Re-description of the rare taillight shark *Euprotomicroides zantedeschia* (Squaliformes, Dalatiidae), based on third and fourth record from off Chile

by

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Abstract. – The third and fourth records of the rare oceanic dalatiid shark *Euprotomicroides zantedeschia* Hulley & Penrith, 1966 from off Chile, near Juan Fernandez Islands, are described. A nearly mature male of 455 mm total length (TL) was caught by a Russian trawler in 1985, and a presumably mature female of 515 mm TL by a Dutch stern trawler in 2008. Both new records of this rare species, hitherto known only from the juvenile female holotype from the SE Atlantic off South Africa and a mature male found off Uruguay in the SW Atlantic, are described and illustrated in detail. Comparison of the Chilean records with the former Atlantic ones confirmed conspecificity of all four so far known specimens. The unique generic diagnostic characters of a huge luminous abdominal pouch gland is illustrated with photographs, the likewise among sharks unique pelvic girdle morphology is shown by computed tomography (CT) images.

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Résumé. – Redescription du rare squale à queue claire, *Euprotomicroides zantedeschia* (Squaliformes, Dalatiidae), sur la base de ses troisième et quatrième nouveaux signalements au large du Chili.

Les troisième et quatrième signalements de la très rare espèce océanique de requin dalatiidé *Euprotomicroides zantedeschia* Hulley & Penrith, 1966 au large du Chili, près des îles Juan Fernandez, sont décrits. Un mâle presque adulte de 455 mm de longueur totale (LT) a été capturé par un chalutier russe en 1985, et une femelle, probablement adulte, de 515 mm LT, par un chalutier pélagique néerlandais en 2008. Les deux nouveaux signalements de cette espèce rare, jusqu'ici connue seulement de l'holotype, une femelle juvénile de l'Atlantique SE au large de l'Afrique du Sud et un mâle adulte capturé au large de l'Uruguay dans l'Atlantique sud-ouest, sont décrits et illustrés en détail. La comparaison des spécimens chiliens avec les précédents provenant de l'Atlantique a confirmé la conspécificité des quatre spécimens connus jusqu'à présent. Les caractères diagnostiques uniques de ce genre sont détaillés : la grande glande lumineuse abdominale est illustrée par des photographies et la morphologie de la ceinture pelvienne par des images de tomodensitométrie (CT-scan).

Key words
Elasmobranchii
Dalatiidae
Euprotomicroides zantedeschia
SE Pacific
Juan Fernandez Islands
New records

Euprotomicroides zantedeschia Hulley & Penrith, 1966 is a rare oceanic dalatiid shark previously known from only two specimens. Hulley and Penrith (1966) described *E. zantedeschia* gen. et sp. n., based on a small, somewhat damaged holotype (SAM 23755) of 176 mm TL from off the west coast of South Africa caught by bottom trawl at about 500 m depth. The authors' generic diagnosis distinguished this shark from at that time seven other dalatiid genera by the following combination of characters: "spines absent on both dorsal fins; gill slits large, the largest (fifth) about equal to base of first dorsal fin; caudal lacking subterminal notch or precaudal pits; first dorsal about midway between snout and caudal origin; second dorsal only slightly longer than first; teeth dissimilar in the two jaws." The holotype was said to be a mature male with "large claspers extending beyond posterior tip of pelvic fin, inner margins orange coloured." Because of the extremely small size of this mature male, the authors called it a "pigmy shark".

Stehmann and Krefft (1988) compared the small SAM holotype in their detailed description of the second record from the SW Atlantic off Uruguay, a mature male of 413.5 mm TL (ISH 701/76, now ZMH 114723). Several errors in the original description became apparent and were corrected by the latter authors (*loc. cit.*), along with significant additions to external morphology and internal anatomy, including clasper characters. It turned out that the original authors, Hulley and Penrith (1966), had misinterpreted and overlooked the most significant, and indeed among sharks, unique diagnostic generic characters. They had mistaken the prominent walls of the abdominal luminous pouch for a pair of claspers of this really juvenile female, and they did not recognise (but possibly their X-rays did not show it) the peculiar, unique shape of the pelvic girdle associated with the abdominal pouch as described and illustrated by Stehmann and Krefft (1988). Some other statements by the original authors may have been due to the somewhat damaged

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condition and small juvenile stage of the holotype female. The mature male in good condition from off Uruguay proved to have a caudal fin with distinct subterminal notch, no lateral keels on caudal peduncle, and the anterior margin of the caudal fin hypural lobe was not twice the length of the anterior margin of the epural lobe, but half the length of the latter. Also the holotype SAM number was misspelled as 23577.

The first two records of *E. zantedeschia* from two distant SE and the SW Atlantic localities suggested this species to be another oceanic pelagic shark and, according to its dentition, of the cookiecutter type (*Isistius* spp.). We are describing and comparing here the third and fourth record of this rare species, an almost mature male, and a presumably mature female, as the so far largest known specimens, from the SE Pacific off Chile in the vicinity of Juan Fernandez Islands. Both records have already been cited as 'personal communication' by Weigmann (2016) in his global checklist of living chondrichthyans.

MATERIALS AND METHODS

AtlantNIRO 23075, subadult male 455 mm TL; 32°S, 95°W, northwest of Juan Fernandez Islands in the open SE Pacific; Russian trawler *Novochebaksarsk* in November 1985, collector I.I. Konovalenko (AtlantNIRO). Specimen with body somewhat twisted, snout a bit squashed, so that some morphometrics are approximations rather; median upper, as well as median and lateral lower teeth broken off.

RMNH.PISC.35639, presumably mature female 515 mm TL; caught on 22.VII.2008 by the Dutch commercial stern trawler MV *Maartje Theodora* fishing at a depth of 75 m (over at least 2000 m bottom depth) for horse mackerel with a pelagic trawl in the Southeast Pacific west off Juan Fernandez Islands. The haul was made during daytime, starting at 9:00 from 35°29'S, 94°15'W and ending at 19:30 at 35°47'S, 94°30'W; collector: observer Tomasz Raczynski, who removed on board median upper, median and some lateral lower teeth to keep them separately, and he registered of the fresh specimen 53 cm TL, 48 cm fork length and 710 g weight. Raczynski took at RMNH Leiden of the defrosted specimen a tissue sample from upper caudal margin, which he transferred to Poland, to the University of Warmia and Mazury in Olsztyn, for DNA analysis, where the sample has not yet been analyzed and registered. The specimen is in almost perfect condition and shape, only slightly compressed due to six months storage in the vessel freezer.

Institutional abbreviations used: AtlantNIRO, Atlantic Research Institute for Fisheries and Oceanography, Kalinin-

Figure 1. – *E. zantedeschia* almost mature male, 455 mm TL, AtlantNIRO No. 23075. **A**: Lateral view; **B**: Dorsal view.

Figure 2. – *E. zantedeschia* assumed mature female, 515.0 mm TL, RMNH. PISC.35639. Preserved (A, B) and freshly caught (C). **A**: Lateral view; **B**: Ventral view; **C**: Lateral view.

Figure 3. – *E. zantedeschia* female, 515.0 mm TL, RMNH.PISC.35639, total lateral view and ventral view of pelvics with luminous pouch. Drawings by Inge van Noortwijk, Naturalis.

grad, Russia; ISH, Institut für Seefischerei Hamburg, Germany; RMNH, Naturalis Biodiversity Center, Leiden, The Netherlands; SAM, Iziko South African Museum, Cape Town, South Africa; ZMH, Zoological Museum Hamburg, Hamburg University, Germany.

Following the scheme by Compagno (1984, 2001), the first author took external morphometrics, to the nearest one tenth of a millimetre with dial callipers, of both 70% ethanol preserved specimens. Photographs and X-rays of the Atlant-NIRO male were taken in Hamburg; co-authors at RMNH Leiden studied the female specimen, which they also lend to Hamburg, also took photographs, X-rays and arranged for CT-scan photos and films.

RESULTS (Figs 1-11)

External morphology (Figs 1-9)

Body in lateral view elongated and becoming more or less slender rearward, laterally compressed; head bulbous and highest section of entire body; dorsal body profile rounded, ventral profile flattened. Head massive, with dorsal contour nearly straight, forehead at most sloping a little towards snout tip; snout bluntly rounded in lateral and especially dorsal views; long underside of snout strongly sloping at about 45° angle from snout tip to mouth. Nostrils small and close to outer edges and tip of snout, with prenarial snout length only about one fourth of distance between nostrils and eyes; small in- and out-current nasal apertures separated by short, triangular anterior nasal flap; nostrils high up on snout about level with eyes. Eye openings low, horizontally slit-like elongated, pointed at both ends; iris yellowish-golden, encircled broadly blackish, with remainder of eyeball whitish. Spiracles large, semi-circular, higher than long, their lower edge about level with horizontal axis of eye, their dorsal edge somewhat above level of upper eye edge; vertically, spiracles level with posterior ends of upper labial furrow. Mouth wide, almost equal to head width, jaws arched, more so in the female than in the male; jaw angles about level with half the distance between eyes and spiracles; extremely long and deep upper labial furrows along three fourths of upper jaw length to close to symphysis in both specimens; lower labial furrows tiny in the male and absent in the female (Tab. I).

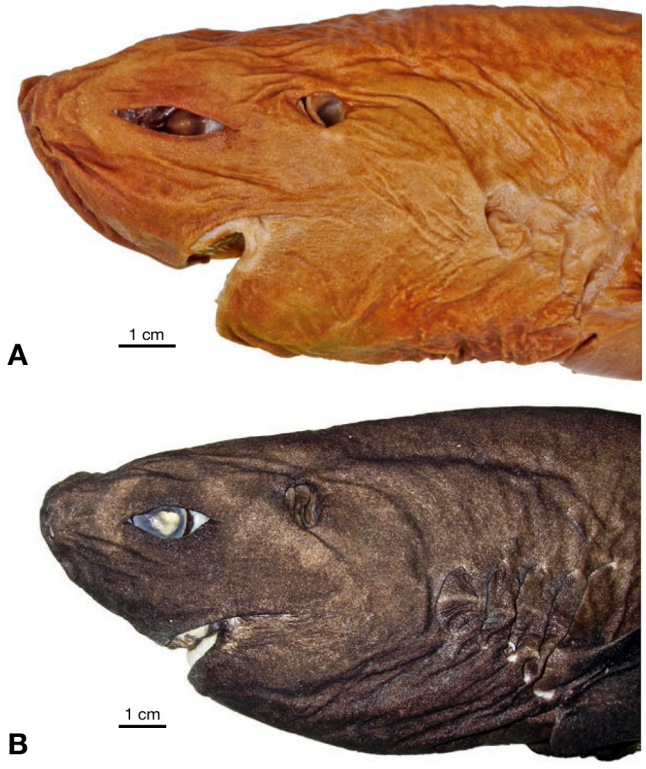

Figure 4. – *E. zantedeschia;* heads in lateral view. **A**: Male, 455 mm TL, AtlantNIRO No. 23075; **B**: Female, 515.0 mm TL, RMNH. PISC.35639.

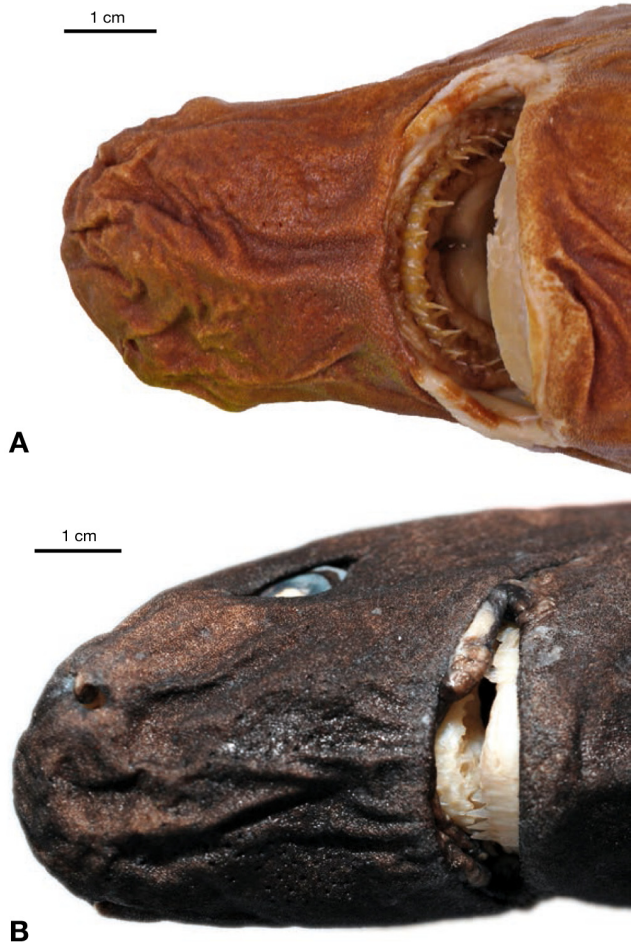

Figure 5. – *E. zantedeschia;* heads in ventral view. **A**: Male, 455 mm TL, AtlantNIRO No. 23075; **B**: Female, 515.0 mm TL, RMNH.PISC.35639.

Table I. – Morphometrics as percentage of TL of both Chilean records of *Euprotomicroides zantedeschia* and comparative values of the two Atlantic records from Stehmann and Krefft (1988). ZMH male from off Uruguay re-measured in 2015. ***: inner pelvic margin completely fused with outer margin clasper to nearly clasper tip; n.a.: not applying

Coll. number Sex	AtlantNIRO 23075 Subadult male	RMNH. PISC.35639 Adult female	ZMH 114732 Adult male	SAM 23755 Juv. female holotype
TOT, total length (mm)	455.0	515.0	405.0	176.0
FOR, fork length	86.8	90.5	89.1	
PRC, precaudal length	78.5	82.1	79.5	78.3
PD2, pre-D2-length	61.5	64.1	61.8	59.6
PD1, pre-D1-length	37.4	40.0	38.7	40.6
HDL, head length	24.0	24.3	25.4	23.6
PG1, prebranchial length	17.8	17.6	20.0	19.9
PSP, prespiracular length	11.0	10.9	13.0	
POB, preorbital length	4.7	4.6	5.0	4.8
PP1, prepectoral length l./r.	21.9	22.1/22.9	23.9	24.7
PP2, prepelvic length	61.5	64.6	63.3	56.6
SVL, snout-ant. vent length	67.7	71.8	68.2	
IDS, interdorsal space	18.8	17.4	17.8	15.6
DCS, dorsal (D2)-caudal space	12.7	10.8	10.9	11.9
PPS, pectoral-pelvic space	38.9	42.0	37.8	34.1
PCA, pelvic-caudal space	9.1	9.4	8.6	9.1
VCL, ant. vent-C tip length	31.2	27.2	29.8	
PRN, prenarial length	1.8	1.2	1.8	1.1
POR, preoral length	8.4	6.0	9.0	9.3
EYL, eye length left/right	4.8	3.6/3.3	4.3	5.7
EYH, eye height left/right	1.1/1.2	1.4/1.3	2.4	2.6
ING, intergill length 1st-last slit	6.0	6.2/7.3	4.6	
GS1, gill slit 1 height (unspr. l/r)	2.4/3.1	2.8/2.9	2.4	3.3
GS2, gill slit 2 height	2.9/3.9	3.8/4.0	2.8	
GS3, gill slit 3 height	3.6/4.6	4.3/4.2	3.8	
GS4, gill slit 4 height	4.7/4.9	4.9/5.0	4.3	
GS5, gill slit 5 height	5.3/5.7	5.6/5.8	5.3	6.5
P1A, pectoral ant. margin length	10.0	10.5/9.5	10.6	9.7
P1B, pectoral base length	5.1	3.1/2.9	3.2	3.9
P1I, pectoral inner margin length	3.4	3.1/2.9	3.4	3.4
P1P, pectoral post. margin length	13.0	11.7/10.9	12.8	7.9
P1H, pectoral height base end to tip 10.3	10.3/10.4	11.1		
P1L, P length ant. base-post. tip	5.6	6.2/5.7	7.4	
CDM, dorsal C margin length	20.2	17.0	18.3	20.7
CPV, preventral C margin length	10.8	11.0	9.7	10.2
CPU, up. postventral C margin l.	6.3	7.3	7.7	
CPL, low. postventral C margin l.	5.7	4.7	5.4	
CFW, caudal fork width	6.2	7.1	7.5	
CFL, caudal fork length	9.5	9.1	9.6	
CST, subterminal C margin length	3.3	2.7	2.9	
CSW, subterminal C width	4.6	4.7	4.5	
CTR, terminal C margin length	5.4	4.7	5.3	
CTL, terminal C lobe length	6.3	5.4	6.4	
D1L, D1 total length	n.a.	n.a.	n.a.	
D1A, D1 ant. margin length	9.5	9.5	12.7	
D1B, D1 base length	4.0	5.9	6.4	6.3
D1 upper margin	4.2	3.2	5.5	
D1H, D1 vertical height	3.8	3.8	3.9	2.8
D1I, D1 inner margin length	n.a.	n.a.	n.a.	

Table I. – Continued.

Coll. number Sex	AtlantNIRO 23075 Subadult male	RMNH. PISC.35639 Adult female	ZMH 114732 Adult male	SAM 23755 Juv. female holotype
D1P, D1 post. margin length	6.3	5.8	5.9	
D2L, D2 total length	10.4	13.9	14.1	
D2A, D2 ant. margin length	9.0	10.7	12.3	
D2B, D2 base length	6.3	7.5	8.9	7.7
D2H, D2 vertical height	5.6	5.9	6.1	4.8
D2I, D2 inner margin length	4.5	5.6	5.4	
D2P, D2 post. margin length	5.7	6.5	6.9	
P2L, pelvic total length l./r.	11.0	11.2/11.7	12.5	
P2A, pelvic ant. margin length	6.4	6.2	6.5	7.4
P2B, pelvic base length	7.3	7.0	6.6	10.6
P2H, pelvic height = max. width	3.6	3.8	4.4	
P2I, pelvic inner margin length	***	3.9	***	
P2P, pelvic post. margin length	6.4	6.4	8.9	
HDH, head height at P origin	15.0	15.0	12.2	13.6
TRH, trunk height at P base end	13.2	14.8	13.0	
ABH, abd. height at D1 base end	9.9	11.7	11.3	
TAH, tail height end pelvic base	4.4	4.5	4.4	
CPH, C peduncle height at C orig.	2.9	3.0	2.7	
DPI, D1 midpoint-P base end	16.6	20.7	15.1	
DPO, D1 midpoint-pelvic origin	21.0	21.8	22.2	
PDI, pelvic midpoint-D1 base end	23.5	24.5	24.0	
PDO, pelvic midpoint-D2 origin	5.8	6.9	7.4	
MOL, mouth length (arc radius)	1.4	2.2	2.1	2.8
MOW, mouth width	8.6	7.0	6.9	8.5
ULA, upper labial furrow length	2.9	5.1	3.0	3.4
LLA, lower labial furrow length	0.7	n.a.	1.0	
NOW, nostril width	2.2	1.7	1.0	
INW, internarial width	3.6	4.1	4.0	4.3
ANF, ant. nasal flap length	0.5	0.5	0.2	
INO, interorb. space, integ./cartil.	6.2/5.3	7.1/5.5	7.2/5.1	8.6/...
SPL, spiracle length left/right	2.0/1.5	1.7/1.5	1.2	1.2
ESL, eye-spiracle space	2.4	2.9/3.1	2.7	4.1
HDW, head width midth gill slits	8.1	7.2	9.3	
TRW, trunk width at P base ends	8.6	6.9	8.7	
ABW, abd. width end D1 base	6.6	4.9	6.0	
TAW, tail width end pelvic base	2.7	2.7	2.9	
CPW, C peduncle width C origin	1.8	1.8	1.9	
CLO, clasper outer margin length	5.9	n.a.	5.1	
CLI, clasper inner margin length	5.4	n.a.	7.8	
CLB, clasper base width	1.6	n.a.	1.3	
Additional morphometrics:				167.5 mm TL
Snout tip to abdominal pouch	62.6	67.8	66.4	62.1
Origin abdom. pouch to tail tip	35.5	32.0	33.4	38.6
Head width at spiracles	9.8	8.2	9.3	11.8
Snout width at jaw angles	8.4	7.7	8.4	10.3
P-origin to level D1 origin	15.8	18.9	14.4	15.5
P-origin to level upper C origin	57.7	60.2	55.8	55.2
Length abdominal pouch	5.5	7.0	6.3	6.8
Clasper length behind abd. pouch	4.5/4.9	n.a.	5.4	
Pelvic-origin to clasper tip l./r.	13.7/14.4	n.a.	15.3	
Spiracle height left/right	1.5/2.2	2.1/1.9	1.7	2.0

Jaw dentition strongly heterodont (Fig. 6); upper jaw teeth with single awl-shaped long, slender and smooth-edged, sharply pointed cusp, somewhat curved towards jaw angles and becoming gradually more slender and shorter towards jaw angles; upper teeth set in 14+1+14 parallel rows in both specimens. Lower jaw teeth totally different in having a large, upright rectangular plate-like base bearing a high, broadly triangular wedge-shaped, smooth-edged cusp and an inner, small and short lateral cusp interlocking with next tooth; primary cusp height about two thirds that of base height; tooth bases interlocked with each other to form a continuous solid, sharp cutting edge of 14+1+14 teeth in both specimens, but cusps broken off in median rows: The entire dentition design is typical for oceanic, so-called cookiecutter dalatiid sharks.

Vertical gill slits (Fig. 4 A, B) long, their upper ends almost level with lower edge of eye, their lower ends more or less level with pectoral fin base; length of gill slits markedly gradually increasing from first to fifth, the latter about twice as long as first one, overlapping pectoral fin base completely and extending to below pectoral base onto belly edge; edges of gill slits more or less wavy, some with irregularly placed short, triangular process in lower half marked white at two left slits of female (possibly artefacts of former parasite infection); gill flaps covered with dermal denticles to their extreme edges.

Small, paddle-shaped pectoral fins inserting low on body flanks about level with jaw angles, with narrow vertical base covered by lower third of long fifth gill slit; pectoral with bluntly rounded posterior tip; anterior margin long and straight, posterior margin even longer, strongly and evenly convex; inner posterior margin weakly convex, short, only a little longer than fin's base; lower pectoral edges overlapping on belly surface (Fig. 2B).

The two dorsal fins are of different shape and size (Figs 1, 2, 7), the second larger than the first one. Origin of first dorsal far posterior on body much behind pectoral tips at about 40% of the distance from pectoral to pelvic origin; first dorsal is short-based, rectangular fan-shaped, inclined rearward at about 45° angle, and its apex widely overhangs base end with about 1.5 times the base length; the straight to weakly convex anterior margin continuous with rounded upper margin; straight posterior margin parallel to anterior margin and ending with the fin's base end; second dorsal fin in contrast, so to speak, of "normal shape"; its origin very posterior on body a little anterior to pelvic fin origin, and its base 1.3-1.6 times longer than base of first dorsal; anterior margin straight, rising at about 45° angle to narrowly rounded upper tip which somewhat overhangs second dorsal base end; posterior margin sloping concavely to the end of the horizontal free inner margin, which is nearly as long as the fin's base length and terminating in a sharply pointed tip.

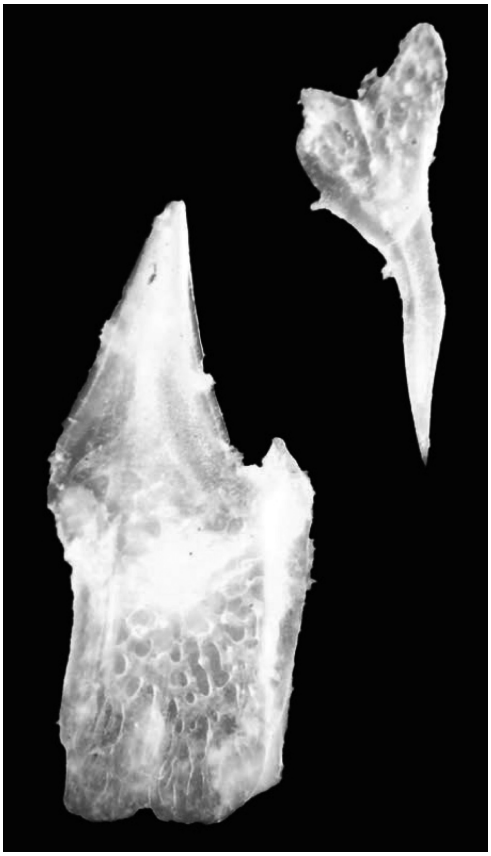

Figure 6. – *E. zantedeschia* female, 515.0 mm TL, RMNH. PISC.35639, upper (right) and lower jaw (left) individual teeth. Light microscope magnification. Natural vertical height of upper tooth 4.1 mm, of lower tooth 5.9 mm.

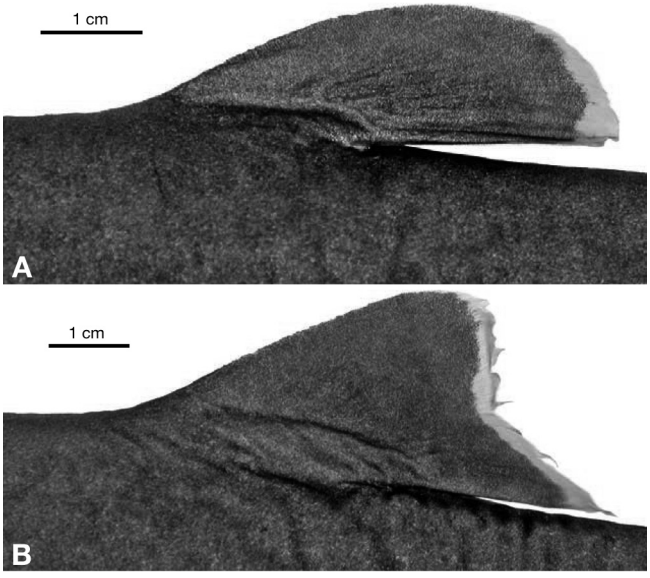

Figure 7. – *E. zantedeschia* female, 515.0 mm TL, RMNH. PISC.35639. **A**: First dorsal fin; **B**: Second dorsal fin. Lateral views.

Interdorsal space very long, about 4-5 times the base length of first dorsal.

Pelvic fins origin nearly level with second dorsal origin; pelvics triangular in their anterior half, with broadly rounded outer corner, almost straight anterior, weakly concave posterior margin anteriorly; posterior margin abruptly narrowing after a deep indentation and terminating as a pointed tip; the latter is longer in the male and totally fused with outer edges of claspers for about three fourth of clasper length, which is in ventral view about equal to the abdominal pouch length (Fig. 8A) but is free and extending only little beyond posterior end of abdominal pouch in the female (Fig. 8B).

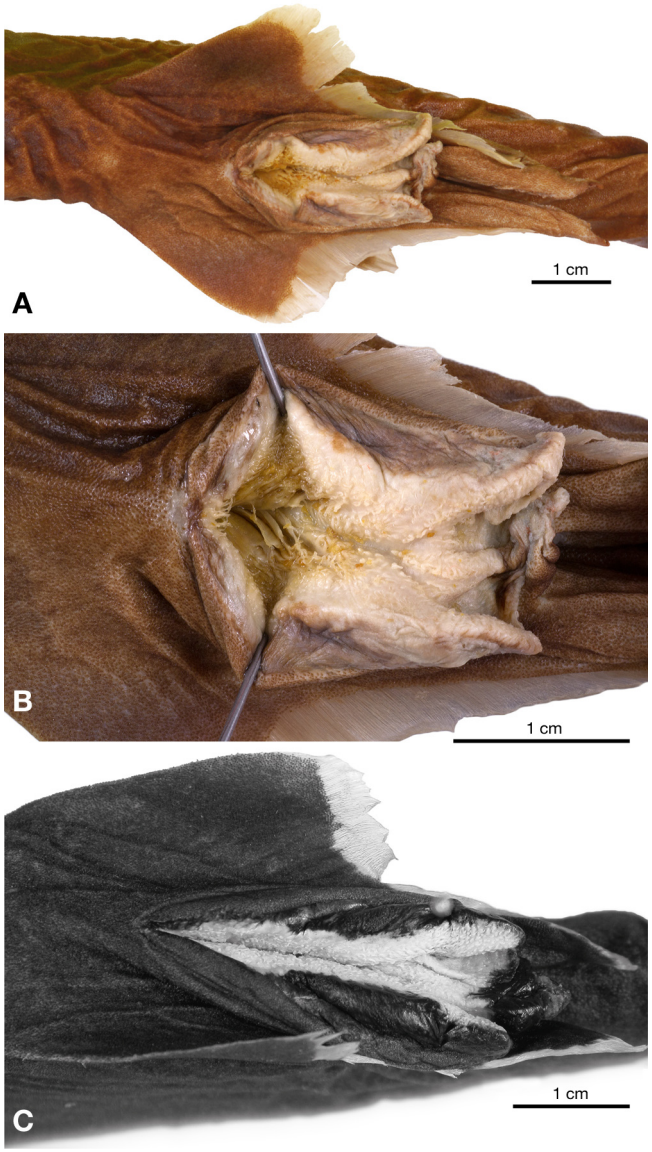

Figure 8. – *E. zantedeschia*. **A, B**: Male, 455 mm TL, AtlantNIRO No. 23075. A: Ventral views of pelvic fins with claspers and opened luminous pouch; B: Close-up of widely opened luminous pouch. **C**: Female, 515.0 mm TL, RMNH.PISC.35639. Pelvic fins with opened luminous pouch.

Abdominal luminous pouch prominent and long, about half as long as pelvic fin in the male, about two thirds in the female. In the male (Fig. 8A), the pouch originates somewhat anteriorly to maximum pelvic width and extends a little beyond inner insertion of claspers; however, due to shrunken condition and wrinkled skin, the origin of the pouch anterior of the opening splitting cannot be defined as precisely as in the female; completely scaled bulbous outer pouch walls narrowing in posterior half of pouch as in the female to give space for two unscaled, elongated pads being the inner pouch walls and extending to the end of the pouch; as in the female, the pouch groove terminates with a greyish, median unscaled small pad and a transverse skin fold. In both specimens, interior of the pouch is light coloured and densely covered with rather fine villi becoming longer and thicker toward the anterior blind end of pouch (Fig. 8A, C). In the female (Fig. 8B), the pouch originates as flat, wedge-shaped median ridge somewhat posterior to pelvic origin, the bilobed opening of the pouch beginning about level with one third pelvic base length, with the prominent, scaled outer walls being in contact in anterior one third pouch length but splitting apart in posterior two thirds; outer pouch walls strongly narrowing in posterior pouch half to become just outer pouch edges, so giving space for scaleless, smooth inner bulbous walls of blackish brown colour; pouch terminating between rear ends

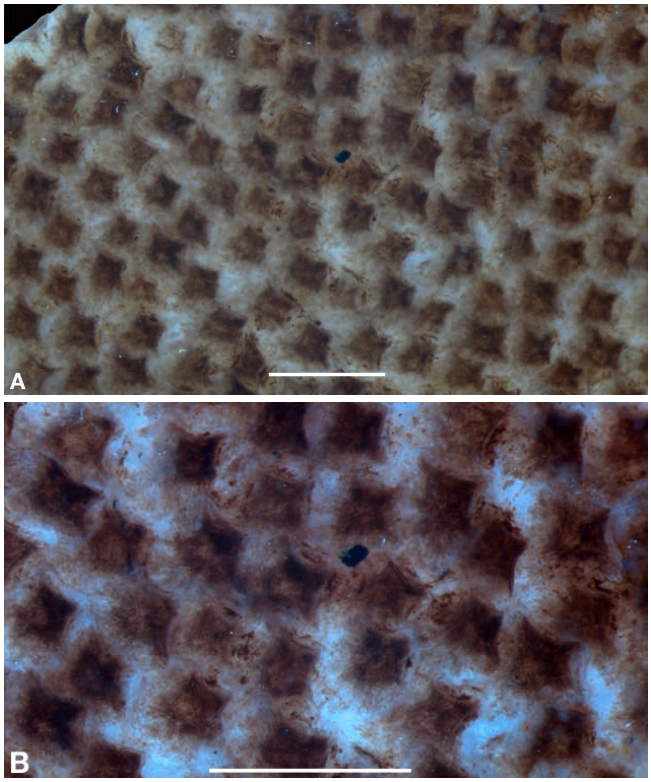

Figure 9. – *E. zantedeschia* female, 515.0 mm TL, RMNH. PISC.35639. **A**: Dermal denticle coverage; **B**: Close-up. Scale bars: 500 μm.

of inner walls with a medially transverse blackish, fleshy pad overhanging inner walls ends a little anterior of pelvic tips. Cloaca of female small, above abdominal pouch about level with pelvic posterior margin indentation, or level with half length of inner pouch walls. Small cloaca of male between insertion of claspers above abdominal pouch.

Caudal peduncle rather long, compressed subrectangular in cross-section; its length less than pelvic fins total length; its dorsal surface weakly rounded, with very shallow median groove; ventrally, a distinct median dorsal ridge from cloaca over three fourths peduncle length and becoming in posterior fourth a shallow groove to lower caudal origin; as in the ZMH male, no lateral keels were found in the Chilean specimens, which were described for the holotype.

Caudal fin (Figs 1, 2) large and elongated, with distinct ventral lobe which is about twice as deep as dorsal lobe; precaudal pits absent. Lower caudal lobe triangular, with straight anterior margin, rounded tip and weakly concave posterior margin which extending upward after about 90° angled concavity much narrower to marked subterminal notch; terminal caudal lobe broadly truncate, with vertical rear margin. Upper caudal lobe much lower than ventral lobe, and with evenly convex margin to tail tip; dorsal caudal edge not showing enlarged dermal denticles.

Squamation (Fig. 9A, B)

Head, body, tail and all fins covered totally and densely with fine, minute dermal denticles, including outer walls of abdominal pouch and both surfaces of claspers, except for the narrow posterior pelvic fin margin of free ceratotrichia being fused to outer dorsal edge of claspers to nearly their tips; interior of labial furrows devoid of dermal denticles. Leading edges of fins a bit more hardened by more closely set and a little imbricated dermal denticles, which are also more closely set but not overlapping with their bases from lower flanks onto belly, where tiny photophores are intermingled more or less densely. Gill slits scaled to their outer edges, but interior surface smooth as also mouth cavity and gums.

Morphology of regular dermal denticles as described and illustrated by SEM-photographs by Stehmann and Krefft (1988: fig. 9a, b) for the holotype and ZMH male; individual dermal denticle subrhomboid, with flat crown with a large, shallow central depression and distinct oblique ridges sloping from all four corners; only dermal denticles around mouth, particularly on upper and lower lips, modified to possess an awl-shaped cusp inclined or curved somewhat towards mouth.

Colour (Figs 1, 2)

The Chilean male shows a certainly somewhat faded colour after some 30 years storage in formalin. It is plain medium brown, with fins distinctly darker brown but all fins with semi-transparent more or less broad creamy-white, frayed margins by free ceratotrichia. Ventral surface somewhat darker than flanks and back of body. Mouth cavity and gums white, as well as interior of gill cavities, but edges of gill flaps brown. Outer walls of abdominal pouch brown, interior creamy-white to light orange (Fig. 8A); posterior half externally greyish and devoid of dermal denticles. Claspers light brown.

The more recently sampled Chilean female is more or less uniformly dark greyish-brown, without apparent dark collar. All fins also with semi-transparent whitish and frayed margins of free ceratotrichia: at pectorals, narrowly along outer half of posterior margin and at outer corner; at first dorsal, broadly along short upper margin; at second dorsal, broadly from upper tip along posterior margin including free rear tip; at pelvics, broadly at outer posterior margin but after angular indentation very narrowly along inner posterior margin to tip; at caudal fin, narrowly from ventral tip along entire ventral posterior margin, and broadly at terminal margin. Interior of gill cavities white to freckled light brown; externally only on left side, a whitish marked, short and pointed integumental process at lower margins of third and fourth gill slits, possibly artefacts of former parasite infection; lower pectoral base edged white as the interior of fifth gill slit overlapping pectoral base. Pectorals in outer two-thirds blackish-brown, darker than sides of body, likewise so for pelvic and caudal fins. Head anterior to spiracles and throat at level of pectorals somewhat darker dusky-brown. Iris of eyeball golden-yellowish. Interior of nasal cavities whitish, as well as interior of long upper labial furrows. Jaws, gums and interior of mouth cavity white, likewise interior of spiracles including pseudobranchial folds. Underside of snout, throat, belly region and underside of caudal peduncle blackish-brown, darker than flanks of body due to tiny blackish photophores distributed rather densely between the minute dermal denticles. Bulky outer walls of prominent abdominal pouch dark brown as entire ventral surface; sharply marked border between outer dark and inner whitish surfaces along inner edges of both pouch walls (Fig. 8C). Pale cloacal aperture above abdominal pouch.

Clasper

Both claspers of the Chilean male with not yet fully calcified skeleton and still a bit flexible; claspers solid rod-shaped but their tips abruptly narrowing and pointed (Fig. 8A); outer clasper surfaces dorsally and ventrally densely set with dermal denticles to the extreme tip, except for the smooth whitish outer margin of pelvic fin extending to nearly clasper tip; inner components of opened terminal region as illustrated by Stehmann and Krefft (1988: fig. 8b), *i.e.* with ridge-like axial cartilage about medially along entire terminal region, a long knife-blade-like fibro-cartilage along proximal two thirds of terminal region; a thick fleshy wall within a shallow

cavity about as long as and ending level with free rear tip of dorsal fibro-cartilage, with a transverse fold at proximal end over an integumental blind-ending cavity resembling clasper component 'slit' in rajiform skates following classification in Weigmann (2016).

Internal meristics of male and female

Total monospondylous trunk vertebrae 45/46, thereof pre-first dorsal origin 18/22, pre-second dorsal origin 38/40; total diplospondylous caudal vertebrae 35/40, thereof pre-lower caudal 12/12, pre-upper caudal 13/13; total vertebrae 80/86.

Tooth row and vertebral counts by Stehmann and Krefft (1988) for the holotype female/ZMH mature male were: 13+1+13/14+1+14 upper, 18+1+18/17+17 lower jaw; total vertebrae 78/86, of which 46/46 monospondylous trunk vertebrae, pre-lower caudal origin 57/58, terminal vertebrae 21/28.

Pelvic girdle (Fig. 10)

It is the other most significant generic diagnostic character and associated with the likewise unique one of the luminous abdominal pouch. Stehmann and Krefft (1988: fig. 12), based on a pelvis part-dissection of the mature Uruguayan male (ZMH 114732 = ex ISH 701/76), illustrated the among all sharks very extraordinary shape of the pelvic girdle with a narrow, subrhomboidal basal plate with a central large foramen ventrally, into which two dorsal inner foramina open, with their farther dorsal apertures opening each to the anterolateral faces of the pelvis' basal element; its posterolateral faces are shortly extended obliquely rearward and provide the articulation with the basipterygia of both pelvic fins. Dorsally, the pelvis' basal plate is extended as a huge, median, rearward curving process bent around the anterior end of the abdominal pouch, and with its horizontal, rearward pointing, gradually much more slender becoming part over the whole length of the abdominal pouch supporting its dorsal bottom.

The coauthors have taken of the RMNH female CT-scans of the pelvic girdle providing a better visualization of its extraordinary shape in various views (Fig. 10A-C), and X-rays also depict the pelvis and its rearward curving process well. If compared with fig. 12 in Stehmann and Krefft (1988), the RMNH female pelvic girdle looks somewhat different, in that the basal part of the dorsal process appears to be split into two clasps becoming fused dorsally at the point, where the process curves horizontally rearward as a single median pointed rod; furthermore, in lateral view a posteromedian process appears to rise from the basal plate and connect with the tip of the horizontal part of the process to support the latter's free tip. This process was not seen in the ZMH male from off Uruguay, what however may be due to the only part-dissection of its pelvis; as was said in

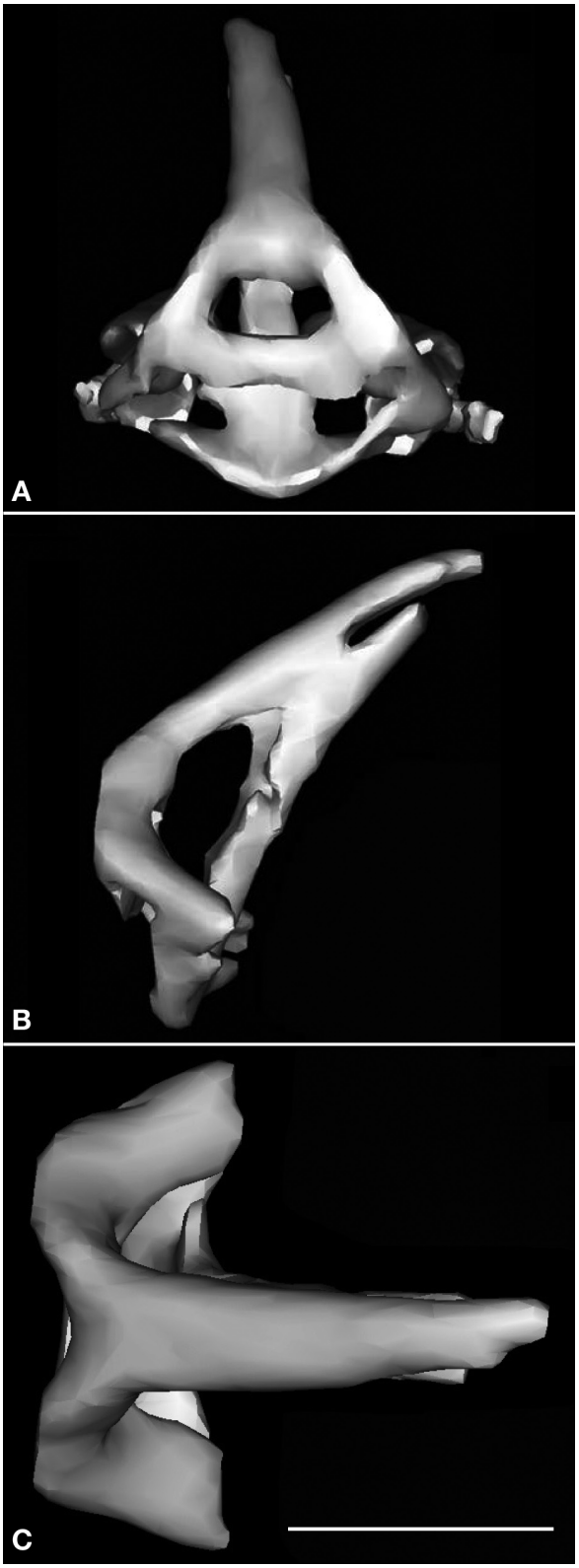

Figure 10. – *E. zantedeschia* female, 515.0 mm TL, RMNH. PISC.35639, three-dimensional CT-scan photos of the pelvic girdle. **A**: Anterior view; **B**: Lateral view; **C**: Dorsal view. B, C: Anterior left. Scale bar = 10 mm equal for A-C.

Figure 11. – *E. zantedeschia* female, 515.0 mm TL, RMNH. PISC.35639, light blue luminous fluid squeezed out manually on board from luminous pouch of the freshly caught specimen.

Stehmann and Krefft (1988: 19), the horizontal part of the median process was not yet calcified (which is why it did not show on X-rays) and the pelvic girdle on purpose not dissected entirely to avoid more damage to this second known specimen; hence, an anterior view (to discover the two basal branches of the process) and total lateral view were not possible, which is why also the posteromedian additional process connecting with the tip of the horizontal part could not be seen. A possible sexual dimorphism may exist, in that in the ZMH male the horizontal posteromedian process part appears to be longer than in the RMNH female, in which this process also appears to not strongly curve into a horizontal position but is obliquely semi-erect.

DISCUSSION

Obviously, *E. zantedeschia* is an oceanic pelagic shark of the cookiecutter type, according to its dentition, and inhabiting epi- to mesopelagic depths also far offshore. Its distribution may be much wider in the Atlantic and Pacific oceans, possibly also in the Indian Ocean, than indicated by the only four so far known records. Like the related *Isistius plutodus* Garrick & Springer, 1964, *E. zantedeschia* appears to be rare and living rather solitarily, quite unlike the well-known more common and schooling cookiecutter shark *I. brasiliensis* (Quoy & Gaimard, 1824) see *e.g.* Springer and Gold, 1989. However, the possession of the huge abdominal pouch gland, capable of ejecting a light blue luminous fluid (Fig. 11), is unique among sharks and indicates that *E. zantedeschia* normally lives rather deep and/or occurs at shallower depth only during night time when following the upward moving scattering layers for feeding. So far, the preferred prey is not yet known for sure, whether it is larger invertebrates such as, *e.g.* squids, or bony fishes or marine mammals as in other cookiecutter shark species (Strasburg, 1963; Le Boeuf *et al.*, 1987). Radiographs of the RMNH female depicted four relatively large circular items within the intestinal tract, which might be squid eye lenses.

Dorsal fins are of equal shape in most shark species but may often differ in size. Among dalatiid sharks, however, a peculiarity is found in several genera with the shape of the first dorsal fin being markedly different from that of the second dorsal fin. Extreme examples are *Euprotomicrus bispinatus* (Quoy & Gaimard, 1824) and *Squaliolus laticaudus* Smith & Radcliffe, 1912, another one is *Isistius plutodus* (see Stehmann and Kukuev, 2015) and likewise *Euprotomicroides zantedeschia*. In both the latter genera/species, the first dorsal fin is fan-shaped and smaller as compared with the second dorsal fin. It may be a matter of interpretation and discussion how to characterise the differing shape of the first dorsal fin, but following the view of Stehmann and Kukuev (2015) for *I. plutodus*, we interpret here the same for *E. zantedeschia*: first dorsal fin is subrectangular shaped, lacks a defined upper apex as the second dorsal, but shows instead a short rounded upper margin being continuous with the anterior margin; the posterior margin runs almost parallel with the anterior margin, and a free inner margin terminating in a pointed tip is absent. For that reason, morphometrics in table I provide for the first dorsal values for "upper margin length" and no values for "free inner margin" and "total length", in contrast to second dorsal.

As the Chilean presumably mature female at RMNH is the only female to compare with the two mature / nearly mature males from off Uruguay and Chile, comments on possible sexual dimorphism must remain rather speculative, whether morphology and size of jaw teeth, or size and density of dermal denticles and even morphology of the pelvic girdle (see above) are concerned. Likewise should the interpretation of morphometrics be seen with reservation, because the Chilean male values are partly somewhat weak and approximations rather, due to its squashed snout and distorted body. It also has to be taken into consideration that the South African holotype is a somewhat damaged, small

female, morphometrics of which are hardly precisely comparable with the other three much larger specimens. Even for the latters, it has to be considered that their condition is not equally good because of their individual distant capture years and, accordingly, their much different storage period in formalin or 70% ethanol preservation having eventually resulted in shrinkage of different degrees. Hence, details of their morphometric differences should not be overestimated, particularly not those concerning body height, width and circumference at defined positions. However, altogether shape, morphometrics and meristics of the new Chilean records are well in accordance with the two Atlantic specimens, and no significant differences are apparent between the former and the latter two specimens.

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