

## *Cephaloscyllium stevensi*: a new species of swellshark (Carcharhiniformes: Scyliorhinidae) from Papua New Guinea

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### Abstract

*Cephaloscyllium stevensi* n. sp., is described from five adult specimens (445-660 mm TL) taken in a *Nautilus* trap set in 240-274 m off eastern Papua New Guinea. It is distinguished from its similar congener, *C. speccum* Last, Séret & White, from off north-western Australia, by its color pattern: gray-brown above and lighter ventrally. The entire body is mottled with brown and whitish spots of variable size; there are six large dorsal dark brown saddle blotches on the head and body and three on the caudal fin; the anterior four dorsal blotches connect or lead obliquely to other dark blotches ventrally; and the small white spots are larger in males than females and are most distinct within or at the edges of the dark brown blotches. The dense mottling of brown and white spots ventrally on the head and body appears unique to this species. A mature female (660 mm TL) had 16 large yellow oocytes (8-21 mm diameter). The proximal half of the claspers of the two adult male paratypes have a closed tube, as has been described for two other benthic sharks in the genera *Ginglymostoma* and *Halaelurus*.

### Zusammenfassung

*Cephaloscyllium stevensi* n. sp. wird anhand von fünf erwachsenen Exemplaren (445-660 mm TL) beschrieben, die mit einer *Nautilus*-Falle 240 bis 274 m vor der Ostküste Papua-Neuguineas gefangen wurden. Diese neue Art unterscheidet sich von einer ähnlichen Art innerhalb der Gattung: *C. speccum* Last, Séret & White, die vor NW-Australien lebt, durch ihre Färbung: graubraun auf der Oberseite, ein hellerer Farbton auf der Unterseite. Der ganze Körper ist mit braunen und weißlichen Flecken unterschiedlicher Größe übersät; auf Kopf und Rumpf gibt es oben sechs große dunkelbraune Sattelflecken sowie drei weitere auf der Schwanzflosse; die vier vorderen Rückenflecken verbinden sich mit weiteren dunklen Flecken auf der Unterseite oder leiten in schräger Richtung dazu über; die kleinen weißen Flecken sind bei Männchen größer als bei Weibchen und innerhalb der dunkelbraunen Flecken oder an ihren Rändern am deutlichsten erkennbar. Die dichte Fleckung in brauner

und weißer Farbe auf der Unterseite von Kopf und Rumpf ist offenbar auf diese Art beschränkt. Ein geschlechtsreifes Weibchen (660 mm TL) besaß 16 große gelbe Eizellen (8-21 mm im Durchmesser). Bei den Klammerorganen der männlichen Vertreter der beiden Paratypen war die körpernahe Hälfte als geschlossene Röhre gestaltet, wie es von zwei anderen benthischen Haien der Gattungen *Ginglymostoma* und *Halaelurus* ebenfalls beschrieben wurde.

### Résumé

*Cephaloscyllium stevensi* n. sp. est décrit sur base de cinq spécimens adultes (445-660 mm de LT) attrapés dans un piège *Nautilus*, à 240-274 m de profondeur, au large de la Papouasie-Nouvelle-Guinée. Il se distingue de son congénère, *C. speccum* Last, Séret & White, au large de l'Australie du Nord-ouest, par son patron de coloration : gris-brun sur le haut et plus clair du côté ventral. Le corps entier est garni de taches brunes et blanchâtres de taille variable, il y a six grandes taches brun foncé en selle dorsalement sur la tête et sur le corps et trois sur la caudale ; les quatre taches dorsales antérieures se relient à ou mènent en oblique vers d'autres taches sombres ventralement ; et les petites taches blanches sont plus grandes chez les mâles que chez les femelles et sont le plus nettes aux limites des taches brun foncé. La densité des taches brunes et blanches ventralement sur la tête et le corps est propre à cette espèce. Une femelle mature (660 mm de LT) avait 16 grands oocytes jaunes (8-21 mm de diamètre). A peu près la moitié des ptérygopodes des deux paratypes mâles adultes ont un canal obturé, comme décrit pour deux autres requins benthiques des genres *Ginglymostoma* et *Halaelurus*.

### Sommario

*Cephaloscyllium stevensi* n. sp., è descritta sulla base di cinque esemplari adulti (445-660 mm TL) pescati con una trappola per *Nautilus* posta a 240-274 m di profondità al largo delle coste orientali di Papua Nuova Guinea. Si distingue dal congenere più simile, *C. speccum* Last, Séret & White, dell'Australia nordoccidentale, per la colorazione:

grigio-marrone dorsalmente e più chiara ventralmente. L'intero corpo è ricoperto da macchie brune e biancastre di dimensioni variabili; inoltre, ci sono sei larghe macchie dorsali a sella di colore bruno scuro sul capo e sul corpo e altre tre sulla pinna caudale. Le quattro macchie anteriori dorsali si connettono o si congiungono obliquamente e ventralmente ad altre macchie scure; le piccole macchie bianche sono più grandi nei maschi rispetto a quelle delle femmine e sono più distinte entro o ai margini delle grandi macchie a sella. La densa macchiatura ventrale sul capo e sul corpo sembra un tratto distintivo di questa specie. Una femmina matura (660 mm TL) conteneva 16 grandi oociti gialli (8-21 mm di diametro). La metà prossimale degli epipeni di due maschi adulti elencati tra i paratipi presentava un canale chiuso, come è stato descritto per due altre specie di squali di fondo dei generi *Ginglymostoma* e *Halaelurus*.

## INTRODUCTION

Swellsharks of the genus *Cephaloscyllium* (family Scyliorhinidae) are unique among sharks in having the ability to swell their bodies from head to anus by filling the cardiac stomach with water or air if removed from the sea (Clark 1947; Yano, et al. 2005; Inoue & Nakaya 2006), like genera of unrelated pufferfishes (Breder & Clark 1947) and two genera of filefishes, *Brachaluteres* and *Paraluteres* (Clark & Gohar 1953), in the teleost order Tetraodontiformes.

Stewart Springer (1979) revised the genus *Cephaloscyllium*. He distinguished it from the other genera in the family Scyliorhinidae by the presence of a supraorbital crest on the chondrocranium and the lack of upper and lower labial furrows. He recognized six species, four in the Indo-Pacific: *C. fasciatum*, *C. isabella*, *C. laticeps* and *C. sufflans*, and two in the eastern Pacific: *C. uter* and *C. ventriosum*. He pointed out the difficulty of separating species of the genus that do not have distinctive color patterns, as have Compagno (1984) and Last (pers. comm.). Of the six species, only *C. fasciatum* is readily distinguished by its color pattern. Springer differentiated the remaining five species mostly on the basis of a combination of color patterns and "minor differences," e.g., length of nasal flaps and strength of ridges on egg capsules.

Compagno (1984) and Compagno et al. (2004) added *Cephaloscyllium nascione* from south-eastern Australia, *C. silasi* from south-west India, and placed *C. uter* in the synonymy of *C. ventriosum*. Yano et al. (2005) described *C. sarawakensis* from Borneo, and Inoue & Nakaya (2006) added *C. parvum* from Borneo. The latter was designated a junior synonym of *C. sarawakensis* by Schaaf-Da Silva & Ebert

(2008a). They redescribed *Cephaloscyllium ventriosum* in a second paper (2008b).

Last & Stevens (1994), in their early compilation of the chondrichthyans of Australia, recognized an additional five undescribed species of *Cephaloscyllium*. They designated these as species A, B, C, D and E, presented drawings, a common name and some distinctive features for each. Their "few" specimens of species E were known from only two localities on the continental slope of tropical Australia: off Rowley Shoals (Western Australia) in 390-440 m, and near Lihou Reef, east of Innisfail (Queensland) in 600-700 m. Specimens from these two collection areas (Fig. 1), were described as having different coloration, "Western forms white ventrally (eastern forms greyish)." Last & Stevens (1994) did not indicate from which coast of Australia the immature specimen used for their illustration (lateral view) was collected, but ventrally it appears pale and unmarked, therefore it is probably the one from off Rowley Shoals.

Seven new species of *Cephaloscyllium*, including the five mentioned above, were described by various authors in a compilation entitled "Descriptions of new Australian Chondrichthyans" edited by Last, White & Pogonoski (2008). For authorship and distribution of these species, see Table I and Fig. 1.

The new species we describe in this paper is similar to species E, the "Speckled Swell Shark" of Last & Stevens (1994) from western Australia, now *C. speccum* Last, Séret and White, 2008. The population of species E off Queensland was described as *C. signourum* Last, Séret and White, 2008.

Peter Last loaned us two specimens of *Cephaloscyllium speccum* from Rowley Shoals off north-western Australia, from the collection of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to compare with our new species from Papua New Guinea (PNG). The specimens of *C. speccum* are ventrally almost uniformly pale, with only a few dark spots. This is in contrast to the dark mottled pattern on the ventral part of the body, head and tail of our five mature specimens from PNG. The proportional dimensions of the two Western Australia specimens are compared with our five PNG specimens in Table II.

Of our five specimens, the female holotype, two male paratypes, and one female paratype are deposited in the National Museum of Natural History of the Smithsonian Institution in Washington, DC (USNM), and one female paratype was given to CSIRO (H6820-01).

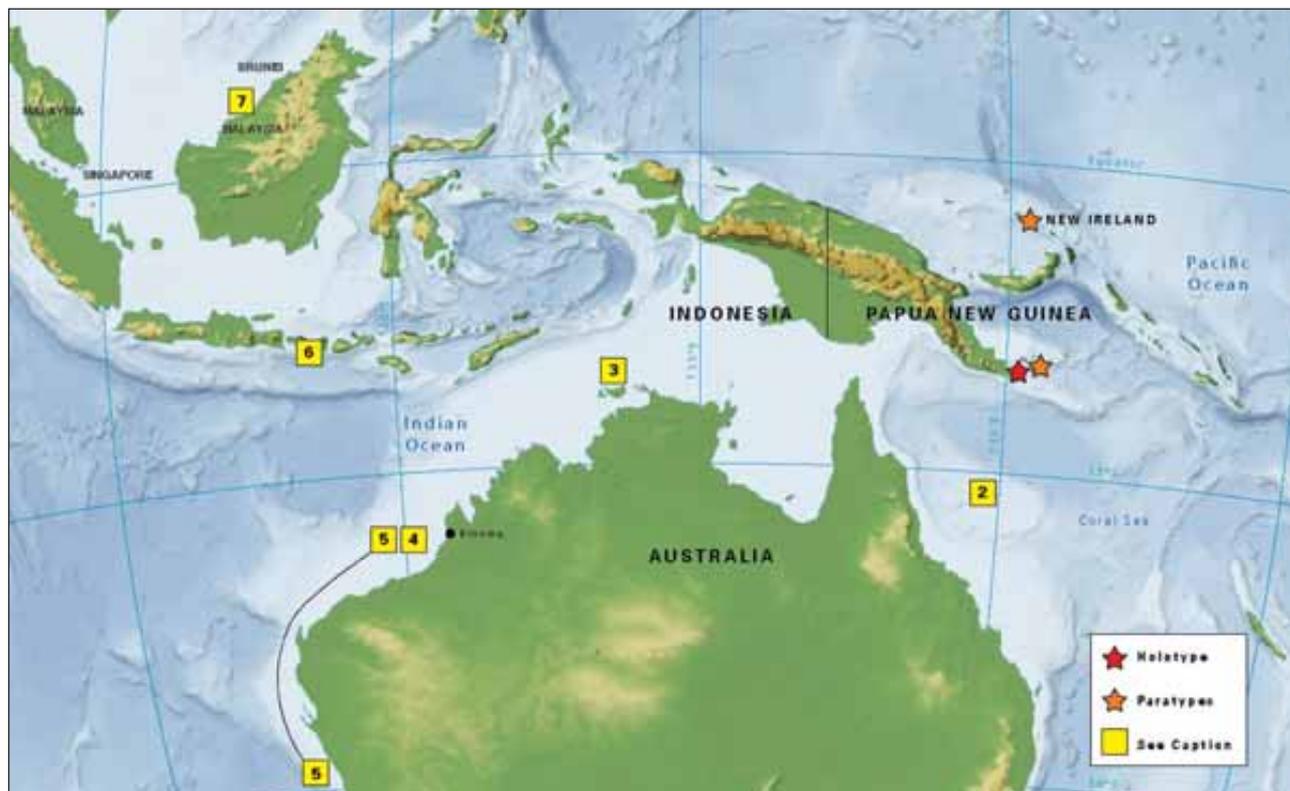
## MATERIAL AND METHODS

The five specimens of *C. stevensi* n. sp. were collected during the night using baited wire cages (*Nautilus* traps) set in deep water. The cages were lowered on a long cable from the dive boat M/V *Telita*, operated by Bob Halstead. Specimens were examined, measured, and dissected aboard the boat and then frozen. The second author photographed the holotype while it was still alive underwater, though moribund, at 2.5 m depth (Figs 2 and 3). On shore, the specimens were preserved in formalin and later transferred to ethyl alcohol. Measurements were made with dial calipers and calibrated rulers. Each measurement and count was taken at least three times, and the averages are reported in Table II as percent of total length (TL), along with tooth and vertebral counts. We added the measurements that Stewart Springer wished he had made: "If I were to start again... I would record additionally the greatest width of the head and... the least distance across the top of the head between the upper eyelids" (Springer 1979: 3).

Our terminology and measurements follow Springer (1979) and Compagno (1984). We made vertebral counts on radiographs according to the method of Springer & Garrick (1964). Testing of the closure of the clasper groove/tube was made by inserting a blunt tapestry needle with a coarse thread into the apophysis and through the clasper groove/tube until it came out the distal end of the clasper. The head of the clasper was opened, the thread was pulled to the side to test the length of the clasper tube; then a cross-section was cut through the clasper tube (Fig. 5b).

### *Cephaloscyllium stevensi*, n. sp. (Figs 1-7; Tables I-II)

**Holotype:** USNM 359091, mature female, 586 mm TL, *Nautilus* trap set overnight, 244 m, east coast of PNG, north-west of Mt. Koia (10°15'S, 150°46.48'E), 15 December 1993, B. Halstead and J. E. Randall (Fig. 1).



**Fig. 1.** Map of Papua New Guinea, Indonesia, and northern Australia showing: (1) three locations where the holotype and paratypes of *Cephaloscyllium stevensi* n. sp. were caught off eastern PNG; (2) where *C. signourum* was found off north-eastern Australia; (3) where *C. cooki* was found off northern Australia; (4) where *C. specum* and other deep sea swellshark species were found off north-western Australia; (5) where *C. hiscosellum* was found off western Australia; (6) where *C. pictum* was found (in a fish market) in central Indonesia; and (7) where *C. sarawakensis* was found off north-eastern Borneo (Malaysia).

**Paratypes:** USNM 329583, mature male, 524 mm TL, *Nautilustrap* set overnight in 240-274 m, area of New Ireland, PNG (02°41'S, 150°31'E), between October 1988 and April 1995, B. Halstead; USNM 358812, mature male, 543 mm TL, *Nautilustrap* set overnight in 240-274 m, New Ireland, PNG (02°41'S, 150°31'E), between October 1988 and April 1995, B. Halstead; CSIRO H6820-01, female, 445 mm TL, *Nautilustrap* set overnight in 240-274 m, New Ireland, PNG (02°41'S, 150°31'E), between October 1988 and April 1995, B. Halstead; USNM 358814, female, 660 mm TL (head only saved), east coast of PNG (10°15'S, 151°03'E), 17 March 1993, B. Halstead and E. Clark (Fig. 1).

**Diagnosis:** *Cephaloscyllium stevensi* n. sp., like the other species of this genus, is most easily distinguished by its color pattern. Gray-brown above, whitish ventrally, mottled with brown and whitish spots of variable size over head and body, including ventrally; six large dark brown saddle blotches dorsally on head and body and three on caudal fin; first four dorsal dark blotches connecting or leading obliquely to other dark blotches below; small white spots most distinct within or at edges of dark brown blotches. Largest specimen, 660 mm TL.

**Description:** The holotype is female, 586 mm TL; largest paratype a 660 mm TL female.

Body proportions, in percent of total length, of



**Fig. 2a-b.** *Cephaloscyllium stevensi*, holotype, female, 586 mm TL, USNM 359091, collected in trap at 244 m off east coast of mainland Papua New Guinea. (a) Dorsal view; (b) Left lateral view. Photographed while still alive, though moribund, in 2.5 m by J. E. Randall.

**Table I.** Seven species of deep-water (118 to 700 m) swellsharks, *Cephaloscyllium*, found in Papua New Guinea, northern Australia, Indonesia, and Malaysia. <sup>1</sup>Location of fish market where shark was acquired. \*DNAC = *Description of New Australian Chondrichthyans* 2008.

Species	Common Name	Reference	Lat. & Long.	Depth m	M+F = T
<i>C. stevensi</i> n. sp.	Steven's swellshark	Clark & Randall manuscript	10° S, 150° E 2° S 150° E	240-274	2+3 = 5
<i>C. signourum</i>	Flagtail swellshark	Last, Seret, & White (2008) DNAC* p. 129 (137)	~9° S & ~17° S	480-700	2+4 = 6
<i>C. cooki</i>	Cook's swellshark	Last, Seret, & White (2008) DNAC p. 129 (130)	10° S, 129° E 8° S, 132° E 9° S, 131° E	223-300	3+3 = 6+
<i>C. speccum</i>	Speckled swellshark	Last, Seret & White (2008) DNAC p. 129 (140)	17° S, 118° E 14° S, 122° E	150-455	4+3 = 7
<i>C. hiscosellum</i>	Australian reticulate swellshark	White & Ebert (2008: 172)	18° S, 117° E 29° S, 113° E	294-420	6+6 = 12
<i>C. pictum</i>	Painted swellshark	Last, Seret, & White (2008) DNAC p. 129 (134)	8° S & 116° E <sup>1</sup> Fish landing, Lombok, Indonesia	(Fish market)	4+1 = 5
<i>C. sarawakensis</i>	Sarawak pygmy swellshark	Yano et al. (2005: 147)	4° N, 109° E 5° N, 111° E	118-165	8+13 = 21
includes synonym: <i>C. parvum</i>		Inoue & Nakaya (2006: 71-92)			8+7 = 15

type specimens are given in Table I. Body moderately robust anteriorly, tapering behind the pelvic fins, head moderately depressed; snout short, its length 3.4- 4.1% of TL; head width 14.7-17.1% (holotype 17.1%, paratypes 14.7-15.4%); gill slits lateral, first slit 17.0-19.4%, last two closer together than slits 1-3, with fourth gill slit anterior to pectoral fin base and fifth gill slit mostly over pectoral fin base; first four slits subequal in length, fifth much smaller; snout slightly rounded; eyes dorsolateral, slit-like, length 3.3-3.8%; suborbital groove longer than eye, spiracle small, oblong, and close to eye, greatest diameter 0.4-0.5%, least diameter 0.2-0.4%; anterior nasal flap short; labial furrows absent; postoral groove short, extending ventrolaterally from corners of mouth; first dorsal fin strongly raked, apex rounded, posterior margin truncate, fin larger than second dorsal fin, its origin over midbase of pelvic fin; second dorsal fin strongly raked, apex narrowly rounded, posterior margin truncate; anal fin much larger and taller than second dorsal fin, its origin ahead of origin of second dorsal fin; pectoral fin short and broad, anterior margin convex and with broadly rounded apex, posterior margin truncate, free tip broadly rounded; pelvic fins relatively small; anal fin larger than second dorsal; claspers cylindrical, elongate and reaching anal fin origin in the mature individual, surface covered with denticles except for tip.

Color pattern dominated by eight large dark brown saddle blotches, first on occiput, constricted medially, leading obliquely to blotch below eye; second above pectoral fins, followed anteroventrally by two dark blotches, lower over gill slits, followed by two blotches on dorsal surface connecting obliquely to two dark blotches on side, one below and extending into each dorsal fin and two across caudal fin; terminal lobe of caudal fin with irregular dark blotch; scattered small white spots present over body, most conspicuous within and at edges of large dark brown blotches. Size of white spots appearing to be sexually dimorphic, larger on male paratypes (1.5-13.9 mm diameter, average ~ 3.5 mm), especially on head and across dorsum at base of pectoral fins, than on female paratypes (1.4-3.4 mm diameter, average ~ 2.0 mm). Rest of head, body and fins mottled with brown and whitish spots of variable size.

Largest female (USNM 358814) dissected while fresh (recorded on videotape) and only head saved. Two conspicuous white nidamental glands, one on each side, measuring 30 x 42 mm each. Right ovary with 16 round yellow oocytes, 8-21 mm diameter and about 60 smaller white oocytes, 1-8 mm diameter. Left ovary not developed. Gut, as in all swellsharks, with highly inflatable cardiac stomach, followed by narrow pyloric stomach leading to spiral valve intestine with eight turns.

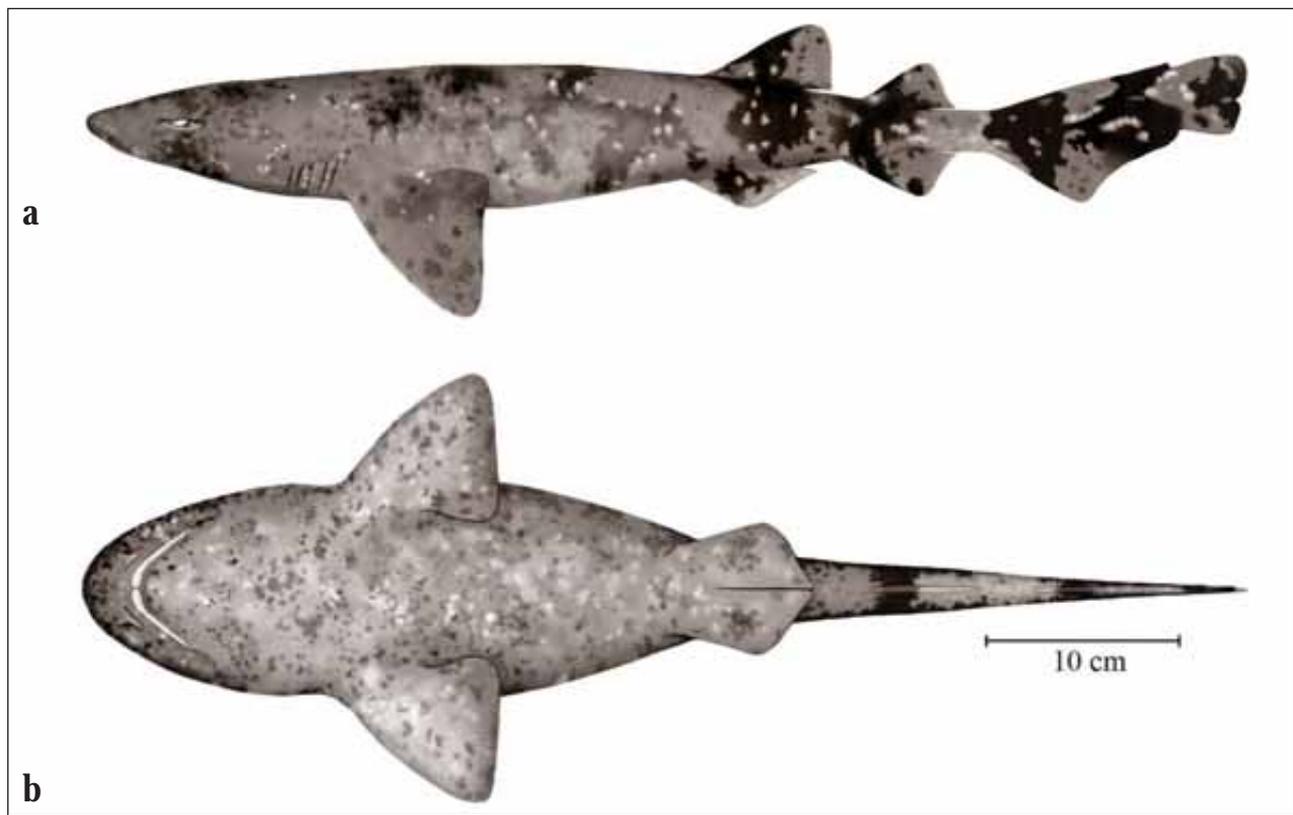


**Fig. 3a-b.** *Cephaloscyllium stevensi*, holotype, female, 586 mm TL, USNM 359091, collected in trap at 244 m off east coast of mainland Papua New Guinea. (a) Close-up, left lateral view, showing green eye, truer coloration (without blue hue of photos in Fig. 2, that were taken through more water), irregular dark band around head and across eye, and dark blotch above gill openings; (b) Close-up, ventral view, showing mottled dark and light spots. Photographed while still alive, though moribund, in 2.5 m by J. E. Randall.

Claspers of two mature male paratypes covered with dermal denticles on ventral side except for tips, exposing naked spur for length of 4.6 mm (Fig. 5). Claspers extending about half of their length beyond pelvic fin tips. Each clasper with base diameter of 9.6 mm narrowing to 6.8 mm for most of length. Dorsal view of relaxed clasper appearing to have groove extending from base to naked tip. However, if clasper groove spread open, tissue on floor of groove seen to be covering closed tube extending from apophyle half length of clasper from its base. Proximal opening of tube connecting with cloaca when clasper flexed forward, as occurring during copulation, enclosing passageway for spermatic fluid, even if only half the clasper inserted into female. Proximal half of clasper a closed tube; dorsal edges of marginal cartilages united by soft tissue and forming closed tube, with fused clasper groove (FCG) from apophyle halfway to the hypophyle. Fused part of clasper is 21 mm long on male in USNM 358812 (Fig. 5), approximately half length of clasper. Tip of each clasper with hard spur. If two claspers stretched apart, pale naked cloacal region exposed, lacking dermal den-

ticles. Cloacal region contains anus, paired openings from siphon sacs and exits for sperm (Fig. 5). No abdominal pores or abdominal papillae. Dark skin covering claspers with at least six white spots on ventrum of each clasper. Fused clasper groove similar to that of *Halaaelurus clevai* (Séret 1987) and *Ginglymostoma cirratum* (Clark & von Schmidt 1965). Clasper tube in *Cephaloscyllium stevensi* may be new structure not homologous to clasper groove of most species.

**Comparisons:** As will be noted from comparison of the measurements of *Cephaloscyllium stevensi* with *C. speccum* (Table II), there are no obvious morphological differences. The color pattern, however, is clearly different, as may be seen by comparing Figure 8 of *C. speccum* in Last, Séret & White (2008) with our figures of *C. stevensi*. The pattern of *C. speccum* consists mainly of dark spots of a near-uniform small size that group to form irregular blotches and the ventral part of the head and body is uniformly pale. The dense pattern of small dark spots and whitish spots of variable size ventrally on the body of *C. stevensi* appears to distinguish it from all other species of the genus.



**Fig. 4a-b.** Female holotype of *Cephaloscyllium stevensi*, 586 mm TL, USNM 359091: (a) Left lateral view (b) Ventral view. Drawing of preserved specimen one year after collected.

**Table II.** *Cephaloscyllium stevensi*, n. sp., proportional dimensions in percentage of total length (TL) of five adult specimens from Papua New Guinea (PNG) compared with two specimens of *C. speculum* from Western Australia (WA). Aside from the holotype, in first column, specimens are arranged according to size to more easily trace any changes in proportion related to size. \*Based on average of right and left measurements. \*\*Total count.

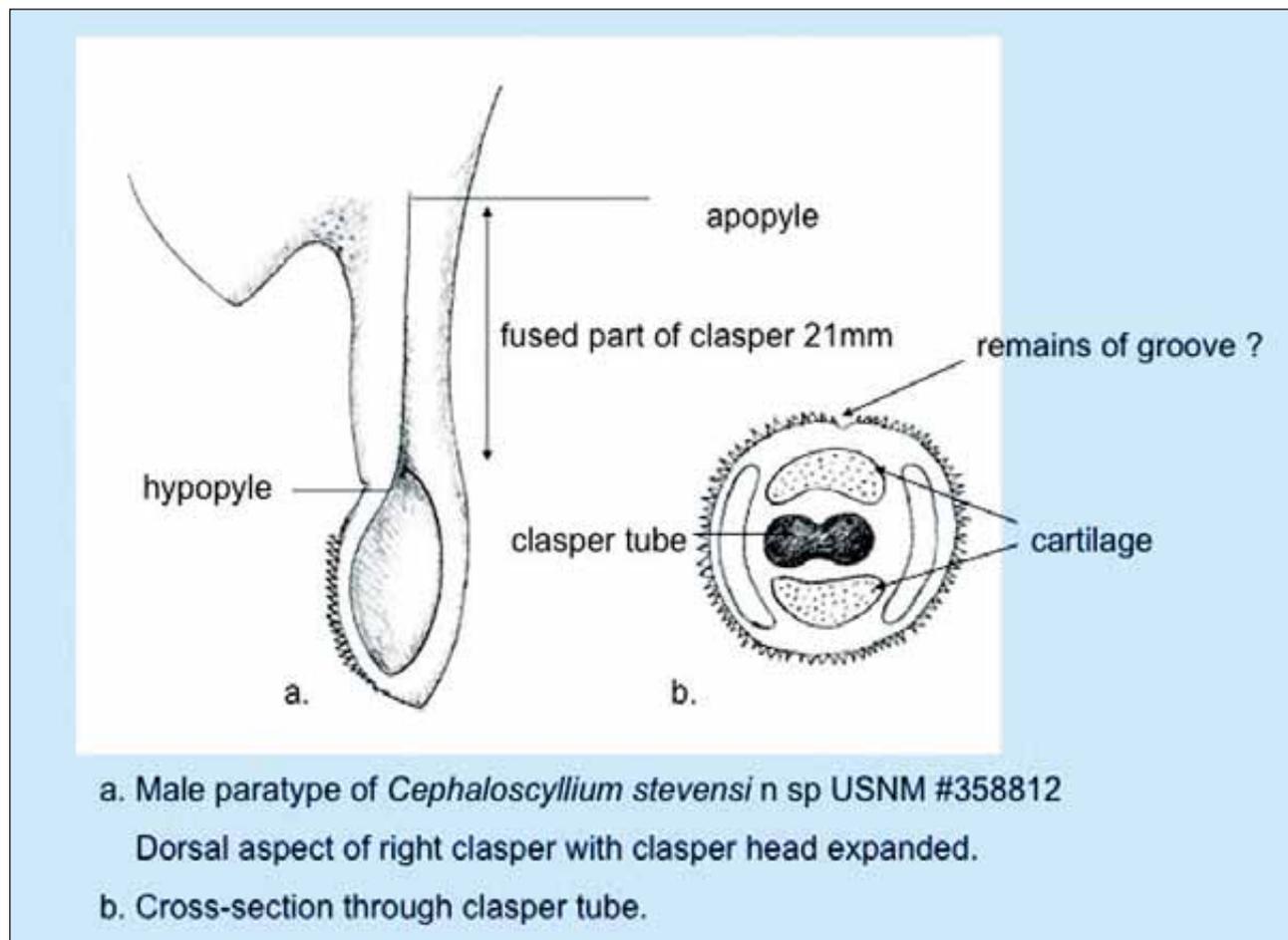
Type/Sex Total length (mm) Location Catalog #	<i>C. stevensi</i>					<i>C. speculum</i>	
	Holotype ♀ 586 mature PNG USNM 359091	Paratype ♀ 445 immature PNG CSIRO H6820-01	Paratype ♂ 524 mature PNG USNM 329583	Paratype ♂ 543 mature PNG USNM 358812	Paratype ♀ 660 mature PNG USNM 358814 (head only)	– ♂ 415 immature WA CSIRO H1634-01	– ♀ 498 immature WA CSIRO H2027-01
Snout tip to:							
front of mouth	4.1	3.9	3.8	3.8	3.4	2.7	3.4
*posterior nasal flap	4.8	4.0	4.2	4.1	3.8	3.9	4.0
*eye	6.7	5.7	6.4	6.8	5.6	5.6	7.0
*spiracle	11.0	9.9	10.6	11.6	–	9.2	10.9
*1st gill slit	17.0	17.4	17.6	19.4	–	15.4	20.5
*2nd gill slit	20.8	21.4	21.8	23.6	–	20.6	22.3
*pectoral fin origin	21.3	19.6	22.0	20.9	–	17.9	21.2
*pelvic fin origin	49.8	44.3	44.6	45.5	–	48.5	46.9
1st dorsal origin	31.2	48.3	52.7	52.1	–	50.4	51.2
2nd dorsal 2 origin	66.0	62.3	62.1	68.0	–	63.6	65.4
anal fin	64.2	59.1	60.1	63.5	–	64.2	62.7
upper caudal lobe	77.0	73.5	73.7	78.1	–	76.8	76.7
cloaca	30.7	47.9	54.0	54.7	–	50.0	50.6
Greatest width of body at:							
origin of pectoral fins	18.2	13.7	14.6	15.0	–	17.0	17.5
origin of pelvic fins	8.0	7.6	5.3	7.6	–	8.5	9.5
caudal peduncle	2.1	2.0	1.7	1.8	–	2.2	2.4
Greatest height of body at:							
origin of pectoral fins	10.0	7.2	7.9	6.2	–	6.3	7.9
origin of pelvic fins	9.3	7.4	6.4	7.6	–	5.7	6.7
caudal peduncle	2.8	3.2	2.7	2.8	–	2.8	3.0
*Eyes, length of orbit	3.3	3.8	3.6	3.6	--	3.0	3.4
*Spiracles:							
greatest diameter	0.4	0.5	0.4	0.5	–	0.4	0.3
least diameter	0.3	0.4	0.2	0.4	–	0.1	0.1
Mouth:							
width	12.6	12.3	10.9	12.2	12.7	12.3	11.9
length	7.2	6.1	6.1	6.6	5.1	5.6	4.2
Nostrils, distance between	3.3	3.0	3.2	3.4	3.0	3.2	3.2
Gill slit lengths:							
1st	1.8	2.5	1.6	2.5	–	2.1	2.1
5th	1.3	1.8	1.1	1.6	–	1.5	1.3
Greatest width of head	17.1	14.7	14.9	15.4	--	15.0	15.7
Least distance between bony orbitals	6.1	5.5	5.6	4.7	6.2	4.8	5.5
Least distance between eyelids	8.3	8.4	8.1	8.0	4.9	8.0	8.6
Second dorsal fin:							
base	5.8	5.5	5.8	5.7	–	4.9	5.4
posterior inner margin	3.0	3.0	2.7	3.6	–	3.2	3.2
height	3.3	3.6	3.0	3.6	–	2.9	3.1
anterior margin	6.9	6.9	6.5	7.0	–	6.2	6.9
overall	8.6	8.4	8.6	9.1	–	8.8	8.7
Anal fin:							
base	7.2	6.8	6.9	7.2	–	7.0	7.4
posterior inner margin	2.8	3.0	2.8	3.5	–	2.9	2.6
height	4.4	4.4	4.2	5.3	–	3.4	3.6
anterior margin	7.5	7.9	7.4	8.3	–	8.8	8.4
overall	9.9	9.9	9.8	10.5	–	10.4	9.9
*Pectoral fin:							
base width	8.3	8.5	8.3	8.0	–	8.3	8.5
anterior margin	16.1	16.6	15.7	16.9	–	14.3	14.5
greatest width	12.7	13.2	11.6	14.9	–	10.8	11.6
overall length	11.0	13.3	13.8	13.9	–	13.0	13.1
*Pelvic fin:							
base width	8.6	7.6	7.5	6.8	–	6.5	8.3
anterior margin	7.0	6.2	7.1	6.7	–	5.6	6.6
posterior margin	6.6	7.8	7.4	9.3	–	6.0	6.8
overall length	11.3	11.2	11.2	12.5	–	10.1	9.4
*Claspers:							
inner length	–	–	8.9	9.5	–	4.5	–
outer length	–	–	7.0	7.5	–	1.8	–
Distance between bases:							
1st & 2nd dorsal fins	5.8	7.5	8.0	7.8	–	6.7	6.7
pectoral & pelvic fins	22.4	19.5	14.7	17.3	–	18.8	19.0
**Teeth:							
upper	62	72	77	65	70	75	64
lower	71	74	72	64	76	78	75
**Vertebrae total	116	114	117	118	–	118	117
(precaudal + caudal)	78+38	76+38	78+39	78+40	–	77+41	78+39
monospondylous precaudal	44	43	44	44	–	(42)	(42)

According to Last et al. (2008), this new species is probably closer to *C. signorum* Last, Séret, and White, 2008 (which has a uniform dark grey venter as in *C. speccum*), than to *C. speccum*, and belongs in the subgroup of variegated swellsharks.

**Etymology:** The specific name *stevensi* is in honor of Dr. John Stevens, whose monumental volume with Peter Last on the sharks of Australia in 1994 was the foundation for research that led to the descriptions of 37 new chondrichthyan fishes, including 11 species of *Cephaloscyllium*.

**Remarks:** There have been few documentations of copulation in sharks. Douglas Wilson photographed the copulation of the small benthic shark *Scyliorhinus canicula* in the London Aquarium. His photographs, showing the elongate male's body looped completely around the female, have been copied many times (e.g. Breder and Rosen 1966: 623; Compagno et al. 2004: 39, all based on Wilson's photograph in Hardy 1965: 178). By con-

trast, the copulation of *Negaprion brevirostris* was witnessed by Dugald Brown, who reported it to Clark (Clark 1969), as a smooth swimming together, giving the appearance of "one shark with two heads." The copulation of the large benthic *Ginglymostoma cirratum* was described by Carrier et al. (1994) and photographed by Nick Caloyianis (Pratt & Carrier 1995), showing only the distal end of a clasper inserted into the female. A series of eight remarkable photographs by Eric M. Le Feuvre show the long, paired inflated siphon sacs of *Triaenodon obesus* during benthic copulation, where only the head of the clasper is inserted into the female (pers. comm. 1982; Tricas & Le Feuvre 1985). Noreen Rouse also took a series of photographs of *G. cirratum* mating in deeper water, that also showed only the head of the clasper inserted in the female. The first author and David Doubilet observed, and Doubilet photographed, the violent courtship of *Carcharhinus amblyrhyn-*



**Fig. 5a-b.** Male paratype of *Cephaloscyllium stevensi*, 543 mm TL, USNM 358812: (a) Dorsal view of left clasper, with clasper head pulled open; (b) Cross-section through clasper tube.



Fig. 6. Ventral view of head of *Cephaloscyllium stevensi* holotype, female, 586 mm TL, USNM 359091. Photo by L. Mitchell.

*chos* in the Red Sea, with the male biting the female. Once the biting courtship phase was over and intromission was attained, there was a long, smooth and synchronous period of swimming during copulation, with no twisting.

It has been assumed that the clasper has an open groove for its entire length which is closed over during copulation for a passageway for sperm. If the clasper grooves of more shark species, especially benthic, are examined closely, it may turn out that a closed tube, rather than a groove, is present for the proximal part of the clasper length in many more species. One of the most elongate-bodied sharks, *Chlamydoselachus anguineus*, has a scroll-like clasper that forms a secure tube for almost its entire length (Smith 1937: 376-377), illustrated by Leigh-Sharpe (1922). Nothing is known of the behavior of this strange, eel-like shark. We were

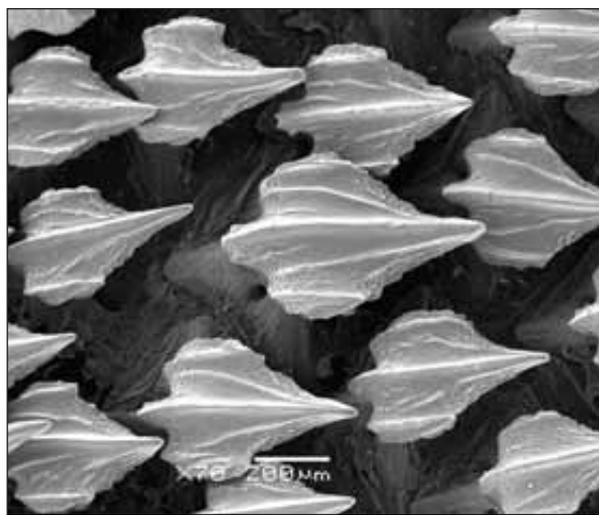


Fig. 7. *Cephaloscyllium stevensi* dermal denticles from below first dorsal fin (micrograph by José I. Castro).

able to check the claspers on a freshly defrosted mature male specimen of this species, courtesy of José I. Castro, as well as the mature claspers of numerous pelagic carcharhinid sharks. Further examinations of clasper “grooves” are needed, especially in sharks with elongate bodies and powerful twisting movements during sperm transfer.

The fused clasper groove (FCG) or clasper tube (CT) has been described previously for only two species of sharks, both benthic: *Ginglymostoma cirratum* by Clark & von Schmidt (1965) and *Halaelurus clevai* by Séret (1987). In this paper we describe the FCG in a third benthic shark, *Cephaloscyllium stevensi*. The CT probably serves to more efficiently transport the spermatic fluid into the female in sharks with strong body-twisting movements during copulation.

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