Part 6 — Description of *Squalus chloroculus* sp. nov., a new spurdog from southern Australia, and the resurrection of *S. montalbani* Whitley

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ABSTRACT.— A new spurdog, *Squalus chloroculus* sp. nov., is described based on specimens from the upper continental slope off southern Australia. This species and a closely related Indo–West Pacific species, *S. montalbani* Whitley, have been consistently confused with each other and misidentified as a western North Pacific spurdog, *S. mitsukurii* Jordan and Snyder. In this paper, the new species is described and *Squalus montalbani* is resurrected and rediagnosed based on material from the Philippines, Indonesia, and tropical and warm temperate Australia. Intraspecific variation between populations of *S. montalbani* across these regions is discussed. These species are compared to *S. mitsukurii* and belong to a subgroup of *Squalus*, the 'mitsukurii group', whose members have a moderately elongate snout, stocky body, and a dark caudal bar on the posterior notch of the caudal fin. These spurdogs are very similar morphologically but can be distinguished using molecular techniques and through a combination of caudal-fin coloration, meristics, and morphometrics of the head, trunk and fins.

Key words. Squaloidea – Squalidae – *Squalus chloroculus* – new species – *Squalus montalbani* – resurrected species – southern Australia

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INTRODUCTION

Squalus mitsukurii Jordan and Snyder in Jordan and Fowler, 1903, which has long been considered to be a very wide ranging dogfish in temperate and tropical oceans (Compagno, 1984), is now thought to be a species complex (Last and Stevens, 1994; Compagno *et al.*, 2005). Members of this complex, referred to here as the 'mitsukurii group', are characterised by their large relative size, a dark caudal bar, low dorsal-fin spines, and a small, raked first dorsal fin. An Australian form referable to *S. mitsukurii* was reported by Last and Stevens (1994) from the temperate and tropical continental slope of Australia between Townsville (Queensland) and Shark Bay (Western Australia). Molecular studies (see Ward *et al.*, 2007, Part 12 of this issue) of Australian members of this complex revealed the existence of two species. One of these spurdogs has a temperate distribution off southern Australia, whereas the other species occurs primarily in subtropical and tropical latitudes off both eastern and western Australia. These species are very similar morphologically to each other and to *S. mitsukurii*.

Market surveys at various landing sites in the Philippines (late 1990's) and eastern Indonesia (April 2001 to March 2006) produced a wide variety of sharks, rays and chimaeras, including many squaloids, for research. This material included multiple species of *Squalus*, one of which appeared to be conspecific with an Australian member of the 'mitsukurii group'. A Philippine species, which was provisionally identified as *S.* cf. *mitsukurii*, was thought to be non-conspecific with *S. mitsukurii* (Compagno *et al.*, 2005). Smith and Radcliffe in Smith (1912) described *Squalus philippinus* (a junior homonym of *S. philippinus* Shaw, 1804 = *Heterodontus portusjacksoni* (Meyer, 1793)) from the west coast of Luzon Island, Philippines. This species, which was later renamed *Squalus montalbani* by Whitley (1931), was considered to be a likely junior synonym of *S. mitsukurii* (Compagno, 1984).

In the following paper, the temperate Australian spurdog is described as a new species and *Squalus montalbani* is resurrected and rediagnosed. These species are compared to the types and other material, from near the type locality (off Japan), of *Squalus mitsukurii*.

METHODS

Methods follow those outlined in Part 1 of this issue (Last *et al.*, 2007). Diagnoses are provided for *S. montalbani* and the new species; mean values for diagnostic ratios and counts are given in parentheses after their ranges. In the new species description, morphometric and meristic values for the holotype are given first followed in parentheses by the ranges of the measured paratypes.

Table 1. Proportional dimensions as percentages of total length for the holotypes of *Squalus montalbani* (USNM 70256) and *Squalus mitsukurii* (SU 12793) and ranges for additional material measured.

	S. montalbani			*S. mitsukurii*		
		n = 14			n = 4	
	Holotype	Min.	Max.	Holotype	Min.	Max.
TL – Total length	311	520	843	719	266	855
PCL – Precaudal length	76.5	77.1	79.9	76.6	78.2	79.0
PD2 – Pre-second dorsal length	57.6	59.1	62.8	59.8	58.6	61.2
PD1 – Pre-first dorsal length	30.7	26.5	30.0	30.9	28.5	32.3
SVL – Pre-vent length	47.2	48.6	52.7	51.5	48.9	52.2
PP2 – Prepelvic length	43.8	47.2	50.8	48.5	47.4	50.1
PP1 – Prepectoral length	22.8	20.8	22.9	23.3	19.9	23.9
HDL – Head length	23.2	21.3	23.4	23.4	20.9	23.5
PG1 – Prebranchial length	20.3	17.6	19.7	19.5	18.0	20.1
PSP – Prespiracular length	13.4	11.3	13.6	12.8	12.1	13.3
POB – Preorbital length	7.1	6.7	8.1	7.5	7.3	7.9
PRN – Prenarial length	4.6	4.0	5.3	5.5	5.0	5.4
POR – Preoral length	10.1	8.7	10.6	10.8	9.4	10.6
INLF – Inner nostril-labial furrow space	5.3	4.2	4.9	4.4	4.2	4.7
MOW – Mouth width	6.5	7.1	8.5	6.2	6.3	7.5
ULA – Labial furrow length	2.5	1.9	2.5	2.4	2.1	2.5
INW – Internarial space	5.2	4.1	5.0	4.8	4.0	4.9
INO – Interorbital space	8.7	7.5	9.6	8.1	7.9	8.4
EYL – Eye length	4.3	3.8	5.2	3.4	3.8	4.7
EYH – Eye height	1.6	1.5	2.3	1.3	1.8	2.5
SPL – Spiracle length	1.5	1.3	1.9	1.2	1.2	1.5
GS1 – First gill-slit height	1.6	1.7	2.5	1.9	1.6	1.7
GS5 – Fifth gill-slit height	2.0	1.7	2.4	2.1	1.8	2.0
IDS – Interdorsal space	21.7	22.1	25.9	21.3	18.7	25.2
DCS – Dorsal-caudal space	11.2	9.7	11.2	9.8	9.9	11.2
PPS – Pectoral-pelvic space	18.9	19.8	25.4	22.5	21.3	24.5
PCA – Pelvic-caudal space	26.3	22.9	26.0	22.7	22.3	27.4
D1L – First dorsal length	14.2	12.8	15.9	14.5	12.5	15.7
D1A – First dorsal anterior margin	12.4	10.4	12.6	12.0	10.5	11.1
D1B – First dorsal base length	8.3	7.6	9.8	8.3	7.8	7.8
D1H – First dorsal height	6.1	5.7	7.4	8.5	4.5	8.3
D1I – First dorsal inner margin	6.2	4.9	6.8	6.3	4.9	6.4
D1P – First dorsal posterior margin	6.7	6.9	8.8	9.7	4.6	7.9
D1ES – First dorsal spine length	2.1	2.2	4.0	3.3	3.5	4.8
D1BS – First dorsal spine base width	0.7	0.5	0.6	0.8	0.6	0.8
D2L – Second dorsal length	13.4	11.1	13.9	12.7	12.0	13.9
D2A – Second dorsal anterior margin	10.2	8.5	10.8	10.2	10.4	10.7
D2B – Second dorsal base length	8.1	7.0	8.5	7.2	8.0	9.2
D2H – Second dorsal height	4.2	3.4	4.6	4.5	3.0	4.6
D2I – Second dorsal inner margin	5.9	4.0	5.7	5.1	4.2	5.4
D2P – Second dorsal posterior margin	5.2	4.5	6.3	5.2	4.1	4.4
D2ES – Second dorsal spine length	3.6	2.0	3.9	3.8	3.8	5.0
D2BS – Second dorsal spine base width	0.8	0.5	0.6	0.7	0.7	0.9

Table 1. cont'd.

	S. montalbani			*S. mitsukurii*		
		n = 14			n = 4	
	Holotype	Min.	Max.	Holotype	Min.	Max.
P1A – Pectoral anterior margin	13.6	12.8	15.5	15.0	11.7	16.1
P1I – Pectoral inner margin	8.9	6.8	8.8	8.2	7.0	7.5
P1B – Pectoral base length	5.0	5.1	6.2	6.8	5.0	6.1
P1P – Pectoral posterior margin	9.6	8.5	11.8	11.0	7.6	11.4
P2L – Pelvic length	10.1	8.6	11.0	10.8	9.6	10.3
P2H – Pelvic height	3.3	3.6	4.8	5.6	4.0	4.9
P2I – Pelvic inner margin	3.7	3.6	5.9	5.8	2.0	3.1
CDM – Dorsal caudal margin	22.6	19.8	23.3	22.6	21.2	21.3
CPV – Preventral caudal margin	12.2	10.9	13.2	12.3	10.2	12.2
CPU – Upper postventral caudal margin	15.9	14.5	17.8	16.4	13.2	16.2
CPL – Lower postventral caudal margin	3.6	3.9	5.9	4.8	3.4	5.6
CFW – Caudal fork width	6.7	6.4	7.7	6.7	5.9	6.7
CFL – Caudal fork length	10.8	9.0	10.8	9.2	9.3	10.3
HANW – Head width at nostrils	7.7	7.0	8.7	7.7	7.6	7.7
HAMW – Head width at mouth	10.6	9.7	11.9	11.5	10.1	10.8
HDW – Head width	12.1	11.3	13.9	14.8	11.5	13.8
TRW – Trunk width	10.9	9.3	12.5	–	8.2	10.7
ABW – Abdomen width	8.2	8.1	13.2	–	6.4	9.6
TAW – Tail width	5.3	5.6	7.0	6.3	4.7	6.7
CPW – Caudal peduncle width	2.7	2.6	3.5	2.5	2.4	3.1
HDH – Head height	9.1	9.0	12.1	8.5	7.5	11.7
TRH – Trunk height	12.0	8.9	13.4	–	7.9	9.1
ABH – Abdomen height	12.6	9.3	13.0	–	7.7	8.4
TAH – Tail height	6.6	6.0	7.3	7.2	5.3	6.2
CPH – Caudal peduncle height	2.5	2.2	2.8	2.6	2.3	2.5
CLO – Clasper outer length	1.4	4.5	5.6	–	1.7	2.6
CLI – Clasper inner length	5.4	7.8	8.8	–	5.2	6.0
CLB – Clasper base width	0.8	1.4	1.9	–	0.9	1.1

Morphometric and meristic data were taken from 9 specimens of *S. montalbani* (CSIRO H 2575–02, CSIRO H 2606–02, CSIRO H 2606–05, CSIRO H 5857–06, CSIRO H 5875–07, CSIRO H 5888–03, CSIRO H 5889–20, SUML F 1198 and SUML unreg BRU 136); morphometrics only from another 6 specimens (USNM 70256 (holotype), CSIRO H 2605–04, CSIRO H 4623–04, CSIRO H 4623–05, QM I 38075 and AMS I 43982–001); and meristics only from another 10 specimens (CSIRO H 1203–02, CSIRO H 1290–02, CSIRO H 1348–01, CSIRO H 2606–06, CSIRO H 4623–02, CSIRO 4708–01, CSIRO H 5889–10, CSIRO H 5889–19, QM I 21518 and WAM P 32843–001). Morphometric and meristic details were taken from the holotype (CSIRO H 4775–01) and two paratypes of the new species (CSIRO H 1405–01, CSIRO H 1662–01); morphometrics only from 7 other paratypes (CSIRO H 2867–02, CSIRO H 2867–03, CSIRO H 2867–04, CSIRO H 2867–05, CSIRO H 2966–01, CSIRO H 5941–01 and NMV A 29563–001); and meristics from 5 other paratypes (CSIRO CA 121, CSIRO H 1350–02 (4 embryos)).

Specimens examined are deposited in the Australian National Fish Collection, Hobart (CSIRO), the Australian Museum, Sydney (AMS), the National Museum of Victoria (NMV), the Queensland Museum (QM), the Western Australian Museum (WAM), the Museum Zoologicum Bogoriense, Jakarta (MZB), the Hokkaido University, Faculty of Fisheries, Hakodate (HUMZ), the California Academy of Sciences, San Francisco (CAS, inc. SU) and the National Museum of Natural History, Washington, D.C. (USNM); their registration numbers are prefixed with these acronyms.

Squalus montalbani Whitley, 1931

Figs 1a–c, 2a,b, 3–5a; Table 1, 2

Squalus philippinus Smith and Radcliffe, 1912 (junior homonym of *S. philippinus* Shaw, 1804 = *Heterodontus portusjacksoni* (Meyer, 1793)). *In*: Smith 1912: 677, pl. 51, fig. 1, *Proc. U. S. Natl. Mus.* v. 41 (no. 1877). Holotype (unique): USNM 70256.
Squalus montalbani Whitley 1931:310. *In*: *Aust. Zool.* v. 6 (pt 4). Replacement name for *Squalus philippinus* Smith and Radcliffe 1912.

Squalus sp. 1: White *et al.*, 2006, *Economically Important Sharks and Rays of Indonesia*, pp 68–69.

Holotype. USNM 70256, immature male 311 mm TL, off Sombrero I., west coast of Luzon Island, 13°45′ N, 120°46′ E, Philippines, Albatross sta. 5111, ca. 425 m.
Other material. 32 specimens. CSIRO H 1290–02, immature male 592 mm TL, east of Flinders Reef, Queensland, 17°38′ S, 149°23′ E, 600 m; CSIRO H 1348–01, female 375 mm TL, north-west of Saumarez Reef, Queensland, 21°20′ S, 153°32′ E, 502 m; QM

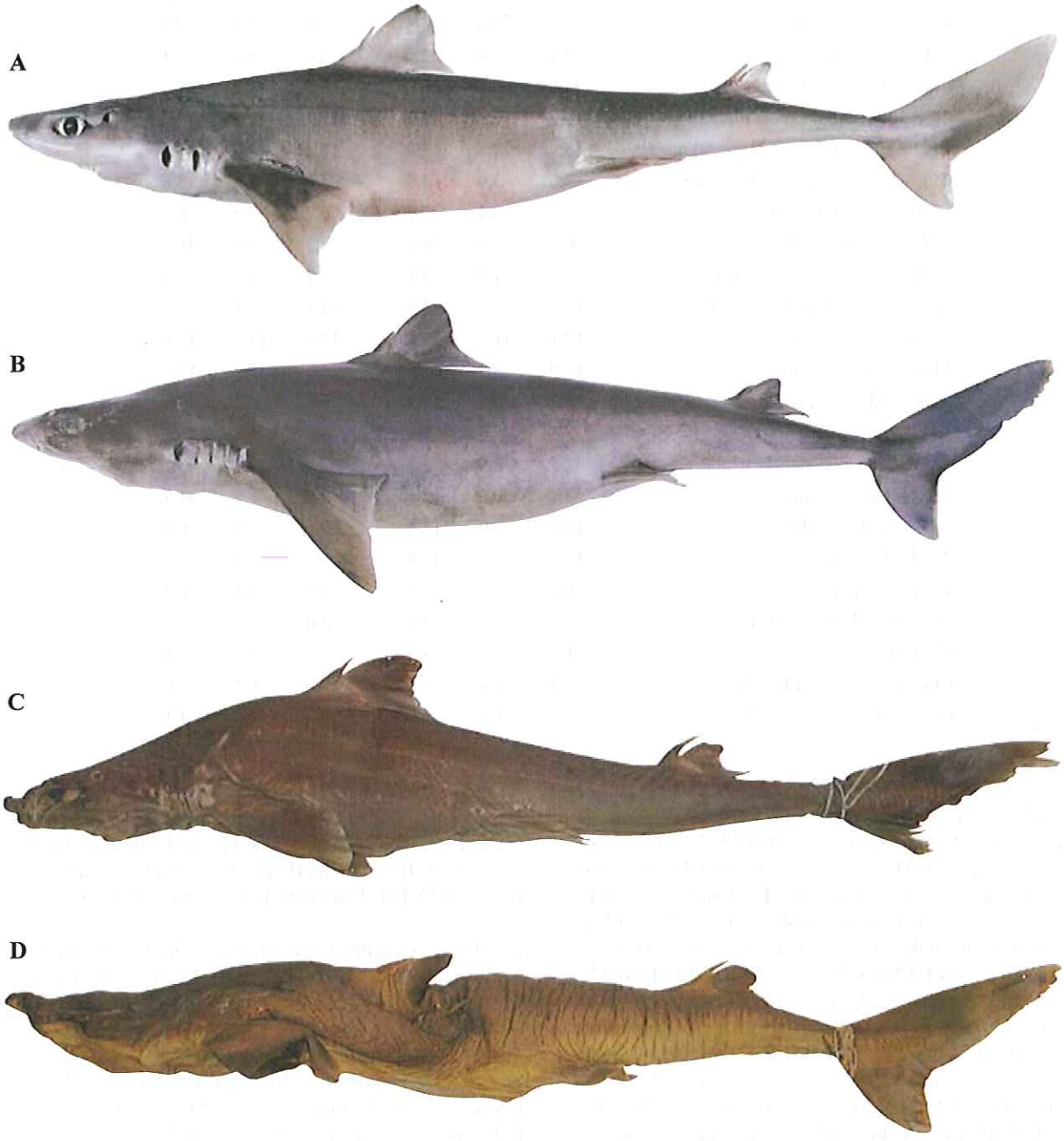

Figure 1. Lateral view of: A. *Squalus montalbani* from NW Australia (CSIRO H 2575–02, adult male 681 mm TL); B. *Squalus montalbani* from Indonesia (MZB 15424, female 945 mm TL); C. *Squalus philippinus* (=*montalbani*) holotype (USNM 70256, immature male 311 mm TL); d. *Squalus mitsukurii* holotype (SU 12793, female 719 mm TL).

I 21518, female 370 mm TL, east of Capricorn Group, Queensland, 23°21′ S, 153°56′ E, 460 m; AMS I 20301–027, 310 mm TL, east of Wooli, New South Wales, 29°53′ S, 153°42′ E, 502 m; CSIRO H 4623–02, female 485 mm TL, CSIRO H 4623–04, adult male 811 mm TL, CSIRO H 4623–05, female 760 mm TL, east of Terrigal, New South Wales, 33°28′ S, 152°04′ E, 383 m; CSIRO H 2606–02, female 557 mm TL, CSIRO H 2606–05, female 607 mm TL, CSIRO H 2606–06, adolescent male 440 mm TL, west of Rottnest Island, Western Australia, 32°02′ S, 114°54′ E, 670 m; CSIRO H 2605–04, female 825 mm TL, north-west of Rottnest Island, Western Australia, 31°44′ S, 114°59′ E, 485 m; WAM P 32843–001, immature male 440 mm TL, west of Greenhead, Western Australia, 29°59′ S, 114°26′ E, 490 m; CSIRO H 2574–04, immature female 221 mm TL, west of Freycinet Estuary, Western Australia, 26°35′ S, 112° 29′ E, 508 m; CSIRO H 2575–02, adult male 681 mm TL, west of Freycinet Estuary, Western Australia, 26° 40′ S, 112°32′ E, 478 m; CSIRO H 1203–02, embryo 208 mm TL, north of Sahul Banks, Timor Sea, Western Australia, 11°33′ S, 124°58′ E, 415 m; MZB 15018, female 862 mm TL, MZB 15019, adult male 862 mm TL, Cilacap fish landing site, Central Java, Indonesia, 07° 40′ S, 109°00′ E; CSIRO H 5857–06, adult male 678 mm TL, CSIRO H 5889–20, adult male 627 mm TL, CSIRO H 5888–03, female 801 mm TL, CSIRO H 5889–10, female 495 mm TL, CSIRO H 5889–19, female 481 mm TL, AMS I 43982–001, adult male 564 mm TL, QM I 38075, female 801 mm TL, QM I 38076, immature male 463 mm TL, MZB 15421, female 912 mm TL, MZB 15424, female 945 mm TL, NMV A 29561–001, female 528 mm TL, Kedonganan fish landing site, Bali, Indonesia, 08°45′ S, 115°10′ E; CSIRO H 5875–07, female 843 mm TL, MZB 15099, female 781 mm TL, Tanjung Luar fish landing site, Lombok, Indonesia, 08°45′ S, 116°35′ E; SUML F 1198, female 694 mm TL, SUML unreg BRU 136, female 520 mm TL, Aliguay Island, Philippines.

DIAGNOSIS.— A large species of *Squalus* of the 'mitsukurii group' with the following combination of characters: body elongate to robust, trunk depth 8.9–13.4% TL (mean 11.4% TL, n=14); snout broadly triangular, mouth width 1.69–2.32 (1.85) times horizontal prenarial length; pre-first dorsal length 26.5–30.7 (29.0)% TL; pre-second dorsal length 57.6–62.8 (60.8)% TL; interdorsal space 21.7–25.9 (23.7)% TL; low raked dorsal fins; second dorsal-fin length 11.1–13.9 (12.4)% TL, height 3.4–4.6 (4.0)% TL, inner margin length 4.0–5.9 (4.8)% TL; second dorsal-fin base 15.8–21.3 (20.8) times base of second dorsal spine; prepectoral length 20.8–22.9 (22.0)% TL; pelvic–caudal space 22.9–26.0 (24.0)% TL; caudal bar almost upright, extending broadly from the caudal fork up the posterior margin of the upper lobe for about 0.6 of its length in immatures, upper caudal fringe forming a deep saddle along mid-length of lobe; flank denticles tricuspid; 41–47 (mainly 42–44) monospondylous centra, 79–85 precaudal centra, 105–114 total centra; adult size more than 84 cm TL.

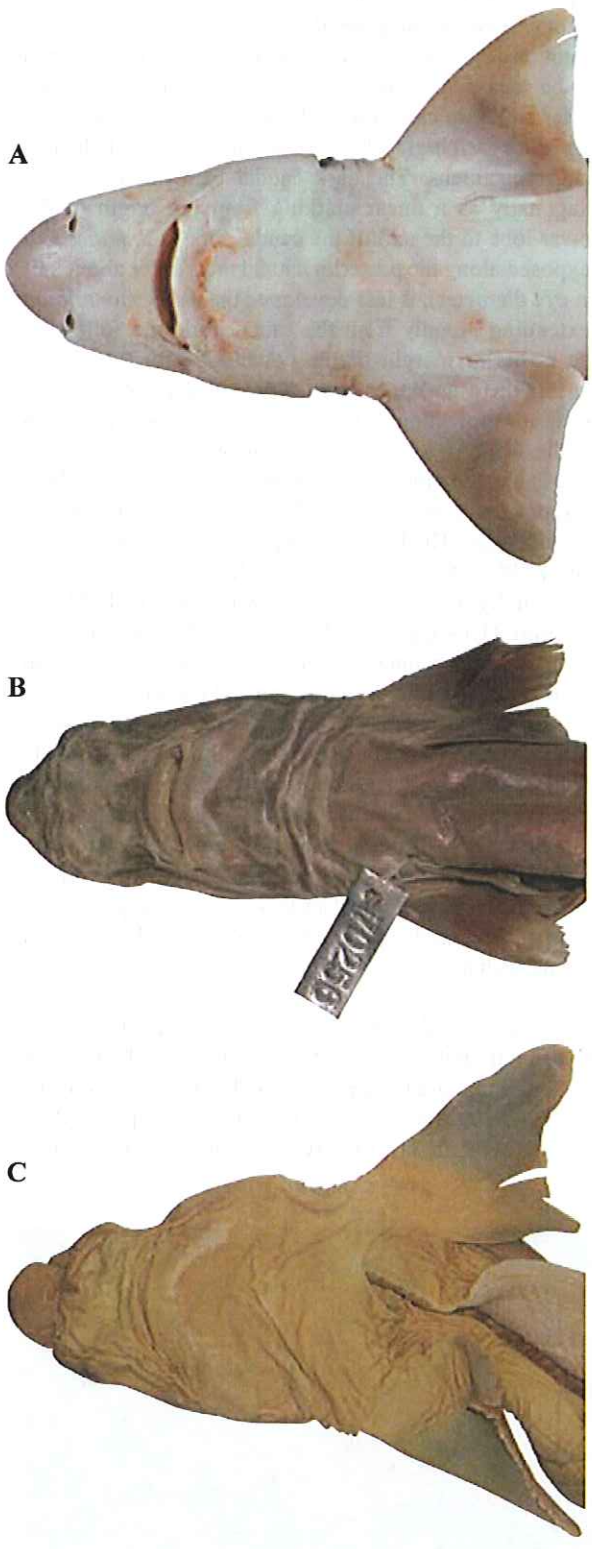

Figure 2. Ventral view of the head of: A. *Squalus montalbani* (CSIRO H 2575–02, adult male 681 mm TL); B. *Squalus philippinus* (=*montalbani*) holotype (USNM 70256, immature male 311 mm TL); C. *Squalus mitsukurii* holotype (SU 12793, female 719 mm TL).

REMARKS.— *Squalus montalbani* is similar in appearance to *S. mitsukurii* and both species occur together in the same general geographic region. Hence, it is not unsurprising that these forms have been considered to be conspecific (Compagno, 1984). These species differ subtly in caudal fin coloration and these markings are more strikingly obvious in young (Fig. 5) than in adult specimens. The dark caudal bar, which extends diagonally as a linear marking from the origin of the lower lobe to the axil of the caudal fork in *S. mitsukurii* (exposed along the posterior caudal margin for about half an eye diameter), is less developed than in *S. montalbani* (extending broadly from the caudal fork and following the posterior margin of the upper lobe for 0.6–0.7 of its length to an upper level typically demarcated by a posterior projection of the distal part of a fleshy portion of the fin). Also, the dark blotch on the upper caudal lobe is located more distally than in *S. montalbani* which is represented as a saddle-like extension of the upper caudal fringe. The late embryo paratypes of *S. mitsukurii* (SU 7748, 228–237 mm TL) are slightly larger than the post-natal young of *S. montalbani* (CSIRO H 1203–02, 207 mm TL) suggesting that they are born at different sizes. These specimens also display slight differences in the form of the anterior nasal flap and pectoral fin which are either attributable to interspecific or ontogenetic differences. It should be noted that, although paratype SU 7748 consists of 8 late-term embryos labeled as "from uterus of type", the literature suggests that it may actually contain embryos from several individuals collected with the holotype (Jordan and Snyder, 1903). However, the 5 (of 8) embryos examined in this study all appear to be conspecific based on their morphology and coloration and as such are representative of *S. mitsukurii*.

These species also differ morphometrically (Table 1). The female holotype (SU 12793, 719 mm TL, Fig. 1d, 2c) and immature male paratype (SU 7184, 266 mm TL) of *Squalus mitsukurii* differ from the holotype (USNM 70256, 311 mm TL, Fig. 1c, 2b) and other material of *S. montalbani* in the following ratios: total length 3.10–3.23 vs. 3.26 (3.33–3.78, n=14) times pre-first dorsal length in *S. montalbani*; pre-first dorsal length 1.45–1.73 vs. 1.42 (1.10–1.30) times interdorsal space; prepectoral length 1.09–1.28 vs. 1.05 (0.85–1.00) times interdorsal space; prepectoral length 1.02–1.07 vs. 0.87 (0.85–0.99) times pelvic–caudal space; and head height 0.58–0.65 vs. 0.76 (0.66–0.96) times its width. *Squalus mitsukurii* also appears to have slightly longer head measurements (direct head length 23.4–23.5 vs. 23.2 (21.3–23.4)% TL, prepectoral length 23.3–23.9 vs. 22.8 (20.8–22.9)% TL, prenarial length 5.4–5.5 vs. 4.6 (4.0–5.3)% TL, preoral length 10.6–10.8 vs. 10.1 (8.7–10.6)% TL) and a more slender body (head height 7.5–8.5 vs. 9.1 (9.0–12.1)% TL, trunk height 7.9 vs. 12.0 (8.9–13.4)% TL, abdomen height 7.7 vs. 12.6 (9.3–13.0)% TL, trunk width 8.2 vs. 10.9 (9.3–12.5)% TL, abdomen width 6.4 vs. 8.2 (8.1–13.2)% TL, and caudal peduncle width 2.4–2.5 vs. 2.7 (2.6–3.5)% TL). The mouth of *S. mitsukurii* appears to be relatively narrow compared to *S. montalbani* (mouth width 6.2–6.3 vs. 6.5 (7.1–8.5)% TL) but this may be due to methodological inconsistencies. Differences between the species also exist in the number of vertebral centra. Chen *et al.* (1979) provided counts and morphometrics for 54 specimens of *S. mitsukurii* from central and northeastern Japan, close to the type locality (Misaki). Their counts for *S. mitsukurii* are higher (45–51 monospondylous centra, 87–93 precaudal centra, 118–127 total centra) than those

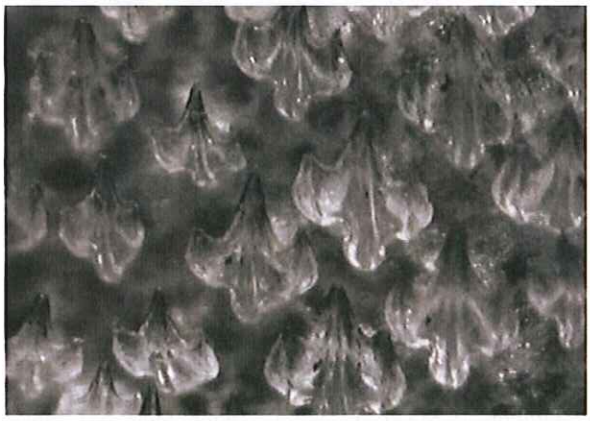

Figure 3. Cusps of the flank denticles of *Squalus montalbani* (CSIRO H 2575–02, adult male 681 mm TL). Field of view width 1.0 mm.

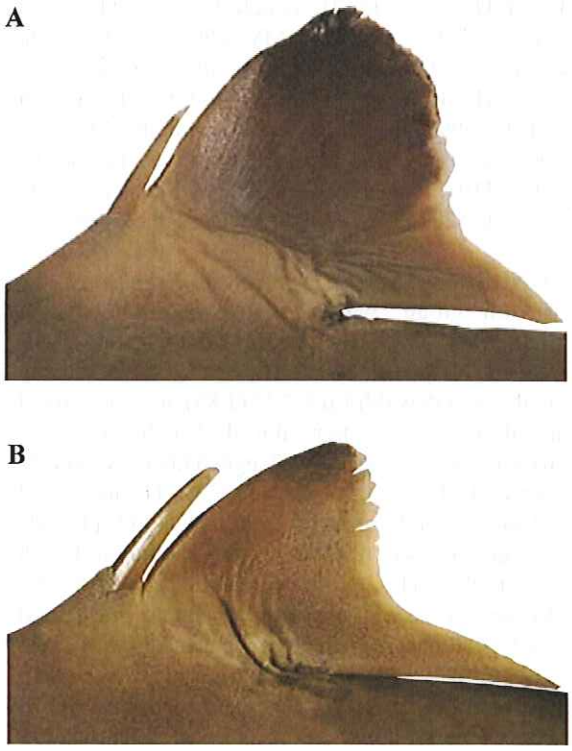

Figure 4. Lateral view of the dorsal fins of *Squalus montalbani* (CSIRO H 2575–02, adult male 681 mm TL) – A. first dorsal fin, B. second dorsal fin.

Table 2. Proportional dimensions as percentages of total length for *S. montalbani* from the Philippines including holotype (USNM 70256), Indonesia and Australia.

		Philippines			Indonesia			Australia		
			n = 2			n = 6			n = 6	
	Holotype	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
TL – Total length	311	607	520	694	719	564	843	707	557	825
PCL – Precaudal length	76.5	78.3	78.2	78.3	78.2	77.3	79.9	77.9	77.1	78.9
PD2 – Pre-second dorsal length	57.6	60.4	60.2	60.6	61.4	59.8	62.8	60.3	59.1	62.1
PD1 – Pre-first dorsal length	30.7	29.8	29.8	29.9	29.0	28.6	30.0	28.6	26.5	29.4
SVL – Pre-vent length	47.2	48.8	48.6	49.0	50.4	48.8	52.7	50.3	48.7	51.5
PP2 – Prepelvic length	43.8	48.1	47.7	48.4	48.7	47.2	50.8	48.7	47.5	50.5
PP1 – Prepectoral length	22.8	21.5	20.8	22.3	22.1	21.2	22.9	22.1	21.0	22.8
HDL – Head length	23.2	22.0	21.7	22.4	22.4	21.7	23.2	22.6	21.3	23.4
PG1 – Prebranchial length	20.3	18.2	17.9	18.4	18.7	17.6	19.3	19.2	18.3	19.7
PSP – Prespiracular length	13.4	11.6	11.3	11.8	12.0	11.4	12.5	12.7	11.9	13.6
POB – Preorbital length	7.1	6.9	6.8	7.1	7.4	6.7	7.7	7.7	7.3	8.1
PRN – Prenarial length	4.6	4.3	4.0	4.5	4.9	4.6	5.1	5.2	4.9	5.3
POR – Preoral length	10.1	9.0	8.7	9.4	9.6	9.2	10.2	10.0	9.3	10.6
INLF – Inner nostril-labial furrow space	5.3	4.3	4.2	4.5	4.6	4.5	4.9	4.7	4.5	4.9
MOW – Mouth width	6.5	7.7	7.6	7.8	7.5	7.1	7.8	8.0	7.5	8.5
ULA – Labial furrow length	2.5	2.2	2.2	2.2	2.2	1.9	2.5	2.2	2.1	2.2
INW – Internarial space	5.2	4.4	4.3	4.5	4.3	4.1	4.5	4.6	4.2	5.0
INO – Interorbital space	8.7	7.8	7.6	8.0	8.2	7.5	9.1	9.0	8.7	9.6
EYL – Eye length	4.3	4.0	3.8	4.2	4.9	4.8	5.2	4.2	4.0	4.6
EYH – Eye height	1.6	1.9	1.9	1.9	1.7	1.5	1.9	2.0	1.8	2.3
SPL – Spiracle length	1.5	1.3	1.3	1.3	1.7	1.5	1.8	1.7	1.6	1.9
GS1 – First gill-slit height	1.6	1.7	1.7	1.7	2.0	1.8	2.2	2.0	1.8	2.5
GS5 – Fifth gill-slit height	2.0	1.8	1.7	1.8	2.2	2.0	2.4	2.1	1.9	2.3
IDS – Interdorsal space	21.7	23.4	22.9	24.0	24.4	22.8	25.9	23.0	22.1	24.1
DCS – Dorsal-caudal space	11.2	10.1	9.7	10.4	10.6	9.7	11.2	10.4	9.9	10.6
PPS – Pectoral-pelvic space	18.9	22.4	21.9	22.9	23.0	19.8	25.1	23.0	22.2	25.4
PCA – Pelvic-caudal space	26.3	23.6	23.4	23.7	24.4	23.0	26.0	23.8	22.9	25.3
D1L – First dorsal length	14.2	13.5	13.0	14.0	14.2	12.8	15.1	14.9	14.5	15.9
D1A – First dorsal anterior margin	12.4	11.3	11.0	11.6	11.6	10.4	12.5	12.2	11.6	12.6
D1B – First dorsal base length	8.3	7.9	7.6	8.3	8.9	8.2	9.3	9.3	8.7	9.8
D1H – First dorsal height	6.1	6.5	6.5	6.6	6.3	5.7	6.7	6.8	6.4	7.4
D1I – First dorsal inner margin	6.2	5.6	5.5	5.8	5.5	4.9	6.2	5.8	5.1	6.8
D1P – First dorsal posterior margin	6.7	7.6	7.4	7.9	7.3	6.9	8.0	8.1	7.5	8.8
D1ES – First dorsal spine length	2.1	2.7	2.4	3.0	2.9	2.2	4.0	3.0	2.5	3.5
D1BS – First dorsal spine base width	0.7	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.5	0.6
D2L – Second dorsal length	13.4	12.3	11.4	13.2	11.8	11.1	12.6	13.0	12.2	13.9
D2A – Second dorsal anterior margin	10.2	9.8	9.2	10.3	8.9	8.5	9.4	10.0	9.0	10.8
D2B – Second dorsal base length	8.1	7.5	7.0	7.9	7.2	7.0	7.5	8.0	7.1	8.5
D2H – Second dorsal height	4.2	4.0	4.0	4.1	3.9	3.4	4.3	4.1	3.5	4.6
D2I – Second dorsal inner margin	5.9	4.8	4.3	5.3	4.5	4.0	5.1	5.1	4.7	5.7
D2P – Second dorsal posterior margin	5.2	5.1	5.0	5.1	5.3	4.5	6.0	5.7	5.0	6.3
D2ES – Second dorsal spine length	3.6	2.9	2.7	3.2	2.9	2.0	3.8	3.3	2.6	3.9
D2BS – Second dorsal spine base width	0.8	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.5	0.6

Table 1. cont'd.

		Philippines			Indonesia			Australia		
		n = 2			n = 6			n = 6		
	Holotype	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
P1A – Pectoral anterior margin	13.6	14.2	14.0	14.3	13.9	12.8	15.2	14.5	13.7	15.5
P1I – Pectoral inner margin	8.9	7.8	7.4	8.1	7.3	6.8	7.7	8.2	7.7	8.8
P1B – Pectoral base length	5.0	5.7	5.7	5.7	5.4	5.1	5.8	5.9	5.5	6.2
P1P – Pectoral posterior margin	9.6	10.8	10.8	10.8	10.0	8.5	11.4	11.0	9.1	11.8
P2L – Pelvic length	10.1	8.8	8.6	9.0	9.9	9.2	10.4	10.2	9.7	11.0
P2H – Pelvic height	3.3	4.7	4.6	4.8	4.1	3.6	4.5	4.5	4.3	4.8
P2I – Pelvic inner margin	3.7	3.9	3.6	4.3	4.9	3.9	5.9	4.9	4.4	5.6
CDM – Dorsal caudal margin	22.6	21.8	21.6	22.0	21.0	19.8	21.8	22.2	20.9	23.3
CPV – Preventral caudal margin	12.2	12.2	11.9	12.5	11.6	10.9	12.1	12.6	11.5	13.2
CPU – Upper postventral caudal margin	15.9	15.9	15.8	16.1	15.4	14.5	16.4	16.8	15.6	17.8
CPL – Lower postventral caudal margin	3.6	4.9	4.9	4.9	4.8	3.9	5.9	5.0	4.4	5.5
CFW – Caudal fork width	6.7	6.8	6.8	6.8	6.7	6.4	7.0	7.3	7.0	7.7
CFL – Caudal fork length	10.8	9.9	9.4	10.4	9.5	9.0	9.8	10.1	9.4	10.8
HANW – Head width at nostrils	7.7	7.5	7.1	7.8	7.2	7.0	7.4	8.1	7.5	8.7
HAMW – Head width at mouth	10.6	10.4	10.0	10.8	10.4	9.7	11.4	11.4	10.6	11.9
HDW – Head width	12.1	13.7	13.5	13.9	12.2	11.3	13.0	12.7	11.8	13.2
TRW – Trunk width	10.9	10.6	10.5	10.7	10.5	9.3	11.7	11.0	9.9	12.5
ABW – Abdomen width	8.2	8.9	8.9	9.0	10.3	8.1	12.6	10.7	8.9	13.2
TAW – Tail width	5.3	6.0	5.9	6.2	6.4	5.6	7.0	6.5	5.7	7.0
CPW – Caudal peduncle width	2.7	2.7	2.6	2.9	3.2	3.1	3.4	3.3	3.2	3.5
HDH – Head height	9.1	9.3	9.2	9.4	10.8	9.2	12.0	10.6	9.0	12.1
TRH – Trunk height	12.0	9.9	9.2	10.7	11.6	10.1	13.1	11.6	8.9	13.4
ABH – Abdomen height	12.6	10.6	10.2	10.9	11.3	9.3	13.0	11.8	9.5	12.9
TAH – Tail height	6.6	6.5	6.4	6.7	6.6	6.0	7.3	6.8	6.2	7.2
CPH – Caudal peduncle height	2.5	2.5	2.5	2.6	2.4	2.2	2.6	2.7	2.6	2.8
CLO – Clasper outer length	1.4	–	–	–	4.9	4.4	5.3	5.0	4.5	5.6
CLI – Clasper inner length	5.4	–	–	–	7.6	7.4	7.9	8.3	7.8	8.8
CLB – Clasper base width	0.8	–	–	–	1.6	1.4	1.9	1.5	1.4	1.7

of *S. montalbani* (41–47 monospondylous centra, 79–85 precaudal centra, 105–114 total centra, n=30).

Some minor differences exist between populations of *S. montalbani* across the Indo–West Pacific. Vertebral counts varied slightly between material from Indonesia (41–45 (mean 42.8) monospondylous centra, 79–83 (mean 80.5) precaudal centra, 105–111 (mean 107.6) total centra, n=12) and northern Australia (42–47 (mean 43.6) monospondylous centra, 81–85 (mean 83.1) precaudal centra, 110–114 (mean 112.2) total centra, n=14). Morphometrics from the three populations are reasonably consistent (Table 2) with minor variation in eye length, first dorsal-fin base length, pelvic-fin inner margin length, spiracle length, caudal peduncle width, and head width at the anterior nostrils. Indonesian material is darker in overall coloration than Australian material but the general morphology of specimens from both regions and the Philippines is similar.

Squalus chloroculus sp. nov.

Figs 6–10; Table 3

Squalus mitsukurii: (not Jordan and Snyder) Last and Stevens, 1994, *Sharks and Rays of Australia*, pp 49, 101, figs 8.24, 8.39, pl. 5; Gomon, Glover and Kuiter, 1994, *The Fishes of Australia's South Coast*, pp 105, 107, 108, figs 56, 57.

Holotype. CSIRO H 4775–01, adult male 753 mm TL, off Portland, Victoria, 38° S, 141° E, 17 April 1998.

Paratypes. 14 specimens. CSIRO CA 121, female 731 mm TL, off Ulladulla, New South Wales, 35°27′ S, 150°51′ E, 400 m; NMV A 29563–001, adult male

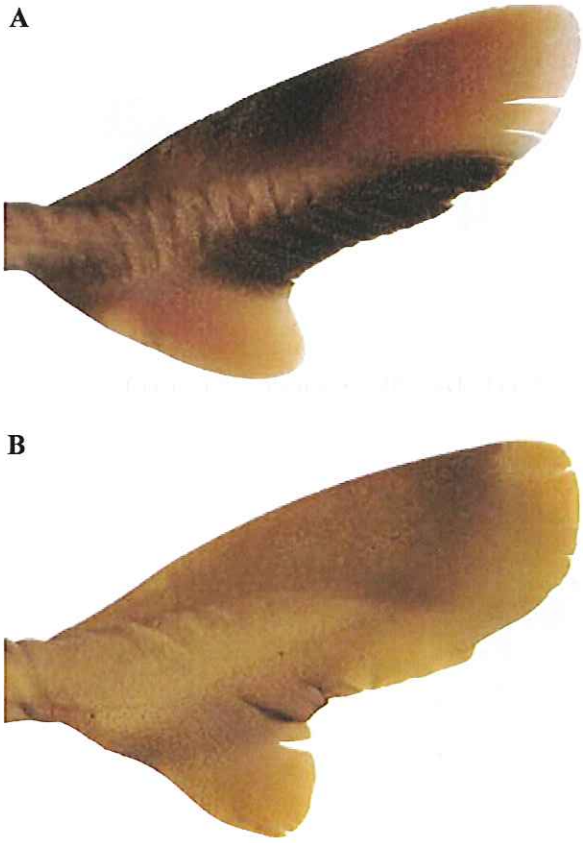

Figure 5. Juvenile coloration of the caudal fin of: A. *Squalus montalbani* (CSIRO H 1203–02, immature female 207 mm TL); B. *Squalus mitsukurii* paratype (CAS SU 7748, female embryo 237 mm TL).

856 mm TL, off St Helens, Tasmania, ca. 42° S, 148° E, 550 m; CSIRO H 5941–01, adult male 762 mm TL, west of Cape Sorell, Tasmania, 42°10′ S, 144°45′ E, 460 m; CSIRO H 1662–01, adult male 722 mm TL, east of Maria Island, Tasmania, 42°40′ S, 148°24′ E, 468 m; CSIRO H 1350–02, 4 embryos 217–238 mm TL, northwest of Macquarie Harbour, Tasmania, 41°52′ S, 144°23′ E, 1370 m; CSIRO H 1405–01, adult male 760 mm TL, south of King Island, Tasmania, 40°46′ S, 143°42′ E, 216 m; CSIRO H 2966–01, female 832 mm TL, Great Australian Bight, South Australia, 33°47′ S, 131° 27′ E, 780 m; CSIRO H 2867–02, adult male 733 mm TL, CSIRO H 2867–03, adult male 685 mm TL, CSIRO H 2867–04, female 797 mm TL, CSIRO H 2867–05, female 789 mm TL, Great Australian Bight, South Australia, 33°25′ S, 129°54′ E, 514 m.

DIAGNOSIS.— A large species of *Squalus* of the 'mitsukurii group' with the following combination of characters: body moderately robust, trunk depth 10.4–13.8%TL (mean 11.7%TL, n=9); snout broadly triangular, mouth width 1.72–2.48 (2.07) times horizontal prenarial length; pre-first dorsal length 29.2–31.8 (30.2)% TL; pre-second dorsal length 60.7–63.6 (61.7)% TL; interdorsal space 23.7–27.5 (24.9)% TL; low raked dorsal fins; second dorsal-fin length 10.9–12.2 (11.6)% TL, height 3.4–4.0 (3.7)% TL, inner margin length 3.9–5.0 (4.4)% TL; second dorsal-fin base 15.1–20.0 (17.2) times base of second dorsal spine; prepectoral length 21.1–24.3 (22.2)% TL; pelvic–caudal space 21.8–25.0 (23.5)% TL; caudal bar almost upright, extending broadly from the caudal fork up the posterior margin of the upper lobe for 0.6–0.7 of its length in immatures, upper caudal fringe forming a narrow saddle along mid-length of lobe; flank denticles tricuspid; 43–46 monospondylous centra, 84–86 precaudal centra, 111–115 total centra; adult maximum size at least 85 cm TL.

DESCRIPTION.— Body fusiform, moderately elongate to robust, nape prominently humped; deepest near first dorsal-fin spine, maximum depth 0.89 (0.88–1.13 in paratypes) times width; trunk depth 1.03 (0.98–1.11) times abdomen depth; head moderately elongate, 23.0 (22.1–23.8)% TL; caudal peduncle robust, 24.0 (21.8–25.0)% TL. Head robust, rather broad, width 1.12 (1.07–1.32) times trunk width, 1.30 (1.05–1.37) times abdomen width, slightly depressed forward of spiracles, becoming subtriangular in cross-section towards pectoral-fin origin, length 2.21 (2.15–2.33) in pre-vent length; height 0.77 (0.67–0.85) times width. Snout moderately elongate, narrowly triangular in lateral view, apex bluntly pointed, lateral prenarial margin weakly angular; narrowly pointed in dorsal view, horizontal length 1.64 (1.61–1.62) times eye length, 0.90 (0.76–0.81) times interorbital space; horizontal prenarial length 2.20 (2.16–2.23) times in preoral length. Eye oval, of moderate size, length 5.25 (4.98–5.37) in head, 2.13 (1.90–2.20) times height; strongly notched posteriorly, notch deep anteriorly, becoming shallow near anteroventral margin of spiracle (not connected to spiracle in some paratypes). Spiracle moderate, broadly crescentic but variable; broad, lobe-like fold on posterior margin; greatest diameter 2.68 (2.22–3.69) in eye length. Gill openings almost upright, first 4 subequal in size, fifth longest, height of fifth slit 2.1 (1.9–2.5)% TL. Mouth almost transverse, upper jaw weakly concave, width 1.28 (1.09–1.30) in preoral length; prominent postoral groove, much longer than upper labial furrows (rarely subequal), extending posterolaterally from angle of jaws; 1 (1–2) series of functional teeth in upper jaw, 2 (2–3) series in lower. Teeth similar in upper and lower jaws; upper teeth unicuspid, interlocking, blade-like, cusps directed strongly laterally, low, base of tooth broader than length of cusp. Nostrils small, almost transverse; anterior nasal flap weakly bilobed or single-lobed; anterior lobe large, narrowly rounded, subtriangular (flattened in some paratypes); posterior lobe of nasal flap either indistinguishable, rudimentary or weak in paratypes (sometimes variable within an individual); internarial space 2.23 (2.93–2.21) in preoral length, 2.65 (2.48–2.83) times nostril length. Dermal denticles (based on adult male CSIRO H 1405–01) on flank very small, strongly imbricate, tricuspidate; crown broad with pronounced median ridge; median ridge

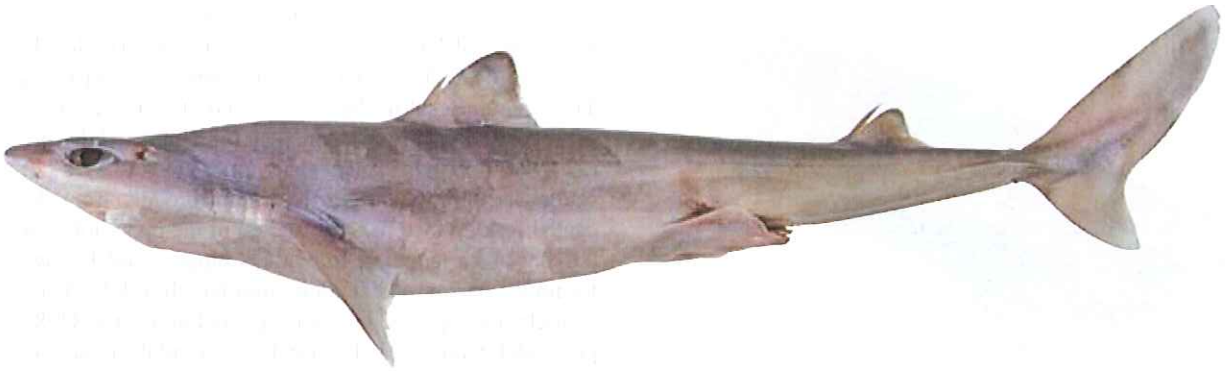

Figure 6. Lateral view of *Squalus chloroculus* sp. nov. holotype (CSIRO H 4775–01, adult male 753 mm TL).

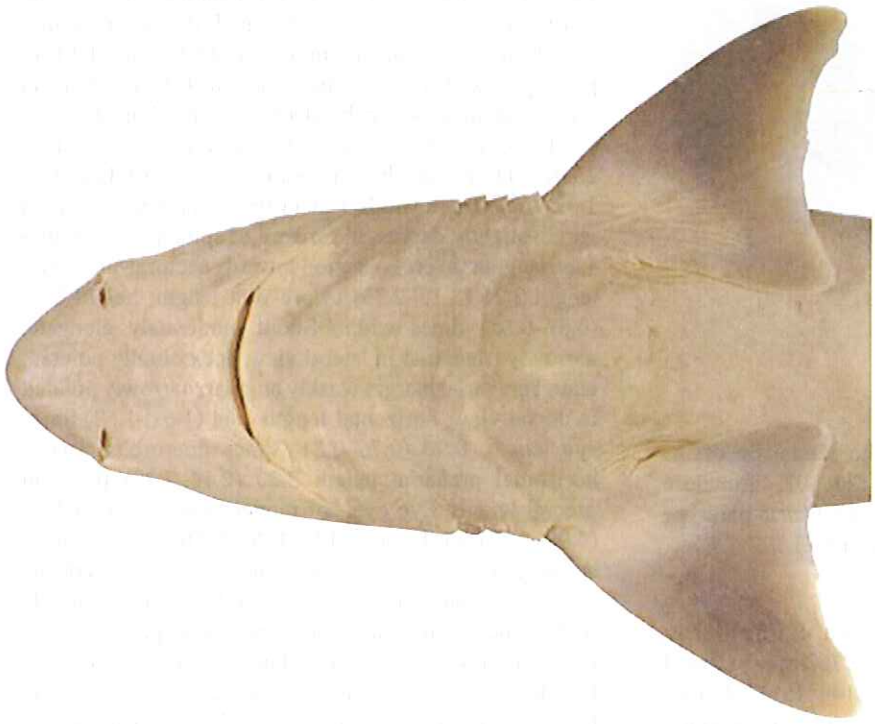

Figure 7. Ventral view of the head of *Squalus chloroculus* sp. nov. holotype (CSIRO H 4775–01, adult male 753 mm TL).

commencing well anterior of rest of crown, with a mesial furrow developing anteriorly and converging towards posterior tip of crown; distal ridge extending laterally along crown, lateral cusps short or variably developed, low, weak, with very narrow mesial furrow. First dorsal fin small, low, strongly raked, very broadly rounded apically; anterior margin strongly convex; posterior margin weakly concave, upper portion subvertical (usually directed slightly or strongly anterodorsally from bottom to top in paratypes); lower half almost straight or weakly concave; free rear tip relatively thick basally, very short; inner margin of fin almost straight; insertion of base extremely well forward of pelvic-fin origin, well posterior to free rear tip of pectoral fin; fin-spine origin slightly posterior to pectoral-fin insertion (more posterior in some paratypes); spine base moderately broad, 0.7 (0.6–0.8)% TL, exposed anteriorly well below junction of spine and soft portion of fin; soft portion of fin connected well above mid-point of total spine length (spine often damaged); spine tapering distally (often abraded apically), anterior margin almost straight; exposed portion only slightly raked, much shorter in length than exposed portion of second dorsal-fin spine (also marginally abraded apically); pre-first dorsal length 3.43 (3.15–3.42) times in TL; first dorsal-fin length 2.41 (2.14–2.41) times its height, 1.25 (1.17–1.26) times second dorsal-fin length; first dorsal-fin height 1.50 (1.59–1.78) times second dorsal-fin height; exposed first dorsal spine length 0.56 (0.39–0.50) times height of fin. Second dorsal fin small, strongly raked; anterior margin

Table 3. Proportional dimensions as percentages of total length for the holotype (CSIRO H 4475–01) and ranges for the 9 paratypes of *Squalus chloroculus* sp. nov.

	S. chloroculus sp. nov.			
		Paratypes		
	Holotype	Min.	Max.	Mean
TL – Total length	753	721	856	783
PCL – Precaudal length	78.8	77.9	79.7	78.6
PD2 – Pre-second dorsal length	61.8	60.7	63.6	61.7
PD1 – Pre-first dorsal length	29.2	29.3	31.8	30.2
SVL – Pre-vent length	50.7	49.5	52.1	50.8
PP2 – Prepelvic length	49.0	47.9	51.0	49.3
PP1 – Prepectoral length	22.3	21.1	24.3	22.2
HDL – Head length	23.0	22.0	23.8	22.7
PG1 – Prebranchial length	19.4	18.5	20.1	19.2
PSP – Prespiracular length	13.0	12.3	13.6	12.8
POB – Preorbital length	7.5	7.5	8.1	7.7
PRN – Prenarial length	5.3	4.7	5.3	5.0
POR – Preoral length	9.9	9.5	10.1	9.8
INLF – Inner nostril-labial furrow space	5.0	4.4	4.9	4.7
MOW – Mouth width	7.7	7.7	9.1	8.1
ULA – Labial furrow length	2.4	2.0	2.5	2.3
INW – Internarial space	4.5	4.5	5.1	4.8
INO – Interorbital space	8.0	8.3	9.5	8.8
EYL – Eye length	4.4	4.3	4.5	4.4
EYH – Eye height	2.1	2.0	2.3	2.2
SPL – Spiracle length	1.6	1.2	2.0	1.5
GS1 – First gill-slit height	1.9	1.7	2.8	2.1
GS5 – Fifth gill-slit height	2.1	1.9	2.5	2.2
IDS – Interdorsal space	25.2	23.7	27.5	24.9
DCS – Dorsal-caudal space	10.2	9.3	10.7	10.1
PPS – Pectoral-pelvic space	24.0	21.6	25.2	23.2
PCA – Pelvic-caudal space	24.0	21.8	25.0	23.5
D1L – First dorsal length	14.5	13.1	14.8	14.2
D1A – First dorsal anterior margin	12.2	10.6	12.5	11.5
D1B – First dorsal base length	9.3	8.1	9.6	8.7
D1H – First dorsal height	6.0	5.9	6.8	6.2
D1I – First dorsal inner margin	5.3	5.1	6.1	5.4
D1P – First dorsal posterior margin	6.7	6.8	8.2	7.4
D1ES – First dorsal spine length	3.4	2.3	3.3	2.9
D1BS – First dorsal spine base width	0.7	0.6	0.8	0.7
D2L – Second dorsal length	11.6	10.9	12.2	11.6
D2A – Second dorsal anterior margin	8.9	8.0	9.6	8.9
D2B – Second dorsal base length	7.4	6.5	7.4	7.2
D2H – Second dorsal height	4.0	3.4	3.9	3.7
D2I – Second dorsal inner margin	4.5	3.9	5.0	4.4
D2P – Second dorsal posterior margin	5.1	4.8	6.1	5.2
D2ES – Second dorsal spine length	4.0	2.5	3.9	3.2
D2BS – Second dorsal spine base width	0.7	0.6	0.8	0.7

Table 1. cont'd.

	S. chloroculus sp. nov.			
		Paratypes		
	Holotype	Min.	Max.	Mean
P1A – Pectoral anterior margin	14.9	13.7	16.9	14.9
P1I – Pectoral inner margin	7.6	7.0	8.6	7.8
P1B – Pectoral base length	5.4	5.1	6.0	5.6
P1P – Pectoral posterior margin	11.0	10.2	12.8	11.2
P2L – Pelvic length	10.5	9.2	10.5	9.8
P2H – Pelvic height	5.1	4.4	5.4	5.0
P2I – Pelvic inner margin	5.3	1.9	4.6	3.3
CDM – Dorsal caudal margin	20.9	19.2	21.7	21.0
CPV – Preventral caudal margin	12.2	11.0	12.8	11.7
CPU – Upper postventral caudal margin	15.8	14.7	16.5	15.8
CPL – Lower postventral caudal margin	5.1	5.2	6.3	5.5
CFW – Caudal fork width	7.1	6.6	7.2	7.0
CFL – Caudal fork length	9.5	9.1	9.7	9.4
HANW – Head width at nostrils	7.9	7.6	8.5	7.9
HAMW – Head width at mouth	11.1	10.8	12.5	11.6
HDW – Head width	13.3	12.7	14.9	13.7
TRW – Trunk width	11.8	10.5	13.0	11.7
ABW – Abdomen width	10.2	10.1	13.2	11.5
TAW – Tail width	6.1	4.8	7.3	6.3
CPW – Caudal peduncle width	3.3	3.0	3.7	3.2
HDH – Head height	10.2	9.4	11.5	10.3
TRH – Trunk height	10.5	10.4	13.8	11.7
ABH – Abdomen height	10.3	10.1	13.5	11.5
TAH – Tail height	6.4	6.0	6.8	6.4
CPH – Caudal peduncle height	2.7	2.3	2.6	2.5
CLO – Clasper outer length	3.8	4.1	4.6	4.3
CLI – Clasper inner length	7.2	6.9	8.8	7.7
CLB – Clasper base width	1.5	1.5	1.7	1.6

convex, apex broadly rounded; posterior margin strongly concave, maximum concavity just above mid-point of margin (variable in paratypes), upper portion almost vertical (directed slightly dorsoposteriorly in paratypes CSIRO H 2867–05 and H 2966–01); free rear tip very elongate, inner margin length 1.12 (1.06–1.39) times fin height; second dorsal-fin length 2.89 (2.97–3.44) times its height; spine length 1.01 (0.68–1.06) in height of fin; fin-spine origin well behind free rear tip of pelvic fin, exposed near level of junction with spine and soft portion of fin (connected slightly above in some paratypes); second spine moderately broad based, 0.7 (0.6–0.8)% TL, sharply pointed distally when undamaged, usually abraded; spine tip when undamaged extending to about level of insertion of fin; soft portion and spine apices subequal in height; interdorsal space 0.89 (0.81–0.99) in length from snout tip to pectoral-fin origin, 1.16 (1.10–1.30) in pre-first dorsal length; interdorsal ridge rudimentary or absent, more obvious posteriorly. Pectoral fin large, more so in large females (anterior margin 15.7–16.9% TL, n=3) than males (anterior margin 13.7–14.9% TL, n=7 inc. holotype), anterior margin weakly convex; inner margin moderately convex, length 7.6 (7.0–8.6)% TL; apex narrowly rounded (variable in some male paratypes, significantly broader), weakly lobe-like and not falcate; posterior margin weakly to moderately concave; free rear tip narrowly rounded to weakly angular; base very short, 2.76 (2.35–3.08) in length of anterior margin. Pelvic fins large, subtriangular, anterior and posterior margins almost straight, apex broadly rounded, free rear tip acute. Clasper extending well beyond free rear tip of pelvic fin. Tail long, subcircular in cross-section anteriorly,

tapering slightly to second dorsal fin, beyond second dorsal fin tapering more rapidly, moderately depressed, broadly semicircular posteriorly; ventral groove well developed, broad, shallow, with obvious medial ridge (better developed posteriorly); lateral keels very well developed, originating under (or slightly posterior to) insertion of second dorsal fin, terminating about half an eye diameter behind caudal-fin insertion; pelvic–caudal space 1.00 (0.94–1.11) in pectoral–pelvic space, 0.93 (0.87–1.11) in prepectoral length; dorsal–caudal space 2.46 (2.31–2.65) in interdorsal length; dorsal caudal pit well developed, ventral caudal pit moderate to weak. Caudal fin relatively long; upper lobe relatively broad, tip narrowly rounded, postventral margin weakly convex (much more pronounced in CSIRO H 5941–01); lower lobe acute (more broadly rounded in CSIRO H 1662–01); dorsal caudal margin 1.10 (1.03–1.16) in head length; length of lower caudal lobe 1.71 (1.66–1.89) in upper lobe length. Vertebral centra 114 (111–115 in 7 paratypes), monospondylous 43 (43–46), precaudal 84 (84–86) and caudal 30 (27–30). Teeth in upper jaw (in paratype CSIRO H 1662–01) 14+15=29, lower jaw 12+12=24.

COLOUR.— When fresh (based on holotype): rather uniformly greyish; undersurface of head paler grey, light and dark tonal areas sharply demarcated, significantly paler ventrally from snout to outer edge of spiracle, along subocular ridge to mid-gill slits; rest of belly paler than dorsal surface, almost white. Dorsal fins mostly pale grey, distinct blackish margin extending from above fin spine and along outer margin to notch in posterior margin (some variation as dark margin not obvious in some paratypes). Second dorsal fin similar with variable defined blackish extremity; no obvious pale areas at anterior base of fins; fin spines pale, greyish brown to opaque white. Caudal fin mostly greyish; broad dark area at notch, extending dorsally for slightly longer than an eye diameter along upper postdorsal margin (usually to a position demarcated by a line through the tail vertebrae where it meets the upper posterior caudal margin); tip of upper lobe and upper posterior margin pale; outer margin of lower lobe pale. Pectoral fin upper surface greyish with narrow pale posterior margin and apex; ventral surface paler, with less well demarcated outer margin. Pelvic fin upper surface similar to upper surface of pectoral fin; posterior margin strongly demarcated pale; ventral surface uniformly pale. Claspers mostly pale, basal dorsal half of clasper greyish. Eye greenish in life, otherwise bluish black. In preservative (based on holotype): similar, more uniformly medium grey above; ventral surface somewhat mottled, slightly paler grey; undersurface of snout off-white, to mottled grey. Pectoral and pelvic fins greyish dorsally with slightly paler posterior margins. Late embryo paratypes from Tasmania (CSIRO H 1350–02, Fig. 10) with more strongly demarcated pale and dark tonal areas on head; apical two-thirds of dorsal fins black, anterior basal half of fins and free rear tip white; skin on anterior dorsal-fin spines blackish. Caudal fin pattern strong, black and white; broad black caudal bar over caudal fork, extending up the dorsal lobe for more than half its length (as a posterior projection of distal part of fleshy portion of fin), then extending slightly above fleshy portion to join large, diffuse-edged, black blotch on central anterior portion of upper lobe; large black blotch at base of lower lobe narrowly connected to caudal bar below fleshy portion of fin; apical third of upper lobe and most of ventral lobe vivid white.

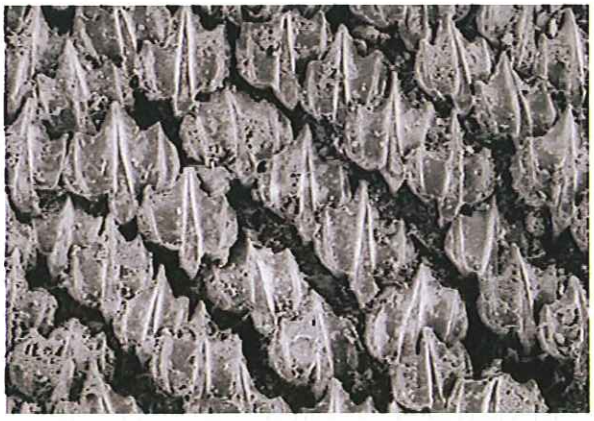

Figure 8. Cusps of the flank denticles of *Squalus chloroculus* sp. nov. paratype (CSIRO H 1405–01, adult male 760 mm TL). Field of view width 1.3 mm.

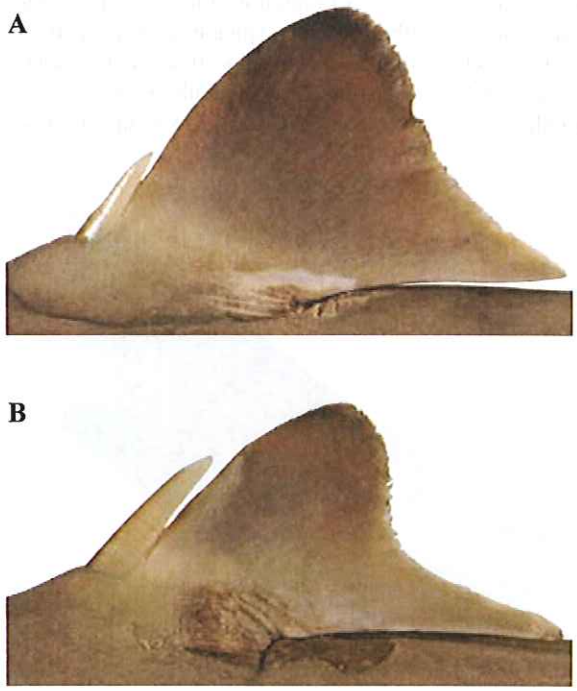

Figure 9. Lateral view of the dorsal fins of *Squalus chloroculus* sp. nov. paratype (CSIRO H 5941–01, adult male 762 mm TL) – A. first dorsal fin, B. second dorsal fin.

SIZE.— Females and males reach at least 832 (paratype) and 856 mm TL (paratype), respectively; males mature by 685 mm TL.

DISTRIBUTION.— Upper to mid continental slope off southern Australia from New South Wales (ca. 35° S) to the Great Australian Bight (33° S, 129° E). Known from depths of 216–1360 m.

ETYMOLOGY.— Derived from the Greek *choloros* meaning 'green' and the Latin *oculus* meaning 'eye' in allusion to the vivid green eyes evident on this species when fresh.

VERNACULAR.— Greeneye Spurdog.

REMARKS.— *Squalus chloroculus* differs from *S. montalbani* in the structure of the CO1 gene (see Ward *et al.*, 2007, Part 12) but the two species are very similar morphologically. Minor differences in coloration were detected in Australian 'mitsukurii'-like spurdogs during investigations for the Australian shark and ray guide (Last and Stevens, 1994) but these forms were provisionally grouped under *S. mitsukurii*. Three shape characters distinguish Australian populations of the two species: pre-first dorsal length 2.41–2.77 vs. 1.91–2.41 times second dorsal-fin length in *S. montalbani*; horizontal pre-second dorsal length 5.03–5.81 vs. 4.20–4.92 times second dorsal-fin length; and second dorsal-fin length 10.9–12.2 vs. 12.2–13.9% TL. In addition, *S. chloroculus* has smaller dorsal fins (the mean values for all 6 measurements of both dorsal fins are higher for *S. montalbani*) with broader fin spine bases (means 0.68 vs. 0.58% TL for first dorsal-fin spine, 0.68 vs. 0.60% TL for second dorsal-fin spine), shorter adult claspers (outer length 3.8–4.6, mean 4.3% TL vs. 4.5–5.6, mean 5.0% TL), and the upper postventral caudal margin is short relative to the lower postventral margin (ratio 2.54–3.15, mean 2.88 vs. 2.92–3.89, mean 3.36). Vertebral counts are very similar, with *S. chloroculus* having a marginally higher average precaudal count (84–86, mean 84.8, n=8 vs. 81–85, mean 83.1, n=14). *Squalus chloroculus* differs from *S. mitsukurii* in caudal fin coloration (caudal bar upright and marginal rather than oblique) and by having slightly lower vertebral counts (43–46 vs. 45–51 monospondylous centra, 84–86 vs. 87–93 precaudal centra, 111–115 vs. 118–127 total centra).

Figure 10. Juvenile coloration of the caudal fin of *Squalus chloroculus* sp. nov. paratype (CSIRO H 1350–02, immature male 225 mm TL).

Squalus chloroculus displays some intraspecific variability in shape. A large adult male paratype from off St Helens, Tasmania (NMV A 29563–001), has a much broader upper caudal lobe, more broadly rounded lower caudal lobe, more robust head, and is more uniformly dark ventrally and dorsally than other types. Its pectoral fin is also less falcate with a more broadly rounded apex.

Other material.

Squalus mitsukurii: SU 7184 (paratype), immature male 266 mm TL, SU 7748 (paratypes), 5 of 8 embryos examined 228–237 mm TL, SU 12793 (holotype), 719 mm TL, Misaki, Honshu Island, Japan; HUMZ 79797, female 855 mm TL, HUMZ 79798, female 854 mm TL, Kyushu–Palau Ridge, Japan, 320–640 m; HUMZ 101719, adult male 657 mm TL, northwest of Okinawa, Japan.

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