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**AUSTRALIAN CATSHARKS
OF THE GENUS *ASYMBOLUS*
(CARCHARHINIFORMES:
SCYLIORHINIDAE)**

P. R. Last (Ed.)



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Australian catsharks of the genus *Aymbolus* (Carcharhiniformes: Scyliorhinidae)

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**AUSTRALIAN SPOTTED CATSHARKS OF THE GENUS
ASYMBOLUS (CARCHARHINIFORMES: SCYLIIORHINIDAE).
PART 1: DESCRIPTIONS OF THREE NEW SPECIES FROM
WESTERN AUSTRALIA**

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ABSTRACT

Three new species of catsharks (genus *Asymbolus*) are described from the seas of Australia: *A. funebris* sp. nov. and *A. submaculatus* sp. nov. (from temperate southwestern Australia), and *A. parvus* sp. nov. (from tropical northwestern Australia). *A. funebris* and *A. submaculatus* can be distinguished from all other members of the genus by their relatively robust bodies, short caudal fins and smooth tricuspidate teeth. *A. submaculatus* is covered in black spots whereas *A. funebris* has only large brownish blotches and has narrower, more erect dorsal fins. The smallest known member of the genus, *A. parvus*, appears to be more closely related to the dark-spotted catsharks of the *analis* subgroup but has a pale brown body covered in white spots and blotches.

INTRODUCTION

Recent trawl surveys of the Australian continental shelf and upper slope have produced a wealth of specimens of the catshark family Scyliorhinidae, along with many other sharks, rays and bony fishes. Reviews of the Scyliorhinidae by Springer (1979) and Compagno (1984, 1988) indicated the existence of new species of this family. At present, the scyliorhinid genus *Asymbolus* is known from two described species, *A. analis* (Ogilby, 1885) and *A. vincenti* (Zeitz, 1908), and six undescribed species, all endemic to Australian seas (Last and Stevens, 1994). A seventh new species has recently been discovered from New Caledonia (Seret, 1994).

The new Australian species were initially described but not named in Last and Stevens (1994) and illustrated as composites of multiple specimens from a variety of colour prints and slides. These are formally described and named in two papers within this publication: part one by Compagno, Stevens and Last (the present paper) gives a diagnosis of the

genus *Asymbolus* and names three, new multicoloured species; part two by Last, Gomon and Gledhill names the three dark-spotted catsharks that are closely related to *A. analis* and provides a key to the species of *Asymbolus*.

MATERIALS AND METHODS

Terminology for external structures and abbreviations, and methodology for measurements, follows the FAO system of Compagno (1984) with modifications based on Compagno and Stevens (1993). The following were taken as horizontal measurements: TL, PCL, PD2, PD1, HDL, PG1, PSP, POB, PP1, PP2, SVL, PAL, CLO, CLI, DAO and DAI; all other measurements were taken point to point. Dorsal-fin origins and the origin of the upper and lower lobes of the caudal fin were taken as the points at which their anterior scale ridge merges with the scales of the body. In some species these points are difficult to ascertain and may be well in advance of the point at which the angle of the origins change most abruptly.

Comprehensive measurements were taken for the holotype and five paratypes (by D. Gledhill) and converted to percentages of total length (Table 1). Additional ratios of selected measurements are included in descriptions. Counts of monospondylous centra and total centra were obtained from radiographs for up to six specimens when available. Counts of diplospondylous precaudal centra proved less reliable because of difficulties determining the point of origin in some species. Tooth row counts were taken directly from specimens. Paratype information in the descriptions are given in parentheses.

Dentition terms are modified from Compagno (1970, 1979) according to a system developed by B. Welton and the senior author. The major difference as used here and in Compagno (1988) is the substitution of the orientation terms 'distal' for 'postlateral', 'mesial' for 'premedial', 'labial' for 'outer' and 'lingual' for 'inner', in conformity with current European terminology. Vertebral count terminology follows Compagno (1979, 1988).

Abbreviations for field, accession, and catalogue numbers include: CSIRO—ISR Munro Ichthyological Collection, Commonwealth Industrial Research Organisation, Hobart; and WAM—Western Australian Museum, Perth.

GENUS *Asymbolus* WHITLEY, 1939

Type species: *Scyllium anale* Ogilby, 1885, by original designation.

DIAGNOSIS. — (modified from Compagno, 1984, 1988). Scyliorhinid with the head slightly depressed, narrowly pointed to rounded in lateral view and not wedge shaped; head short, less than 0.2 of total length in adults. Snout short to slightly elongated, less than mouth width, thick, and slightly flattened; without upturned tip; not expanded laterally or pointed, rounded to parabolic and slightly bell shaped in dorsoventral view. Ampullal pores not greatly enlarged on snout. Nostrils of moderate size, with incurrent and excurrent apertures only partly open to exterior; anterior nasal flaps formed as triangular lobes, without barbels, well-separate from each other and falling somewhat anterior to mouth; internarial space 0.6–1.0 times nostril width; no nasoral grooves. Eyes dorsolateral on head, narrow subocular ridges present below eyes. Branchial region not greatly enlarged, distance from spiracles to fifth gill slits about half head length; gill openings lateral on head and situated on (and not above) horizontal head rim. Mouth angular to arched, moderately long, with lower symphysis well behind upper symphysis so that upper teeth are exposed in ventral view. Labial furrows present along both upper and lower jaws, these short and ending well behind level of upper symphysis of mouth. Body not tadpole shaped, slender and subcylindrical, tapering slightly to caudal fin; body firm and thick skinned, stomach not inflatable. Body with well-calcified dermal denticles; no enlarged, spike-like denticles on back, skin not very rough. Tail moderately long, length from vent to lower caudal-fin origin about 0.67 to almost equal to snout–vent length. Pectoral fins moderately large, their width about 0.7–1.4 times mouth width. Inner margins of pelvic fins fused over claspers and forming an ‘apron’ in adult males. Adult claspers moderately long to very long, fairly thick to slender, and distally blunt or pointed, extending about half of their lengths or more behind the pelvic-fin tips; claspers with a long, bilobate exorhipidion that has a low or high posterior lobe but lacks a prominent ridge and process on its upper surface; exorhipidion without clasper hooks or a lateral groove along its edge; pseudopera present and about opposite pseudosiphon when latter is present; pseudopera extending partly behind cover rhipidion; pseudosiphon usually present; rhipidion either absent or short to moderately long but falling short of clasper tip; cover rhipidion either poorly differentiated or strong, short, high, and well in front of clasper tip; envelope low and tapering rearwards; clasper tip tapering and straight or truncated and twisted, without a brush-like structure of dermal papillae or modified sawlike denticles. Two dorsal fins present, about equal-sized; origin of first dorsal fin

over or slightly behind pelvic-fin insertions; origin of second dorsal varying from about over the anal-fin midbase to over the rear most third of its base. Anal fin moderately large but not greatly elongated, about as large as pelvic fins and larger than dorsal fins, base length 1.3–1.8 times second dorsal-fin base; origin of anal fin far behind pelvic-fin bases, and insertion separated from lower caudal-fin origin by a broad variable space. Caudal fin short and broad, about a quarter to a fifth of total length in adults; no crests or denticles on the caudal margins. Supraorbital crests absent from cranium. Valvular intestine with 7–9 turns. Total vertebral counts 119–148. Colour pale to dark brown above, light below, with simple color pattern of scattered white or dark spots, blotches or saddles on sides and dorsal surface, and sometimes dark spots on underside of head; underside of head without black-pigmented pores.

REMARKS. — Whitley (1939) proposed two genera for Australian catsharks, *Asymbolus* for *Scyllium anale* Ogilby, 1885, and *Juncrus*, for *Scyllium vincenti* Zeitz, 1908. Whitley (1939, 1940) distinguished both genera by the basally fused pelvic inner margins in adult males, which form an ‘apron’ over the claspers, but offered little other than coloration to distinguish these genera from each other. Fowler (1941) synonymised *Asymbolus* and *Juncrus* with *Halaelurus* Gill, 1862, but Springer (1979) recently resurrected these genera as constituted by Whitley (1939, 1940). Springer distinguished the resurrected genera only by relative clasper length in males (very long and slender in *J. vincenti* and shorter and thicker in *A. analis*) and by the form of the ‘apron’ over the claspers.

Data from recently reported Australian material of *Asymbolus*–*Juncrus* catsharks, which includes the six undescribed species (Last and Stevens, 1994), supports observations by Compagno (1984, 1988) that only a single genus is valid. A new, multicoloured *Asymbolus* (sp. C *sensu* Last and Stevens) has *vincenti*-like elongated claspers with dark, *analis*-like spots, while another undescribed *Asymbolus* (sp. A *sensu* Last and Stevens) has pale, *vincenti*-like markings combined with short, *analis*-like claspers. Comparisons of adult males of all of these sharks revealed only minor differences in the form of the ‘pelvic apron’, providing support for a single genus, *Asymbolus* Whitley, 1939. Definition and scope of *Asymbolus* follows Compagno (1984, 1988).

Asymbolus funebris sp. nov.

Fig. 1, Table 1

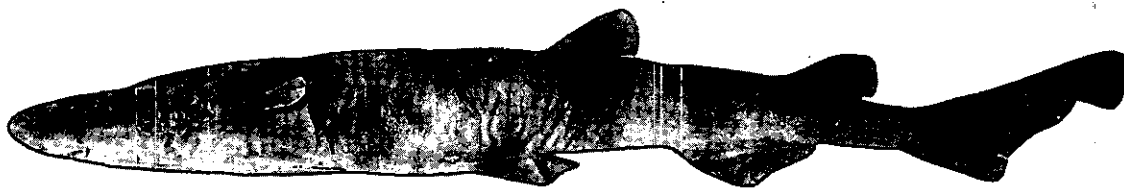


Fig. 1. — *Asymbolus funebris* sp. nov. holotype, CSIRO T569, 442 mm TL female, lateral view.

Asymbolus sp. B: Last and Stevens, 1994, *Sharks and rays of Australia*, pp 171, 182, fig. 26.10, pl. 22.

Holotype.— CSIRO T569, female, 442 mm TL, south of Cape Leeuwin, Western Australia, 34°35'S, 114°53'E, caught by demersal trawl at 144 m depth, Feb. 23, 1981.

DIAGNOSIS. — A small, distinctive blotched catshark of the genus *Asymbolus* with the following combination of characters: characteristic pattern of dark brown blotches and saddles on body and fins; without black or white spots; relatively large, stocky head and short caudal fin; preoral length exceeding 5% TL; teeth relatively large, smooth with 3 cusps, central tooth cusp greatly enlarged, lateral cusps minute; short, oval caudal peduncle; anal-fin base much longer than pelvic-anal space; inner margin of dorsal fins elevated slightly; and 36 monospondylous centra.

DESCRIPTION. — Body rather slender and firm; trunk slightly compressed anteriorly, more so towards caudal fin, not tapering abruptly at pelvic-fin insertion; head slightly depressed, height 8.6% TL; abdomen relatively short, pectoral to pelvic space 16.9% TL, 0.90 of head length; pelvic-anal space shorter than anal-fin base, distance 0.72 of anal-fin base; caudal peduncle not especially slender and relatively short, anal to caudal space 0.44 of anal-fin base; peduncle compressed, oval in cross section, convex dorsally and ventrally, width 1.47 in height. Snout short, rounded to parabolic in dorsoventral view, tip narrowly rounded, bluntly pointed in lateral view; preoral length 5.4% TL, 0.91 times mouth width; prenarial snout 1.02 times eye length. Eyes large, length 3.2% TL, 5.80 in head length; dorsolateral on head, with well-developed subocular ridges. Mouth moderately large and long, broadly arched, width 6.0% TL, 2.01 times its length; upper and lower labial furrows much less than half of mouth length. Nostril large with tube-like

incurrent apertures, well separated, internarial space 2.1% TL, and well short of mouth; anterior nasal flap subtriangular with pronounced lobe-like apex, margin irregular; posterior lobe broad, margin irregular. Teeth relatively large, not ridged, with 3 cusps; long, pointed median cusp flanked by two, minute lateral cusps; in about 41 rows in upper jaw; upper jaw teeth exposed when mouth closed. Dermal denticles on side small, imbricated, skin somewhat velvety; pedicle long; crown shield like, tricuspidate with well developed lateral cusps and a long, pointed median cusp; strong longitudinal ridge terminating at end of median cusp. No crest of enlarged denticles at base of caudal fin. Clasper morphology unknown. Dorsal fins of similar size, stiff, subtriangular, raked slightly, with straight to slightly convex anterior margins; apices broadly rounded; posterior margins truncate to slightly convex; inner margin elevated slightly with free rear tip angular, well separated from dorsal surface; first dorsal-fin origin over pelvic-fin insertion, second originating slightly forward of anal-fin insertion. Pectoral fin relatively large, anterior margin almost straight to weakly convex, length 10.5% TL; apex broadly rounded, posterior margin truncate to weakly concave, free rear tip broadly rounded. Pelvic fins small, low, angular, length 11.5% TL; free rear tip narrow, margin angular. Anal fin elongate, subtriangular, well developed, base 13.4% TL, 1.07 in interdorsal space; origin closer to first dorsal-fin insertion than second dorsal-fin origin, anal-fin height 3.66 in base length. Caudal fin relatively short, dorsal caudal margin length 19.0% TL; origin of upper lobe rather abrupt; lower lobe well developed, anterior margin with a deep inflexion near its origin; terminal caudal lobe fan-like with biconvex outer margin. Monospondylous centra 36; dorsal precaudal centra 91; total centra 126.

Coloration. Dorsal surface medium brown with large, dark brown blotches and saddles; 3 predorsal saddles, additional bars beneath each dorsal fin and one interdorsally; markings spaced irregularly with diffuse edges; no small dark or pale spots. Unpaired fins and upper surfaces of paired fins darkest anteriorly. Ventral surface only slightly paler than rest of body.

SIZE. — To at least 442 mm TL.

DISTRIBUTION. — Known from a single specimen taken from the outer continental shelf south of Cape Leeuwin in 144 m depth.

ETYMOLOGY. — Derived from the Latin “funnebris” of a funeral, in reference to its sombre appearance compared to other members of the genus.

VERNACULAR. — Blotched catshark.

REMARKS. — One of the most distinctive members of the genus based on its colour pattern, body shape, and dentition. It shares a relatively robust body, short caudal fin and smooth tricuspidate teeth with *A. submaculatus* (all other species are more slender, have larger caudal fins, and possess smaller teeth with 5–7 cusps and basal ridges). However, compared to *A. submaculatus*, its colour pattern is much duller (lacking multicoloured blotches and a peppering of black spots) and it has narrower, more erect dorsal fins. Although difficult to confirm without additional material, *A. funebris* appears to have a broader head, taller pectoral fin, and slightly longer predorsal distances than *A. submaculatus*.

In preparing this document we found a discrepancy in published distributional information for the holotype. Last and Stevens (1994) recorded the distribution of this species as being off the Recherche Archipelago (Great Australian Bight) in 195 m. The basis of this record is unclear. The CSIRO fish collection registers note that the type was taken slightly further west off Cape Leeuwin in 144 m depth. This location matches trawl station data from the RV 'Hai Kung' which operated in the area at the time the specimens was collected.

Asymbolus submaculatus sp. nov.

Fig. 2, Table 1

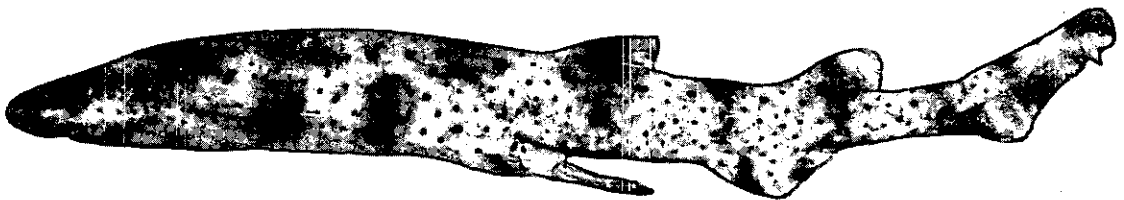


Fig. 2. — *Asymbolus submaculatus* sp. nov. holotype, CSIRO CA3336, 381 mm TL mature male, lateral view.

Asymbolus sp.: Hutchins and Swainston, 1986, *Sea fishes of southern Australia*, p. 22, fig. 13.

Asymbolus sp. 1: Gomon *et al.*, 1994, *The fishes of Australia's south coast*, p. 131–132, figs 94, 95.

Asymbolus sp. C: Last and Stevens, 1994, *Sharks and rays of Australia*, pp 172, 183, fig. 26.11, pl. 21.

Holotype.-- CSIRO CA3336, mature male, 381 mm TL, off Cape Howe, New South Wales, 37°39.0'S, 150°13.0'E, caught by demersal trawl at 180–200 m depth, Feb. 2, 1980.

Paratypes.-- CSIRO CA3335, female, 395 mm TL, Western Australia, 34°33.0'S, 123°44.0'E, 195–198 m depth, July 26, 1981; CSIRO CA3337, female, 438 mm TL, Western Australia, 33°53.7'S, 124°49.0'E, 70 m, Nov. 30, 1981; CSIRO CA3338, mature male, 385 mm TL, Western Australia, 34°33.0'S, 123°44.0'E, 195–198 m, Jul. 26, 1981; CSIRO H5241–01, female, 351 mm TL, border of Western Australia and South Australia, 1987; WAM P711.001, mature male, 414 mm TL, Western Australia, 34°37'S, 116°29'E, Aug. 25, 1920; WAM P28483–001, mature male, 387 mm TL, Western Australia, 34°09'S, 121°46'E, 73 m, Aug., 1985; WAM P29399.001, mature male, 414 mm TL, Western Australia, 33°20'S, 115°38'E, 30 m, 1987.

DIAGNOSIS. — A small, spotted catshark of the genus *Asymbolus* with the following combination of characters: greyish brown with darker, rusty-brown and bluish grey, saddle-like blotches; densely peppered with small, sharply defined, very dense black spots; relatively large, smooth teeth with 3 cusps; large, strongly tricuspidate denticles; rounded dorsal fins; relatively deep head and tail, and tall dorsal, anal and pelvic fins; relatively short caudal fin and long preanal length; anal-fin base longer than pelvic-anal space; mature males with very long, subcylindrical claspers; and 34–36 monospondylous centra.

DESCRIPTION. — Body relatively robust (particularly so in large females) and firm; trunk slightly compressed anteriorly, more so towards caudal fin, tapering abruptly at pelvic-fin insertion; tail relatively deep, depth at origin of anal fin subequal to length of base of first dorsal fin; head slightly depressed, height 9.7 (8.3–9.9, $n = 5$)% TL, increasing rapidly in depth behind eye; abdomen moderately elongate, pectoral to pelvic space 16.1 (16.8–18.9)% TL, 0.89 (0.89–0.98) of head length; pelvic to anal space usually shorter than anal-fin base, distance 1.18 (0.72–0.89) of anal-fin base; caudal peduncle rather low and moderately elongate, anal to caudal space 0.37 (0.41–0.52) of anal-fin base; peduncle compressed, subrectangular in cross section, flattened dorsally, rounded ventrally; width 1.62 (1.35–1.70) in height. Snout short, broadly rounded in dorsoventral view, tip usually broadly rounded, blunt in lateral view; preoral length 5.0 (4.3–5.5)% TL, 0.84 (0.74–1.00) times mouth width; prenarial snout 0.96 (0.99–1.18) times eye length. Eyes large, length 3.1 (2.9–3.3)% TL, 5.75 (5.38–6.60) in head length;

dorsolateral on head, with well-developed subocular ridges. Mouth moderately large and long, broadly arched, width 6.0 (5.5–6.5)% TL, 1.94 (1.82–2.11) times its length; upper and lower labial furrows much less than half of mouth length. Nostril large with tube-like incurrent apertures, well separated, internarial space 2.0 (1.8–2.4) % TL, and well short of mouth; anterior nasal flap lobe like, hind margin deeply concave; posterior lobe rather broad. Teeth relatively large, smooth, with 3 cusps, typically with a long, pointed median cusp flanked by two much smaller lateral cusps; in 42 (42, n=1) rows in upper jaw; upper jaw teeth exposed when mouth closed. Dermal denticles on side somewhat deciduous, small, weakly imbricated, skin velvety; pedicle long; crown shield like, broad, strongly tricuspidate, with long lateral cusps and a slightly longer, pointed median cusp; longitudinal median ridge on crown indistinct. No crest of enlarged denticles at base of caudal fin. Adult clasper subcylindrical, very long and slender, tapering posteriorly to pointed tip, extending over about three quarters of pelvic-anal space, outer length 11.6 (11.7–12.0)% TL, inner length 9.36 (10.00–11.49, n=2) times base width; base width 2.48 (1.95) times spiracle length; proximal inner margin of pelvic fin fused to dorsal clasper, dorsal margins of claspers connected to each other by narrow, naked membrane to form a feeble apron over clasper insertion; no clasper hooks; denticles on anterior of clasper small, imbricated, those distally enlarged, not imbricated and directed anteriorly. Dorsal fins similar in size and shape, broadly subtriangular, raked, with convex anterior margins; apices very broadly rounded; posterior margins distinctly convex; free rear tip angular; first dorsal fin originating over or forward of pelvic-fin insertion, second inserted well forward of anal-fin insertion. Pectoral fin relatively large, anterior margin convex, length 10.9 (10.3–11.5)% TL; apex broadly rounded, posterior margin truncate to weakly concave, free rear tip broadly rounded. Pelvic fins relatively large, deep, apex angular, length 10.0 (11.6–13.0)% TL; free rear tip broad, margin angular. Anal fin elongate, deep subtriangular, well developed, base 11.6 (12.5–13.4)% TL, 1.05 (0.87–1.14) in interdorsal space; origin slightly closer to first dorsal-fin insertion than second dorsal-fin origin, anal-fin height 2.65 (2.68–3.59) in base length. Caudal fin relatively short, dorsal caudal margin length 20.8 (18.1–20.2)% TL; origin of upper lobe forming a short, low ridge anteriorly; lower lobe well developed, anterior margin without a deep inflexion, not forming low ridge anteriorly, origin distinct; terminal caudal lobe fan-like with irregular outer margin; damaged in holotype, convex above with a deep incision below. Monospondylous centra 36 (34–36, n = 6); dorsal precaudal centra 89 (86–91, n=4); total centra 122 (119–127, n=5).

Coloration. Dorsal surface of body and fins pale yellowish brown to off white with several diffuse, rusty-brown, saddle-like blotches and bluish grey blotches on sides; covered with numerous sharply-defined, dark brown or black spots (on most specimens

subequal to spiracle diameter in size and almost always smaller than height of fifth gill slit); spots most heavily concentrated on sides but sometimes extending to undersurface of head and belly. Upper surfaces of fins with or without spots; when present usually most heavily concentrated near fin bases. Paler ventrally.

SIZE. — To at least 438 mm TL; males mature by 380 mm TL.

DISTRIBUTION. — Continental shelf off Western Australia from Perth to Esperance in 30–200 m depth. Possibly also occurring near the shelf break off southeastern Australia.

ETYMOLOGY. — Combination of the Latin “sub” meaning “under” and “maculatus” meaning “spot or mark” in reference to the presence of spots on the undersurface in slightly more than half of the types.

VERNACULAR. — Variegated catshark.

REMARKS. — Distinguishable from most other members of the genus based on its colour pattern, body shape, and dentition. It shares a relatively robust body, short caudal fin and smooth, tricuspidate teeth with *A. funebris* (all other species are more slender, have larger caudal fins, and their smaller teeth have 5–7 cups with basal ridges). However, the colour pattern of *A. submaculatus* is more ornate and has multicoloured blotches overlain with a peppering of black spots (*A. funebris* lacks black spots) and its dorsal fins are larger and more rounded. Other possible morphometric differences are discussed under *A. funebris*.

The holotype was taken during RV ‘Soela’ cruise SO1/80 which sampled fishes from across southern Australia (from Western Australia to New South Wales, including Tasmania). According to the CSIRO registers, the holotype was caught at trawl station 41, off Cape Howe, southern NSW. Interestingly, all other specimens of this species have been taken west of Esperance (western Great Australian Bight) despite almost two decades of trawl survey work made off Victoria and the New South Wales coast. We suggest that this is likely to be due to a labelling error, particularly as the vessel surveyed most of the known range of this species during that cruise.

Asymbolus parvus sp. nov.

Fig. 3, Table 1

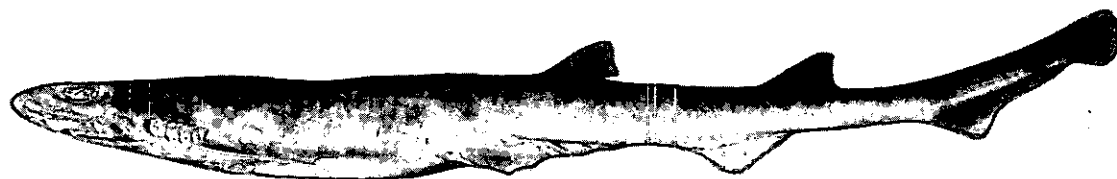


Fig. 3. — *Asymbolus parvus* sp. nov. holotype, CSIRO H1505-01, 335 mm TL, mature male, lateral view.

Asymbolus sp. A: Last and Stevens, 1994, *Sharks and rays of Australia*, pp 172, 181, fig. 26.9, pl. 22.

Holotype.— CSIRO H1505-01, mature male, 335 mm TL, north of Nickol Bay, Western Australia, 19°07.3'S, 117°04.4 'E, caught by demersal trawl at 177–184 m depth, Oct. 5, 1988.

Paratypes.— CSIRO CA2864, female, 341 mm TL, Western Australia, 18°22.5'S, 118°25.6'E, 201–202 m depth, Apr. 2, 1982; CSIRO CA2865, female, 300 mm TL, Western Australia, 18°22.5'S, 118°25.6'E, 201–202 m depth, Apr. 2, 1982; CSIRO CA3326, female, 342 mm TL, Western Australia, 18°22.5'S, 118°25.6'E, 201–202 m depth, Apr. 2, 1982; CSIRO CA3327, female, 235 mm TL, Western Australia, 18°22.5'S, 118°25.6'E, 201–202 m depth, Apr. 2, 1982; CSIRO CA4070, mature male, 349 mm TL, Western Australia, 19°13.2'S, 116°26.8'E, 192–194 m depth, Aug. 11, 1983; CSIRO H1035-21, female, 332 mm TL, Western Australia, 19°08.4 'S, 116°54.1'E, 196–198 m depth, Oct. 24, 1986; CSIRO H1035-22, female, 357 mm TL, Western Australia, 19°08.4'S, 116°54.1'E, 196–198 m depth, Oct. 24, 1986; CSIRO T1500, female, 272 mm TL, Western Australia, 18°45.8'S, 117°48.4 'E, 192–200 m depth, Aug. 16, 1983; CSIRO T1501, adolescent male, 279 mm TL, Western Australia, 14°47.9'S, 121°50.5'E, 252–260 m depth, Feb. 17, 1984; CSIRO T1513, mature male, 334 mm TL, Western Australia, 18°34.3'S, 118°10.4'E, 160–164 m depth, Oct. 10, 1983.

DIAGNOSIS. — A very small, distinctive catshark of the genus *Asymbolus* with the following combination of characters: pale brown body with numerous white spots and blotches; without dark brown or black spots; relatively thin caudal peduncle; long preoral length; low anal fin; very small, ridged teeth with 5–7 cusps; small, densely imbricated, weakly tricuspidate denticles; and 34–35 monospondylous centra.

DESCRIPTION. — Body very slender and firm; trunk subcylindrical anteriorly, somewhat compressed laterally, gently tapering to caudal fin, usually abrupt at pelvic insertion (more pronounced in males); head moderately depressed, height 7.3 (6.8–7.3, n=5)% TL; abdomen relatively short, pectoral to pelvic space 16.1 (15.8–16.9)% TL, 0.87 (0.85–0.92) of head length; pelvic to anal space slightly shorter than anal-fin base, distance 0.97 (0.60–1.08) of anal-fin base; caudal peduncle relatively low and elongate, anal to caudal space 0.46 (0.30–0.53) of anal-fin base; peduncle rather compressed, almost oval in cross section, flattened to weakly convex dorsally, width 1.45 (1.10–1.55) in height. Snout short, rounded to parabolic in dorsoventral view, tip broadly rounded, bluntly pointed in lateral view; preoral length 5.5 (5.6–5.9)% TL, 0.82 (0.83–0.93) times mouth width; prenarial snout 1.38 (1.13–1.19) times eye length. Eyes large, length 3.1 (3.0–3.3)% TL, 6.01 (5.36–6.36) in head length; dorsolateral on head, with well-developed subocular ridges. Mouth moderately large and long, broadly arched, width 6.7 (6.1–7.1)% TL, 1.97 (1.68–2.35) times its length; upper and lower labial furrows less than twice spiracle length. Nostril large with tube-like incurrent apertures, well separated, internarial space 1.8 (1.8–2.1)% TL; anterior nasal flap subtriangular, well short of mouth, with posterior tip somewhat lobe like; posterior lobe very narrow. Teeth very small, 5–7 cusps (usually 5), with distinct basal ridges; typically with a long, pointed median cusp flanked by 4, much smaller lateral cusps; outer lateral cusps only slightly smaller than inners; some teeth with pair of additional, outer rudimentary cusps (often difficult to see); in 47 (59, n=1) rows in upper jaw; upper jaw teeth exposed when mouth closed. Dermal denticles on side minute, strongly imbricated, skin velvety; pedicle moderately long; crown shield like, tricuspidate with short lateral cusps and longer, pointed, median cusp; well-defined longitudinal ridge terminating at end of median cusp. No crest of greatly enlarged denticles at base of caudal fin, denticles on basal ridge of upper caudal fin slightly larger than those adjacent. Adult clasper subcylindrical, long and slender, tapering posteriorly to pointed tip, reaching for almost two-thirds of pelvic-anal space, outer length 7.9 (8.7–8.8, n=2)% TL, inner length 7.37 (7.59–10.06) times base width; base width 2.06 (1.74–1.85) times spiracle length; proximal inner margin of pelvic fin fused to dorsal surface of clasper, dorsal margin of claspers connected to pelvic fin and to each other by narrow, naked membrane over clasper insertion; no clasper hooks, most of clasper covered with minute, anteriorly directed denticles. Dorsal fins subequal in size and shape; erect, with straight to weakly convex anterior margin; apices bluntly rounded; posterior margin weakly concave; free rear tip protruding slightly; first dorsal fin originating over pelvic-fin insertion (sometimes behind in mature males), second originating well forward of anal-fin insertion (sometimes just forward). Pectoral fins relatively small, anterior margin weakly convex, length 10.4 (9.8–10.7)% TL; apex broadly rounded, posterior margin truncate (sometimes weakly concave), free rear tip

broadly rounded. Pelvic fins small, low, angular, length 11.6 (11.1–12.3)% TL; free rear tip acutely angular. Anal fin small, subtriangular, base 11.1 (10.4–12.7)% TL, 1.18 (0.98–1.37) in interdorsal space; origin closer to first dorsal-fin insertion than second dorsal-fin origin, anal-fin height 3.31 (3.19–4.05) in base length. Caudal fin moderately elongate, dorsal caudal margin length 24.2 (22.5–24.3) % TL; origin of upper lobe barely distinguishable, forming a very low ridge anteriorly; lower lobe moderately developed, anterior margin with a deep inflexion at about half its length, forming very low ridge anteriorly, usually barely distinguishable at origin; terminal caudal lobe fan-like, with irregular outer margin. Monospondylous centra 34 (34–35, n=6); dorsal precaudal centra 88 (85–88, n=6); total centra 127 (126–129, n=6).

Coloration. Dorsal surface pale brown with numerous white spots and flecks; white spots on back irregularly shaped, mostly subequal to spiracle diameter; head uniformly pale brown, no spots dorsally forward of centre of eye or below eye; no greyish or black markings on body; lacking distinct saddles and blotches, some irregular blotches forward of second dorsal fin; two prominent brownish bands usually present on caudal fin; pectoral, pelvic and anal fins uniformly pale brown; single irregular blotches anteriorly and along bases of dorsal fins. Ventral surface of head, lower abdomen, and tail below lateral midline off white.

SIZE. — To at least 357 mm TL; males mature at about 280 mm TL.

DISTRIBUTION. — Occurs on the continental shelf and upper slope off northwestern Australia between Dampier and the Buccaneer Archipelago in 160–260 m.

ETYMOLOGY. — From the Latin “parvus” meaning little in reference to its small relative size within the genus.

VERNACULAR. — Dwarf catshark.

REMARKS. — This catshark is distinguishable from all other members of the genus by its pale brownish body covered with whitish spots and blotches but lacking dark brown or black spots. Only one other species, *A. vincenti*, is white-spotted without blackish spots. Springer (1979) noted that the *A. vincenti* material examined by him was heterogeneous, and, while including it in a single species, he stated that more material was necessary to determine if it represented more than one species. *A. parvus* is separable from typical *A. vincenti* in having a much paler base colour, larger and fewer light spots, shorter, thicker, pointed claspers, and in being considerably smaller.

Table 1. Proportional dimensions as percentages of total length for: holotype of *Asymbolus funebris* (CSIRO T569); holotype (CSIRO CA3336) and ranges for five paratypes of *A. submaculatus*; and holotype (CSIRO H1505-01) and ranges for five paratypes of *A. parvus*.

	<i>A. funebris</i>	<i>A. submaculatus</i>		<i>A. parvus</i>			
	Holotype	Holotype	Paratypes (n=5)		Holotype	Paratypes (n=5)	
			Min.	Max.		Min.	Max.
TL-Total length (mm)	442	381	351	438	335	272	357
PCL-Precaudal length	80.5	79.9	79.1	81.3	75.5	73.9	78.0
PD2-Pre-second dorsal length	67.3	65.3	64.3	66.3	63.8	62.7	65.3
PD1-Pre-first dorsal length	47.6	45.8	44.3	47.0	44.7	43.0	45.7
HDL-Head length	18.8	18.0	17.6	19.4	18.5	17.4	19.1
PG1-Prebranchial length	13.9	12.9	13.0	15.1	13.2	13.0	14.2
PSP-Prespiracular length	8.8	8.1	8.6	9.2	9.5	9.3	10.2
POB-Preorbital length	4.9	4.4	4.9	5.8	5.9	5.8	6.4
POB- Preorbital length (direct)	5.9	5.4	5.0	6.4	7.2	6.2	7.0
POR-Preoral length	5.4	5.0	4.3	5.5	5.5	5.6	5.9
PRN-Prenarial length	3.3	3.0	3.2	3.4	4.2	3.4	3.9
PP1-Prepectoral length	18.0	16.4	16.0	18.4	17.6	16.1	18.5
PP2-Prepelvic length	38.8	37.8	36.8	41.2	38.2	36.1	37.9
SVL-Snout-vent length	41.4	41.5	40.7	43.7	40.8	38.9	40.9
PAL-Preanal length	56.6	58.8	57.3	58.3	54.9	52.8	55.7
IDS-Interdorsal space	14.3	12.2	11.6	14.6	13.1	12.5	15.0
DCS-Dorsal-caudal space	6.4	6.9	5.9	9.3	5.9	3.6	6.5
PPS-Pectoral-pelvic space	16.9	16.1	16.8	18.9	16.1	15.8	16.9
PAS-Pelvic-anal space	9.6	13.7	9.2	11.1	10.7	7.7	11.7
ACS-Anal-caudal space	5.9	4.3	5.3	6.6	5.1	3.8	5.8
EYL-Eye length	3.2	3.1	2.9	3.3	3.1	3.0	3.3
EYH-Eye height	0.8	0.7	0.7	1.1	1.1	0.4	0.8
INO-Interorbital space	6.8	6.2	5.8	6.6	7.3	6.3	7.2
NOW-Nostril width	2.4	2.5	2.6	2.8	3.0	2.3	2.9
INW-Internarial space	2.1	2.0	1.8	2.4	1.8	1.8	2.1
ANF-Anterior nasal flap length	1.5	1.6	1.4	1.6	1.4	1.2	1.3
SPL-Spiracle length	0.6	0.7	0.5	0.8	0.8	0.6	1.0
ESL-EYE spiracle space	0.7	1.0	0.5	0.8	0.5	0.4	0.9
MOL-Mouth length	3.0	3.1	3.0	3.2	3.4	3.0	3.6
MOW-Mouth width	6.0	6.0	5.5	6.5	6.7	6.1	7.1
ULA-Upper labial furrow length	1.4	1.5	1.3	1.7	1.3	1.2	1.7
LLA-Lower labial furrow length	1.8	1.7	1.7	1.9	1.7	1.6	1.7
GS1-First gill slit height	1.8	1.7	1.6	1.8	1.6	1.5	1.7
GS2	1.9	1.8	1.7	2.2	1.7	1.5	1.8
GS3	1.8	1.8	1.4	2.0	1.8	1.2	1.7
GS4	1.7	1.6	1.2	1.8	1.7	0.9	1.4
GS5-Fifth gill slit height	0.8	1.0	0.9	1.2	1.3	0.7	1.0
HDH-Head height	8.6	9.7	8.3	9.9	7.3	6.8	7.3
TRH-Trunk height	9.8	10.5	8.3	12.7	8.6	7.5	8.9
CPH-Caudal peduncle height	3.8	4.3	4.0	4.3	3.2	2.8	3.5
HDW-Head width	11.3	9.5	10.2	10.7	10.6	9.4	11.6
TRW-Trunk width	10.0	8.9	8.5	11.2	8.6	8.2	9.7

Table 1 (cont'd)

	<i>A. funebris</i>		<i>A. submaculatus</i>		<i>A. parvus</i>		
	Holotype	Holotype	Paratypes (n=5)		Holotype	Paratypes (n=5)	
			Min.	Max.		Min.	Max.
CPW-Caudal peduncle width	2.6	2.7	2.3	3.2	2.2	2.3	2.6
GIR-Girth	31.5	30.7	28.4	36.8	26.7	27.2	30.7
P1L-Pectoral length	10.5	10.9	10.3	11.5	10.4	9.8	10.7
P1A-Pectoral anterior margin	11.2	11.9	10.7	11.8	10.4	10.1	11.0
P1B-Pectoral base	5.5	5.4	5.3	5.8	5.6	5.0	5.5
P1H-Pectoral height	8.8	6.8	7.3	8.2	6.9	6.1	7.3
P1I-Pectoral inner margin	6.3	6.2	6.3	7.2	6.4	6.4	7.5
P1P-Pectoral posterior margin	9.0	8.5	7.6	9.6	7.7	7.9	9.0
P2L-Pelvic length	11.5	10.0	11.6	13.0	11.6	11.1	12.3
P2A-Pelvic anterior margin	5.7	6.1	6.1	7.8	5.5	5.0	5.2
P2B-Pelvic base	8.1	7.4	8.3	9.6	6.7	6.0	7.7
P2H-Pelvic height	4.5	5.1	4.4	5.6	3.3	2.7	4.1
P2I-Pelvic inner margin length	3.7	3.7	3.6	4.2	5.1	4.4	5.5
P2P-Pelvic posterior margin length	8.6	7.4	7.4	9.4	7.1	6.8	8.6
CLO-Clasper outer length	-	11.6	11.7	12.0	7.9	8.7	8.8
CLI-Clasper inner length	-	15.2	15.7	15.9	12.4	12.2	12.6
CLB-Clasper base width	-	1.6	1.4	1.6	1.7	1.3	1.6
D1L-First dorsal length	8.6	9.9	9.8	10.4	8.6	8.1	9.5
D1A-First dorsal anterior margin	9.1	10.5	9.9	10.8	8.9	8.0	8.8
D1B-First dorsal base	6.7	7.5	7.1	8.0	6.4	5.8	6.8
D1H-First dorsal height	4.8	4.5	4.4	5.7	3.8	3.1	4.7
D1I-First dorsal inner margin	2.3	2.3	2.3	2.7	2.4	2.1	2.6
D1P-First dorsal posterior margin	4.3	5.1	4.1	6.3	3.9	3.9	4.6
D2L-Second dorsal length	9.5	9.2	9.6	10.6	9.3	8.9	10.2
D2A-Second dorsal Anterior margin	9.5	10.8	10.1	11.3	9.2	8.4	10.0
D2B-Second dorsal base	7.5	8.0	7.6	8.1	7.1	6.6	8.1
D2H-Second dorsal height	4.5	4.3	3.9	5.1	3.9	3.4	4.7
D2I-Second dorsal inner margin	2.4	2.4	2.4	2.7	2.2	2.3	2.6
D2P-Second dorsal posterior margin	4.4	4.2	4.0	5.3	4.1	3.8	5.1
ANL-Anal length	14.8	13.1	14.0	14.8	12.6	12.1	14.3
ANA-Anal anterior margin	9.4	8.9	8.7	10.0	8.5	8.0	9.8
ANB-Anal base	13.4	11.6	12.5	13.4	11.1	10.4	12.7
ANH-Anal height	3.6	4.4	3.6	4.7	3.3	2.9	3.3
ANI-Anal Inner margin	1.8	1.5	1.3	1.8	1.9	1.7	2.1
ANP-Anal posterior margin	7.2	7.0	7.6	9.5	6.5	6.1	7.3
CDM-Dorsal caudal margin	19.0	20.8	18.1	20.2	24.2	22.5	24.3
CPV-Preventral caudal margin	11.0	12.6	9.6	11.9	13.1	12.9	16.4
CPL-Lower postventral caudal margin	2.1	2.3	2.7	2.8	2.5	2.2	3.3
CPU-Upper postventral caudal margin	7.5	7.2	6.7	9.1	7.8	6.7	7.9
CST-Subterminal caudal margin	4.2	-	3.6	4.4	4.5	4.2	4.7
CTR-Terminal caudal margin	5.4	-	5.4	6.0	4.8	4.6	5.5
CTL-Terminal caudal lobe	6.3	6.4	5.9	6.4	6.4	6.0	6.8
DAO-Second dorsal origin-anal origin	10.5	6.6	7.0	9.1	7.6	8.9	9.5
DAI-Second dorsal insert.-anal insert.	3.5	2.9	1.8	3.8	3.7	4.1	5.2

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REFERENCES

- Compagno, L. J. V. 1970. Systematics of the genus *Hemitriakis* (Selachii: Carcharhinidae), and related genera. *Proceedings of the California Academy of Sciences*, 4 (38): 63–98.
- Compagno, L. J. V. 1979. Carcharhinid sharks: morphology, systematics and phylogeny. Unpublished Ph D. Thesis, Stanford University, 932 pp.
- Compagno, L. J. V. 1984. FAO Species Catalogue. Vol. 4, Sharks of the World. An annotated and illustrated catalogue of shark species known to date. FAO Fisheries Synopsis No. 125, 4 (2): 1–404.
- Compagno, L. J. V. 1988. Sharks of the order Carcharhiniformes. Princetown University Press, New Jersey, 486 pp.
- Compagno, L. J. V. and Stevens, J. D. 1993. *Atelomycterus fasciatus* n. sp., a new catshark (Chondrichthyes: Carcharhiniformes: Scyliorhinidae) from tropical Australia. *Records of the Australian Museum*, 45: 147–169.
- Fowler, H. W. 1941. The fishes of the groups Elasmobranchii, Holocephali, Isospondyli, and Ostarophysi obtained by United States Bureau of Fisheries Steamer 'Albatross' in 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. *Bulletin United States National Museum*, 100 (13): 1–879.
- Gill, T. N. 1862. Analytical synopsis of the order Squali; and revision of the nomenclature of the genera. *Annals. Lyceum Natural History*, 7: 367–408.
- Gomon, M. F., Glover, C. J. M. and Kuitert, R. H. (eds). 1994. The fishes of Australia's south coast. State Print, Adelaide, 992 pp.
- Hutchins, B. and Swainston R. 1986. Sea fishes of southern Australia. Swainston Publishing, Perth, 180 pp.

Last, P. R. and Stevens, J. D. 1994. Sharks and rays of Australia. CSIRO Publications, Melbourne, 513 pp.

Ogilby, J. D. 1885. Notes and descriptions of some rare Port Jackson fishes. *Proceedings of the Linnean Society of New South Wales*, 10 (2): 199–223, 225–232, 445–447.

Seret, B. 1994. Chondrichthyan fishes of New Caledonia. *Chondros*, 5(3): 6–9.

Springer, S. 1979. A revision of the catsharks, family Scyliorhinidae. National Oceanic and Atmospheric Administration Technical Report, National Marine Fisheries Circular, 442: 1–152.

Whitley, G. P. 1939. Taxonomic notes on sharks and rays. *Australian Zoologist*, 9 (3): 227–262.

Whitley, G. P. 1940. The fishes of Australia. Part 1. The sharks, rays, devilfish, and other primitive fishes of Australia and New Zealand. Australian Zoological Handbook. Royal Zoological Society of New South Wales, Sydney, 280 pp.

Zeitz, A. H. C. 1908. A synopsis of the fishes of South Australia. Part 1. *Transactions of the Royal Society of South Australia*, 32: 288–293.

AUSTRALIAN SPOTTED CATSHARKS OF THE GENUS *ASYMBOLUS* (CARCHARHINIFORMES: SCYLORHINIDAE). PART 2: DESCRIPTIONS OF THREE NEW, DARK-SPOTTED SPECIES

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ABSTRACT

Three new species of dark-spotted catsharks (genus *Asymbolus*) are described from the seas of Australia: *A. pallidus* sp. nov. (from the tropical western Coral Sea), *A. rubiginosus* sp. nov. (from the temperate western Tasman Sea), and *A. occiduus* sp. nov. (from the temperate southeastern Indian Ocean). These species can be distinguished from a closely related congener, *A. analis* (Ogilby), which is similar in morphology and colour, by the following characters: *A. pallidus* is smaller, lacks saddles and bands, and has a very short anal fin, relatively more slender caudal peduncle and lower unpaired fins; the sympatric *A. rubiginosus* is more rusty coloured without white spots, and has smaller, denser denticles, a larger caudal fin and a longer interdorsal space; and *A. occiduus* has distinct bands and saddles, a very thin trunk, a much shorter head, and a relatively short snout-vent distance.

INTRODUCTION

The scyliorhinid genus *Asymbolus* is known from two described and six undescribed species in Australian seas (Last and Stevens, 1994). Four pale, dark-spotted species are now known to exist but were identified as morphs of *A. analis* in earlier publications (Springer, 1979; Last *et al.*, 1983; Compagno, 1984). Members of this subgroup occur around the Australian coastline from temperate central Western Australia to tropical northern Queensland, including Tasmania, on the continental shelf and upper slope.

The new species were initially described but not named in Last and Stevens (1994) and illustrated as composites of multiple specimens from a variety of colour prints and slides. These are formally described and named in two papers within this publication: part one by

Compagno, Stevens and Last gives a diagnosis of the genus *Asymbolus* and names three, new multicoloured species; the present paper (part two) by Last, Gomon and Gledhill names the three undescribed spotted catsharks of the *analis* subgroup and provides a key to the species of *Asymbolus*.

MATERIALS AND METHODS

Terminology for external structures and abbreviations, and methodology for measurements generally follows the FAO system of Compagno (1984) with modifications as they appear in Compagno and Stevens (1993). The following were taken as horizontal measurements: TL, PCL, PD2, PD1, HDL, PG1, PSP, POB, PP1, PP2, SVL, PAL, CLO, CLI, DAO and DAI; all other measurements were taken point to point. Dorsal-fin origins and the origin of the upper and lower lobes of the caudal fin were taken as the points at which their anterior scale ridge merges with the scales of the body. In some species this point is difficult to ascertain. Comprehensive measurements were taken for the holotype and five paratypes (by D. Gledhill) and converted to percentages of total length (Table 1). Additional ratios of selected measurements are included in descriptions.

Meristic data, including counts of monospondylous centra and total centra, were obtained for at least six specimens from radiographs. Vertebral count terminology follows Compagno (1979). Counts of diplospondylous precaudal centra proved less reliable because of difficulties determining the point of origin in some species. Tooth row counts were taken directly from specimens. Important meristic and morphometric information for paratypes presented in the descriptions are given in parentheses.

Dentitional terms are modified from Compagno (1970, 1979) according to a system developed by B. Welton and L. Compagno. The major difference as used here and in Compagno (1988) is the substitution of the orientation terms 'distal' for 'postlateral', 'mesial' for 'premedial', 'labial' for 'outer' and 'lingual' for 'inner', in conformity with current European terminology.

Abbreviations for field, accession, and catalogue numbers include: CSIRO—ISR Munro Ichthyological Collection, Hobart; AMS—Australian Museum, Sydney; NMV—Museum Victoria, Melbourne; QM—Queensland Museum, Brisbane; and WAM—Western Australian Museum, Perth.

SPECIES DESCRIPTIONS

Asymbolus occiduus sp. nov.

Fig. 1, Table 1

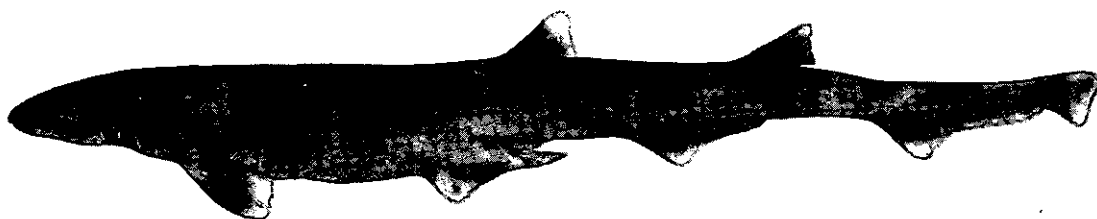


Fig. 1. — *Asymbolus occiduus* sp. nov. holotype, CSIRO H 2263-02, 595 mm TL mature male, lateral view.

Asymbolus sp. F: Last and Stevens, 1994, *Sharks and rays of Australia*, pp 172, 186, fig. 26.14a, b, pl. 21.

Holotype.-- CSIRO H2263-02, mature male, 595 mm TL, south of Cape Leeuwin, Western Australia, 34°57'S, 114°56'E, caught by demersal trawl at 200 m depth, Feb. 9, 1989.

Paratypes.-- CSIRO CA3331, mature male, 588 mm TL, South Australia, 33°01'S, 131°22'E, 98-100 m depth, Aug. 6, 1981; CSIRO CA3332, female, 530 mm TL, South Australia, 33°01'S, 131°22'E, 98-100 m depth, Aug. 6, 1981; CSIRO CA3333, female, 385 mm TL, South Australia, 33°27'S, 131°19'E, 240-280 m depth, Aug. 6, 1981; CSIRO CA3334, mature male, 601 mm TL, South Australia, 33°36.9'S, 132°00.1'E, 138 m depth, Dec. 8, 1981; CSIRO H2613-01, female, 497 mm TL, Western Australia, 32°08.4'S, 115°09.0'E, 225-230 m depth, Feb. 13, 1991; CSIRO H2620-01, female, 279 mm TL, Western Australia, 33°21.4'S, 114°30.6'E, 350-400 m depth, Feb. 16, 1991; CSIRO H2620-02, immature male, 353 mm TL, Western Australia, 33°21.4'S, 114°30.6'E, 350-400 m depth, Feb. 16, 1991; CSIRO H2620-03, immature male, 365 mm TL, Western Australia, 33°21.4'S, 114°30.6'E, 350-400 m depth, Feb. 16, 1991; CSIRO T500, immature male, 390 mm TL, South Australia, 33°23'S, 129°06'E, 247-250 m depth, June 4, 1983.

DIAGNOSIS. — A medium-sized, spotted catshark of the genus *Aymbolus* with the following combination of characters: pale, yellowish green body with 8 or 9 pale brownish saddles on the upper surface and sides; body covered with sharply defined, brownish black spots, prominent dark spot usually beneath each eye and single spot on dorsal midline between each saddle; narrow trunk; relatively short head, preoral length and snout-vent distance; long caudal fin and deep caudal peduncle; low dorsal and pelvic fins; anal-fin base longer than pelvic-anal space; posterior margin of first dorsal fin 0.61–0.77 times its base; teeth ridged, with 5 main cusps; 37–41 monospondylous centra.

DESCRIPTION. — Body slender and firm; trunk compressed only slightly anteriorly, more so towards caudal fin, tapering abruptly at pelvic-fin insertion; head moderately depressed, height 7.7 (7.2–8.3)% TL (n=5); abdomen relatively short, pectoral to pelvic space 16.7 (14.6–16.9)% TL, 1.09 (0.87–1.05) of head length; pelvic to anal space shorter than anal-fin base, distance 0.76 (0.75–0.90) of anal-fin base; caudal peduncle rather slender and moderately elongate, anal to caudal space 0.37 (0.28–0.40) of anal-fin base; peduncle compressed, narrowly rectangular in cross section, flattened dorsally, width 1.53 (1.47–1.54) in height. Snout short, rounded to parabolic in dorsoventral view, tip broadly rounded, bluntly pointed in lateral view; preoral length 3.9 (4.2–4.8)% TL, 0.68 (0.70–0.81) times mouth width; preanal snout 0.95 (1.00–1.14) times eye length. Eyes large, length 3.0 (2.7–3.1)% TL, 5.11 (5.18–6.03) in head length; dorsolateral on head, with well-developed subocular ridges. Mouth moderately large and long, broadly arched, width 5.8 (5.7–6.5)% TL, 2.02 (1.85–2.43) times its length; upper and lower labial furrows much less than half of mouth length. Nostril large with tube-like incurrent apertures, well separated, internarial space 1.6 (1.5–2.3)% TL, and well short of mouth; anterior nasal flap subtriangular with posterior tip somewhat lobe like, margin irregular; posterior lobe narrow. Teeth very small, ridges distinct, mainly with 5 cusps, typically with long, pointed median cusp flanked by two smaller, inner lateral cusps and even smaller (often indistinct) outer lateral cusps (rarely with additional single mesial rudiment near angle of jaw); in 63 (63, n=1) rows in upper jaw; upper jaw teeth exposed when mouth closed. Dermal denticles on side small, strongly imbricated, skin somewhat velvety; pedicle long; crown shield like, weakly tricuspidate with short or rudimentary lateral cusps and long, pointed median cusp; strong longitudinal ridge terminating at end of median cusp. No crest of enlarged denticles at base of caudal fin; denticles on basal ridge of upper caudal fin barely larger than those below. Adult clasper subcylindrical, long and moderately stout, tapering, tip pointed, extending well past midpoint of pelvic-anal space; outer length 8.6% TL, inner length 8.39 times base width; base width 1.59 times spiracle length; proximal inner margin of pelvic fin fused to dorsal surface of clasper, dorsal margin of claspers connected to pelvic fin and to each other by broad,

naked membrane over clasper insertion; no clasper hooks, most of clasper covered with minute, anteriorly directed denticles. Dorsal fins similar in size, subtriangular, raked slightly, with straight to slightly convex anterior margins; apex of first narrowly rounded, second more angular in holotype; posterior margins weakly concave; free rear tip barely protruding; first dorsal fin originating over or slightly behind pelvic-fin insertion, second originating well forward of anal-fin insertion. Pectoral fin relatively small, anterior margin almost straight, length 9.4 (9.1–9.8)% TL; apex broadly rounded, posterior margin truncate to weakly concave, free rear tip broadly rounded. Pelvic fins small, low, angular, length 10.1 (9.0–11.1)% TL. Anal fin elongate, subtriangular, well developed, base 13.9 (11.7–13.4)% TL, 1.09 (1.08–1.34) in interdorsal space; origin closer to first dorsal-fin insertion than second dorsal-fin origin, anal-fin height 4.12 (3.43–4.13) in base length. Caudal fin relatively long, dorsal caudal margin length 22.2 (22.6–25.4)% TL; origin of upper lobe often indistinct, forming a low ridge anteriorly; lower lobe moderately developed, anterior margin with a deep inflexion at about half its length, forming low ridge anteriorly, indistinct at origin; terminal caudal lobe fan-like with biconvex outer margin. Monospondylous centra 40 (37–41, n=6); dorsal precaudal centra 99 (97–99, n=3); total centra 147 (139–146, n=6).

Coloration. Fresh specimens yellowish brown dorsally (usually with greenish hue) with 8–9 pale-bordered brownish saddles (one over gill slits, two above belly, beneath each dorsal fin, one between dorsals, and 2–3 posterior to dorsals); saddles most pronounced in small specimens. Spots dark, large (about equal to or larger than spiracle), mostly concentrated in blotches within saddles; dark spot or diffuse blotch located on suborbital ridge beneath eye; single spot usually on dorsal midline between saddles, mostly one before each dorsal fin. Fins similar to body but with white margins; dorsal fins generally with dark anterior portion (extension of saddle) and white posteriorly, generally with dark spot at insertion and just posterior to origin; other fins lightly spotted dorsally. Uniformly pale to white ventrally. Eyes yellowish to green. Juveniles brownish and white with more pronounced saddles and paler, more poorly defined spots. Saddles usually retained in preserved material.

SIZE. — To at least 600 mm TL; males mature at 586 mm TL.

DISTRIBUTION. — Known from the continental shelf and upper slope off southwestern Australia (between Fremantle, Western Australia, and Fowlers Bay, South Australia) in 98–400 m depth.

ETYMOLOGY. — From the Latin “occiduus” with reference to its western distribution in Australian seas.

VERNACULAR. — Western spotted catshark.

REMARKS. — Possibly the most distinctive of the dark-spotted catsharks with its yellowish green body and pale-edged, brownish saddles, single dark spots on the cheek and before the first dorsal fin, and relatively narrow head and trunk. It has modally the highest monospondylous vertebral count (37–41 centra) of the new species described in this paper (34–38). Like *A. analis* it has a relatively deep caudal peduncle (3.8–4.5 vs 3.1–3.9% TL in the other new species) but has a much shorter head (15.3–16.8 vs 18.1–19% TL in *A. analis*) and larger interdorsal space (14–15.6 vs 10.7–12.5% TL).

Of those species described in the preceding paper (part 1), only *A. submaculatus* has dark spots. *A. submaculatus* differs from all the dark-spotted catsharks in this paper, including *A. analis*, in having a relatively deeper body (head depth usually exceeding 8% TL), smooth tricuspid teeth (rather than with 5–7 cusps and basal ridges), more strongly tricuspidate denticles, a longer preanal length, and relatively larger pelvic fins.

***Asymbolus pallidus* sp. nov.**

Fig. 2, Table 1

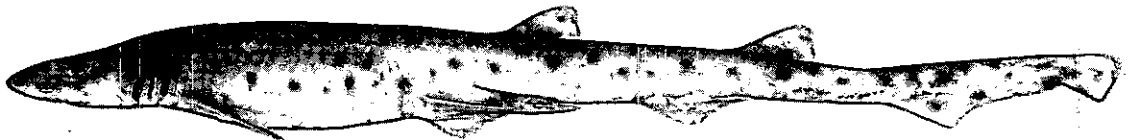


Fig. 2. — *Asymbolus pallidus* sp. nov. holotype, CSIRO H448–01, 439 mm TL mature male, lateral view.

Asymbolus sp. E: Last and Stevens, 1994, *Sharks and rays of Australia*, pp 172, 185, fig. 26.13, pl. 21.

Holotype.— CSIRO H448–01, mature male, 439 mm TL, east of Rockhampton, Queensland, 22°52.9'S, 152°42.3'E, caught by lobster trawl at 225–282 m depth, Nov. 19, 1985.

Paratypes.-- AMS I39855-001, female, 447 mm TL, Queensland, 17°32.8'S, 149°46.2'E, 338 m depth, Dec. 3, 1985; CSIRO H601-07, female, 340 mm TL, Queensland, 22°35.1'S, 153°40.0'E, 314-319 m depth, Nov. 16, 1985; CSIRO H601-08, female, 359 mm TL, Queensland, 22°35.1'S, 153°40.0'E, 314-319 m depth, Nov. 16, 1985; CSIRO H601-09, immature male, 290 mm TL, Queensland, 22°35.1'S, 153°40.0'E, 314-319 m depth, Nov. 16, 1985; CSIRO H769-05, female, 467 mm TL, Queensland, 17°27.7'S, 149°46.5'E, 338-348 m depth, Dec. 3, 1985; CSIRO H1113-02, immature male, 190 mm TL, Queensland, 22°06.1'S, 153°18.3'E, 246-254 m depth, Nov. 19, 1985; CSIRO H1113-03, juvenile male, 321 mm TL, Queensland, 22°06.1'S, 153°18.3'E, 246-254 m depth, Nov. 19, 1985; CSIRO H2343-02, juvenile male, 346 mm TL, Queensland, 20°48.3'S, 152°19.8'E, 314-319 m depth, Nov. 22, 1985; CSIRO H5240-01, female, 460 mm TL, off northern Queensland, Nov.-Dec., 1985; QM I31515, female, 353 mm TL, Queensland, 18°39.3'S, 148°03.4'E, 248 m depth, Dec. 8, 1985.

DIAGNOSIS. — A small, spotted catshark of the genus *Aymbolus* with the following combination of characters: very pale body covered with widely spaced, sharply-defined dark brown spots; no dark spots or blotches beneath the eye; relatively long head and preoral length; slender caudal peduncle; low dorsal, anal and pelvic fins; anal-fin base equal to or shorter than pelvic-anal space; posterior margin of first dorsal fin 0.59-0.69 times its base; teeth ridged with 5 cusps; 34-36 monospondylous centra.

DESCRIPTION. — Body very slender and firm; trunk subcylindrical anteriorly, somewhat compressed laterally, gently tapering to caudal fin; head moderately depressed, height 6.9 (6.8-8.6, n=5)% TL; abdomen relatively short, pectoral to pelvic space 16.1 (14.4-17.1)% TL, 0.98 (0.78-0.94) of head length; pelvic to anal space slightly longer than anal-fin base, distance 1.13 (1.01-1.21) of anal-fin base; caudal peduncle slender and moderately elongate, anal to caudal space 0.62 (0.51-0.90) of anal-fin base; peduncle rather compressed, almost rectangular in cross section, flattened dorsally, width 1.79 (1.23-1.60) in height. Snout short, rounded to parabolic in dorsoventral view, tip broadly rounded, bluntly pointed in lateral view; preoral length 5.0 (5.3-5.8)% TL, 0.84 (0.82-0.91) times mouth width; prenarial snout 1.06 (1.03-1.36) times eye length. Eyes large, length 3.0 (2.9-3.1)% TL, 5.49 (5.81-6.31) in head length; dorsolateral on head, with well-developed subocular ridges. Mouth moderately large and long, broadly arched, width 6.0 (6.0-6.6)% TL, 1.83 (1.86-2.30) times its length; upper and lower labial furrows much less than half of mouth length. Nostril large with tube-like incurrent apertures, well separated, internarial space 1.9 (1.8-2.1)% TL, and well short of mouth; anterior nasal flap subtriangular with posterior tip somewhat lobe like; posterior lobe

relatively narrow. Teeth very small, strongly ridged, mainly with 5 cusps, typically with long, pointed median cusp flanked by two slightly smaller, inner lateral cusps and much smaller (often indistinct) outer lateral cusps; in 66 (59, n=1) rows in upper jaw; upper jaw teeth exposed when mouth closed. Dermal denticles on side minute, strongly imbricated, skin velvety; pedicle long; crown shield like, weakly tricuspidate with short or rudimentary lateral cusps and long, pointed median cusp; strong longitudinal ridge terminating at end of median cusp. No crest of enlarged denticles at base of caudal fin; denticles on basal ridge of upper caudal fin barely large than those below. Adult clasper subcylindrical, long and slender, tapering posteriorly to pointed tip, extending slightly past midpoint of pelvic-anal space; outer length 6.9 (7.6, n=1)% TL, inner length 8.29 times base width; base width 1.62 (2.99) times spiracle length; proximal inner margin of pelvic fin fused to dorsal clasper; dorsal margin of claspers connected to pelvic fins and to each other by a broad, naked membrane over clasper insertion; no clasper hooks, most of clasper covered with minute, anteriorly directed denticles. Dorsal fins subequal in size and shape; raked slightly, with weakly convex anterior margin; apices narrowly rounded; posterior margin slightly concave; free rear tip protruding weakly; first dorsal fin originating over or slightly behind pelvic-fin insertion, second originating slightly forward of anal-fin insertion. Pectoral fins relatively small, anterior margin straight to weakly convex, length 10.4 (10.0–10.3)% TL; apex broadly rounded, posterior margin almost truncate, free rear tip broadly rounded. Pelvic fins small, low, angular, length 10.3 (11.3–13.2)% TL; free rear tip narrow, margin rounded. Anal fin subtriangular, relatively small, base 11.0 (9.3–10.5)% TL, 1.33 (1.32–1.61) in interdorsal space; origin closer to first dorsal-fin insertion than second dorsal-fin origin, anal-fin height 3.66 (2.80–3.28) in base length. Caudal fin relatively short, dorsal caudal margin length 23.4 (20.9–24.5)% TL; origin of upper lobe barely distinguishable, forming a very low ridge anteriorly; lower lobe moderately developed, anterior margin with a deep inflexion at about half its length, forming very low ridge anteriorly, barely distinguishable at origin; terminal caudal lobe fan-like with irregular to truncate outer margin. Monospondylous centra 36 (34–36, n=8); dorsal precaudal centra 89 (85–93, n=6); total centra 134 (129–138, n=8).

Coloration. Dorsal surface pale yellowish brown to creamy white with numerous rather regularly distributed, well-defined, dark brown spots (each about equal to or slightly larger than spiracle diameter) on sides and back; usually with a pair of spots on the dorsal midline preceding each dorsal fin; lacking distinct saddles and blotches, and lacking spots and blotches below eye. Upper surfaces of pectoral, dorsal and caudal fins usually with spots. Pale ventrally.

SIZE. — To at least 468 mm TL; males maturing at about 320 mm; young hatching at about 190 mm.

DISTRIBUTION. — Known from the continental slope off northeastern Australia (between Bundaberg and Cairns, Queensland) in 225–402 m depth.

ETYMOLOGY. — From the Latin “pallidus” in reference to the wan body colour giving it the appearance of being distinctively paler than other dark-spotted catsharks.

VERNACULAR. — Pale spotted catshark.

REMARKS. — *Asymbolus pallidus* is the smallest and palest of the dark-spotted catsharks of the *analus* species complex. It has a relatively small anal fin (length 11–11.8 vs 12.8–16.3% TL in the other three subgroup members, *A. analis*, *A. occiduus* and *A. rubiginosus*), and the pelvic-anal space is usually longer than the anal-fin base (rather than shorter). All other dark-spotted catsharks are temperate species and are allopatric with *A. pallidus*.

Of those species described in the preceding paper (part 1), only *A. submaculatus* has dark spots. The main distinguishing features of this shark and species treated in part 1 are covered in the Remarks section of *A. occiduus*.

Asymbolus rubiginosus sp. nov.

Fig. 3, Table 1

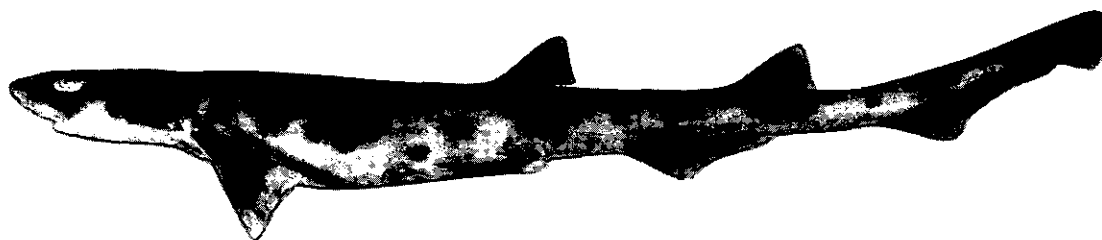


Fig. 3. — *Asymbolus rubiginosus* sp. nov. holotype, CSIRO H3528–01, 419 mm TL female, lateral view.

Asymbolus sp. 2: Gomon *et al.*, 1994, *Fishes of Australia's south coast*, pp 131–132, figs 96, 97.

Asymbolus sp. D: Last and Stevens, 1994, *Sharks and rays of Australia*, pp 172, 184, fig. 26.12, pl. 21.

Holotype.-- CSIRO H3528-01, female, 419 mm TL, south of Gabo Island, Victoria, 37°46.7'S, 149°55.2'E, caught by demersal trawl at 120–130 m depth, Aug. 10, 1993.

Paratypes.-- AMS I39854-001, female, 399 mm TL, Tasmania, 108 m depth, May, 1978; CSIRO CA4059, immature male, 376 mm TL, New South Wales, 36°33'S, 150°16'E, 150–155 m depth, Apr. 2, 1981; CSIRO CA4060, juvenile male, 393 mm TL, New South Wales, 36°33'S, 150°16'E, 150–155 m depth, Apr. 2, 1981; CSIRO H253-01, female, 374 mm TL, Tasmania, 42°49.8'S, 148°19.9'E, 118–120 m depth, May 30, 1985; CSIRO H1325-01, juvenile male, 343 mm TL, Tasmania, 42°49.6'S, 148°18.6'E, 117–120 m depth, May 30, 1985; CSIRO H2693-01, female, 451 mm TL, New South Wales, 31°55'S, 152°52'E, 90–92 m depth, Apr. 16, 1991; CSIRO H2967-04, juvenile male, 396 mm TL, New South Wales, 30°20'S, 153°24'E, 139–154 m depth, Mar. 11, 1992; CSIRO H3427-01, mature male, 481 mm TL, New South Wales, 36°37'S, 150°10'E, 115–117 m depth, Mar. 12, 1993; CSIRO H3427-02, female, 527 mm TL, New South Wales, 36°37'S, 150°10'E, 115–117 m depth, Mar. 12, 1993; NMV A20925, female, 363 mm TL, Tasmania, 42°50.7'S, 148°18.1'E, 120 m depth, May 29, 1985.

DIAGNOSIS. — A medium-sized, spotted catshark of the genus *Asymbolus* with the following combination of characters: pale brownish body covered with orange brown spots (with soft edges and variably spaced); usually with an indistinct brownish blotch beneath the eye and cluster of spots on the dorsal midline between each dark saddle; relatively short and slender caudal peduncle; relatively broad head and trunk; head length usually less than 5 times eye diameter; long anal-fin base; posterior margin of first dorsal fin 0.70–0.93 times its base; anal-fin base much longer than pelvic-anal space; teeth ridged, mainly with 5 cusps; 35–38 monospondylous centra.

DESCRIPTION. — Body slender and firm; trunk subcylindrical anteriorly, somewhat compressed laterally, gently tapering to caudal fin; head moderately depressed, height 7.1 (7.0–8.3, n=5)% TL; abdomen relatively short, pectoral to pelvic space 15.0 (15.2–17.7)% TL, 0.84 (0.85–1.06) of head length; pelvic to anal space much shorter than anal-fin base, distance 0.64 (0.49–0.72) of anal-fin base; caudal peduncle relatively slender and moderately elongate, anal to caudal space 0.14 (0.08–0.27) of anal-fin base; peduncle rather compressed, almost rectangular in cross section, flattened dorsally, width 1.78 (1.62–1.91) in height. Snout short, rounded to parabolic in dorsoventral view, tip

broadly rounded, bluntly pointed in lateral view; preoral length 4.7 (4.5–5.6)% TL, 0.74 (0.73–0.88) times mouth width; prenarial snout 1.02 (0.95–1.15) times eye length. Eyes relatively large, length 3.1 (3.0–3.7)% TL, 5.87 (4.52–5.60) in head length; dorsolateral on head, with well-developed subocular ridges. Mouth moderately large and long, broadly arched, width 6.3 (6.0–6.4)% TL, 2.33 (1.88–2.20) times its length; upper and lower labial furrows much less than half of mouth length. Nostril large with tube-like incurrent apertures, well separated, internarial space 1.6 (1.5–1.8)% TL, and well short of mouth; anterior nasal flap subtriangular with posterior tip somewhat lobe like; posterior lobe relatively narrow. Teeth very small, with distinct basal ridges, mainly with 5 cusps; typically with broad median cusp flanked by two much smaller, inner lateral cusps and smaller outer lateral cusps (outer cusps occasionally barely detectable, teeth appearing tricuspidate); in 58 (57, n=1) rows in upper jaw; upper jaw teeth exposed when mouth closed. Dermal denticles on side very small, densely imbricated, skin somewhat velvety; pedicle moderately long; crown shield like, narrow, weakly tricuspidate with short lateral cusps and long, pointed median cusp; strong longitudinal ridge terminating at end of median cusp. No crest of enlarged denticles at base of caudal fin; denticles on basal ridge of upper caudal fin slightly larger than those below. Adult clasper subcylindrical, very long, rather robust, tapering posteriorly, tip very slender, almost reaching anal-fin origin; outer length (9.0, n=1)% TL, inner length (7.14) times base width; base width (1.94) times spiracle length; proximal inner margin of pelvic fin fused to dorsal clasper, dorsal margin of claspers connected to pelvic fin and to each other by broad, naked membrane over clasper insertion; no clasper hooks, most of clasper covered with minute, anteriorly directed denticles. Dorsal fins subequal in size and shape; triangular, erect, with almost straight anterior margin; apex narrowly rounded; posterior margin oblique, truncate; free rear tip absent or protruding weakly; first dorsal fin originating slightly forward of pelvic-fin insertion, second originating well forward of anal-fin insertion. Pectoral fins of moderate size, anterior margin straight to weakly convex, length 10.9 (10.3–11.2)% TL; apex broadly rounded, posterior margin almost truncate, free rear tip broadly rounded. Pelvic fins small, low, angular, length 11.0 (9.8–12.5)% TL; free rear tip narrow, margin rounded. Anal fin subtriangular, well developed, base 13.9 (12.1–14.9)% TL, 1.06 (0.91–1.25) in interdorsal space; origin closer to first dorsal-fin insertion than second dorsal-fin origin, anal-fin height 3.84 (3.61–4.43) in base length. Caudal fin relatively short, dorsal caudal margin length 23.7 (24.0–26.6) % TL; origin of upper lobe indistinct, forming low ridge anteriorly; lower lobe moderately developed, anterior margin with deep inflexion behind half its length, forming very low ridge anteriorly that extends almost to free rear tip of anal fin (origin often indistinct); terminal caudal lobe fan-like with truncate to slightly convex outer margin. Monospondylous centra 35 (36–38, n=4); dorsal precaudal centra 88 (85–91, n=4); total centra 129 (125–134, n=3).

Coloration. Fresh captured specimens pale brown above with faint greyish brown saddles and blotches over gill region, on body below dorsal fins and laterally on pectoral-pelvic interspace; mostly with diffuse brownish bar beneath eye and rarely containing single, indistinct rusty spot. Spots on upper surface and sides dark brown to rusty with diffuse orange-brown borders (no white spots); variable in number and size, usually larger than spiracle; scattered irregularly but often in small clusters; rosette of 3–7 spots on dorsal midline preceding first dorsal fin. Dorsal fins generally dark with light posterior margins; spots few, faint. Pectoral fin moderately spotted dorsally. Pelvic and anal fins generally pale, sparsely spotted. Uniformly pale ventrally. General body colour and spots relatively darker in preservative.

SIZE. — To at least 549 mm TL; males maturing at about 344 mm.

DISTRIBUTION. — Known from the continental shelf and upper slope off southeastern Australia from Port Arthur (Tasmania) to Moreton Bay (Queensland) in 25–540 m depth.

ETYMOLOGY. — From the Latin “*rubiginosus*” in allusion to its rusty body coloration.

VERNACULAR. — Orange spotted catshark.

REMARKS. — This species resembles the sympatric *A. analis* in general appearance but has rusty brown spots (rather than chocolate brown spots) and lacks white spots (faint white spots present in *A. analis*). It also has smaller and more densely imbricated denticles, a much larger caudal fin (dorsal caudal margin 23.7–26.6% TL vs 19.9–21.9% TL), a larger pectoral-fin base (5.6–6.1% TL vs 4.8–5.5% TL), longer interdorsal space (12.9–15.1% TL vs 10.7–12.5% TL), a shorter head (16.7–18% TL vs 18.1–19% TL) and smaller posterior nasal flap (broadly semicircular in *A. analis*).

The other closely related, dark-spotted catsharks described in this paper, *A. occiduus* and *A. pallidus*, occur in other regions of Australia. *A. rubiginosus* differs from these species in colour pattern, has a relatively shorter caudal peduncle, and a larger eye (expressed by the eye length in head ratio). *A. rubiginosus* has a much longer anal-fin base (12.1–14.9 vs 9.3–10.5% TL) than the tropical eastern *A. pallidus* and reaches a larger maximum size. *A. occiduus* has a relatively deeper caudal peduncle (3.8–4.5 vs 3.5–3.9% TL),

narrower head (9–10.1 vs 10.8–11.8% TL) and trunk (7.1–8.1 vs 8.4–11% TL) than *A. rubiginosus*.

Of other new species described in the preceding paper (part 1), only *A. submaculatus* has dark spots. The main distinguishing features of this shark, and species treated in part 1, are covered in the Remarks section of *A. occiduus*.

Vertebral counts of an additional, 11 non-type specimens of *A. rubiginosus* were similar to those obtained from the type series: monospondylous centra were identical (i.e. 36–38 in both series); dorsal precaudal centra (85–92 vs 85–91 in the type series); total centra (128–138 vs 125–134).

KEY TO AUSTRALIAN *ASYMBOLUS* SPECIES

- 1A. Body with large dark brown blotches and saddles but lacking dark or pale spots
..... *Asymbolus funebris* sp. nov. (southwestern Australia)
- 1B. Body with dark or pale spots and sometimes blotches and saddles.2.
- 2A. Body with mainly pale spots or blotches, dark spots rare or absent.3.
- 2B. Body covered with small, dark spots..... 4.
- 3A. Body pale brown with numerous, large white spots and blotches. Teeth with 5–7
cusps. Monospondylous centra 37 or less.....
..... *Asymbolus parvus* sp. nov. (northwestern Australia)
- 3B. Body greyish brown, mottled with numerous, small white spots. Teeth mostly with
three cusps. Monospondylous centra more than 37.....
..... *Asymbolus vincenti* (southern Australia)
- 4A. Teeth with 3 cusps, large (length of longest exceeding half spiracle diameter). Dorsal-
fin tips broadly rounded. Black spots sometimes on underside of head, abdomen and
tail..... *Asymbolus submaculatus* sp. nov. (southwestern and
possibly southeastern Australia)

4B. Teeth with 5–7 cusps, smaller than half spiracle diameter. Dorsal-fin tips angular or only slightly rounded. No spots on underside of head, abdomen and tail.5.

5A. Spots distinctly orange brown, many of those on flank distinctly larger with less well-defined borders than those on predorsal space; posterior margin of first dorsal fin usually more than 4.7% TL.....
..... *Asymbolus rubiginosus* sp. nov. (southeastern Australia)

5B. Spots dark brown or black, spots on flank and back of similar size and equally well defined; posterior margin of first dorsal fin less than 4.7% TL.6.

6A. Body dark greyish with poorly-defined, dark brown spots; white spots usually also evident. Interdorsal distance much less than 1.5 times total length of first dorsal fin.....
..... *Asymbolus analis* (southeastern Australia)

6B. Body pale, with well-defined, brownish black spots; no white spots. Interdorsal distance 1.5 times or more total length of first dorsal fin.7.

7A. No obvious saddles or bands on dorsal surface; no dark spot beneath eye; usually with a pair of spots on the dorsal midline preceding each dorsal fin and a single spot at the centre of each dorsal-fin base; anal-fin length less than 2.5 times preoral length.
..... *Asymbolus pallidus* sp. nov. (northeastern Australia)

7B. Distinct saddles present on dorsal surface (more prominent in juveniles); usually a dark spot or blotch beneath each eye; mostly with a single spot on the dorsal midline preceding each dorsal fin; anal-fin length more than 2.5 times preoral length.....
..... *Asymbolus occiduus* sp. nov. (southwestern Australia)

Table 1. Proportional dimensions as percentages of total length for holotypes and five paratypes of: *A. occiduous* (holotype CSIRO H2263-02); *A. pallidus* (holotype CSIRO H448-01) and *A. rubiginosus* (holotype CSIRO H3528-01).

	<i>A. occiduous</i>			<i>A. pallidus</i>			<i>A. rubiginosus</i>		
	Holotype	Paratypes (n=5)		Holotype	Paratypes (n=5)		Holotype	Paratypes (n=5)	
		Min.	Max.		Min.	Max.		Min.	Max.
TL-Total length (mm)	595	353	530	439	340	467	419	393	527
PCL-Precaudal length	78.5	73.9	76.8	75.9	76.3	78.0	75.4	72.9	75.7
PD2-Pre-second dorsal length	64.5	62.0	64.8	63.1	62.6	65.6	62.2	61.3	64.8
PD1-Pre-first dorsal length	43.8	41.8	44.5	43.3	42.8	45.7	42.3	41.4	44.6
HDL-Head length	15.3	15.9	16.8	16.5	17.2	18.9	17.9	16.7	18.0
PG1-Prebranchial length	11.2	11.9	13.0	12.5	12.4	13.7	12.8	12.7	14.2
PSP-Prespiracular length	8.0	8.3	9.3	8.9	7.9	9.6	8.3	9.0	10.1
POB-Preorbital length	5.0	4.7	5.9	5.7	4.8	6.4	5.6	5.3	6.1
POB- Preorbital length (direct)	5.0	5.1	6.2	6.1	6.0	6.9	5.8	5.9	6.2
POR-Preoral length	3.9	4.2	4.8	5.0	5.3	5.8	4.7	4.5	5.6
PRN-Prenarial length	2.8	3.1	3.3	3.2	3.2	4.3	3.1	3.4	3.7
PP1-Prepectoral length	15.5	15.2	17.1	15.5	15.9	17.8	17.1	15.9	17.1
PP2-Prepelvic length	36.9	35.1	36.2	35.5	36.0	38.2	36.8	36.2	38.3
SVL-Snout-vent length	40.1	37.8	38.1	39.4	38.8	39.8	39.1	39.2	40.2
PAL-Preanal length	53.8	51.5	54.0	54.4	54.5	57.0	52.6	51.4	54.7
IDS-Interdorsal space	15.1	14.0	15.6	14.6	12.8	15.3	14.7	12.9	15.1
DCS-Dorsal-caudal space	7.2	6.0	7.4	6.3	6.0	7.5	5.4	3.3	5.1
PPS-Pectoral-pelvic space	16.7	14.6	16.9	16.1	14.4	17.1	15.0	15.2	17.7
PAS-Pelvic-anal space	10.5	10.0	11.7	12.4	9.9	12.1	8.8	7.4	10.7
ACS-Anal-caudal space	5.1	3.8	5.4	6.8	5.4	8.6	2.0	1.3	3.4
EYL-Eye length	3.0	2.7	3.1	3.0	2.9	3.1	3.1	3.0	3.7
EYH-Eye height	-	0.7	1.0	0.9	0.6	1.1	0.6	0.7	1.1
INO-Interorbital space	6.3	5.9	7.4	5.7	6.2	7.7	7.0	6.1	7.2
NOW-Nostril width	2.1	1.9	2.7	2.4	2.6	3.0	2.5	2.1	2.7
INW-Internarial space	1.6	1.5	2.3	1.9	1.8	2.1	1.6	1.5	1.8
ANF-Anterior nasal flap length	1.0	0.9	1.2	1.2	1.2	1.4	1.3	1.0	2.3
SPL-Spiracle length	0.8	0.7	0.9	0.9	0.7	1.0	0.9	0.6	0.8
ESL-EYE spiracle space	0.6	0.4	0.8	0.4	0.5	0.7	0.6	0.6	0.7
MOL-Mouth length	2.9	2.5	3.1	3.3	2.8	3.5	2.7	2.9	3.3
MOW-Mouth width	5.8	5.7	6.5	6.0	6.0	6.6	6.3	6.0	6.4
ULA-Upper labial furrow length	1.6	1.4	1.7	1.3	1.0	1.5	1.2	1.3	1.6
LLA-Lower labial furrow length	1.8	1.7	2.1	1.5	1.5	1.7	1.6	1.6	2.1
GS1-First gill slit height	2.3	1.7	2.6	1.9	1.5	2.0	2.2	1.7	2.4
GS2	2.0	1.4	2.0	1.7	1.5	2.0	1.7	1.5	2.3
GS3	1.8	1.3	1.8	1.5	1.3	2.0	1.7	1.5	2.2
GS4	1.6	1.1	1.5	1.3	1.0	1.7	1.6	1.2	1.9
GS5-Fifth gill slit height	0.9	0.7	1.2	0.7	0.7	1.2	1.1	0.8	1.3
HDH-Head height	7.7	7.2	8.3	6.9	6.8	8.6	7.1	7.0	8.3
TRH-Trunk height	9.0	7.9	9.8	7.0	8.0	10.9	8.6	8.5	10.0
CPH-Caudal peduncle height	3.8	4.0	4.5	3.3	3.1	3.8	3.8	3.5	3.9
HDW-Head width	9.1	9.0	10.1	9.2	9.7	11.0	11.8	10.8	11.8
TRW-Trunk width	7.1	7.5	8.1	8.3	8.3	10.0	8.8	8.4	11.0

Table 1 (cont'd)

	<i>A. occiduus</i>			<i>A. pallidus</i>			<i>A. rubiginosus</i>		
	Holotype	Paratypes (n=5)		Holotype	Paratypes (n=5)		Holotype	Paratypes (n=5)	
		Min.	Max.		Min.	Max.		Min.	Max.
CPW-Caudal peduncle width	2.2	2.7	3.0	1.9	2.0	3.0	2.2	1.9	2.8
GIR-Girth	25.5	25.5	28.0	24.4	25.5	32.6	28.6	24.9	34.3
P1L-Pectoral length	9.4	9.1	9.8	9.5	9.7	10.0	10.4	10.0	10.3
P1A-Pectoral anterior margin	10.2	9.3	10.3	9.6	9.5	10.2	10.9	10.3	11.2
P1B-Pectoral base	5.3	4.9	5.7	5.2	5.4	5.6	5.8	5.6	6.1
P1H-Pectoral height	7.2	7.4	8.5	7.4	7.1	8.3	7.3	6.9	8.8
P1I-Pectoral inner margin	5.8	5.7	6.9	7.0	5.3	7.0	6.1	6.2	7.3
P1P-Pectoral posterior margin	9.2	8.4	8.9	8.0	8.1	9.5	9.5	8.7	11.0
P2L-Pelvic length	10.1	9.0	11.1	10.3	11.3	13.2	11.0	9.8	12.5
P2A-Pelvic anterior margin	5.1	4.6	5.2	4.5	4.7	5.6	4.3	4.0	5.1
P2B-Pelvic base	6.3	6.1	7.8	5.6	7.4	8.5	7.1	5.6	7.9
P2H-Pelvic height	4.0	2.9	3.6	3.8	2.7	3.7	3.0	2.8	3.7
P2I-Pelvic inner margin length	4.5	3.0	3.6	5.0	4.2	5.1	3.6	3.2	5.0
P2P-Pelvic post. margin length	7.5	6.4	7.4	6.9	7.2	9.1	8.8	6.0	10.3
CLO-Clasper outer length	8.6	-	-	6.9	-	-	-	9.0	9.0
CLI-Clasper inner length	11.3	-	-	12.3	-	-	-	11.7	11.7
CLB-Clasper base width	1.3	-	-	1.5	-	-	-	1.6	1.6
D1L-First dorsal length	8.0	7.5	8.4	8.4	8.1	8.8	8.5	8.1	9.4
D1A-First dorsal anterior margin	8.0	7.7	9.0	8.2	8.1	8.9	8.4	7.7	9.7
D1B-First dorsal base	5.9	5.0	6.5	6.0	6.1	6.4	6.0	5.7	7.1
D1H-First dorsal height	4.1	3.9	4.5	3.6	3.3	4.3	4.7	4.1	5.1
D1I-First dorsal inner margin	2.2	2.1	2.4	2.4	2.0	2.5	2.3	2.2	3.0
D1P-First dorsal posterior mar.	4.3	3.8	4.4	3.8	3.7	4.4	5.0	4.7	6.1
D2L-Second dorsal length	8.5	8.2	9.3	9.2	7.6	9.1	9.0	8.6	10.1
D2A-Second dorsal Anterior mar.	8.3	8.2	10.1	8.7	7.6	9.1	8.4	8.3	10.0
D2B-Second dorsal base	6.4	5.9	7.1	6.8	6.0	6.9	6.9	6.1	7.9
D2H-Second dorsal height	4.2	4.0	4.5	3.7	3.5	4.7	4.1	3.8	4.7
D2I-Second dorsal inner margin	2.1	2.1	2.5	2.6	2.1	2.3	2.2	2.2	2.8
D2P-Second dorsal post. margin	4.5	3.9	4.3	4.0	3.9	4.5	4.4	4.1	4.7
ANL-Anal length	14.8	13.3	14.7	12.6	11.0	11.8	15.2	13.9	16.3
ANA-Anal anterior margin	7.6	7.3	8.0	7.2	6.3	7.2	7.7	7.4	9.1
ANB-Anal base	13.9	11.7	13.4	11.0	9.3	10.5	13.9	12.1	14.9
ANH-Anal height	3.4	3.2	3.9	3.0	3.0	3.4	3.6	3.0	3.5
ANI-Anal Inner margin	1.3	1.4	1.6	1.8	1.6	1.8	1.4	1.4	2.0
ANP-Anal posterior margin	9.2	7.7	9.7	7.3	6.2	7.2	9.3	7.8	9.2
CDM-Dorsal caudal margin	22.2	22.6	25.4	23.4	20.9	24.5	23.7	24.0	26.6
CPV-Preventral caudal margin	12.3	12.6	14.5	12.5	9.5	13.5	15.2	14.6	16.4
CPL-Lower postventr. caud. mar.	3.1	2.9	4.0	4.0	1.9	2.6	2.7	1.6	3.0
CPU-Up. postventr. caud. mar.	9.5	9.0	11.0	7.6	7.8	9.0	8.8	8.7	9.7
CST-Subterminal caudal margin	4.1	3.6	4.3	4.5	3.6	4.5	3.6	3.9	4.4
CTR-Terminal caudal margin	5.4	5.4	6.0	4.6	5.3	5.9	5.8	5.4	6.2
CTL-Terminal caudal lobe	6.2	6.4	6.9	6.2	6.3	6.7	6.4	5.7	7.2
DAO-Second dors. orig.-anal orig.	11.2	9.5	11.0	9.0	7.6	8.7	10.9	9.7	11.7
DAI-Sec. dor. insert.-anal insert.	3.4	3.2	4.0	4.5	3.9	4.6	3.3	3.2	4.4

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REFERENCES

- Compagno, L. J. V. 1970. Systematics of the genus *Hemitriakis* (Selachii: Carcharhinidae), and related genera. *Proceedings of the California Academy of Sciences* 4, (38): 63–98.
- Compagno, L. J. V. 1979. Carcharhinid sharks: morphology, systematics and phylogeny. Unpublished Ph. D Thesis, Stanford University, 932 pp.
- Compagno, L. J. V. 1984. FAO Species Catalogue. Vol. 4, Sharks of the World. An annotated and illustrated catalogue of shark species known to date. FAO Fisheries Synopsis No. 125, 4 (2): 1–404.
- Compagno, L. J. V. 1988. Sharks of the order Carcharhiniformes. Princetown University Press, New Jersey, 486 pp.
- Compagno, L. J. V. and Stevens, J. D. 1993. *Atelomycterus fasciatus* n. sp., a new catshark (Chondrichthyes: Carcharhiniformes: Scyliorhinidae) from tropical Australia. *Records of the Australian Museum*, 45: 147–169.
- Gomon, M. F., Glover, C. J. M. and Kuitert, R. H. (eds). 1994. The Fishes of Australia's South Coast. State Print, Adelaide, 992 pp.
- Last, P. R., Scott, E. O. G. and Talbot, F. H. 1983. Fishes of Tasmania. Tasmanian Fisheries Development Authority, Hobart, 563 pp.
- Last, P. R. and Stevens, J. D. 1994. Sharks and rays of Australia. CSIRO Publications, Melbourne, 513 pp.
- Springer, S. 1979. A revision of the catsharks, family Scyliorhinidae. National Oceanic and Atmospheric Administration Technical Report, National Marine Fisheries Circular, 442: 1–152.

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