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***Pristiophorus lanæ* sp. nov., a new sawshark species from the Western North Pacific, with comments on the genus *Pristiophorus* Müller & Henle, 1837 (Chondrichthyes: Pristiophoridae)**

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Abstract

A new species of sawshark, *Pristiophorus lanæ* sp. nov., is described from off the Philippine Islands. The new species is the second member of the genus *Pristiophorus* described from the western North Pacific and can be separated from its closest geographic congener, *P. japonicus*, by having fewer rostral teeth in front of rostral barbels (17–26 versus 25–32), mouth at corners extending forward to below the rear margin of the eye versus extending below the rear one-third of eye margin, a greater mouth width at 6.9–7.8 times into pre-oral length (versus 5.8–6.9), eye length into head length (15.6–15.9 versus 9.8–13.2), mouth width into head length 9.0–10.0 versus 7.4–8.5 times, head width at nostrils 5.2–6.1 times into pre-orbital length versus 3.9–4.9 times, shorter prebarbel length (from snout tip to barbel) of 50.7–54.5% of preoral length versus 53.6–59.2%, a snout angle of 10.6–13.0° versus 12.4°–14.6°, and lateral trunk denticles with flat crowns that are imbricated versus erect crowns that are not imbricated. The number of monospondylous vertebrae is slightly lower in *P. lanæ* (43–48) versus *P. japonicus* (51–52). The genus is reviewed, with a revised key to its species presented.

Key words: Pristiophoridae, *Pristiophorus*, new species, Western North Pacific Ocean, Philippines

Introduction

The Pristiophoridae (Chondrichthyes: Pristiophoriformes) are a small, highly derived, group of sharks that are transitional between typical “shark-like” fishes and batoids, with several unique morphological characteristics (Ebert & Compagno, in press). The sawsharks are an unmistakable group, easily distinguished by their elongated and flattened rostrum edged with slender sharp lateral teeth and a pair of long rostral barbels in front of the nostrils. These sharks have two dorsal fins, no anal fin, a short transverse mouth and small cuspidate teeth in both jaws. The family consists of two genera, *Pliotrema* Regan, 1906 and *Pristiophorus* Müller & Henle, 1837, and seven valid species (Ebert & Cailliet, 2011).

The first sawshark species described was by Latham (1794) from Australian waters and was placed in the family Pristidae, genus *Pristis*, as *P. cirratus*. However, it was subsequently classified as a shark rather than a batoid and transferred to the genus *Squalus* by Lacépède (1802) and Shaw (1804). Müller & Henle (1837) proposed the genus *Pristiophorus* for this distinctive shark group, for which Bleeker (1859) later proposed a new family, Pristiophoroidei. Most subsequent authors recognized the sawshark family Pristiophoridae, although Regan (1906) and Engelhardt (1913) reduced it to a subfamily of the Squalidae. Jordan (1923) recognized the Pristiophoridae as a valid family, but proposed a separate family, Pliotremidae, for the sixgill sawshark, *Pliotrema warreni*, which had been described by Regan (1906) and placed in the family Pristiophoridae by Garman (1913) and subsequent authors. Fowler (1947, 1969) reduced the family Pliotremidae to a subfamily of Pristiophoridae. Despite the extra gill arch in *Pliotrema*, the genera *Pliotrema* and *Pristiophorus* are very similar morphologically and are readily

placed in the same family, Pristiophoridae. Adding further support to the placement of both genera into a single family, Naylor *et al.* (2012a) in a molecular analysis found that *Pliotrema warreni* Regan, 1906 grouped as the sister species of *Pristiophorus japonicus* Günther, 1870.

Most members of the family Pristiophoridae occur in the Indo-West Pacific, except for *Pristiophorus schroederi* Springer & Bullis, 1960, which occurs in the western North Atlantic, and *Pliotrema warreni*, which primarily occurs in the western Indian Ocean, but with several nominal eastern South Atlantic records from off the west coast of South Africa. All members of the family appear to be regional endemics: three species, *P. cirratus* (Latham, 1794), *P. delicatus* Yearsley, Last, & White, 2008 and *P. nudipinnis* Günther, 1870 are found in Australian waters, *P. nancyae* Ebert & Cailliet, 2011, is known from the western Indian Ocean, and *P. japonicus* occurs in the western North Pacific.

Fowler (1941) first reported on a second species from the western North Pacific, and identified it as *P. cirratus* from the Philippines. Springer & Bullis (1960) subsequently examined this specimen and considered it to be an undescribed species, while later authors variously referred to Philippines pristiophorids as *P. japonicus*, *Pristiophorus* sp. or *Pristiophorus* sp. C (Compagno, 1984, 1998; Compagno *et al.* 2005a, 2005b). Examination of *Pristiophorus* species from the Philippines by the authors confirmed that these specimens possess several distinctive morphological characteristics that separate it from the other six known species of this genus. Here we described this new *Pristiophorus* species from the Philippines.

Methods

Morphometric measurements follow a modification of Compagno (2001), Yearsley *et al.* (2008), and Ebert & Cailliet (2011). Morphometric values are presented as ratios for the holotype followed by a range of paratype values in parentheses. Meristics including tooth, spiral valve, pectoral fin radial, and vertebral counts, were taken. Comparative material of all nominal sawshark species was obtained from collections at the Biodiversity Research Center, Academia Sinica (ASIZP), Australian National Fish Collection, Hobart, Australia (CSIRO), California Academy of Sciences (CAS), Hokkaido University Museum, Fisheries Science Center (HUMZ), L.J.V. Compagno field number (LJVC), Museum Comparative Zoology (MCZ), Natural History Museum (BMNH), South African Museum (SAM), Stanford University (SU: now housed at the CAS), and United States National Museum (USNM). Institutional abbreviations follow Sabaj Pérez (2013).

Pristiophorus Müller & Henle, 1837

Genus *Pristiophorus* Müller & Henle, 1837a, 2: 116. Also Müller & Henle, 1837b, 3: 399; Müller & Henle, 1838a, 2: 89 ("*Pristis cirratus*, Latham" designated as type species); Müller & Henle, 1838b, 6: 65; Müller & Henle, 1839, pt. 2: 97.

Type species. *Pristis cirratus* Latham, 1794, by monotypy.

Pristiophorus lanae sp. nov.

Lana's Sawshark

(Figures 1–4, Tables 1, 2)

Pristiophorus cirratus: Fowler, 1941: 280 (USNM 10107; now USNM-151231 according to Springer & Bullis, 1960).

Pristiophorus japonicus: Compagno, 1984: 134, Philippines sawsharks possibly referable to this species.

Pristiophorus sp.: Springer & Bullis, 1960: 10(2): 253; Compagno, 1998: 1236, fig.

Pristiophorus sp. C: Compagno *et al.*, 2005a: 135, ill., pl. 16; Compagno *et al.*, 2005b: 57; Ebert *et al.*, 2013: 182, fig., pl. 19.

Holotype. CAS 34942, 775 mm TL, female, NW of Baltazar Island, Marinduque, Philippines, ca. 13° 23' N, 121° 79' E, 163–168 fa. (298–307 m), 10 December 1966, collected by J.E. Norton.

Paratypes. CAS 34930, 725 mm TL, female, south of Barrio Salong, Balayan Bay, Luzon Island, Batangas, Philippines, ca. 13° 44' N, 121° 00' E, 125–135 fa. (229–247 m), 18 July 1966, collected by J.E. Norton; CAS 236420, 669 mm TL, male, NW of Baltazar Island, Marinduque, Philippines, ca. 13° 23' N, 121° 79' E, 163–168 fa. (298–307 m), 10 December 1966, collected by J.E. Norton.

Non-types. CAS 34193, 396 mm TL, female, Siburio Point, Ragay Gulf, Camarines Sur, Philippines, ca. 13° 33' N, 122° 48' E, 319–324 fa. (584–593 m), 24 November 1966, collected by J.E. Norton; Mark Harris Collection (3 specimens), PMH 271-01, 830 mm TL, female, 271-02, 673 mm TL, female, 271-03, 613 mm TL, female, all landed at the Pasil fishing port, Cebu, Philippine Islands, caught by bottom trawlers operating in the Bohol Sea, ca. 350 m, 8 May 2008, collected by Mark Harris.



FIGURE 1. *Pristiophorus lanae* sp. nov., holotype, CAS 34942.



FIGURE 2. Pre-branched ventral head view of *Pristiophorus lanae* sp. nov., holotype, CAS 34942.

Diagnosis. A slender bodied five-gilled sawshark distinct from other members of the genus by a combination of characteristics including a narrow, relatively long rostrum, with a pre-oral length 27.5–30.6% TL, a pre-barbel length of 51–55% of pre-oral length, and a rostral width at nostrils of 4.8–6.1 times pre-orbital length. Barbels located closer to the mouth than to rostral tip. First dorsal fin originates posterior to free rear tip of pectoral fin. Lateral dermal denticles unicuspidate, mostly flat, and imbricated. Coloration is a uniform dark brown above, lighter below; no bars, blotches or other distinctive markings.

Description. Proportional measurements expressed as a percentage of the total length (TL) are given for the holotype followed by the paratypes in parenthesis; partial measurements from a non-type specimen (now skeletonized) are included when available (Table 1).

TABLE 1. *Pristiophorus lanae* proportional measurements expressed as a percentage of total length (TL%) of the holotype (CAS 34942), paratypes (CAS 34930 and CAS 34942) and a non-type specimens (CAS 34193).

| | <i>Pristiophorus lanae</i> | | | |
|---|----------------------------|-----------|------------|-----------|
| | Holotype | Paratype | Paratype | non-type |
| | CAS 34942 | CAS 34930 | CAS 236420 | CAS 34193 |
| | F | F | M | F |
| Total length (mm) | 775 | 725 | 669 | 396 |
| Pre-caudal length | 82.6 | 81.5 | 79.2 | – |
| Pre-barbel length | 13.9 | 14.8 | 14.3 | 16.7 |
| Pre-narial length | 23.9 | 25.4 | 24.4 | 26.8 |
| Pre-oral length | 27.5 | 29.0 | 28.4 | 30.6 |
| Pre-orbital length | 24.9 | 26.8 | 25.9 | 28.8 |
| Pre-spiracle length | 28.0 | 29.2 | 30.2 | – |
| Pre-gill length | 33.3 | 34.1 | 33.6 | – |
| Pre-pectoral length | 36.1 | 37.2 | 36.9 | – |
| Pre-pelvic length | 53.5 | 54.9 | 51.6 | – |
| Snout-vent length | 57.2 | 57.2 | 53.6 | – |
| Pre-first dorsal fin length | 47.4 | 47.3 | 47.1 | – |
| Pre-second fin dorsal length | 67.6 | 66.9 | 65.5 | – |
| Inter-dorsal fin length | 15.5 | 14.8 | 13.8 | – |
| Dorsal-caudal space | 10.2 | 9.2 | 8.7 | – |
| Pectoral-pelvic space | 15.1 | 16.0 | 13.9 | – |
| Pelvic-caudal space | 22.5 | 23.6 | 22.1 | – |
| Pectoral origin-first dorsal fin origin length | 11.0 | -0.4 | 1.6 | – |
| Pectoral origin-second dorsal fin origin length | 8.5 | 8.3 | 8.7 | – |
| Eye length | 2.3 | 1.0 | 2.5 | – |
| Eye height | 1.0 | 1.0 | 1.2 | – |
| Eye to last rostral tooth length | 0.9 | 1.8 | 2.4 | – |
| Interorbital length | 3.7 | 3.4 | 3.6 | – |
| Interbarbel width | 1.8 | 2.3 | 2.5 | – |
| Barbel length | 5.3 | 7.2 | 5.7 | 9.3 |
| Barbel-nostril length | 9.5 | 10.6 | 10.0 | 10.1 |
| Barbel tip to nostril length | 4.5 | 3.7 | 4.6 | 2.5 |
| Nostril width | 0.8 | 0.8 | 1.0 | – |
| Internarial length | 2.5 | 2.8 | 2.5 | 3.8 |
| Anterior nasal flap | 0.5 | 0.6 | 0.6 | – |
| Nostril-mouth symphysis length | 3.0 | 3.3 | 3.0 | 4.0 |
| Nostril-mouth rictuses (corners) length | 4.9 | 4.7 | 4.3 | 5.1 |
| Nostril to first gill opening length | 7.9 | 9.4 | 7.9 | 9.6 |
| Spiracle length | 1.2 | 1.0 | 1.2 | – |
| Spiracle width | 0.4 | 0.4 | 0.4 | – |
| Interspiracle width | 3.2 | 3.3 | 3.3 | – |
| Eye-spiracle length | 0.8 | 0.4 | 0.4 | – |
| Mouth length | 1.5 | 1.5 | 1.6 | – |

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TABLE 1 (continued).

| | <i>Pristiophorus lanæ</i> | | | |
|---|---------------------------|-----------|------------|-----------|
| | Holotype | Paratype | Paratype | non-type |
| | CAS 34942 | CAS 34930 | CAS 236420 | CAS 34193 |
| | F | F | M | F |
| Mouth width | 4.0 | 3.7 | 3.6 | – |
| Lower labial furrow | 0.4 | 0.3 | 0.3 | – |
| 1st Gill height | 1.0 | 0.8 | 0.7 | – |
| 2nd Gill height | 1.2 | 0.6 | 0.9 | – |
| 3rd Gill height | 1.4 | 0.6 | 0.9 | – |
| 4th Gill height | 1.4 | 0.7 | 0.9 | – |
| 5th Gill height | 1.4 | 0.8 | 1.0 | – |
| Head height at eye | 2.2 | 2.2 | 2.4 | – |
| Head height at mouth | 2.8 | 4.0 | 2.7 | – |
| Head height at first gill opening | 4.0 | 3.2 | 3.4 | – |
| Head height at nostril | 1.8 | 1.4 | 1.8 | – |
| Head width at eye | 5.7 | 5.0 | 5.7 | 6.1 |
| Head width at mouth | 6.1 | 6.3 | 5.8 | – |
| Head width at first gill opening | 5.9 | 6.1 | 6.0 | – |
| Head width at nostril | 4.3 | 4.4 | 5.4 | 5.6 |
| Trunk height | 6.5 | 4.1 | 5.1 | – |
| Trunk width | 6.7 | 5.8 | 5.4 | – |
| Caudal peduncle height at second dorsal fin | 2.7 | 2.8 | 2.7 | – |
| Caudal peduncle height at caudal origin | 1.9 | 2.1 | 2.1 | – |
| Caudal peduncle width at second dorsal fin | 3.0 | 2.6 | 3.1 | – |
| Caudal peduncle width at caudal origin | 1.8 | 1.8 | 2.1 | – |
| Girth | 22.2 | 19.3 | 19.1 | – |
| Pectoral fin length | 8.9 | 8.8 | 9.0 | – |
| Pectoral fin anterior margin length | 11.5 | 9.2 | 11.1 | 11.1 |
| Pectoral fin base length | 3.4 | 3.6 | 3.4 | – |
| Pectoral fin height | 9.2 | 8.8 | 9.4 | – |
| Pectoral fin inner margin length | 5.9 | 5.5 | 5.8 | – |
| Pectoral fin posterior margin length | 8.4 | 8.4 | 8.8 | – |
| Pelvic fin length | 7.6 | 7.3 | 9.1 | – |
| Pelvic fin anterior margin length | 5.3 | 5.7 | 5.8 | – |
| Pelvic fin base length | 4.8 | 4.6 | 4.5 | – |
| Pelvic fin height | 4.3 | 2.9 | 2.7 | – |
| Pelvic fin inner margin length | 3.5 | 3.0 | 3.6 | – |
| Pelvic fin posterior margin length | 5.0 | 4.7 | 5.2 | – |
| Outer clasper length | – | – | 2.2 | – |
| Inner clasper length | – | – | 5.8 | – |
| Clasper base | – | – | 0.9 | – |
| First dorsal fin length | 7.2 | 7.2 | 7.3 | – |
| First dorsal fin anterior margin length | 8.1 | 8.0 | 9.0 | – |

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TABLE 1 (continued).

| | <i>Pristiophorus lanae</i> | | | |
|--|----------------------------|-----------|------------|-----------|
| | Holotype | Paratype | Paratype | non-type |
| | CAS 34942 | CAS 34930 | CAS 236420 | CAS 34193 |
| | F | F | M | F |
| First dorsal fin base length | 5.4 | 4.3 | 4.6 | – |
| First dorsal fin height | 6.3 | 5.5 | 6.4 | – |
| First dorsal fin inner margin length | 2.3 | 2.5 | 2.5 | – |
| First dorsal fin posterior margin length | 6.3 | 5.4 | 5.4 | – |
| Second dorsal fin length | 7.6 | 7.3 | 7.6 | – |
| Second dorsal fin anterior margin length | 8.6 | 8.4 | 9.0 | – |
| Second dorsal fin base length | 5.2 | 4.8 | 5.1 | – |
| Second dorsal fin height | 6.5 | 5.1 | 6.4 | – |
| Second dorsal fin inner margin length | 2.5 | 2.8 | 2.7 | – |
| Second dorsal fin posterior margin length | 6.3 | 5.7 | 6.3 | – |
| Caudal fin dorsal margin | 17.2 | 17.8 | 18.7 | – |
| Caudal fin pre-ventral margin | 4.0 | 6.5 | 4.2 | – |
| Caudal fin lower-upper margin | 9.2 | 6.5 | 7.9 | – |
| Caudal fin subterminal margin | 2.6 | 2.6 | 2.8 | – |
| Caudal fin terminal margin | 3.0 | 3.6 | 2.8 | – |
| Caudal fin terminal lobe | 4.3 | 4.8 | 4.6 | – |
| First dorsal fin midpoint-pectoral fin insertion | 11.9 | 10.9 | 11.4 | – |
| First dorsal fin midpoint-pelvic fin origin | 4.5 | 5.2 | 3.7 | – |
| Pelvic fin midpoint-first dorsal fin insertion | 3.7 | 4.4 | 3.4 | – |
| Pelvic fin midpoint-second dorsal fin origin | 11.0 | 9.8 | 10.3 | – |

Body slender, snout elongated, flattened, forming blade-like rostrum, narrowing anteriorly to tip; pre-barbel length 13.9 (14.3–16.7)% TL; snout angle 13.0° (10.6°–12.5°). Head strongly depressed over eyes, laterally expanded, very narrow, subtriangular, head width at mouth 6.3 (5.8–6.1)% TL, height greatest at first gill opening 3.3 (3.3)% TL; head width at nostrils 6.4 (5.5–6.6) times in pre-orbital length. Trunk cylindrical, subcircular in cross-section, not flattened and ray-like, narrow, tapering toward caudal origin; head length 0.6 (0.5) times trunk length; pectoral-pelvic space 15.1 (13.9–16.0)% TL; dorsal-caudal length 10.2 (8.7–9.2)% TL; caudal peduncle height at second dorsal insertion 3.8 (3.2–3.4) into dorsal caudal space, and width 0.9 (0.9–1.1) in height. Lateral keels present; no precaudal pits.

Rostrum very long, narrow and tapering; pre-oral length 27.5 (28.4–30.6)% TL; sides of rostrum relatively straight from tip to barbels, slightly convex at barbels, becoming slightly concave from barbels to nostrils. Ratio of pre-orbital length to rostrum width at nostrils 5.8 (4.8–6.1). Parallel rows of enlarged pits absent on underside of pre-barbel snout. Barbels closer to mouth than rostral tip, pre-barbel length 50.7 (50.5–54.5)% of pre-oral length; space from barbel to nostril 1.2 (1.1–1.3) times space from nostril to first gill opening; barbels ending less than 1.9 (1.6–1.8) times eye length anterior to nostrils. Large lateral rostral saw-teeth along sides of snout and head total 24 (24–42), including 18 (17–26) teeth in front of barbels and 6 (7–17) teeth behind barbels; smaller lateral rostral teeth between large lateral rostral teeth 1–3. Post-narial lateral rostral teeth extending 0.4 (0.8–0.9) times eye length behind eye. Bases of lateral and ventral rostral teeth relatively smooth. Ventral rostral teeth anterior to barbels number 14 (14), between barbels and nostril 9 (9). An enlarged ventral rostral tooth present just in front of nostril.

Eyes oval, large, lateral on head, length 2.3 (2.3–2.5)% TL; distance to last rostral tooth 0.9 (1.8); inter-orbital concave width 3.7 (3.4–3.6)% TL; sub-ocular groove present. Spiracles moderately large, length 2.0 (2.1–2.4) times eye length, slightly oblique; located just posterior to eye. Gill openings small, lateral on head, closer to ventral surface than dorsal; each similar in length; fifth gill opening arches slightly around pectoral fin origin.

Nostrils relatively small, anterior nasal flap well developed, tear-shaped; excurrent apertures transversely oval, nearly circular, width 0.8 (0.8–1.0)% TL, 3.9 (3.2–4.0) in internarial width. Distance from nostrils to mouth 1.2 (1.1–1.2) times internarial space. Distance from nostrils to barbels 1.9 (2.0–2.3) times distance between nostrils and mouth corners.

Mouth broadly arched, extending forward to about opposite posterior of eye orbit, width 4.0 (3.6–3.7)% TL. Lower labial furrows short, about 0.4 (0.3)% TL, upper labial furrows absent. Teeth with a single prominent acute cusp, in well defined rows, bases flattened and rounded. Tooth row counts 48 (36–48) on upper jaw and 44 (32–40) on lower jaw; series of functional teeth about 3–5.

Lateral trunk dermal denticles closely imbricated, with flat mostly unicuspidate crowns; outer margins of dorsal and pectoral fins scaled.

Pectoral fins large, anterior margin weakly convex, anterior margin length 11.5 (9.2–11.1)% TL, and 41.8 (31.9–38.9)% of pre-oral length; posterior margin nearly straight to weakly concave, apex broadly rounded; inner margin convex; height slightly greater than posterior margin length; free rear tip terminates anterior to origin of first dorsal fin. Pectoral fin skeletal radials divided into 2–3 segments; propterygium with one radial, mesopterygium with (10) radials, metapterygium with (12) radials, and total radial count 20 (22–23). Pelvic fins large, anterior margin 5.3 (5.7–5.8)% TL, length about equal to first and second dorsal fin lengths; anterior margin slightly convex, posterior margin weakly concave, broadly rounded at apex; inner margin nearly straight, length about 1.4 (1.4–1.6) times into posterior margin length, free rear tip narrowly rounded.

First dorsal fin broad, semifalcate, anterior margin slightly convex to nearly straight, with broadly rounded apex anterior to insertion, posterior margin slanting posteroventrally, slightly convex before tip; inner margin straight, free rear tip narrowly acute; origin about opposite or slightly behind free pectoral rear tips; insertion over pelvic fin origins or slightly anterior to them by less than a fourth of fin base, free rear tip extending to about opposite or slightly in front of pelvic insertions. Second dorsal fin subequal to first, with base and height shorter; origin behind pelvic insertions by distance about equal to or less than first dorsal fin base. Caudal fin long, dorsal margin slightly convex, length 17.2 (17.8–18.7)% TL, lower post-ventral lobe absent, upper post-ventral margin broadly rounded; terminal lobe well developed, caudal terminal margin slightly concave, apices angular.

Total vertebral count 138 (140–145), monospondylous precaudal count 44 (43–48), diplospondylous precaudal count 51 (47–50), total precaudal count 95 (90–98), and caudal count 43 (50–51). Intestinal valve turns (6).



FIGURE 3. Mouth and teeth of *Pristiophorus lanae* sp. nov., holotype, CAS 34942.

Coloration. After preservation these sharks are a uniform medium brown above, becoming lighter ventrally; rostrum lighter except for two distinct longitudinal stripes extending length; lateral rostral teeth light colored; trailing dorsal, pectoral and pelvic fins with light to white fin edges; caudal fin terminal margin and upper post ventral margins lighter to white.

Size. The species is known from seven specimens, six females and a single male. The females range in size from 396–830 mm TL and the male measured 669 mm TL. The maturity status of the females was not determined, but the male appears to be maturing or mature based on calcification and development of the claspers.

Distribution. At present this new sawshark species is known only from the Philippine Islands, off Zamboangita, Apo Island between Negros and Siquijor, and off southern Luzon in Balayan Bay and Ragay Gulf, although it likely has a wider distributional range in the western North Pacific. The approximate capture location for three non-type specimens, all from the Bohol Sea, was provided by Mark Harris (pers. comm.).

General Biology. Virtually nothing is known about the biology of this sawshark. It is an inhabitant of upper continental slopes in tropical waters found at depths of 229 to 593 m. Litter size unknown. It may be caught and discarded as bycatch by trawlers and other deepwater fisheries operations off the Philippines. A bony fish skeleton can be seen in the digestive tract in an x-ray of the holotype.

Etymology. The species name *lanae* is after shark enthusiast Lana Ebert on the occasion of her graduation from the University of San Francisco. The proposed common name is “Lana’s Sawshark”.

Comparison to other *Pristiophorus* species. *Pristiophorus lanae* can be separated from all other members of this genus by a combination of characteristics, including pre-oral rostrum length of 27.5 to 31% TL, ventral rostrum without conspicuous large pits, a pre-barbel length of 50.7 to 54.5% of pre-oral length, rostral width at nostrils of 5.2 to 6.0 times pre-orbital length, mostly flat, unicuspidate lateral denticles that are imbricated, relatively large spiracles almost three-quarters eye-length, and a uniform dark brown coloration above without bars, spots, or other prominent markings. The new species can be separated from its closest geographic congener, *P. japonicus*, by having a narrow, slightly longer rostrum (27.5–31% versus 26–29% TL), fewer large rostral teeth in front of rostral barbels (17–26 versus 25–32), mouth at corners extending forward to below the rear margin of the eye versus extending below the rear one-third of eye margin, a greater mouth width at 6.9–7.8 times into pre-oral length (versus 5.8–6.9), eye length into head length (15.6–15.9 versus 9.8–13.2), mouth width into head length 9.0–10.0 versus 7.4–8.5 times, head width at nostrils 5.2–6.1 times into pre-orbital length versus 3.9–4.9 times, shorter pre-barbel length (from snout tip to barbel) of 50.7–54.5% of pre-oral length versus 53.6–59.2% (Figure 4), a snout angle of 10.6°–13.0° versus 12.4°–14.6°, and lateral trunk denticles with flat crowns that are imbricated versus erect crowns that are not imbricated. The number of monospondylous vertebrae is slightly lower in *P. lanae* (46–49) versus *P. japonicus* (51–52). Also, *P. lanae* appears to be a smaller species, maximum length of at least 830 mm, compared to 1530 mm TL for *P. japonicus*; males appear to mature at about 669 mm TL in *P. lanae*, while *P. japonicus* males mature at about 1070 mm TL (Ebert *et al.*, 2013).

The next closest congener to *P. lanae*, is the recently described *P. delicatus*, which can be separated by the location of their rostral barbels (Figure 4); *P. lanae* has its barbels located slightly closer to its mouth, with a pre-barbel length of 51–55% versus *P. delicatus* which has its barbels located about equidistance to slightly closer to its rostral tip, and pre-barbel length of 45–51%. *Pristiophorus lanae* also has a smaller nostril to mouth distance times internarial space ratio (1.1–1.2) compared to *P. delicatus* (over 1.3 times), and the spiracle length of *P. lanae* is relatively large, 0.75 times eye diameter, compared to *P. delicatus*, which is smaller, 0.43–0.59 (Yearsley *et al.*, 2008). The number of monospondylous vertebrae is slightly lower in *P. lanae* (46–49) versus *P. delicatus* (49–55). The dorsal coloration of *P. lanae* is a uniform dark brown compared to a pale to medium yellowish brown in *P. delicatus*.

Pristiophorus lanae differs from the other two Australian species, *P. cirratus* and *P. nudipinnis*, in having a longer pre-barbel length from its snout tip to barbel, over 50% TL of pre-oral length versus less than 43% TL (Figure 4). Also, *P. cirratus* and *P. nudipinnis* geographically are restricted to shallow, temperate waters of southern Australia, while *P. lanae* is known only from deep, tropical waters of the Philippines. The other two *Pristiophorus* species, *P. nancyae* and *P. schroederi*, are both deepwater species, like *P. lanae*, but in addition to being geographically distant, all are morphologically distinct. *Pristiophorus nancyae* from the western Indian Ocean is the only described member of the genus known to have a very distinctive double row of 4 to 5 conspicuous large pits anterior to the nasal barbels on the underside of its snout (Ebert & Cailliet, 2011). The western North Atlantic *P. schroederi* has a very elongated snout, with a pre-oral length over 31% TL (Figure 4), and tricuspidate lateral denticles that are widely spaced. *Pristiophorus lanae* by comparison has a slightly shorter snout, 27.5–31% TL, and unicuspidate lateral denticles that are closely imbricated.



FIGURE 4. Dorsal (upper row) and ventral (lower row) views of rostrums of all seven *Pristiophorus* species (from left to right): *P. lanae* (Holotype: CAS 34942), *P. delicatus* (Holotype: CSIRO H 931-01), *P. japonicus* (HUMZ 195735), *P. nancyae* (Holotype: SAM 34013), *P. nudipinnis* (CSIRO H 3777-01), *P. cirratus* (CSIRO H 1135), and *P. schroederi* (CAS 234057). All photographs by D.A. Ebert except for HUMZ (195735) by K. Nakaya.



FIGURE 4. (continued)

TABLE 2. Vertebral counts, including monospondylous (MP), diplospondylous precaudal (DP), total precaudal (PC), diplospondylous caudal (DC), and total vertebrae (Total) for all seven known sawshark species. *Pristiophorus lanae* sp. nov., in **bold**.

| Species | n | MP | DP | PC | DC | Total |
|-------------------------------|----------|--------------|--------------|--------------|--------------|----------------|
| <i>Pliotrema warreni</i> | 15 | 53–58 | 47–52 | 101–108 | 43–54 | 146–157 |
| <i>Pristiophorus cirratus</i> | 16 | 52–55 | 47–53 | 101–108 | 46–54 | 149–158 |
| <i>P. delicatus</i> | 12 | 49–55 | 50–54 | 101–105 | 46–51 | 149–156 |
| <i>P. japonicus</i> | 7 | 51–52 | 47–52 | 99–103 | 50–51 | 147–150 |
| <i>P. lanae</i> | 4 | 43–48 | 47–51 | 90–98 | 43–51 | 138–145 |
| <i>P. nancyae</i> | 7 | 42–45 | 45–51 | 90–93 | 44–50 | 132–139 |
| <i>P. nudipinnis</i> | 10 | 51–54 | 45–53 | 98–106 | 45–50 | 143–153 |
| <i>P. schroederi</i> | 1 | – | – | 100 | 55 | 155 |

General Remarks. Compagno (1973, 1977) considered the Pristiophoriformes to be highly derived and transitional between “typical” sharks and batoids. Most subsequent authors (Shirai, 1992, 1996; de Carvalho, 1996; Compagno, 2001; Ebert & Compagno, 2013) have placed the pristiophorids as an intermediate sister group to the batoids, but kept them as a separate order to form the Squalomorphii along with the Hexanchiformes, Squaliformes, and Squatiniformes (Nelson, 2006). Interestingly, Naylor *et al.* (2005, 2012a, 2012b) showed that molecularly the Pristiophoriformes formed a clade with the Squaliformes and Squatiniformes to the exclusion of the Hexanchiformes. Furthermore, Naylor *et al.* (2012b) commented that the interrelationships between the Pristiophoriformes, Squatiniformes, and Echinorhinidae remained unclear and warranted further investigation.

The interspecific relationship of the genus *Pristiophorus* has been little studied and remains open to interpretation. The genus with inclusion of the heretofore describe *P. lanae*, includes seven valid species, all of which appear to be regional endemics with relatively restricted geographic distributions (see introduction above and Ebert & Cailliet, 2011; Ebert & Compagno, in press). The members of this genus can be subdivided into two species subgroups by habitat, one of temperate water mostly coastal, continental shelf species (*P. cirratus*, *P. japonicus*, *P. nudipinnis*) and another of tropical deepwater, continental and insular slope species (*P. delicatus*, *P. lanae*, *P. nancyae*, *P. schroederi*). Ebert & Compagno (in press) suggested a further subdivision that included four species subgroups based on their morphology in addition to habitat. This includes a subgroup of relatively shallow-water, temperate, stout bodied, western Pacific species (*P. cirratus*, *P. japonicus*), a subgroup of deepwater, tropical, mostly slender bodied species (*P. delicatus*, *P. lanae*, *P. schroederi*), and two monotypic subgroups; one subgroup comprised of the highly distinctive, deepwater, western Indian Ocean, dwarf species *P. nancyae*, and a subgroup consisting of the relatively large, southern Australian endemic *P. nudipinnis*. The genus can also be subdivided morphologically based on the relative position of the barbel (Figure 4); a subgroup of species whose barbels are distinctly closer to the mouth (*P. japonicus*, *P. nancyae*, *P. nudipinnis*), about equidistant to slightly in front of or behind, the rostral midpoint between the rostral tip and mouth (*P. delicatus*, *P. lanae*, *P. schroederi*), and a subgroup with their barbels located distinctly closer to the rostral tip (*P. cirratus*). Further detailed morphological studies, combined with newer molecular methods, will be required to fully resolve the interspecific relationships between these various species. The only information available from molecular studies to date shows *P. japonicus* clusters closer to *P. warreni* rather than to *P. cirratus* (Naylor *et al.* 2012a).

Key to the species of the genus *Pristiophorus*: (modified after Ebert & Cailliet, 2011)

- 1a. A double row of 4 to 5 conspicuous large pits on underside of snout in front of barbels. Larger rostral teeth with prominent transverse ridges on their bases. First dorsal fin very broadly triangular, with apex well in front of insertion and free rear tip about over pelvic insertions. *Pristiophorus nancyae*
- 1b. No enlarged pits on pre-barbel snout. Larger rostral teeth apparently lacking basal ridges. First dorsal fin narrower and triangular to semifalcate, with apex over or behind insertion and free rear tip over or anterior to first third of pelvic bases . . . 2
- 2a. Rostrum short, broad, and strongly tapering, pre-oral length 22 to 24% of total length. Snout width at nostrils 2.7 to 4.3 times in pre-orbital length. Nostrils about equidistant between barbels and mouth corners. Nostrils diagonally oval and elongated *Pristiophorus nudipinnis*
- 2b. Rostrum more elongated, narrower, and less strongly tapering, pre-oral length 25 to 32% of total length. Snout width at nostrils 4.4 to 6.1 times in pre-orbital length. Nostrils considerably closer to mouth corners than to barbels. Nostrils transversely oval, nearly circular. 3
- 3a. Body and fins with a color pattern of dark blotches and spots (occasionally faint). Pre-barbel rostrum length from only 40 to 43% of pre-oral length. *Pristiophorus cirratus*
- 3b. Body and fins uniform in color. Pre-barbel rostrum length 44 to 59% of pre-oral length 4
- 4a. Snout greatly elongated, pre-oral length 31% or more of total length. Lateral trunk denticles largely tricuspidate *Pristiophorus schroederi*
- 4b. Snout shorter, pre-oral length 31% or less of total length. Lateral trunk denticles unicuspidate 5
- 5a. Mouth extending forward to below posterior third of eye. 25 to 32 large lateral rostral saw-teeth in front of barbels. Barbel origin distinctly closer to mouth than to rostral tip. Tooth rows 35 to 71 in upper jaw, increasing with growth. Lateral trunk denticles with erect crowns that are not closely imbricated *Pristiophorus japonicus*
- 5b. Mouth extending forward to below rear margin of eye. 17 to 26 large lateral rostral saw-teeth in front of barbels. Barbel origin more or less equidistant between mouth and rostral tip. Tooth rows 31 to 48 in upper jaw. Lateral trunk denticles with flat crowns that are imbricated 6
- 6a. Barbels slightly closer to rostral tip than to mouth or approximately equidistant, pre-barbel length 45 to 51% of pre-oral length. Spiracles moderately large, width less than 0.5 of eye length. Distance from nostrils to mouth more than 1.3 times internarial space. Origin first dorsal fin behind pectoral free-rear tip. *Pristiophorus delicatus*
- 6b. Barbels approximately equidistant or slightly closer to mouth than rostral tip, pre-barbel length 51 to 54% of pre-oral length. Spiracles large, width almost less 0.75 of eye length. Distance from nostrils to mouth about 1.1 to 1.2 times internarial space. Origin first dorsal fin about opposite to slightly behind pectoral free rear tip *Pristiophorus lanae* new species

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Appendix 1. Comparative material examined

Pliotrema warreni. 7 specimens: *Syntype* (1): BMNH 1905.6.8.9, female, 800 mm TL, coast of Natal (kwaZulu–Natal), 73 m, received from Dr. E. Warren of the Natal Government Museum; BMNH 1899.2.10.4, female, ca. 700 mm TL, False Bay, Cape of Good Hope, received from Dr. J.D.F. Gilchrist, possible syntype although listed as “*Pristiophorus cirratus*” in the collection, this is actually a *Pliotrema warreni*; SU 31456, immature female, 345 mm TL, Cape of Good Hope, South Africa, received from Cecil Von Bonde; 4 specimens collected by R/V *Africana* on the Agulhas Bank, South Africa: LJVC 860705, mature male, 1023 mm TL, LJVC 870909, mature male, 1030 mm TL, LJVC 870114, immature female, 870 mm TL, LJVC 920505, immature female, 857 mm TL.

Pristiophorus cirratus. 19 specimens: CSIRO H 1135–01, 965 mm TL, mature male, E of St. Patrick’s Head, Tasmania, Australia, 41° 35’ S, 148° 31’ E, 1986; CSIRO H 2267.02, immature male, S of Cape Leeuwin, Western Australia, Australia, 34° 57’ S, 114° 56’ E, 201 m, 1989; CSIRO H 2609.02, W of Rottneest Island, Western Australia, Australia, 32° 06’ S, 115° 08’ E, 295 m, 1991; CSIRO H 2612.04, 423 mm TL, immature male, SW of Rottneest Island, Western Australia, Australia, 32° 12’ S, 115° 05’ E, 297 m, 1991; CSIRO H 2620.04, 603 mm TL, immature male, W of Bunbury, Western Australia, Australia, 33° 21’ S, 114° 30’ E, 350 m, 1991; CSIRO H 2620.05, 666 mm TL, immature male, W of Bunbury, Western Australia, Australia, 33° 21’ S, 114° 30’ E, 350 m, 1991; CSIRO H 2620.06, W of Bunbury, Western Australia, Australia, 33° 21’ S, 114° 30’ E, 350 m, 1991; CSIRO H 3426.01, 705 mm TL, female, NE of Tathra, New South Wales, Australia, 36° 34’ S, 150° 10’ E, 121 m, 1993; CSIRO H 3579.04, 588 mm TL, immature male, E of Disaster Bay, New South Wales, Australia, 37° 17’ S, 150° 19’ E, 141 m, 1993; CSIRO H 3582.01, 705 mm TL, female, E of Tathra, New South Wales, Australia, 36° 43’ S, 150° 09’ E, 102 m, 1993; CSIRO H 3582.02, 730 mm TL, female, E of Tathra, New South Wales, Australia, 36° 43’ S, 150° 09’ E, 102 m, 1993; CSIRO H 3582.04, 622 mm TL, female, E of Tathra, New South Wales, Australia, 36° 43’ S, 150° 09’ E, 102 m, 1993; CSIRO H 3707.01, 450 mm TL, female, E of Bega, New South Wales, Australia, 36° 40’ S, 150° 09’ E, 106 m, 1994; CSIRO H 3784.01, 894 mm TL, female, E of Bermagui, New South Wales, Australia, 36° 29’ S, 150° 12’ E, 123 m, 1994; CSIRO H 4257–01, 970 mm TL, female, E of Lakes Entrance, Victoria, Australia, 37° 55’ S, 148° 15’ E, 42 m, 1996; CSIRO H 4441.01, 443 mm TL, male, E of Bermagui, New South Wales, Australia, 36° 23’ S, 150° 06’ E, 29 m, 1996; MCZ 38611 (3 specimens), all females, 557 mm TL, 600 mm TL, and 965 mm TL, New South Wales, Australia; SU 20805, immature female, 337 mm TL, Port Jackson, New South Wales, Australia, collected David G. Stead.

Pristiophorus delicatus. 12 specimens: *Holotype*: CSIRO H 931-01, 698 mm TL, female, south of Saumarez Reef, Queensland, Australia, 22° 59' S, 152° 59' E, 343–350 m, 18 November 1985; *Paratypes* (11): CSIRO H 601-11, 438 mm TL, immature male, south of Saumarez Reef, Queensland, Australia, 22° 06' S, 153° 18' E, 314–319 m, 16 November 1985; CSIRO H 601-12, 448 mm TL, female, south of Saumarez Reef, Queensland, Australia, 22° 06' S, 153° 18' E, 314–319 m, 16 November 1985; CSIRO H 617-01, 585 mm TL, female, south of Saumarez Reef, Queensland, Australia, 22° 10' S, 153° 29' E, 303–333 m, 19 November 1985; CSIRO H 617-02, 577 mm TL, female, south of Saumarez Reef, Queensland, Australia, 22° 10' S, 153° 29' E, 303–333 m, 19 November 1985; CSIRO H 630-14, 506 mm TL, immature male, south of Saumarez Reef, Queensland, Australia, 22° 36' S, 153° 50' E, 345–350 m, 17 November 1985; CSIRO H 630-15, 509 mm TL, immature male, south of Saumarez Reef, Queensland, Australia, 22° 36' S, 153° 50' E, 345–350 m, 17 November 1985; CSIRO H 931-02, 845 mm TL, female, south of Saumarez Reef, Queensland, Australia, 22° 59' S, 152° 59' E, 343–350 m, 18 November 1985; CSIRO H 931-03, 780 mm TL, female, south of Saumarez Reef, Queensland, Australia, 22° 59' S, 152° 59' E, 343–350 m, 18 November 1985; CSIRO H 954-01, 809 mm TL, female, south of Saumarez Reef, Queensland, Australia, 23° 12' S, 153° 33' E, 399–405 m, 18 November 1985; CSIRO H 1113-07, 438 mm TL, female, south of Saumarez Reef, Queensland, Australia, 22° 06' S, 153° 18' E, 246–254 m, 19 November 1985; CSIRO H 1113-08, 625 mm TL, immature male, south of Saumarez Reef, Queensland, Australia, 22° 06' S, 153° 18' E, 246–254 m, 19 November 1985.

Pristiophorus japonicus, 15 specimens: ASIZP 0057267 (2 specimens), male, 582 mm TL, female, 356 mm TL, Dongsha Islands, Taiwan, 19° 85' N, 114° 03' E, collected by K.T. Shao, 15 May 1993; BMNH 1862.11.1.37, immature male, 734 mm TL, Japan; BMNH 1953.8.10.6, immature female, ca 700 mm TL, Japan; BMNH 1867.2.20.1-2 (2 specimens), females, ca 100 and 120 mm TL, Japan; HUMZ 195735, female, 1174 mm TL, off Shiriuchi, southern Hokkaido, Japan, 150 m depth; MCZ 1045, female, 865 mm TL, Suruga Bay at Yenoura, Japan, 9 March 1903, collector Alan Owston; MCZ 1283 male embryo, 304 mm TL, 4 March 1906, Sagami Sea, Japan, collector Alan Owston; SU 7258, immature female, 499 mm TL, Aomori, Honshu, Japan, collected by David S. Jordan & John O. Snyder; SU 7258, immature male, 578 mm TL, Aomori, Honshu, Japan, collected by David S. Jordan & John O. Snyder; SU 7258, immature male, 578 mm TL, Aomori, Honshu, Japan, collected by David S. Jordan & John O. Snyder; SU 12916, mature female, 1030 mm TL, Mutsu Wan, Aomori, Honshu, Japan; SU 13464, immature male, 695 mm TL, Mutsu Wan, Aomori, Honshu, Japan; SU uncat., mature female, 1030 mm TL, Mutsu Wan, Aomori, Honshu, Japan; USNM 99500, mature male, 1072 mm TL, Hokkaido Prefecture, Hakodate, Japan, Albatross, Station TT 3657.

Pristiophorus nancyae, 8 specimens: *Holotype*: SAM 34013, 616 mm TL, mature male, R/V *Algoa*, Mozambique Scad Survey, bottom trawl, Station C00840 014 037 3074, 22° 07' S, 35° 45' E, 500 m, 19 June 1994; *Paratypes*: (7): SAM 33477 440 mm TL, maturing male taken with holotype, R/V *Algoa*, Mozambique Scad Survey, bottom trawl, Station C00840 014 037 3074, 22° 07' S, 35° 45' E, 500 m, 19 June 1994; SAM 33502, 573 mm TL, maturing female, R/V *Algoa*, Mozambique Scad Survey, bottom trawl, Station C00848 014 045 3179, 25° 21' S, 34° 30' E, 286 m, 21 June 1994; SAM 33511 (5 specimens), 314 mm and 358 mm TL, both immature males, 391 mm TL immature female, 522 mm and 550 mm TL, both mature males, R/V *Algoa*, Mozambique Scad Survey, bottom trawl, Station C00841 014 038 3118, 23° 32' S, 35° 51' E, 490 m, 20 June 1994.

Pristiophorus nudipinnis, 14 specimens: *Syntype*: BMNH 1863.1.15.45, mature male, 1040 mm TL; BMNH 1859.9.11.1, *Holotype*: *Pristiophorus oweni*, immature female, 323 mm TL; BMNH uncat., female embryo, 315 mm TL; MCZ 665, female, 1000 mm TL, female, New South Wales, received in mid-1800s; SU 29452, embryo or neonate female, 269 mm TL, received from the Australian Museum; CSIRO CA 3356, 621 mm TL, immature male, Great Australian Bight, Western Australia, Australia, 32° 54' S, 127° 47' E, 51 m, 1981; CSIRO H 2726.01, 398 mm TL, female, Fredrick Henry Bay, New South Wales, Australia, 42° 51' S, 147° 35' E, 6 m, 1991; CSIRO H 2726.02, 345 mm TL, female, Fredrick Henry Bay, New South Wales, Australia, 42° 51' S, 147° 35' E, 6 m, 1991; CSIRO H 2727.01, 636 mm TL, immature male, Fredrick Henry Bay, Tasmania, Australia, 42° 51' S, 147° 35' E, 9 m, 1991; CSIRO H 3401.01, 378 mm TL, immature male, Fredrick Henry Bay, New South Wales, Australia, 42° 55' S, 147° 31' E, 8 m, 1992; CSIRO H 3535.17, 640 mm TL, female, Fredrick Henry Bay, New South Wales, Australia, 37° 22' S, 149° 58' E, 44 m, 1993; CSIRO H 3777-01, 937 mm TL, mature male, Disaster Bay, New South Wales, Australia, 37° 18' S, 149° 59' E, 33 m, 1994; CSIRO H 4171.01, 630 mm TL, immature male, E. of Newcastle, New South Wales, Australia, 32° 53' S, 152° 00' E, 71 m, 1995; CSIRO H 4252-01, 992 mm TL, female, Bass Strait, south of Lakes Entrance, Victoria, Australia, 38° 40' S, 148° 19' E, 108 m, 1996.

Pristiophorus schroederi, 4 specimens: *Holotype*: USNM 185946, immature female, 383 mm TL, collected 24 June 1957, 15 miles east of Dog Rocks, cay Sal Bank, Bahamian Archipelago, Bahamas Islands, 24° 05' N, 79° 46' W, Vessel Combat, Station C-449, depth 640 m; USNM 185947, 645 mm TL and 805 mm TL, immature male and female, 9 June 1958, Little Bahama Bank, 28° 03' N, 78° 46' W, Vessel Silver Bay, Station 445, depth 1000 m; CAS 234057, 493 mm TL, immature female, Bahamas, 23° 40' N, 79° 18' W, R/V Silver Bay, station 2458, depth 580 m, 5 November 1960.