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Dipturus amphispinus sp. nov., a new longsnout skate (Rajoidei: Rajidae) from the Philippines

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Abstract

A new long-snouted skate, *Dipturus amphispinus* sp. nov., is formally described based on material caught in the Sulu Sea and later acquired from fish markets of the central and southern Philippines. It differs from its congeners in the western North Pacific, apart from *D. wuhanlingi* (East and South China Seas), in having a variably-defined, parallel row of posterolaterally directed lumbar thorns, and well-developed scapular thorns on each side of the disc. However, the paired rows of lumbar thorns are better defined in *Dipturus amphispinus* sp. nov. than in *D. wuhanlingi*, and these species also differ in some aspects of their morphometrics, meristics and squamation. *Dipturus amphispinus* sp. nov. displays marked sexual dimorphism with adult males having a relatively broader mouth, much longer teeth, a relatively shorter snout, head and disc, a taller first dorsal fin, and a proportionally longer posterior pelvic-fin lobe and tail, than adult-sized females.

Key words: Rajidae, skate, *Dipturus amphispinus,* new species, Sulu Sea, Philippines

Introduction

The need for a taxonomic revision of the polyphyletic skate genus *Dipturus* (family Rajidae) has been discussed previously by Last *et al.* (2008a). Fourteen valid nominal species were considered to occur in the Indo–Pacific region: *D. campbelli* (Wallace, 1967), *D. crosnieri* (Séret, 1989), *D. ecuadoriensis* (Beebe & Tee-Van, 1941), *D. gigas* (Ishiyama, 1958), *D. gudgeri* (Whitley, 1940), *D. innominatus* (Garrick & Paul, 1974), *D. johannisdavisi* (Alcock, 1899), *D. kwangtungensis* (Chu, 1960), *D. lanceorostratus* (Wallace, 1967), *D. macrocaudus* (Ishiyama, 1955), *D. pullopunctatus* (Smith, 1964), *D. springeri* (Wallace, 1967), *D. stenorhynchus* (Wallace, 1967), and *D. tengu* (Jordan & Fowler, 1903), and as well as some 14 undescribed species (Ebert & Compagno, 2007). Last *et al.* (2008b) described five new long-snouted *Dipturus* (*D. acrobelus*, *D. healdi*, *D. apricus*, *D. melanospilus* and *D. queenslandicus*) from deepwater off Australia, and Last (2008) described an additional six short-snouted *Dipturus* (*D. canutus*, *D. confusus*, *D. endeavouri*, *D. falloargus*, *D grahami*, *D. oculus*) mainly from shallower Australian seas. Another three Australian short-snouted skates are also presently placed in *Dipturus*: *Dipturus australis* (Macleay, 1884), *Dipturus cerva* (Whitley, 1939), and *Dipturus polyommata* (Ogilby, 1910). Around the same time, Jeong & Nakabo (2008) described a new skate, *D. wuhanlingi*, from near Taiwan, in the southern East China Sea and South China Sea.

About a decade ago, an investigation of sharks and rays landed in local fish markets of the Philippines (Compagno *et al*., 2005), led to the discovery of species of *Dipturus* (figured as *D*. sp. 4) which was later thought by the authors to be possibly conspecific with *D. wuhanlingi.* However, this skate, described below, differs from all other members of the genus (including *D. wuhanlingi*) through a combination of body shape, squamation, morphometrics and meristics.

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Materials and Methods

Seven specimens were collected from fish markets near the Sulu Sea as part of a WWF–funded project to investigate the chondrichthyan fauna of the Philippines (Compagno *et al*., 2005). Most types are held at the Silliman University Marine Laboratories (SUML) and unregistered specimens from this project are prefixed with the field label acronyms JPAG, MMLM or BRU. Other types, including the holotype, are held by the Philippine National Museum, Manila (PNM) and in the ichthyological collection of the Australian National Fish Collection, Hobart (CSIRO). The descriptive format is based on McEachran & Fechhelm (1982), and meristic and morphometric methods are outlined in a special publication on new Australian skates (Last *et al*., 2008a). Detailed descriptive information is based on an adolescent male (PNM 15178, formerly SUML JPAG078, 657 mm TL, designated as the holotype) and a large female (SUML MMLM 018, 883 mm TL), referred to herein as the 'primary female paratype' (see Last *et al*., 2008a); no juvenile individuals were available for this study. Morphological variability within paratypes is discussed where necessary. Body measurements, expressed as a percentage of total length (TL), are provided in tables; range data for paratypes are provided in parentheses after data for the holotype in the descriptive treatment. Radiographs were used to obtain counts of tooth rows, vertebrae, and pectoral and pelvic-fin radials; meristic data was obtained for the holotype and an adult male paratype (CSIRO H 7416–01, formerly SUML BRU 096) by J. Pogonoski. Vertebral counts were made using methods described by Hubbs & Ishiyama (1968); trunk counts include only monospondylous centra and whole synarcual centra (the anteriormost element is often fragmented anteriorly). Total centra counts are approximate as the final caudal elements were sometimes difficult to count. During the review process, the senior author visited the Shanghai Fisheries University collection (SFC) to examine the types of *Dipturus wuhanlingi*: holotype, SFC D1113, immature male, 668 mm TL, collected from the open waters of the southern East China Sea, by Y.-T. Chu, April 1961; single paratype, SFC S7672, presumed immature female, 784 mm TL, collected off Haimen, Gwangdong, in the South China Sea, by Y.-T. Chu, October 1956. The paratype was examined but the holotype was unavailable, still on loan to one of the authors.

Species Treatment

***Dipturus amphispinus* sp. nov.**
(Figures 1–10, Table 1)

Dipturus sp. 4: Compagno *et al.*, 2005, p. 67, fig. 1b.

Holotype. PNM 15178 (SUML JPAG 078), adolescent male 657 mm TL (original measurement 666 mm TL), collected Dipolog City public market, Dipolog City, Zamboanga del Norte, J.P. Gaudiano, 7 April 1999.

Paratypes. 5 specimens. SUML BRU 147, female 878 mm TL (original measurement 876 mm TL), Punta Miray, Baliangao, Misamis Occidental, 29 March 2000; CSIRO H 7416–01 (SUML BRU 096), adult male 621 mm TL (original measurement 637 mm TL), Palapala, Cadiz City, Negros Occidental, 18 April 1999; SUML MMLM 014, female 855 mm TL, Dumaguete City, Negros Oriental, 11 June 1999; SUML MMLM 018 (primary female paratype), female 883 mm TL (original measurement 896 mm TL), Silliman Beach, Bantayan, Dumaguete City, Negros Oriental, 17 August 1999; SUML MMLM 021, female 804 mm TL (original measurement 805 mm TL), Silliman Beach, Bantayan, Dumaguete City, Negros Oriental, 19 August 1999.

Other material. 1 specimen. SUML JPAG 091, female (original measurement 897 mm TL), Bukana, Sikayab, Dapitan City, Zamboanga del Norte, 17 April 1999.

Diagnosis. A medium-sized species of the genus *Dipturus* (to almost 90 cm TL) with two parallel rows of posterolaterally directed thorns along its posterior median disc. It is also distinguishable from its congeners by the following combination of characters: disc relatively broad with angular apices, width 67–72% TL, 1.2 times its length; snout angle 73–76°; tail length sexually dimorphic, in females 0.7, in males 0.8–0.9 in distance from snout tip to rear of cloaca; tail relatively slender, width 1.2–1.6 times height at its midlength, 1.2–1.7 times at first dorsal-fin origin; pre-upper jaw length 18–24% TL, 2.2–3.0 times internasal width; ventral head length 33–38% TL; preorbital snout length 3.5–4.2 times interorbital width; orbit diameter 52–74% interorbital width; first dorsal-fin

height 1.7–2.1 in its base length; distance from first dorsal-fin origin to tail tip 3.5–4.0 times first dorsal-fin base length, 3.1–4.0 times caudal-fin length; pelvic fins of medium size, length of posterior lobe 16–17% TL, length of anterior lobe 74–75% of posterior lobe in large males; adult clasper elongate 23–25% TL; anterior margins of both surfaces of disc with bands of fine denticles; 1-2 scapular thorns on each side of disc (rarely paired); row of prescapular thorns; no malar thorns in single adult male; tail with a single median thorn row in males and a few lateral thorns near its base, median row and additional pair of variably developed lateral rows in females; total pectoral radials 83–85; trunk centra 25–32; predorsal centra 77–83; total centra about 137–140; tooth rows in upper jaw 28–33, in lower jaw 33; mainly brownish dorsally, slightly paler brownish and more blotchy ventrally; ventral sensory pores small, distinct, black-edged, not surrounded by greyish blotches.

FIGURE 1. *Dipturus amphispinus* sp. nov., adolescent male holotype (PNM 15178, 657 mm TL, preserved): A, dorsal surface; B, ventral surface.

Description. Disc quadrangular, 1.15 times as broad as long in adolescent male holotype (1.22 times in adult male paratype, 1.15–1.17 in four female paratypes); angle in front of spiracles 75° (73–76°); axis of greatest width 62% (61–65%) of disc length; anterior margin moderately double concave in adult males and large females, concave anteriorly, straight to moderately convex beside and just forward of eyes, strongly concave just beside level of spiracles; apex narrowly rounded to subangular; posterior margin moderately convex; free rear tip very broadly rounded. Head long, preorbital snout length 5.63 (4.72, 6.36–7.40) times orbit length, 4.05 (3.51, 3.71–4.23) times interorbit; pre-upper jaw length 2.25 (2.15, 2.60–3.00) times internarial distance. Snout tip very well produced, narrowly pointed; no fleshy process at apex. Orbit small, diameter 0.72 (0.74, 0.52–0.64) times interorbital width. Spiracle large, length 1.99 (1.12, 1.34–1.91) in orbit diameter; opening mainly tear-drop shaped. Nostril suboval, often distorted; anterior nasal flap expanded slightly, its lateral margin forming a low semi-circular tube; anterior margin of flap weakly lobe-like, partly concealed beneath nasal curtain; posterior inner margin not or barely concealed beneath nasal curtain; posterior lobes forming nasal curtain, well developed, produced slightly posterolaterally, narrowly rounded to lobe-like distally, posterior margin with well developed fringe; internarial distance 1.85 (1.87–2.02) in distance between first gill slits, 0.99 (0.96–1.13) in distance between fifth gill slits. Upper jaw moderately well arched (less arched in females), not indented at symphysis; lower jaw strongly convex at all sizes; lateral teeth of upper jaw not or only partly concealed by lobe of nasal curtain. Teeth of adult male paratype (CSIRO H 7416–01) strongly unicuspid (much less so in late adolescent male holotype), with subcircular to rhomboidal bases; arranged in longitudinal rows rather than in quincunx; medial cusps long, subconical, bluntly pointed, posteriorly and lingually directed in upper jaw; cusps much shorter and more oblique laterally; teeth of primary female paratype (SUML MMLM 018) with broadly suboval bases and relatively broad-based, blunt subtriangular cusps (most pronounced near jaw symphysis), arranged in defined rows.

Pelvic fins of medium size, deeply forked; anterior lobe in males relatively short, slender, bluntly pointed distally (females broader and more rounded apically), lateral margin entire, inner margin very deeply incised; posterior lobe moderately elongate, longer in mature males (length 16.1–17.3% TL) than in females (length 13.8–15.9% TL), lateral margin weakly convex to straight and weakly incised; inner margin concave, connected to lateral margin of clasper at 39–41% of its postcloacal length; anterior lobe 0.74 (0.75) times posterior lobe in males, 0.80–0.88 in females. Clasper elongate, 22.7 (24.9)% TL, moderately robust, slightly depressed, glans noticeably expanded; morphology is typical of the 'generalised' *Dipturus* clasper as figured for *D. gudgeri* (Last & Gledhill, 2007: fig 2b). Its clasper components include a proximal slit and distal cleft, terminal bridge, rhipidion, shield, spike and sentinel; denticles and pseudosiphon absent.

Tail short, rather slender; in males, weakly depressed and suboval basally, becoming subrectangular medially, moderately depressed distally; in females, more uniformly depressed along its length and more flattened ventrally than dorsally; in both sexes, narrow at base, initially tapering strongly, then very gradually to first dorsal-fin origin, not expanded at its midlength; expanded slightly below base of first dorsal fin in males; tapering evenly and gradually to tail tip from origin of second dorsal fin; width at insertions of pelvic fins 2.50 (2.42, 1.82–2.05) times width at midlength of tail and 2.51 (2.76, 2.02–2.26) times width at first dorsal-fin origin; length from rear of cloaca 0.83 (0.89, 0.67–0.74) times distance from tip of snout to rear of cloaca; anterior cross-section very narrowly oval, equally convex dorsally and ventrally more strongly convex on dorsal surface than ventral surface distally; cross section of mid tail more convex dorsally, in holotype more rectangular ventrally and its median surface flat, in primary female paratype almost equally convex above and below; postdorsal tail very narrow, pointed, with its ventral surface almost uniformly flat; width 1.57 (1.42–1.82) times height at insertion of pelvic fin, 1.20 (1.23, 1.30–1.61) times height at midlength, 1.18 (1.19, 1.41–1.68) times height at first dorsal fin origin. Lateral tail fold weak, narrow, relatively long-based, similar in males and females; originating as a low membranous ridge beside or slightly behind pelvic fin, terminating slightly forward of tail tip (beneath middle of caudal fin base in primary female paratype); not obviously broader at any point along its length, maximum width less than a quarter height of caudal fin in holotype. Dorsal fins of moderate size and shape, first dorsal fin slightly taller and more upright than second in holotype, fins subequal in size and similar in shape in most paratypes; first dorsal-fin height 1.69 (1.79, 1.90–2.05) in base length; fins strongly raked with elongate bases; anterior margins of both fins long and weakly convex, apices broadly rounded; posterior margins short, strongly convex in first dorsal fin, more vertical in second dorsal fin; free rear tip broadly rounded (usually blending into posterior margin); inner margins short, either directed anteroventrally or almost upright; second dorsal-fin base subequal or only marginally longer than first dorsal-fin base; interdorsal space moderate, rear tip of first dorsal fin not overlapping base of second, 2.05 (1.78–4.17) times in length of first dorsal-fin base; distance from first dorsal-fin origin to tail tip 3.69

(3.47–3.99) times first dorsal-fin base length, 3.69 (3.13–3.98) times caudal-fin length; first dorsal-fin base 1.00 (0.90–1.02) times caudal-fin length. Epichordal caudal-fin lobe well developed, long-based, low, maximum height only slight less than tail width at fin origin in holotype, about two-thirds tail width in primary female paratype; relatively uniform in height along its length, its dorsal margin weakly convex; connected sub-basally to second dorsal fin by a low membranous ridge; hypochordal caudal lobe rudimentary.

FIGURE 2. *Dipturus amphispinus* sp. nov., female paratype (SUML MMLM 018, 883 mm TL, preserved): A, dorsal surface; B, ventral surface.

Dorsal surface of adolescent male holotype with well-developed orbito-spiracular (forming a rosette with small patches anteriorly and posteriorly), scapular, mid-dorsal and tail thorns, and well-developed alar thorn patch; no malar thorns; primary female paratype with well-developed orbital, median disc, scapular and tail thorns. Main

orbital thorns of holotype about 9–11 (3–4 on preorbit, 2–3 on midorbit, 3–4 on postorbit, including spiracular region), about 9 main thorns in adult male paratype, forming an incomplete rosette (gap beside mid eye); thorns very variable in size, very short to well developed, pungent, narrow based; anteriormost thorns flanked by a few thornlets, merging with anteriormost midorbital thorns anteriorly; thorns adjacent spiracle flanked by a few thornlets, merging with posteriormost midorbital thorns beside hind margin of orbit. Primary female paratype with a rosette of 11–12 orbital thorns (4 on preorbit, 3 on midorbit, 4–5 on postorbit, including spiracular region), 13–17 in other female paratypes; thorns forming a rosette, similar in shape and position to primary female; in a single row above eye, forming small clusters on preorbit and above spiracle; occasional thornlets on preorbit and above spiracle. Mediodorsal thorns of disc of holotype very well developed; row of 4 posteriorly directed prescapular thorns extending in a linear series from nuchal area to level of scapular thorns; short parallel rows of about 13 strongly tilted, posterolaterally directed lumbar thorns on a slightly elevated ridge forward of cloaca; most female paratypes with these rows uniting forward of cloaca to form a single row continuous with median row on tail; prescapular thorns of paratypes 0–5, well developed when present, upright or tilted, with strongly compressed, elongate bases; postscapular lumbar thorns similar in size to prescapular thorns, but strikingly tilted away from each other posterolaterally; small interspace (about size of orbit) separating last prescapular and first postscapular thorns. Scapular thorns single, pungent, broad-based (paired in BRU 147); tips thin, acute, directed posterolaterally. Alar thorns 27–28 in adult male paratype, in 2–4 semi-regular rows; small, much smaller than tail thorns, embedded, tips pungent, directed almost medially; patch short, length much less than twice orbit diameter, width about half orbit diameter or less.

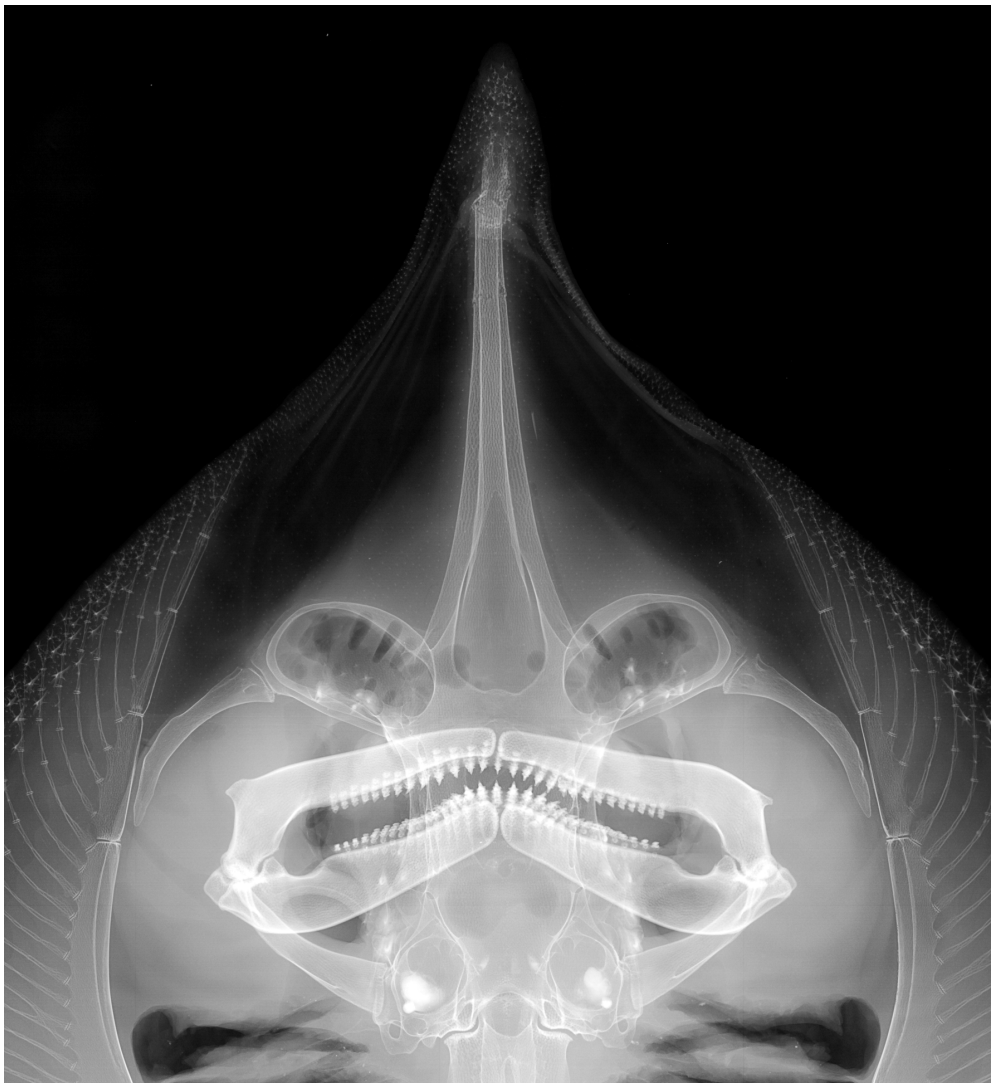

FIGURE 3. Radiograph of the head of *Dipturus amphispinus* sp. nov., adult male paratype (CSIRO H 7416–01, 621 mm TL, preserved).

FIGURE 4. *Dipturus amphispinus* sp. nov., adolescent male holotype (PNM 15178, 657 mm TL, preserved) showing snout, orbito-spiracular and nuchal regions.

FIGURE 5. *Dipturus amphispinus* sp. nov., female paratype (SUML MMLM 018, 883 mm TL, preserved) showing the well-developed scapular thorns and the characteristic paired thorns in the lumbar region.

Tail thorns of male well developed, pungent, upright, weakly recurved apically; mostly in single continuous, linear, median row, not paired (holotype with additional 1–3 lateral thorns near tip of pelvic fin, these thorns absent in male paratype (CSIRO H 7416–01); median row commencing over cloaca in holotype, extending to first dorsal fin, with 16 main thorns and about 15 much shorter interstitial thornlets; main thorns usually preceded by

interstitial thornlets; evidence of weak dermal flaps on posterior bases of some thorns; interdorsal thorns absent. Tail of female paratype with 3 rows of thorns (often with a few slightly elevated lateral thorns near tail base), lateral rows well developed; median row continuous along tail length to first dorsal fin, usually continuous with median thorns of disc; median series linear, similar to male holotype, with 28 predorsal thorns (19 main thorns and 9 smaller interstitial thornlets), 17–20 main thorns in median row of other female paratypes, main thorns often preceded by interstitial thornlets; lateral rows well developed extending from near pelvic tips (slightly more forward in primary female paratype); primary female paratype with about 19 main lateral thorns (with a few smaller thornlets), mostly finishing near base of first dorsal fin; 15–22 main thorns in other female paratypes; interdorsal thorns 0–1, often with small thornlet.

Denticles of males poorly developed. In holotype, dorsal denticles confined to small patch on snout tip, a dense well-developed band along anterolateral margin of disc (from anterior tip of propterygium to almost level with front of alar patch, its maximum width subequal to orbit diameter), and a band of very small, widely spaced denticles on mid disc above abdomen; tail mostly lacking denticles, but some present over dorsal fins and interdorsally. Ventrally, denticles over most of head; concentrated above rostral cartilage and along disc margin to level of about first gill slits; rest of disc, pelvic fins, claspers and tail naked. Denticles of primary female paratype confined to snout tip, along anterior disc margin on dorsal surface; ventrally on most of head forward of gills (densest along anterior disc margin and on mid-snout), sparse over abdomen, and on dorsal fins.

Meristics (n=2, based on adolescent male holotype PNM 15178 and adult male paratype CSIRO H 7416–01 in parentheses) as follows. Tooth rows in upper jaw 31 (28); lower jaw 33 (33). Pectoral-fin propterygial radials 33 (31–33); mesopterygial radials 13–14 (13); metapterygial radials 37–39 (39); total radials 84–85 (83–85). Pelvic-fin radials 1 (1) + 18 (19–20). Trunk centra 25 (32); predorsal caudal centra 52 (51); predorsal centra 77 (83); centra between origins of dorsal fins 16 (13); diplospondylous centra 112 (108); total centra about 137 (140).

FIGURE 6. Oronasal region of the head of *Dipturus amphispinus* sp. nov: adolescent male holotype (PNM 15178, 657 mm TL, preserved) showing sensory pores, tooth bands and coloration.

Colour (in preservative). Dorsal surface of disc, tail, and pelvic, dorsal and caudal fins mostly uniform medium brown (pale patches where skin has been chaffed off); paler yellowish on snout beside rostral cartilage, around posterior margin of disc and over spiracles; thorns paler yellowish to white (contrasting with body colour). Claspers brownish dorsally, somewhat blotched with pale patches, inner glans white; whitish ventrally. Ventral surface of disc slightly paler brown and more blotched than dorsal surface, posterior margin semi translucent ; paler yellowish along anterior margin of disc and beside rostral cartilage; whitish blotches beside gill slits (strongly demarcated from darker areas adjacent), and around cloaca; anterior lobes and base of pelvic fin brownish, posterior lobes whitish; mouth and nostrils yellowish; tail mainly pale with brownish areas; sensory pores small, distinct, dusky to black-edged, not surrounded by indistinct dusky blotches, obvious on preoral snout, much less obvious posteriorly. Primary female paratype very similar to holotype; ventral surface distinctly paler than dorsal surface.

Size. Largest known specimen a female 897 mm TL (measured fresh); the largest paratype (SUML MMLM 018) was measured in 1999 at 896 mm TL (Compagno *et al.*, 2005) and shrank to 878 mm TL when measured a decade later. Of the two known males, one was sexually mature (621 mm TL) and the slightly larger holotype was at a late adolescent stage (657 mm TL); birth size unknown.

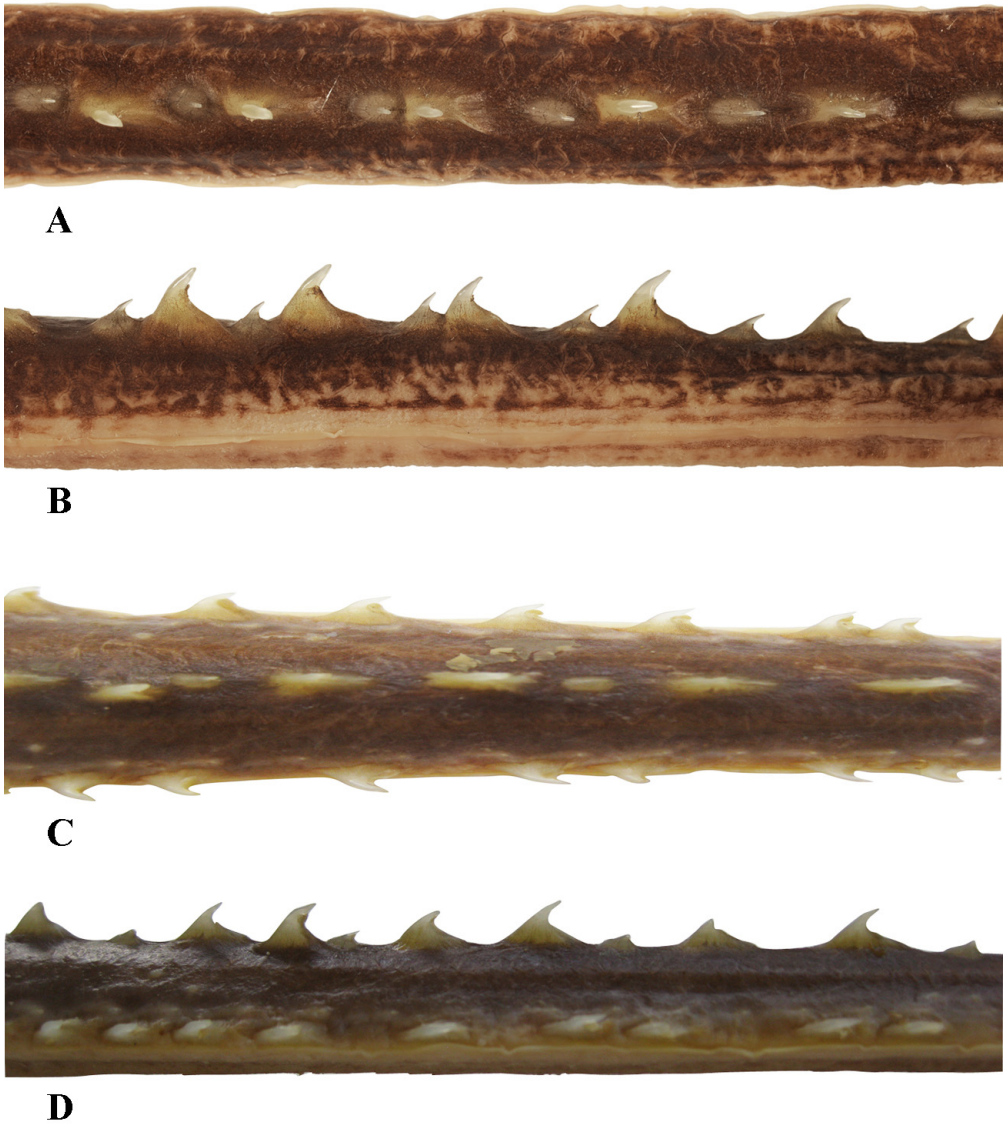

FIGURE 7. Thorns at midlength of tail in *Dipturus amphispinus* sp. nov: A, dorsal and B, lateral views of adolescent male holotype (PNM 15178, 657 mm TL, preserved); C, dorsal and D, lateral views of female paratype (SUML MMLM 018, 883 mm TL, preserved).

FIGURE 8. Lateral view of dorsal and caudal fins of *Dipturus amphispinus* sp. nov., adolescent male holotype (PNM 15178, 657 mm TL, preserved).

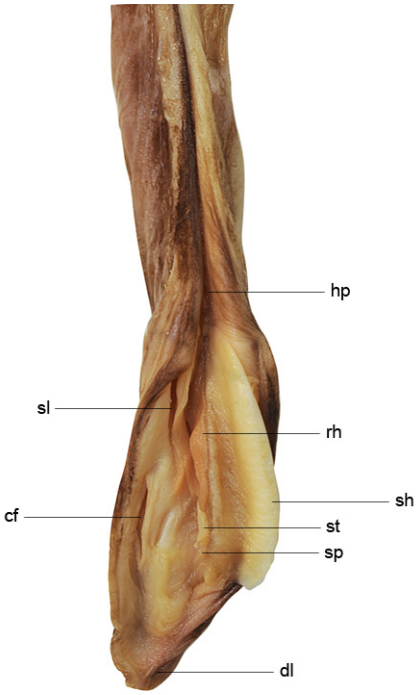

FIGURE 9. Lateral view of right clasper of *Dipturus amphispinus* sp. nov: adult male paratype (CSIRO H 7416–01, 621 mm TL, preserved). Abbreviations: cf—cleft, dl—distal lobe, hp—hypopyle, rh—rhipidion, sl—slit, st—sentinel, sh—shield, sp—spike.

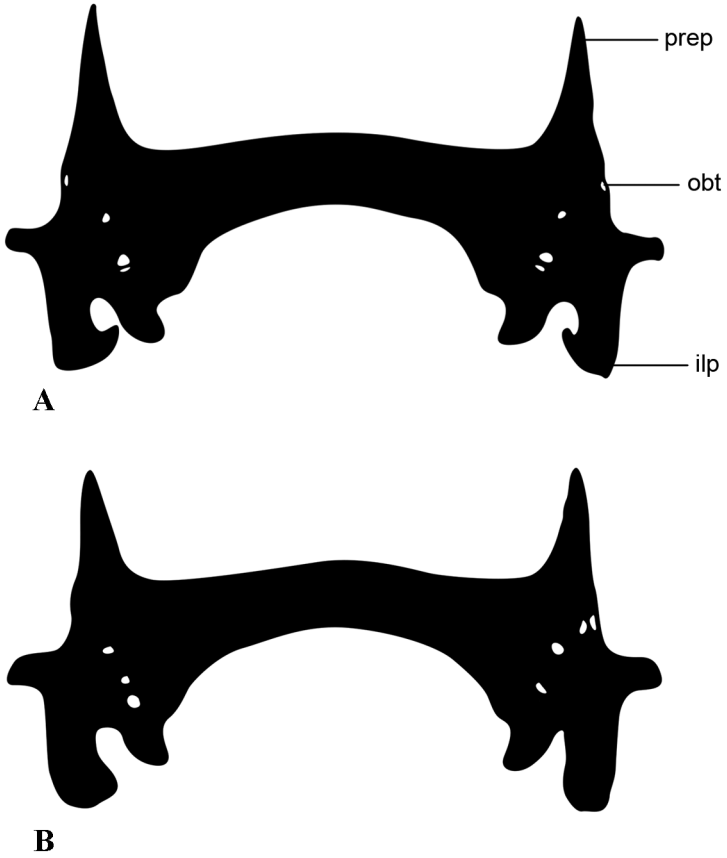

FIGURE 10. Pelvic girdle of *Dipturus amphispinus* sp. nov: A, adolescent male holotype (PNM 15178, 657 mm TL), B, adult male paratype (CSIRO H 7416–01, 621 mm TL). Drawn from radiographs. Abbreviations: ilp—iliac process; obt—obturator foramina, prep—pre-pelvic process.

Distribution. Collected from fish markets at Punta Miray (Baliangao), Dipolog City Public Market, Palapala Fish Port (Cadiz City), Bukana, Sikayab (Dapitan City); Silliman Beach (Dumaguete City) in the central and southern Philippines. During the preparation of this manuscript, Arthur Bos, from The American Museum in Cairo, sent through an image of two mature male specimens captured at a fish market in Panabo, near Davao City (see Figure 11). Capture depth unknown, but probably from deep slopes of the Sulu Sea and adjacent waterways.

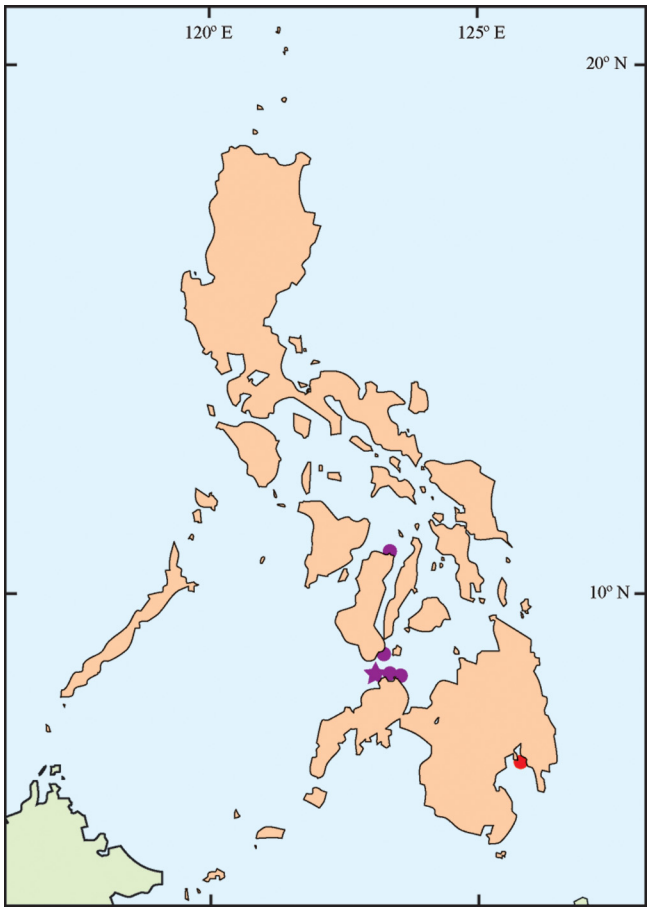

FIGURE 11. Map of the collection sites of *Dipturus amphispinus* sp. nov near the Sulu Sea in the central/southern Philippines. Holotype—purple star; paratypes—purple dots; non-types (from image only)—red dot.

Etymology. Combination of the Greek *amphi* (meaning on both sides, double) and the Latin *spinus* (thorn) in reference to the two prominent rows of strongly tilted thorns forming a ridge on the median disc. Suggested vernacular name: Ridgeback Skate.

Remarks. *Dipturus amphispinus* and *D. wuhanlingi* differ from all other *Dipturus* skates in the Indo–Pacific in having a variably formed, parallel row of tilted thorns (their apices strongly posterolaterally directed) along the lumbar region of the disc. In the *D. wuhanlingi* paratype these parallel rows are poorly formed, appearing as a single staggered row, leading the authors to describe them as "Three nuchal thorns, 14 lumbar thorns, 31 tail thorns and two interdorsal thorns, all arranged in a single medial row". The lumbar thorns were described similarly. In *Dipturus amphispinus* these parallel rows are much better developed, situated on a raised ridge, and usually with at least some thorns paired.

The presence of scapular thorns is an uncommon state in Indo-Pacific *Dipturus*, but *D. amphispinus* has either 1–2 pairs of well-developed scapular thorns. *Dipturus wuhanlingi*, along with an Atlantic species *D. garricki* (Bigelow & Schroeder, 1958), has a single pair of scapular thorns, a similar disc shape, and a single median row of nuchal and tail thorns, in both males and females (Jeong & Nakabo, 2008); the absence of lateral tail thorns in the female paratype of *D. wuhanlingi* (SFC S 07672) was confirmed by inspection by one of us (PL). However, in *D. amphispinus* the prescapular and tail thorns are in single median rows in males, but the tail thorns are represented in females by three well-developed rows (15–22 main lateral thorns on each side). The ventral squamation is similar in *D. amphispinus* and *D. wuhanlingi*, but Jeong & Nakabo (2008) stated that the disc is entirely smooth

dorsally (presumably intentionally excluding primary thorn parches, and figuring denticles on the ventral surface of the disc but nothing dorsally), whereas the anterodorsal margin of the disc of *D. amphispinus* has a dense band of thornlets and denticles covering most of its length. *Dipturus amphispinus* also has a relatively shorter interdorsal space (length 1.2–2.3 vs. 3.3–3.4% TL in *D. wuhanlingi*), shorter distance from the first dorsal-fin origin to the caudal-fin tip (i.e. procaudal length, 15.1–17.6 vs. 18.1–19.0% TL), greater distance between the first gill openings (15.5–16.3 vs. 14.7–14.8% TL), tail slightly deeper at the first dorsal-fin origin (1.1–1.2 vs. 1.2–1.3% TL), and possible has a higher predorsal vertebral count (77–83 vs. 74 centra in *D. wuhanlingi*) and a lower pectoral radial count (83–85 vs. 92 centra).

Dipturus wuhanlingi is known only from two confirmed specimens; the very immature male holotype (668 mm TL) is of similar size to the late adolescent male holotype (657 mm TL) and fully developed male paratype (621 mm TL) of *D. amphispinus*, suggesting that *D. wuhanlingi* may attain a larger maximum size. Also, the pelvic girdle of *D. wuhanlingi* was considered by Jeong & Nakabo (2008) to be taxonomically important, and the possession of 3 pairs of obturator foramina was included as diagnostic. However, from radiographs the position and number of foramina in *D. amphispinus* appears to be variable (from 3–4 and sometimes located near the anterolateral margin of the pelvic girdle (see Figure 10). From their figure of the 668 mm TL immature male holotype of *D. wuhanlingi*, the puboischiadic bar is more strongly arched and the lateral prepelvic processed much shorter than in *D. amphispinus.*

Four other species of *Dipturus* occur in the western North Pacific (Jeong & Nakabo, 2008): *D. gigas*, *D. kwangtungensis*, *D. macrocaudus* and *D. tengu*. These species are presently under review by the senior author in collaboration with Hans Ho and Rou-Rong Chen (National Museum of Marine Biology and Aquarium, Checheng, Taiwan), so more detailed comparisons and a key to the species will be provided in a separate manuscript on the Taiwanese fauna. However, these species can be readily distinguished from *D. amphispinus* because none of them has scapular thorns or parallel rows of thorns in the lumbar region.

Dipturus amphispinus displays marked sexual dimorphism with adult/adolescent male types (621–657 mm TL) having a relatively broader mouth (ca 8.5% vs. 7.7–8.1% TL in females) with much longer teeth, a relatively shorter preorbital snout (length 16.9–19.1 vs. 21.4–22.5% TL), head (dorsal head length 25.6–23.5 vs. 27.4–29.9% TL; ventral head length 33.6–32.3 vs. 35.7–38.3% TL) and disc (direct length 58.6–56.0 vs. 59.5–62.7% TL), a taller first dorsal fin (height 2.8–2.8 vs. 2.1–2.3% TL), and a proportionally longer posterior pelvic-fin lobe (length 16.1–17.3 vs. 13.8–15.9% TL) and tail (length 45.2–47.2 vs. 40.0–42.2% TL) than adult-size females (804–883 mm TL).

TABLE 1. Morphometric data for *Dipturus amphispinus* sp. nov: adolescent male holotype (PNM 15178), adult male paratype (CSIRO H 7416–01), and four female paratypes (SUML BRU 147, MMLM 014, 018, 021). Values are expressed as proportions of total length (TL).

	Holotype	**Male paratype**	**Female paratypes**	
	PNM 15178	**CSIRO H 7416–01**	**Min**	**Max**
Total length	657	621	804	883
Disc width	67.3	68.6	68.8	72.0
Disc length (dir)	58.6	56.0	59.5	62.7
Snout to maximum width	36.5	34.4	36.7	39.3
Snout length (preorbital) - dir	19.1	16.9	21.4	22.5
Snout to spiracle	24.4	21.9	25.8	27.7
Head - dorsal	25.6	23.5	27.4	29.9
Orbit diameter	3.4	3.6	2.9	3.5
Orbit and spiracle length	5.2	5.2	4.5	5.4
Spiracle length - main pore	1.7	3.2	1.8	2.2
Distance between orbits	4.7	4.8	5.3	6.1
Distance between spiracles	6.2	6.5	6.3	6.6
Distance-snout to cloaca	54.8	52.8	57.3	60.0
Cloaca to D1	27.8	29.6	24.6	26.3
Cloaca to D2	34.4	36.0	30.4	32.1

.....continued on the next page

TABLE 1. (Continued)

	Holotype	Male paratype	Female paratypes	
	PNM 15178	CSIRO H 7416–01	Min	Max
Cloaca to caudal origin	40.5	41.6	36.0	38.1
Distance-cloaca to caudal fin tip	45.2	47.2	40.0	42.2
Snout length (pre upper jaw)	18.8	17.9	20.7	24.2
Prenasal length	16.7	14.8	18.3	20.0
Head length to fifth gill	33.6	32.3	35.7	38.3
Mouth width	8.5	8.5	7.7	8.1
Distance between nostrils	8.4	8.3	8.0	8.3
Nasal curtain-length	4.3	4.7	4.3	5.0
Nasal curtain-total width	9.6	9.2	8.9	9.4
Nasal curtain - min width	6.7	6.8	5.9	6.4
Nasal curtain - lobe width	1.9	1.5	1.8	2.1
Width of first gill opening	1.9	1.5	1.8	2.0
Width of fifth gill opening	1.0	1.4	1.2	1.5
Distance between first gill openings	15.5	15.6	15.7	16.3
Distance between fifth gill openings	8.3	8.0	8.8	9.2
Clasper-post cloacal length	22.7	24.9	-	-
Length of anterior pelvic lobe	11.9	12.9	11.0	14.0
Length of posterior pelvic lobe	16.1	17.3	13.8	15.9
Pelvic base - width	7.5	7.4	8.0	10.0
Tail at axil pelvic fins - width	3.3	3.6	3.2	3.7
Tail at axil pelvic fins - height	2.1	2.4	2.0	2.4
Tail at midlength - width	1.3	1.5	1.6	2.0
Tail at midlength - height	1.1	1.2	1.1	1.3
Tail at D1 origin - width	1.3	1.3	1.6	1.7
Tail at D1 origin - height	1.1	1.1	1.0	1.2
D1 base - length	4.7	5.1	4.1	4.4
D1 - height	2.8	2.8	2.1	2.3
D1 orig to caudal fin tip	17.4	17.6	15.1	16.6
D2 orig to caudal fin tip	10.4	11.2	9.1	10.3
Caudal-fin length	4.7	5.6	4.2	4.8
Interdorsal space	2.3	1.2	1.2	2.3

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References

Alcock, A.W. (1899) *A descriptive catalogue of the Indian deep-sea fishes in the Indian Museum. Being a revised account of the deep-sea fishes collected by the Royal Indian marine survey ship 'Investigator'.* Calcutta. Deep-sea Fishes Indian Museum, 211 pp.

Beebe, W. & Tee-Van, J. (1941) Eastern Pacific expeditions of the New York Zoological Society. XXVIII. Fishes from the tropical eastern Pacific. [From Cedros Island, Lower California, south to the Galápagos Islands and northern Peru.] Part 3. Rays, Mantas and Chimaeras. *Zoologica (N. Y.)*, 26, 245–280.

Bigelow, H.B. & Schroeder, W.C. (1958) Four new rajids from the Gulf of Mexico. *Bulletin of the Museum of Comparative Zoology*, 119, 201–233.

Chu, Y.T. (1960) *Cartilaginous fishes of China*. Scientific Press, Peiping, 225 pp.

Compagno, L.J.V., Last, P.R., Stevens J.D. & Alava, M.N.R. (2005) Checklist of Philippine Chondrichthyes. *CSIRO Marine Laboratories Report*, 243, 1–103.

Ebert, D.A. & Compagno, L.J.V. (2007) Biodiversity and systematics of skates (Chondrichthyes: Rajiformes: Rajoidei). *Environmental Biology of Fishes*, 80, 111–124.
http://dx.doi.org/10.1007/s10641-007-9247-0

Garrick, J.A.F. & Paul, L.J. (1974) The taxonomy of New Zealand skates (suborder Rajoidea), with descriptions of three new species. *Journal of the Royal Society of New Zealand*, 4, 345–377.
http://dx.doi.org/10.1080/03036758.1974.10419402

Hubbs, C.L. & Ishiyama, R. (1968) Methods for taxonomic study and description of skates (Rajidae). *Copeia*, 1968 (3), 483–491.
http://dx.doi.org/10.2307/1442016

Ishiyama, R. (1955) Studies on the rays and skates belonging to the family Rajidae, found in Japan and adjacent regions. 6. *Raja macrocauda*, a new skate. *Journal of the Shimonoseki Collection of Fishes*, 4, 43–51.
http://dx.doi.org/10.2307/1440023

Ishiyama, R. (1958) Studies on the rajid fishes (Rajidae) found in the waters around Japan. *Journal of the Shimonoseki Collection of Fishes*, 7, 191–394.

Jeong, C.-H. & Nakabo, T. (2008) *Dipturus wuhanlingi*, a new species of skates (Elasmobranchi; Rajidae) from China. *Ichthyological Research*, 55 (2), 183–190.
http://dx.doi.org/10.1007/s10228-007-0031-0

Jordan, D.S. & Fowler, H.W. (1903) A review of the elasmobranchiate fishes of Japan. *Proceedings of the U.S. National Museum*, 26, 593–674.
http://dx.doi.org/10.5479/si.00963801.26-1324.593

Last, P.R. (2008) New short-snout members of the skate genus *Dipturus* (Rajoidei: Rajidae) from Australian seas. *In*: Last, P.R., White, W.T., Pogonoski, J.J. & Gledhill, D.C. (Eds.), *Descriptions of new Australian skates (Batoidea: Rajoidei)*. CSIRO Marine & Atmospheric Research Paper 021, pp. 53–98.

Last, P.R. & Gledhill, D.C. (2007) The Maugean skate, *Zearaja maugeana* sp. nov. (Rajiformes: Rajidae)—a micro-endemic, Gondwanan relict from Tasmanian estuaries. *Zootaxa*, 1494, 45–65.

Last, P.R., White, W.T. & Pogonoski, J.J. (2008b) New skates of the genus *Dipturus* (Rajoidei: Rajidae) from Australian seas. *In*: Last, P.R., White, W.T., Pogonoski J.J. & Gledhill, D.C. (Eds.), *Descriptions of new Australian skates (Batoidea: Rajoidei)*. CSIRO Marine & Atmospheric Research Paper 021, pp. 9–52.

Last, P.R., White, W.T., Pogonoski, J.J. & Gledhill, D.C. (2008a) New Australian skates (Batoidea: Rajoidei)—background and methodology. *In*: Last, P.R., White, W.T., Pogonoski, J.J. & Gledhill, D.C. (Eds.), *Descriptions of new Australian skates (Batoidea: Rajoidei)*. CSIRO Marine & Atmospheric Research Paper 021, pp. 1–8.

McEachran, J.D. & Fechhelm, J.D. (1982) A new species of skate from western Australia with comments on the status of *Pavoraja* Whitley, 1939 (Chondrichthyes: Rajiformes). *Proceedings of the Biological Society of Washington*, 95, 1–12.

Macleay, W. (1884) Some results of trawl fishing outside Port Jackson. *Proceedings of Linnean Society New South Wales*, 8, 457–462.

Ogilby, J.D. (1910) On some new fishes from the Queensland coast. *Endeavour Series*, 1, 85–139.

Séret, B. (1989) Deep water skates of Madagascar. Part 3. Rajidae (Pisces, Chondrichthyes, Batoidea). *Raja* (*Dipturus*) *crosnieri* sp. n. *Cybium*, 13, 115–130.

Smith, J.L.B. (1964) Fishes collected by Dr. Th. Mortensen off the coast of South Africa in 1929, with an account of the genus *Crurirajia* Bigelow & Scroeder, 1954 in South Africa. *Videnskabelige Meddelelser Naturhistorisk Forening i København*, 126, 283–300.

Wallace, J.H. (1967) The batoid fishes of the east coast of southern Africa. Part 3: skates and electric rays. *Investigative Reports of the Oceanographic Research Institute of Durban*, 17, 1–62.

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

Whitley, G.P. (1940) *The fishes of Australia. Part I. The sharks, rays, devil-fish, and other primitive fishes of Australia and New Zealand*. Royal Zoological Society of New South Wales, Sydney, 280 pp.