	9.8	9.6	9.5	10.0
Body width - second dorsal-fin origin	4.8	4.9	5.0	5.1	4.9	5.2
Body depth - maximum	5.7	4.1	5.4	5.8	4.9	6.1
Body depth - pelvic-fin insertion	4.5	4.6	4.9	4.6	4.5	5.0
Body depth - first dorsal-fin origin	3.5	3.4	3.7	3.6	3.6	4.1
Body depth - second dorsal-fin origin	2.3	2.3	2.4	2.4	2.4	2.6

maximum width across capsules 1.28 times nasobasal length of cranium (base of rostrum to occipital condyles); length of nasal capsule about equal to its width; basal plate narrow, its minimum width 4.35 times in nasobasal length; cranial roof with small oval fenestra, located behind precerebral cavity by a distance equivalent to its length; anterior cartilage narrowly triangular, sickle shaped, posterior apex bluntly pointed, without an anterior lobe extending beyond nasal capsules; preorbital processes indistinct; postorbital processes well developed, weakly bifurcate, posterior process most pronounced; greatest width across processes 1.65 times in nasobasal length. Nasal lamellae 51-55. Pectoral skeleton with 30-31 (28-33, n = 5) propterygial, 7 (7-10) mesopterygial, 2 (0-2) neopterygial, 29 (27-30) metapterygial, 68-69 (67-71) total radials; anterior radials of propterygium extending forward of nasal capsules by about 14.5% of rostral length. Total pelvic radials 27-29 in females (n = 5), 26-28 in males (n = 2) excluding clasper; one greatly enlarged, branched radial on the puboischiadic bar; 25-28 basipterygial radials; clasper of holotype not calcified. Vertebral column with 192 (188-193) total segments (synarcual and free), 179 (176-180) post-synarcual centra; 134 (132-137) total precaudal centra; 13 (12-14) synarcual segments; 29 (26-29) monospondylous precaudal centra, last two centra of holotype without ribs; 105 (104-108) diplospondylous precaudal centra, 45 (43-44) diplospondylous caudal centra.

Colour

In alcohol, subadults: dark greyish brown on dorsal surface over disc with evidence of rusty brown blotches; no evidence of white spots; distinctly paler yellowish brown lateral to rostral cartilage, on posterior margin of disc and outer pelvic fin and along upper lateral skin fold, precerebral fontanelle and spiracular folds; eyes dark bluish black, orbital membrane similar to coloration of disc. Ventral surface more or less uniformly creamy white, sometimes darker around branchial region and with irregular blotches on disc and tail in largest specimens; dark, volcanic sand granules impregnated between denticles appearing as melanophores. Dorsal fins medium brownish yellow, usually more dusky on posterior half; caudal fin similar to dorsal fins, ventral margin paler.

Prenatal juveniles: yellowish brown on dorsal surface, densely covered with slightly darker and paler spots; dark spots greyish, diffuse, similar in size, arranged more or less in transverse rows on posterior disc and tail; spots pale yellow, similar in size to and scattered between dark spots; margin of disc and pelvic fins paler than rest of dorsal surface, weakly spotted. Ventral surface uniformly pale. Fins on tail yellowish, dorsal fins each with large median dark spot, caudal fin with two large spots, spots slightly smaller than pupil diameter.

Size

The type series consists of two adolescent males, 579

(holotype) and 654 mm TL, and three females between 507 and 559 mm TL. Maximum sizes of specimens from Indonesian fish markets were 994 mm TL for females (n = 148, range 491-994 mm TL), and 892 mm TL for males (n = 104, range 506-892 mm TL). Males mature at about 770-800 mm TL. Smallest pregnant female 747 mm TL. Pregnant females have 6-11 embryos (n = 4); birth size unknown but embryos well developed at 130 mm TL.

Distribution

Known only from southern Bali, Indonesia. Caught by artisanal fishers using small demersal gill and trammel net vessels in Jimbaran Bay and landed at the nearby Kedonganan fish market at the northern end of the bay.

Etymology

Named after Jimbaran Bay, the type locality and only place from where specimens have so far been collected.

Comparisons

Rhinobatos jimbaranensis differs significantly from the following new species, with which it appears to occur sympatrically. The two species are similar in general body shape but differ in colour, meristics and in some body proportions. *Rhinobatos jimbaranensis* lacks white spots and has a relatively narrower (length 1.35-1.39 *vs* 1.20-1.27 times width) but shorter (length 43-45% *vs* 45-47% TL) disc, a slightly longer (tail length from anterior cloaca 1.28-1.37 *vs* 1.18-1.30 times precloacal length) and marginally less depressed tail (tail width 2.07-2.23 *vs* 2.20-2.36 times depth at pelvic-fin insertions), a shorter ventral head (length 28.3-29.8 *vs* 29.5-32.0% TL), and smaller oronasal (preoral length 3.65-3.74 *vs* 3.08-3.44 times mouth width, 7.67-8.07 *vs* 6.87-7.09 times internarial distance), and ocular regions (preorbital snout length 3.44-3.61 *vs* 2.99-3.17 times interspiracular length and 5.03-5.47 *vs* 3.95-4.47 times interorbital width). The two species also vary in proportions around the nostrils (i.e. nostril length of *R. jimbaranensis* 3.27-3.68 *vs* 2.91-3.14 times anterior aperture width, 0.83-0.91 *vs* 1.08-1.17 times distance from nostril to edge of disc; anterior nasal flap 2.27-2.42 *vs* 1.81-2.18 times anterior aperture width; posterior nasal flap width 1.02-1.12 *vs* 0.79-0.95 times anterior aperture width). In *R. jimbaranensis*, the first dorsal fin is more widely separated from the pelvic fin (interspace 0.74-0.86 *vs* 0.60-0.75 times interdorsal distance, 9.0-10.5 *vs* 7.0-8.5% TL) and the dorsal caudal-fin margin 2.06-2.14 *vs* 2.14-2.56 times preventral margin length.

Compagno and Last (1999) list 8 species of *Rhinobatos* from the Western Central Pacific: *R. formosensis* Norman, 1926; *R. granulatus* Cuvier, 1829; *R. halavi* (Forsskål, 1775); *R. obtusus* Müller & Henle, 1841; *R. sainsburyi* (formerly as *R.* sp. A); *R. schlegelii* Müller & Henle, 1841; *R. thouin*; and *R. typus*. Of these species, *R. jimbaranensis* is closest to three species (i.e. *R. formosensis, R. sainsburyi*, and *R. schlegelii*) that belong to an unresolved subgroup of *Rhinobatos* that is characterised by having well-separated, submarginal insertions of the anterior nasal flap, and rostral cartilages rather well separated and subparallel to each other (Last *et al*., 2004). This group, which includes the type species of the genus *Rhinobatos, R. rhinobatos* (Linnaeus, 1758), is represented in the Indian Ocean by *R. annandalei* Norman, 1926, *R. lionotus* Norman, 1926, *R. holcorhynchus* Norman, 1922, *R. nudidorsalis* Last, Compagno & Nakaya, 2004, and *R. punctifer* Compagno & Randall, 1987, and in the western North Pacific by *R. hynnicephalus* Richardson, 1846 and an unidentified species from the Philippines. *Rhinobatos jimbaranensis* is closest to *R. formosensis* from Taiwan in being largely plain coloured (without a distinct dorsal pattern of spots and/or rings and lacking a dark blotch on the ventral snout apex), having a long snout with narrow rostral ridges that are well separated throughout their length (rather than a short or moderate snout with median constrictions of the rostral ridges), a straight or weakly concave snout margin (otherwise with concave margins producing a bottle-shaped snout), and rudimentary tubercular denticles along its mid-disc (rather than denticles enlarged slightly and blunt). *Rhinobatos jimbaranensis* differs from *R. formosensis* (based on Norman's description) in having: a preoral length 3.1-3.4 (rather than 3.6-3.7 in *R. formosensis*) times its mouth width; its nostril length 1.5-1.6 (rather than 1.4-1.5) in its mouth width and 1.3-1.4 (rather than 1.5) times its internarial width; the first dorsal-fin height subequal to its length (0.9-1.1 times, rather than nearly 2 times taller); the first dorsal-fin base 2.7-2.9 (rather than 3-3.2) in the interdorsal distance, and the distance from pelvic-fin base to the dorsal-fin origin less (rather than equal to or greater) than the interdorsal distance.

***RHINOBATOS PENGGALI* SP. NOV.**

(Figs 4, 5, 3B, Tab. I)

[English Name: Indonesian shovelnose ray]

Holotype. - MZB 12904, male, 494 mm TL, Kedonganan fish market (08°45'S, 115°10'E), Bali, Indonesia, 17 Jun. 2002.

Paratypes. - Four specimens collected at same locality as holotype: CSIRO H 5632-02, female, 650 mm TL; CSIRO H 5632-03, female, 502 mm TL, 7 Jul. 2001; CSIRO H 5873-01, female, 746 mm TL; CSIRO H 5873-02, female, 552 mm TL, 16 Jun. 2002.

Diagnosis

A species of the genus *Rhinobatos* distinguished by the following combination of adult characters: broadly wedge-shaped disc, width 36-37% TL, disc length less than 1.3

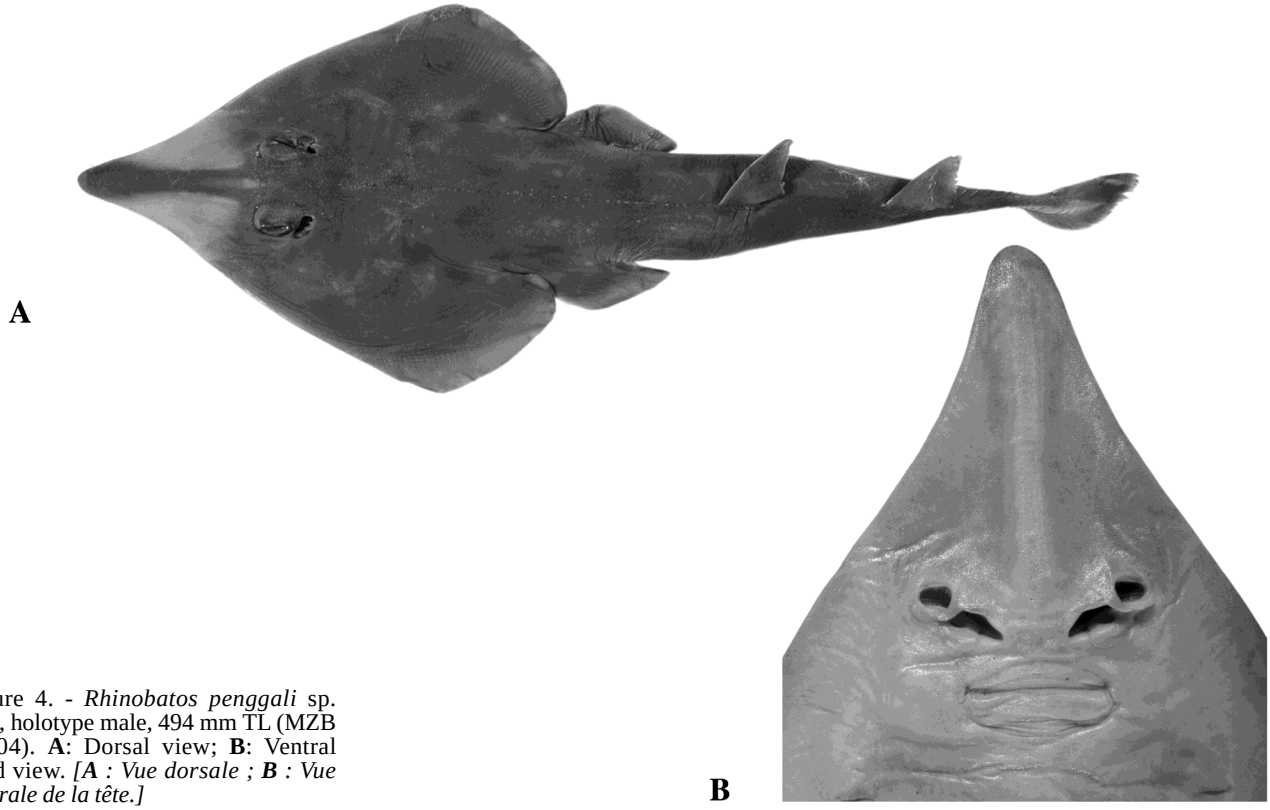

Figure 4. - *Rhinobatos penggali* sp. nov., holotype male, 494 mm TL (MZB 12904). **A**: Dorsal view; **B**: Ventral head view. *[**A** : Vue dorsale ; **B** : Vue ventrale de la tête.]*

(1.20-1.27) times width; moderately elongate snout, length 3-3.2 times interspiracular distance, 4-4.5 times interorbital width; medium-sized orbit, 1.4-1.6 times spiracle length; weakly oblique nostrils, their length 1.3-1.4 times internarial distance; preoral length 6.9-7.1 times internarial distance; anterior nasal flaps penetrating slightly into internarial space but well separated at their insertion; posterior nasal flaps broad; two spiracular folds, outermost fold about twice height of inner fold; ridges of rostral cartilage almost parallel, converging slightly anteriorly but not constricted medially; anterior cartilage narrow, subtruncate to bilobed posteriorly; distance between fifth gill slits 2.6-3 times in ventral head length; prebranchial sensory pore patch obvious, extending to first gill slit; postscapular sensory canal obscure, without exposed lateral pores, not grooved; thorn patches on supraorbit, scapular region, and dorsal midline small but obvious; pelvic-fin inner margin slightly shorter than its base; interdorsal distance more than 2.5 (2.7-2.9) times first dorsal-fin base; dorsal caudal margin 2.1-2.6 times preventral margin; upper teeth in 75-83 rows; 166-170 post-synarcual centra; more than 50 (53-57) nasal lamellae; dorsal fin obviously bicolored; and dorsal disc with white spots (sometimes faint).

Description

Disc broadly wedge shaped, angular anteriorly, angle before eyes 61-64°; outer margins broadly rounded, narrowly rounded distally, length 1.26 (1.20-1.27) times width. Pelvic fins elongate, short-based, base length 0.79 (0.71-0.82) of inner margin length; total length 1.75 (1.66-1.74) times their base length, 2.36 (2.27-2.56) times width; anterior margin weakly convex anteriorly then becoming straight, apex broadly rounded, posterior margin convex. Tail relatively short, broad anteriorly, tapering, in cross-section nearly flat below, rounded above; tail length from anterior cloaca 1.18 (1.20-1.30) times precloacal length, 1.16 (1.17-1.26) times disc length, 5.05 (5.01-5.45) times width at pelvic-fin insertions; tail width 2.30 (2.20-2.36) times depth at pelvic-fin insertions, 2.69 (2.43-2.71) at first dorsal-fin origin, 2.17 (1.95-2.17) at second dorsal-fin origin. Dermal fold lateral on tail, originating slightly anterior to free rear tip of pelvic fin, reaching just behind ventral caudal-fin origin; fold moderate, maximum width at interdorsal space about a quarter width of posterior nasal flap. Head long, ventral length 31.2 (29.5-32.0)% TL; snout moderately long and bluntly pointed; preoral length 3.28 (3.08-3.44) times mouth width, 6.88 (6.87-7.09) times internarial distance, 1.50 (1.30-1.53) times dorsal caudal-fin margin, 5.71 (5.39-5.75) times distance from nostril to margin of disc; direct preorbital snout length 3.07 (2.99-3.17) times interspiracular length, 4.11 (4.05-4.57) times orbit, 4.47 (3.95-4.42) time interorbital width; interorbital space slightly concave, rather broad; eyes mod-

Figure 5. - Radiograph of the chondrocranium of the holotype of *Rhinobatos penggali* sp. nov. (MZB 12904). *[Radiographie du chondrocrâne de l'holotype.]*

erately large, not elevated or protruding, orbit relatively small, diameter 1.51 (1.42-1.64) times spiracle length, 1.09 (0.86-1.02) times interorbital distance. Spiracles narrowly bean-shaped, relatively large; two strongly compressed folds on posterior margin, length of innermost spiracular fold 0.4-0.6 of outer fold; distance between bases of folds 0.5-1 length of shortest fold. Nostril moderately large, oblique, nasal flaps well developed; anterior aperture oval, width greatly exceeding length; nostril length 2.95 (2.91-3.14) times anterior aperture width, 1.56 (1.44-1.65) times anterior nasal-flap base length, 1.17 (1.08-1.11) times distance from nostril to edge of disc, 1.41 (1.33-1.42) times internarial distance. Anterior nasal flap narrow with long, slender process anteriorly; flap base 1.66 (1.61-1.84) times its width at process, 1.90 (1.81-2.18) times anterior aperture width; inserted slightly into internarial space, medial to nostril margin; minimum distance between insertions of flaps 3.15 (3.17-3.39) in greatest distance across nostrils, 0.91 (0.91-1.01) in minimum internarial distance; process of flap about twice as long as wide, bluntly pointed distally, abutting posterolateral nasal flap and determining hind margin of anterior aperture. Posterolateral nasal flap lobe-like, broadest medially, length 5.02 (4.81-5.19) times width; originating just behind lateral extremity of anterior nasal aperture, extending posteromedially as a free fold to about level of insertion of anterior nasal flap. Posterior nasal flap strongly lobe-like, base length 2.36 (2.11-2.40) times its width, well short of innermost margin of nostril; width 0.79 (0.80-0.95) times anterior aperture width, 1.64 (1.43-1.68) times posterolateral nasal-flap width. Mouth moderately broad, width 1.49 (1.52-1.62) times nostril length, 7.30 (6.80-7.43) in precloacal length; positioned over or slightly forward of hind margin of orbit. Upper jaw weakly convex, upper lip arched; lower lip pronounced, separated from oral groove by ridges of strongly corrugated skin; strong, short lateral grooves around corners of mouth. Teeth small, blunt, broader than long, crowns rhomboidal, posterior margins lacking cusps in holotype; no information available for mature males; teeth quincuncial, in 75 (75-83, mean 78) rows in upper jaw; upper and lower jaw teeth similar in shape and size. Gill openings distinctly s-shaped, fifth less so; length of third gill slit 2.40 (2.03-2.30) in nostril length, 6.25 (5.43-6.12) in distance between fifth gill slits; distance between first gill slits 1.38 (1.30-1.39) times distance between fifth gill slits; distance between fifth gill slits 3.67 (3.54-3.94) times internarial distance, 1.75 (1.66-1.86) times mouth width, 0.35 (0.33-0.38) of ventral head length. Dorsal fins relatively short, raked slightly; apices narrowly rounded rather than angular; anterior margins slightly convex; posterior margins weakly concave, broadly falcate; free rear tips mostly very weakly produced, almost forming right angle; first dorsal fin slightly taller than second, length of first 1.00 (0.94-1.12) times its height, base length 1.65 (1.67-1.80) times inner margin length; second dorsal-fin length 1.12 (0.98-1.15) times its height, base length 2.00 (2.11-2.32) times inner margin length. First dorsal fin well behind pelvic-fin insertion, interspace 0.75 (0.60-0.73) times interdorsal distance; interdorsal space short, 1.86 (1.78-1.97) times second dorsal-fin height, 2.68 (2.65-2.85) times base of first dorsal fin, 1.64 (1.56-1.68) times interspace between second dorsal-fin insertion and upper origin of caudal fin. Caudal fin relatively small, relatively deep and short; dorsal caudal margin 2.14 (2.14-2.56) times preventral margin length. Dermal denticles small, close-set, covering entire body and fins; surfaces uniformly coarsely granular but becoming enlarged slightly in some regions; slightly enlarged on midline of tail between dorsal fins, and on snout tip; dense covering of denticles over nasal lamellae. Thorns present on orbit, dorsal midline, and scapular region; mostly of similar size, short, broad based, tips

bluntly pointed; narrow rosette around eye commencing adjacent anterior extremity of orbit, extending around supraorbit to spiracle, thorns at extremity of rosette largest; single row of irregularly spaced thorns extending from just behind head almost to origin of first dorsal fin, series broken on prenuchal region; median thorns similar in size, weakly recurved, about 43 in single series; two enlarged scapular thorns on each side. Prebranchial sensory pore patch indistinct, extending to first gill slit. Postscapular sensory canals deeply embedded, not undulated anteriorly, terminating about halfway to pectoral-fin insertions; sensory pores not evident; sensory canal not forming a shallow groove. Rostral cartilage broad, its shaft increasing in width only slightly in a posterior direction; rostral node moderately expanded, rounded apically, not angular, axis at widest part of node 18.2% of length of rostral cartilage from snout tip; precerebral cavity relatively broad posteriorly, tapering to a point anteriorly at rostral node, dorsolateral edges of cartilage surrounding cavity well separated, not becoming constricted medially; rostral cartilage about 64% of length of neurocranium, ventral edges of rostral cartilage united; nasal capsules large, their transverse axes anterolaterally directed; maximum width across capsules 1.29 times nasobasal length of cranium; length of nasal capsule about equal to its width; basal plate narrow, its minimum width 4.55 times in nasobasal length; cranial roof with small oval fenestra, located behind precerebral cavity by more than its length; anterior cartilage narrow, not triangular, curved with subtruncate to bilobed posterior apex, anterior lobe not extending beyond nasal capsules; preorbital processes weak; postorbital processes well developed, strongly bifurcate, posterior process most pronounced; greatest width across processes 1.58 times in nasobasal length. Nasal lamellae 53-57. Pectoral skeleton with 33-34 (33-36, n = 5) propterygial, 6-7 (6-8) mesopterygial, 2-3 (2-4) neopterygial, 27 (27-29) metapterygial, 69-70 (69-73) total radials; anterior radials of propterygium extending just forward of nasal capsules, by about 10.2% of rostral length. Total pelvic radials 26-28 in females (n = 5); one greatly enlarged, branched radial on the puboischiadic bar; 25-27 basipterygial radials. Vertebral column with 182 (179-183) total segments (synarcual and free), 168 (166-170) post-synarcual centra; 124 (123-127) total precaudal centra; 14 (12-13) synarcual segments; 26 (25-26) monospondylous precaudal centra, all with ribs; 98 (97-101) diplospondylous precaudal centra, 44 (41-44) diplospondylous caudal centra.

Colour

In alcohol, subadults: dark greyish brown on dorsal surface with faint white spots; spotting variable within types, often indistinct in preserved material; outer margins of pectoral and pelvic fins paler than central disc; snout lateral to rostral cartilage pale, rostral cartilage sharply demarcated; dorsal fins distinctly bicolored, base and distal and posterior half of fin greyish, area between distinctly yellowish or brownish; caudal fin base and median portion dark greyish dorsally, strongly contrasted from white ventral portion; upper caudal-fin lobe yellowish anteriorly, greyish posteriorly; ventral caudal-fin lobe pale anteriorly, dusky posteriorly. Ventral surface mostly uniform whitish (becoming more yellowish in preservative), holotype with a dark blotch on left side below second dorsal fin; posterior margins of pectoral and pelvic fins dusky or slightly darker than other parts of disc; mouth and nasal folds whitish. Primary pattern consisting of 11 pairs of diffuse-edged white spots, each subequal in diameter to the length of the longest spiracular fold; streak-like spot along each margin of rostral cartilage near its midlength; 3 pairs of well-spaced spots (equidistant from each other) on each suborbit, anterior spot almost level with origin of orbit, posterior spot lateral to hind margin of spiracle, middle spot closest to orbit; single spot on posteromedial margin of each orbit; single closely positioned prenuchal spot on each side, about spiracle length behind junction of head and trunk; two widely spaced spots on each side just posterior to scapular region, outermost spot almost completely lateral to innermost spot; single spot on each side near dorsal midline above each pelvic fin; single spot on each side just anterior to pectoral and pelvic insertions. Secondary spots sometimes present just in advance of scapular patch, in interorbital and interspiracular space, and also near disc margin beside spiracle.

Prenatal individuals (based on images of 3 embryos from a pregnant female, not kept): dorsally more greyish than free-swimming individuals; primary spotting clearly demarcated; one individual with additional spots on either side of trunk above pelvic fin free rear tips and beside first dorsal-fin origin, another specimen with a supplementary white spot on each side near disc margin lateral to prenuchal spots.

Size

The type series consists of the single adolescent male holotype (494 mm TL) and four females between 502 and 746 mm TL. Maximum sizes of specimens from Indonesian fish markets were 992 mm TL for females (n = 248, range 492-992 mm TL), and 864 mm TL for males (n = 215, range 492-864 mm TL). Males mature at about 700-720 mm TL. Smallest mature female 751 mm TL. Pregnant females have 4-13 embryos (n = 10); birth size unknown but embryos well developed at 220 mm TL.

Distribution

Known from eastern Indonesia from Palabuhanratu in West Java, Cilacap in Central Java and southern Bali, Indonesia. Caught by fisherman at these locations using small demersal gill and trammel nets, and small demersal longlines.

Etymology

Adopted from the Indonesian word penggali meaning 'shovel' in allusion to the common name used to describe the shape of the head in this group of rays.

Comparisons

Similar to *Rhinobatos jimbaranensis* in general body shape but differs significantly in colour, meristics and in body proportions. *Rhinobatos penggali* is white spotted (rather than covered in faint blotches that are darker than the body colour), has lower vertebral counts (25-26 *vs* 27-29 monospondylous centra; 123-127 *vs* 132-137 precaudal centra; and 165-170 *vs* 175-180 total free centra), and more propterygial rays (33-36 *vs* 30-33 in *R. jimbaranensis*). *Rhinobatos penggali* has a significantly greater body ratio (25 proportions exhibit no or minimal overlap, see Tab. I) indicating, among other things: a relatively longer and wider disc; larger spiracles, mouth, nostrils, and first dorsal fin; and larger interorbital, interspiracular, intergill and internarial distances.

Rhinobatos penggali is similar to *R. punctifer*, a white-spotted species from the Red Sea but differs greatly in morphometrics, some meristics, and in the position of the spots (comparative morphometrics below are based on Compagno and Randall's (1987) data for the holotype of *R. punctifer*). For example, *R. penggali* has a relatively longer snout (snout length 16.6-18 *vs* 12.6% TL; preoral distance 19.4-21.4 *vs* 15.9% TL) and predorsal distance (57.4-58.9 *vs* 53% TL), smaller dorsal fins (first dorsal-fin length 6.5-7 *vs* 8.1% TL, height 6.2-7.2 *vs* 9.5% TL; second dorsal-fin length 6.3-7.1 *vs* 7.8% TL, height 6.1-6.5 *vs* 8.5% TL), a smaller caudal fin (dorsal caudal margin 13.7-15 *vs* 15.2% TL; preventral caudal margin 5.8-6.5 *vs* 7.4% TL), and a shorter distance between the pelvic-fin base and dorsal-fin origin (7-8.1 *vs* 14.1% TL). The position of spots in *R. punctifer* is similar to *R. penggali* but the spots in the predorsal and area below first dorsal fin seem to be always present in *R. punctifer*. The size at maturity also differs between these two species with one male specimen of *R. punctifer* (CSIRO H 6231-01) mature at 570 mm TL, whereas males of *R. penggali* do not reach maturity until 700-720 mm TL. *R. punctifer* appears to have more vertebrae (179 *vs* 166-170 post-synarcual centra in *R. penggali*).

Comparative material

Rhinobatos punctifer. - CSIRO H 6231-01, adult male, 570 mm TL, CSIRO H 6231-02, adult male, 590 mm TL, Gulf of Oman, Oman.

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