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An unusual, dwarf new species of Neotropical freshwater stingray, *Plesiotrygon nana* sp. nov., from the upper and mid Amazon basin: the second species of *Plesiotrygon* (Chondrichthyes: Potamotrygonidae)

Marcelo R. de Carvalho[1,2]
Maíra P. Ragno[1,3]

ABSTRACT

A new species of the relatively poorly known Neotropical freshwater stingray genus Plesiotrygon *Rosa, Castello & Thorson, 1987 is described from the main channel and smaller tributaries (Ríos Itaya and Pachitea) of the upper Amazon basin in Peru. The first specimen to be collected, however, was from much farther east in Rio Solimões in 1996, just down-river from Rio Purus (specimen unavailable for this study).* Plesiotrygon nana *sp. nov., is a very distinctive and unusually small species of freshwater stingray (Potamotrygonidae), described here mostly from three specimens representing different size classes and stages of sexual maturity.* Plesiotrygon nana *sp. nov., is distinguished from its only congener,* P. iwamae *Rosa, Castello & Thorson, 1987, by numerous unique features, including: dorsal coloration composed of very fine rosettes or a combination of spots and irregular ocelli; very circular disc and snout; very small and less rhomboidal spiracles; short snout and anterior disc region; narrow mouth and nostrils; denticles on dorsal tail small, scattered, not forming row of enlarged spines; adult and preadult specimens with significantly fewer tooth rows; fewer caudal vertebrae; higher total pectoral radials; very small size, probably not surpassing 250 mm disc length or width, males maturing sexually at around 180 mm disc length and 175 mm disc width; distal coloration of tail posterior to caudal stings usually dark purplish-brown; and features of the ventral lateral-line canals (hyomandibular canal very narrow, infraorbital and supraorbital canals not undulated, supraorbital and infraorbital loops small and narrow, supraorbital loop very short, not extending posteriorly to level of mouth, jugular and posterior infraorbital canals short, not extending caudally to first gill slits, subpleural loop very narrow posteriorly; absence of anterior and posterior subpleural tubules). To provide a foundation for the description of* P. nana *sp. nov., morphological variation in* P. iwamae *was examined based on all type specimens as well as newly collected and previously unreported material. Two specimens topotypic with the male paratype of* P. nana *sp. nov., referred to here as* Plesiotrygon *cf.* iwamae, *are also reported. Relationships of the new species to* P. iwamae *are discussed; further characters indicative of* Plesiotrygon *monophyly are proposed, but the genus may still not be valid.* Plesiotrygon

[1.] Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo, Rua do Matão, Travessa 14, nº 101, CEP 05508-900, São Paulo, SP, Brasil.
[2.] E-mail: mrcarvalho@ib.usp.br
[3.] E-mail: mairaportella@gmail.com

nana *sp. nov., is commercialized with some regularity in the international aquarium trade from Iquitos (Peru), an alarming circumstance because nothing is known of its biology or conservation requirements.*

Key-Words: *Plesiotrygon iwamae;* Taxonomy; Morphology; Myliobatiformes; Rio Solimões; Río Ucayali; South America.

INTRODUCTION

The Neotropical freshwater stingray *Plesiotrygon iwamae* Rosa, Castello & Thorson, 1987 first appeared in the literature, misidentified as *Elipesurus strogylopterus* (not of Schomburgk, 1843), in P. de Miranda Ribeiro's (1959) catalogue of the fish collection of the Museu Nacional (Rio de Janeiro). Miranda Ribeiro's specimen, of unknown origin, is a partially mutilated juvenile male lacking the tail that, unfortunately, was a poor representative of this unusual stingray. It is no wonder that almost three decades went by before the genus and species were formally described (Rosa *et al.,* 1987); in between these accounts, there was a single literature record, but again misidentified (as *Potamotrygon scobina;* Taniuchi, 1982). Rosa *et al.* (1987) provided a thorough description of *P. iwamae* based on six specimens collected primarily between 1969 and 1981 and deposited in museums in Brazil and North America; the first specimen of *P. iwamae* to become available for study was the paratype in Hamburg collected in 1909. *Plesiotrygon iwamae* continued to be rare both in collections and the specialized literature even after being described. But more recent collecting efforts have revealed that *P. iwamae* is a widespread Amazonian species, distributed from Peru and Ecuador to the much lower waters of Rio Pará near the mouth of Rio Amazonas, occurring mostly in its main channel, but capable of entering lower parts of its major tributaries (such as in Rio Purus).

With such a broad distribution within the Amazon basin, and based on a much larger series of specimens than was previously available, we set out to discover if *P. iwamae* concealed a greater (and undescribed) cryptic diversity. Our studies led us to examine the stingray holdings of the Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, in Lima (Peru). Although no specimens of *P. iwamae* were found, a much smaller, darker individual very distinctive from "typical" representatives of *P. iwamae,* was located. This unique specimen appeared to be conspecific with a smaller individual captured during the 1996 Calhamazon Project in Rio Solimões just below its confluence with Rio Purus (for a summary, see Fernandes *et al.,* 2004), a photograph of which was examined by the senior author in that same year (this specimen, however, was unavailable for this study). The Lima specimen also resembled a small female individual in our possession, collected in 2009 by a colleague from Río Itaya, a tributary of Río Nanay in the vicinity of Iquitos (Peru). These specimens, along with another one collected in the Río Amazonas of Peru in late 2010, agree with a form called the "black-tailed" or "dwarf" antenna ray in the aquarium literature (*e.g.* Ross & Schäfer, 2000), and are described below as only the second species of *Plesiotrygon.* Our work is based on a thorough examination of the variation present in *P. iwamae* across its range, which unveiled noteworthy morphological distinctions between both species, such as in size, coloration, disc shape, proportions of nasoral region, spiracles and snout, ventral lateral line canals, and dermal covering; results of our study on *P. iwamae* are not presented in full here, but are forthcoming.

MATERIAL AND METHODS

Counts of vertebrae and fin rays taken from specimens are based on Compagno & Roberts (1982) and Carvalho & Lovejoy (2011). Tooth rows were counted following Stehmann *et al.* (1978) on preserved specimens and from radiographs (and include all tooth rows, not just those exposed). Terminology for skeletal morphology follows Nishida (1990) and Carvalho *et al.* (2004), and for lateral-line canals Garman (1888), Ewart & Mitchell (1892), and Chu & Wen (1979). Anatomical abbreviations are given in figure legends. Skeletal structures were studied from material of all species of potamotrygonids, through radiographed, dissected, and cleared and stained specimens (prepared following Dingerkus & Uhler, 1977).

Measurements follow classic protocols for batoids established in Bigelow & Schroeder (1953) and Hubbs & Ishiyama (1968), and further modified for potamotrygonids by Rosa (1985) (see also Carvalho & Lovejoy, 2011; Silva & Carvalho, 2011).

Measurements, taken point to point, are presented in Tables 1, 3 and 5 as both raw data in mm and transformed into % DW; measurements are as follows: *total length,* distance from tip of snout to tip of tail; *disc length,* greatest distance from tip of snout to posterior margin of disc; *disc width,* greatest distance between lateral margins of disc; *interorbital distance,* distance between upper margins of eyes; *interspiracular distance,* distance between posterior margins of spiracles; *eye length,* greatest horizontal diameter of exposed portion of eyeball; *spiracle length,* oblique distance between anterior and posterior spiracular margins; *preorbital length,* distance from tip of snout to anterior margin of eyes; *prenasal length,* distance from tip of snout to anterior margin of nostrils; *preoral length,* distance from tip of snout to median portion of mouth slit; *internarial distance,* distance between anterior margins of nostrils; *mouth width,* greatest distance between lateral edges of mouth; *distance between 1st gill slits,* distance between inner margins of first pair of gill slits; *distance between 5th gill slits,* distance between inner margins of fifth pair of gill slits; *branchial basket length,* distance between outer margin of first and inner margin of fifth gill slits; *pelvic fin anterior margin length,* length of anterior margin of pelvic fin; *pelvic fin width,* greatest width between posterior margins of pelvic fins; *clasper external length,* distance from posterior margin of pelvic fin to tip of clasper; *clasper internal length,* distance from posterior margin of cloaca to tip of clasper; *distance between cloaca and tail tip,* distance from posterior margin of cloaca to tip of tail; *tail width,* greatest width of base of tail; *snout to cloaca distance,* distance from tip of snout to proximal margin of cloaca; *pectoral to posterior pelvic length,* distance from pectoral axil, at the joint of posterior margin of disc and tail, to posterior margin of pelvic fin; *distance from cloaca to sting origin,* distance from posterior margin of cloaca to base of first caudal sting; *sting length,* length of exposed portion of caudal sting (dorsalmost sting when more than one is present); *sting width,* width taken at the origin of caudal sting (dorsalmost sting when more than one is present). Abbreviations in text: **DL,** disc length; **DW,** disc width; **TL,** total length. Meristic features are presented in Table 2.

Material of *Plesiotrygon* examined is deposited in the Field Museum of Natural History, Chicago (FMNH); Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima (formerly MHNJP) (MUSM); Museu Nacional, Rio de Janeiro (MNRJ); Museu de Zoologia da Universidade de São Paulo, São Paulo (MZUSP); National Museum of Natural History (NMNH), Smithsonian Institution, Washington DC; and Zoological Museum of Hamburg, Hamburg (ZMH). Collected specimens were fixed in 10% formalin and subsequently transferred to 70% ethanol. Comparative material of *Paratrygon aiereba* deposited in the MZUSP (which does not amount to all *Paratrygon* material examined) is listed in Carvalho & Lovejoy (2011). Comparative material of *Potamotrygon* spp. examined is mostly deposited in MZUSP, representing all valid species except *P. magdalenae* (Valenciennes, 1865). Historical material of Potamotrygonidae, including type specimens in European and South American museums, has also been examined. Other examined material is listed in Carvalho *et al.* (2004).

RESULTS

Family Potamotrygonidae Garman, 1913
Genus *Plesiotrygon* Rosa, Castello & Thorson, 1987

Diagnosis

A genus of Potamotrygonidae distinguished from the other genera of the family (*Paratrygon* Duméril, 1865, *Potamotrygon* Garman, 1877, and *Heliotrygon* Carvalho & Lovejoy, 2011) by the following characters: pelvic fins projecting posteriorly well beyond posterior disc margins (about one-half of pelvic fin length visible dorsally); distal caudal filament extremely long, much longer than disc (usually more than twice disc length), even in large adult specimens (distal caudal filament rarely broken off even in large adult specimens); eyes very small, not protruding above disc; ventral tail-fold well developed, almost as tall as tail, but lacking dorsal fold; caudal stings well developed and positioned relatively far posterior on dorsal tail; single, very broad, robust and relatively short angular cartilage; relatively few pectoral fin radials (total radials ranging from 75-91).

Remarks

The characters listed above are present in both *Plesiotrygon iwamae* and the new species, described below. Of these characters, the posterior placement of the pelvic fins, the extremely long caudal filament, posterior position of caudal stings, and the well developed ventral tail fold are unique among potamotrygonids. But angular cartilage morphology and a

FIGURE 1: Holotype of *Plesiotrygon nana* sp. nov., in dorsal **(A)** and ventral **(B)** views (MUSM 20328, adult male, 1024 mm TL, 243 mm DL, 247 mm DW, from Río Pachitea, tributary of Río Ucayali, near Puerto Inca, Peru).

relatively lower number of pectoral fin rays in *Plesiotrygon* require further comment.

Paratrygon and *Heliotrygon* lack angular cartilages, which are present in all species of *Potamotrygon* (Garman, 1913; Rosa, 1985; Carvalho *et al.,* 2004; Carvalho & Lovejoy, 2011; Carvalho *et al., in press*). Most species of *Potamotrygon,* however, have two angular elements associated to the hyomandibular-Meckelian ligament (in between the hyomandibula and Meckel's cartilage). These angulars are usually of similar dimensions, and the anterior angular frequently is strongly concave, features that are clearly distinct from the single, stout angular of *Plesiotrygon.* Also distinct are the angulars observed in specimens of *P. signata* Garman, 1913, which have a very wide anterior angular element and reduced, concealed posterior component. A single angular cartilage is present in *Potamotrygon schroederi* Fernandez-Yépez, 1958, *P. orbignyi* (Castelnau, 1855), *P. humerosa* Garman, 1913, *P. histrix* (Müller & Henle, 1834), *P. marinae* Deynat, 2006, and *P. tigrina* Carvalho, Sabaj & Lovejoy, 2011, but it is not as broad and stout as in species of *Plesiotrygon* (variations in the angular and their systematic significance are presently being studied).

The relatively low number of pectoral fin radials in species of *Plesiotrygon,* varying from 75-91 total radials, is much lower than in *Paratrygon* and *Heliotrygon,* which have counts upwards of 100 total pectoral radials (Rosa, 1985; Carvalho & Lovejoy, 2011). Some species of *Potamotrygon* have pectoral radial numbers more comparable to *Plesiotrygon,* such as *P. scobina* Garman, 1913, and *P. magdalenae.* But *P. brachyura* (Günther, 1880) has much higher counts (typically at least 106, according to radiographed MZUSP specimens), and *P. falkneri* Castex & Maciel, 1963, *P. orbignyi, P. humerosa* Garman, 1913, *P. marinae,* and *P. motoro* (Müller & Henle, 1841) have slightly higher counts ranging from about 93-105 (Loboda, 2010; Silva, 2010; Silva & Carvalho, 2011). Even though *Plesiotrygon* and many species of *Potamotrygon* are similar in pectoral radial numbers, whether this is significant in terms of uniting both genera is still undetermined. Rosa (1985: 410) united *Potamotrygon* and *Paratrygon* as a monophyletic group on the basis of high modal number of pectoral fin radials, but this feature is somewhat continuous with *Plesiotrygon,* and species of *Potamotrygon* vary slightly in this regard.

Type-species

Plesiotrygon iwamae Rosa, Castello & Thorson, 1987 by original designation.

Plesiotrygon nana sp. nov. (Figures 1-15, 27; Tables 1-2)

Holotype

MUSM 20328, adult male (1024 mm TL, 243 mm DL, 247 mm DW), Río Pachitea, tributary of Río Ucayali, up-river from town of Puerto Inca, Puerto Inca Province, Huánuco Department, Peru, 09°25'S, 74°55'E, 15 August 2002, coll. Edgardo Castro (Figures 1, 2, 8, 9, 11, 13-15).

Paratypes

MUSM 40243, preadult male (671 mm TL, 174 mm DL, 170 mm DW), Río Amazonas, Aucayo Caserio, near Tamshiyacu, Sargento Lores District, Maynas Province, Loreto Department, Peru, 03°59'13.21"S, 73°10'02.80"W, altitude 89 m, 15 November 2010, coll. Homero Sanchez; MZUSP 108777, juvenile female (463 mm TL, 81 mm DL, 72 mm DW), Río Itaya, tributary of Río Nanay (itself an affluent of Río Amazonas), near Iquitos, Departamento Loreto, Peru, 18 October 2009, coll. F. Marques (PU 09-45) (Figures 3-7, 11, 12, 27).

Non type specimen

MZUSP 57642, juvenile or preadult female, 912 mm TL, 124 mm DL, 118 mm DW, from Rio Solimões, just down-river from the confluence with Rio Purus (Brazil), 03°36'22.9"S, 61°20'14.0"W, to 03°36'26.0"S, 61°19'52.3"W, 1996 Calhamazon Project, 28 Jul 1996, coll. A. Zanata *et al.,* collected 50 m from shore over predominantly clay bottom (AMZ-96-081).

Diagnosis

A species of *Plesiotrygon* diagnosed by the following unique characters: (1) dorsal color pattern composed of a dark gray to dark brown background color, with tan to yellow highly curved, slender and convoluted stripes or small spots forming rosette-like pattern over dorsal disc, or with creamy white to yellowish irregularly shaped, scattered spots and ocelli, smaller than interorbital distance (pale gray or brown dorsal background color in *P. iwamae,* composed of faint, incomplete markings outlined by small spots, or small irregular blotches and creamy,

faint spots); (2) disc circular in preadults and adults, about as wide as long (markedly oval in *P. iwamae* in all sizes); (3) broadly rounded anterior disc (anterior disc sharply oval in *P. iwamae*); (4) spiracles only faintly rhomboidal, very small, ranging from 2.8 to 3.5% DW in adult and preadult specimens (spiracle strongly rhomboidal, with mean spiracle length 6.8% DW in *P. iwamae*); (5) snout very short, mean preorbital length 21.2% DW, mean prenasal length 15.2% DW, and mean preoral length 18.7% DW (snout proportionally much more elongate in *P. iwamae,* with mean preoral length 27.4% DW, mean prenasal length 19.5% DW, and mean preoral length 25% DW); (6) mouth and nostrils very slender especially in adult and preadult specimens, with mean mouth and internarial width 6.3% DW (mouth and internarial distance much greater in *P. iwamae,* with mean mouth width 10.9% DW, and mean internarial distance 8.7% DW); (7) denticles on dorsal tail relatively small, scattered, not forming row of greatly enlarged spines (*P. iwamae* usually with a single irregular row of enlarged spines on dorsal tail region); (8) adult and preadult specimens with few (20-21/19) tooth rows (adult specimens of *P. iwamae* have numerous tooth rows, ranging from about 40-60/42-64); (9) caudal vertebrae ranging from 86-88, with a modal count of 86 (93-98, with a modal count of 94 caudal vertebrae in *P. iwamae*); (10) total pectoral radials in adult and preadult specimens 90-91 (in *P. iwamae,* total pectoral radials varied from 77-84); (11) overall size very small (probably not surpassing 250 mm DL or DW), males sexually maturing probably between 180 and 220 mm DL, and 175 and 225 mm DW (*P. iwamae* attains great sizes, upwards of 650 mm DL or DW, reaching sexual maturity only at about 420 mm DL or DW); (12) distal coloration of tail, as of caudal stings, usually a dark purplish brown, remaining this color to extremity of whip (in *P. iwamae,* tail as of caudal stings creamy white ventrally and light gray dorsally, with creamy white distal whip); (13) ventral lateral-line canals with the following unique characters: hyomandibular canal very narrow, with external and internal components close together; infraorbital and supraorbital canals not undulated; supraorbital and infraorbital loops small and narrow, without wavy contours; supraorbital loop of anterior infraorbital canal very short, not extending posteriorly to level of mouth; jugular and posterior infraorbital canals short, not extending posteriorly to close to gill slits; subpleural loop very narrow posteriorly; anterior and posterior subpleural tubules of hyomandibular canal absent (for comparison with ventral lateral-line canals in *P. iwamae* and other anatomical differences between both species, as well as further details concerning features listed here, see Discussion below).

External morphology

Disc very circular, about as long as wide, and widest at more or less midlength, near level of scapulocoracoid (for description below, refer to Figures 1-10). Disc length 98.4% DW in holotype, ranging between 98.4 and 112.5% DW (mean 104.4% DW) (Table 1). Disc very low and flat, tallest at head region. Snout with broadly rounded anterior margin, and with a minute but clearly visible, rostral knob-like projection protruding from anterior disc. Rostral knob somewhat fleshy, well developed in all specimens. Snout length considerably small. Preorbital snout length less than one-fourth disc width, slightly less than twice interorbital distance; preorbital snout length from 20.0 to 22.7% DW (mean 21.2% DW). Prenasal (12.1 to 18.1% DW, mean 15.2% DW) and preoral (16.2 to 22.2% DW, mean 18.7% DW) snout lengths also relatively short, shorter than preorbital snout length. Eyes very small, slightly rounded, protruding very little from top of head and disc in live specimens (see Figure 27); eyes smaller than spiracles in diameter. Spiracles closely adjacent to eyes, oval-rounded, not very rhomboidal, and relatively small. Spiracles without elevated spiracular rims or central knob posteriorly. Interspiracular distance slightly greater than interorbital distance.

Mouth very small and narrow, with opening somewhat straight across. Mouth width less about one-third distance between first gill slits, and more or less equal to internarial distance. Two small labial folds present at outer jaw corners posterior to tubular narial fold, extending anterolaterally away from jaw corners. Nostrils anteroposteriorly elongated, slit-like, close in length to internarial distance. Nasal curtain very narrow, straight and not widening posteriorly, with highly fringed and medially notched posterior margin (Figure 8). Rounded, tubular narial fold present lateral to posterior corners of nasal curtain. Teeth set in quincunx, not visible externally with mouth closed in holotype. Tooth rows 20/19 in holotype, 21/19 in male paratype, and 13/16 in much smaller female paratype; teeth small, rhomboidal, with small cusps in holotype (an adult male). Five buccal papillae present inside mouth. Branchial basket about twice as wide as long, its length about one-tenth DW. Distance between first gill slits slightly greater than distance between fifth gill slits. Gill openings slightly obliquely positioned, very small; fifth gill slit smallest.

Pelvic fins with broadly rounded outer margins, much wider than long (48.6 to 57.6% DW, mean 54.0% DW), and with undulating posterior margins. Pelvic fins protruding significantly from posterior disc region, and triangular in dorsoventral view, broadest at more or less posterior apices. Anterior margins of pelvic fins with marked angle at more or less mid-length of anterior surface, more prominent in larger specimens; outer portions of pelvic fins fleshy. Clasper relatively slender, projecting well beyond posterior margin of pelvic fin (Figure 9). Clasper dorsoventrally flattened, with rounded posterior tip. Clasper groove deflects inward toward midline at clasper glans region; dorsal pseudosiphon relatively small, positioned at a slight angle. Hypopyle at beginning of clasper glans, extending posteriorly in a very straight line. Ventral pseudosiphon situated on external margin of clasper tip, about as elongated as hypopyle.

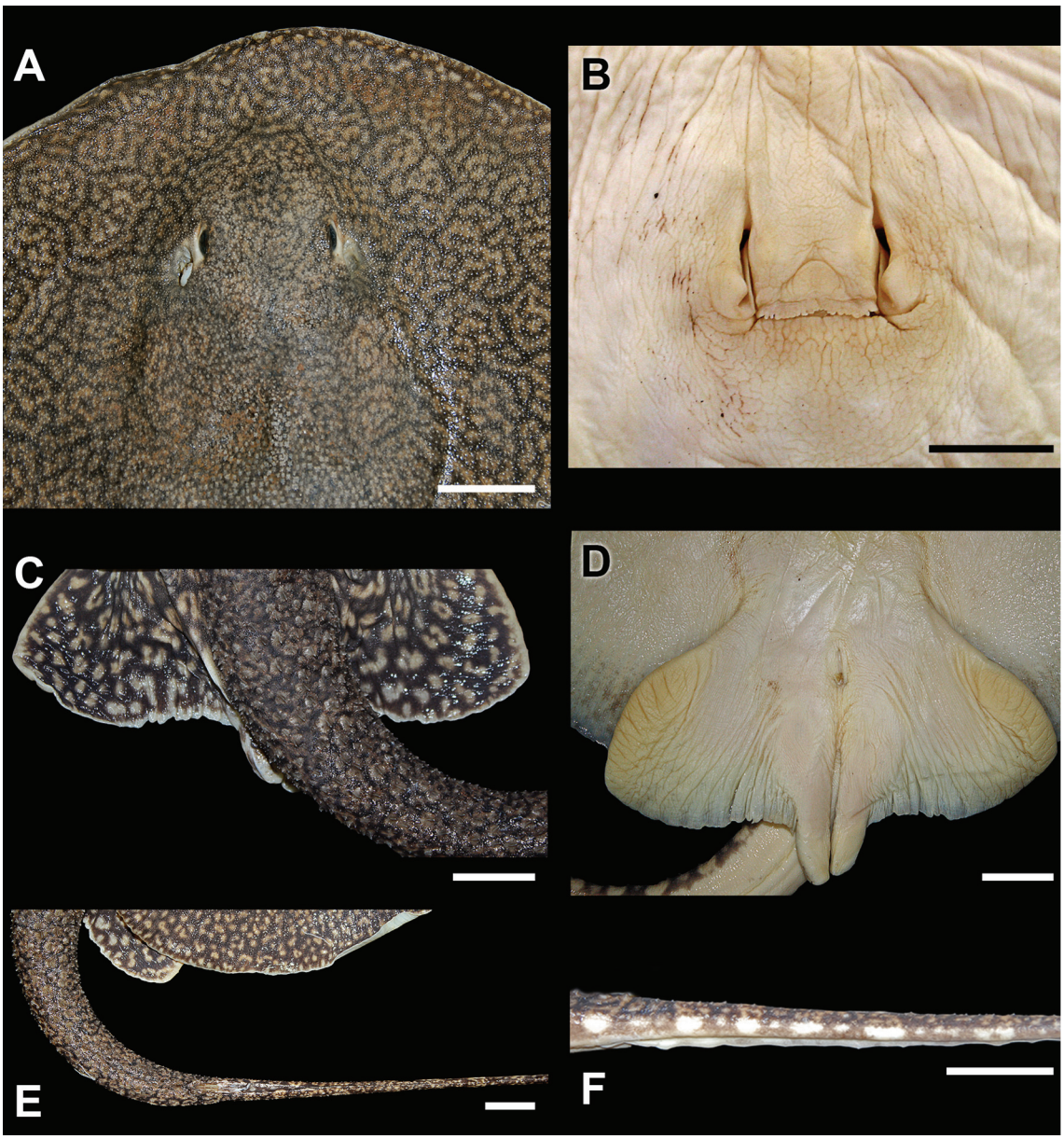

FIGURE 2: Morphological details of holotype of *Plesiotrygon nana* sp. nov. (MUSM 20328, adult male, 1024 mm TL, 243 mm DL, 247 mm DW, from Río Pachitea, tributary of Río Ucayali, near Puerto Inca, Peru). **A)** Dorsal view of anterior disc and head region. **B)** Nasoral region. **C)** Dorsal view of base of tail and pelvic fins. **D)** Ventral view of pelvic fins and clasper. **E)** Dorsal view of tail region at caudal stings (removed). **F)** Lateral view of tail at region of caudal stings (removed), showing ventral tail-fold. Scale bar in A, C-F = 2 cm; B = 1 cm.

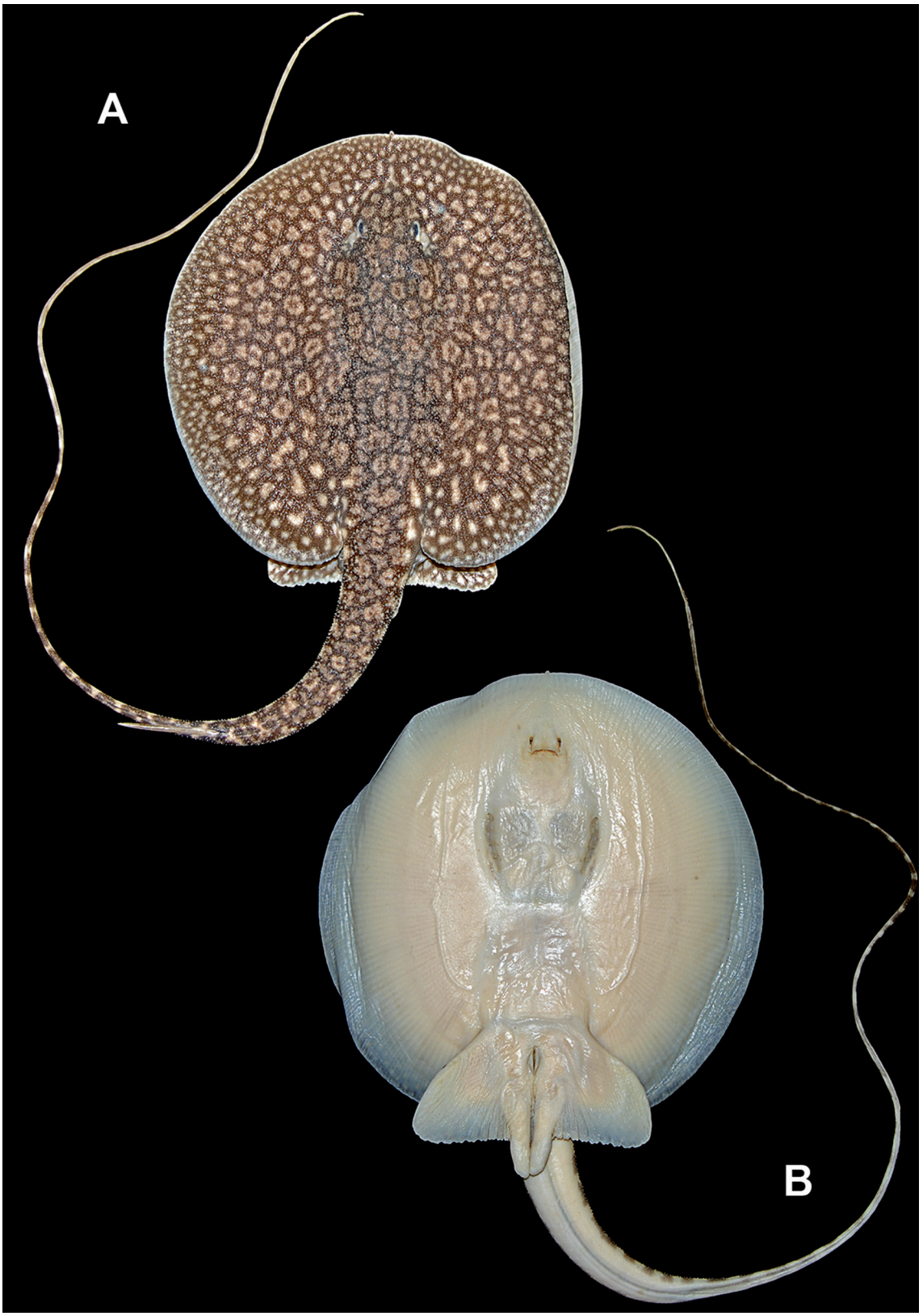

FIGURE 3: Paratype of *Plesiotrygon nana* sp. nov., in dorsal **(A)** and ventral **(B)** views (MUSM 40243, preadult male, 671 mm TL, 174 mm DL, 170 mm DW, Río Amazonas, near Tamshiyacu, Peru).

Tail at base about as wide as interorbital distance (tail width 11.1 to 15.3% DW, mean 12.9% DW). Tail strongly tapering from base, terminating far posteriorly as an elongated, filiform whip. In holotype (adult male), disc length and width only about one-fourth of total length; in female paratype, total length almost six times as long as disc length or width; in male paratype distal tail slightly shorter). Tail whip decreasing in diameter posteriorly, terminating as a very small point. Tail dorsoventrally flattened in cross-section throughout, with ventral, medially positioned groove present from tail base, extending very posteriorly beyond caudal stings. Relatively broad ventral tail fold originating within groove at more or less level of caudal sting origin, tallest at more or less midlength of caudal stings, and extending posteriorly for more

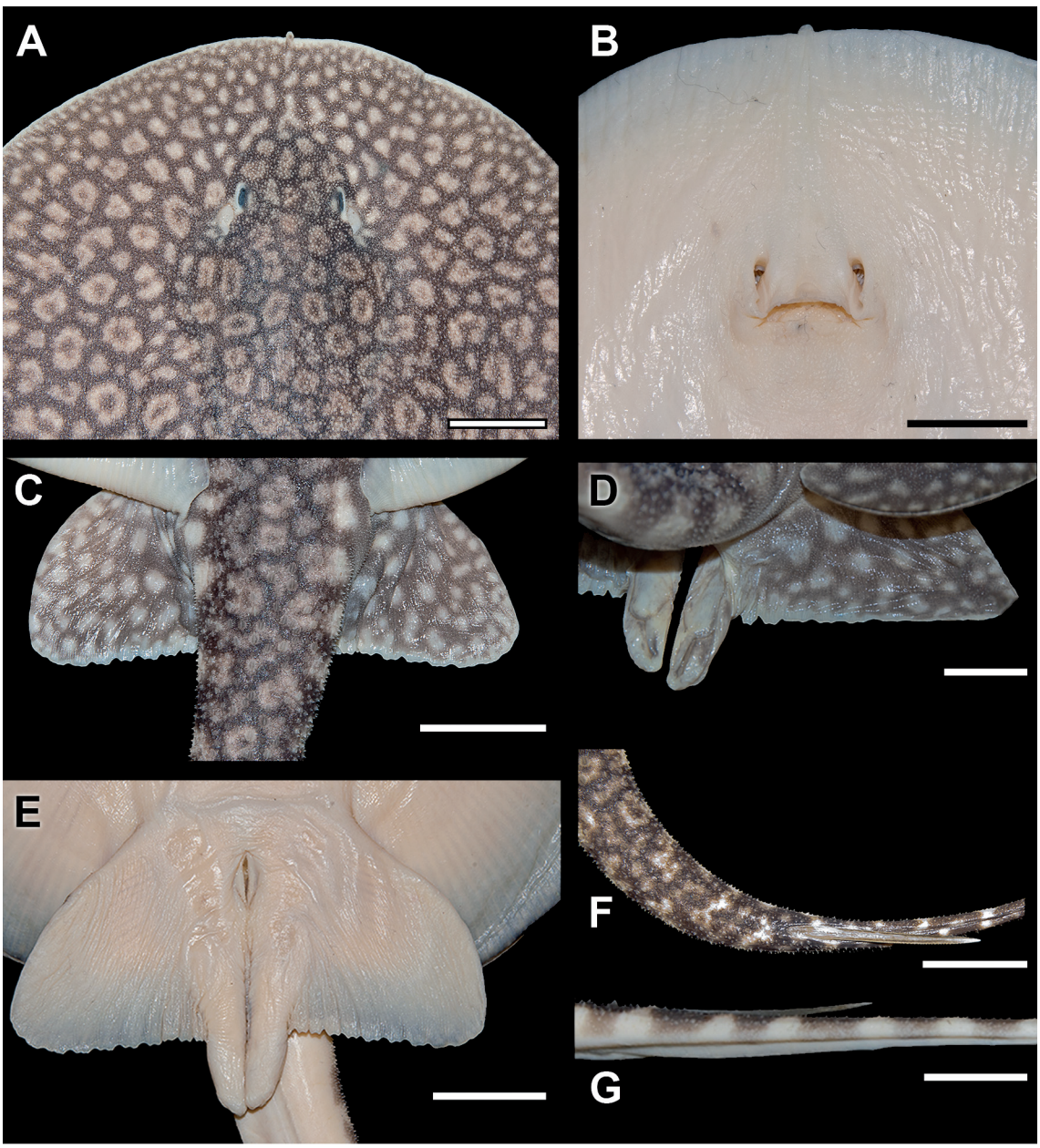

FIGURE 4: Morphological details of paratype of *Plesiotrygon nana* sp. nov. (MUSM 40243, preadult male, 671 mm TL, 174 mm DL, 170 mm DW, Río Amazonas, near Tamshiyacu, Peru). **A)** Dorsal view of anterior disc and head region. **B)** Nasoral region. **C)** Dorsal view of base of tail and pelvic fins. **D)** Dorsal view of claspers and pelvic fins. **E)** Ventral view of pelvic fins and claspers. **F)** Dorsal view of base of tail and tail region at caudal stings. **G)** Lateral view of tail at caudal sting region, showing ventral tail-fold. Scale bar in A, C, E, F, G = 2 cm; B, D = 1 cm.

than twice length of caudal stings. Tail without lateral or dorsal tail folds. Cloaca to distal tail length great (311.2 to 540.3% DW, mean 402.8% DW). Caudal stings positioned far posteriorly on dorsal tail (distance from tail base to their origin greater than one-half of disc width). Caudal stings clearly greater than interorbital distance or tail width at base. Caudal stings very slender, their width in male paratype about one-twentieth their length, but in female paratype caudal sting width about one-tenth of length. Caudal stings with acute distal apex and with posteriorly directed and sharp lateral serrations.

Coloration

Dorsal color of disc somewhat variable in material studied (Figures 1-7, 10). In live specimens, colors

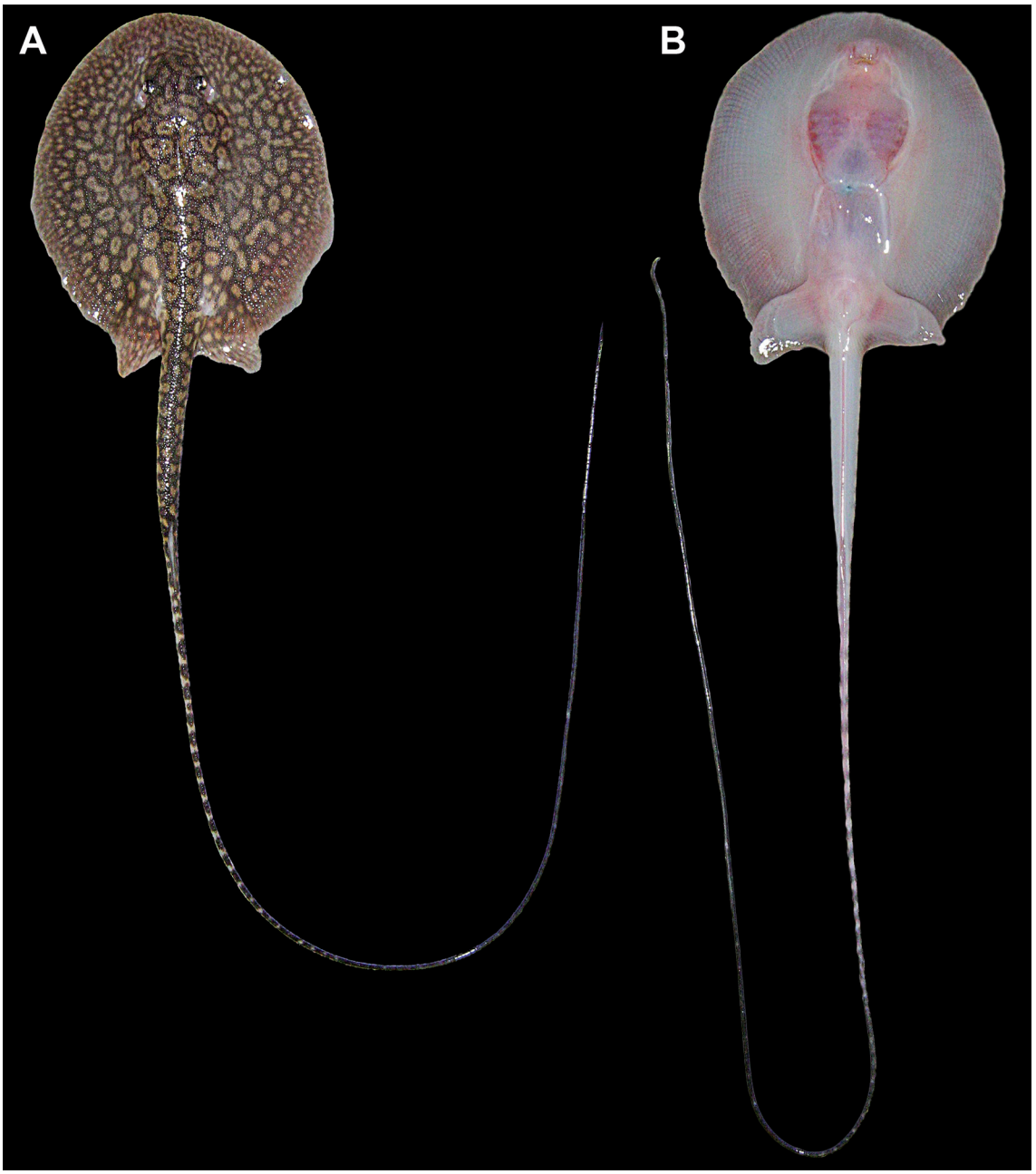

FIGURE 5: Paratype of *Plesiotrygon nana* sp. nov., in dorsal **(A)** and ventral **(B)** views, shortly after capture (MZUSP 108777, juvenile female, 463 mm TL, 81 mm DL, 72 mm DW, Río Itaya, tributary of Río Nanay, near Iquitos, Peru). Image courtesy of F. Marques.

TABLE 1: Measurements of type-series of *Plesiotrygon nana* sp. nov. **A:** MUSM 20328 (holotype), adult male. **B:** MUSM 40243 (paratype), preadult male. **C:** MZUSP 108777 (paratype), juvenile female. **SD:** standard deviation.

PARAMETER	A		B		C		Range	Mean		SD	
	mm	% DW	mm	% DW	mm	% DW	% DW	mm	% DW	mm	% DW
Total length (TL)	1024.0	—	671.0	—	463.0	—	—	719.3	—	283.6	—
Disc length (DL)	243.0	98.4	174.0	102.4	81.0	112.5	98.4-112.5	166.0	104.4	81.3	7.3
Disc width (DW)	247.0	100.0	170.0	100.0	72.0	100.0	—	163.0	—	87.7	—
Interorbital distance	26.0	10.5	20.0	11.8	12.0	16.7	10.5-16.7	19.3	13.0	7.0	3.2
Interspiracular distance	31.0	12.6	23.0	13.5	18.0	25.0	12.6-25.0	24.0	17.0	6.6	6.9
Eye length	5.0	2.0	3.0	1.8	4.0	5.6	1.8-5.6	4.0	3.1	1.0	2.1
Spiracle length	7.0	2.8	6.0	3.5	5.0	6.9	2.8-6.9	6.0	4.4	1.0	2.2
Preorbital length	56.0	22.7	34.0	20.0	15.0	20.8	20.0-22.7	35.0	21.2	20.5	1.4
Prenasal length	30.0	12.1	26.0	15.3	13.0	18.1	12.1-18.1	23.0	15.2	8.9	3.0
Preoral length	40.0	16.2	30.0	17.6	16.0	22.2	16.2-22.2	28.7	18.7	12.1	3.1
Internarial distance	15.0	6.1	11.0	6.5	6.0	8.3	6.1-8.3	10.7	7.0	4.5	1.2
Mouth width	16.0	6.5	14.0	8.2	6.0	8.3	6.5-8.3	12.0	7.7	5.3	1.0
Distance between 1st gill slits	48.0	19.4	37.0	21.8	21.0	29.2	19.4-29.2	35.3	23.5	13.6	5.1
Distance between 5th gill slits	41.0	16.6	29.0	17.1	15.0	20.8	16.6-20.8	28.3	18.2	13.0	2.3
Branchial basket length	27.0	10.9	22.0	12.9	9.0	12.5	10.9-12.9	19.3	12.1	9.3	1.1
Pelvic fin anterior margin length	60.0	24.3	40.0	23.5	22.0	30.6	23.5-30.6	40.7	26.1	19.0	3.9
Pelvic fins width	138.0	55.9	98.0	57.6	35.0	48.6	48.6-57.6	90.3	54.0	51.9	4.8
Clasper external length	16.0	6.5	15.0	8.8	—	—	6.5-8.8	15.5	7.7	0.7	1.7
Clasper internal length	38.0	15.4	28.0	16.5	—	—	15.4-16.5	33.0	15.9	7.1	0.8
Distance between cloaca and tail tip	882.0	357.1	529.0	311.2	389.0	540.3	311.2-540.3	600.0	402.8	254.1	121.2
Tail width	30.0	12.1	26.0	15.3	8.0	11.1	11.1-15.3	21.3	12.9	11.7	2.2
Snout to cloaca distance	208.0	84.2	146.0	85.9	68.0	94.4	84.2-94.4	140.7	88.2	70.2	5.5
Pectoral to posterior pelvic length	70.0	28.3	51.0	30.0	16.0	22.2	22.2-30.0	45.7	26.9	27.4	4.1
Distance from cloaca to sting origin	158.0	64.0	122.0	71.8	57.0	79.2	64.0-79.2	112.3	71.6	51.2	7.6
Sting length	—	—	37.0	21.8	16.0	22.2	21.8-22.2	26.5	22.0	14.8	0.3
Sting width	3.0	1.2	2.0	1.2	1.5	2.1	1.2-2.1	2.2	1.5	0.8	0.5

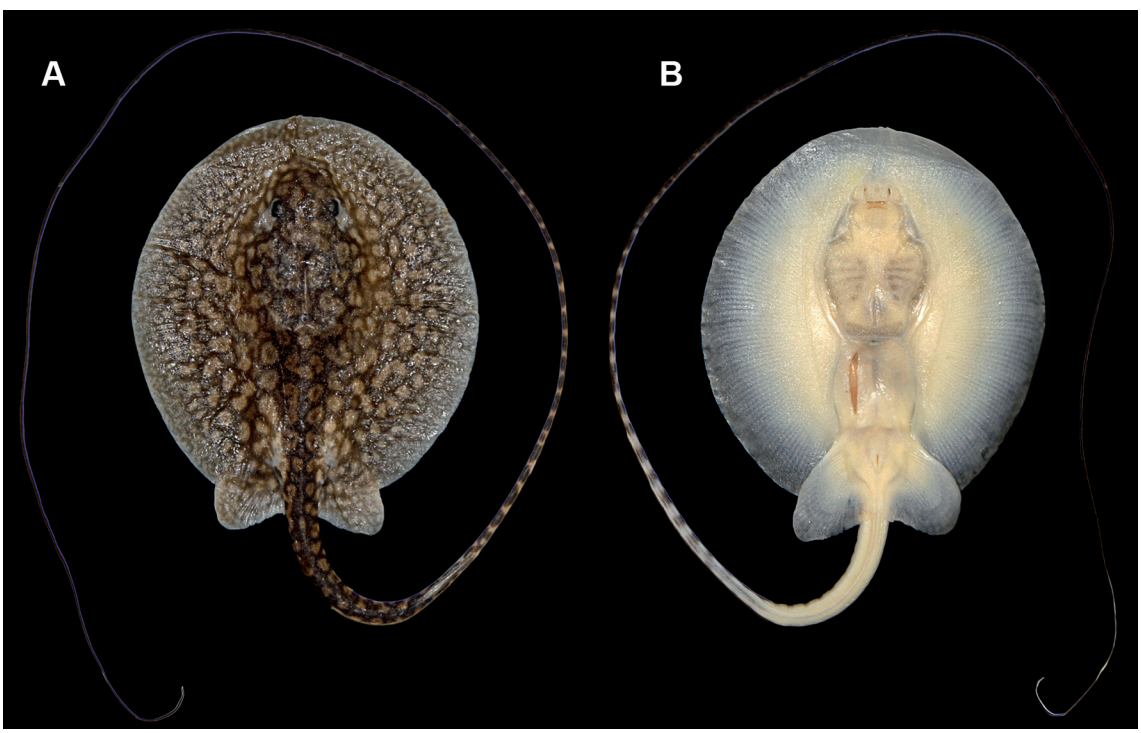

FIGURE 6: Paratype of *Plesiotrygon nana* sp. nov., in dorsal **(A)** and ventral **(B)** views (MZUSP 108777, juvenile female, 463 mm TL, 81 mm DL, 72 mm DW, Río Itaya, tributary of Río Nanay, near Iquitos, Peru).

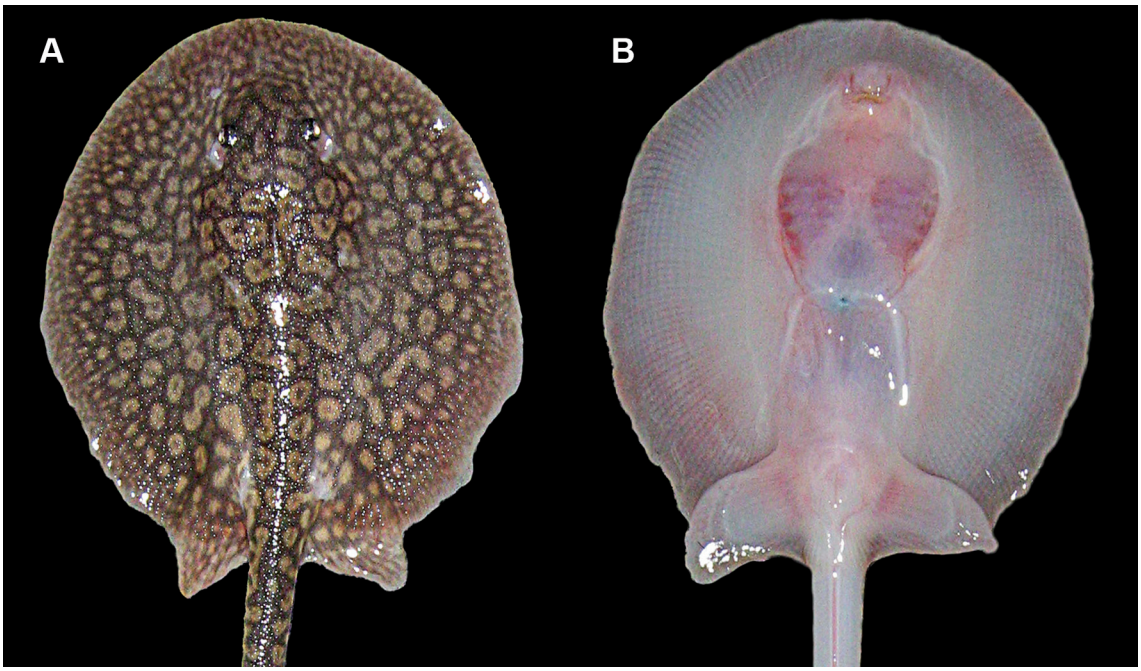

FIGURE 7: Dorsal **(A)** and ventral **(B)** discs of paratype of *Plesiotrygon nana* sp. nov. (MZUSP 108777, juvenile female, 463 mm TL, 81 mm DL, 72 mm DW, Río Itaya, tributary of Río Nanay, near Iquitos, Peru).

more intense but not significantly different. Dorsal disc with light to dark brown or blackish-brown background color, slightly lighter close to disc margin in preserved material. Background color forming a dark reticulate pattern surrounding tan to yellowish irregular patterns of rosettes, spots and/or incomplete ocelli of alternating sizes. In holotype (largest male specimen), rosettes very conspicuous, formed from very slender and convoluted individual lines and small spots of lighter color. Largest rosettes about equal to interorbital distance in diameter, smaller rosettes about half this size. Larger rosettes present on mid-lateral disc, reducing in size toward outer disc. Outer disc with interrupted yellow lines, and outermost disc region with numerous very small tan to yellowish spots. Rosettes closely adjacent, and may mesh together forming elaborate patterns over mid and outer disc regions. Rosettes over central disc obscured by intense covering of dermal denticles. Dorsal aspect of pelvic fins with more individual spots, these relatively more isolated, occasionally forming incomplete ocelli. Claspers with creamy white background and irregular, diffuse brown and grayish blotches dorsally, more concentrated on region of hypopyle, clasper groove and dorsal clasper glans; claspers creamy white ventrally. Color of base of tail also obscured by denticles, but with a speckled darker and lighter color, with fewer lighter spots than outer disc. Lateral aspect of tail, anterior to caudal stings, with alternating creamy white and grayish or brown stripes; grayish stripes with diffuse whitish areas within; white stripes with slightly darker areas interspersed. Dorsal aspect of tail also with alternating pattern but much more concealed by denticles, not as sharp. Ventral surface of holotype a uniform creamy white, with slight patches of dusky gray at posterior disc and posterior pelvic fin margins. Ventral tail creamy white until about midlength of ventral tail fold, with darker bands alternating with lighter bands present until about just greater than one-half of tail length. Posterior more or less two-thirds of tail uniformly dark purplish brown; distal tail extremity evenly dark on all sides.

Preadult male paratype with slightly distinct color pattern, with more background color present, and with spots and ocellated markings relatively smaller than in holotype. Spots and ocelli more scattered, much smaller than interorbital distance, and irregularly shaped. Clearly defined rosettes, as in holotype, absent. Spots and dorsal markings tan to yellow, reducing in diameter closer to disc outer margin. Laterally elongated and irregularly shaped spots present on disc. Pelvic fins with similar dorsal pattern as disc, but with slightly more regularly spaced creamy white spots. Claspers also with dorsal pigmentation most concentrated on dorsal clasper glans region, similar to holotype. Base of tail more marked with creamy white bands on lateral aspect, and with more whitish markings compared to holotype. Alternating bands of

darker gray and creamy white present distally on tail posterior to caudal stings. Distal filiform tail creamy white ventrally, not dark as in holotype and female paratype. On ventral disc and base of tail, male paratype creamy white throughout.

Female paratype with color pattern more or less similar to male paratype, composed of numerous creamy white to yellowish irregularly shaped spots and ocelli (Figures 5-7). Spots very reduced in size, especially at outer disc. Spots and irregular ocelli greater at middisc region. Incomplete ocelli present mostly over central disc area. Laterally elongated and irregularly shaped spots present on disc. On anterior disc region, fine vermiculate pattern present. Base of tail with darker midline region and dorsolaterally positioned lighter ocelli. Lateral tail with alternating bands of lighter and darker from base of tail, where bands are less defined, to about one-half of tail length; tail uniformly very dark purplish-brown at posterior half to tail extremity. Solimões specimen with similar color pattern, but with more reticulate background, and larger, more rectangular lighter markings on central dorsal disc region; spots diminish in size closer to outer disc margin (Figure 10). Caudal whip also dark purplish-brown in this specimen.

TABLE 2: Meristic data for specimens of *Plesiotrygon nana* sp. nov. **A:** MUSM 20328 (holotype), adult male. **B:** MUSM 40243 (paratype), preadult male. **C:** MZUSP 108777 (paratype), juvenile female. **SD:** standard deviation.

CHARACTER	A	B	C	Range	Mode	SD
Precaudal vertebrae	26	25	25	25-26	25	0.6
Caudal vertebrae	88	86	86	86-88	86	1.2
Total vertebrae	114	111	111	111-114	111	1.7
Diplospondylous vertebrae	84	82	82	82-84	82	1.2
Upper tooth rows	20	21	13	13-21	—	4.4
Lower tooth rows	19	19	16	16-19	19	1.7
Propterygial radials	42	42	—	42	42	0.0
Mesopterygial radials	16	16	—	16	16	0.0
Metapterygial radials	33	32	—	32-33	—	0.7
Total pectoral radials	91	90	—	90-91	—	0.7
Pelvic radials	19	18	—	18-19	—	0.7

Dermal denticles

Dermal covering in holotype and preadult male paratype with low and relatively wide, intensely packed dermal denticles on anterior disc and snout, middisc and tail-base regions, with slightly larger, more acute spines on posterolateral disc, and sharp, taller spines on dorsal and lateral aspects of tail from tail base posteriorly to caudal stings (Figures 11, 13, 14C). Larger dorsal disc denticles with stellate bases, usually with five to ten basal ridges radiating from denticle base. Denticles thoroughly covering disc, even on outer disc margins. Denticles larger, with wider bases, and more closely packed on middisc especially over disc midline. Outer disc with slightly enlarged spines, more developed on anterior and posterior outer disc regions; these larger, outer disc denticles evenly spaced apart, relatively straight, not organized in rows, and surrounded by smaller denticles. These smaller denticles are also very erect, without radiating basal ridges. Base of tail region with numerous enlarged spines not forming regular, discrete rows. Enlarged spines much smaller than in *P. iwamae, Paratrygon* and species of *Potamotrygon.* Spines sharp, with enlarged, wide bases and short, radiating basal ridges; central crown well developed with acute, posteriorly directed, tall central spine. Spines greatest on anterior dorsal tail base region. Smaller spines present in between larger spines, evenly spaced apart, on base of tail, dorsal tail extending posteriorly to caudal stings, and lateral tail regions. Denticles on lateral tail region also well developed, extending posteriorly well beyond level of caudal stings. Distal tail whip with very minute denticles ('prickles') until more or less midtail area in both male specimens. Dorsal aspect of pelvic fins also with evenly scattered denticles, but smaller and less packed than on disc. Small female paratype with dorsal disc denticles less developed, not as sharp, but denticles numerous, and without developed dorsolateral disc spines or enlarged spines on dorsal and lateral tail regions. Solimões specimen with slightly more denticles and with small spines on dorsal disc and tail base (from photograph).

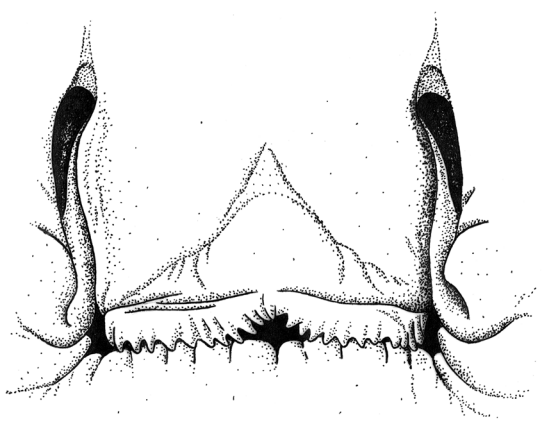

FIGURE 8: Nasal curtain and mouth (closed) of holotype of *Plesiotrygon nana* sp. nov., showing triangular mark on nasal curtain formed by junction of suborbital and prenasal canals of ventral lateral-line system, tubular narial grooves, and labial folds (MUSM 20328, 243 mm DL, 247 mm DW). Distance between nostrils = 1.5 cm.

Ventral lateral-line canals

The principal canals of the ventral lateral-line system resemble those present in *Plesiotrygon iwamae* (Figure 12) and in species of *Potamotrygon,* but are very distinct from *Paratrygon* or *Heliotrygon* (*e.g.* Carvalho & Lovejoy, 2011). In general, ventral lateral-line system narrow, occupying small portion of ventral disc between outer disc and branchial slits, but anterolateral disc and snout canals proportionally less narrow. Prenasal canal extends vertically from the nasal curtain to the anterior snout tip, running more or less parallel to its homologous component on the other side. Prenasal is crossed anteriorly by infraorbital canal and is continuous posteriorly with supraorbital canal, where it forms a small, markedly triangular figure on nasal curtain. Infraorbital and supraorbital canals relatively straight, not undulated. Infraorbital canal with very straight, vertical external margin from supraorbital loop to infraorbital loop; supraorbital and infraorbital loops small, relatively narrow and uniform in width, without wavy contours. Supraorbital loop of anterior infraorbital canal very short, not extending posteriorly to level of mouth. Jugular canal somewhat narrow and also not undulated. Jugular and infraorbital canals not very elongate anteroposteriorly, not extending posteriorly to close to first pair of gill slits. Mandibular canal not observed. Hyomandibular canals forming very narrow loop posteriorly. External hyomandibular canal very straight, not curved or inflected, running very close to external infraorbital canal anteriorly and branchial slits at midlength. Internal hyomandibular canal slightly curved medially away from gill slits. Hyomandibular canal widest at more or less its posterior one-fifth where it bulges laterally, anterior to subpleural loop. Subpleural loop very narrow, somewhat acute posteriorly. Anterior and posterior subpleural tubules of hyomandibular canal absent.

Skeletal morphology

Neurocranium elongate, longer than twice greatest width, and widest at postorbital processes and nasal capsules. Neurocanium very slender at orbital region and central cranial floor, strongly tapering posteriorly from nasal capsules to postorbital processes. Nasal capsules relatively large, oval, broadly rounded anteriorly, and slightly inclined toward midline; internasal septum very slender (Figures 13-15). Orbital region very concave. Preorbital processes broadly triangular and posterolaterally oriented. Postorbital processes very elongate, anterolaterally directed, reaching level of angular cartilages anteriorly. Precerebral and frontoparietal fontenellae long, but not as long as usually present in species of *Potamotrygon,* and about two-thirds of neurocranial length. Supraorbital process relatively wide and broadly triangular, situated just anterior to postorbital process. Neurocranium widens significantly at its posterior third where it articulates with hyomandibulae. Neurocranium very elongate posterior to postorbital processes; its length posterior to postorbital processe about 40% of neurocranial total length. Antorbital cartilage slightly laterally compressed, triangular, very slender and elongate, widest anteriorly, and extending posteriorly to level of palatoquadrates, anterior to angular cartilage.

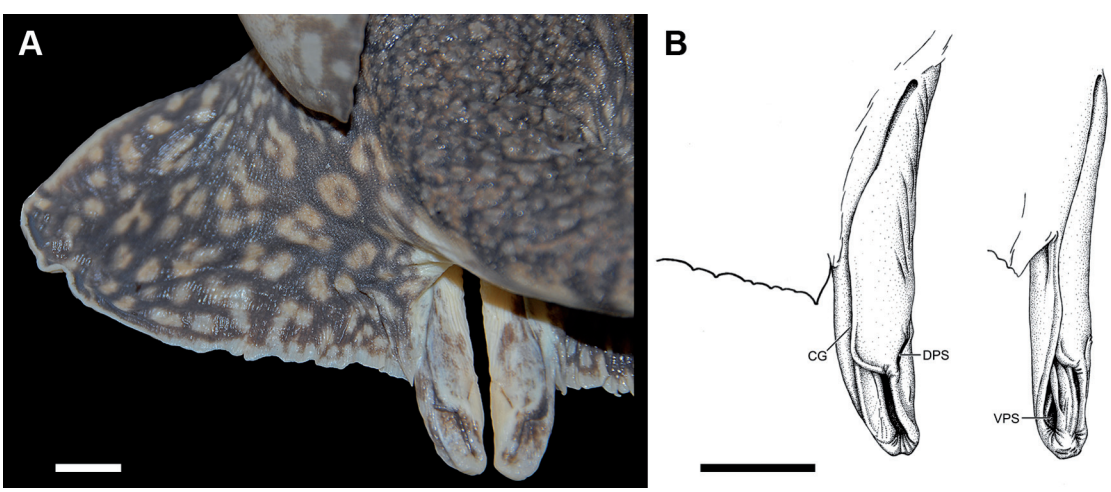

FIGURE 9: Dorsal **(A, B)** and external **(C)** aspect of clasper of holotype of *Plesiotrygon nana* sp. nov. (MUSM 20328, adult male, 243 mm DL, 247 mm DW). Abbreviations: CG, clasper groove; DPS, dorsal pseudosiphon; VPS, ventral pseudosiphon (mostly concealed in dorsal view). Scale bar = 1 cm.

Meckel's cartilage very stout, with strong anteromedial deflection toward midline. Dorsally projecting lateral process of Meckel's cartilage low and broadly triangular, not slender and elongate. Palatoquadrates very slender, shorter than Meckel's cartilage, and also somewhat inclined toward midline (Figures 14A, B). Hyomandibulae relatively short, slender and more or less straight, widest at midlength; hyomandibula only slightly curved anteriorly toward midline, and faintly concave distally to accommodate hyomandibular-Meckelian tendon. Angular cartilage well developed, very stout, at least as stout as hyomandibula, and relatively short, about one-third length of hyomandibula (Figures 14B, C, 15B). Angular cartilage more or less straight, without concave anterior or posterior margins, slightly thicker closer to Meckel'cartilage. Hypobranchials slender, inclined toward midline, reaching anteriorly to level of postorbital processes of

FIGURE 10: Small, free-living specimen of *Plesiotrygon nana* sp. nov. MZUSP 57642, juvenile or preadult female 912 mm TL, 124 mm DL, 118 mm DW. Characters that allow it to be identified as *P. nana* include its dorsal color pattern, dark purplish-brown caudal whip, proportionally smaller spiracles and nasoral region, and ventral lateral-line canals. Photo courtesy M. Toledo-Piza.

neurocranium. Basihyal element(s) not calcified, not apparent in radiographs. Basibranchial anteriorly triangular, extending forward to level of hyomandibular facet of neurocranium. Pseudohyoid arch more slender than subsequent branchial arches; all branchial arches short, not elongated laterally. Gill rays extending to propterygium.

Cervicothoracic synarcual elongate, its greatest width just under greatest width of neurocranium. Thoracolumbar synarcual very slender, not strongly calcified. Individual vertebral centra occurring posterior to level of caudal sting origin, last discernible centrum at more or less caudal sting extremity. Distal to caudal stings, an uncalcified notochordal extension (cartilaginous rod) present, continuing caudally toward whip extremity. Transition from mono- to diplospondyly occurs at fourth to fifth centra posterior to pelvic girdle.

Propterygium widest posteriorly, more stout than meso- and metapterygium (Figures 13, 14A, 15A). Propterygium anteriorly also relatively wide, much more so than in species of *Potamotrygon,* extending anteriorly to level of posterior nasal capsules; anterior segment of propterygium smaller than width of nasal aperture, extending forward to almost nasal capsule anterior margin. Metapterygium more slender and slightly more broadly arched than propterygium, with two smaller, more slender posterior segments. Mesopterygium elongate and more slender anteriorly, slightly convex externally, and highly concave internally where it articulates with lateral aspect of scapulocoracoid. Articular surface with scapulocoracoid extensive, more so than in species of *Potamotrygon.* Mesopterygium extends posteriorly only slightly. Pectoral radial elements sometimes fused at base between mesopterygium and anterior metapterygium. Pectoral radials slender close to pectoral basals, slightly wider and shorter at middisc, and slender again distally; some 16 total lateral pectoral radial segments present (from pectoral basals to outer disc); pectoral basals bifurcating at distal segments 9 and 10. Scapulocoracoid, in ventral view, very elongate anteroposteriorly from where it articulates anteriorly with propterygium to articular area with metapterygium, proportionally much longer than in any potamotrygonid. Coracoid bar with straight posterior margin but highly concave and relatively narrow anterior border. Articular surface for fifth ceratobranchial on anterior surface of scapulocaoracoid markedly protruding.

Pelvic girdle with concave anterior margins lateral to prepelvic process, more concave than in *P. iwamae.* Lateral prepelvic processes rather low, not very acute. Iliac processes extending caudally beyond triangular ischial processes; both structures triangular and relatively slender. Puboischiadic bar anteroposteriorly elongate at sides, more so than in *P. iwamae* and species of *Potamotrygon.* Posterior margin of puboischiadic bar very concave, highly oval, extending posteriorly to a significant degree (Figure 13). Three to four obturator foramina present. Basipterygium relatively wide, tapering posteriorly, about equal in length to one-half of puboischiadic bar width. First enlarged pelvic radial element articulating with lateral projection of iliac region, and about twice thickness of following radial segments. Pelvic radials subdivided laterally into three or four segments; segment contacting basipterygium much longer than others. Pelvic fin widest at sixth pelvic radial. Posteriormost radials articulating with basipterygium splayed. Clasper not dissected for skeleton, but in radiographs two basal segments discernible.

Remarks

The variation in dorsal color pattern observed among the three type-specimens of *Plesiotrygon nana,* although seemingly significant, is not enough to consider them separate species. Nor is the distinction in color pattern between the Rio Solimões specimen (Figure 10) and those from Peru very great. All specimens represent different size-classes and stages of sexual maturity (and all come from different localities, although the paratypes were collected not too far from each other). The paratypes are more similar in color, with more isolated irregular spots and incomplete ocelli present on dorsal disc. In the preadult male, the light yellow dorsal markings are relatively more spaced-apart, which, in relation to the smaller female, represents a pattern that can be achieved with growth. The holotype, though, is somewhat distinct in dorsal color. The irregular rosettes formed by very slender lines and small spots on disc are not present in the other specimens. The preadult male (174 mm DL, 170 mm DW) is significantly smaller than the holotype (243 mm DL, 247 mm DW), but it is difficult to envision its color changing to resemble the holotype if it were to have kept growing, although this cannot be discarded based on our small sample size. Of the four specimens depicted in one aquarium source (Ross & Schäfer, 2000: 140, 144), one has similarities in color with the male paratype (p. 144, figure on lower right), and another resembles the holotype to some degree (p. 140, figure on top). Clearly, *P. nana* should be expected to be somewhat variable in dorsal color.

The creamy white distal tail extremity in the preadult male paratype (MUSM 40243; Figure 3) is, however, more difficult to account for. The caudal filiform whip in this specimen resembles that of the holotype from tail base to more or less level of caudal stings. The mid region of the whip in the holotype, however, has a predominantly dark grayish color, even where it is alternately banded with lighter stripes anterior to its midlength. But in MUSM 40243 the mid caudal whip region beyond the caudal stings is predominantly light colored ventrally, and remains so to caudal extremity. In contrast, in the holotype, the smaller female paratype and the Solimões specimen, the caudal whip becomes a uniform dark

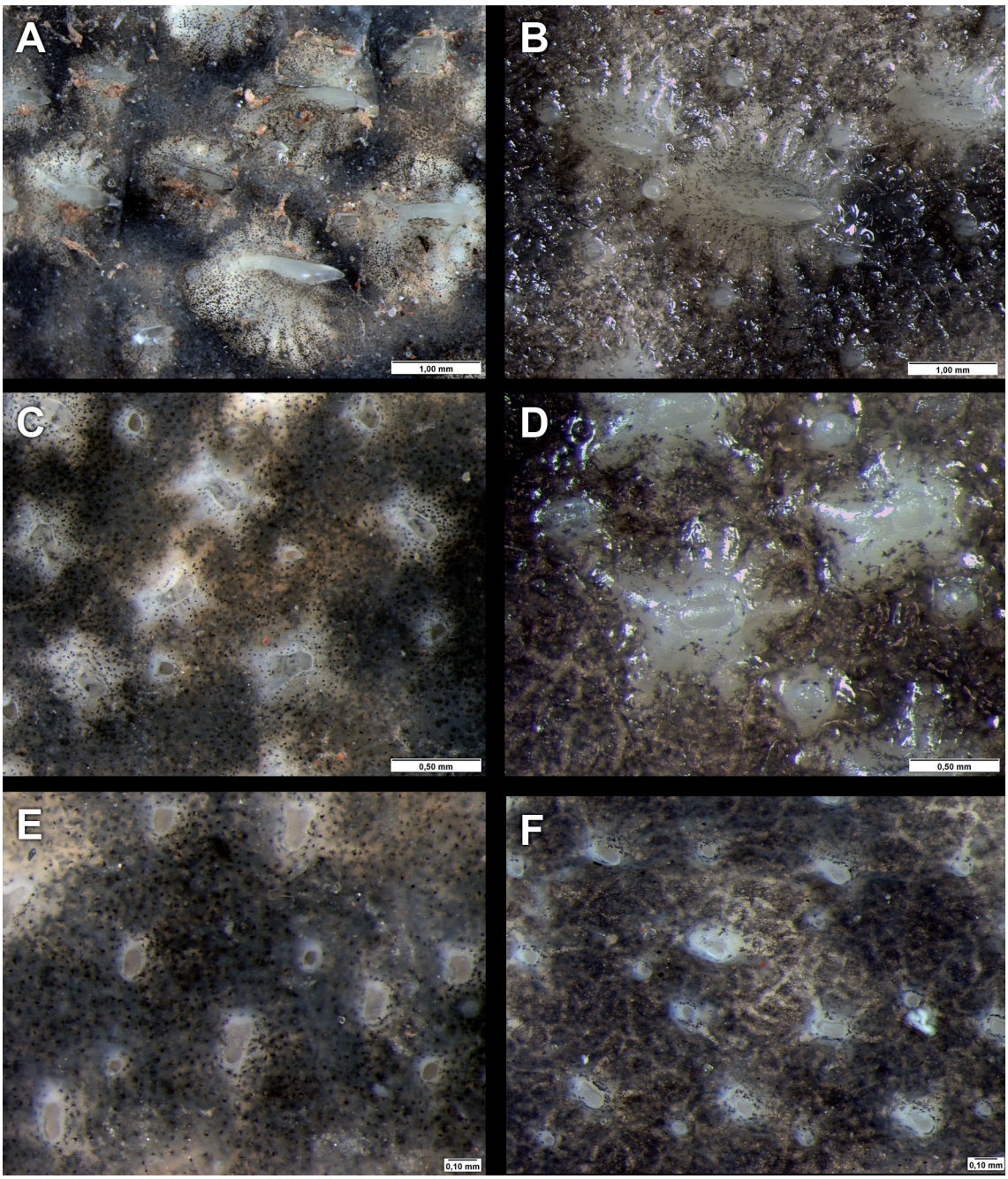

FIGURE 11: Dermal denticles and larger spines in holotype (left column) and male paratype (right column) of *Plesiotrygon nana* sp. nov. **A, B)** Enlarged spine from dorsal tail base. **C, D)** Scale bars: A, B = 1 mm; C, D = 0.5 mm; E, F = 0.1 mm.

purplish-brown anterior to its midlength and remains this color posteriorly to caudal extremity. All aquarium specimens depicted in the literature (*e.g.* Ross & Schäfer, 2000) also have a very dark caudal whip for about two-thirds of tail length (hence one of their popular names, "black-tailed" antenna ray). *Plesiotrygon iwamae,* on the other hand, has a much lighter distal tail from level of caudal stings posteriorly (for about two-thirds tail length), and even when darker, the tail of *P. iwamae* is much lighter than the tail of *P. nana.* At present we can only conclude that this feature may be variable, even if minimally so (note that the holotype of *P. iwamae* has a grayish white distal tail whip, slightly darker than other specimens from Rio Solimões and from Peru). The preadult male paratype (MUSM 40243) clearly shares many diagnostic features with the holotype and female paratype of *P. nana,* and cannot be identified with *P. iwamae.*

There is also variation in disc shape among the four specimens of *Plesiotrygon nana.* The small female paratype has a markedly oval disc, but the Solimões specimen has a rounder disc, whereas both larger males have clearly rounded discs (especially the holotype). These variations are ontogenetic, and not sexually dimorphic, as larger females depicted in the aquarium literature also have more circular discs compared to the small female paratype (Ross & Schäfer, 2000).

Plesiotrygon nana is one of the smallest potamotrygonids known; it appears to be even smaller than *Potamotrygon magdalenae* and a new species of *Potamotrygon* from the Rio Negro basin. The holotype is a fully mature male (243 mm DL, 247 mm DW) that is probably close to the largest size reached by males of this species; females probably reach slightly larger sizes as is common in the family (in some species females are significantly larger; Araújo, 1998; Rosa *et al.,* 2010). Males become sexually mature probably around 180 mm DL or DW but perhaps even smaller, as judged from the preadult male paratype that has well developed claspers, but which are still not fully rigid (it is probable that sexual maturity for this specimen would not have depended on additional growth). Remarkably, the smaller female, at 81 mm DL and

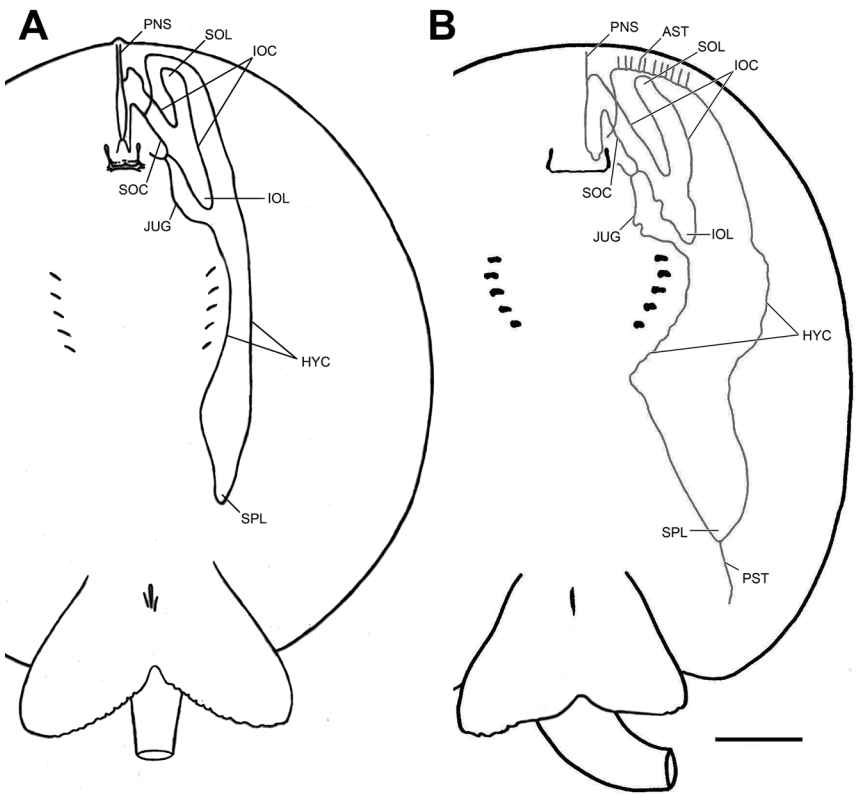

FIGURE 12: Ventral lateral-line system in species of *Plesiotrygon.* **A)** *P. nana* sp. nov. (based on female paratype, MZUSP 108777, 81 mm DL, 72 mm DW). **B)** *P. iwamae* (MZUSP 59899, 325 mm DL, 310 mm DW). Abbreviations: AST, anterior subpleural tubules; HYC, hyomandibular canal; IOC, infraorbital canal; IOL, infraorbital loop; JUG, jugular canal; PNS, prenasal canal; PST, posterior subpleural tubule; SOC, supraorbital canal; SOL, suborbital loop; SPL, subpleural loop. Scale bar = 3 cm.

72 mm DW, was a free-living individual (there is no sign of an umbilical scar, just a small, dark-pigmented area), and at this size represents the smallest free living potamotrygonid recorded (the Rio Solimões specimen depicted in Figure 10, which is slightly larger than the female paratype at 124 mm DL and 118 mm DW, was also a free-living specimen collected alone). *Plesiotrygon* is the only batoid genus (and probably chondrichthyan genus) in which one species reaches great sizes while its sister-group is so remarkably small in comparison; *P. nana* is almost three times smaller than *P. iwamae,* an interesting phenomenon in a family notorious for the great sizes (over 120 cm DW in some cases), attained by many of its members [*e.g. Paratrygon aiereba* (Müller & Henle, 1841), *Heliotrygon* spp., *Potamotrygon brachyura*].

FIGURE 13: Radiograph of skeleton of holotype of *Plesiotrygon nana* sp. nov. (MUSM 20328, adult male, 1024 mm TL, 243 mm DL, 247 mm DW). Distal tail filament not shown.

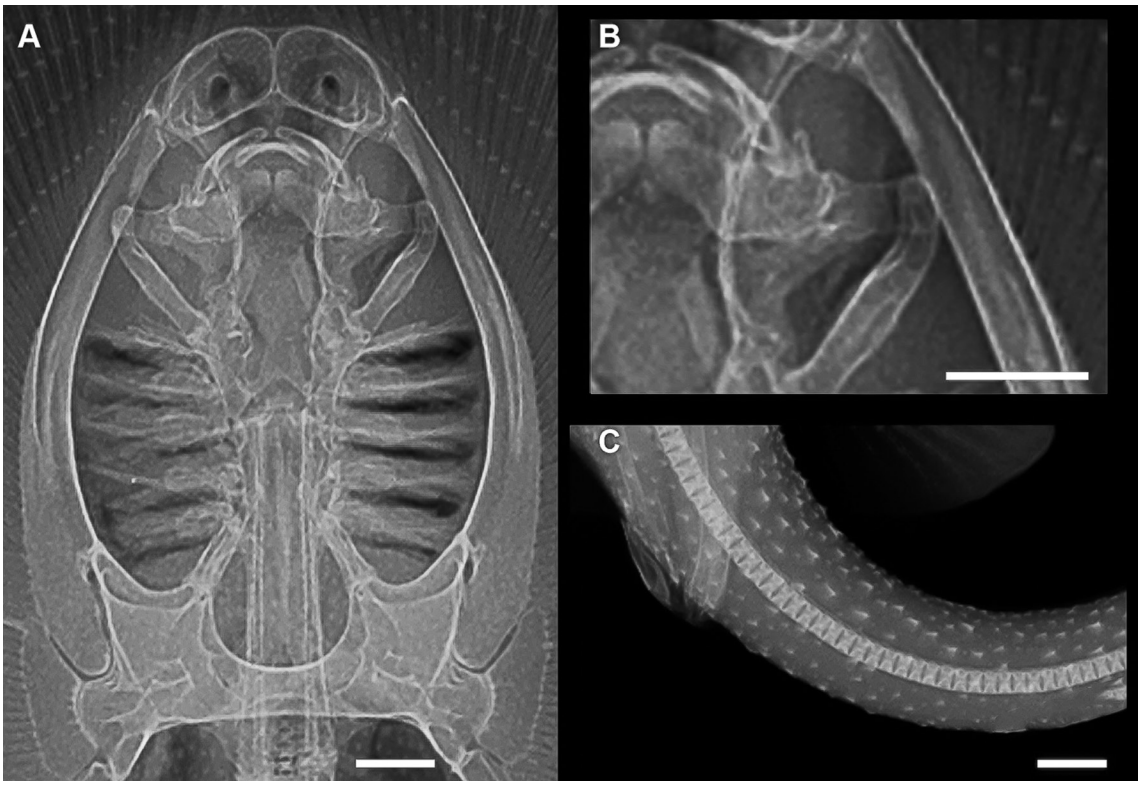

FIGURE 14: Details of the skeleton and dermal covering in holotype of *Plesiotrygon nana* sp. nov., from radiograph (MUSM 20328, adult male, 1024 mm TL, 243 mm DL, 247 mm DW). **A)** Splanchnocranium and scapular region. **B)** Angular cartilage magnified. **C)** Base of tail region showing arrangement of dorsal spines and denticles. For an anatomical guide, refer to Figure 15. Scale bar = 1 cm.

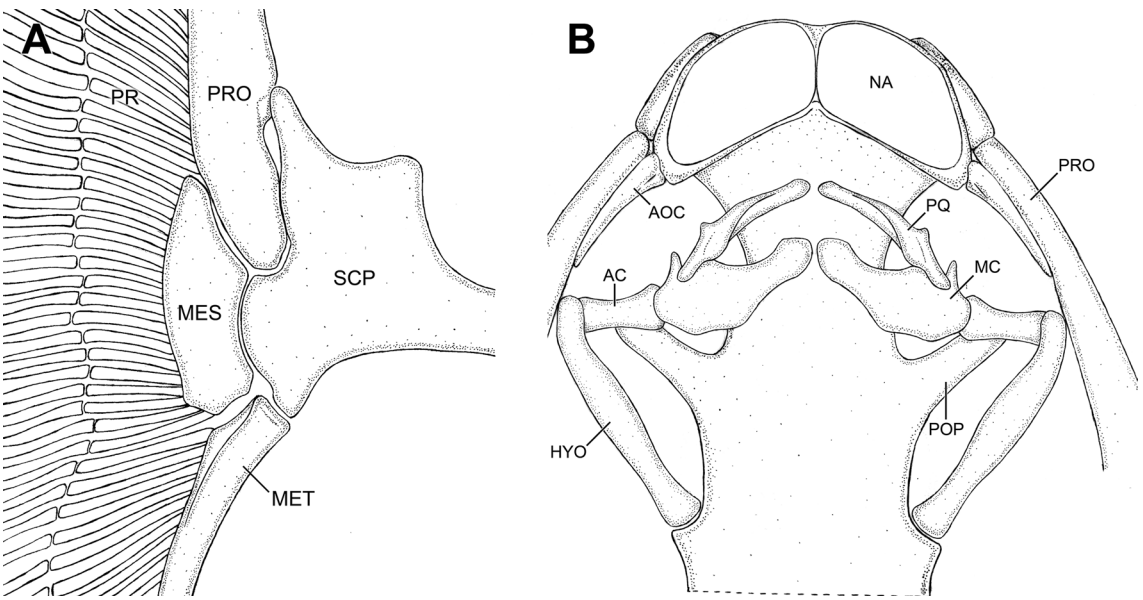

FIGURE 15: Skeletal aspects of holotype of *Plesiotrygon nana* sp. nov. (MUSM 20328, adult male, 1024 mm TL, 243 mm DL, 247 mm DW). **A)** Articulation between pectoral basal elements and shoulder girdle, showing pectoral radials and lateral aspect of scapulocoracoid. **B)** Detail of propterygium, neurocranium, and mandibular and hyoid arches in ventral view. Abbreviations: AC, angular cartilage; AOC, antorbital cartilage; HYO, hyomandibula; MC, Meckel's cartilage; MES, mesopterygium; MET, metapterygium; NA, nasal aperture; POP, postorbital process; PQ, palatoquadrate; PR, pectoral radials; PRO, propterygium; SCP, scapulocoracoid.

Geographic distribution

As far as is known, *Plesiotrygon nana* occurs in the upper Río Amazonas basin of Peru, both in smaller tributaries and in the main Río Amazonas channel, and in the lower course of Rio Solimões in Brazil, just down-river from the mouth of Rio Purus (MZUSP 57642). The small female paratype is from Río Itaya, a small tributary of Río Nanay (near Iquitos). The male paratype was collected in Río Amazonas slightly farther south, near Tamshiyacu, and the holotype was found in Río Pachitea, a triburay of Río Ucayali near Puerto Inca (Figure 16). This species may be expected to occur in Río Napo and other regions of the upper Río Amazonas inhabited by *P. iwamae*. *Plesiotrygon nana* is not restricted to the main Amazonas channel as previously thought (accounts from the aquarium fish trade conflict).

Etymology

The specific epithet *nana* is in reference to its dwarf size (from the Latin *nanus*). Gender feminine.

Common name

Dwarf antenna ray (as in aquarium literature; also known as "black-tailed" antenna ray).

Plesiotrygon iwamae Rosa, Castello & Thorson, 1987 (Figures 17-27; Tables 3-6)

Elipesurus strogylopterus: Miranda Ribeiro, 1959: 6 (*non* Schomburgk, 1843).

Potamotrygon scobina: Taniuchi, 1982: 27 (*non* Garman, 1913).

Plesiotrygon iwamae Rosa, Castello & Thorson, 1987: 447-458, figures 1-10 (original description); Taniuchi & Ishihara, 1990: 14, 15 (claspers); Zorzi, 1995: 18 (historical account); Compagno & Cook, 1995: 67, 72, 73, 80 (brief account, compiled from Rosa *et al.,* 1987); Carvalho, 1996: 1048 (cited); Lovejoy, 1996: 212, 216, 223-229, 233, 234 (morphology, relationships); Lovejoy *et al.,* 1998: 1 (molecular phylogeny); Compagno, 1999: 495 (listed as valid); Carvalho *et al.,* 2003: 23 (taxonomic account);

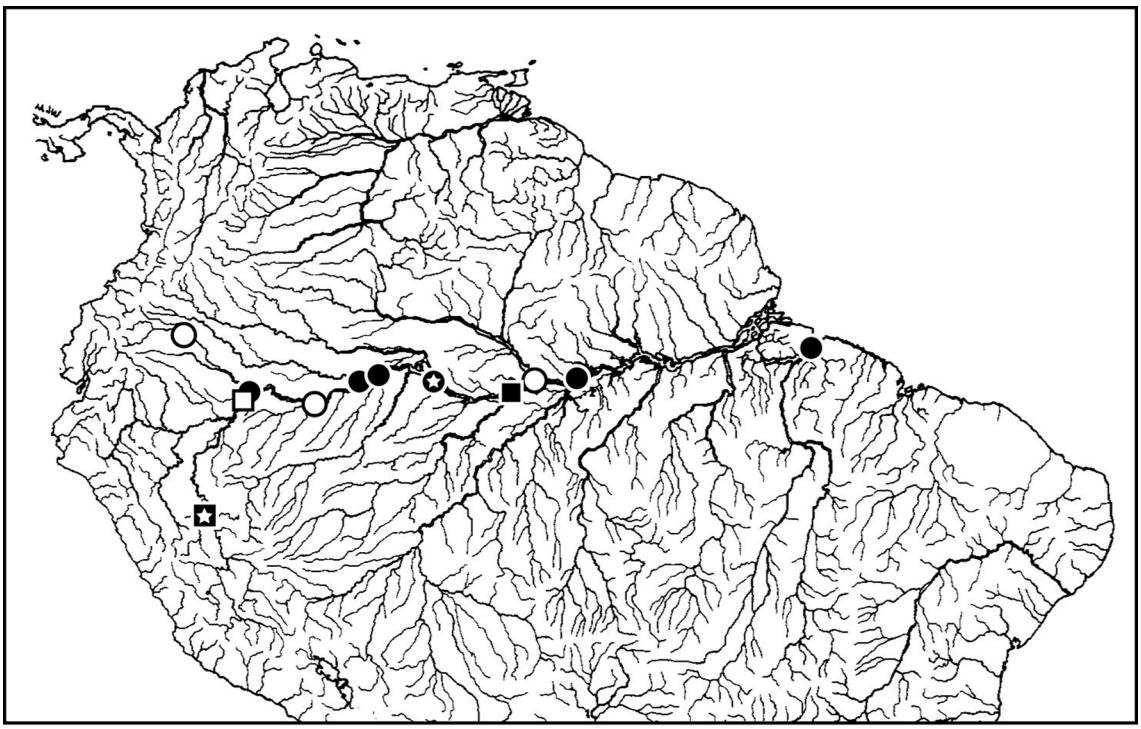

FIGURE 16: Distribution of specimens of *Plesiotrygon* examined in this study (*see* text for details). Square with star: holotype of *P. nana* (Río Pachitea, tributary of Río Ucayali, near Puerto Inca, Peru). Open square: paratypes of *P. nana* (representing two separate, but proximal, localities). Closed square: specimen collected and photographed from Rio Solimões in 1996. Closed circle with star: holotype of *P. iwamae* (Rio Solimões, above Tefé). Open circles: paratypes of *P. iwamae.* Closed circles: non-type specimens of *P. iwamae.* Base map by M.J. Weitzman.

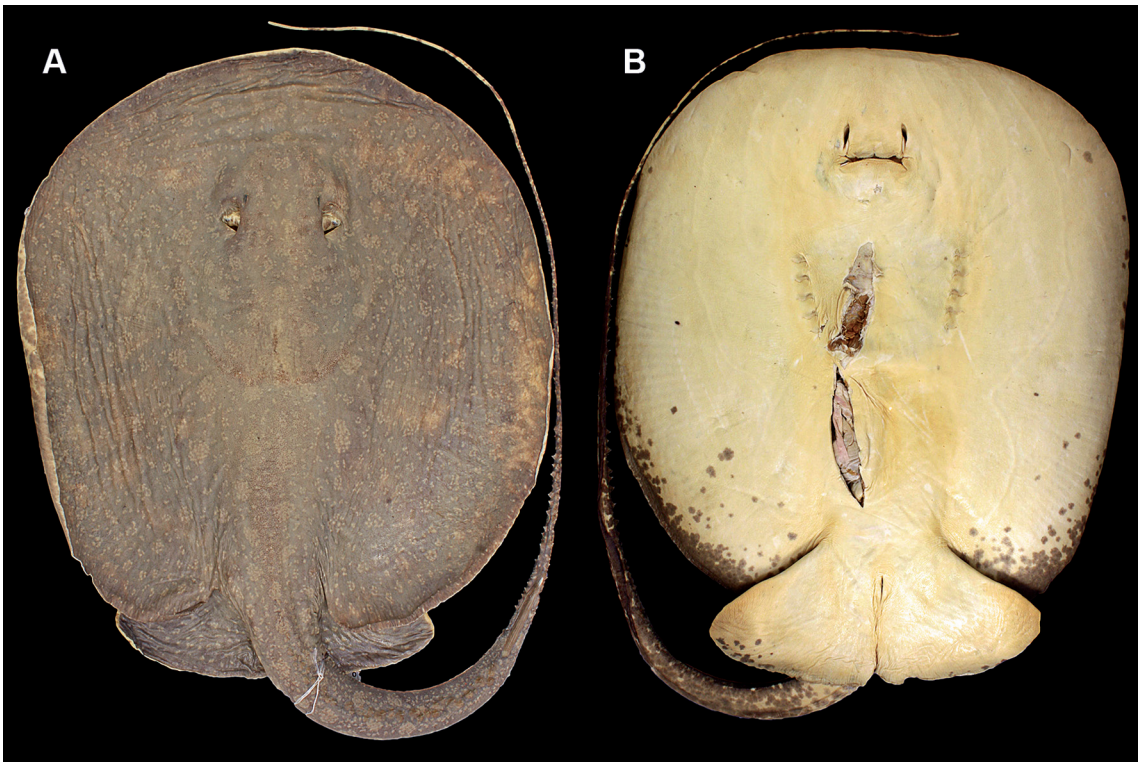

FIGURE 17: Paratype of *Plesiotrygon iwamae* in dorsal **(A)** and ventral **(B)** views (FMNH 94500, adult female, 565 mm DL, Río Napo, Ecuador).

Carvalho *et al.,* 2004: 10, 61, 81, 88, 90 (morphology, relationships); Compagno, 2005: 540 (listed as valid); Schaefer & Summers, 2005: 303, 312 (listed, material examined); Lonardoni *et al.,* 2006: 196 (cited); Rosa & Carvalho, 2007: 17 (listed as valid, Brazil); Luchetti *et al.,* 2008: 131-133, 135, 140 (parasites); Toffoli *et al.,* 2008: 325, 327, 332 (molecular phylogeny); Shibuya *et al.,* 2009: 467, 471 (stomach contents); Domingues & Marques, 2010: 829, 832 (parasites); Ortega *et al.,* 2010: 34 (listed, Peru); Rosa *et al.,* 2010: 246, 247, 257, 260, 264 (general account on family).

Holotype

MZUSP 10153, Rio Solimões, 03°22'S, 64°43'W, near Tefé, Amazonas, Brazil, 3 October 1981, coll. H. Britski.

Paratypes

FMNH 94500, Río Napo, at Anangu, Napo district, Ecuador, 00°31'36"S, 76°23'12"W, 10 October 1981, coll. D. Stewart, M. Ibarra & R. Barriga (Figures 17, 24); MNRJ 573, Rio Amazonas, Amazonas, Brazil, from Instituto Oswaldo Cruz (no further data); MZUSP 14789, Rio Solimões, 03°25'S, 60°17'W, Amazonas, Brazil, January 1977, R/V Alpha Helix; USNM 258298, Rio Solimões, Tabatinga, Amazonas, Brazil, 13 June 1969, coll. T.B. Thorson *et al.;* ZMH 10343, Rio Solimões, Amazonas, Brazil, 6 November 1909, coll. Scholz.

Non type material

MZUSP 42848, Baía de Marajó, Tupinambá, Pará, Brazil, coll. M. Goulding; MZUSP 59896, Rio Solimões, 03°18'S, 67°92'W, Amazonas, Brazil, 22 November 1993, coll. J.P. Friel *et al.;* MZUSP 59897 (same data as MZUSP 59896); MZUSP 59898, Rio Jutaí, 02°87'S, 66°93'W, Amazonas, Brazil, 16 November 1993, coll. J.G. Lundberg *et al.* (Figure 18); MZUSP 59899, Rio Amazonas, 03°28'S, 58°57'W, Amazonas, Brazil, 20 October 1994, coll. M. Westneat *et al.;* MZUSP 108706, data as in MZUSP 108767 (below) (PA 07-21); MZUSP 108707, data as in MZUSP 108767 (below) (PA 07-31); MZUSP 108767, Baía de Marajó, 00°55'34"S, 48°17'25"W,

TABLE 3: Measurements of specimens of *Plesiotrygon iwamae.* **A:** MZUSP 10153 (holotype), adult male. **B:** MZUSP 14789 (paratype), juvenile male. **C:** Specimens from Rio Pará (MZUSP 108767, adult female; MZUSP 108768, juvenile male; MZUSP 108770, juvenile male; MZUSP 108793, adult female). **D:** Specimens from Rio Solimões (MZUSP 59896, adult female; MZUSP 59897, juvenile female; MZUSP 59898, adult female). Mean and standard deviation calculated from all specimens. **N:** number of specimens. **SD:** standard deviation.

PARAMETER	A		B		C		D		Mean		SD	
	mm	% DW	mm	% DW	% DW	N	% DW	N	mm	% DW	mm	% DW
Total length (TL)	1365.0	—	1337.0	—	—	—	—	—	1305.4	—	266.9	—
Disc length (DL)	585.0	104.5	230.0	107.0	98.6-104.5	4	99.7-103.0	3	392.8	102.3	104.8	2.6
Disc width (DW)	560.0	100.0	215.0	100.0	—	—	—	—	384.0	100.0	100.0	0.0
Interorbital distance	62.0	11.1	19.7	9.2	11.1-12.2	4	11.1-11.4	3	43.5	11.3	12.0	0.9
Interspiracular distance	77.0	13.8	30.2	14.0	13.7-16.2	4	13.1-14.0	3	54.2	14.2	13.3	0.9
Eye length	10.0	1.8	—	—	1.4-2.4	4	1.4-1.8	3	7.0	1.8	1.5	0.4
Spiracle length	45.0	8.0	12.7	5.9	6.4-8.0	4	5.9-6.6	3	26.5	6.8	9.0	0.8
Preorbital length	161.0	28.8	55.2	25.7	26.9-28.9	4	25.7-27.6	3	105.7	27.4	29.2	1.3
Prenasal length	101.0	18.0	41.0	19.1	18.0-23.2	4	18.3-19.6	3	74.7	19.5	18.2	1.6
Preoral length	130.0	23.2	60.0	27.9	22.6-25.4	4	24.9-25.7	3	95.1	25.0	21.7	1.5
Internarial distance	56.0	10.0	19.2	8.9	8.5-10.0	4	7.6-8.0	3	33.5	8.7	10.6	0.8
Mouth width	72.0	12.9	28.6	13.3	9.1-13.9	4	8.1-9.5	3	41.7	10.9	14.5	2.2
Distance between 1st gill slits	141.0	25.2	48.0	22.3	21.9-26.1	4	21.9-25.6	3	92.2	23.7	28.7	1.6
Distance between 5th gill slits	110.0	19.6	37.4	17.4	17.6-20.4	4	17.5-19.3	3	72.9	18.8	21.6	1.1
Branchial basket length	80.0	14.3	27.0	12.6	12.9-14.7	4	11.5-12.0	3	49.8	12.9	14.6	1.1
Pelvic fin anterior margin length	131.0	23.4	50.9	23.7	23.4-19.4	4	26.7-27.6	3	102.4	26.7	25.3	2.1
Pelvic fins width	300.0	53.6	103.8	48.3	45.5-56.4	4	47.9-53.8	3	195.6	50.5	58.7	3.0
Clasper external length	50.0	8.9	16.3	7.6	3.7-8.9	2	—	0	24.8	6.6	17.2	2.3
Clasper internal length	120.0	21.4	7.3	3.4	14.0-21.4	2	—	0	57.3	13.7	46.8	7.6
Distance between cloaca and tail tip	857.0	153.0	1134.0	527.4	145.5-234.8	4	269.3-393.7	3	951.6	268.6	284.6	125.8
Tail width	70.0	12.5	25.6	11.9	12.5-19.6	4	9.6-12.2	3	56.5	14.8	19.0	4.1
Snout to cloaca distance	493.0	88.0	209.0	97.2	87.5-90.4	4	84.7-90.7	3	341.6	89.4	84.4	3.5
Pectoral to posterior pelvic length	130.0	23.2	35.0	16.3	15.9-23.6	4	15.3-16.7	3	72.7	18.4	29.7	3.5
Distance from cloaca to sting origin	324.0	57.9	133.0	61.9	53.5-66.2	4	56.8-63.3	3	230.2	60.3	56.0	3.8
Sting length	98.0	17.5	58.0	27.0	17.5-22.9	4	20.0-21.0	3	79.0	21.1	13.0	2.7
Sting width	7.0	1.3	4.0	1.9	1.3-1.7	4	1.6-1.9	3	6.3	1.7	1.4	0.2

Colares, Pará, Brazil, 20 August 2007, coll. F.P.L. Marques, M. Cardoso Jr. & V.M. Bueno (PA 07-23); MZUSP 108768, data as in MZUSP 108767 (PA 07-24); MZUSP 108769, data as in MZUSP 108767 (PA 07-27); MZUSP 108770, data as in MZUSP 108767 (PA 07-28); MZUSP 108771, data as in MZUSP 108767 (PA 07-29); MZUSP 108793, data as in MZUSP 108767 (PA 07-30); MZUSP 108772, data as in MZUSP 108767, 21 August 2007 (PA 07-38); MZUSP 108773, data as in MZUSP 108767, 22 August 2007 (PA 07-39); MZUSP 108774, data as in MZUSP 108767, 22 August 2007 (PA 07-40); MZUSP 108775, data as in MZUSP 108767, 22 August 2007 (PA 07-47); MZUSP 108776, data as in MZUSP 108767, 22 August 2007 (PA 07-48); MZUSP 108790, Baía de Marajó, 00°55'34"S, 48°17'25"W, Colares, Pará, Brazil, 16 August 2007, coll. F.P.L. Marques, M. Cardoso Jr. & V.M. Bueno (PA 07-01); MZUSP 108791, Baía de Marajó, 00°55'34"S, 48°17'25"W, Colares, Pará, Brazil, 16 August 2007, coll. F.P.L. Marques, M. Cardoso Jr. & V.M. Bueno (PA 07-08); MZUSP 108792, Baía de Marajó, 00°55'34"S, 48°17'25"W, Colares, Pará, Brazil, 20 August 2007, coll. F.P.L. Marques, M. Cardoso Jr. & V.M. Bueno (PA 07-22). *Plesiotrygon* cf. *iwamae* (2 specimens): MUSM 39977, Río Amazonas, Loreto Department, Maynas Province, Sargento Lores District, town of Aucayo Caserio, near Tamshiyacu, Peru, 03°59'13.21"S, 73°10'02.80"W, altitude 89 m, 15 November 2010, coll. Homero Sanchez.

Diagnosis

A species of *Plesiotrygon,* distinct from *P. nana,* by presenting the following characters: dorsal disc

coloration with a light gray, brown or light reddish-brown background color, with numerous white or creamy-white larger blotches (close to size of spiracles) and irregular ocelli formed by smaller spots on central and posterolateral disc, with smaller, irregular spots sometimes surrounding ocelli; disc and snout markedly oval; spiracle strongly rhomboidal, with mean spiracle length 6.8% DW; snout proportionally elongate (preorbital and preoral lengths greater or equal to one-fourth DW, respectively); nasal curtain relatively wide (mouth width and internarial distance close to 10.0% DW); dorsal tail region usually with a single irregular row of enlarged spines extending to caudal stings; adult specimens with numerous tooth rows, ranging from about 40-60/42-64; distal coloration of tail, as of caudal stings, creamy white ventrally and light gray dorsally, with creamy white distal whip; relatively low number of pectoral radials, from 77-84 with a modal count of 78 (Table 4); relatively high caudal vertebrae ranging from 93-98, with a modal count of 94 (Table 4); great size, upwards of 650 mm DL or DW, reaching sexual maturity only at or over 420 mm DL or DW; external hyomandibular canal of the ventral lateral-line system with undulations at midlength, where canal bulges towards outer disc; hyomandibular canal abruptly inflected toward midline at its posterior third; and internal hyomandibular canal strongly directed toward midline posterior to gill arches. For comparisons, see also diagnosis above for *Plesiotrygon nana.*

Description

Plesiotrygon iwamae has an oval disc, consistently longer than wide (DL ranging from 98.6 to 104.5% DW, mean 102.3% DW; Table 3) (for description below, refer to Figures 17-21). Anterior disc also markedly oval, with knob-like anterior protrusion always present. Anterior disc region relatively elongate, with preorbital length varying from 25.7 to 28.9% DW (mean 27.4% DW), prenasal lengths from 18.0 to 23.2% DW (mean 19.5% DW), and preoral length ranging from 22.6 to 27.9% DW (mean 25.0% DW). Eyes very small, not protruding from head, but spiracles relatively wide, rhomboidal, much greater than reduced eyes (in measured specimens, mean length of spiracles 6.8% DW, mean eye-diameter 1.8% DW; in holotype, spiracle length 8% DW, and eye-length 1.8% DW). Nasal curtain relatively wide, wider than long, with medially notched, fringed posterior margin. Junction of prenasal and supraorbital canals forming a concealed, triangular mark on nasal curtain. Rounded, tubular narial fold present. Internarial distance from 7.6 to 10.0% DW (mean 8.7% DW). Mouth also relatively wide, from 8.1 to 13.9% DW (mean 10.9% DW; 12.9% DW in holotype). Teeth set in quincunx, very small and numerous (30-60/31-64 rows, holotype with 60/64 teeth), with greater cusps in larger males. Usually five buccal papillae present inside mouth.

Pelvic fins protruding significantly from posterior disc region, somewhat triangular in dorsoventral view, and broadest posteriorly. Pelvic fin width ranging from 45.5 to 56.4% DW (mean 50.5% DW, in holotype 53.6% DW). Clasper relatively stout and short, with rounded posterior tip. Clasper groove broadly arched from apopyle to hypopyle; dorsal pseudosiphon relatively small, positioned at a slight angle (Figure 21). Ventral pseudosiphon situated on external margin of clasper tip, slightly concealed in dorsal view. Tail width at base about as wide as interspiracular distance, greatly variable in preserved material (ranging from 9.6 to 19.6% DW, mean 14.8% DW, in holotype 12.5% DW). Tail very long, greater than twice DL or DW, terminating far posteriorly as a filiform whip. Ventral median groove present, extending from tail base to beyond caudal stings posteriorly. Relatively tall ventral tail-fold originating within groove near level of caudal sting origin, tallest at more or less midlength of caudal stings (Figure 19F), and extending posteriorly for more than twice length of caudal stings. Lateral and dorsal tail folds absent. Caudal stings positioned relatively far posteriorly on dorsal tail (distance from tail base to their origin greater than one-half of disc width).

Dorsal color variable, with light gray, brown to reddish-brown background (Figure 20). Numerous large (near size of spiracles), faint, creamy white or white spots or irregular ocelli present over middisc or posterolateral disc. These spots formed by smaller speckles of white, with slightly lighter interior color. Larger, irregular spots surrounded by smaller, very faint spots. Other light irregular vermicular markings sometimes present. Some specimens with more regular, circular ocelli (*e.g.* MZUSP 59896; Figure 19A). Intensity of dorsal spots and ocelli vary greatly among specimens. Holotype with more uniform dark grayish-brown color, with scattered darker spots about size of eye-diameter, and smaller, white specks on outer disc. Tail base region and area of caudal stings with lateral alternating stripes of gray and creamy white. Filiform whip creamy white in color ventrally, sometimes grayish dorsally. Ventral color white to creamy white, some specimens, such as holotype, with grayish markings on posterior disc margins, pelvic fins and base of tail area. Holotype with dark filiform caudal whip.

TABLE 4: Meristic data for specimens of *Plesiotrygon iwamae*. **A:** MZUSP 10153 (holotype), adult male, 585 mm DL, 560 mm DW. **B:** MZUSP 14789 (paratype), juvenile male, 221 mm DL, 208 mm DW. **C:** MZUSP 108768, juvenile female, 342 mm DL, 347 mm DW. **D:** MZUSP 108770, juvenile male, 333 mm DL, 328 mm DW. **E:** MZUSP 108771, juvenile male, 292 mm DL, 294 mm DW. **F:** MZUSP 108772, juvenile female, 298 mm DL, 300 mm DW. **G:** MZUSP 108773, adult female, 298 mm DL, 300 mm DW. **H:** MZUSP 108774, adult female, 495 mm DL, 495 mm DW (caudal vertebrae not possible to count). **I:** MZUSP 108775, adult male, 452 mm DL, 442 mm DW. **J:** MZUSP 108776, adult female, 396 mm DL, 398 mm DW. A, B from Rio Solimões; C-J from Rio Pará. **SD:** standard deviation.

CHARACTER	A	B	C	D	E	F	G	H	I	J	Range	Mode	SD
Precaudal vertebrae	23	27	27	25	25	25	26	25	26	25	23-27	25	1.2
Caudal vertebrae	94	—	94	93	96	98	—	98	94	94	93-98	94	2.0
Total vertebrae	117	—	121	118	121	123	—	123	120	119	117-123	121	2.2
Diplospondylous vertebrae	92	—	90	88	84	89	—	95	88	98	84-98	88	4.4
Upper tooth rows	60	32	35	34	38	34	50	40	40	30	30-60	34	9.2
Lower tooth rows	64	31	40	36	39	35	51	42	41	36	31-64	36	9.5
Propterygial radials	37	37	38	37	40	38	38	38	36	42	36-42	38	1.7
Mesopterygial radials	14	16	16	14	15	14	14	17	18	14	14-18	14	1.5
Metapterygial radials	27	24	25	27	25	26	28	29	28	31	24-31	27	2.1
Total pectoral radials	78	77	79	78	80	78	80	84	82	87	77-84	78	3.2
Pelvic radials	21	15	20	21	19	19	24	24	23	16	15-24	21	3.1

Remarks

Plesiotrygon iwamae was already known to have a relatively broad distribution when described; the type-series includes specimens from Ecuador (Río Napo) and Brazil (Rio Solimões, as far east as near Manaus). Specimens are now known from Peru in the upper Río Amazonas (*e.g.* near Iquitos; Ross & Schäfer, 2000; Ortega *et al.,* 2010), as well as from Baía de Marajó, Rio Pará, their easternmost occurrence (see material examined) – a span of more than 5000 km. Based on examination of material from its entire range, however, we can advance that although there is variation, especially in dorsal coloration (Figure 20) and dorsal tail spines, consistent characters that subdivide *P. iwamae* into more than one species are lacking (more detailed morphological data and our results on variation in *P. iwamae* will be presented elsewhere). Dorsal color patterns, for example, vary even in a single locality, as demonstrated in

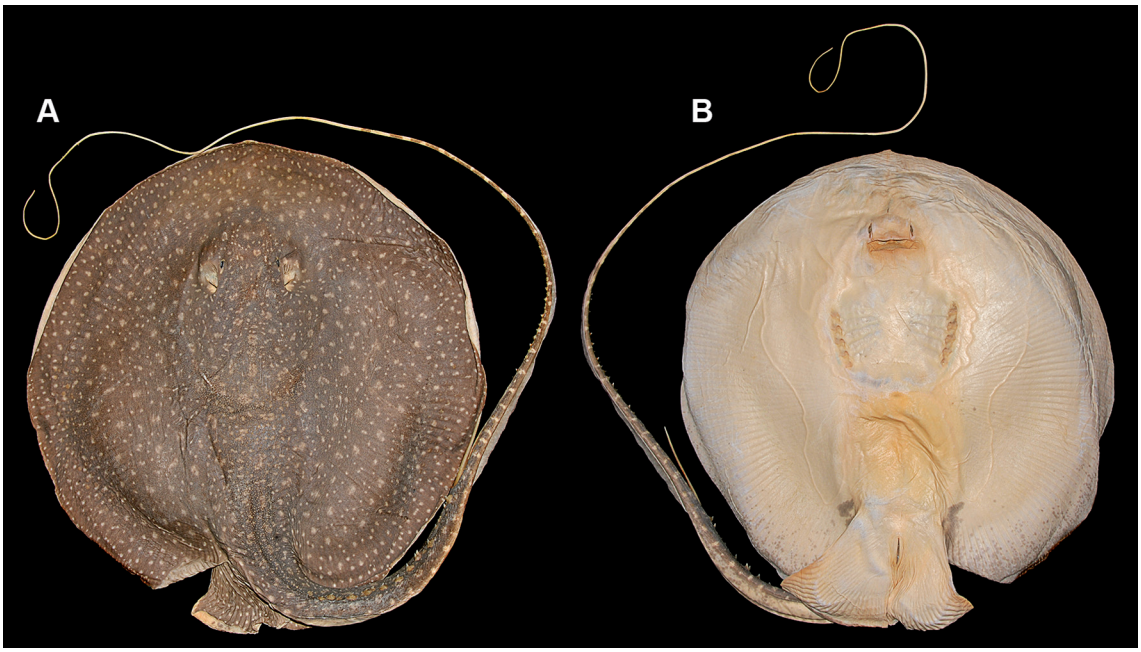

FIGURE 18: Specimen of *Plesiotrygon iwamae* (MZUSP 59898, 432 mm DL, 425 mm DW) from the Rio Jutaí (Amazonas state, Brazil), in dorsal **(A)** and ventral **(B)** views.

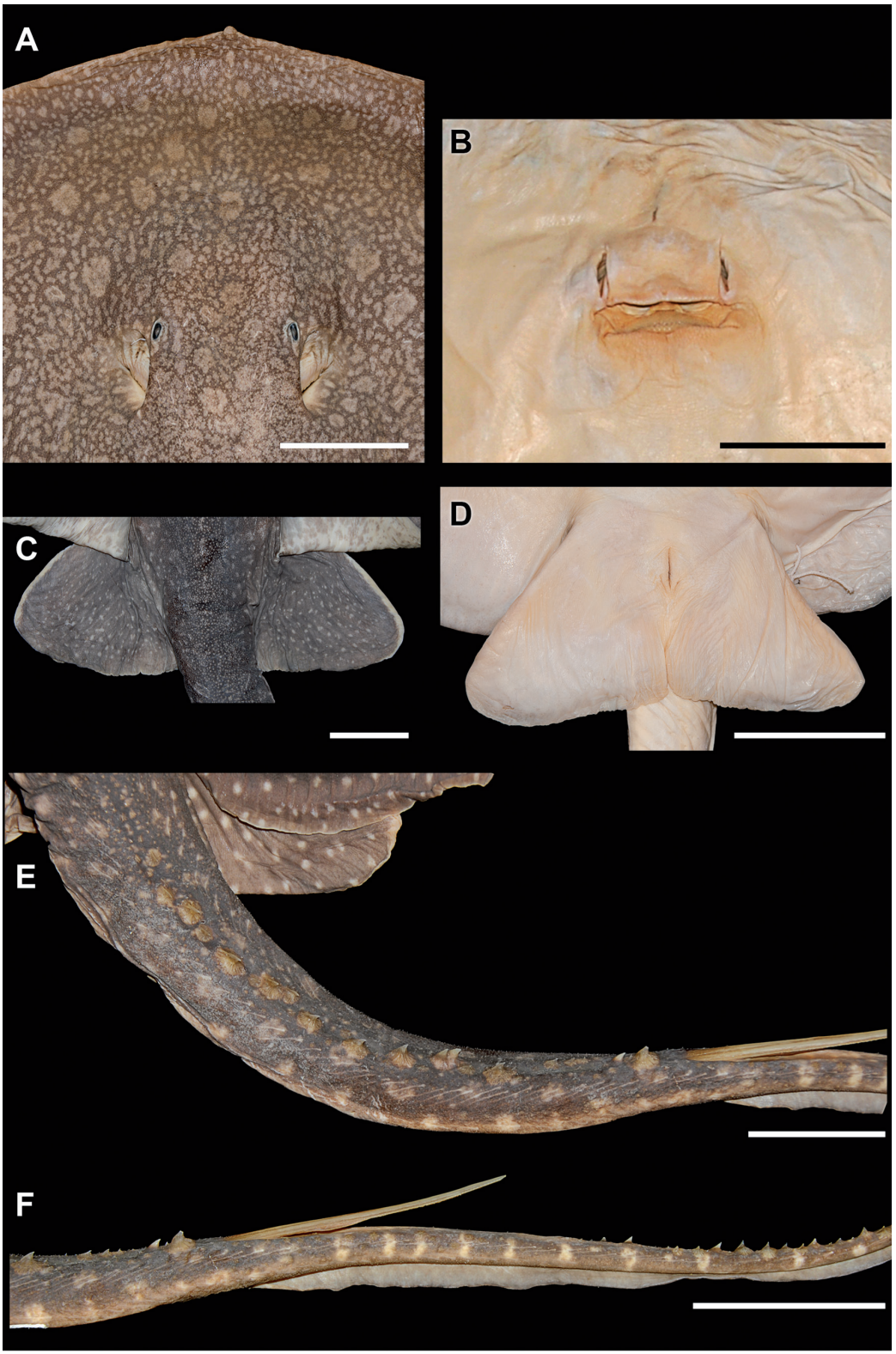

FIGURE 19: Morphological details of *Plesiotrygon iwamae.* **A)** Dorsal view of anterior disc and head region (MZUSP 59896). **B)** Nasoral region (MZUSP 59898). **C)** Dorsal view of base of tail and pelvic fins (MZUSP 108773). **D)** Ventral view of pelvic fins (MZUSP 59897). **E)** Dorsal view of base of tail and tail region at caudal stings (MZUSP 59898). **F)** Lateral view of tail at caudal sting region, showing ventral tail-fold (MZUSP 59898). Scale bar = 5 cm.

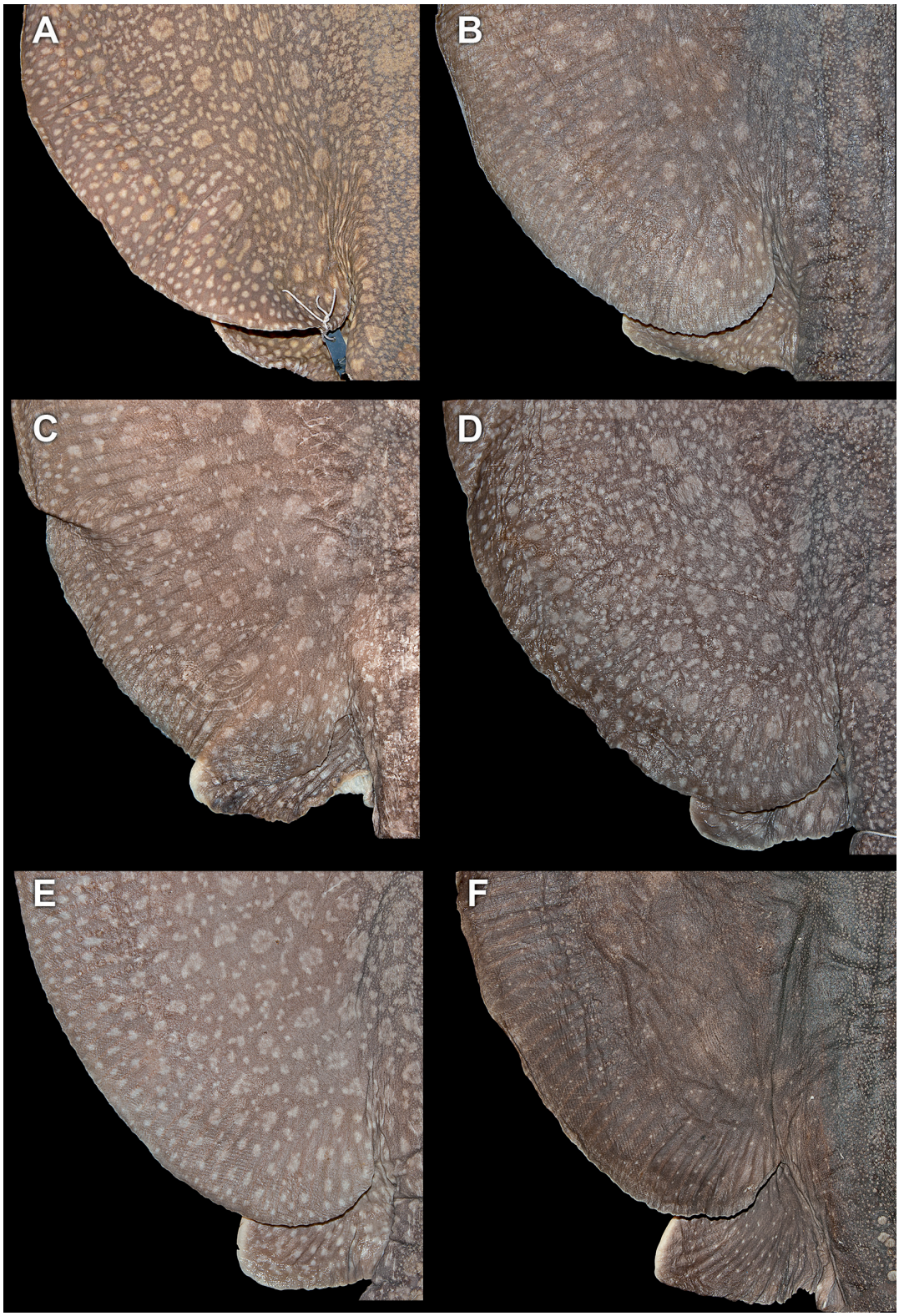

FIGURE 20: Left posterolateral disc region in *Plesiotrygon iwamae,* showing some of the variation in dorsal disc color present in specimens examined. **A)** MZUSP 59896 (Rio Solimões, 470 mm DL, 460 mm DW). **B)** MZUSP 108706 (Rio Pará, 350 mm DL, 355 mm DW). **C)** MZUSP 108771 (Rio Pará, 292 mm DL, 294 mm DW). **D)** MZUSP 108772 (Rio Pará, 298 mm DL, 300 mm DW). **E)** 108776 (Rio Pará, 396 mm DL, 398 mm DW). **F)** MZUSP 108775 (Rio Pará, 452 mm DL, 442 mm DW).

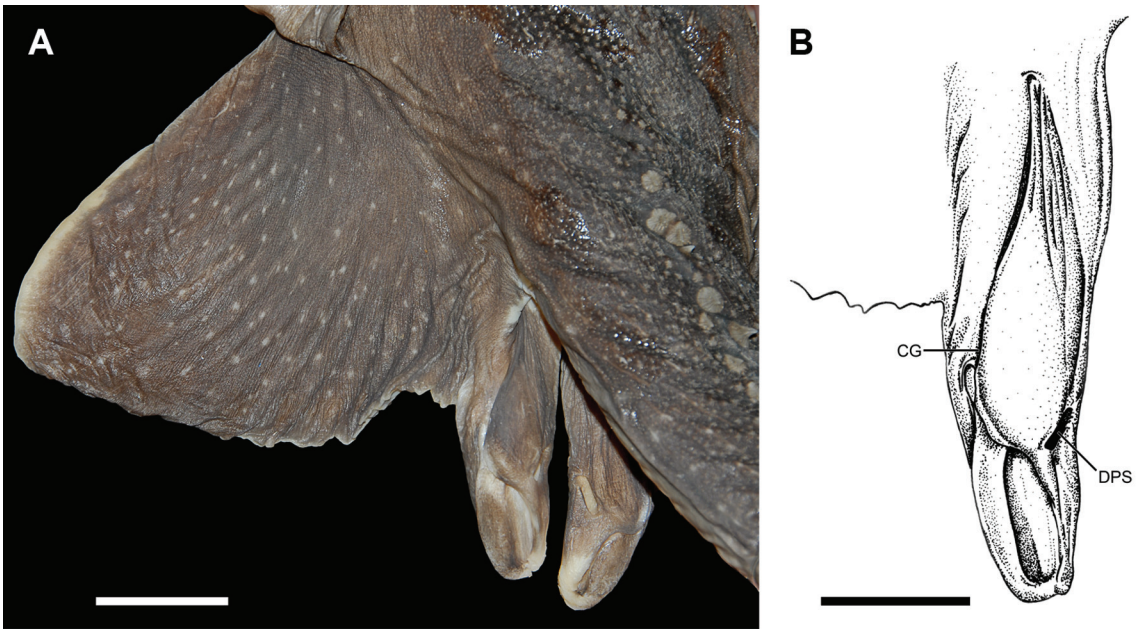

FIGURE 21: External clasper morphology of *Plesiotrygon iwamae* in dorsal view (MZUSP 108775). Abbreviations: CG, clasper groove; DPS, dorsal pseudosiphon. Scale bar in A = 3 cm; B = 2 cm.

Figure 20 (specimens depicted in B-E come from the same locality in Rio Pará). Enlarged dorsal tail spines, with very wide bases and high, acute crowns arranged in a single irregular row, are present in the vast majority of specimens of *P. iwamae,* but some specimens (MZUSP 59897, 108706, 108707, 108767, 108773) lack them altogether or present smaller, more scattered spines with few larger spines interspersed (Figures 19E, F, 23, 24C). Denticle morphology is similar to *P. nana* (Figure 22).

Two specimens of *Plesiotrygon* recently collected in November 2010 (MUSM 39977) from the main channel of the Río Amazonas near the town of Tamshiyacu (Peru), about 45 km upriver from Iquitos, are intriguing as they clearly cannot be identified with *Plesiotrygon nana,* but also differ slightly in coloration from "typical" specimens of *P. iwamae* (see Figures 23, 25-27). Both specimens are comparable to *P. nana* in size (221 mm DL and 211 mm DW, 206 mm DL and 195 mm DW; Table 5), but

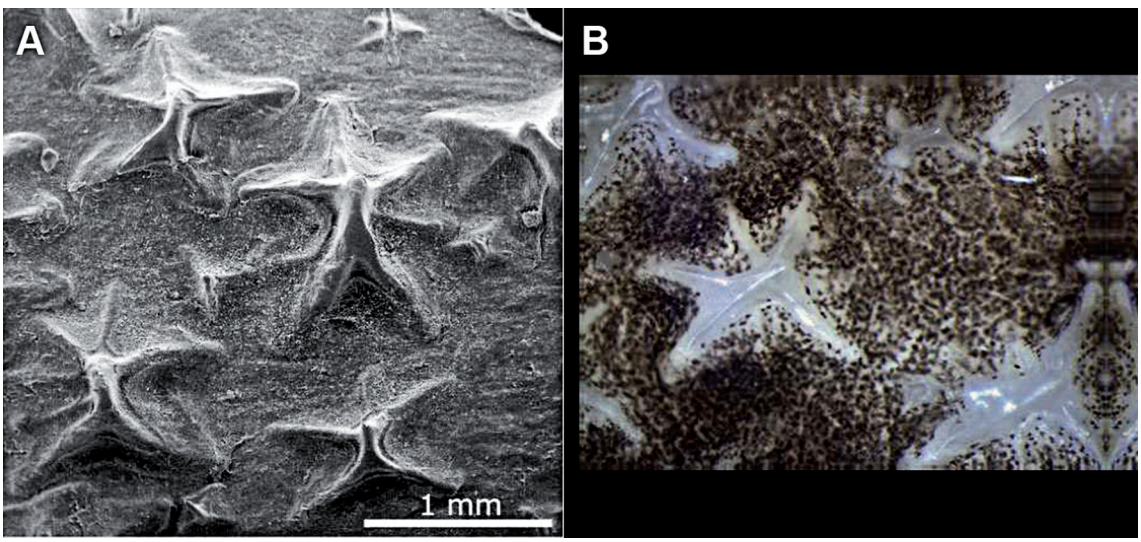

FIGURE 22: Dermal denticles in *Plesiotrygon iwamae* from central disc region. **A)** MZUSP 108706 (350 mm DL, 355 mm DW). **B)** MZUSP 108776 (396 mm DL, 398 mm DW).

TABLE 5: Measurements taken from specimens of *Plesiotrygon* cf. *iwamae* from Río Amazonas, near Tamshiyacu, Loreto Department, Peru. **A:** MUSM 39977 (juvenile male). **B:** MUSM 39977 (also juvenile male). **SD:** standard deviation.

PARAMETER	A		B		Mean		SD	
	mm	% DW	mm	% DW	mm	% DW	mm	% DW
Total length (TL)	1096.0	—	1095.0	—	1095.5	—	0.7	—
Disc length (DL)	221.0	104.7	206.0	105.6	213.5	105.2	10.6	0.6
Disc width (DW)	211.0	100.0	195.0	100.0	203	100.0	11.3	0.0
Interorbital distance	30.0	14.2	24.0	12.3	27	13.3	4.2	1.4
Interspiracular distance	36.0	17.1	31.0	15.9	33.5	16.5	3.5	0.8
Eye length	5.0	2.4	4.0	2.1	4.5	2.2	0.7	0.2
Spiracle length	14.0	6.6	12.0	6.2	13	6.4	1.4	0.3
Preorbital length	63.0	29.9	56.0	28.7	59.5	29.3	4.9	0.8
Prenasal length	44.0	20.9	41.0	21.0	42.5	20.9	2.1	0.1
Preoral length	57.0	27.0	51.0	26.2	54	26.6	4.2	0.6
Internarial distance	18.0	8.5	18.0	9.2	18	8.9	0.0	0.5
Mouth width	23.5	11.1	21.0	10.8	22.25	11.0	1.8	0.3
Distance between 1st gill slits	57.0	27.0	52.0	26.7	54.5	26.8	3.5	0.2
Distance between 5th gill slits	42.0	19.9	39.0	20.0	40.5	20.0	2.1	0.1
Branchial basket length	33.0	15.6	31.0	15.9	32	15.8	1.4	0.2
Pelvic fin anterior margin length	60.0	28.4	50.0	25.6	55	27.0	7.1	2.0
Pelvic fins width	140.0	66.4	110.0	56.4	125	61.4	21.2	7.0
Clasper external length	18.0	8.5	15.0	7.7	16.5	8.1	2.1	0.6
Clasper internal length	7.0	3.3	6.0	3.1	6.5	3.2	0.7	0.2
Distance between cloaca and tail tip	895.0	424.2	932.0	477.9	913.5	451.1	26.2	38.0
Tail width	40.0	19.0	38.0	19.5	39	19.2	1.4	0.4
Snout to cloaca distance	192.0	91.0	174.0	89.2	183	90.1	12.7	1.2
Pectoral to posterior pelvic length	44.0	20.9	39.0	20.0	41.5	20.4	3.5	0.6
Distance from cloaca to sting origin	132.0	62.6	99.0	50.8	115.5	56.7	23.3	8.3
Sting length	39.0	18.5	49.0	25.1	44	21.8	7.1	4.7
Sting width	3.0	1.4	5.0	2.6	4	2.0	1.4	0.8

are juvenile males, with claspers that are just beginning to protrude beyond pelvic fin posterior web (Figure 26E). They also differ significantly in having almost 10 more tooth rows, more caudal vertebrae, much fewer total pectoral radials (see Tables 2, 6), and many proportions of disc, snout, spiracles and eyes. In contrast, these specimens share with *P. iwamae* similar snout and disc proportions, disc shape, nasal curtain and spiracular proportions (Table 5), tooth row counts, similar relatively low counts of pectoral radials, similar elevated counts of caudal vertebrae, creamy white color of filiform whip, conspicuous ventral lateral-line canal patterns (*e.g.* greatly inflected external hyomandibular canal), and a relatively stout hyomandibula (see Figures 23, 24), but differ in dorsal coloration from smaller specimens of *P. iwamae* (such as MZUSP 14789). However, little is known concerning the dorsal color pattern of small specimens of *P. iwamae.* The dorsal color pattern of the Tamshiyacu material is somewhat similar to the paratypes of *P. nana,* and they were collected together with the preadult male paratype of this species. Given these uncertainties, we refer to these specimens as *Plesiotrygon* cf. *iwamae* until further material from the upper Amazon can be examined; we can ascertain, though, that they are much closer morphologically to *P. iwamae* than to the highly

TABLE 6: Counts taken from specimens of *Plesiotrygon* cf. *iwamae* from Río Amazonas, near Tamshiyacu, Loreto Department, Peru. **A:** MUSM 39977 (juvenile male). **B:** MUSM 39977 (also juvenile male). **SD:** standard deviation.

CHARACTER	A	B	Range	Mode	SD
Precaudal vertebrae	24	24	24	24	0.0
Caudal vertebrae	96	96	96	96	0.0
Total vertebrae	120	120	120	120	0.0
Diplospondylous vertebrae	93	90	90-93	—	2.1
Upper tooth rows	27	28	27-28	—	0.7
Lower tooth rows	30	30	30	30	0.0
Propterygial radials	38	37	37-38	—	0.7
Mesopterygial radials	14	13	13-14	—	0.7
Metapterygial radials	27	26	26-27	—	0.7
Total pectoral radials	79	76	76-79	—	2.1
Pelvic radials	19	18	18-19	—	0.7

distinctive *P. nana.* These specimens from near Tamshiyacu are illustrated in detail here to serve as a basis for future comparison because small specimens of *P. iwamae* are lacking in collections. The smallest captured specimen of *P. iwamae* we have examined is the smaller male paratype from the Rio Solimões (230 mm DL, 215 mm DW). This lack of smaller material (not counting late-term embryos aborted by captured gravid females) may be an indication that their early life-cycle after birth takes place in deeper channels.

DISCUSSION

Comparisons of *Plesiotrygon nana* with *Plesiotrygon iwamae*

Plesiotrygon nana shares with *P. iwamae* many generic-level characters (see also generic diagnosis above), but morphological differences between both species are considerable. In addition to the characters already mentioned as distinct in their diagnoses, some external characters deserve further notice. *Plesiotrygon nana* has

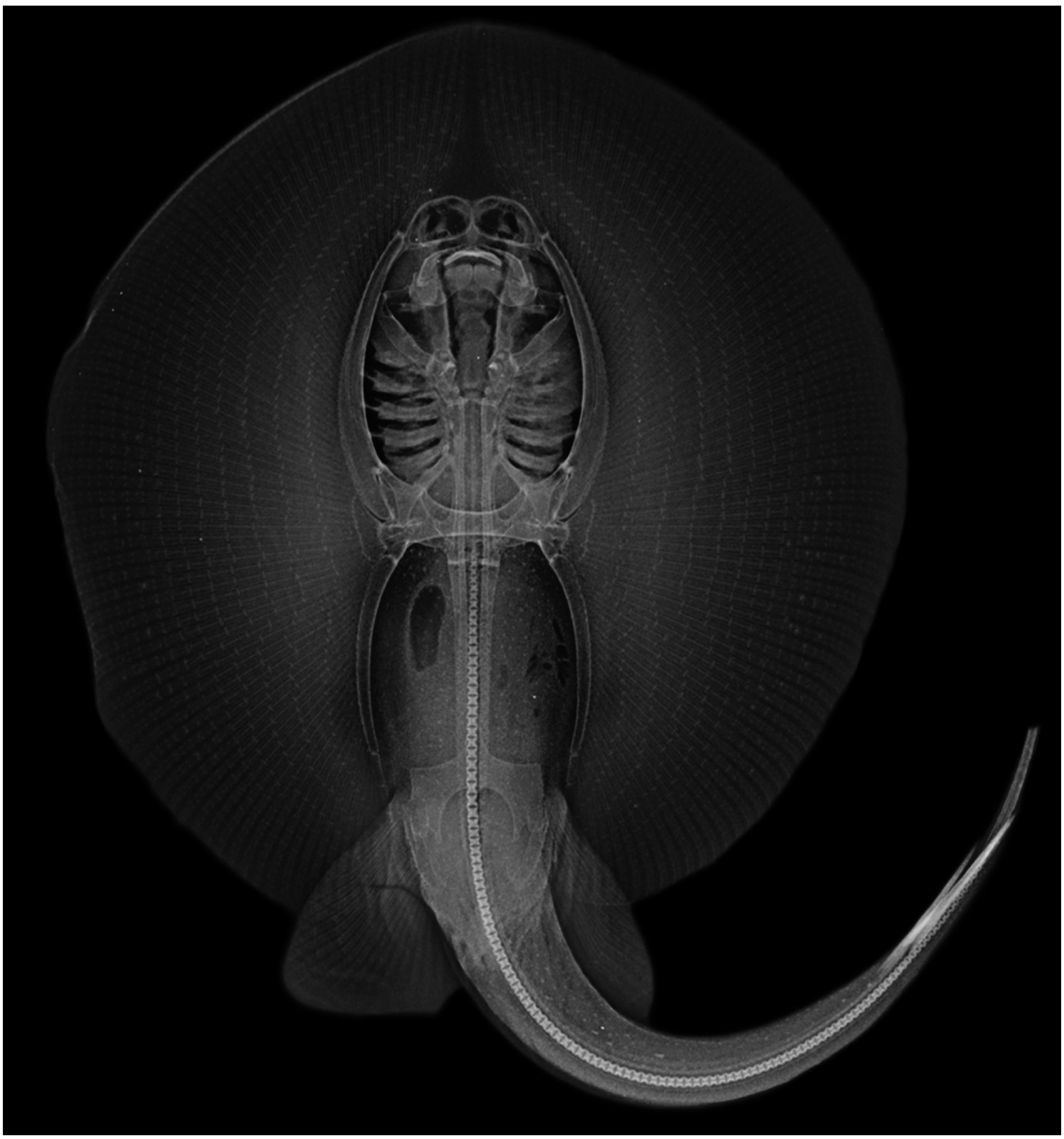

FIGURE 23: Skeleton of *Plesiotrygon* cf. *iwamae* from radiograph (MUSM 39977, juvenile male, 1096 mm TL, 221 mm DL, 211 mm DW). Tail posterior to caudal stings not depicted in radiograph.

a more intense covering of dermal denticles over disc and tail (*e.g.* Figure 27); dorsal disc denticles are very numerous in both male specimens, and even in the smaller female paratype (also in Solimões specimen, as from photograph). More apparent, however, is the difference in shape and size of the spiracles. In *P. iwamae,* the spiracles are similar to the general condition in other potamotrygonids, being rhomboidal, and much larger than the eyes (this is true even in *Potamotrygon,* which has proportionally much larger eyes than in *Plesiotrygon, Paratrygon* and *Heliotrygon*). But in *P. nana,* the spiracles are more evenly proportioned, even oval-rounded to some degree, and much smaller proportionally (Figure 27). *Plesiotrygon nana* has the smallest spiracles proportionally of any potamotrygonid. The spiracles do not even grow significantly in this species. The female paratype (81 mm DL, 72 mm DW) has spiracles measuring 5 mm in length (6.9% DW), whereas the largest specimen (holotype, 243 mm DL, 247 mm DW) has spiracles just barely greater at 7 mm in length (2.8% DW), and the preadult male paratype (174 mm DL, 170 mm DW) has spiracles almost of

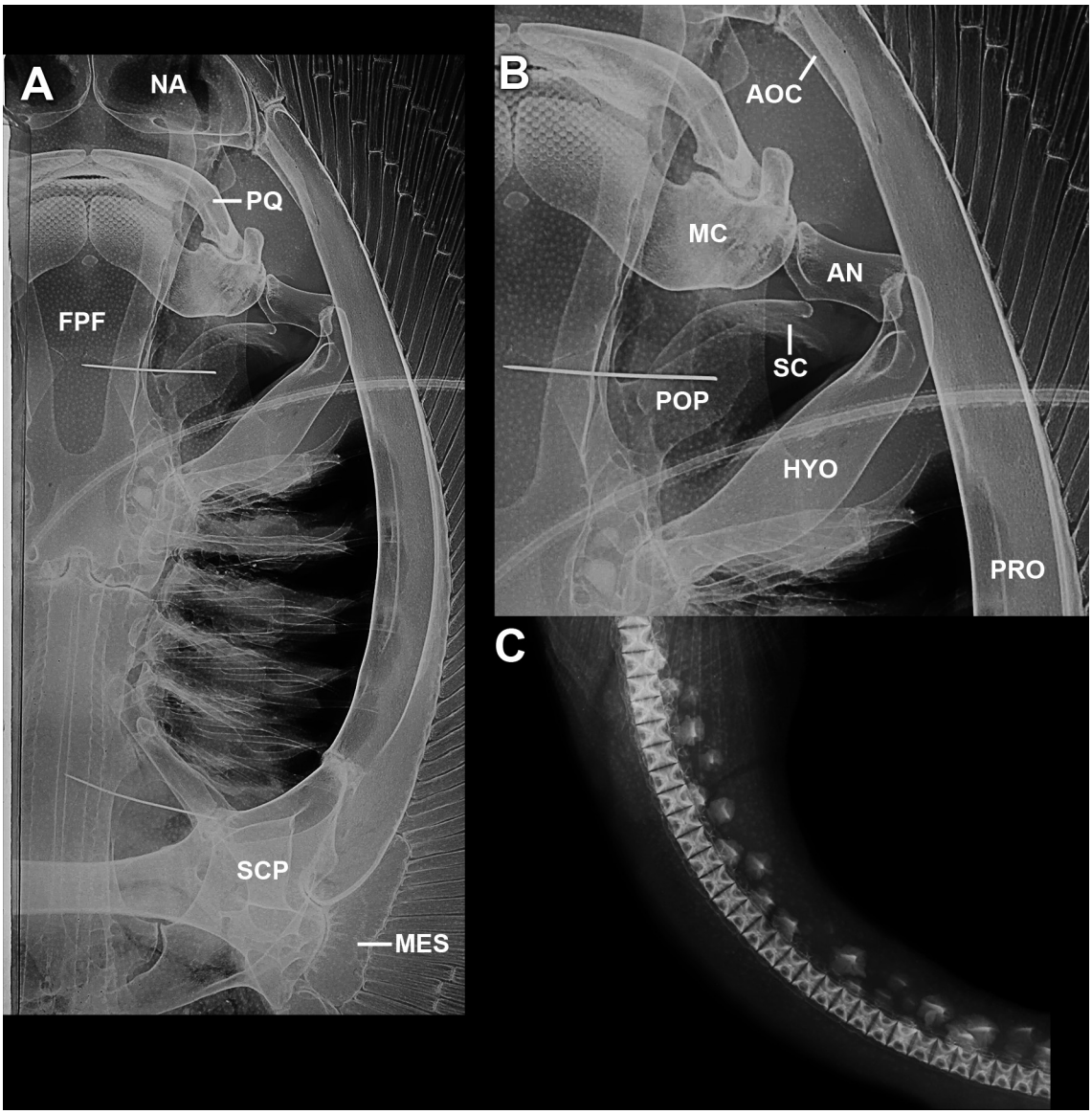

FIGURE 24: Skeleton and dermal covering in paratype of *Plesiotrygon iwamae* (FMNH 94500, adult female, 565 mm DL). **A)** Splanchnocranium and scapular region. **B)** Close-up of angular cartilage. **C)** Base of tail region showing arrangement of dorsal spines and denticles. Abbreviations: AC, angular cartilage; AOC, antorbital cartilage; HYO, hyomandibula; MC, Meckel's cartilage; MES, mesopterygium; NA, nasal aperture; POP, postorbital process; PQ, palatoquadrate; PRO, propterygium; SC, spiraclular cartilage (anterior); SCP, scapulocoracoid.

the same size (6 mm in length, 3.5% DW). The specimen of *P. nana* depicted in Figure 27A has the greatest difference between eye and spiracle length of the three specimens reported (eye-spiracle ratio, in mm, is 3/6 in this specimen, but in the holotype it is 5/7, and 4/5 in the smallest specimen). In contrast, the mean spiracular length is four times the mean eye length in specimens of *P. iwamae* (Table 3).

There are also slight differences in clasper shape, which in *P. nana* is slender, elongate and relatively flattened, but in *P. iwamae* is stouter, shorter and more cylindrical (Figures 9, 21). Clasper proportions, however, are not too compelling (mean external clasper length 7.7% DW, and mean internal clasper length 15.9% DW in *P. nana,* compared to mean external clasper length 6.6% DW, and mean internal clasper length 13.7% DW in *P. iwamae*), but few specimens have been examined for both species in this regard. The claspers of *P. iwamae* are also darker in color than in *P. nana.* Clasper skeleton seems to be similar in both species, judging from radiographs (we did not dissect the claspers in *P. nana*).

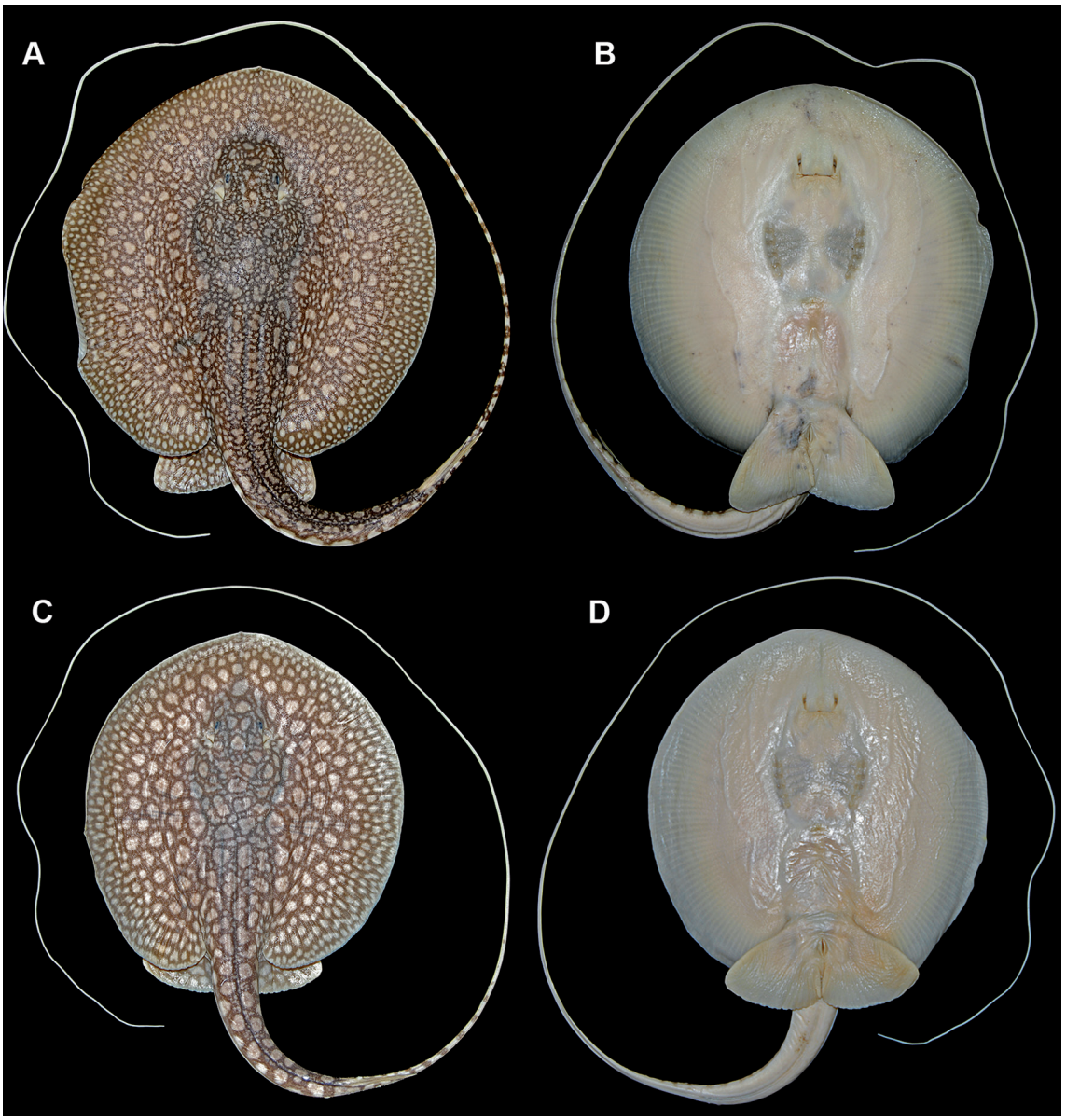

FIGURE 25: Dorsal **(A, C)** and ventral **(B, D)** views of *Plesiotrygon* cf. *iwamae* (Río Amazonas, near Tamshiyacu, Loreto Department, Peru). A, B) MUSM 39977 (juvenile male, 221 mm DL, 211 mm DW). C, D) MUSM 39977 (juvenile male, 206 mm DL, 195 mm DW).

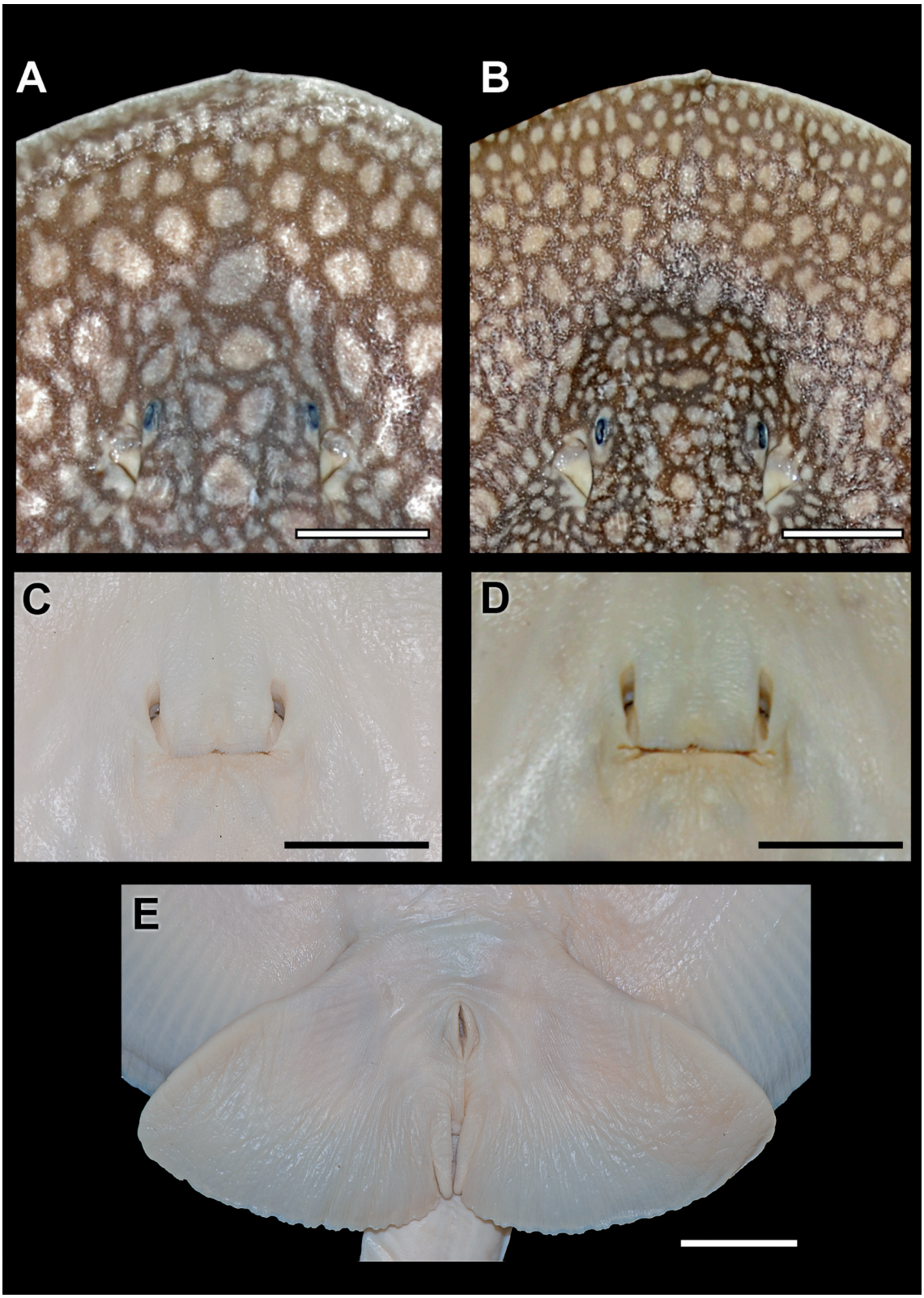

FIGURE 26: Morphological details of *Plesiotrygon* cf. *iwamae.* **A, B)** Dorsal view of anterior disc and head region. **C, D)** Nasoral region. **E)** Ventral view of pelvic fins and claspers. A, C and E based on MUSM 39977 (juvenile male, 206 mm DL, 195 mm DW); B and D from MUSM 39977 (juvenile male, 221 mm DL, 211 mm DW). Scale bar = 2 cm.

Greater distinctions between *P. nana* and *P. iwamae* are present in their ventral lateral-line canals (Figure 12). Both anterior and posterior subpleural tubules of hyomandibular canal are absent in *P. nana.* In *P. iwamae,* the anterior subpleural tubules are restricted to its dorsalmost portion right at anterior disc margin, and are few in number (some 10-15 tubules are typically present); the posterior subpleural tubule in *P. iwamae* extends caudally from the subpleural loop, and is very slender, easily missed in dissections. The hyomandibular canal is very narrow in *P. nana,* narrower than in any other potamotrygonid. In contrast, the hyomandibular canal is relatively wide in *P. iwamae,* even compared to species of *Potamotrygon* which have a similar ventral lateral-line arrangement. Both external and internal components of the hyomandibular canal in *P. iwamae* are highly recurved at midlength, whereas in *P. nana* this canal is very straight. The slightly undulated infraorbital and supraorbital canals of *P. iwamae* are also distinct from the condition in *P. nana,* in which they are straight; species of *Potamotrygon,* on the other hand, have very undulated infraorbital and supraorbital canals (hypothesized to be a derived character for them). The supraorbital and infraorbital loops in *P. iwamae* resemble those of species of *Potamotrygon* in being elongated. The supraorbital loop is very long, as long as three-fourths preoral distance, and extends posteriorly past level of mouth in *P. iwamae* and in most species of *Potamotrygon,* but in *P. nana* it is very short, not reaching mouth posteriorly. The infraorbital loop extends posteriorly to close to the gill openings in *P. iwamae* and *Potamotrygon* spp., but in *P. nana* it does not come close to the gill slits (this character may be related to the shortened snout region in *P. nana*); the same pattern is present for the jugular canal. These characters of the ventral lateral-line have been observed in many specimens of *P. iwamae* through dissections as well as from external observations (and in *Potamotrygon* spp. as well), and in all four specimens of *P. nana.*

Size comparisons are a further reliable way to corroborate the separation of *P. nana* from *P. iwamae.* The smaller male paratypes of *P. iwamae* (MZUSP 14789, 226 mm DL, 210 mm DW; ZMH 10343, 285 mm DW; both specimens from Rio Solimões) are comparable in length to the holotype of *P. nana* (243 mm DL, 247 mm DW), but represent juvenile males with claspers barely noticeable, not projecting beyond pelvic fin posterior margin in the MZUSP paratype, and just extending beyond pelvic fin in the ZMH paratype (this could be related to its dried condition). The claspers in the holotype of *P. nana* are fully calcified and developed, and extend well beyond pelvic posterior margin. Specimens MZUSP 108772 (from Colares, Rio Pará, 299 mm DL, 295 mm DW) and MZUSP 108768 (also from Colares, Rio Pará, 344 mm DL, 349 mm DW) are much larger than the holotype of *P. nana* and have claspers that are very slender and barely projecting beyond pelvic fins; specimen MZUSP 108775 (again from Colares, Rio Pará, 442 mm DL, 436 mm DW) is fully sexually mature with well developed, stout claspers. Sexual maturity for *P. iwamae,* therefore, initiates at a much larger size than in *P. nana,* probably around 400 to 420 mm DL or DW, which is close to twice the size of the onset of sexual maturity for male specimens of *P. nana.*

Regarding skeletal morphology, the hyomandibula of *P. iwamae* is stouter than in *P. nana,* especially at its proximal one-third (Figures 14, 23, 24). Variation observed in this feature in the many specimens of *P. iwamae* examined is not great, but more material of *P. nana* is necessary. However, the pectoral and pelvic girdles of *P. nana* differ slightly from those of *P. iwamae.* Both girdles are proportionally more elongate anteroposteriorly in *P. nana,* as measured at their greatest length in dorsoventral view (Figures 13, 14, 23, 24). The coracoid bar in *P. nana* has a more pronounced concavity on anterior ventral margin (somewhat less concave and oval in *P. iwamae;* Figures 14, 24). Even though there is a difference of degree in scapulocoracoid length and in the anterior ventral concavity of the coracoid bar in both species of *Plesiotrygon,* these features may be more similar between *P. nana* and *P. iwamae* when compared to other potamotrygonid genera. In species of *Paratrygon* and *Heliotrygon* the scapulocoracoid is anteroposteriorly shortened (Carvalho & Lovejoy, 2011), and most species of *Potamotrygon* have a more subtle anterior coracoid concavity; also, the scapulocoracoid is slightly less elongated (but still more similar to *Plesiotrygon*). But there is some variation in the anterior coracoid concavity and shoulder girdle length in species of *Potamotrygon,* as well as among specimens of *P. iwamae* examined. Nonetheless, these features reinforce the separation of *P. nana* and *P. iwamae.*

The greatest anteroposterior length of the puboischiadic bar in *P. nana,* measured laterally in a straight line between lateral prepelvic process and posteriormost point of iliac process, is about two-thirds the greatest width of pelvic girdle. Similar proportions occur in *P. iwamae,* according to our material. But in *Potamotrygon, Paratrygon* and *Heliotrygon,* the greatest anteroposterior length of the pelvic girdle is only about one-half its greatest width. In both species of *Plesiotrygon,* the space delimited by the posterior margin of the puboischiadic bar is more sharply oval than

in the other potamotrygonid genera as well. These features of the pelvic girdle require less additional corroboration than the greater anterior concavity of the coracoid discussed above, and represent further derived characters for *Plesiotrygon.*

Quo vadis *Plesiotrygon?*

Recent molecular phylogenetic studies have placed *Plesiotrygon iwamae* nested with species of *Potamotrygon* in approaches using neighbor joining, likelihood, and Bayesian methods (Toffoli *et al.,* 2008). The results are highly variable, as *Plesiotrygon* changes position frequently among the analyses presented (Toffoli *et al.,* 2008). What is more or less consistent, however, is that when *Plesiotrygon* is nested among species of *Potamotrygon,* it usually does so with *P. schroederi* from the Negro and Orinoco basins. This is similar to conclusions achieved through a more thorough molecular parsimony analysis using POY (Marques *et al.,* in prep; F. Marques, pers. comm.), and not incompatible with the earlier molecular phylogeny of Lovejoy *et al.* (1998), in which *Plesiotrygon iwamae* is grouped with *Potamotrygon orbignyi,* but again from the Río Orinoco. These conclusions, if corroborated, have implications for the acceptance of *Plesiotrygon* as a valid potamotrygonid genus.

In the present paper, further characters supporting the monophyly of *Plesiotrygon,* found in both species, were uncovered. These include their anteroposteriorly elongated puboischiadic bar, greatly concave posterior aspect of puboischiadic bar, single and uniquely stout and short angular cartilage, and greater posterior position of caudal stings on dorsal tail (this character still needs scrutiny, as some specimens of *Potamotrygon scobina* and *P. falkneri* may rival *Plesiotrygon* in this regard). Additionally, we can cite the posterior placement of the pelvic fins, the extremely long caudal filament, and the well developed ventral tail fold as unique among potamotrygonids. But substantiating the monophyly of *P. nana* and *P. iwamae* together as a clade (of which there can be little doubt) will not affect conclusions as to the validity of the nominal genus *Plesiotrygon* (*i.e.* both species can be sister groups *and* nested within *Potamotrygon,* corroborating the molecular phylogenetic scenario). For *Plesiotrygon* to be considered valid, both species must either be basal to all *Potamotrygon* species, which themselves need to be monophyletic without the inclusion of *P. nana* and *P. iwamae,* or *Potamotrygon* would require subdivision into multiple genera to allow for separate monophyletic subgroups (of which only those species nested with the type-species, *Potamotrygon histrix,* would remain in *Potamotrygon*).

The real question, therefore, concerns not the monophyly of *Plesiotrygon* per se, but the monophyly of *Potamotrygon* without *Plesiotrygon.* Along these lines, we have alluded to one character above, regarding the greater undulation of the infraorbital and supraorbital lateral-line canals in species of *Potamotrygon.* There are other features of the lateralis system that also figure in support of *Potamotrygon* monophyly, but these will not be advanced here. Skeletal features of the gill arches also potentially corroborate *Potamotrygon* as monophyletic, along with other morphological characters. More obvious features unique for *Potamotrygon* within the family include its much thicker, taller head and disc (*Plesiotrygon, Paratrygon* and *Heliotrygon* have a very low head and very thin, flat disc), and bulging, much larger eyes

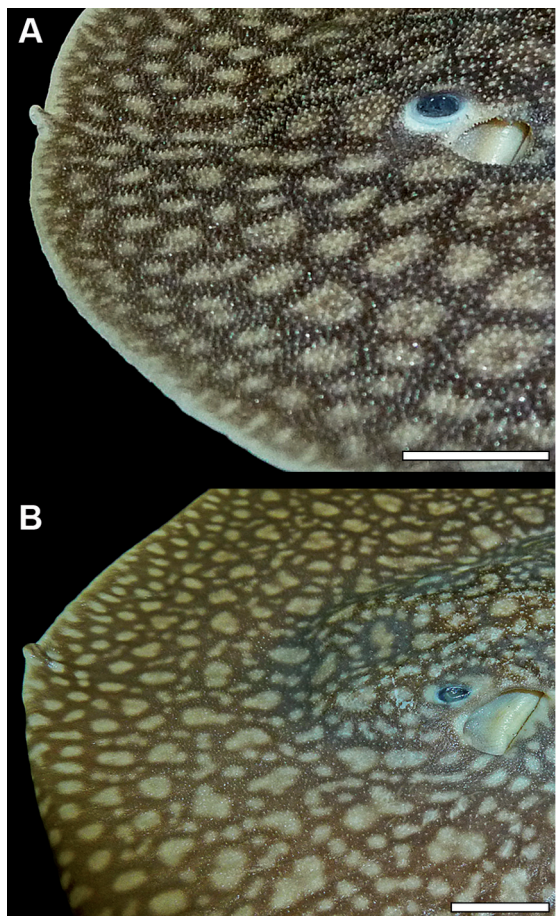

FIGURE 27: Anterior disc and head region depicting relative proportions of eyes and spiracles in **(A)** subadult male paratype of *Plesiotrygon nana* sp. nov. (MUSM 40243, 174 mm DL, 170 mm DW), and **(B)** juvenile male *Plesiotrygon* cf. *iwamae* (MUSM 39977, 221 mm DL, 211 mm DW). Scale bar in A = 1 cm; B = 2 cm.

proportionally, but these characters may be primitive when all myliobatiform genera are taken into account (*e.g.* Carvalho *et al.,* 2004). In any case, this issue can only be resolved with a species-level phylogeny of all potamotrygonid taxa; in the meantime, we see merit in recognizing *Plesiotrygon* as valid.

RESUMO

Uma nova espécie do relativamente desconhecido gênero de raia de água doce Neotropical Plesiotrygon *Rosa, Castello & Thorson, 1987 é descrita do canal principal e de tributários menores (Ríos Itaya e Pachitea) do alto da bacia Amazônica do Peru. O primeiro exemplar coletado, porém, foi capturado em 1996 muito mais ao leste no Rio Solimões, pouco abaixo da sua confluência com o Rio Purus (exemplar não disponível para estudo).* Plesiotrygon nana *sp. nov., é uma espécie pequena, muito distinta e incomum de raia de água doce (Potamotrygonidae), descrita aqui principalmente a partir de três indivíduos representando diferentes classes de tamanho e estágios de maturação sexual.* Plesiotrygon nana *sp. nov., distingue-se da única espécie previamente conhecida,* P. iwamae *Rosa, Castello & Thorson, 1987, por inúmeras características únicas, incluindo: coloração dorsal composta por rosetas muito finas ou uma combinação de pontilhados e ocelos irregulares; disco e focinho muito circular; espiráculos rombóides e bem pequenos; focinho curto; boca e narinas estreitas; dentículos no dorso da cauda pequenos, dispersos, sem formação de fileira de espinhos desenvolvidos; espécimes adulto e pré-adulto com um número significativamente menor de fileiras de dentes; menos vértebras caudais; maior número total de raios peitorais; tamanho muito pequeno, provavelmente não ultrapassando 250 mm de comprimento ou largura de disco; maturidade sexual dos machos perto de 180 mm de comprimento de disco e 175 mm de largura de disco; coloração distal da cauda posterior ao espinho caudal normalmente marrom escuro arroxeado; e características dos seus canais ventrais da linha lateral (canal hiomandibular delgado, canais infraoribital e supraorbital não ondulados, voltas supraorbital e infraorbital pequenas e estreitas, volta supraorbital não se estendendo posteriormente ao nível da boca, canais jugular e infraorbital posterior pequenos, não se estendendo caudalmente ao primeiro par de fendas branquiais, volta subpleural muito delgada posteriormente). Para fundamentar a descrição de* P. nana *sp. nov., variações morfológicas em P. iwamae foram examinadas baseadas em todos os exemplares da série tipo e em outros recém-coletados mas até então não reportados. Dois espécimes topotípicos com o parátipo macho de* P. nana *sp. nov., aqui referidos como* Plesiotrygon *cf.* iwamae, *também são descritos. Relações evolutivas da espécie nova com* P. iwamae *são discutidas; caracteres indicativos da monofilia do gênero são propostos, mas este pode ainda não ser válido.* Plesiotrygon nana *sp. nov., é comercializada com alguma freqüência no mercado internacional de peixes ornamentais de Iquitos (Peru), uma circunstância alarmante já que nada é conhecido sobre sua biologia ou possíveis diretrizes para conservação.*

Palavras-Chave: *Plesiotrygon iwamae;* Taxonomia; Morfologia; Myliobatiformes; Rio Solimões; Rio Ucayali; América do Sul.

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