Description of two new species of smooth-hounds, *Mustelus widodoi* and *M. ravidus* (Carcharhiniformes: Triakidae) from the western central Pacific

by

William T. WHITE (1) & Peter R. LAST (2)

ABSTRACT. - Two new species of the genus *Mustelus* Linck, 1790 (Carcharhiniformes: Triakidae) are described from the Western Central Pacific. *Mustelus widodoi* sp. nov. is known from the continental shelf of eastern Indonesia (Jimbaran Bay, Bali) at depths of 60 to 120 m. *Mustelus ravidus* sp. nov. occurs on the continental shelf of Western Australia at depths of 106 to 300 m. These two new species differ from other Australian and Indonesia *Mustelus* species in having the palatine processes of the palatoquadrates subdivided at the symphysis with a short, separate medial segment on each side, and the lower labial furrows subequal to or longer than the upper furrows. *Mustelus griseus* Pietschmann, from Japan, also shares these characteristics but differs from the two new species by having much lower precaudal vertebral counts. *Mustelus widodoi* and *M. ravidus* are similar species which are clearly separated by differences in morphometrics and slight differences in vertebral counts and coloration.

RÉSUMÉ. - Description de deux espèces nouvelles d'émissoles *Mustelus widodoi* et *Mustelus ravidus* (Carcharhiniformes : Triakidae) du Pacifique occidental central.

Deux espèces nouvelles du genre *Mustelus* Linck, 1790 (Carcharhiniformes, Triakidae) sont décrites du Pacifique occidental central. *Mustelus widodoi* sp. nov. a été récoltée sur le plateau continental de l'Indonésie orientale (Baie de Jimbaran, Bali) entre 60 et 120 m de profondeur. *Mustelus ravidus* sp. nov. a été récoltée sur le plateau continental de l'Australie occidentale entre 106 et 300 m de profondeur. Ces deux espèces diffèrent des autres espèces australiennes et indonésiennes par le processus palatin du cartilage palatocarré qui est subdivisé au niveau de la symphyse, formant un petit segment médian séparé du reste du palatocarré, de part et d'autre de la symphyse. Elles diffèrent aussi par leurs sillons labiaux inférieurs qui sont presque aussi longs ou plus longs que les sillons labiaux supérieurs. *Mustelus griseus* du Japon présente aussi cette caractéristique, mais elle diffère des deux nouvelles espèces par son nombre de vertèbres précaudales qui est plus petit. *Mustelus widodoi* et *M. ravidus* se ressemblent, mais elles se distinguent nettement par certains caractères morphométriques, un nombre de vertèbres légèrement différent et par leur coloration.

Key words. - Triakidae - *Mustelus widodoi* - *Mustelus ravidus* - ISEW - New species.

The genus *Mustelus*, proposed by Linck, 1790 for *Squalus mustelus* Linnaeus, 1758, consists of some 22 described species. Members of this genus are small, benthic sharks (less than 2 m TL) that inhabit the continental shelves of temperate and tropical waters throughout the world. Some species of smooth-hounds, or gummy sharks, are an important food resource in some countries, for example, *Mustelus antarcticus* Günther, 1870 within southern Australia and *Mustelus manazo* Bleeker, 1854 within Japan. This genus is one of the largest genera of sharks, but is also one of the most systematically troublesome groups (Compagno, 1988). Although this genus appears to be diverse in the Western Hemisphere, current composition for the Eastern Hemisphere is probably anomalous due to the lower level of taxonomic research. For example, studies on *M. manazo* reported large differences in size and age at maturity and timing of reproductive events, and significant differences in genetic structure in populations from Japan compared to those from Taiwan (Yamaguchi *et al.*, 2000; Chen *et al.*, 2001). These two populations may reveal two distinct species when detailed morphometric and meristic data will be collected for specimens from both regions. A more detailed examination of members of this genus from the Western Central Pacific is required.

Market surveys at various landing sites in eastern Indonesia between April 2001 and October 2004 produced a variety of sharks, skates, rays and chimaeras, including several triakid species. Amongst this material were 30 specimens of one of the new *Mustelus*. Similar research trawl collections from the outer continental shelves and upper slopes of the north-west shelf off Western Australia in the 1980s yielded numerous other sharks and rays (Gloerfelt-Tarp and Kailola, 1984; Sainsbury *et al.*, 1985). Included in this material are specimens of a new smooth-hound, described as *Mustelus* sp. A in Last and Stevens (1994), which is very similar to the Indonesian species but differs in certain morphological char-

(1) Centre for Fish and Fisheries Research, Murdoch University, Murdoch 6150, Perth, WA, AUSTRALIA. [w.white@murdoch.edu.au].
(2) CSIRO Marine Research, GPO Box 1538, Hobart 7001, Tasmania, AUSTRALIA. [peter.last@csiro.au]

acteristics and fin coloration. Material of these two species, which includes both adult and immature individuals of both sexes, are clearly separable from each other and from all other *Mustelus* species occurring in the region.

Table I. - Morphometric data for the holotype of *Mustelus widodoi* sp. nov. and *M. ravidus* sp. nov., with ranges provided for the paratypes. Measurements expressed as percentages of the total length.*[Données morphométriques pour les holotypes de* Mustelus widodoi *sp. nov. et* M. ravidus *sp. nov., et valeurs limites pour les paratypes. Les mesures sont exprimées en pourcentage de la longueur totale.]*

	Mustelus widodoi sp. nov.			*Mustelus ravidus* sp. nov.		
	Holotype	Paratypes n = 7		Holotype	Paratypes n = 5	
	MZB 13591	Min	Max	CSIRO H 4072-06	Min	Max
Total length (mm)	1085	661	907	788	567	728
Pre-second dorsal length	60.9	57.9	60.2	59.5	58.1	61.3
Pre-first dorsal length	28.0	26.0	27.9	26.1	25.8	27.9
Head length	18.4	18.4	19.5	18.9	18.9	19.9
Pre-branchial length	14.5	14.9	16.1	15.8	15.4	16.0
Pre-spiracular length	9.3	9.9	10.7	10.7	10.4	10.9
Pre-orbital length (direct)	6.5	6.6	7.2	7.2	7.0	7.3
Pre-pectoral length	17.2	17.7	19.2	18.6	17.8	19.3
Pre-pelvic length	43.9	41.3	42.9	44.2	40.6	45.1
Snout-vent distance	45.2	42.1	44.5	45.7	43.0	47.0
Pre-anal length	63.8	61.7	63.5	64.3	63.5	65.3
Interdorsal distance	21.7	21.0	22.6	21.2	20.7	21.5
Dorsal-caudal distance	10.8	10.5	11.8	9.8	9.5	10.5
Pectoral-pelvic distance	23.2	20.9	22.2	24.3	20.2	24.1
Pelvic-anal distance	15.8	15.0	17.8	15.3	15.1	17.5
Anal-caudal distance	7.4	7.7	8.8	6.5	6.2	6.8
Pelvic-caudal distance	29.4	29.2	33.5	28.3	27.9	31.2
Pre-narial length	4.2	4.4	4.9	4.8	4.6	5.0
Pre-oral length	5.4	6.0	6.6	6.4	6.3	6.7
Eye length	2.5	2.6	3.0	2.9	2.9	3.0
First gill slit height	2.4	1.9	2.4	2.2	1.9	2.2
Fifth gill slit height	1.9	1.5	2.1	1.5	1.6	1.8
Pectoral fin - anterior margin length	14.4	13.3	14.3	13.5	13.0	13.9
Pectoral fin - base length	3.9	3.6	4.1	3.8	3.7	3.9
Pectoral fin - posterior margin length	10.3	9.1	10.9	10.3	9.5	10.4
Pectoral fin - inner margin length	5.3	5.0	6.1	5.8	5.5	6.0
Caudal fin - dorsal margin length	19.3	19.3	21.7	20.3	19.3	21.6
Caudal fin - preventral margin length	9.4	8.7	9.9	9.4	8.5	10.3
Caudal fin - upper postventral margin length	7.6	7.0	8.5	7.8	7.4	8.0
Caudal fin - lower postventral margin length	2.3	1.7	2.0	1.9	1.6	2.1
Caudal fin - fork width	4.7	4.0	5.2	4.9	4.3	4.9
Caudal fin - fork length	8.7	7.8	9.1	8.6	7.8	9.2
Caudal fin - subterminal margin length	3.3	3.2	3.7	3.3	3.2	3.7
Caudal fin - subterminal margin width	2.4	2.4	2.7	2.6	2.6	2.8
Caudal fin - terminal margin length	5.4	5.6	6.1	6.0	5.9	6.5
Caudal fin - terminal lobe length	6.9	7.2	7.7	7.5	7.4	8.1
First dorsal fin - length	14.9	13.6	15.1	17.3	14.9	16.8
First dorsal fin - anterior margin length	13.9	13.2	13.9	15.1	13.1	15.0
First dorsal fin - base length	11.8	10.5	12.2	13.9	11.7	13.7
First dorsal fin - height	8.9	8.1	9.1	8.2	8.5	9.0
First dorsal fin - inner margin length	3.1	3.0	3.9	3.4	3.3	3.8
First dorsal fin - posterior margin length	9.7	8.6	10.5	10.0	8.9	10.6

METHODS

Numerical characters were selected to enable morphological and meristic comparisons with other *Mustelus* species. The holotype and 7 of the 12 paratypes of *M. widodoi* (MZB 12903, CSIRO H 5872-09, CSIRO H 5870-01, CSIRO H 5870-02, CSIRO H 5889-11, CSIRO H 5889-13, CSIRO H 5889-27) and the holotype and all five paratypes of *M. ravidus* were measured in full (Tab. I). In the description, morphometric and meristic values for the holotype are given first followed in parentheses by the ranges of the paratypes. The measurements used follow the FAO system of Compagno (1984), with a modified measurement for mouth length described by Compagno and Stevens (1993). The angle of the ventral caudal lobe was also determined as described in Heemstra (1997). The distribution of buccopharyngeal denticles on the palate and floor of the mouth was also recorded for both species because this pattern was shown by Heemstra (1997) to be diagnostic for members of this genus. Meristics were taken from X-rays of 11 of the 12 paratypes of *M. widodoi*, and of all 6 types of *M. ravidus*. Since the holotype of *M. widodoi* was not transported from Indonesia, it was not possible to obtain meristics for this specimen. Vertebral counts were obtained separately for trunk (monospondylous centra), precaudal (monospondylous + diplospondylous centra to origin of upper lobe of the caudal fin) and caudal (centra of the

caudal fin) regions (Tab. II). Morphology of the palatine processes of the palatoquadrate was also obtained from the X-rays. Tooth row counts were taken *in situ* from the dissected mouth of one paratype of each species (CSIRO CA 3038 and CSIRO H 5889-27).

Type specimens are deposited in the ichthyological collections of the Commonwealth Scientific and Industrial Research Organisation, Hobart (CSIRO) and the Museum Zoologicum Bogoriense (MZB) in Indonesia; their registration numbers are prefixed with these acronyms.

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

	Mustelus widodoi sp. nov.			*Mustelus ravidus* sp. nov.		
	Holotype	Paratypes n = 7		Holotype	Paratypes n = 5	
	MZB 13591	Min	Max	CSIRO H 4072-06	Min	Max
Second dorsal fin - length	11.5	11.1	12.7	12.8	12.7	13.9
Second dorsal fin - anterior margin length	11.2	10.0	11.2	11.4	11.1	12.5
Second dorsal fin - base length	9.4	9.0	10.6	10.4	10.3	11.7
Second dorsal fin - height	6.8	5.8	7.0	6.1	6.1	6.8
Second dorsal fin - inner margin length	2.4	2.1	2.5	2.5	2.2	2.6
Second dorsal fin - posterior margin length	6.8	6.5	7.8	6.8	7.1	7.8
Pelvic fin - length	8.8	8.2	9.4	8.7	9.7	10.2
Pelvic fin - anterior margin length	7.6	6.8	7.9	7.1	7.3	8.1
Pelvic fin - height	5.5	5.7	6.5	6.1	5.9	6.5
Pelvic fin - inner margin length	3.5	3.6	4.4	3.3	3.9	4.7
Pelvic fin - posterior margin length	5.7	5.1	5.7	5.5	5.4	6.2
Anal fin - length	8.6	8.1	9.0	8.4	8.8	9.1
Anal fin - anterior margin length	7.7	7.1	8.2	7.6	8.0	8.5
Anal fin - base length	6.9	6.4	7.3	6.7	7.1	7.3
Anal fin - height	3.7	2.8	3.4	3.0	3.0	3.4
Anal fin - inner margin length	1.8	1.5	2.0	1.8	1.7	1.9
Anal fin - posterior margin length	3.4	2.7	3.4	3.4	2.9	3.4
Head height	9.4	7.5	8.9	8.5	7.6	8.3
Trunk height	10.5	8.2	9.7	8.9	7.9	9.5
Abdomen height	11.1	7.9	9.3	9.6	8.5	9.1
Tail height	6.8	6.3	7.0	7.5	6.0	6.8
Caudal peduncle height	2.3	2.3	2.6	3.8	2.3	2.7
Pelvic midpoint-first dorsal insertion	8.6	6.1	7.9	7.9	5.8	7.5
Pelvic midpoint-second dorsal origin	13.5	12.8	16.2	12.5	12.6	14.9
Second dorsal origin-anal origin	4.1	3.0	5.0	5.0	4.6	5.6
Second dorsal insertion-anal insertion	1.7	0.7	1.4	1.4	1.1	2.0
Mouth length	2.7	2.3	2.6	2.8	2.2	2.7
Mouth width	4.3	4.2	5.0	4.7	4.0	4.8
Upper labial furrow length	1.0	0.9	1.0	1.0	0.9	1.2
Lower labial furrow length	1.0	1.0	1.3	1.2	1.0	1.2
Nostril width	1.5	1.6	1.6	1.5	1.5	1.7
Internarial space	2.4	2.3	2.9	2.7	2.4	2.7
Clasper inner length	0.0	0.0	8.9	0.0	0.0	9.9
Clasper base width	0.0	0.0	1.4	0.0	0.0	1.5
Interorbital space	5.8	5.4	6.2	5.9	5.6	6.0
Head width	9.4	7.9	9.3	9.5	8.4	9.1
Trunk width	10.7	7.8	9.2	9.0	7.6	8.9
Abdomen width	9.5	7.0	8.1	7.4	6.1	7.7
Tail width	6.6	5.9	6.5	5.9	5.5	6.4
Caudal peduncle width	2.0	2.0	2.5	2.1	2.0	2.5

MUSTELUS WIDODOI SP. NOV.

(English name: white-fin smooth-hound)
(Figs 1-3, Tabs I, II)

Holotype. - MZB 13591, pregnant female 1085 mm TL, Kedonganan fish market, Bali, Indonesia, 8°45'S-115°10'E, 15 Jun. 2002.

Paratypes. - 12 specimens collected at same locality as holotype: MZB 12903, female 758 mm TL, CSIRO H 5872-09, adult male 907 mm TL, 15 Jun. 2002; CSIRO H 5870-01, female 746 mm TL, CSIRO H 5870-02, female 709 mm TL, 5 Jun. 2002; CSIRO H 5889-11, female 692 mm TL, CSIRO H 5889-13, immature male 661 mm TL, CSIRO H 5889-27, female 756 mm TL, 31 Jul. 2002; CSIRO H 5693-01, female 610 mm TL, CSIRO H 5693-02, immature male 535 mm TL, CSIRO H 5693-03, immature male 550 mm TL, CSIRO H 5693-04, female, 570 mm TL, CSIRO H 5693-05, immature male 540 mm TL, 2 Nov. 2001.

Diagnosis

A moderately large *Mustelus* with the following combination of characters: low preanal length to anal-caudal space (7.1-8.7) and to dorsal-caudal space (5.3-6) ratios; dorsal fins moderately large, upright, base length of first dorsal fin 1.3-1.5 times anal-caudal space; claspers of adults moderately long, outer length about 9% TL; claspers of adult males terminating well short of anal-fin origin; teeth in about 73/69 rows, exposed evenly around symphysis of lower jaw when mouth closed; precaudal vertebral centra 86-89, monospondylous centra 33-35; broad white margin on first dorsal fin; distinct black margin on apex of second dorsal fin and a distinct black tip on terminal caudal lobe.

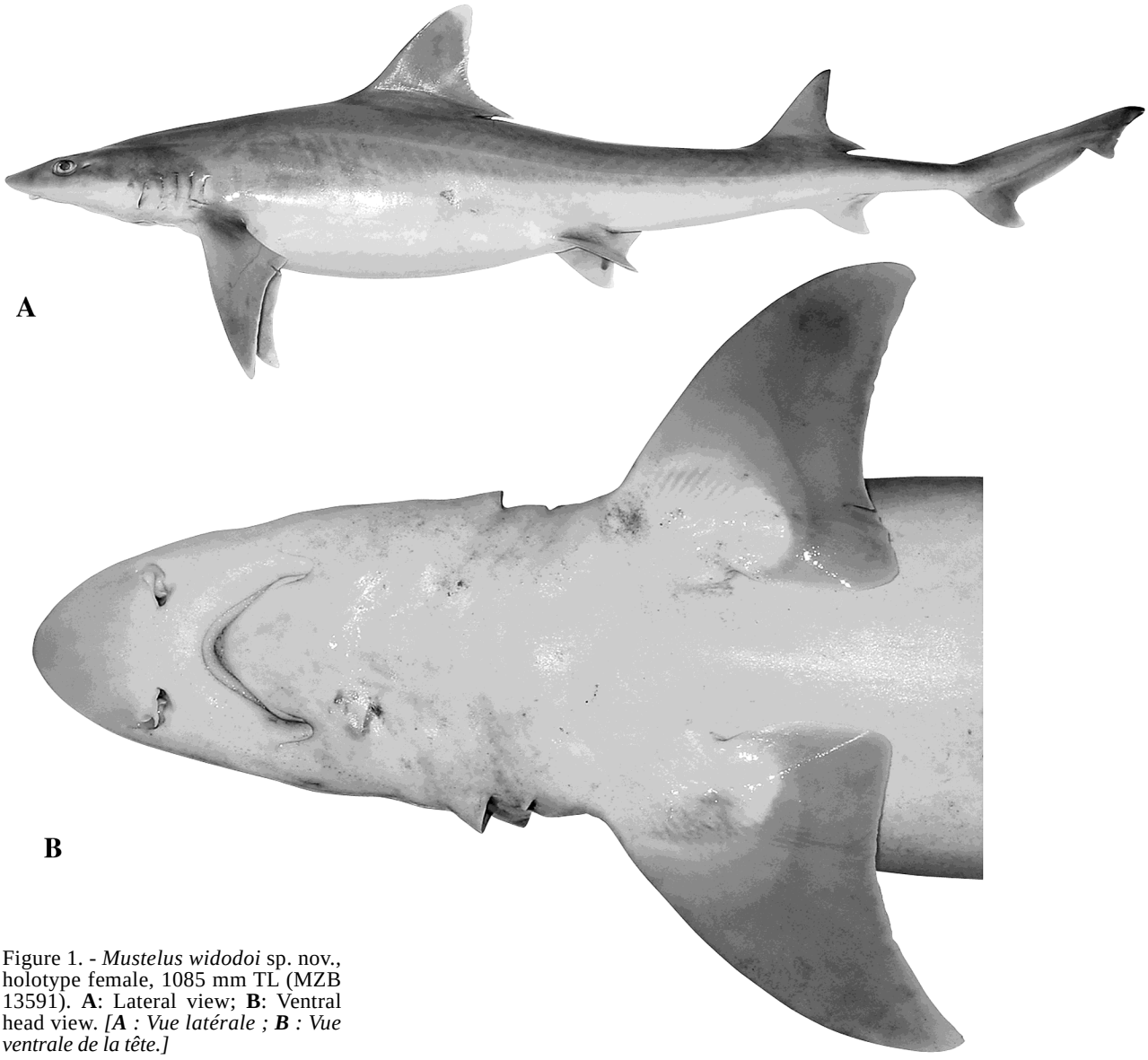

Figure 1. - *Mustelus widodoi* sp. nov., holotype female, 1085 mm TL (MZB 13591). **A**: Lateral view; **B**: Ventral head view. *[**A** : Vue latérale ; **B** : Vue ventrale de la tête.]*

Table II. - Vertebral counts and ratios for specimens of *Mustelus widodoi* sp. nov. and *Mustelus ravidus* sp. nov. *[Comptes et proportions des vertèbres pour les spécimens de* Mustelus widodoi *sp. nov. et* Mustelus ravidus *sp. nov.]*

	Mustelus widodoi sp. nov.		*Mustelus ravidus* sp. nov.		
	Paratypes (n = 11)		Holotype CSIRO H 4072-06	Paratypes (n = 5)	
	Min	Max		Min	Max
Vertebrae:					
monospondylous (MP)	33.0	35.0	35.0	35.0	37.0
diplospondylous - trunk (DP)	51.0	56.0	55.0	53.0	56.0
diplospondylous - caudal (DC)	46.0	53.0	49.0	49.0	53.0
total precaudal (PC)	86.0	89.0	90.0	90.0	91.0
Total (TC)	134.0	142.0	139.0	139.0	144.0
% MP	24.6	24.6	25.2	25.2	25.7
% DP	38.1	39.4	39.6	38.1	38.9
% DC	34.3	37.3	35.3	35.3	36.8
DP/MP	1.5	1.6	1.6	1.5	1.5
DC/MP	1.4	1.5	1.4	1.4	1.4

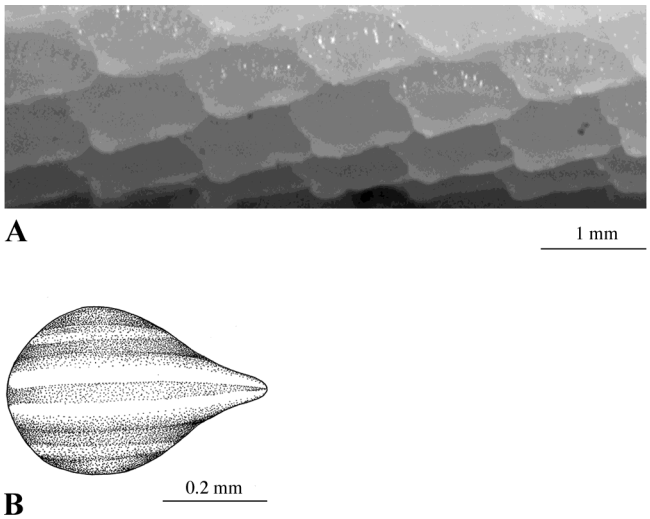

Figure 2. - *Mustelus widodoi* sp. nov., paratype female (CSIRO H 5889-11). **A**: Upper anterior teeth; **B**: Lateral trunk denticle. *[**A** : Dents antérieures supérieures ; **B** : Denticule latéral du tronc.]*

Description

Proportions as percentages of total length for the holotype and paratypes (7) are presented in table I.

Body elongate and slender, trunk weakly compressed, oval in cross-section at first dorsal-fin base; length of trunk from fifth gill openings to vent 1.46 (1.27-1.33) times head length; second dorsal-fin origin to anal-fin origin 3.28 (2.58-4.79) in second dorsal-fin origin to pelvic-fin midpoint; anal-caudal space 8.65 (7.00-8.21) in preanal length; predorsal ridge weak, extending forward to about in line with posterior gill slits; interdorsal ridge low, usually absent immediately before second dorsal-fin origin; postdorsal ridge weak, most pronounced above middle of caudal peduncle; lateral line forming a weak ridge, extending from head forward of first gill slit to beneath second dorsal fin. Caudal peduncle slender, cylindrically-tapering, without lateral keels; height 1.16 (0.97-1.25) in width at upper caudal-fin origin, 4.62 (4.18-4.91) in dorsal-caudal space. Precaudal pits absent. Head short, length 0.79 (0.84-0.90) in pectoral-pelvic space; relatively narrow, moderately depressed, roughly trapezoidal in cross-section at eyes; outline of prespiracular head in lateral view nearly straight dorsally, becoming convex above gills; post-oral head slightly convex; parabolic in dorsoventral view; preoral snout moderate, 1.24 (1.21-1.45) in mouth width. Snout bluntly pointed in lateral view, convex above and below; tip narrowly rounded in dorsoventral view, without shallow indentations anterior to nostrils. Eyes large and elongate-oval in shape, eye length 7.44 (6.41-7.24) in head length; slightly dorsolateral on head; lower edges slightly medial to lateral margin of head in dorsal view; subocular ridges strong; external opening with prominent posterior notch, no anterior notch; nictitating lower eyelids external; subocular pouches deep, entirely scaled with secondary lower eyelids. Spiracles small, their length only slightly less than eye to spiracle distance, located dorsal to lower edge of eye. Third and fourth fill slits tallest, fifth shortest; first gill slit moderately higher than fifth, height of fifth 0.79 (0.75-0.96) of first; height of first 7.49 (7.58-9.88) in head and 0.99 (0.68-0.87) of eye length. Anterior margin of gill slits undulate or slightly convex; not elevated on dorsolateral surface of head, upper margin slightly above lower edges of eyes; gill filaments not visible externally. Nostrils with large oval incurrent apertures lacking posterolateral keels; well in front of mouth; width 1.61 (1.43-1.76) in internarial space, 1.68 (1.62-1.85) in eye length, and 1.67 (1.23-1.56) in first gill slit height; excurrent apertures small, oval. Anterior nasal flaps with broadly rounded apices, prominent mesonarial flaps, and small posterior nasal flaps. Anterior nasal aperture bluntly angular anteriorly, forming a gradual depression. Mouth relatively strongly and broadly arched; width 4.24 (3.75-4.49) in head length; length 1.61 (1.64-2.14) in width; tongue large, flat, broadly rounded, filling floor of mouth; buccal papillae absent, buccopharyngeal denticles covering palate and floor to at least mid point of fourth and fifth gill arches; labial furrows moderately long, upper 0.96 (0.78-0.99) times lower furrows; anterior end of uppers under mid-eye, extending only slightly forward of corners of mouth; palatine processes of the palatoquadrates subdivided at symphysis with a short, separate medial segment on each side. Teeth asymmetric between jaws, with a moderately high, rounded cusp, no cusplets; no apparent sexual heterodonty; no toothless spaces at symphysis; exposed evenly around symphysis of lower jaw when mouth closed; not differentiated in each jaw and along jaws; in 73/69 rows (one paratype, CSIRO H 5889-27); formula is 36 + 37 in upper jaw, 35 + 34 in lower jaw. Lateral trunk denticles below first dorsal fin small and closely imbricated; broadly lanceolate, apices extended, with four longitudinal ridges extending entire length of crown; crown length almost 1.5 times width. Denticles absent at insertion of pectoral and pelvic fins. First dorsal fin tall and moderately falcate; anterior margin convex, narrow apically; posterior margin broadly concave; free rear tip acutely pointed, inner margin nearly straight; fin origin slightly posterior to free rear tips of pectoral fins, midpoint of base near midpoint of distance between pelvic-fin origins and pectoral-fin insertions; insertion well anterior to pelvic-fin origins; posterior margin upright or slanting slightly anteroventrally from apex; insertion almost above level of fin apex; first dorsal-fin base 1.84 (1.72-2.14) in interdorsal space, 1.64 (1.67-1.98) in dorsal caudal-fin margin; fin height 1.33 (1.20-1.48) in base length; inner margin 2.89 (2.21-2.96) in height, 3.83 (2.92-4.07) in base length. Second dorsal fin moderately tall and upright, apically narrow and moderately falcate; slightly smaller than first dorsal fin, height 0.76 (0.70-0.81) of first dorsal-fin height, base length 0.80 (0.80-0.92) of first dorsal-

fin base length; anterior margin straight to slightly convex; apex narrowly rounded; posterior margin deeply concave; inner margin straight or slightly concave, free rear tip acutely pointed, terminating slightly anterior to anal-fin free rear tip and well in front of upper caudal-fin origin; origin separated from pelvic-fin insertions by a space about 2.81 (1.94-3.72) times pelvic-fin base; posterior margin extending anteroventrally from apex; insertion slightly posterior to fin apex; second dorsal-fin base length 1.15 (1.05-1.23) in dorsal-caudal space; fin height 1.39 (1.32-1.77) in base length; inner margin 2.82 (2.51-3.25) in height, 3.91 (3.99-4.81) in base length. Anal fin low, apically narrow, semifalcate, much smaller than second dorsal fin; height 0.55 (0.41-0.53) in second dorsal-fin height, base length 0.73 (0.63-0.76) times second dorsal-fin base length; anterior margin convex; apex very narrowly rounded; posterior margin deeply notched, slanting anterodorsally from apex; free rear tip acutely pointed, well in front of lower caudal-fin origin; inner margin nearly straight; preanal ridges indistinct; origin slightly behind second dorsal-fin origin, by 0.44 (0.34-0.49) of second dorsal-fin base; insertion slightly anterior to apex, slightly behind second-dorsal fin insertion; anal-fin base length 1.07 (1.06-1.34) in anal-caudal space; fin height 2.01 (2.03-2.38) in base length; inner margin 1.92 (1.57-1.82) in height, 3.86 (3.18-4.26) in base length. Pectoral fins narrow and strongly falcate; substantially larger in area than first dorsal fin; anterior margins broadly convex, length 1.40 (1.28-1.48) times posterior margin; bases narrow; apices acutely pointed, posterior margins broadly concave; free rear tips broadly rounded, inner margins strongly convex; origins under fourth gill opening. Apex of pectoral fin well posterior to its free rear tip when fin is elevated and appressed to body. Pelvic fins broadly subtriangular; area slightly greater than anal-fin area; anterior margins slightly convex, length 0.53 (0.49-0.55) length of pectoral-fin anterior margins; angular apically, with posterior margins broadly concave; free rear tips pointed, inner margins nearly straight. Claspers of adult male paratype rel-

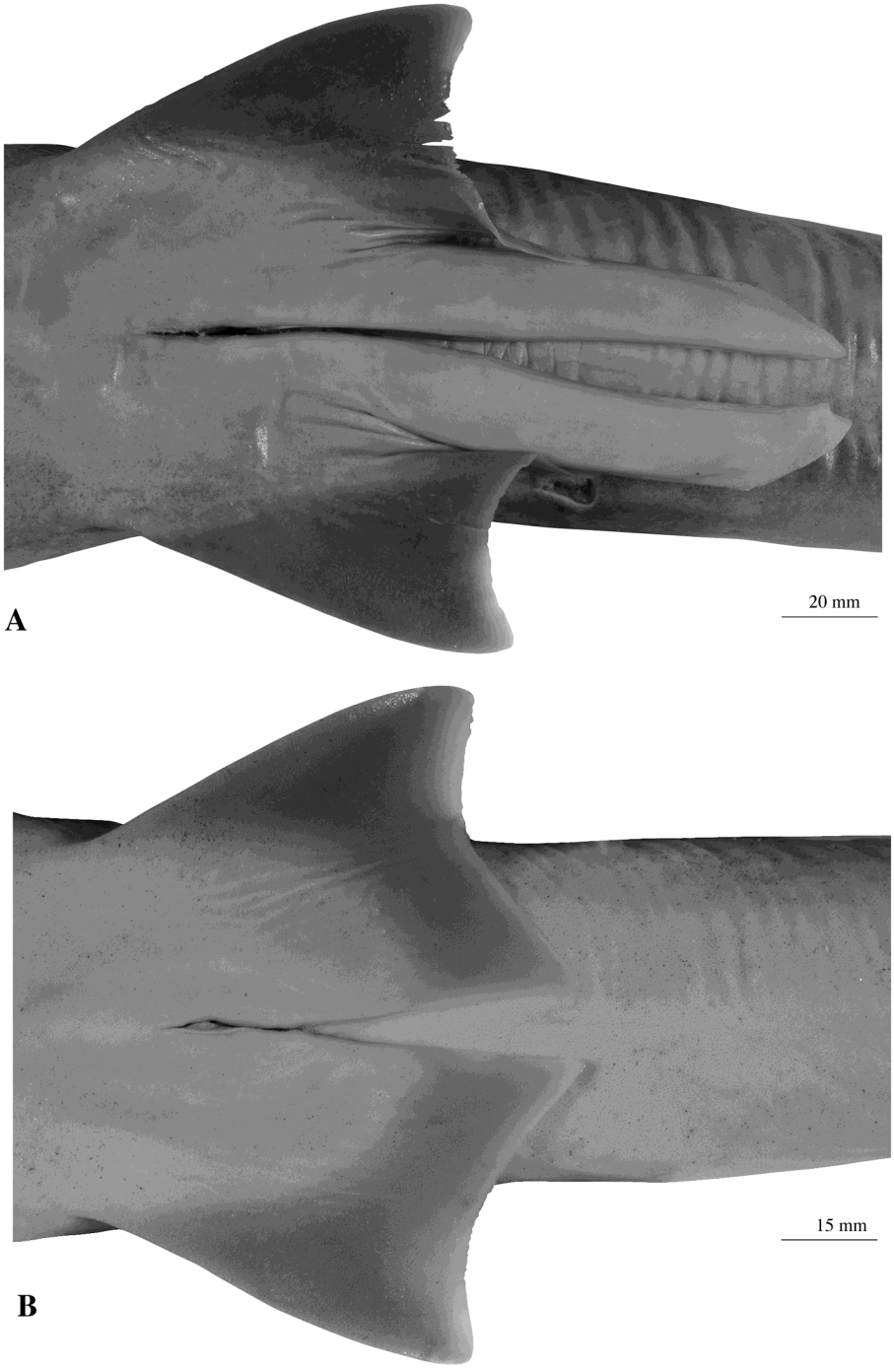

Figure 3. - Ventral view of the symmetrical pelvic fins of *Mustelus widodoi* sp. nov. **A**: Male paratype (CSIRO H 5872-09); **B**: Female paratype (CSIRO H 5889-11). *[Vue ventrale des nageoires pelviennes symétriques de* M. widodoi *sp. nov.* ***A*** *: Paratype mâle;* ***B*** *: Paratype femelle.]*

atively long and basally stout, slightly convex to nearly straight for most of outer margin length and strongly tapering near tip; extending well behind pelvic-fin free rear tips, distance 1.8 times pelvic-fin inner margin; apex about 1.2 times anal-fin base short of anal-fin origin; glans moderately short, length slightly more than one third of clasper outer margin, blunt distally with a narrow apex; covered laterally and ventrally with small clasper denticles; dorsomedial surfaces of glans (including rhipidion) and lateral strip adjacent to clasper groove naked. Caudal fin asymmetrical, upper lobe narrow; terminal lobe moderately enlarged, ventral lobe prominent, subtriangular, weakly falcate; dorsal caudal margin moderately long, 4.20 (3.64-4.16) in precaudal length, double convex, mesially concave, without lateral undulations; preventral margin convex, length 3.64 (3.45-3.92) in dorsal caudal margin; tip of ventral lobe bluntly pointed; lower postventral margin nearly straight to concave; upper postventral margin nearly straight to convex, notch between these forming angle of 71-96°; subterminal notch a narrow, deep slot; subterminal margin slightly concave, terminal margin slightly to strongly concave, lobe formed by these margins bluntly angular; subterminal margin 1.62 (1.52-1.80) in terminal margin; tip of tail pointed, terminal lobe length 2.79 (2.55-2.90) in dorsal caudal margin. Vertebral counts, ratios and statistics of 11 of the 12 paratypes in table II and summarised as follows: total counts (TC) 134-142, precaudal (PC) counts 86-89, monospondylous precaudal (MP) centra 33-35, diplospondylous precaudal (DP) centra 51-56. Last few MP centra before MP-DP transition hardly enlarged, not forming 'stutter zone' of alternating long and short centra.

Colour

In alcohol: light greyish above, paler below; darker areas above merging gradually with pale area below on sides of body; interface more pronounced on head, dark portion passing just below eye level then extending along mid portion of gill slits; first dorsal fin greyish, with prominent silvery-white margin posteriorly, originating just anterior of apex, broadest distally; second dorsal fin greyish, with black apical margin, dark area commencing on anterior margin about half an eye diameter below fin apex, terminating more than an eye diameter below apex on posterior margin, posterior angle of fin and free rear tip with very narrow pale margin; white margins on pectoral, pelvic and anal fins and ventral lobe of caudal fin; terminal caudal lobe broadly black-tipped, more pronounced in smaller specimens. Colour of fresh specimens similar, but fin markings more defined.

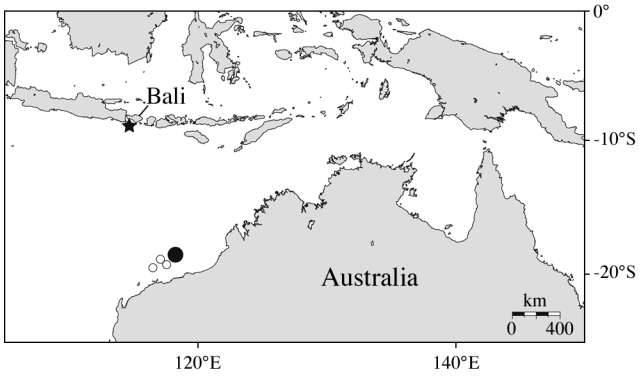

Figure 4. - Map of the Indo-Australian region showing the type localities of *Mustelus widodoi* sp. nov. (★) and the holotype (●) and the paratype (○) localities of *Mustelus ravidus* sp. nov. *[Carte de la région Indo-australienne montrant les localités de capture de* M. widodoi *sp. nov.* (★) *et de l'holotype* (●) *et du paratype* (○) *de* M. ravidus *sp. nov.]*

Size

The female holotype at 1085 mm TL is the largest known specimen of *Mustelus widodoi*. Of the 33 specimens recorded to date, 18 (including 5 of the paratypes and the holotype) are females between 490 and 1085 mm TL, 10 (including one paratype) are adult males 830 to 916 mm TL and 5 (including one paratype) are immature males 535 to 760 mm TL. No pregnant females have been recorded.

Distribution

Mustelus widodoi is known only from the island of Bali in eastern Indonesia where it is caught regularly by fishermen operating from Jimbaran Bay in the south of the island (Fig. 4). The type series and all other specimens were collected at the Kedonganan fish market located at the northern end of Jimbaran Bay. The fishers that catch these and other shark and ray species typically set their long lines demersally at depths of 60 to 120 m.

Etymology

The species name is in acknowledgement of the dedicated efforts of the late Dr. Johannes Widodo whose research on the shark and ray fisheries of Indonesia has provided important baseline data for this important faunal region.

MUSTELUS RAVIDUS SP. NOV.

(English name: Australian grey smooth-hound)
(Figs 5-7, Tabs I, II)

Mustelus sp. A. - Last and Stevens, 1994: 213, 214 (Plate 28, Figure 27.7); Compagno, Dando and Fowler, 2005: 279 (Plate 46).

Mustelus sp. - Sainsbury, Kailola and Leyland, 1985: 26, fig. (of CSIRO CA 1236).

Holotype. - CSIRO H 4072-06, female 788 mm TL, off Port Hedland, Western Australia, 18°30'S-118°43'E, 9 Sep. 1995.

Paratypes. - 5 specimens: CSIRO CA 3037, adult male 677 mm TL, CSIRO CA 3038, adult male 672 mm TL, off

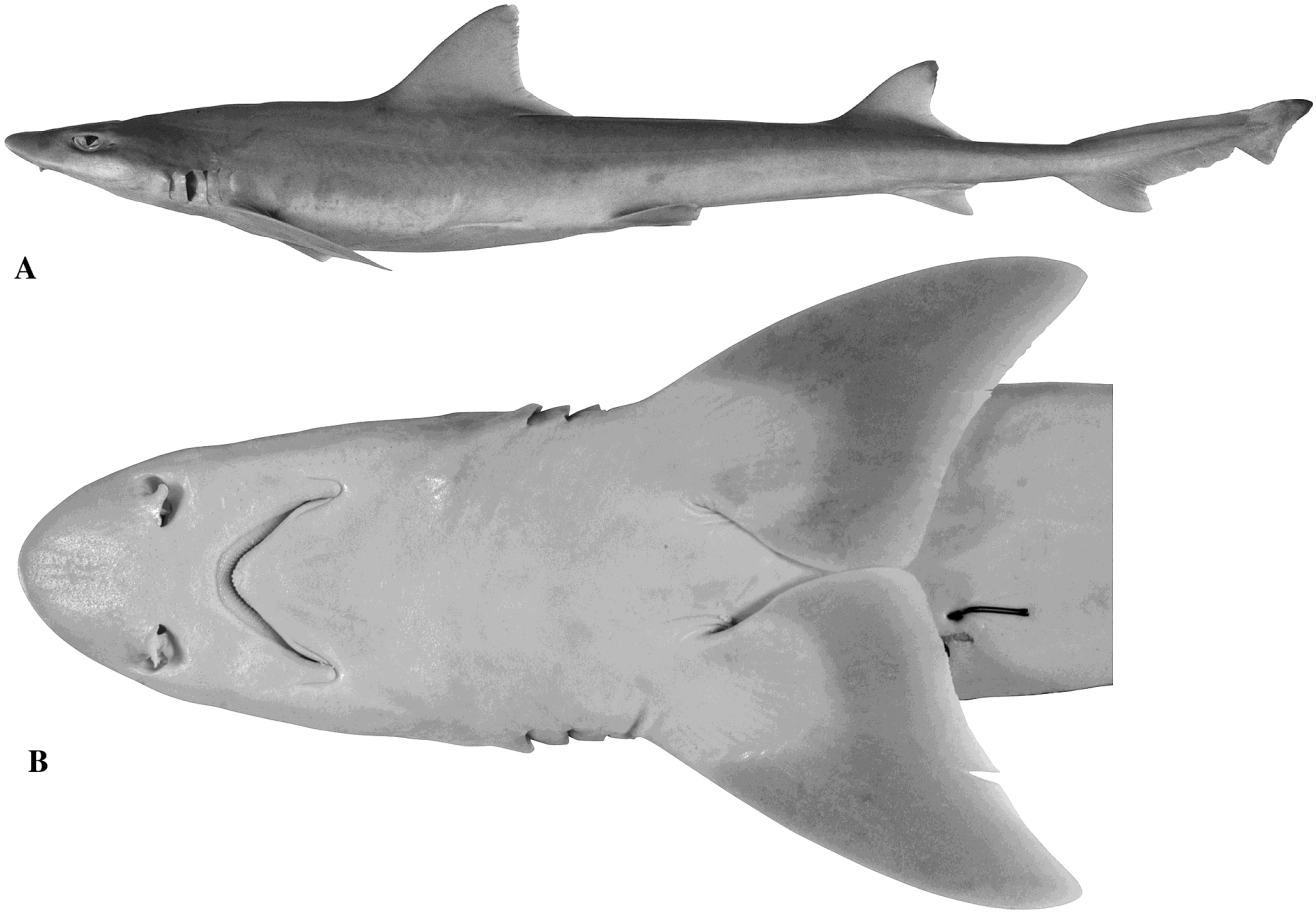

Figure 5. - *Mustelus ravidus* sp. nov., holotype female, 788 mm TL (CSIRO H 4072-06). **A**: Lateral view; **B:** Ventral head view. *[**A** : Vue latérale ; **B** : Vue ventrale de la tête.]*

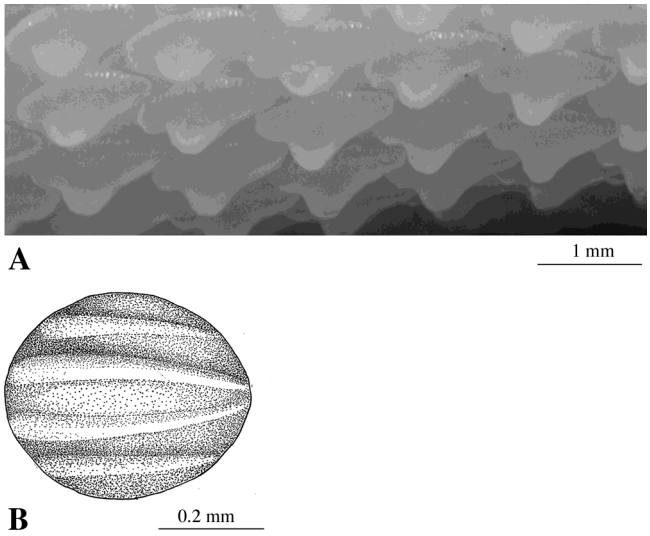

Figure 6 - *Mustelus ravidus* sp. nov., holotype female (CSIRO H 4072-06). **A**: Upper anterior teeth; **B**: Lateral trunk denticle. *[**A** : Dents antérieures supérieures ; **B** : Denticule latéral du tronc.]*

Port Hedland, Western Australia, 19°01'S 117°59'E, 2 Oct. 1982; CSIRO CA 3319, subadult male 567 mm TL, off Port Hedland, Western Australia, 18°54'S-117°02'E, 13 Apr. 1982; CSIRO CA 3367, female 728 mm TL, CSIRO CA 3368, adult male 662 mm TL, north of Dampier Archipelago, Western Australia, 19°27'S-116°33'E, 22 Nov. 1982.

Diagnosis

A moderately sized *Mustelus* with the following combination of characters: high preanal length to anal-caudal space (9.6-10.5) and to dorsal-caudal space (6.1-6.8) ratios; dorsal fins large, slightly raked back, base length of first dorsal fin (0.8-1) times anal-caudal space; claspers of adult males relatively long, outer length about 10% TL, terminating only slightly short of anal fin origin; teeth in about 77/73 rows, exposed to a greater extent around symphysis of lower jaw when mouth closed; precaudal vertebral centra 90-91, monospondylous centra 35-37; narrow white tip and thin pale margin on first dorsal fin, distinct dusky tip on second dorsal fin and distinct black tip on terminal caudal lobe.

Description

Proportions as percentages of total length for the holotype and paratypes (5) are presented in table I.

Body elongate and slender, trunk weakly compressed, oval in cross-section at first dorsal-fin base; length of trunk from fifth gill openings to vent 1.42 (1.24-1.36) times head length; second dorsal-fin origin to anal-fin origin 2.52 (2.65-2.92) in second dorsal-fin origin to pelvic-fin midpoint; anal-caudal space 9.97 (9.56-10.48) in preanal length; predorsal ridge indistinct (more pronounced in some paratypes); interdorsal ridge low, usually absent immediately before second dorsal-fin origin; postdorsal ridge weak, slightly more pronounced above middle of caudal peduncle; lateral line distinct, forming a weak ridge, extending from above spiracle to about level of caudal-fin origin. Caudal peduncle slender, cylindrically-tapering, without lateral keels; height 1.79 (1.06-1.22) in width at upper caudal-fin origin, 2.58 (3.69-4.49) in dorsal-caudal space. Precaudal pits absent. Head short, length 0.78 (0.83-0.94) in pectoral-pelvic space; relatively narrow, moderately depressed, roughly trapezoidal in cross-section at eyes; outline of prespiracular head in lateral view nearly straight anteriorly, nape convex, humped, becoming elevated above hind margin of eye; parabolic in dorsoventral view; preoral snout moderate, 1.36 (1.40-1.58) in mouth width. Snout bluntly pointed in lateral view, straight to slightly concave dorsally and convex below; tip narrowly rounded in dorsoventral view, without shallow indentations anterior to nostrils. Eyes large and elongate-oval in shape, eye length 6.63 (6.32-6.62) in head length; slightly dorsolateral on head; lower edges slightly medial to lateral margin of head in dorsal view; subocular ridges strong; external opening with prominent posterior notch, no anterior notch; nictitating lower eyelids external; subocular pouches deep, entirely scaled with secondary lower eyelids. Spiracles very small, length less than half the eye to spiracle distance, located dorsal to lower level of eye. Gill slits variable in length, third and fourth tallest, fifth shortest; first gill slit moderately higher than fifth, height of fifth 0.67 (0.74-0.90) of first; height of first 8.57 (8.61-10.04) in head and 0.77 (0.63-0.75) of eye length; becoming increasingly more elevated from first to fifth, bottom of first below level of origin of pectoral fin, fourth slightly above level of origin of pectoral fin; fifth slit positioned above and just posterior to pectoral-fin origin; upper edge of slits greatly increasing in elevation from anterior to posterior, first below lower margin of eye, fifth at level of upper eye; first four slits visible in ventral view; anterior margin of gill slits undulate or slightly convex; gill filaments not visible externally. Nostrils with large oval incurrent apertures lacking posterolateral keels; well in front of mouth; width 1.78 (1.61-1.71) in internarial space, 1.85 (1.80-2.01) in eye length, and 1.43 (1.23-1.47) in first gill slit opening; excurrent apertures small, oval. Anterior nasal flaps with broadly rounded apices, prominent mesonarial flaps, and small posterior nasal flaps. Anterior nasal aperture bluntly angular anteriorly, forming a gradual depression. Mouth relatively strongly and very broadly arched; width 4.02 (4.01-4.70) in head length; length 1.69 (1.48-1.87) in width; tongue large, flat, broadly rounded, filling floor of mouth; buccal papillae absent, buccopharyngeal denticles covering palate and floor to about fifth gill arch; labial furrows moderately long, upper 0.80 (0.84-0.99) times lower furrows; anterior ends of uppers slightly posterior to mid-eye, extending only slightly forward of corners of mouth; palatine processes of the palatoquadrates subdivided at symphysis with a short, separate medial segment on each side. Teeth asymmetric between jaws, with a relatively high, rounded cusp, no cusplets; no apparent sexual heterodonty; no toothless spaces at symphysis; exposed to a greater extent around symphysis of lower jaw when mouth closed; not differentiated in each jaw and along jaws; in 77/73 rows (one paratype,

Figure 7. - Ventral view of the symmetrical pelvic fins of *Mustelus ravidus* sp. nov. male paratype (CSIRO CA 3368). *[Vue ventrale des nageoires pelviennes symétriques de* M. ravidus *sp. nov., paratype mâle.]*

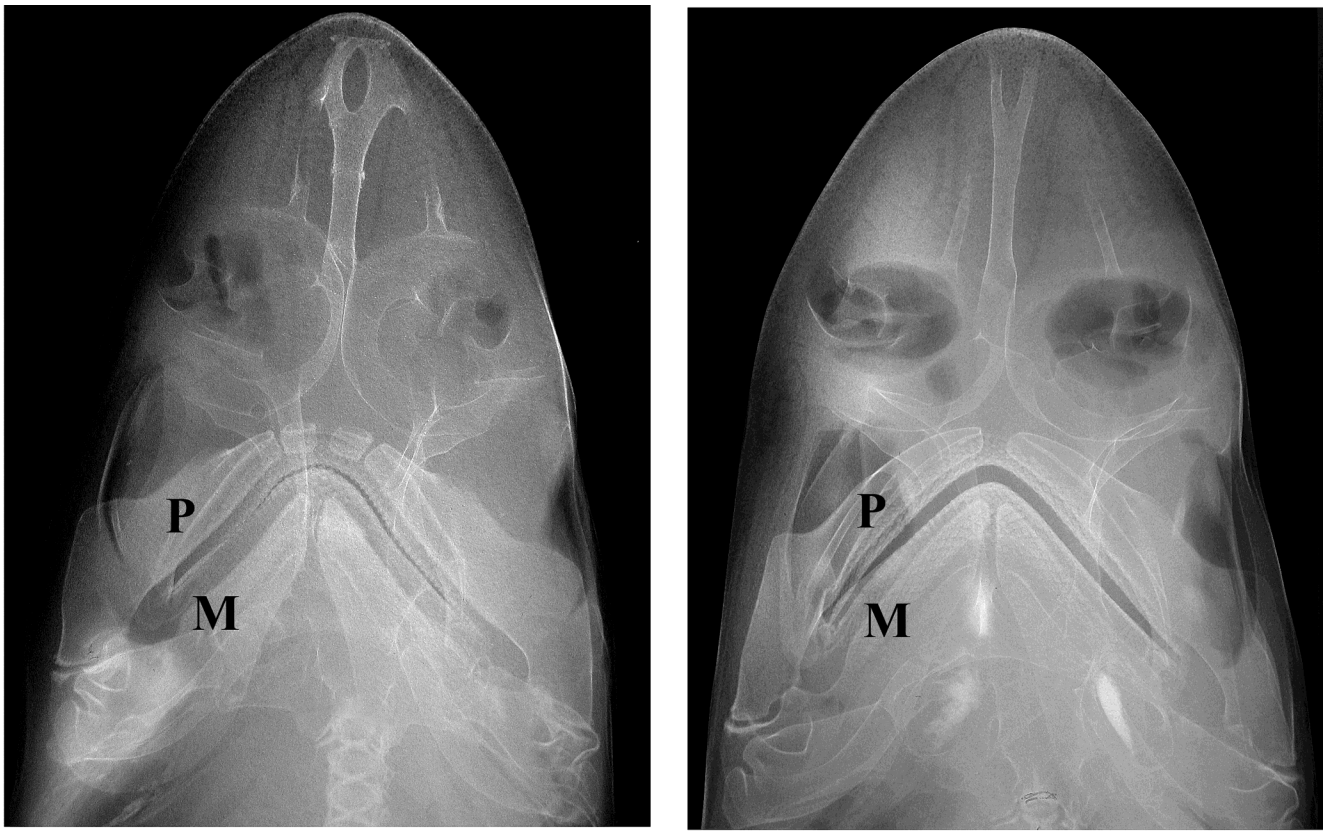

Figure 8. - The two main types of palatoquadrate cartilages in species of *Mustelus*. **A**: Subdivided palatoquadrate cartilage (4-part) found in *M. widodoi* and *M. ravidus*; **B**: Undivided palatoquadrate cartilage (2-part) found in most other species of *Mustelus*. P = palatoquadrate, M = Meckel's cartilage. *[Les deux types principaux de cartilages palatocarrés chez les espèces de* Mustelus. ***A** : Cartilage palatocarré subdivisé (4 parties) trouvé chez* M. widodoi *et* M. ravidus *; **B** : Cartilage palatocarré non divisé (2 parties) trouvé chez la plupart des autres espèces de* Mustelus. *P = palatocarré, M = cartilage de Meckel.]*

CSIRO CA 3038); formula is 38 + 39 in upper jaw, 36 + 37 in lower jaw. Lateral trunk denticles below first dorsal fin small and closely imbricated; ovate with about four longitudinal ridges extending entire length of crown; crown length less than 1.5 times width. Denticles absent at insertion of pectoral and pelvic fins. First dorsal fin relatively tall and weakly falcate; anterior margin convex, narrow apically; posterior margin almost upright, broadly concave at junction of free rear tip; free rear tip acutely pointed, inner margin nearly straight; fin origin about in line with free rear tips of pectoral fins, midpoint of base near midpoint of distance between pelvic-fin origins and pectoral-fin insertions; insertion well anterior to pelvic-fin origins; insertion of fin posterior to level of fin apex; first dorsal-fin base 1.53 (1.52-1.83) in interdorsal space, 1.46 (1.45-1.80) in dorsal caudal-fin margin, fin height 1.69 (1.32-1.53) in base length; inner margin 2.44 (2.25-2.74) in height, 4.13 (3.28-4.19) in base length. Second dorsal fin tall and raked back, apically relatively narrow and moderately falcate; slightly smaller than first dorsal fin, height 0.74 (0.71-0.79) of first dorsal-fin height, base length 0.75 (0.81-0.90) of first dorsal-fin base length; anterior margin moderately convex; apex narrowly rounded; posterior margin deeply concave, upper portion directed posterodorsally; inner margin straight or slightly concave, free rear tip acutely pointed, terminating slightly anterior to anal-fin free rear tip and well in front of upper caudal-fin origin; origin separated from pelvic-fin insertions by a space about 2.11 (1.76-2.42) times pelvic-fin base; posterior margin extending anteroventrally from apex; insertion slightly anterior to fin apex; second dorsal-fin base length 0.94 (0.88-1.00) in dorsal-caudal space; fin height 1.73 (1.52-1.82) in base length; inner margin 2.46 (2.60-2.96) in height, 4.25 (4.22-5.39) in base length. Anal fin very low, apically narrow, semifalcate, much smaller than second dorsal fin; height 0.49 (0.47-0.50) in second dorsal-fin height, base length 0.64 (0.61-0.69) times second dorsal-fin base length; anterior margin convex; apex narrowly rounded; posterior margin moderately notched, slanting slightly anterodorsally from apex; free rear tip acutely pointed, well in front of lower caudal-fin origin; inner margin nearly straight; preanal ridges indistinct; origin slightly behind second dorsal-fin origin, by 0.48 (0.44-0.51) of second dorsal-

fin base; insertion slightly anterior to apex, slightly behind second-dorsal fin insertion; anal-fin base length 0.97 (0.87-0.94) in anal-caudal space; fin height 2.25 (2.11-2.35) in base length; inner margin 1.68 (1.60-1.85) in height, 3.77 (3.74-4.15) in base length. Pectoral fins narrow and weakly falcate; anterior margins broadly convex, length 1.31 (1.27-1.46) times posterior margin; bases narrow; apices narrowly rounded, posterior margins moderately concave; free rear tips broadly rounded, inner margins strongly convex; origins under fourth gill opening; slightly larger in area than first dorsal fin. Apex of pectoral fin well posterior to its free rear tip when fin is elevated and appressed to body. Pelvic fins broadly subtriangular; area much greater than anal-fin area; anterior margins slightly convex, length 0.53 (0.53-0.60) length of pectoral-fin anterior margins; angular apically, with posterior margins moderately concave; free rear tips angular, inner margins nearly straight. Claspers of adult male paratype relatively long, nearly straight for most of outer margin length and strongly tapering near tip; extending well behind pelvic-fin free rear tips, distance 1.8 times pelvic-fin inner margin; apex about 0.3 times anal-fin base short of anal-fin origin; glans moderately long, length about half of clasper outer margin, blunt distally with a narrow apex; covered laterally and ventrally with small clasper denticles; dorsomedial surfaces of glans (including rhipidion) and lateral strip adjacent to clasper groove naked. Caudal fin asymmetrical, upper lobe narrow; terminal lobe moderately enlarged, ventral lobe prominent, subtriangular, weakly falcate; dorsal caudal-fin margin moderately long, 3.92 (3.65-4.22) in precaudal length, double convex, mesially concave, without lateral undulations; preventral margin convex, length 3.52 (3.32-3.63) in dorsal caudal margin; tip of ventral lobe bluntly pointed, angular; lower postventral margin nearly straight to concave; upper postventral margin nearly straight to convex, notch between these forming angle of 98-114˚; subterminal notch a narrow, deep slot; subterminal margin slightly concave, terminal margin slightly to strongly concave, lobe formed by these margins bluntly angular; subterminal margin 1.80 (1.75-1.88) in terminal margin; tip of tail pointed, terminal lobe length 2.71 (2.39-2.91) in dorsal caudal margin. Vertebral counts, ratios and statistics of the holotype and five paratypes in table II and summarised as follows: total counts (TC) 139 (139-144), precaudal (PC) counts 90 (90-91), monospondylous precaudal (MP) centra 35 (35-37), diplospondylous precaudal (DP) centra 55 (53-56). Last few MP centra before MP-DP transition hardly enlarged, not forming 'stutter zone' of alternating long and short centra.

Colour

In alcohol: pale yellowish-brown above, paler below; darker areas above merging gradually with pale area below on sides of body; interface more pronounced on head, dark portion passing just below eye level then extending along profile of upper gill margins; first dorsal fin brownish, with dusky submargin and apex, in holotype posteriorly with narrow pale margin; pale margins also on pectoral, pelvic and anal fins and ventral lobe of caudal fin; second dorsal-fin dusky tipped, with a pale central posterior margin and free rear tip; terminal caudal lobe dusky-edged. Similar in colour when fresh.

Size

The largest known specimen of *Mustelus ravidus* is a 788 mm TL female. Of the six specimens recorded to date, two (paratypes) are females of 728 and 788 mm TL, three (including the holotype) are adult males 662 to 683 mm TL, and one (paratype) is an immature male 567 mm TL. No pregnant females have been recorded.

Distribution

Mustelus ravidus is known only from the north-west shelf off Western Australia between longitudes 116° and 119°, in depths of 106 to 300 m (Fig. 4).

Etymology

From the Latin word "ravidus" (greyish) in reference to its pale grey dorsal coloration.

Comparison with other species

Compagno (1984, 1988) noted that members of the genus *Mustelus* are unusually difficult to separate from one another and the morphological, morphometric and meristic characters used to distinguish species typically overlap and vary greatly within a species.

Two kinds of upper jaw skeletons typify members of the genus *Mustelus*. The majority of species have an upper jaw skeleton with only two palatoquadrate cartilages while another group of species have the palatoquadrate subdivided at symphysis with a short separate medial segment on each side (Fig. 8). *Mustelus widodoi* and *M. ravidus* have the latter upper jaw skeleton type along with *M. whitneyi* Chirichigno, 1973, *M. mento* Cope, 1877, *M. californicus* Gill, 1864 and *M. griseus* Pietschmann, 1908. *Mustelus whitneyi* differs from other members of this group by the presence of high tooth cusps while *M. mento* has teeth with broadly rounded crowns without cusps. The remaining species have asymmetrical teeth with low blunt cusps.

Mustelus griseus, *M. widodoi* and *M. ravidus* differ from *M. californicus* in possessing an expanded and falcate ventral caudal lobe, the angle of which is approximately 90°, rather than a ventral caudal lobe that is not expanded and only weakly falcate, and which forms an angle far greater than 90°.

Mustelus griseus differs from *M. widodoi* and *M. ravidus* in having much lower vertebral counts, i.e. diplospondylous precaudal centra 40-48 vs 51-56 and precaudal centra 73-80 vs 86-91. The latter two species also differ in having a white margin on the first dorsal fin and black markings on second dorsal fin and terminal caudal lobe whereas *M. griseus* is uniformly greyish in coloration.

Mustelus widodoi differs from *M. ravidus* in having a broader and much more distinct white margin on the first dorsal fin, and smaller, more upright dorsal fins. *Mustelus ravidus* also differs in having a slightly higher precaudal vertebral count, i.e. 90-91 *vs* 86-89. *Mustelus widodoi* also differs from *M. ravidus* in having a more elongate caudal peduncle (postdorsal distance) resulting in a much lower preanal length to anal-caudal space ratio. *Mustelus widodoi* is a larger shark than *M. ravidus*, with the largest specimens recorded for both species being 1085 and 788 mm TL, respectively. Furthermore, Last and Stevens (1994) states a size at maturity for males of *Mustelus* sp. A (= *ravidus*) of ~580 mm TL, while the smallest mature male of *M. widodoi* was 830 mm TL and the largest immature male was 760 mm TL.

Acknowledgements. - The market surveys of eastern Indonesia were supported by a research grant from the Australian Centre for International Agricultural Research (ACIAR). The authors would like to acknowledge Dharmadi from the Research Centre for Capture Fisheries (RCCF), Fahmi from the Indonesian Institute of Sciences (LIPI), and Michael Travers from Murdoch University (MU) for their assistance in the field, to Spikey Riddoch for assisting with the capture of meristic data, Alastair Graham for assembling collection material and to Lindsay Marshall for the illustrations of the denticles. Other important contributors in this ground-breaking project include Dr. Subhat Nurhakim (RCCF), Dr. Johannes Widodo (RCCF), Dr. Ono Kurnaen Sumadhiharga (LIPI), Dr. Ian Potter (MU), Ashlee Jones (MU), Dr. Simon de Lestang (MU), Dr. John Stevens (CSIRO), Dr. Steve Blaber (CSIRO), Gary Fry (CSIRO) and Dr. Ilona Stobutzki from the World Fish Centre.

REFERENCES

CHEN C.T., HUANG S.Y & S.C. LEE, 2001. - Genetic variation between populations of starspotted dogfish *Mustelus manazo* in central Japan and northern Taiwan. *Fish. Sci*., 67: 30-35.

COMPAGNO L.J.V., 1984. - FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 2- Carcharhiniformes. *FAO Fish. Synop*., (125) Vol. 4(2): 655 p.

COMPAGNO L.J.V., 1988. - Sharks of the Order Carcharhiniformes. 572 p. New Jersey: Princetown Univ. Press.

COMPAGNO L.J.V. & J.D. STEVENS, 1993. - *Hemitriakis falcata* n.sp. and *H. abdita* n.sp., two new houndsharks (Carcharhiniformes: Triakidae) from Australia. *Rec. Aust. Mus*., 45: 195-220.

COMPAGNO L.J.V., DANDO M. & S. FOWLER, 2005. - A Field Guide to the Sharks of the World. 368 p. London: Harper Collins Publishing Ltd.

GLOERFELT-TARP T. & P.J. KAILOLA, 1984. - Trawled Fishes of Southern Indonesia and Northwestern Australia. xvi + 406 p. Australian Development Assistance Bureau; Directorate General of Fisheries, Indonesia; German Agency for Technical Cooperation.

HEEMSTRA P.C., 1997. - A review of the smooth-hound sharks (genus *Mustelus*, family Triakidae) of the western Atlantic Ocean, with descriptions of two new species and a new subspecies. *Bull. Mar. Sci*., 60: 894-928.

LAST P.L. & J.D. STEVENS, 1994. - Sharks and Rays of Australia. 513 p. Australia: CSIRO.

SAINSBURY K.J., KAILOLA P.J. & G.G. LEYLAND, 1985. - Continental Shelf Fishes of Northern and North-Western Australia. 375 p. CSIRO Division of Fisheries Research, Clouston & Hall/Peter Pownall Fisheries Information Service, Canberra.

YAMAGUCHI A., TANIUCHI T. & M. SHIMIZU, 2000. - Geographic variations in reproductive parameters of the starspotted dogfish, *Mustelus manazo*, from five localities in Japan and Taiwan. *Environ. Biol. Fish*., 57: 221-233.

Reçu le 19 mai 2005.
Accepté pour publication le 26 mars 2006.