



Four new species of deep-water catsharks of the genus *Parmaturus* (Carcharhiniformes: Scyliorhinidae) from New Caledonia, Indonesia and Australia

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Abstract

Four new species of rare scyliorhinid catsharks are provisionally assigned to the genus *Parmaturus*: *P. lanatus* **sp. nov.** from Indonesia, *P. albimarginatus* **sp. nov.** and *P. albipenis* **sp. nov.** from northern New Caledonia, and *P. bigus* **sp. nov.** from northeastern Australia. These species differ from each other by a combination of body morphology, denticle shape, dentition, colour and vertebral counts. An identification key to the Indo-Pacific *Parmaturus* species is provided. Comments on the diagnostic features separating the genera *Halaelurus* and *Parmaturus* are given.

Key words: Scyliorhinidae, *Parmaturus albimarginatus*, *Parmaturus albipenis*, *Parmaturus bigus*, *Parmaturus lanatus*, New Caledonia, Indonesia, Australia, deep-water catsharks, new species

Résumé

Quatre nouvelles espèces d'holbiches de profondeur du genre *Parmaturus* (Carcharhiniformes: Scyliorhinidae) de Nouvelle-Calédonie, d'Indonésie et d'Australie.

Quatre nouvelles espèces d'holbiches rares sont provisoirement assignées au genre *Parmaturus* : *P. lanatus* **sp. nov.** d'Indonésie, *P. albimarginatus* **sp. nov.** et *P. albipenis* **sp. nov.** du nord de la Nouvelle-Calédonie et *P. bigus* **sp. nov.** du nord-est de l'Australie. Ces espèces diffèrent entre elles par une combinaison de caractères morphologiques, la forme des denticules cutanés, la dentition, la coloration et le nombre de vertèbres. Une clef d'identification des espèces indo-pacifiques de *Parmaturus* est fournie. Les caractères diagnostiques séparant théoriquement les genres *Halaelurus* et *Parmaturus* sont donnés.

Introduction

During French and Australian exploratory cruises in the past decades to investigate the marine biodiversity of the Indo-Pacific region, numerous new species of fishes have been collected. Amongst these were representatives of some poorly known elasmobranch genera, including members of the catshark genus *Parmaturus* Garman. Five nominal species are presently assigned to this group and three of them occur in the Indo-Pacific: *P. melanobranchus* (Chan, 1966) and *P. pilosus* Garman, 1906 from China and Japan, and *P. macmillani* Hardy, 1985 from New Zealand and south of Madagascar (Compagno *et al.*, 2005). However, the status and composition of *Parmaturus*, as well as the scyliorhinid genera *Galeus* Rafinesque and *Halaelurus* Gill, have been questioned because of the intrageneric variability of some diagnostic features, such as the presence or absence

of a crest of enlarged denticles on the upper caudal lobe (Garman, 1913; Springer, 1979; Séret, 1987; Compagno, 1988; Compagno and Stevens, 1993).

Garman (1906) defined the genus *Parmaturus* for his new species *P. pilosus* with the following set of characters: anal and subcaudal long, snout short and thick, nostrils near mouth, supracaudal crest of denticles, first dorsal fin above pelvic fins and second dorsal fin above anal fin. In comparing the diagnostic features of *Halaelurus* and *Parmaturus* as listed by Compagno (1984), it appears that few characters separate the two genera: body firm and thick-skinned in *Halaelurus* versus body soft and flabby in *Parmaturus*; head moderately to considerably depressed versus head slightly depressed; subocular ridges broad versus narrow; claspers rather slender versus rather robust; and no crest of denticles on the caudal margins versus a well-developed crest of denticles on the dorsal caudal margin and sometimes on the preentral caudal margin. Of these, the most useful diagnostic features appear to be the consistency of the body (firm or soft) and the presence/absence of a supracaudal crests of enlarged denticles.

A revision of the genus *Parmaturus* and related genera is needed. However the New Caledonian, Indonesian and Australian species herein described are tentatively assigned to this genus on the basis of the following features: soft-bodied, deep-water scyliorhinid catsharks with velvety skin, a crest of enlarged denticles usually present but sometimes rudimentary on upper caudal margin (also often on the ventral caudal margin), relatively small pectoral fins, well developed dorsal fins, the first dorsal about opposite to the pelvic fin, the second dorsal about opposite to the anal, a large anal fin, and a simple, mostly uniform coloration.

This paper describes four new deep-water *Parmaturus* catsharks from New Caledonia, Indonesia and Australia, based on specimens collected in recent voyages.

Material and methods

Morphometric data were taken according to Compagno (2001) and were expressed in Tables as total length (TL) in mm; other measurements are expressed as percentages of TL; ratios of selected measurements were also calculated. Vertebral centra counts were obtained from radiographs; they include the numbers of monospondylous centra, precaudal centra (monospondylous + diplospondylous centra to the origin of lower lobe of caudal fin) and total centra. Tooth rows were obtained directly from specimens. Specimens were deposited in the collections of the Muséum National d'Histoire Naturelle, Paris (MNHN) and the Australian National Fish Collection (CSIRO). The capture localities of types are shown in Fig. 1. Although these new catsharks are not harvested commercially, recommended common names are proposed for use by non-specialists in monitoring fishery bycatch.

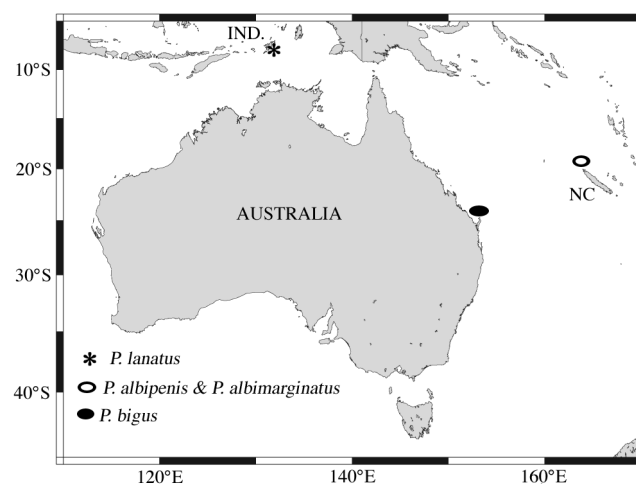


FIGURE 1. Map showing the capture localities of the four new *Parmaturus* species: *P. albimarginatus* (white oval), *P. albipennis* (white oval), *P. bigus* (black oval) and *P. lanatus* (black star).

The new species were compared to the Indo-West Pacific species of the genus *Parmaturus*: *P. pilosus* Garman, 1906, *P. melanobranchus* (Chan, 1966) and *P. macmillani* Hardy, 1985.

Taxonomic accounts

Parmaturus albimarginatus sp. nov.

Figs 2 and 3, Tables 1–3

White-tip Catshark (English), holbiche à pointes blanches (French).

Parmaturus sp.: Grandperrin *et al.*, 1995: table 3, p. 35 and table 4, p. 42 (listed)

Material. 1 specimen.

New Caledonia. Cruise HALICAL 1, stn 15, 18°54'S, 163°05'E (Grand Passage), 688–732 m depth, longline, R.V. “Alis”, 21 November 1994, adult male 577 mm TL (MNHN 1997.3584: holotype).

Diagnosis. A scyliorhinid catshark with the following combination of characters: a soft body; velvet-like skin with large tricuspidate denticles; plain pale to medium brown coloration; dorsal, caudal and anal-fin posterior margins distinctly white-edged; pronounced caudal crests on upper and lower anterior caudal fin margins, denticles on crests greatly enlarged; teeth mainly tricuspidate with greatly elongate median cusps, in 92 rows in both jaws; first dorsal fin slightly behind middle of back; pelvic fins slightly in front of mid-body, pre-pelvic length 47% TL; vent at mid-length, pre-vent length 50% TL; snout relatively short, pre-narial length 3.7% TL; mouth short, length 3.7% TL; labial furrows short, 1.7–2.0% TL, lower furrows subequal in length to upper furrows; head depressed, shorter than abdomen, length 19.2% TL, pectoral-pelvic length 24.8% TL; second dorsal fin larger than first, anterior margins of first and second dorsal fins 8.7% and 10.4% TL respectively; subterminal caudal lobe relatively small, subterminal margin length 3.3% TL, terminal margin length 3.8% TL; monospondylous centra 43; precaudal centra 95.

Description. Scyliorhinid catshark with flabby, soft body, trunk slightly depressed, tail compressed and tapering to caudal fin, head well depressed, height 6.9% TL, head shorter than abdomen, pectoral to pelvic space 24.8% TL, 1.3 in head length; pelvic to anal space 0.7 in anal-fin base; caudal peduncle moderately elongate, anal to caudal space 1.1 of anal-fin base; peduncle moderately compressed, caudal peduncle width 1.6 in height, dorsal and ventral profile longitudinally ridged by anterior part of upper and lower caudal fin crest. Snout short and rounded-parabolic in dorsoventral view, tip broadly rounded, conical in lateral view; preoral length 6.3% TL, 0.7 in mouth width; pre-narial snout 0.9 times eye length. Eyes large, length 3.9% TL, 4.9 in head length; eyes dorsolateral on head, with well-developed subocular ridges. Labial furrows short but well defined. Nostrils large with tube-like incurrent apertures, anterior nasal flaps sub-triangular, posterior tip not forming a pronounced lobe, nostrils well separated, internarial length 2.1% TL; well removed from mouth.

Teeth of upper jaw fully exposed when mouth closed; anterior teeth tricuspidate with a long pointed central cusp flanked by much smaller lateral, often barely distinguishable cusps; lateral teeth with shorter median cusps, and relatively longer lateral cusps, lateral cusps often with a short accessory cusp (teeth weakly five-cusped), base of teeth ridged, teeth in 92/92 rows in upper and lower jaw respectively; teeth in quincunx arrangement but lateral teeth appear as arranged in oblique rows due to the equal or decreasing size of the cusps. Dermal denticles on side: weakly imbricated and erect; shield-like tricuspidate crown with a very long pointed median cusp ending in a longitudinal ridge and mostly short lateral cusps. A strong caudal crest of enlarged denticles on basal half of upper caudal margin falling short of second dorsal-fin insertion by length of about first gill slit; denticles of caudal crest greatly enlarged laterally (tricuspidate, often more than three times longer than body denticles below, lateral cusps barely shorter than median cusp, directed posterolater-

ally, with about three rows of smaller denticles between greatly enlarged lateral denticles, denticles largest anteriorly decreasing in size posteriorly on crest to merge with denticles of tail, crest well elevated, naked area of skin separating crest denticles from those on side of tail); a similar but less well-developed crest on caudal peduncle ventrally, barely extending onto ventral caudal margin; crest less well elevated than dorsal crest, in 4–5 rows, denticles smaller in size than those in dorsal crest.



FIGURE 2. *Parmaturus albimarginatus* **sp. nov.** holotype adult male 577 mm TL (MNHN 1997–3584).



FIGURE 3 Ventral view of head of *Parmaturus albimarginatus* **sp. nov.** holotype adult male 577 mm TL (MNHN 1997–3584).

First dorsal fin much smaller than second dorsal, first originating slightly forward of pelvic fin insertion; second originating over posterior half of anal fin base; anterior margin of both dorsal fins weakly convex, apices narrowly rounded; posterior margin of first dorsal fin strongly convex, second dorsal posterior margin much less convex; rear corner obtusely angular; inner margin straight, directed posterodorsally. Pectoral fins small and rounded distally, somewhat lobe-like, anterior margin 9.4% TL; anterior and posterior margins moderately convex, apex and rear corners broadly rounded. Pelvic fins small, subtriangular, apex broadly rounded, length 9.4% TL. Anal fin triangular, similar in size to second dorsal fin, base 10.7% TL, 0.9 times interdorsal space; origin at about level of anterior half of interdorsal space, anal-fin height 2.3 in base length.

Caudal fin relatively short, dorsal caudal margin length 21.9% TL, upper and lower lobes originating as low ridges of enlarged denticles; lower lobe moderately developed distally; terminal caudal lobe fan-like with pronounced convex posterior margin. Monospondylous centra 43; precaudal centra 95; total 136.

TABLE 1. Biometrical features of *Parmaturus* species, in mm and in % of TL.

Species	<i>P. albimarginatus</i> sp. nov.		<i>P. albipenis</i> sp. nov.		<i>P. bigus</i> sp. nov.		<i>P. lanatus</i> sp. nov.	
Catalogue number	MNHN 1997-3584 holotype		MNHN 1997-3583 holotype		CSIRO H-947.10 holotyp		MNHN 2007-1499 holotype	
Sex and maturity	adult male		adult male		adult female		juvenile male	
Total length (mm)	577.0	100.0	415.0	100.0	713.0	100.0	360.0	100.0
Pre-first dorsal length	295.0	51.1	191.9	46.2	391.5	54.9	165.0	45.8
Pre-second dorsal length	386.0	66.9	267.3	64.4	497.6	69.8	220.0	61.1
Precaudal length	455.0	78.9	303.8	73.2	599.0	84.0	266.0	73.9
Prepectoral length	110.8	19.2	75.4	18.2	141.2	19.8	71.0	19.7
Prepelvic length	270.7	46.9	195.3	47.1	348.7	48.9	144.0	40.0
Preanal length	341.0	59.1	253.1	61.0	368.0	51.6	197.0	54.7
Snout-vent length	286.5	49.7	215.7	52.0	362.0	50.8	159.0	44.2
Preorbital length (direct)	34.8	6.0	27.3	6.6	48.5	6.8	25.0	6.9
Eye length	22.8	3.9	15.6	3.8	24.5	3.4	15.0	4.2
Eye height	3.0	0.5	2.6	0.6	9.8	1.4	9.0	2.5
Interorbital space	44.5	7.7	33.1	8.0	38.7	5.4	29.0	8.1
Prespiracular length	67.8	11.8	50.9	12.3	77.7	10.9	43.0	11.9
Spiracle length	1.4	0.2	1.8	0.4	4.7	0.7	1.0	0.3
Prenarial length	21.2	3.7	17.8	4.3	29.6	4.2	17.0	4.7
Nostril width	14.4	2.5	11.8	2.8	16.4	2.3	11.0	3.1
Internarial space	12.2	2.1	11.8	2.8	16.1	2.3	10.0	2.8
Anterior nasal flap length	6.1	1.1	5.0	1.2	5.7	0.8	5.0	1.4
Preoral length	36.3	6.3	24.3	5.9	40.5	5.7	21.0	5.8
Mouth width	52.7	9.1	41.1	9.9	47.5	6.7	34.0	9.4
Mouth length	21.5	3.7	13.0	3.1	25.8	3.6	18.0	5.0
Upper labial furrow length	10.0	1.7	3.0	0.7	8.6	1.2		
Lower labial furrow length	11.4	2.0	3.8	0.9	12.0	1.7		
Prebranchial length	91.0	15.8	67.1	16.2	122.8	17.2	61.0	16.9
Head length	110.7	19.2	82.1	19.8	141.4	19.8	77.0	21.4
First gill slit height	10.0	1.7	10.0	2.4	16.1	2.3	8.0	2.2
Fifth gill slit height	4.5	0.8	4.4	1.1	10.7	1.5	5.0	1.4
First dorsal-fin anterior margin	47.5	8.2	46.8	11.3	36.8	5.2	33.0	9.2
First dorsal-fin base	39.1	6.8	39.6	9.6	34.9	4.9	25.0	6.9
First dorsal-fin height	18.3	3.2	24.7	5.9	25.2	3.5	15.0	4.2
First dorsal-fin inner margin	9.3	1.6	15.9	3.8	11.4	1.6	9.0	2.5
First dorsal-fin posterior margin	17.8	3.1	21.8	5.2	21.5	3.0	10.0	2.8
Interdorsal space	56.6	9.8	46.6	11.2	66.1	9.3	34.0	9.4

to be continued.

TABLE 1. (continued)

Species	<i>P. albimarginatus</i> sp. nov.		<i>P. albipenis</i> sp. nov.		<i>P. bigus</i> sp. nov.		<i>P. lanatus</i> sp. nov.	
Second dorsal-fin anterior margin	59.9	10.4	47.0	11.3	66.4	9.3	37.0	10.3
Second dorsal-fin base	46.4	8.0	38.5	9.3	51.9	7.3	28.0	7.8
Second dorsal-fin height	26.7	4.6	21.4	5.1	34.3	4.8	16.0	4.4
Second dorsal-fin inner margin	10.6	1.8	15.5	3.7	12.3	1.7	9.0	2.5
Second dorsal-fin posterior margin	22.7	3.9	19.5	4.7	27.2	3.8	13.0	3.6
Pectoral-fin anterior margin	54.4	9.4	46.1	11.1	53.9	7.6	40.0	11.1
Pectoral-fin base	25.6	4.4	22.5	5.4	34.1	4.8	23.0	6.4
Pectoral-fin inner margin	24.7	4.3	26.2	6.3	14.5	2.0	15.0	4.2
Pectoral-fin posterior margin	36.8	6.4	37.3	9.0	35.2	4.9	36.0	10.0
Pectoral-pelvic space	143.1	24.8	100.4	24.2	181.4	25.4	61.0	16.9
Pelvic-fin anterior margin	43.9	7.6	28.8	6.9	46.2	6.5	20.0	5.6
Pelvic-fin base	32.6	5.7	25.9	6.2	32.9	4.6	25.0	6.9
Pelvic-fin length	54.1	9.4	44.8	10.8	52.2	7.3	35.0	9.7
Pelvic-fin inner margin length	13.8	2.4	23.1	5.6	18.0	2.5	13.0	3.6
Pelvic-fin posterior margin length	21.2	3.7	24.3	5.9	39.5	5.5	21.0	5.8
Pelvic-anal space	41.7	7.2	20.1	4.8	57.5	8.1	20.0	5.6
Anal-fin anterior margin	51.8	9.0	37.1	8.9	57.1	8.0	32.0	8.9
Anal-fin base	61.9	10.7	39.0	9.4	69.0	9.7	32.0	8.9
Anal-fin height	21.9	3.8	24.4	5.9	29.7	4.2	11.3	3.1
Anal-fin length	67.1	11.6	48.2	11.6	69.3	9.7	39.0	10.8
Anal-fin inner margin	7.6	1.3	9.5	2.3	9.2	1.3	7.0	1.9
Anal-fin posterior margin	27.8	4.8	24.3	5.9	40.2	5.6	15.0	4.2
Dorsal-caudal space	16.2	2.8	3.2	0.8	40.9	5.7	19.0	5.3
Anal-caudal space	65.6	11.4	1.7	0.4	83.4	11.7	18.0	5.0
Caudal peduncle height	16.9	2.9	16.7	4.0	18.1	2.5	14.0	3.9
Caudal peduncle width	10.5	1.8	9.9	2.4	10.6	1.5	9.0	2.5
Dorsal caudal-fin margin	126.5	21.9	111.2	26.8	144.0	20.2	100.0	27.8
Preventral caudal-fin margin	41.3	7.2	119.8	28.9	51.8	7.3	52.0	14.4
Subterminal caudal-fin margin	18.9	3.3	23.6	5.7	26.9	3.8	17.0	4.7
Terminal caudal-fin margin	21.9	3.8	21.0	5.1	25.3	3.6	19.1	5.3
Clasper outer length	29.5	5.1	23.3	5.6			5.0	1.4
Clasper inner length	34.0	5.9	29.0	7.0			10.0	2.8
Clasper base width	10.0	1.7	9.6	2.3			3.0	0.8
Head height	40.1	6.9	35.7	8.6	65.0	9.1	24.3	6.8
Head width	74.5	12.9	59.7	14.4	67.5	9.5	49.3	13.7

Coloration. (from preserved specimen). Plain pale to medium brown dorsally, no evidence of body markings; lower flanks yellowish white, gradating into slightly darker coloration above; brownish coloration on dorsal tail delineated clearly from lighter lower side; yellowish white ventrally; dorsal, caudal, anal and dorsal

surfaces of pectoral and pelvic fins brownish, somewhat darker than body; posterior margins of dorsal, caudal and anal fins with broad, white posterior margins; posterior margin of pectoral and pelvic fins light but not forming conspicuous white stripe. Floor and roof of mouth greyish, pores on roof of mouth black-edged. Claspers yellowish ventrally, milky white above; naked skin at pelvic insertion white.

Size. Known only from the holotype, an adult male 577 mm TL.

Distribution. From the insular slopes off northern New Caledonia (Grand Passage) in 590–732 m depth (Fig. 1).

Etymology. From the Latin “*albus*” (white) and “*marginatus*” (with a border) in reference to its broad, white, posterior fin margins.

Comparisons. *Parmaturus albimarginatus* can be distinguished from its congeners by the following:

Parmaturus melanobranchus differs from *P. albimarginatus* by: first dorsal-fin origin forward of mid-length (after midlength in *P. albimarginatus*), pre-first dorsal length about 46% TL (versus about 51% TL); teeth with 3–5 cusps (versus mainly 3); shorter pre-pelvic length (39% TL versus 47% TL); longer mouth (7.0% TL versus 3.7% TL); head longer than abdomen (rather than shorter); and a dark brown or grey coloration (rather than pale brown).

Parmaturus pilosus differs from *P. albimarginatus* by: first dorsal-fin origin forward of mid-length (after midlength in *P. albimarginatus*), pre-first dorsal length 45–46% TL (versus about 51% TL); teeth with mainly 5–6 cusps (versus mainly 3); dorsal fins subequal (versus second dorsal larger); and a larger subterminal caudal lobe (5.5% TL versus 3.3% TL).

Parmaturus macmillani differs from *P. albimarginatus* by: first dorsal-fin origin forward of mid-length (after midlength in *P. albimarginatus*), pre-first dorsal length about 48% TL (versus 51% TL); teeth with 5–6 cusps (versus mainly 3); and dorsal fins subequal (versus second dorsal larger).

***Parmaturus albipenis* sp. nov.**

Figs 4 and 5, Tables 1–3

White-clasper Catshark (English), holbiche à sexe blanc (French)

Halaehurus sp.: Grandperrin *et al.*, 1995: table 3, p. 35 and table 4, p. 42 (listed)

Material. 1 specimen.

New Caledonia. HALICAL 1, stn 15, 18°54'S, 163°05'E (Grand Passage), 688–732 m depth, longline, R.V. “Alis”, 21 November 1994, adult male 415 mm TL (MNHN 1997–3583: holotype).

Diagnosis. A scyliorhinid catshark with the following combination of characters: soft body; velvety skin with small, tricuspidate denticles; claspers whitish, contrasting with a brownish body coloration; caudal crests present but denticles not enlarged, crests extending almost to second dorsal and anal-fin insertions; teeth tri- or quadricuspidate, in about 130 rows in upper jaw; first dorsal fin slightly in front middle of back, pre-first dorsal length 46.2% TL, origin slightly in front of pelvic-fin origin; pelvic-fin origin slightly in front of mid-body, pre-pelvic length 47.1% TL; vent slightly behind mid-body, pre-vent length 52.0% TL; snout short, pre-narial length 4.3% TL; mouth short, mouth length 3.1% TL; labial furrows very short, confined to mouth corners; head shorter than abdomen, head length 19.8% TL, pectoral-pelvic length 24.2% TL; dorsal fins large, subequal in size, anterior margins about 11.3% TL, first dorsal more erect than second; subterminal caudal lobe well developed, subterminal margin length 5.7% TL, terminal margin length 5.1% TL; monospondylous centra 39; precaudal centra 79.

Description. Scyliorhinid catshark with flabby, soft body, trunk slightly depressed, tail compressed and tapering to caudal fin, head moderately depressed, height 8.6% TL, head shorter than abdomen, pectoral to pelvic space 24.2% TL, 1.2 in abdomen length; pelvic to anal space short, 1.9 as long as anal-fin base; caudal

peduncle high and compressed (width 1.7 in height) but strongly reduced (long upper and lower caudal lobes extending anteriorly almost to insertions of dorsal and anal fins as low convex ridges), anal to caudal space 4.2% anal-fin base length. Snout short and rounded-parabolic in dorsoventral view, tip broadly rounded, narrowly rounded in lateral view; preoral length 5.9% TL, 1.7 times mouth width; preanial snout 1.1 times eye length. Eyes of moderate size, length 3.8% TL, 5.2 times in head length; eyes strongly dorsolateral on head, with well-developed subocular ridges. Mouth large, short and very broad; broadly arched, width 9.9% TL, 1.7 times its length; labial furrows very short, confined to mouth corner, lower furrows somewhat longer than upper furrows, 0.9% TL. Nostrils large with tube or slit-like incurrent apertures (somewhat asymmetric in holotype); anterior nasal flap more or less subtriangular with posterior tip forming a distinct, laterally extended lobe; nostrils well separated, internarial length 2.8% TL, falling short to mouth.



FIGURE 4. *Parmaturus albipenis* sp. nov. holotype adult male 415 mm TL (MNHN 1997–3583).



FIGURE 5. Ventral view of head of *Parmaturus albipenis* sp. nov. holotype adult male 415 mm TL (MNHN 1997–3583).

Teeth of upper jaw not exposed when mouth closed; teeth very small, mainly tricuspidate near symphysis, tri- or quadricuspidate laterally; typically with a pointed central cusp flanked with two/one slightly smaller

lateral cusps; in about 130 rows in upper jaw; teeth in quincunx arrangement but cusps of almost equal size give an oblique appearance to the rows, mainly on lateral jaws. Dermal denticles on side small, densely imbricate and semi-erect; crown shield-like, tricuspidate, top of crown flattened, median cusp sometimes marked by a short, low ridge. Caudal crest present, denticles not enlarged, similar in size to those of adjacent tail; in about 12–14 rows along dorsal midline of caudal peduncle; in about 8–10 rows along ventral midline of caudal peduncle; denticles directed posteriorly on middle of crest, more posterolaterally near edges of crest; central cusp of crest denticles barely longer than lateral cusps rather than much longer typical of flank denticles, merging with normal caudal denticles on fin.

TABLE 2. Ratios of selected measurements for the four new species of *Parmaturus*.

Species	<i>P. albimarginatus</i> sp. nov.	<i>P. albipenis</i> sp. nov.	<i>P. bigus</i> sp. nov.	<i>P. lanatus</i> sp. nov.
Catalogue number	MNHN 1997-3584 holotype	MNHN 1997- 3583 holotype	CSIRO H- 947.10 holotype	MNHN 2007- 1499 holotype
Geographical area	New Caledonia	New Caledonia	NE Australia	Indonesia
Sex and maturity	adult male	adult male	adult female	juvenile male
Total length (mm)	577	415	713	360
Head height / Head width	0.5	0.6	1.0	0.5
Head length / Pectoral-pelvic space	0.8	0.8	0.8	1.3
Pre-first dorsal length / Prepelvic length	1.1	1.0	1.1	1.1
Pre-first dorsal length / Interdorsal space	5.2	4.1	5.9	4.9
Pre-second dorsal length / Preanal length	1.1	1.1	1.4	1.1
Pelvic-anal space / Anal base length	0.7	0.5	0.8	0.6
Pelvic-anal space / Anal-caudal space	0.6	11.7	0.7	1.1
Anal-fin base length / Anal-caudal space	0.9	22.7	0.8	1.8
Anal-caudal space / Anal-fin base length	1.1	0.04	1.2	0.6
Preoral length / Mouth width	0.7	0.6	0.9	0.6
Preoral length / Eye length	1.6	1.6	1.6	1.4
Prepectoral length / Prenarial length	5.2	4.2	4.8	4.2
Prenarial length / Eye length	0.9	1.1	1.2	1.1
Pectoral-pelvic space / Head length	1.3	1.2	1.3	0.8
Head length / Eye length	4.9	5.3	5.8	5.1
Mouth width / Mouth length	2.5	3.2	1.8	1.9
First dorsal height / Second dorsal height	0.7	1.2	0.7	0.9
Interdorsal space / Anal-fin base length	0.9	1.2	1.0	1.1
Caudal peduncle height / Peduncle width	1.6	1.7	1.7	1.6
Clasper outer length / Clasper base width	2.9	2.4		1.7

Dorsal fins rather large, subequal in size; anterior margin length of both dorsal fins 11.3% TL; first dorsal fin more erect and less elongate than second dorsal fin, its origin slightly in front of anal fin origin; second dorsal originating slightly forward of middle of anal-fin base; anterior margins of both dorsal fins weakly convex, apices rounded; posterior margin of first dorsal fin weakly convex, directed anterodorsally; posterior margin of second dorsal fin almost truncate, orientation almost vertical; rear corners of both fins rounded,

almost forming a right angle. Pectoral fins of moderate size, rounded, lobate, anterior margin 11.1% TL; anterior margin more convex than posterior margin; apex and rear corner rounded. Pelvic fins moderately small, semi-oval, apex broadly rounded, length 10.8% TL. Anal fin deeply subtriangular, larger than second dorsal fin, base 9.4% TL, 1.2 in interdorsal space; origin slightly behind level of middle of interdorsal space; anal-fin height 1.6 in base length. Caudal fin long, dorsal caudal margin length 26.8% TL; upper and lower lobes originating as caudal crests near insertions of second dorsal and anal fins respectively; lower lobe moderately well developed; terminal caudal lobe deep, fan-like, with truncate posterior margin, its subterminal margin 5.7% TL, terminal margin 5.1% TL. Monospondylous centra 39; precaudal centra 79; total centra 123.

Coloration. (from preserved specimen). Body plain brownish; back and fins slightly darker, abdomen paler. Floor and roof of mouth whitish. Claspers and pelvic insertion white, contrasting with the darker coloration of the body.

Size. Known only from the holotype, an adult male 415 mm TL.

Distribution. Type from the slope off northern New Caledonia (Grand Passage) at 688–732 m depth (Fig. 1).

Etymology. From the Latin “*albus*” (white) and “*penis*” (copulatory organ) in reference to its white claspers which contrast strongly with its dark brownish body coloration.

Comparisons. *Parmaturus albipenis* can be distinguished from its congeners by the following:

Parmaturus albimarginatus differs from *P. albipenis* by: well-developed crests of enlarged denticles on caudal margins (crests without enlarged denticles in *P. albipenis*); lower number of tooth rows in upper jaw (92 versus about 130); and a smaller subterminal lobe (length 3.3% TL versus 5.7% TL).

Parmaturus melanobranchus differs from *P. albipenis* by: well-developed crests of enlarged denticles on caudal margins (crests without enlarged denticles); shorter pre-pelvic length (39% TL versus 47% TL); longer mouth (7% TL versus 3.1% TL); head longer than abdomen (rather than shorter); and a dark brown or greyish coloration (brownish).

Parmaturus pilosus differs from *P. albipenis* by: well-developed crests of enlarged denticles on caudal margins (crests without enlarged denticles); and teeth with 5–7 cusps (versus 3–4). *Parmaturus macmillani* differs from *P. albipenis* by: well-developed crests of slightly enlarged denticles on caudal margins (crests without enlarged denticles); and teeth with 5–6 cusps (versus 3–4).

***Parmaturus bigus* sp. nov.**

Figs 6 and 7, Tables 1–3

Beige catshark (English), holbiche beige (French)

Parmaturus sp. A: Last & Stevens, 1994: 204, fig 26.32, pl. 20 (short-tail catshark)

Material. 1 specimen.

Northeastern Australia. South of Saumarez Plateau (Queensland), 22°56'S, 154°21'E, 590–606 m depth, 17 November 1985, FRV “Soela”, lobster trawl, adult female 710 mm TL (CSIRO H 947.10: holotype).

Diagnosis. A scyliorhinid catshark with the following combination of characters: a soft body; velvety skin with small tricuspidate denticles; plain pale yellowish brown coloration; fins yellowish brown with slightly paler edges; dorsal caudal crest well-developed, ventral crest distinct but weak, denticles enlarged on crest; teeth mainly tricuspidate, in 120 rows in upper jaw; first dorsal fin slightly behind mid-length, pre-first dorsal length 54.9% TL; pelvic fins slightly forward of mid-length, pre-pelvic length 48.9% TL; vent at middle of body, pre-vent length 50.8% TL; snout relatively short, prenarial length 4.2% TL; mouth short, length 3.6% TL; labial furrows short, lower furrow longer than upper furrow, 1.7% and 1.2% TL respectively; head not depressed, its height subequal to its width, length shorter than abdomen, 19.8% TL; pectoral-pelvic length

25.4% TL; second dorsal fin larger than first, anterior margins of first and second dorsal fins 5.2% and 9.3% TL respectively; subterminal caudal lobe relatively small, subterminal margin length 3.8% TL, terminal margin length 3.6% TL; monospondylous centra 47; precaudal centra 102.

Description. Scyliorhinid catshark with a rather soft body; trunk slightly compressed, tail moderately compressed and tapering slightly to caudal fin; head not depressed, height 9.1% TL, shorter than abdomen; pectoral to pelvic space 25.4% TL, 1.3 in head length; pelvic to anal space 0.8 in anal-fin base. Caudal peduncle low, elongate, anal to caudal space 1.2 of anal-fin base length; moderately compressed, width 1.7 in height, dorsal and ventral profiles longitudinally ridged by anterior part of upper and lower caudal crests. Snout short and narrowly parabolic in dorsoventral view, tip broadly rounded, conical in lateral view; preoral length 5.7% TL, 0.7 in mouth width; prenarial snout 1.2 times eye length. Eyes large, length 3.4% TL, 5.8 in head length; eyes almost lateral on head, with well-developed subocular ridges. Labial furrows short but well developed, right lower furrow longer than upper, 1.7 and 1.2% TL respectively. Nostrils large with tube-like incurrent apertures, anterior nasal flaps sub-triangular, posterior tip expanded, forming a weak lobe; nostrils well separated, internarial length 2.3% TL; nasal flaps well short of front of mouth.

Teeth of upper and lower jaws exposed when mouth closed; anterior teeth mainly tricuspidate, with greatly enlarged median cusp, lateral cusps much shorter; lateral teeth asymmetrical, with relatively smaller median cusps, lateral cusps toward angle of jaw usually reduced or absent, lateral edge towards anterior part of mouth with 1–2 cusps; upper jaw double concave at symphysis, longest teeth adjacent to symphysis, 2–3 rows of very short teeth at symphysis; teeth in lower jaw similar, also with poorly developed lateral cusps toward angle of jaw; tooth bases ridged; in 120 rows in upper jaw; in oblique rows or in quincunx arrangement. Dermal denticles on side small, tricuspidate, weakly imbricate, erect, densely packed; crown shield-like with a long pointed median cusp, ending in a longitudinal ridge; lateral cusps short, variably developed (cf. illustration in Last and Stevens, 1994, p. 204). Upper caudal crest well developed, extending from upper caudal margin to below second dorsal-fin rear corner, in a deep groove near its origin; elevated slightly above rest of fin; lacking a well-defined naked area at its base; denticles at lateral edge of crest mainly directed posterolaterally and slightly ventrally, largest at least twice length of tail denticles; lateral denticles tricuspidate with lateral cusps barely shorter than median cusps, separated by 3–5 rows of smaller denticles. Crest on ventral midline of caudal peduncle originating above anal-fin rear corner, but not extending onto preventral caudal margin; denticles barely larger than those of adjacent tail, some directed slightly laterally (unlike the posterior orientation of those on the flanks).

First dorsal fin much smaller than second dorsal; first dorsal originating slightly forward of pelvic-fin insertion, second originating over posterior half of anal-fin base; anterior margin of both dorsal fins slightly convex, apices rounded; posterior margin of first dorsal fin strongly convex, margin of second dorsal less convex; rear corner of first dorsal fin broadly rounded; rear corner of second dorsal fin acutely angular; inner margins short, straight, directed posterodorsally. Pectoral fin very small, almost subcircular, lobe-like, anterior margin 7.6% TL; all margins convex, apex less rounded than rear corner. Pelvic fin relatively large, semi-oval, apex broadly rounded, length 7.3% TL. Anal fin triangular, slightly lower than second dorsal fin, base 9.7% TL; its base length about equal to interdorsal space; origin below anterior half of interdorsal space, anal-fin height 2.1 in base length. Caudal fin very short, dorsal caudal margin length 20.2% TL; upper and lower lobes originating from caudal crests; lower lobe moderately developed distally; terminal caudal lobe fan-like, bilobed, with a deep median notch. Monospondylous centra 47; precaudal centra 102; total centra 144.

Coloration. (from preserved specimen). Body plain, uniform pale yellowish brown, slightly paler ventrally. Fins similar to body, with slightly paler posterior margins. Floor and roof of mouth greyish, roof with some dark-edged pores.

Size. Known only from the holotype adult female 710 mm TL.

Distribution. Known from near the Saumarez Plateau, 22°56'S, 154°21'E, (northeastern Australia) in 590–606 m depth (Fig. 1).



FIGURE 6. *Parmaturus bigus* sp. nov., holotype female 710 mm TL (CSIRO H 947–10).



FIGURE 7. Ventral view of head of *Parmaturus bigus* sp. nov., holotype female 710 mm TL (CSIRO H 947–10).

Etymology. From the Latin “bigus” meaning beige in reference to the general plain pale yellowish brown coloration.

Remarks. The holotype had an egg-capsule coming out of the cloaca when caught.

Comparisons. *Parmaturus bigus* is set apart from all other new *Parmaturus* species by its deep, almost subcylindrical head. In comparison, other Indo-Pacific species have a much more depressed head (height only 0.5–0.6 in its width rather than subequal to its width).

Parmaturus albipenis also differs from *P. bigus* by: caudal crest without enlarged denticles (crest well-developed with enlarged denticles in *P. bigus*); first dorsal fin forward of mid-length (after mid-length); and a longer subterminal caudal lobe (5.7% TL versus 3.8% TL).

Parmaturus albimarginatus also differs from *P. bigus* by: a shorter precaudal length (78% TL versus 84% TL in *P. bigus*); longer preanal length (about 59% TL versus 52% TL); wider interorbital space (7.7% TL versus 5.4% TL); shorter dorsal-caudal space (2.8% TL versus 5.7% TL), and fewer tooth rows (92 versus 120 rows in the upper jaw).

Parmaturus melanobranchus also differs from *P. bigus* by: first dorsal fin forward of mid-length (after mid-length in *P. bigus*); head longer than abdomen (rather than shorter); and a dark brown or grey coloration (pale yellowish brown).

Parmaturus pilosus also differs from *P. bigus* by: teeth with 5–6 cusps (versus mainly 3 in *P. bigus*); first dorsal fin forward of mid-length (after mid-length); and a longer and deeper subterminal lobe (length 5.5% versus 3.8% TL).

Parmaturus macmillani also differs from *P. bigus* by: first dorsal fin forward of mid-length (after mid-length in *P. bigus*); dorsal fins subequal in size (versus second dorsal larger than first); and 38 monospondylous vertebral centra (versus 47).

TABLE 3. Meristics of the four new *Parmaturus* species.

Species	<i>P. albimarginatus</i> sp. nov.	<i>P. albipenis</i> sp. nov.	<i>P. bigus</i> sp. nov.	<i>P. lanatus</i> sp. nov.
Catalogue number	MNHN 1997-3584 holotype	MNHN 1997-3583 holotype	CSIRO H 947-10 holotype	MNHN 2007- 1499 holotype
Geographical area	New Caledonia	New Caledonia	NE Australia	Indonesia
Sex and maturity	adult male	adult male	adult female	juvenile male
Total length (mm)	577	415	713	360
Monospondylous centra	43	39	47	46
Precaudal centra	95	79	102	85
Total number of centra	136	123	144	134
Tooth rows upper jaw	92	130		94
Tooth rows lower jaw	92			92

***Parmaturus lanatus* sp. nov.**

Figs 8 and 9, Tables 1–3

Velvet Catshark (English), holbiche laineuse (French)

Parmaturus melanobranchus : Séret, 1993 (abstract of 4th IPFC, Bangkok)

Material. 1 specimen.

Indonesia. KARUBAR, stn 73, 8°29'S, 131°33'E (Tanimbar Isl.), 855–840 m depth, beam trawl, R.V. “Baruna Jaya 1”, 2 November 1991, juvenile male 360 mm TL (MNHN 2007–1499 : holotype).

Diagnosis. A scyliorhinid catshark with the following combination of characters: soft body; velvety skin with long-cusped, tricuspidate denticles; plain brownish coloration; crests of small denticles (not enlarged) on upper and lower caudal fin and peduncle margins; teeth mainly quadricuspidate, in about 90 rows in both jaws; first dorsal fin forward of mid-length, pre-first dorsal length 44.4% TL; pelvic fins and vent well in front of mid-length, pre-pelvic length 40.0% TL and pre-vent length 44.2% TL; snout relatively short, prenarial length 4.7% TL; mouth relatively long, mouth length 5.0% TL; labial furrows rudimentary; head longer than abdomen, length 21.4% TL, pectoral-pelvic length 16.9% TL; dorsal fins elevated, anterior margins of first and second dorsal fins 9.2% and 10.3% TL respectively; subterminal caudal lobe developed, subterminal margin length 4.7% TL, terminal margin length 5.3% TL; monospondylous centra 46; precaudal centra 85.

Description. Scyliorhinid catshark with flabby, soft, tadpole-shaped body; trunk slightly depressed; tail compressed and tapering to caudal fin; head very depressed, height 5.5% TL; abdomen shorter than head, pectoral to pelvic space 16.9% TL, 1.3 of head length; pelvic to anal space 1.6 times anal-fin base length. Caudal peduncle moderately deep, elongate, width 1.6 in its height, anal to caudal space 0.6 of anal-fin base; rather compressed, dorsal surface flattened, ventral surface interrupted by caudal crest. Snout short, rounded-parabolic in dorsoventral view; tip broadly rounded, bluntly pointed in lateral view; preoral length 5.8% TL, 1.6

times mouth width; prenarial snout 1.1 times eye length. Eye large, length 4.2% TL, 5.1 in head length; strongly dorsolateral on head, with well-developed subocular ridges. Mouth large, moderately long, semi-angular, width 9.4% TL, 1.9 times its length; labial furrows rudimentary, reduced small slits at mouth corner. Nostrils large with tube-like incurrent apertures, anterior nasal flaps triangular, posterolateral tip forming a short lobe; well separated, internarial length 2.8% TL; falling short to mouth.



FIGURE 8. *Parmaturus lanatus* **sp. nov.**, holotype juvenile male 360 mm TL (MNHN 2007–1499).



FIGURE 9. Ventral view of head of *Parmaturus lanatus* **sp. nov.**, holotype juvenile male 360 mm TL (MNHN 2007–1499).

Teeth of both jaws exposed when mouth closed; mainly quadricuspidate, similar in size, typically with a pointed central cusp flanked with one/two slightly smaller lateral cusps; about 94 rows in upper jaw, about 92 rows in lower jaw (teeth in quincunx arrangement but cusps, particularly those near jaw angle, appear in oblique rows). Dermal denticles on side densely imbricate, erect; crown shield-like, tricuspidate, with very long, pointed, median cusp and variably developed lateral cusps. Caudal crests not well developed; dorsal

crest confined to anterior portion of upper caudal margin; ventral crest more developed, extending well along caudal peduncle but not reaching anal-fin insertion, barely present on lower caudal margin; denticles hardly enlarged, smaller than or subequal in size to flank denticles; no distinct crest on preventral caudal margin.

First dorsal fin distinctly smaller than second dorsal; first originating slightly forward of middle of pelvic-fin base; second originating over middle of anal-fin base; anterior margins of both dorsal fins convex; apex of first dorsal more narrowly rounded than apex of second dorsal; posterior margin of first dorsal very short, subtruncate, almost upright; posterior margin of second dorsal longer, subtruncate, directed slightly anterodorsally; rear corner of first dorsal obtuse, second dorsal almost forming right angle, corners rounded. Pectoral fins of moderate size, lobate, rounded, anterior margin 11.1% TL; anterior and posterior margins convex; apex and rear corners rounded. Pelvic fins small, subtriangular, apex broadly rounded, length 9.7% TL. Anal fin subtriangular, moderately developed, base 8.9% TL, 1.1 in interdorsal space; origin at about level of middle of interdorsal space, anal-fin height 2.9 in base length. Caudal fin relatively long, dorsal caudal margin length 27.8% TL; origins of upper and lower lobes obscured by caudal crests; lower lobe low; terminal caudal lobe fan-like with subtruncate posterior margin. Monospondylous centra 46; precaudal centra 85; total centra 134.

Coloration. (from preserved specimen). Body plain brown; gills and fins marginally darker; pelvic insertion whitish. Floor of mouth pale, roof of mouth greyish.

Size. Known only by the holotype, a juvenile male of 360 mm TL.

Distribution. Collected from the continental slope off Tanimbar Island in the Arafura Sea (Indonesia) in 840–855 m depth (Fig. 1).

Etymology. From the Latin “*lanatus*” meaning soft like wool in reference to the velvety feel of the skin.

Comparisons. *Parmaturus lanatus* can be distinguished from its congeners by the following:

Parmaturus albipenis differs from *P. lanatus* by: more tooth rows in jaws (130 versus about 90); longer pre-pelvic length (about 47% TL versus 40% TL); longer pre-vent length (52% TL versus 44% TL); shorter mouth (length 3.1% TL versus 5.0% TL); and head shorter than abdomen (rather than longer).

Parmaturus albimarginatus differs from *P. lanatus* by: crests of enlarged denticles well developed on caudal margins (crests without enlarged denticles in *P. lanatus*); teeth mainly tricuspidate (rather than quadricuspidate); first dorsal fin after mid-length (before mid-length); much longer pre-pelvic (about 47% TL versus 40% TL) and pre-vent lengths (50% TL versus 44% TL); head shorter than abdomen (rather than longer); second dorsal fin larger than first dorsal (rather than subequal in size); and a much deeper head (ratio head height/head width 1.0 versus 0.5).

Parmaturus bigus differs from *P. lanatus* by: crest of enlarged denticles well developed on caudal margins (crests without enlarged denticles in *P. lanatus*); teeth mainly tricuspidate (rather than quadricuspidate); first dorsal fin after mid-length (before mid-length); much longer pre-pelvic (about 49% TL versus 40% TL) and pre-vent lengths (51% TL versus 44% TL); head shorter than abdomen (rather than longer); and second dorsal fin larger than first dorsal (rather than subequal in size).

Parmaturus melanobranchus differs from *P. lanatus* by: a well-developed crest of enlarged denticles on caudal margins (crests without enlarged denticles in *P. lanatus*); mouth longer (about 7% TL versus 5% TL); and coloration darker with gill septa blackish (rather than brownish).

Parmaturus pilosus differs from *P. lanatus* by: a well-developed crest of enlarged denticles on caudal margins (crests without enlarged denticles in *P. lanatus*); teeth with 5–7 cusps (versus 4); head shorter than abdomen (longer in *P. lanatus*); and coloration plain reddish above, white below, with fin margins darker (rather than uniform brownish).

Parmaturus macmillani differs from *P. lanatus* by: a well-developed crest of enlarged denticles on caudal margins (crests without enlarged denticles in *P. lanatus*); teeth with 5–6 cusps (versus 4); longer prepelvic (about 49% TL versus 40% TL) and prevent lengths (about 52% TL versus 44% TL); and head shorter than abdomen (pectoral-pelvic length about 29% TL versus 17% TL).

Discussion

Compagno *et al.* (2005) mention that the New Zealand species *P. macmillani* also occurs on the submarine ridge south of Madagascar. An examination of CSIRO material collected from the Madagascar Ridge caused the present authors to consider that another two new *Parmaturus* species occur in this area: a catshark with small denticles and beige coloration, the other species with larger denticles, a dark brown body, and a dark brown ventral snout. Similarly, unidentified material from New Zealand, sent to the authors by Andrew Stewart (NMNZ), represent two new large species (ca 100 cm TL) that both have very rough denticles. These undescribed species will be the subject of future manuscripts and are not included in the following key to Indo–West Pacific species.

Key to Indo–West Pacific *Parmaturus* species

- 1a Head not depressed, head height subequal to head width *P. bigus* **sp. nov.** (NE Australia)
- b Head conspicuously depressed, head height about half head width 2
- 2a Caudal crests without enlarged denticles 3
- b Caudal crests with enlarged denticles, 2–4 times longer than those on flanks 4
- 3a Head shorter than abdomen (head length/pectoral-pelvic space about 0.8); about 130 tooth rows
..... *P. albipenis* **sp. nov.** (New Caledonia)
- b Head longer than abdomen (head length/pectoral-pelvic space about 1.2); about 90 tooth rows
..... *P. lanatus* **sp. nov.** (Indonesia)
- 4a Head much shorter than abdomen 5
- b Head longer than abdomen *P. melanobranchus* (China, Japan)
- 5a First dorsal-fin origin before mid-length of body (pre-first dorsal length < 50 % TL) 6
- b First dorsal-fin origin after mid-length of body (pre-first dorsal length about 51 % TL)
..... *P. albimarginatus* **sp. nov.** (New Caledonia)
- 6a Pectoral-pelvic length short (about 21% TL) *P. pilosus* (China, Japan)
- b Pectoral-pelvic length long (about 29% TL) *P. macmillani* (New Zealand)

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