

Redescription of two species of wobbegongs (Chondrichthyes: Orectolobidae) with elevation of *Orectolobus halei* Whitley 1940 to species level

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Abstract

Two closely related species of the genus *Orectolobus* (Orectolobidae), *O. ornatus* (De Vis) and *O. halei* Whitley, are redescribed based on fresh material from temperate eastern Australia. Although described as a subspecies by Whitley (1940), *O. halei* was formerly synonymized with *O. ornatus* because of the lack of research material to assess their conspecificity. Due to its smaller size, *O. ornatus* was previously thought to be the juvenile form of the larger *O. halei*. *Orectolobus ornatus* occurs from Port Douglas, (Queensland) to Sydney (New South Wales) whereas *O. halei* occurs from Southport (Queensland) around the southern coast to Norwegian Bay (Western Australia). Both species are commercially targeted within the hook and line fishery off New South Wales. *Orectolobus ornatus* differs from *O. halei* in color pattern, a smaller adult size, fewer dermal lobes at the posterior preorbital group, lower vertebral and spiral valve counts, and the absence of supraorbital knob. Morphometrically, *O. ornatus* has a longer pelvic fin to anal fin interspace, smaller pectoral fins, smaller head dimensions, and relatively smaller claspers in mature specimens.

Key words: Orectolobidae, *Orectolobus ornatus*, *Orectolobus halei*, redescription, NSW

Introduction

Wobbegong sharks (family Orectolobidae Gill 1896) are bottom-dwelling sharks found in warm temperate to tropical continental waters of the western Pacific (Compagno 2001). They can be distinguished from all other sharks (except angel sharks, family Squatinidae) by their flattened and variegated bodies, and from all other elasmobranchs by possessing dermal lobes along the sides of the head. Wobbegongs also have a short, nearly terminal mouth in front of the eyes, nasoral grooves, circumnarial grooves and flaps, symphyseal grooves, large spiracles and dorsolateral eyes (Compagno 2001).

The family currently comprises seven valid species that are divided into three recognized genera: *Eucrossorhinus* consisting of *E. dasyopogon* (Bleeker 1867); *Orectolobus* consisting of *O. japonicus* Regan 1906, *O. maculatus* (Bonnaterre 1788), *O. ornatus* (De Vis 1883), *O. wardi* Whitley 1939, and *O. hutchinsi* Last *et al.* 2006; and *Sutorectus* consisting of *S. tentaculatus* (Peters 1864). The systematics of the family is not fully resolved and two new species of wobbegongs from Western Australia have recently been identified (P. Last and J. Chidlow personal communication). Furthermore, new material from Indonesia (W. White personal communication), Borneo (Manjaji 2002) and the Philippines (Compagno *et al.* 2005) suggests that additional species exist in the Indo-West Pacific.

Two species, *O. ornatus* and *O. maculatus*, are thought to occur off temperate eastern Australia, but it has been suggested that other closely related species-level taxa may also be present. Whitley (1940) described the subspecies *O. ornatus halei*, from southern Australia and distinguished it from *O. ornatus ornatus* from northeastern waters by “differences in its color pattern and in the form of the tentacles around the head”. No further description was given by Whitley apart for the size of the holotype of 288.3 cm. Furthermore, some specimens of *O. ornatus* are mature at 70–80 cm total length (TL) which is considerably smaller than the normal size of maturity at about 175 cm TL (Last and Stevens, 1994; Chidlow, 2001). This discrepancy between ‘small’ and ‘large’ morphs of *O. ornatus* was observed by Last and Stevens (1994) but they could not resolve the alpha taxonomy because of the paucity of research material. The small morph has since been observed mating (S. Hartley 2004 personal communication), and small pregnant females are regularly caught in the targeted wobbegong commercial fishery (Huveneers unpublished data). Apart from these reports, there has been no positive evidence to support the existence of a third species off eastern and southern Australia. The original description of *O. ornatus halei* was inadequate and it has subsequently been considered as a synonym of *O. ornatus* (Compagno 2001).

Wobbegongs have been targeted off the eastern Australian state of New South Wales (NSW) by commercial fishers for at least 15 years. However, catches have declined over the past decade leading to public concern about the potential impact of the fishery on wobbegong populations (NSW Department of Primary Industries 2001). There are minimal management strategies specifically regulating wobbegong fisheries in NSW. Those currently in place directly applying to wobbegongs are a recreational bag limit of two wobbegongs per day, gear limit of no more than ten lines each with a maximum of six hooks when setlining within three nautical miles of the coast, and the *defacto* protection given to shared critical habitats with grey nurse shark (*Carcharias taurus*). The lack of specific strategies directed at wobbegong commercial fishing and the decline in catches, has resulted in *O. ornatus* and *O. maculatus* being listed as ‘Vulnerable’ in the IUCN Red List in NSW and as ‘Near Threatened’ globally (Cavanagh *et al.* 2003). NSW Department of Primary Industries (NSW DPI) has expressed the need for appropriate management to ensure the viability of wobbegong populations in NSW (NSW DPI 2001). Suitable

regulations require knowledge of all wobbegongs species marketed in NSW, especially if the sizes at maturity and reproductive biology differ between those species. Consequently, the subspecies needed to be investigated to help distinguish them and assess their conspecificity. These taxa are shown to be non-conspecific and both taxa are fully described below. A taxonomic key to *Orectolobus* species in NSW is also provided.

Material and methods

Morphometrics followed Compagno (1984, 2001), with additional measurements taken to incorporate the different morphology of orectolobids. Dermal lobe measurements followed Last *et al.* (2006). Additionally, the distance between the nasal barbel and the anterior preorbital group (nasal-preorbital space), as well as the distance between the preorbital groups (preorbital space), were also measured. Several new head measurements were also measured to account for subtle differences in head morphology: head height at eye level (HDHe) (Fig. 1), head width at anterior of spiracle level (HDWs), head width at anterior of posterior preorbital lobes (HDWpo), and head width at nasal barbel level (HDWn) (Fig. 2). Caudal fin measurements varied from Compagno (2001) due to the difference in shape compared with carcharhinid sharks (Fig. 3). Counts and measurements for the holotype are given first, followed by ranges of all specimens examined. Meristics were taken from X-rays. Tooth row counts, which are difficult to obtain from radiographs, were taken directly from specimens. Spiral valve whorl counts were obtained from dissecting other specimens collected at the same locations as registered specimens.

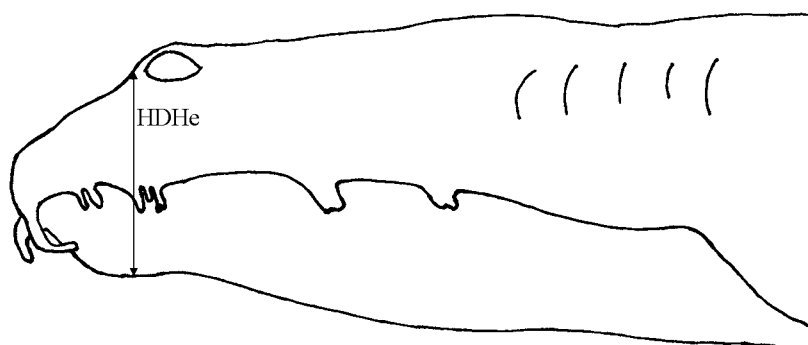


FIGURE 1. Lateral view of *Orectolobus ornatus* showing new head height measurement (HDHe: head height at eye level).

New material of the large morph were collected by NSW commercial fishers targeting wobbegongs using setlines off Sydney (34° 14S, 151° 04E). Specimens of the small morph were caught using a handnet (under NSW Fisheries permit number P03/0057) using SCUBA off Tomaree Head, Port Stephens (32° 43S, 152° 11E). The holotype of *O. ornatus* is held at the Queensland Museum (QM) and the newly designated neotype of

O. halei was deposited at the Australian Museum (AMS). Other new material was dispersed between the AMS and the Australian National Fish Collection (CSIRO). Additional specimens were examined at the AMS, CSIRO and QM. Other institutional abbreviations follow Leviton *et al.* (1985).

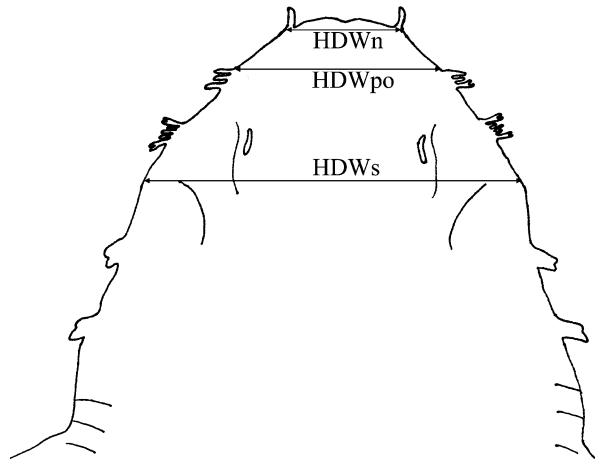


FIGURE 2. Dorsal view of *Orectolobus halei* showing new head width measurements (HDWs: head width at anterior of spiracle level; HDWpo: head width at anterior of posterior preorbital lobes level; HDWn: head width at nasal barbel level).

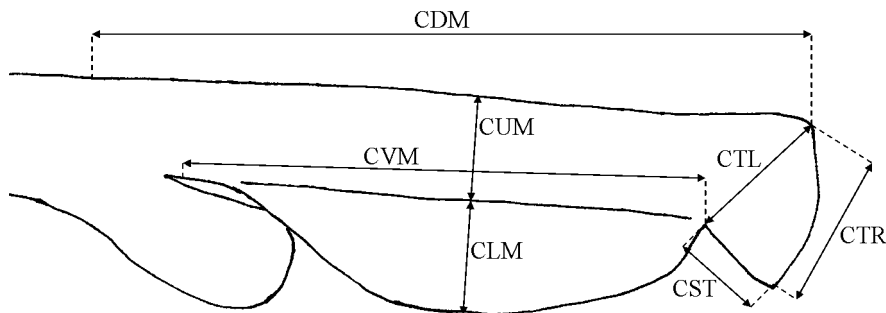


FIGURE 3. Lateral view of caudal fin showing measurements (CDM: dorsal caudal fin margin; CVM: ventral caudal fin margin; CUM: upper caudal fin margin; CLM: lower caudal fin margin; CTL: terminal caudal fin margin; CST: subterminal caudal fin margin; CTR: terminal caudal fin margin).

Results

Orectolobus halei Whitley, 1940

(Figs. 4–6, Table 1–2)

Material examined

Holotype. SAMA 2883 mm TL female (cast), type locality: St. Vincent Gulf, South

Australia. Lost according to Eschmeyer (CD-Rom, 1998).

Neotype (designated herein). AMS I 43628-002, 1700 mm TL, mature male, longline, type locality: the Hump, 3.3 nautical miles offshore between Garie Beach and Wollongong, 34° 14S, 151° 04E, 20–35 m, 9th June 2005, collector Charlie Huveneers and Jason Moyce.

Other specimens examined. AMS I43628-001, 1285 mm TL, female; CSIRO H 6278-01, 1775 mm TL, female; CSIRO H6278-02, 1869 mm TL, mature male; AMS I43628-003, 1520 mm TL, immature male. All four specimens collected using longline at the Hump, 3.3 nautical miles offshore between Garie Beach and Wollongong, 34° 14S, 151° 04E, 20–35 m, 9th June 2005, collector Charlie Huveneers and Jason Moyce. AMS I43629-001, 1140 mm TL, immature male, setline, Merimbula 50–100m from shore, 36° 54S, 149° 57E, 10–20 m, 24th April 2005, collector Charlie Huveneers, Shannon Corrigan and Shannon Fantham.

Diagnosis

A large species of *Orectolobus* with the following combination of characters: no warty tubercles on head or body; four groups of dermal lobes below and in front of eyes on each side of head; no dermal lobes on chin; nasal barbel closest to mouth branched; five to six lobes in second preorbital group (rarely four) with lobes at extremities usually longer and branched; broad branched postspiracular groups; two supraorbital knobs; base of anterior postspiracular lobe 3.28–3.69 in its distance from postorbital group, 1.36–2.36 in its distance from posterior postspiracular lobe; pelvic-fin insertion at first dorsal-fin midpoint; prepelvic length 2.40–3.13 times pelvic-anal space; pelvic-caudal space 1.04–1.25 times trunk width; teeth in upper jaw 25–28, those in medial row at symphysis rudimentary; spiral valve turns 29–32; precaudal vertebrae count 108–112. Light and dark brown coloration with nine darker brown, blotch-shaped saddles located dorsally; each saddle has conspicuous black edges.

Description

Body depressed anteriorly from snout to pelvic-fin origin, slightly firm dorsal musculature with relatively flaccid flanks; trunk depressed, broadest over midtrunk; body shape changing from depressed to compressed and tapering from pelvic-fin origin; dorsal musculature slightly elevated from flank musculature forming a small ridge from the fifth gill slit to pelvic-fin insertion, decreasing anteriorly to first dorsal-fin origin. Head broad, strongly depressed, somewhat oval in cross-section with truncate anterior when viewed from above, length 21.4 (21.0–21.8) % TL, 2.08 (2.08–2.76) times second dorsal-fin origin to anal-fin origin, height at gill level 8.5 (7.3–9.1) % TL, 1.74 (1.33–1.74) in pelvic-fin midpoint to first dorsal-fin insertion; trunk width 21.7 (20.4–23.0) % TL; abdomen elongate, width 5.94 (5.26–6.34) % TL. Pectoral-pelvic space 19.3 (16.8–21.9) % TL, 0.90 (0.73–1.00) times head length; pelvic-anal space 2.10 (1.93–2.50) times anal-fin base; snout-vent length 0.99 (0.99–1.04) times vent-caudal length. Caudal peduncle absent,

lower origin of caudal fin almost connected to anal-fin insertion, strongly compressed, oval in cross section at anal-caudal junction, caudal peduncle width 1.59 (1.33–1.64) in height.

A



B



C



FIGURE 4. Photographs of neotype *Orectolobus halei* AMS I 43628-002, 1700 mm TL, mature male: A) lateral view; B) dorsal view; and C) ventral view.

Snout short, narrowly rounded in lateral view, truncate in dorsoventral view, slightly rounded angles; preoral length 0.8 (0.8–1.2) % TL, 12.50 (8.33–12.50) in mouth width; prenarial length negligible. Eyes dorsal on head, small, slit-like, length 1.7 (1.5–1.8) % TL, 12.35 (12.35–12.99) in head length; supraorbital crest elevated over and behind eye; two knobs on supraorbital crest, posterior knob longer; weak supraorbital ridge extending above spiracle; subocular pocket 2.26–2.70 times eye length; interorbit weakly concave. Spiracles slit-like, oblique to horizontal axis, longer than eye, 1.99 (1.91–2.29) times eye length; anterior margin convex well elevated above weakly convex posterior margin; small eye spiracle space 0.4 (0.3–0.6) % TL; fold above spiracle anterior margin. Gill slits lateral on head, first three of similar length (2.2–3.0 % TL), fourth gill slit smaller, 0.94 (0.82–1.01) times third gill slit, last gill slit longest 1.17 (1.00–1.27) times first; last gill slit anterior to pectoral-fin midbase; pectoral-fin origin between second and third gill slit. Mouth subterminal, large 3.1 (2.9–3.3) % TL, horizontally expanded, broadly arched, width 10.7 (9.6–10.7) % TL, 3.47 (2.96–3.47) times its length, 4.76 (4.76–5.26) in vent to caudal length; 0.96 (0.83–1.09) times dorsal-fin midpoint to pelvic-fin origin; upper labial furrows 4.3 (4.1–4.9) % TL, originating at ventral margin of nostrils; lower labial furrows longer 5.4 (4.6–5.5) % TL, almost connected near symphysis of lower jaw. Nostrils small, widely separated, internarial space 5.4 (4.5–5.4) % TL, adjacent upper lip of mouth. Nasal barbel terminal on head, medial to nostrils, proboscis-like, rounded basally, tapering distally, length less than upper labial furrows; short flattened branched lobe at basal third of posterior margin; lateral nasal lobe broad, well elevated, subcircular, most expanded posteriorly.

Fang-like teeth relatively large, long and pointed, not exposed when mouth closed. Upper jaw with rudimentary symphyseal tooth recessible into upper lip and flanked distally by one larger symphyseal on either side. Lower jaw with three rows of enlarged symphyseals, their cusps subequal in length to each other and to those at symphysis in upper jaw; tooth cusps distal to symphysis decreasing sequentially in size; tooth shape varies distally from symphysis, first two to three teeth lack cusplets, one to two cusplets from the third or fourth parasymphysial on either side of the cusp on about four to seven teeth, distal cusplets more pronounced than medial ones, three to five most distal teeth generally lack cusplets on either side of cusp; teeth formula ($n = 14$): upper jaw (11–12) + 1 + 1 + 1 + (11–12) = (25–27); lower jaw (8–11) + 3 + (8–10) = (19–24).

Dermal lobes well developed; anterior preorbital group with three to four simple lobes, posterior lobe longest; posterior preorbital group with five to six lobes, longest lobes at extremities, anterior and second most posterior lobe longer and branched; combined distance across preorbital groups 8.3 (7.0–9.8) % TL; anterior and posterior postspiracular group with short, broader, branched single lobe, base width of anterior postspiracular lobe 1.6 (0.9–1.7) % TL, base width of posterior postspiracular lobe 1.7 (0.8–1.7) % TL; distance between preorbital group and anterior postspiracular lobe 3.5 (3.2–4) % TL, between postspiracular lobes 1.9 (1.9–2.5) % TL.

Dermal denticles small, non-imbricated, crown shield-like, weakly tricuspidate at anterior end, weak ridge on all cusps at anterior end, rounded posterior end. Clasper elongate, extending well beyond tip of pelvic fins, inner length 17.8 (16.0–17.8) % TL, 6.40 (6.40–6.55) times width at base, tip bluntly pointed; four terminal cartilages: ventral terminal, accessory terminal cartilage (or spur), dorsal terminal 2 and dorsal terminal, approximate one-to-one ratio with all terminal cartilages, end-style of axial cartilage slightly calcified and fused with dorsal terminal. When terminal cartilages of clasper are open, spear-like extension near lateral side of axial 21.1 (18.5–24.7) % clasper shaft length.

Dorsal fins similar in size and shape, triangular; anterior margins oblique; apices broadly rounded, first dorsal-fin apex slightly more rounded than second dorsal-fin apex; posterior margins vertical, very slightly convex to straight; inner margin parallel originating at level of pelvic-fin rear tip; second dorsal-fin height 8.4 (7.6–9.3) % TL, 0.99 (0.69–0.99) times pelvic-fin midpoint to second dorsal-fin origin; pre-first dorsal-fin length 48.9 (48.1–50.1) % TL, pre-second dorsal-fin length 61.2 (61.2–64.7) % TL; first dorsal-fin origin forward of pelvic-fin insertion (3.5 % TL); second dorsal-fin insertion anterior to anal-fin origin (0.7–0.8 % TL).

Pectoral fin large, length 15.7 (13.4–15.7) % TL, 2.81 (2.81–3.01) times pelvic-fin inner margin length; base fleshy, anterior margin slightly convex; apex broadly rounded; posterior margin slightly convex; inner margin straight, free rear tip very broadly rounded; prepectoral length 16.2 (16.2–19.5) % TL; pectoral-pelvic space 19.3 (16.8–21.9) % TL.

Pelvic fins moderately large, length 14.9 (12.0–14.9) % TL; anterior margin straight; apex very broadly rounded; posterior margin convex; inner margin straight, free rear tip broadly rounded; origin slightly anterior to first dorsal-fin origin, insertion first dorsal-fin midpoint; prepelvic length 44.1 (44.1–46.4) % TL, 2.51 (2.40–2.68) times pelvic-anal space; pelvic-anal space 17.6 (17.1–18.7) % TL, pelvic-caudal space 22.8 (21.9–26.57) % TL, 1.05 (1.03–1.26) times trunk width.

Anal fin elongate, lobe-like, well developed, base 8.5 (7.5–8.9) % TL, 2.09 (1.55–2.20) times interdorsal space; anterior and inner margins almost parallel, anterior margin first slightly concave then slightly convex; apex very broadly rounded; posterior margin straight, much smaller than anterior margin; inner margin straight, free rear tip slightly rounded; origin slightly posterior to second dorsal-fin insertion, insertion slightly posterior to caudal-fin origin; anal-fin height 1.61 (1.45–1.85) in base length; second dorsal-fin origin to anal-fin origin 10.3 (8.2–10.3) % TL, second dorsal-fin insertion to anal-fin insertion 1.36 (1.11–1.48) times terminal caudal margin.

Caudal fin long, strongly compressed; dorsal caudal margin length 21.0 (19.1–21.6) % TL, its origin slightly anterior to anal-fin insertion; upper lobe originating as a very low ridge, slightly distinguishable; anterior margin with a deep inflexion near its origin; outer rim straight and oblique; rounded apices; terminal caudal lobe fan-like; terminal caudal margin 6.2 (5.5–6.2) % TL.

Vertebral counts ($n = 7$): pre-first dorsal count 54–55; pre-second dorsal count 78–80; precaudal count 108–112. Spiral valve whorl count: 29–32 ($n = 32$, based on discarded specimens).

Coloration

Body light and dark brown coloration with nine darker brown blotch-shaped saddles located dorsally; each saddle has conspicuous black edges followed by grayish coloration, light brown and gray freckle-like blotches between saddles; first saddle weakly visible, posterior to spiracle, anterior to second gill slit; second saddle at pectoral-fin base level, broader than long; posterior end of third saddle at pelvic-fin origin level, length similar to width, lighter brown saddle extending laterally; fourth saddle small, anterior to first dorsal-fin origin, overlapping with inflexion of first dorsal-fin; fifth saddle from first dorsal-fin midbase to slightly anterior to second dorsal-fin origin, extending laterally and ventrally below mid body, nearly connecting at ventral midline; sixth saddle from second dorsal-fin midbase to slightly anterior of caudal-fin origin, extending laterally and ventrally below mid body, nearly connecting at ventral midline; seventh saddle at origin of caudal fin, anterior to anal-fin insertion, longer than broad, extending laterally, not extending on lower lobe of caudal fin; eighth saddle on upper caudal lobe, longer than broad, extending laterally, not extending on lower lobe of caudal fin; ninth saddle slightly anterior to caudal-fin tip, extending laterally, not extending on lower lobe of caudal fin. Gray bluish blotches sometimes with black edges on saddles decreasing in number and size from fourth saddle. V-shaped pattern anterior to interorbit; white spot on posterior tip of spiracle.

Underneath of head, trunk, abdomen and snout uniformly pale yellow, mouth and labial furrows with dark brown spots extending between posterior dermal lobe preorbital groups. Tail with three darker brown stripes on the flanks.

Pectoral fins green brown with blotches, underneath yellow at base, increasing brown color towards posterior margins, slight light brown blotches and white freckles; pelvic fins brown gray with blotches, underneath yellow at base, increasing brown color towards posterior margins, slight light brown blotches and white freckles; anal fin green brown, similar to tail coloration; dorsal fins brown, darker brown where saddles occur, green gray blotches/spots; caudal fin green brown, darker brown where saddles occur.

Remarks

Orectolobus halei was previously synonymized with *O. ornatus* due to the similarity in morphology and color pattern. Whitley (1940) first mentioned this species as a subspecies of *O. ornatus* and only described it as differing from *O. ornatus* “in color pattern and the form of the tentacles around the head”. The holotype, lodged at the South Australian Museum, Adelaide (SAMA), has been missing since at least 1997. The designation of a neotype is required due to the following. First, the previous description was so incomplete as to make it impossible to reliably distinguish *O. ornatus* from *O. halei*. Secondly, there currently is a significant problem of misidentification between those

two species within the targeted fishery for wobbegong sharks. Lastly, declining catches of wobbegong sharks strongly argue for a reliable means of identifying the target species.

Orectolobus halei can be distinguished from *O. ornatus* by several measurements (Table 1) and the two species also differ in 11 specific ratios (Table 2).

Orectolobus halei, which is regionally sympatric with *S. tentaculatus*, *O. maculatus*, *O. wardi*, *O. hutchinsi*, and two undescribed species of *Orectolobus* off WA, can be distinguished from these species by the combination of the number of dermal lobes, color pattern and the absence of tubercles. *Orectolobus hutchinsi* has slender unbranched postspiracular lobes (broad and branched in *O. halei* and *O. maculatus*) and a distinctive yellowish brown upper body coloration with well-defined, darker brown saddles containing paler markings that lacks whitish rings and blotches (unlike *O. ornatus* and *O. maculatus*) (Last *et al.*, 2006). *Sutorectus tentaculatus* has large rounded tubercles on both the head and body, not present in the adults of other members of the family Orectolobidae. *Orectolobus maculatus* has six to ten dermal lobes, *O. wardi* has unbranched nasal barbels, whereas *O. halei* has five dermal lobes and branched nasal barbels. *Orectolobus wardi* has a simple color pattern with fewer dark spots, while *O. maculatus* and *O. halei* have a more elaborate pattern of variegated spots and saddles. *Orectolobus maculatus* has white O-shaped spots and white blotches that are absent in *O. halei*.

TABLE 1. Morphometric data for the holotype of *Orectolobus ornatus* and neotype of *Orectolobus halei*, with ranges provided for the other specimens examined. Total length is provided in mm, measurements expressed as percentage of the total length. Measurements in bold highlights are those that appeared to differ between the two species (missing data is due to morphometric measurements being unmeasurable).

	<i>O. ornatus</i>			<i>O. halei</i>				
	Holotype	other specimens (n = 5)		Neotype	other specimens (n = 5)			
	QM I 164	Min	Max	AMS I 43628–002	Min	Max	Mean	
Total length	560	876	925	1700	1140	1869		
Fork length	95.5	95.5	96.4	96.0	95.3	94.5	95.5	95.2
Partial length	60.4	60.0	62.8	61.3	60.2	59.3	62.0	60.4
Precaudal length	80.2	78.1	80.2	79.3	80.2	78.8	81.9	80.0
Prenarial length	2.5	2.4	2.8	2.5	2.9	2.6	2.9	2.8
Preoral length	1.5	0.9	1.5	1.1	0.8	0.8	1.2	0.9
Preorbital length	4.6	3.9	5.2	4.8	5.3	5.2	6.0	5.7
Prespiracular length	6.8	6.8	7.4	7.0	7.2	6.8	7.6	7.2
Prebranchial length	14.7	14.4	16.1	15.1	14.7	14.7	17.9	16.0

to be continued.

TABLE 1 (continued).

	<i>O. ornatus</i>				<i>O. halei</i>			
	Holotype	other specimens (n = 5)			Neotype	other specimens (n = 5)		
	QM I 164	Min	Max	Mean	AMS I 43628-002	Min	Max	Mean
Head length	20.8	19.3	20.8	20.3	21.4	21.0	21.8	21.4
Prepectoral length	17.3	15.3	19.1	17.5	16.2	16.2	19.5	18.0
Prepelvic length	42.5	39.6	43.5	41.7	44.1	44.1	46.4	45.1
Snout-vent length		45.8	48.5	47.2	50.4	50.2	52.5	51.2
Preanal length	74.3	71.8	77.4	74.4	72.6	71.9	74.7	73.1
Pre-first dorsal length	50.0	48.7	50.3	49.5	48.9	48.1	50.1	49.2
Pre-second dorsal length	64.5	61.6	64.5	63.1	61.2	61.2	64.7	63.1
Interdorsal space	5.2	3.6	5.2	4.3	4.1	4.1	4.9	4.4
Dorsal-caudal space	6.0	6.0	7.9	7.1	7.8	6.9	8.4	7.6
Pectoral-pelvic space	17.9	15.4	18.2	17.2	19.3	16.8	21.9	18.9
Pelvic-anal space	23.0	19.6	23.0	21.5	17.6	17.1	18.8	18.0
Pelvic-caudal space	30.1	28.1	31.4	29.3	22.8	21.9	26.5	24.7
Vent-caudal space		53.0	56.1	54.6	50.7	49.3	50.9	50.4
Eye length	1.7	1.6	2.0	1.8	1.6	1.5	1.8	1.6
Eye height	1.3	1.0	1.3	1.1	1.0	0.9	1.1	1.0
Interorbital space	6.7	6.2	6.8	6.5	5.4	5.4	6.8	6.4
Nostril width		0.5	0.7	0.6	0.7	0.6	0.8	0.7
Internarial space	4.4	4.4	5.1	4.8	5.4	4.5	5.4	5.0
Spiracle length	2.7	2.7	3.1	2.8	3.3	3.0	3.8	3.4
Eye-spiracle space	0.5	0.3	0.7	0.5	0.4	0.2	0.6	0.4
Mouth length	2.6	2.4	2.6	2.5	3.1	2.9	3.3	3.1
Mouth width	8.6	8.6	9.1	8.9	10.7	9.6	10.7	10.1
Upper labial furrow length	3.9	3.6	4.0	3.9	4.3	4.1	4.9	4.3
Lower labial furrow length	4.3	4.2	4.6	4.3	5.4	4.6	5.5	5.1
Intergill length	5.3	4.6	5.5	5.1	5.5	4.8	6.2	5.5
First gill-slit height	1.6	1.6	2.1	1.8	2.8	2.2	2.8	2.6
Second gill-slit height	1.8	1.6	2.1	1.9	2.8	2.6	3.0	2.7

to be continued.

TABLE 1 (continued).

	<i>O. ornatus</i>				<i>O. halei</i>			
	Holotype	other specimens (n = 5)			Neotype	other specimens (n = 5)		
	QM I 164	Min	Max	Mean	AMS I 43628-002	Min	Max	Mean
Third gill-slit height	1.6	1.6	2.0	1.8	3.0	2.5	3.0	2.7
Fourth gill-slit length	1.6	1.5	1.8	1.7	2.8	1.9	2.8	2.4
Fifth gill-slit	2.4	2.4	2.7	2.5	3.5	2.6	3.5	3.1
Head height at third gill level	8.9	7.9	8.9	8.3	8.5	7.3	9.1	8.4
Head height at eye level	6.1	5.0	6.1	5.5	6.9	5.1	6.9	6.0
Head width at third gill level	16.8	16.8	18.5	17.7	22.0	19.5	22.0	20.6
Head width at spiracle level	14.5	14.4	16.0	15.3	17.5	16.0	17.9	16.9
Head width at posterior preorbital lobes	10.7	10.7	12.6	11.8	10.7	8.7	10.7	9.5
Head width at nasal barbel	6.0	6.0	6.7	6.3	6.5	6.0	6.7	6.3
Trunk height	9.6	7.3	9.6	8.1	8.8	7.6	9.4	8.5
Trunk width	17.4	16.9	18.7	17.8	21.6	20.4	23.0	21.7
Abdomen height	6.1	5.0	6.1	5.5	5.2	4.8	6.0	5.4
Abdomen width	5.5	5.3	5.7	5.5	5.9	5.9	6.3	6.2
Tail height	8.4	7.5	8.4	7.8	7.6	6.0	7.9	7.0
Tail width	9.0	7.5	9.0	7.9	7.7	3.3	8.1	6.2
Caudal peduncle height	2.8	2.8	3.3	3.0	3.5	3.0	3.5	3.3
Caudal peduncle width	4.0	2.1	4.0	2.5	2.2	2.1	2.5	2.2
Girth	45.6	42.0	45.6	43.2	48.4	42.1	49.9	46.9
Pectoral-fin length	12.7	12.2	13.6	13.0	15.7	14.1	15.7	14.7
Pectoral-fin anterior margin		12.7	13.6	13.1	17.9	15.1	17.9	16.5
Pectoral-fin base	7.8	6.9	8.2	7.8	9.5	8.5	10.2	9.7
Pectoral-fin height		10.0	11.8	10.8	14.8	12.0	14.8	13.8
Pectoral-fin anterior margin	5.1	4.6	5.4	5.1	5.6	4.9	5.6	5.1

to be continued.

TABLE 1 (continued).

	<i>O. ornatus</i>				<i>O. halei</i>			
	Holotype	other specimens (n = 5)			Neotype	other specimens (n = 5)		
	QM I 164	Min	Max	Mean	AMS I 43628-002	Min	Max	Mean
Pectoral-fin posterior margin		11.1	12.9	11.6	16.1	14.5	16.1	15.2
Pelvic-fin length	11.0	11.0	14.5	13.0	14.9	12.0	14.9	13.5
Pelvic-fin anterior margin	9.5	7.9	10.2	9.1	10.5	8.2	10.9	9.9
Pelvic-fin base	8.1	8.1	11.8	10.4		9.7	12.5	10.5
Pelvic-fin height	5.4	5.4	7.5	6.3	7.1	7.1	8.7	7.9
Pelvic-fin inner margin	3.6	3.0	3.6	3.3	3.5	3.4	4.7	4.0
Pelvic-fin posterior margin	7.2	7.2	10.9	9.2	11.2	9.0	11.2	10.2
Outer clasper length (mature specimens)		8.3	8.9	8.6	10.1	9.2	10.1	9.6
Inner clasper length (mature specimens)		14.6	15.6	15.2	17.8	16.0	17.8	16.9
Clasper base (mature specimens)		3.0	3.7	3.4	2.8	2.4	2.8	2.6
First dorsal-fin length	12.8	12.6	13.9	13.3	13.6	12.4	13.9	13.1
First dorsal-fin anterior margin	11.4	11.4	12.7	12.1	13.9	11.7	13.9	12.7
First dorsal-fin base	9.3	9.3	10.7	10.2	10.4	8.9	10.9	10.0
First dorsal-fin height	6.4	6.4	8.4	7.8	9.2	7.6	9.2	8.3
First dorsal-fin inner margin	2.8	2.8	3.8	3.2	3.9	3.2	3.9	3.5
First dorsal-fin posterior margin	7.7	7.7	9.3	8.7	9.5	8.5	9.8	9.0
Second dorsal-fin length	12.2	12.0	12.9	12.5	13.1	11.8	13.1	12.2
Second dorsal-fin anterior margin	11.0	10.2	11.2	10.9	12.2	10.9	12.2	11.6
Second dorsal-fin base	10.0	9.4	10.4	9.8	10.2	8.9	10.2	9.4
Second dorsal-fin height	6.4	6.4	8.0	7.2	8.4	7.6	9.3	8.4

to be continued.

TABLE 1 (continued).

	<i>O. ornatus</i>				<i>O. halei</i>			
	Holotype	other specimens (n = 5)			Neotype	other specimens (n = 5)		
	QM I 164	Min	Max	Mean	AMS I 43628-002	Min	Max	Mean
Second dorsal-fin inner margin	2.7	2.6	3.5	3.0	3.1	2.9	3.5	3.2
Second dorsal fin posterior margin	7.4	7.4	8.9	8.3	8.9	8.1	9.8	9.0
Anal-fin length	8.9	8.9	11.3	10.0	10.7	9.2	10.9	10.0
Anal-fin anterior margin	8.9	8.9	10.4	9.8	11.2	8.9	11.6	10.2
Anal-fin base	7.1	7.1	8.6	7.8	8.5	7.5	8.9	8.1
Anal-fin height	3.1	3.1	4.9	4.0	5.3	4.1	5.3	4.8
Anal-fin inner margin	2.5	2.4	3.0	2.7	2.9	2.1	3.0	2.6
Anal-fin posterior margin	2.5	2.5	3.9	3.4	3.9	3.6	4.0	3.8
Dorsal caudal margin	21.1	20.3	21.9	21.3	21.0	19.1	21.6	20.5
Lower caudal margin	2.8	2.8	3.6	3.3	3.7	3.1	3.9	3.6
Ventral caudal margin	14.0	14.0	15.7	14.9	15.0	13.9	15.5	14.6
Upper caudal margin	2.6	2.6	3.4	3.1	3.4	3.1	3.7	3.4
Subterminal margin	3.5	2.9	3.8	3.2	3.0	2.6	3.4	3.0
Terminal caudal margin	4.3	4.3	5.1	4.7	6.2	5.5	6.2	5.9
Terminal caudal lobe	4.8	4.2	5.0	4.7	6.0	5.4	6.2	5.8
First dorsal midpoint-pectoral insertion	39.1	30.3	39.1	32.2	30.5	27.0	31.3	29.7
First dorsal midpoint-pelvic origin	13.5	13.4	15.4	14.0	11.2	8.9	11.8	10.3
Pelvic midpoint-first dorsal insertion	11.6	7.9	11.6	9.2	4.9	4.9	6.8	5.8
Pelvic midpoint-second dorsal origin	15.0	13.1	15.0	14.0	8.5	8.5	11.7	10.2
Second dorsal origin-anal origin	11.6	11.6	12.4	11.9	10.3	8.2	10.3	9.1
Second dorsal insertion-anal insertion	7.6	7.6	9.8	9.1	8.5	6.8	8.5	7.7

to be continued.

TABLE 1 (continued).

	<i>O. ornatus</i>				<i>O. halei</i>			
	Holotype	other specimens (n = 5)			Neotype	other specimens (n = 5)		
	QM I 164	Min	Max	Mean	AMS I 43628-002	Min	Max	Mean
Nasal-preorbital space	0.6	0.6	0.9	0.7	1.1	1.0	1.6	1.3
Preorbital space	0.9	0.6	1.0	0.8	1.0	1.0	1.3	1.2
Preorbital-postspiracular space	3.8	3.5	4.8	4.2	3.5	3.2	4.0	3.5
Postspiracular space	2.6	1.5	2.6	2.3	1.9	1.9	2.5	2.2
Nasal barbel width	0.7	0.6	0.7	0.7	0.7	0.6	0.7	0.7
Anterior preorbital	1.3	1.3	1.6	1.5	1.9	1.4	1.9	1.5
Posterior preorbital	2.2	2.2	2.7	2.4	2.7	2.2	3.3	2.8
Anterior postspiracular	1.1	1.1	1.3	1.2	1.6	0.9	1.7	1.3
Posterior postspiracular	0.9	0.9	1.2	1.0	1.7	0.8	1.7	1.1

Size

To at least 2060 mm TL; males mature at 1684-1819 mm TL, females mature at 1605-1871 mm TL (Huveneers unpublished data).

Distribution

Temperate Australia, from Southport (27° 06S, 153° 26E), Qld, to Norwegian Bay (22° 54S, 113° 59E), WA. Southern records to Flinders Island (40° 19S, 147° 48E), Bass Strait.

***Orectolobus ornatus* De Vis, 1883**

(Figs. 7-9, Table 1-2)

Material examined

Holotype. QM I 164, 560 mm TL, female, type locality: Moreton Bay, registered 5th of December 1911.

Other specimens. Five specimens: AMS I 43621-001, 890 mm TL, mature male; AMS I 43628-002, 890 mm TL, mature male; AMS I 43628-003, 876 mm TL, mature male; AMS I 43628-004, 925 mm TL, mature male; AMS I 43628-005, 905 mm TL, mature male. All specimens caught together in 5-10 m of water, 10-15 m off northern tip of Tomaree Head, Port Stephens, NSW, 32° 43S, 152° 11E. Collector Charlie Huveneers, Rob Harcourt and Roger Laird on the 7th and 8th of May 2005.



FIGURE 5. Photographs of holotype *Crossorhinus ornatus*, QM I 164, 560 mm TL, female: A) lateral view; B) dorsal view; and C) ventral view.

Diagnosis

A small *Orectolobus* species with the following combination of characters: no warty tubercles on head or body; four groups of dermal lobes below and in front of the eyes on each side of head; no dermal lobes on chin; nasal barbel closest to mouth branched; three lobes at second preorbital group (rarely four) with first and last lobes branched and longer than middle one; broad unbranched postspiracular groups; lack of supraorbital knobs; base of anterior postspiracular lobe 2.19–3.56 in its distance from postorbital group, 1.19–2.11 in its distance from posterior postspiracular lobe; pelvic-fin insertion anterior to first dorsal-fin midpoint; prepelvic length 1.78–2.22 times pelvic-anal space; pelvic-caudal space 1.52–1.95 times trunk width; teeth in upper jaw 23–27, those in medial row at symphysis rudimentary; spiral valve turns 20–23; precaudal vertebrae count 98–104. Brownish, greenish and grayish coloration with eight darker brown blotch-shaped saddles located dorsally; small light brown, freckle-like blotches between saddles.

Description

Body depressed anteriorly from snout to first dorsal fin origin, firmness of body unknown as holotype is a dry mount but other examined specimens have slightly firm dorsal musculature with relatively flaccid flanks; trunk depressed, broadest over midtrunk; body shape changing from depressed to compressed and tapering from pelvic-fin midpoint; dorsal musculature slightly elevated from flank musculature forming a small ridge from the fifth gill slit to pelvic-fin insertion, decreasing anteriorly to first dorsal-fin origin. Head broad, strongly depressed, somewhat oval in cross-section with truncate anterior when viewed from above, length 20.8 (19.3–20.8) % TL, 1.79 (1.61–1.79) times second

dorsal-fin origin to anal-fin origin, height at gill level 8.9 (7.9–8.9) % TL, 0.77 (0.77–1.06) in pelvic-fin midpoint to first dorsal-fin insertion; trunk width 17.4 (16.9–18.7) % TL; abdomen elongate, width 5.5 (5.3–5.7) % TL. Pectoral-pelvic space 18.0 (15.4–18.2) % TL, 0.86 (0.74–0.92) times head length; pelvic-anal space 3.24 (2.58–3.24) times anal-fin base; snout-vent length (0.81–0.91) times vent-caudal length. Caudal peduncle absent, lower origin of caudal fin almost connected to anal-fin insertion, strongly compressed, oval in cross section at anal-caudal junction, caudal peduncle width 0.71 (0.71–1.56) times height.

Snout short, narrowly rounded in lateral view, truncate in a semi-hexagonal shape in dorsoventral view; preoral length 1.5 (1.0–1.5) % TL, 5.88 (5.88–10.00) in mouth width; prenarial length negligible. Eyes dorsal on head, small, slit-like, length 1.7 (1.6–2.0) % TL, 12.5 (10.00–12.50) in head length; supraorbital crest elevated over and behind eye; no supraorbital knob; ridge extending supraorbital crest above spiracle terminating slightly behind spiracle, terminating above spiracle in other specimens examined; supraocular crest absent in holotype, moderate in size in other specimens examined; interorbit flat to weakly convex, 3.89 (3.07–4.04) times eye length. Spiracles slit-like, oblique to horizontal axis, longer than eye, 1.56 (1.43–1.76) times eye length; anterior margin convex well elevated above concave posterior margin; small eye spiracle space 0.5 (0.3–0.7) % TL; fold above spiracle absent. Gill slits lateral on head, first three of similar length (1.6–2.1 % TL), fourth gill slit smaller, 0.91 (0.82–0.92) times second gill slit, last gill slit longest, 1.38 (1.18–1.46) times second, last gill slit anterior to pectoral-fin midbase; pectoral-fin origin between second and third gill slit. Mouth subterminal, large 2.2 (2.2–2.6) % TL, horizontally expanded, broadly arched, width 8.1 (8.1–9.1) % TL, 3.35 (3.35–3.81) times its length, 1.59 (1.49–1.59) in dorsal-fin midpoint to pelvic-fin origin; upper labial furrows 3.9 (3.6–4.0) % TL originating at ventral margin of nostrils; lower labial furrows longer 4.8 (4.2–4.6) % TL, 1.09 (1.07–1.17) times upper labial furrows, almost connected to symphysis of lower jaw. Nostrils small, widely separated, internarial space 4.4 (4.4–5.1) % TL, adjacent upper lip of mouth. Nasal barbel terminal on head, medial to nostrils, proboscis-like, rounded basally, tapering distally, length subequal to upper labial furrows; short flattened unbranched lobe at basal third of posterior margin; lateral nasal lobe broad well elevated, subcircular, most expanded posteriorly.

Fang-like teeth relatively large, long and pointed, not exposed when mouth closed. Upper jaw with rudimentary symphyseal tooth recessible into upper lip and flanked distally by one larger symphyseal on either side. Lower jaw with three rows of enlarged symphyseals, their cusps subequal in length to each other and to those at symphysis in upper jaw; tooth cusps distal to symphysis decreasing sequentially in size; tooth shape varies distally from symphysis, first two to three teeth lack cusplets, one to two cusplets from the third or fourth parasymphysial on either side of the cusp on about four to seven teeth, distal cusplets more pronounced than medial ones, three to five most distal teeth generally lack cusplets on either side of cusp; teeth formula (n = 12): upper jaw (10–12) +1

+ 1 + 1 + (10–12) = (23–27); lower jaw (7–9) + 3 + (7–9) = (18–21).

Dermal lobes well developed; anterior preorbital group with two to three simple lobes, posterior lobe longest; posterior preorbital group with three lobes, anterior and posterior lobe longer and branched; combined distance across preorbital groups 6.7 (6.1–7.9) % TL; anterior and posterior postspiracular group with short, broader, unbranched single lobe, base width of anterior postspiracular lobe 1.1 (1.1–1.3) % TL, base width of posterior postspiracular lobe 0.9 (0.9–1.2) % TL; distance between preorbital group and anterior postspiracular lobe 3.8 (3.5–4.8) % TL, between postspiracular lobes 2.6 (1.5–2.6) % TL.

Dermal denticles small, non-imbricated, crown shield-like, weakly tricuspidate at anterior end, weak ridge on all cusps at anterior end, rounded posterior end. Clasper elongate, extending well beyond tip of pelvic fins, inner length of mature male 14.6–15.6 % TL, (3.91–5.06) times width at base, tip bluntly pointed; four terminal cartilages: ventral terminal, accessory terminal cartilage (or spur), dorsal terminal 2 and dorsal terminal, approximate one-to-one ratio with all terminal cartilages, end-style of axial cartilage slightly calcified and fused with dorsal terminal. When terminal cartilage of clasper is open, spear-like extension near lateral side of axial 16.9 (14.5–19.5) % clasper shaft length.

Dorsal fins similar in size and shape, triangular; anterior margins oblique; apices broadly rounded; posterior margins vertical, very slightly convex to straight; inner margin parallel originating behind pelvic-fin rear tip; second dorsal-fin height 6.3 (6.3–8.0) % TL, 0.43 (0.43–0.59) times pelvic-fin midpoint to second dorsal-fin origin; pre-first dorsal fin 50.0 (48.7–50.3) % TL, pre-second dorsal fin 64.5 (61.6–64.5) % TL; first dorsal-fin origin slightly forward to pelvic-fin insertion (1.6 % TL); second dorsal-fin insertion slightly anterior to anal-fin origin 1.9 (1.8–3.0) % TL.

Pectoral fin large, length 12.7 (12.2–13.6) % TL, 2.48 (2.40–2.74) times pelvic-fin inner margin length; unknown fleshiness of base due to preservation but fleshy base in other specimens examined; anterior margin slightly convex; apex broadly rounded; posterior margin slightly convex; inner margin straight, free rear tip very broadly rounded; prepectoral length 17.3 (15.3–19.1) % TL; pectoral-pelvic space 17.9 (15.4–18.2) % TL.

Pelvic fins moderately large, length 11.0 (11.0–14.5) % TL; anterior margin straight; apex very broadly rounded; posterior margin convex; inner margin straight, free rear tip broadly rounded; origin anterior to first dorsal-fin origin, insertion anterior to first dorsal-fin midpoint; prepelvic length 42.5 (39.6–43.5) % TL, 1.85 (1.83–2.22) times pelvic-anal space; pelvic-anal space 23.8 (19.6–23.8) % TL, pelvic-caudal space 30.1 (28.1–31.4) % TL, 1.73 (1.52–1.85) times trunk width.

Anal fin elongate, lobe-like, well developed, base 7.1 (7.2–8.6) % TL, 1.37 (1.37–2.15) times interdorsal space; anterior and inner margins almost parallel, anterior margin first slightly concave then slightly convex; apex very broadly rounded; posterior margin straight, much smaller than anterior margin; inner margin straight, free rear tip slightly rounded; origin slightly posterior to second dorsal-fin insertion; anal-fin height

2.27 (1.49–2.44) times base length; second dorsal-fin origin to anal-fin origin 11.1 (11.6–12.4) % TL; second dorsal-fin insertion to anal-fin insertion 1.74 (1.74–2.04) times terminal caudal margin.

Caudal fin long, strongly compressed; dorsal caudal margin length 21.2 (20.3–21.9) % TL. its origin slightly anterior to anal-fin insertion; upper lobe originating as a very low ridge, slightly distinguishable, anterior margin with a deep inflexion near its origin; outer rim straight and oblique; rounded apices; terminal caudal lobe fan-like; terminal caudal margin 4.1 (4.1–5.1) % TL.

Vertebral counts (n = 10): pre-first dorsal count 46–51; pre-second dorsal count 69–74; precaudal count 98–104. Spiral valve whorl count: 20–23 (n = 22, based on discarded specimens).

Coloration

Body brownish, greenish, and grayish with eight darker brown, blotch-shaped saddles located dorsally; light brown freckle-like blotches between saddles; first saddle broader than long, posterior to spiracle, anterior to first gill slit, symmetrical from dorsal midline; second saddle at pectoral-fin base level, broader than long; posterior end of third saddle at pelvic-fin origin level, length similar to width, lighter brown green saddle extending laterally; fourth saddle small, lighter brown, anterior to first dorsal-fin origin, overlapping with inflexion of first dorsal fin; fifth saddle from first dorsal-fin midbase to slightly anterior to second dorsal-fin origin, extending laterally and ventrally below mid body, nearly connecting at ventral midline; sixth saddle from second dorsal-fin midbase to slightly anterior to caudal-fin origin, extending laterally and ventrally, nearly connecting at ventral midline; seventh saddle at origin of caudal fin, anterior to anal-fin insertion, longer than broad, extending laterally, not extending on lower lobe of caudal fin; eighth saddle on upper caudal lobe, longer than broad, extending laterally, not extending on lower lobe of caudal fin; green gray blotches on saddles decreasing in number and size from snout to caudal fin. V-shaped pattern anterior to interorbit; white spot on posterior tip of spiracle.

Underneath of head, trunk and abdomen uniformly yellow green. Tail with three darker brown stripes on the flanks.

Pectoral fins light and dark brown with blotches and white freckles, underneath uniform yellow with white spots; pelvic fins light and dark brown with blotches and white freckles, underneath yellow at base, increasing brown green color towards posterior margins, slight blotches; anal fin gray brown, similar to tail coloration; dorsal fins light and dark brown with blotches and white freckles and darker brown where saddles occur; caudal fin brown green, darker brown where saddles occur.

Remarks

Orectolobus ornatus was previously considered to be juvenile *O. halei* due to its similarity in morphology and color pattern. It can be distinguished from *O. halei* by

several measurements (Table 1) and also differs in 11 specific ratios (Table 2).

Orectolobus ornatus is also sympatric with *O. maculatus* and *O. wardi* and can be easily distinguished from them by the number of supraorbital knobs and dermal lobes, and the color pattern. *Orectolobus maculatus* and *O. wardi* have one or two supraocular knobs, whereas these knobs are absent in *O. ornatus* (Goto 2001). *Orectolobus maculatus* has six to ten dermal lobes, *O. wardi* has unbranched nasal barbels, whereas *O. ornatus* has five dermal lobes and branched nasal barbels. *Orectolobus wardi* has a simple color pattern with few dark spots while *O. maculatus* and *O. ornatus* have more elaborate variegated spots and saddles. *Orectolobus maculatus* has white rings that are absent in *O. ornatus*.

TABLE 2. Ranges of measurement ratios that appear to differ between *Orectolobus ornatus* and *Orectolobus halei*.

Ratios of morphometric measurements	<i>O. ornatus</i>	<i>O. halei</i>
Head length/second dorsal origin-anal origin	1.61–1.79	2.08–2.76
Prepelvic length/pelvic-anal space	1.83–2.22	2.40–2.68
Snout-vent length/vent-caudal length	0.81–0.91	0.99–1.04
Pelvic-caudal space/trunk width	1.52–1.85	1.04–1.26
Mouth width/first dorsal midpoint-pelvic origin	0.58–0.67	0.83–1.09
Head height at gill level/pelvic midpoint-first dorsal insertion	0.82–1.06	1.37–1.74
Pectoral length/pectoral inner margin	2.40–2.74	2.81–3.01
Second dorsal height/pelvic midpoint-second dorsal origin	0.43–0.59	0.69–0.99
Second dorsal insertion-anal insertion/terminal caudal fin margin	1.74–2.04	1.10–1.47
Preorbital-postspiracular space/lower labial furrow length	0.83–1.13	0.64–0.74
Spiracle length/eye length	1.43–1.76	1.91–2.29

Size

To at least 1017 mm TL; males mature between 796–830 mm TL, females mature between 795–864 mm TL (Huvneers 2005 unpublished data).

Distribution

Eastern Australia from Port Douglas (16° 32S, 145° 29E), Qld, to Sydney (151° 23E, 33° 36S), NSW.

Discussion

The very poor description of *O. halei* (Whitley, 1940) makes it impossible to quantitatively compare diagnostic features between the neotype herein designated and the previous description. The neotype was therefore assigned from the differing characters in

“the color pattern and the form of the tentacles” as highlighted by Whitley (1940).

The aim of this paper was to define and redescribe *O. halei* and *O. ornatus* to facilitate species identification. Unfortunately, juvenile *O. halei* (smaller than 1100 mm) were not collected despite intensive searching over two years. The ranges of sizes of *O. ornatus* and *O. halei* examined did not overlap and thus differences in morphometry should be interpreted with caution due to allometric factors. Juvenile *O. halei* (smaller than 900 mm) are needed to confirm morphometric differences identified in this study.

The two species can, however, be differentiated using counts of precaudal vertebrae (greater than 105 in *O. halei* and less than 105 in *O. ornatus*) and/or spiral valves (greater than 26 in *O. halei* and less than 26 in *O. ornatus*). However, these characters are impractical for application in the field. Therefore, simpler but equally robust methods are needed to differentiate species under field conditions.

Total length is the simplest field character for differentiating NSW species. Any wobbegong exceeding 110 cm is either *O. halei* or *O. maculatus* (but not *O. ornatus*) and these two can be easily differentiated using color pattern and dermal lobes. Wobbegongs smaller than 110 cm are harder to identify. In the case of small males, if the claspers are calcified, the species is *O. ornatus*. For immature males or females, other traits have to be used. Color pattern may help identification with *O. ornatus*, which is freckled and green/gray (brownier in *O. halei*), and lacks black edges along its saddle markings (otherwise present). However, coloration is highly variable in these species and *O. ornatus* specimens have been observed with an *halei*-like color pattern. Care must therefore be taken when using coloration alone to identify *Orectolobus* species.

Three further key features to differentiate between the two species are the number of dermal lobes at the posterior preorbital group, the position of the pelvic fins, and the supraorbital knobs. *Orectolobus ornatus* usually has only three lobes at the posterior preorbital group, consisting of two branched lobes at the extremities and a shorter unbranched lobe in the middle (more lobes are present in *O. halei*). However, both *O. ornatus* and *O. halei* have been observed with four lobes. Pelvic fins are located further back on *O. halei* with the pelvic-fin insertion at the level of the first dorsal midpoint (*O. ornatus* has the pelvic-fin insertion anterior to the first dorsal midpoint). Lastly, *O. halei* has two small knobs on the supraorbit (absent in *O. ornatus*).

By preference, these features should always be used together to maximize correct identification of *Orectolobus* species in NSW. Commercial fishers using these features should be able to identify *Orectolobus* species and report them accordingly. In the past, all species have been combined together as ‘carpet shark’. Commencing in 2005, NSW DPI has required fishers to report *O. maculatus* separately. Using the characteristics described above, fishers should now be able to report catches of *O. maculatus*, *O. ornatus* and *O. halei* separately. Catch rate statistics could then be used to assess each species independently to investigate potential population decline.

Key to *Orectolobus* species in New South Wales

1. About 6 to 10 dermal lobes at the posterior preorbital group; white O-shaped spots and white blotches..... *Orectolobus maculatus*
About 3 to 6 dermal lobes at the posterior preorbital group; back with dark color variegated with blotches and prominent saddle markings 2
2. Spiral valve whorl count 20–23; precaudal vertebrae count 98–104; size-at-maturity about 800 mm; about 3 to 4 dermal lobes at the posterior preorbital group; no supraocular knobs; pelvic-fin insertion slightly anterior to the first dorsal midpoint
..... *Orectolobus ornatus*
Spiral valve whorl count 29–32; precaudal vertebrae count 106–112; size-at-maturity about 1750 mm; about 4 to 6 dermal lobes at the posterior preorbital group; two distinct supraocular knobs; pelvic-fin insertion at about the level of the first dorsal midpoint..... *Orectolobus halei*

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