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## CEPHALOPODS FROM THE NETHERLANDS INDIAN OCEAN PROGRAMME (NIOP)- I. *CHIOTEUTHIS SPOELI* N. SPEC. AND *CHIOTEUTHIS PICTETI SOMALIENSIS* N. SUBSPEC.

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### ABSTRACT

Two new squids from the western Indian Ocean acquired during the Netherlands Indian Ocean Programme (NIOP) expeditions in 1992-1993 are described. The species new to science is *Chiroteuthis* (*C.*) *spoeli*, member of the subgenus *Chiroteuthis* *s.str.*, which differs from the type species *Chiroteuthis* (*C.*) *joubini* chiefly in the enlarged suckers on arm II and III and the tentacular sucker morphology. The new subspecies is assigned to the subgenus *Chirothauma* in the species *Chiroteuthis* (*C.*) *picteti* and defined as *Chiroteuthis* (*C.*) *picteti somaliensis*, and is characterized by the sharp teeth in the arms. The genus *Chiroteuthis*, as now defined, consists of 2 subgenera, 7 species and 4 subspecies.

### INTRODUCTION

The genus *Chiroteuthis* is one of the few bathypelagic squids that still need to be properly characterized. The first chiroteuthid originally belonged to the same family as a histioteuthid because of their close general resemblance, such as the short mantle and large armature, but was made into an independent family by Pfeffer (1900). Thus, *C. veranyi*, described by Férussac in 1834, was the first member of the genus

defined by d'Orbigny (1841). Chun (1910) attempted the first revision, defining 4 species. He considered *C. lacertosa* Verrill, 1881 synonymous with *veranyi* Férussac, 1834. The other 3 species, *C. picteti* Joubin, 1894, *C. macrosoma* Goodrich, 1896 and *C. imperator* Chun, 1910 are closely related and were organized under his subgenus *Chirothauma*. Pfeffer (1912) then organized *Chiroteuthis* into 5 subgenera and 13

species, 6 of them dora-topsis forms. A species from South Africa, *C. capensis* Voss, 1967, added more variations to the poorly known family. Roper et al., (1969) rearranged *Chiroteuthis* and *Mastigoteuthis* into 2 different families as proposed by Verrill (1881), an arrangement that had been previously rejected by Jatta and Joubin, who preferred a subfamilial division (Chun, 1910). Young (1972) attempted his first revision, mentioning 8 species and indicating that *picteti*, *macrosoma* and *imperator* are related and distinguished by the 3 rows of photophores on the eyeball. He defined *C. calyx* and associated his species with *C. capensis* Voss and *C. atlantica* (MacDonald & Clench), because of the 2 stripes on the eyeball. But the most closely related species to *calyx* from California were *C. veranyi* (Férussac), and *lacertosa* Verrill. Nesis (1987) designated 5 species and 2 subspecies, considering *C. picteti* Joubin the valid species and *C. imperator* and *C. macrosoma* its synonyms. He considered *C. capensis* Voss, which lacked ink sac photophores, a senior synonym of *C. atlantica* (MacDonald & Clench). He divided *C. veranyi* (Férussac) into 2 subspecies, *veranyi veranyi* (Férussac) and *veranyi lacertosa* Verrill. Another 2 species, *C. calyx* and *C. joubini*, are closely related to *C. veranyi*, but clearly distinguishable by the tentacle morphology, *C. calyx* by the size of the arm suckers, and *C. joubini* by the arrangement of the photophores in the eyeball and the ink sac. In his second revision, Young (1991) outlined the doratopsis group and the chiroteuthid lineage. Contrary to Nesis (1987), he considered *C. imperator* a valid species, and described its paralarval and juvenile stages, and also defined an unnamed new species from Hawaii related to *C. joubini*.

In the present study, material from the western Indian Ocean, and the re-examination of the type specimen of *Chiroteuthis capensis* Voss and of reference collections, provided the information to improve the characterization of some of the species members of the genus *Chiroteuthis*, and to define a new species and a new subspecies.

Characterization of the two subgenera of *Chiroteuthis* and their species will lead to their better identification in the Indo-Pacific region, since there is a strong possibility that undescribed species and subspecies for both subgenera exist in these and other oceans.

## MATERIAL AND METHODS

For the present study, chiroteuthid specimens from the NIOP collection (Salcedo-Vargas, 1994) were examined and the sampled area is indicated in fig. 1. In addition to the material examined from the western Indian Ocean, other reference specimens were studied at the Zoological Museum of Amsterdam (ZMA), the Netherlands. Material from Japan consisted of Dr. Madoka Sasaki's collection (The University Museum, The University of Tokyo). Additional material from the Royal Institute of Natural Sciences of Belgium (IRSNB), Brussels, and from the South African Museum (SAM), Cape Town, was also examined. Of the 38 specimens examined, 7 come from the Netherland Indian Ocean Programme (NIOP) collection and are diagnosed and compared with the nominal species by contrasting the major taxonomic characters.

*Definitions:* *Mantle:* The mantle is divided into 3 parts. The muscular-mantle (MM) is the area between the anterior margin of the mantle and its distal point where the pseudoconus starts. The vesiculated-mantle (VM) is the narrow area usually supported by the fins, and covers the pseudoconus with vesiculated tissue, which is usually lost in paralarval and juvenile specimens. The tail is the extension, normally broken, of the gladius beyond the vesiculated-mantle fins insertion. (fig. 2A-B) *Gladius:* The conus of the gladius is characterized by 3 levels (fig. 2C): level-A is the anterior fins-mantle insertion point; level-B is the middle point between both insertions; and level-C is the posterior fins-mantle insertion point (fig. 2D). The dorsal keel is the structure formed by the narrow section of the vane, mainly in Levels A, B and C in cross section views. The conus field is the wall which gives form to the conus. The hard transparent tissue is the internal component of the pseudoconus that supports the walls of the pseudoconus field: its formation starts at Level-B, but in Level-C an internal cavity still remains. *Arms:* The half-scabard-like extension (fig. 2E) is the lateroventral extension in which the tentacle rests on arm IV of some bathypelagic species. It is homologous to the tentacular pocket in other cephalopods. The club-area (club in other decapods; fig. 2G) is the distal part of the tentacular arm which bears the suckers and sometimes

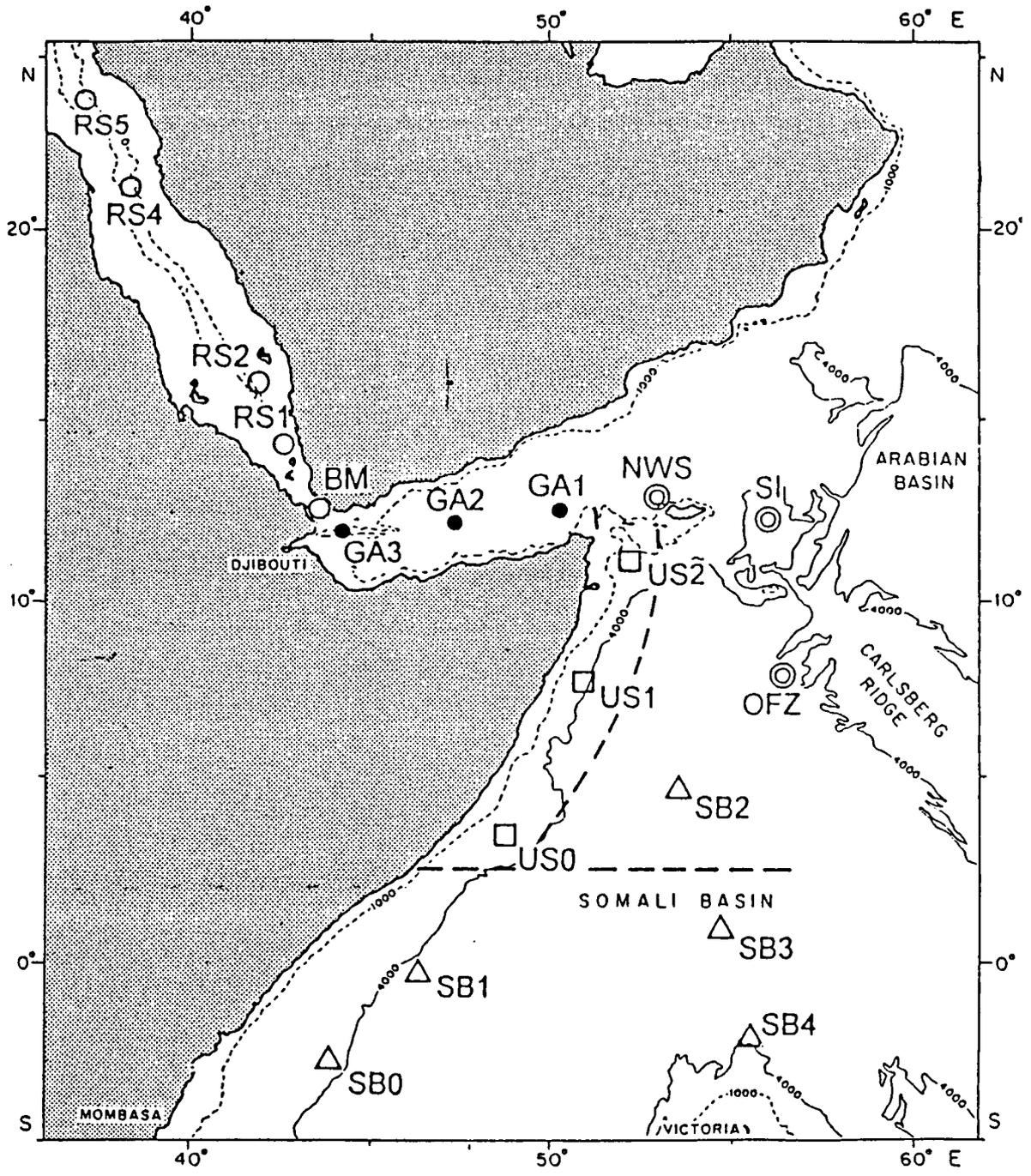


Fig. 1. RMT8 stations of the R/V *Tyro* during the cruises in 1992-1993. Dashed lines indicate the border of the areas used for pooling data. Abbreviations: RS=Red Sea; BM=Bab-el-Mandab; GA=Gulf of Aden; US=Upwelling Somalia; NSW=NW of Socotra; SI=Socotra Island; OFZ=Owen Fracture Zone; SB=Somalia Basin.

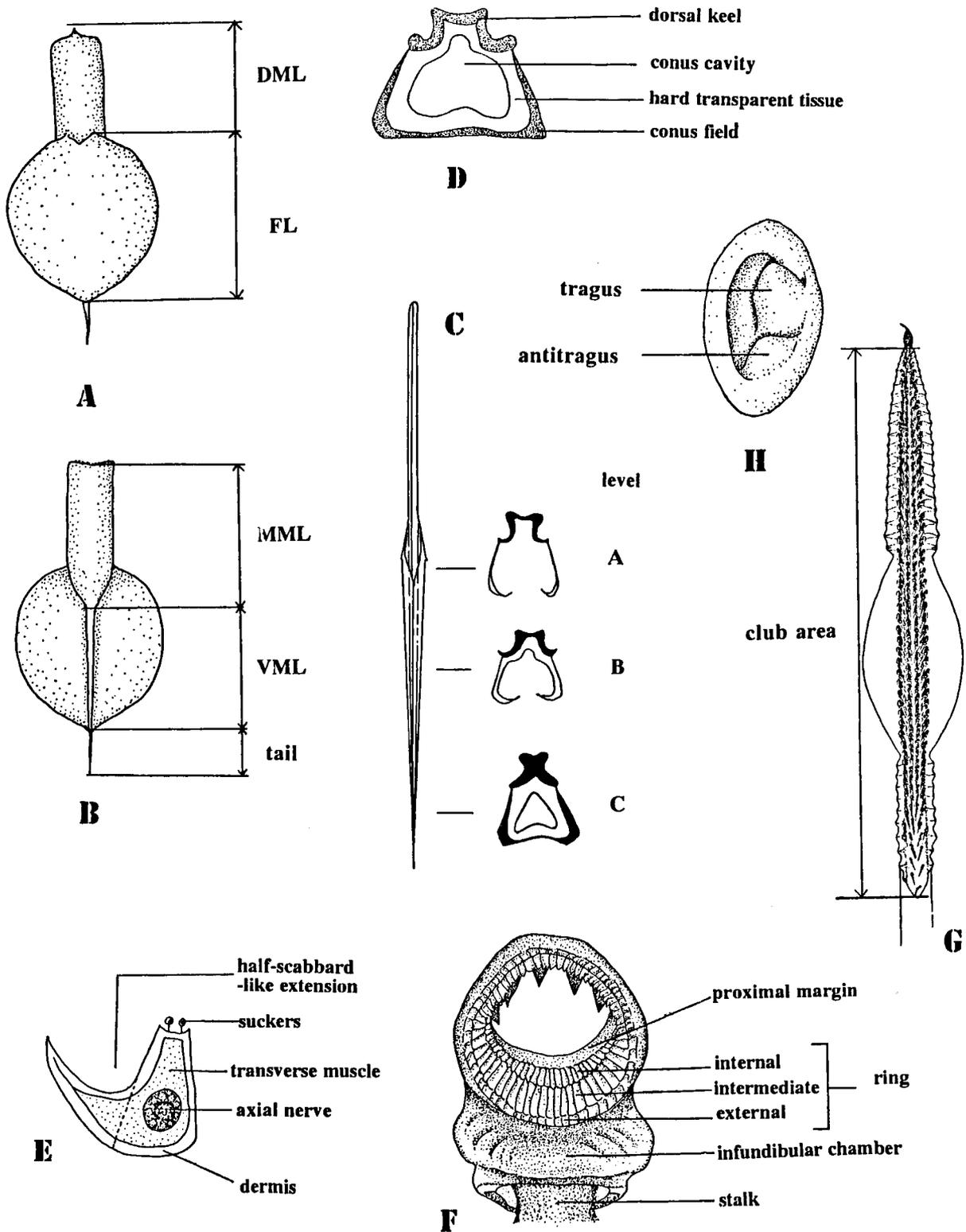


Fig. 2. Measurements and Terminology. A: DML=Dorsal Mantle Length, FL=Fin Length; B: MML=Muscular-mantle Length, VML=Vesiculated-mantle Length; C: Gladius, pseudoconus levels in cross section; D: Cross section of Level-C; E: Cross section of arm IV; F: Tentacular sucker; G: Club area; H: Funnel cartilage.

develops protective membrane and trabeculae. The dactylus, carpus and manus are not clearly defined or not developed in this genus. *Sucker morphology*: The veil is an extension of the infundibular ring into the acetabular cavity in arm suckers. The infundibular ring (formerly known as the horny ring, inner ring or chitinous ring), is located on the infundibulum, and it generally bears several types of protrusions, called teeth or denticles. The infundibular chamber (fig. 2F) is the modification of the infundibular ring when a chamber of horny material develops inside the acetabulum, and mostly develops in specific "sucker types" (hooked, cushioned, or in tentacular suckers of bathypelagic cephalopods). The papillated ring (formerly called the inner ring), is located on the periphery of the infundibulum and is in close contact with the infundibular ring. The papillated ring consists of a series of 3 to 8 independent rings. Each ring is formed by structural units defined as polygonal processes. The 3 sub-rings of the papillated ring can be named as follows: the one in contact with the infundibular ring can be called the internal ring; the one or more between the sub-rings are called the intermediate ring(s); and the one in contact with the rim the external ring. (For detailed description and illustrations see Salcedo-Vargas, 1995).

*Abbreviations*: DML: Dorsal Mantle Length; VMML: Ventral Muscular-mantle Length; VVML: Ventral Vesiculated-mantle Length; TaL: Tail Length; FCL: Funnel Cartilage Length; NCL: Nuchal Cartilage Length; MW: Mantle Width; FL: Fin Length; FW: Fin Width; ALI: Arm Length Index, I to IV; TL: Tentacle Length; CL: Club-area Length; HL: Head Length; HW<sub>1</sub>: Head Width (ventrally); HW<sub>2</sub>: Head Width (laterally); ED: Eye Diameter. I: In all cases means Index, the figures in brackets are the real measurements in mm. (Roper & Voss, 1983).

The terms defined above and the key taxonomic characters of the taxa described from the NIOP collection are illustrated in Figs. 2–5. Their measurements, indices, and data are indicated in Table 1.

## TAXONOMY

Genus *Chiroteuthis* d'Orbigny, 1841

*Chiroteuthis* d'Orbigny, 1841: 325; Verrill, 1881: 102; Chun, 1910: 187; Pfeffer, 1912: 554; Young, 1972: 69; Nesis, 1987: 241; Roper & Sweeney, 1992: 173.

*Diagnosis*: Body short to large, mantle conical to cylindrically shaped; vesiculated, soft and smooth; fins nearly circular; eyes large; funnel small; funnel cartilage ear-like, with tragus and antitragus; photophores on ventral side of eyeball; arms long, arm IV longest, longer than ML; tentacle whip-shaped with glandular knobs along stalk; club-area symmetrically trabeculated; one large photophore in tip of club-area; iridescent tissue or pair of photophores on ink sac; tentacular suckers in 4 rows.

*Type species*: *Chiroteuthis veranyi* (Férussac, 1835).

*Type locality*: North Atlantic.

*Type depository*: No longer extant (M. Sweeney, NMNH, Smithsonian, pers. comm.).

Subgenus *Chiroteuthis* d'Orbigny, 1841 s. str.

*Chiroteuthis veranyi* Férussac, 1835: pl. 65, figs. 1-10; Chun, 1910: 240, 243, 244, 252, 253, 257, 281, pl. 40, fig. 1, pl. 42, fig. 5, pl. 44, figs. 1, 2, 4, 5; Pfeffer, 1912: 594-606, pl. 44, figs. 1-4, pl. 45, figs. 1-4; Young, 1972: 135, pl. 21, fig. C; p. 137, pl. 22, figs. L, M.

*Chiroteuthis veranyi lacertosa* Verrill, 1881: 107, pl. LVI, fig. 1; Pfeffer, 1912: 607-608; Chun, 1910: 281-283.

*Chiroteuthis lacertosa* Joubin, 1933 non Verrill: 26-30, text figs. 23-29.

*Chiroteuthis joubini* Voss, 1967: 79, pl. 5, fig. H; Nesis & Nikitina, 1984: 145-153, text figs. 1-3.

*Chiroteuthis calyx* Young, 1972: 69-72, pl. 21, figs. A, B, pl. 22, figs. A-K, except L, M.

*Diagnosis*: Body short to medium; mantle tapering gradually, without swollen part in end of fin mantle-insertion; tail small; club-area bordered symmetrically with small trabeculae; wide trabeculated part or fin-like, non-trabeculated membrane present in first third of club-area; sucker stalk thick and cylindrical, thinner stalk

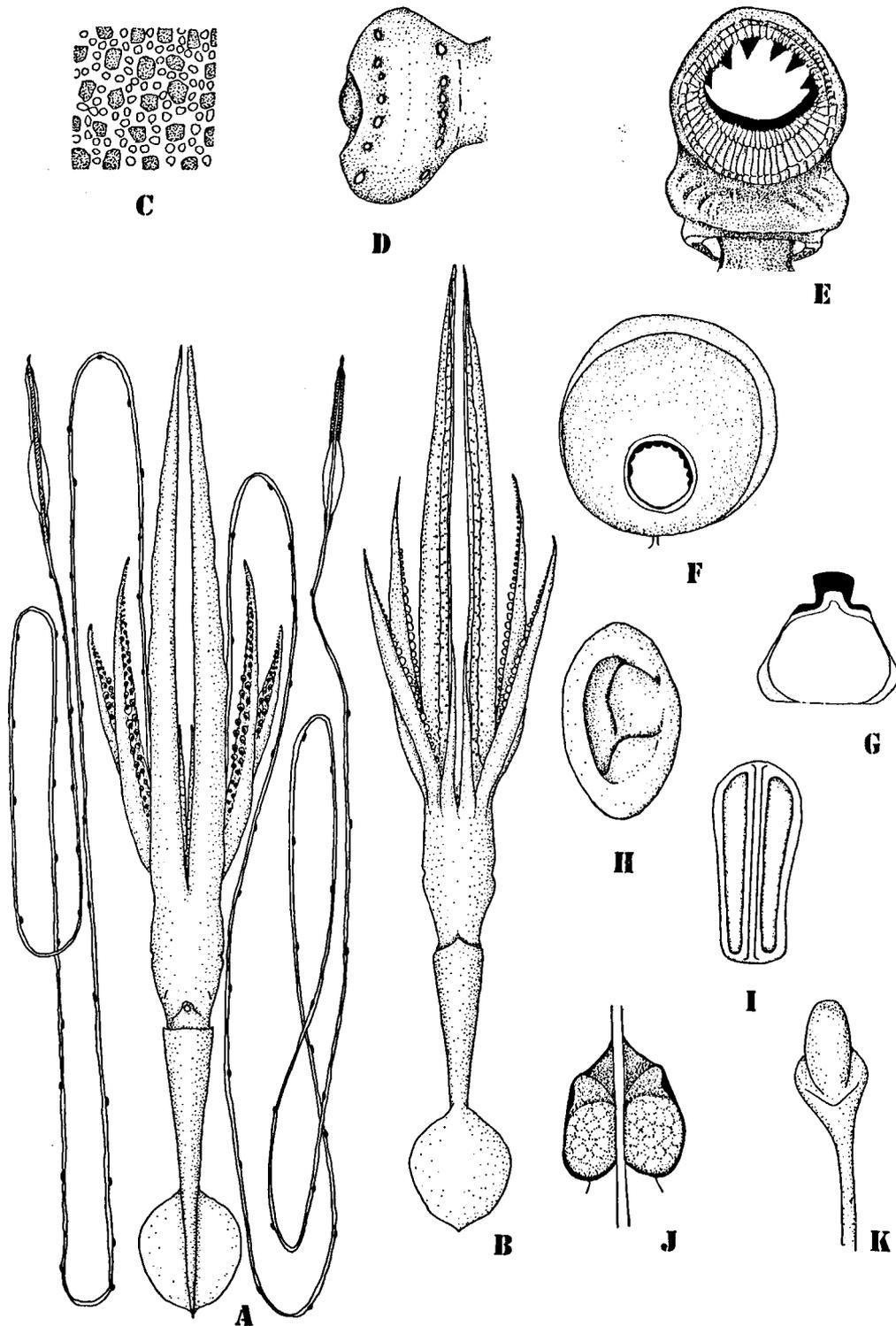


Fig. 3. *Chroteuthis (Chroteuthis) spoeli* n. spec. Holotype. 85 mm ML, No. 663, Sta. SB2. A: Ventral view; B: Same specimen, dorsal view; C: Chromatophore pattern; D: Eyeball, 13 mm and luminous organs arrangement; E: Tentacular sucker, 0.4 mm; F: Arm III, fifth row sucker, 3.5 mm diameter; G: Leve-C of pseudoconus; H: Funnel cartilage, 3.5 mm; I: Nuchal cartilage, 7 mm; J: Photophores on the ink sac, 5 mm; K: Olfactory papilla, 3 mm.

that bears suckers protrudes from skirt, cup or ring-like thickened section; large sucker in arms II and III in some species; 2 stripes or rows of photophores on eyeball; 1 or 2 photophores on ink sac.

*Type species: Chiroteuthis veranyi* (Férussac, 1835).

*Type locality:* North Atlantic.

*Type depository:* No longer extant.

**Chiroteuthis (Chiroteuthis) joubini** (Voss, 1967)

*Chiroteuthis lacertosa* Joubin, 1933 non Verrill: 26-30, text fig. 23-29.

*Chiroteuthis joubini* Voss, 1967: 79, pl. 5, fig. H; Nesis & Nikitina, 1984: 145-153, text fig. 1-3.

*Diagnosis:* Mantle tapering gradually; 10-14 eyeball photophores of unequal size arranged in 2 rows; funnel cartilage ovate, protruding tragus and well-developed antitragus; club-area divided in 3 by oval, fin-like, non-trabeculated membrane, except for its proximal end where some trabeculae are evident; tentacular suckers have 6 sharp teeth of similar size; tentacular suckers on dark and thick stalk, narrowing distally; proximal arm suckers have obtuse teeth in distal margin, but sharp teeth only in distal suckers; no large suckers; 1 or 2 photophores on ink sac.

*Type species: Chiroteuthis joubini* (Voss, 1967).

*Holotype:* Unsexed specimen, 103 mm ML; "Dana" st. 1171.

*Type locality:* 08°19'N, 44°35'W, Atlantic Ocean.

*Type depository:* Zoological Museum, University of Copenhagen, Denmark.

**Chiroteuthis (Chiroteuthis) spoeli** n. spec.  
Figs. 2A-K, 5A-C; table 1

*Material examined:* Holotype, an immature female, 85 mm ML, 15/Jan./1993, No. 663, Sta. SB2, daytime, depth 540-860 m. Paratype, an immature female, 70 mm ML, 19/July/1992, No. 319, Sta. US1, daytime, depth 400-600 m. 2 specimens.

*Description:* Muscular-mantle (MM) short and

conical, vesiculate-mantle (VM) short, tail very short; fins ovoid, FL 45-50% and FW 40% ML; armature large; head long, 50% ML, wider than mantle; head depth (HW<sub>2</sub>) 25% ML; neck poorly defined; eyes deeply embedded in head, medium, but look smaller because of head size; 14 luminous organs arranged in 2 rows, red-brown with gold color around their periphery on ventral side of eyeball; first row near eye lens, has 7 photophores, 2 photophores at extremes of the row clearly separated from other 5, which are lumped in center and smaller; second row in internal side, also 7 organs, arranged as in first row (fig. 3D); olfactory papillae between eye and funnel small, slightly pedunculated, tapered distally (fig. 3K); funnel small, laterally fused to neck, small opening; funnel organ inverted V-like, ventral pads oval; funnel cartilage 4 mm, ear-shaped; tragus strongly developed and protruding; antitragus well-developed, triangularly shaped (fig. 3H); nuchal cartilage 8-10% ML, two times longer than its width, slightly spatulate anteriorly (fig. 3I); armature large and strong; AF: IV>III>II>I; arm IV longest, about two times ML, with medium size half-scabbard-like extension, and 36-40 photophores, which are covered by dark chromatophores and embedded in the integument along the arm alternating with suckers; photophores in the 70mm ML specimen as large as sucker diameter; arms I-III have small swimming keel and low protective membrane; suckers biserially arranged, decreasing in size distally; suckers of arms II and III, have large and globular suckers, 2-3 mm diameter, from 3rd to 10th or 13th pairs in arm II, and from 4th to 11th or 14th in arm III, six times larger than those in arm IV; smallest suckers in arm IV; infundibular ring has large veil especially in larger suckers, but all have small openings; 8-14 wide and round teeth in suckers, arranged mainly in distal margin; distal suckers have slightly elongate and thin teeth, blunt, which in medial to proximal suckers grow wider and become round; some teeth in proximal margin fuse with each other to form smooth margin; tentacle stalk 6 times ML with ovaly-shaped glandular knobs along the stalk up to the club-area, number unknown because of specimen condition; club-area 47-75% ML (fig. 5A); protective membrane

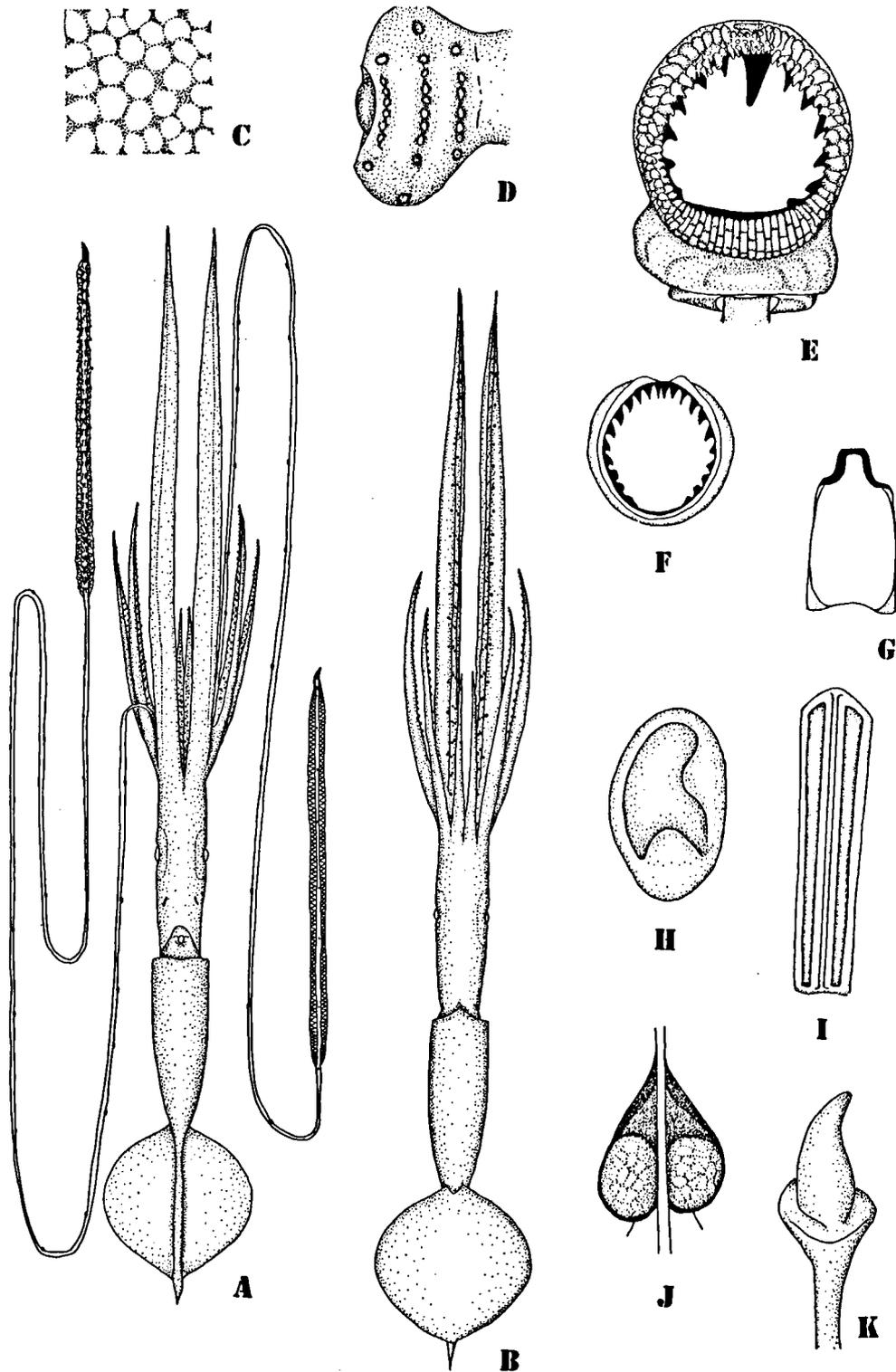


Fig. 4. *Chiroteuthis (Chirotauma) picteti somaliensis* n. subspec. Holotype. 90 mm ML, No. 776, Sta. US1. A: Ventral view; B: Same specimen, dorsal view; C: Chromatophore pattern; D: Eyeball, 15 mm and luminous organs arrangement; E: Tentacular sucker, 1 mm; F: Arm III, fifth row sucker, 1 mm; G: Leve-C of pseudoconus; H: Funnel cartilage, 4 mm; I: Nuchal cartilage, 10 mm; J: Photophores on the ink sac, 3 mm (from No. 763, 70 mm ML); K: Olfactory papilla, 2 mm.

Table 1. Measurements, indices and data of the two taxa of the genus *Chiroteuthis* examined from the Netherland Indian Ocean Programme (NIOP) (1992-1993).

Abbreviations: DML: Dorsal Mantle Length; VMML: Ventral Muscular-mantle Length; M: Muscular; VVML: Ventral Vesiculate-mantle Length; TaL: Tail Length; FCL: Funnel Cartilage Length; NCL: Nuchal Cartilage Length; MW: Mantle Width; FL: Fin Length; FW: Fin Width; ALI: Arm Length Index, I to IV; TL: Tentacle Length; CL: Club-area Length; HL: Head Length; HW<sub>1</sub>: Head Width (ventrally); HW<sub>2</sub>: Head Width (laterally); ED: Eye Diameter. I: In all cases means Index, the figures in brackets are the real measurements in mm. (Roper and Voss, 1983).

Material examined: *Chiroteuthis (Chiroteuthis) spoeli*. Holotype, Figs. 3A-K, immature female, 85 mm ML, 15/Jan./1993, No. 663, Sta. SB2, daytime, depth 540-860 m; Paratype, 1 immature female, 70 mm ML, 19/July/1992, No. 319, Sta. US1, daytime, depth 400-600 m. 2 specimens. *Chiroteuthis (Chirothauma) picteti somaliensis*. Holotype, figs. 4A-K, 5D-F, juvenile unsexed, 90 mm ML, 18/Jan./1993, No. 776, Sta. US1; night-time, depth 105-200 m; Paratypes, 1 juvenile unsexed, 70 mm ML, 18/Jan./1993, No. 763, Sta. US1; night-time, depth 0-150 m; 1 juvenile unsexed, 60 mm ML, 29/Jan./1993, No. 1109, Sta. GA2; night-time, depth 0-98 m; 1 juvenile unsexed, 50 mm ML, 27/Jan./1993, No.1039, Sta. GA1, night-time, depth 105-200 m; 1 juvenile unsexed, 45 mm ML, 27/Jan./1993, No. 1017, Sta. GA1, daytime, depth 505-910 m. 4 specimens.

Specimen sp. /subsp.	N°. 663 <i>spoeli</i>	N°. 319 <i>spoeli</i>	N°. 776 <i>somaliensis</i>	N°. 763 <i>somaliensis</i>	N°. 1109 <i>somaliensis</i>	N°. 1039 <i>somaliensis</i>	N°. 1017 <i>somaliensis</i>
Sex	im. female	unsexed	unsexed	unsexed	unsexed	unsexed	unsexed
DML	85	70	90	70	60	50	45
VMMLI (M)	51.7 (44)	57.1 (40)	55.5 (50)	68.5 (48)	58.5 (35)	50 (25)	62.2 (28)
VVMLI (V)	41.1 (35)	37.1 (26)	44.4 (40)	28.5 (20)	41.6 (25)	40 (20)	33.3 (15)
TaLi (TaL)	2.35 (2)	4.2 (3)	11.1 (10)	2.85 (2)	8.33 (5)	10 (5)	17.1 (8)
FCLI (FC)	5.2 (4.5)	5.7 (4)	4.44 (4)	5.00 (3.5)	5 (3)	6 (3)	6.66 (3)
NCLI (NC)	10 (8.5)	8.6 (6)	12.2 (11)	11.4 (8)	13.3 (8)	8 (4)	8.88 (4)
MWI (MW)	17.6 (15)	14.2 (10)	18.8 (17)	18.6 (13)	21.6 (13)	20 (10)	22.2 (10)
FLI (FL)	42.3 (36)	51.4 (36)	50 (45)	50 (35)	55 (33)	60 (30)	66.6 (30)
FWI (FW)	37.6 (32)	40.0 (28)	46.6 (42)	40 (28)	50 (30)	54 (27)	51.1 (23)
ALI							
I	58.8 (50)	51.4 (36)	55.5 (50)	42.9 (30)	58.3 (35)	50 (25)	55.5 (25)
II	94.1 (80)	92.8 (65)	80 (72)	64.3 (45)	83.3 (50)	80 (40)	84.4 (38)
III	117 (100)	107 (75)	88.8 (80)	78.6 (55)	91.6 (55)	90 (45)	100 (45)
IV	194 (165)	178 (125)	177 (160)	157 (110)	183 (110)	160 (80)	144 (65)
IVWI (IVW)	14.1 (12)	14.2 (10)	10 (9)	9.3 (6.5)	————	————	7.7 (3.5)
TLI (TL)	882 (750)	514 (360)	588 (530)	357 (250)	————	————	————
CLI (CL)	70.5 (60)	47.1 (33)	122 (110)	57.1 (40)	————	120 (60)	133 (60)
HLI (HL)	48.2 (41)	50.0 (35)	55.5 (50)	50 (35)	41.6 (25)	60 (30)	55.5 (25)
HWI1 (HW)	23.5 (20)	18.5 (13)	17.7 (16)	18.6 (13)	21.6 (13)	18 (9)	20 (9)
HWI2 (HW)	23.5 (20)	24.2 (17)	22.2 (20)	19.3 (13.5)	4.16 (2.5)	————	21.1 (9.5)
EDI (ED)	15.2 (13)	17.1 (12)	16.6 (15)	18.6 (13)	16.6 (10)	14 (7)	15.5 (7)

symmetrical; club-area with 51-65 suckers, divided into 3 sections: proximal section, weakly trabeculated with 11-15 rows of suckers, at its most proximal part rows arranged from 1 to 3 suckers; medial section, non-trabeculated, instead has long, oval and soft but fleshy membrane, fin-like with 20-22 rows of suckers; distal section fully trabeculated and wider than proximal section, but narrower than medial section; its first trabeculae, next to the distal end of medial section, has

split tip; trabeculae and suckers reduced in size towards tip, in distal section 20-30 rows of suckers; at tip of club-area large and round photophore embedded in swollen part, 1.5 mm, with thin extension (fig. 5B); tentacular suckers smaller than in arm IV, with thick, long and striped ring-like stalk, darkly pigmented, out of which thinner pedicel rises bearing helmet-shaped sucker (figs. 5C, 5CC); 5-7 small, sharp teeth in distal margin; no large teeth; proximal margin

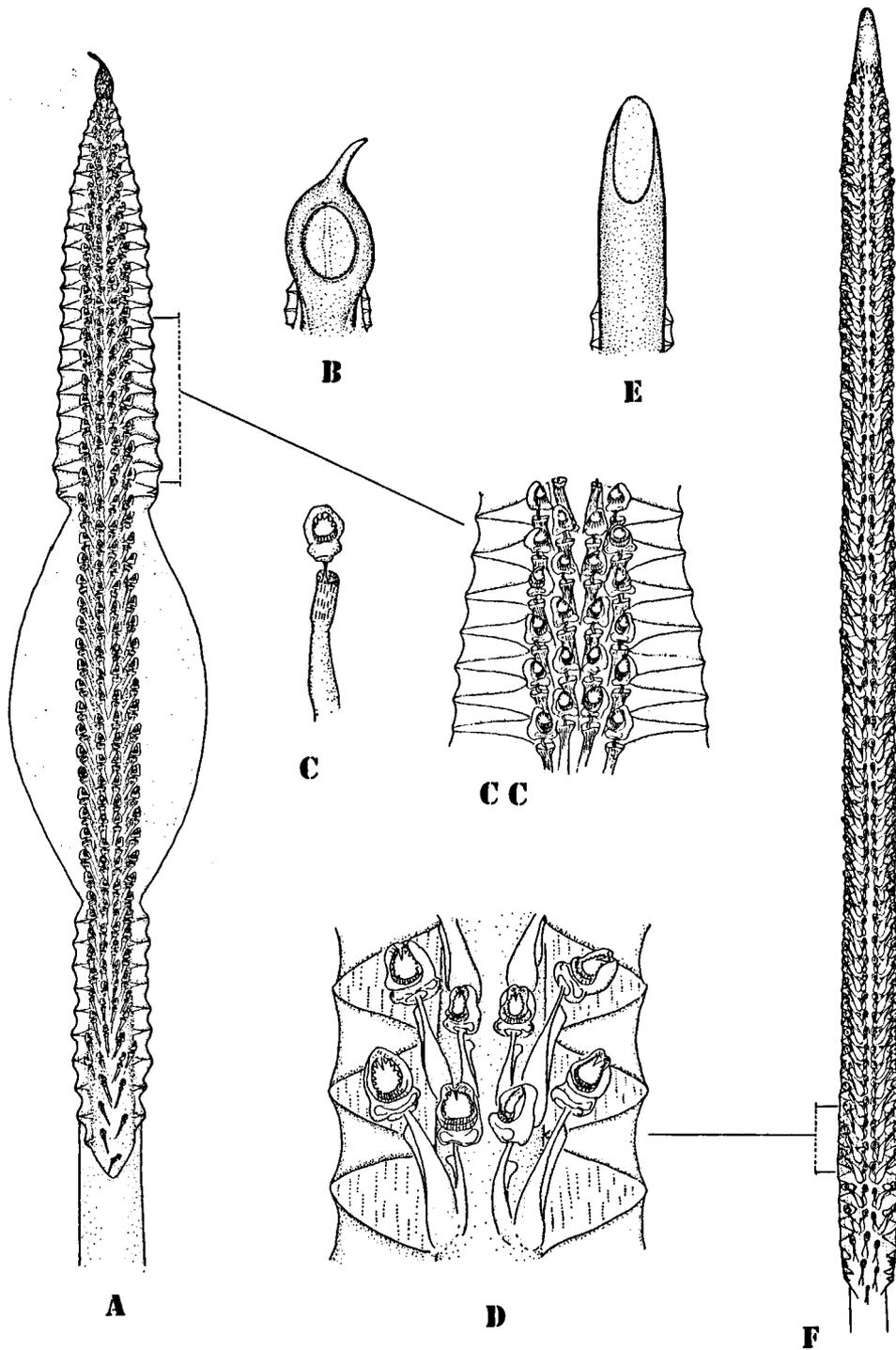


Fig. 5. A-C, *Chiroteuthis (Chiroteuthis) spoeli* n. spec. Paratype. 70 mm ML, No. 319, Sta. US1. A: General appearance of the club area, 33 mm; B: Photophore of the distal-most part of the club-area, 2.5 mm; C: Close-up view of a single sucker, 2 mm; CC: Close up view of the tentacular suckers' arrangement, section of 5 mm; D-F, *Chiroteuthis (Chirothauma) picteti somaliensis* n. subspec. Holotype. 90 mm ML, No. 776, Sta. US1. D: Close up view of the tentacular suckers' arrangement, section of 7 mm; E: Photophore of the distal-most part of the club area, 3.5 mm; F: General appearance of the club area, 110 mm.

smooth; 3 slender rectangular and flat polygonal processes in proximal margin of papillated ring; polygonal processes of internal and intermediate subrings almost rectangular, intermediate ring has larger polygonal processes, but those in external subring extremely small, usually not observed; pegs present only in distal margin (fig. 3E); gladius slim and elongate, pseudoconus about 40% of gladius length (GL); Level C cross section view shows dorsal keel squarish and wide, with broad lateral processes; conus field wider in corners, or even slightly concave, and pyramidal in shape; hard transparent tissue thick at lateral wall, but thin ventrally (fig. 3G); two photophores on ink sac, apex of each vesicle points dorsoventrally or looks truncated (fig. 3J); chromatophores dark brown to reddish-brown, alternating with smaller light-brown ones (fig. 3C).

*Type locality:* Coast of Somalia.

*Type depository:* Zoological Museum of Amsterdam (ZMA), University of Amsterdam.

*Etymology:* The name of this species, *spoeli*, is assigned to honor Dr. S. van der Spoel of the University of Amsterdam for his great contribution to marine biology and taxonomy, especially the pelagic molluscs.

*Remarks:* This new species is characterized by its head being wider than the mantle, the morphology of the ink sac vesicle, the well-defined non-trabeculated membrane in the club-area, the striped stalk of tentacle suckers and the enlarged suckers on arms II and III. It is closely related to the type species *C. joubini* (Voss) by the 2 rows of photophores in the eyeball, the general morphology of the club-area, but clearly differs in the morphology of the tentacular sucker stalk and the enlarged suckers of arms II and III.

This new species also clearly differs from the other nominal species of this subgenus, *C. veranyi* and *C. calyx*, which are characterized by the trabeculated membrane in the club-area, the bands of luminous tissue on the eyeball and the enlarged teeth in the tentacular suckers.

*C. spoeli* could be analogous to *C. calyx*, which differs from *C. veranyi* in the enlarged suckers in arms II and III and club-area morphology of the membrane. This species differs from *C. joubini* by the same features: the enlarged suckers in arms II and III and the morphology of club-area and suckers.

The *C. joubini* (Voss) is a lesser known species which was defined by Joubin (1933) under the name of *C. lacertosa*, and redesignated as *C. joubini* by Voss (1967). Nesis & Nikitina (1984) redescribed the species based on 9 specimens from the Atlantic, the West and the South Indian Ocean and the Banda Sea. However, neither Joubin (1933) in its original description nor Nesis & Nikitina (1984) in its redescription, mentioned the large suckers of arms II and III, the morphology of the ink sac photophores vesicle, or the striped stalk of tentacular suckers.

Four specimens from the South African Museum (SAM) which are closely related to this species, differ in the non-enlarged suckers on the arms, and the teeth number and shape (24 to 16 sharp teeth from distal to proximal suckers), and the fact that the tentacular sucker stalk is not striped. Examination of these characters indicate that the South African specimens probably belong to the *C. joubini* (Voss). Unfortunately, the type specimen from the University of Copenhagen (T. Schiotte, April 1996, personal communication) was not available during the elaboration of this manuscript for the South African specimens definition.

*Variation:* Considerable changes in size and metamorphosis can not give a clue in determining the growing stages. However, the presence of the adult characters in the NIOP specimens, regardless of their size, indicate that there is no further metamorphosis, except to grow in size.

Depending on the preservation conditions, in *C. spoeli* the non-trabeculated fin-like membrane can look wider or narrower, and is sometimes folded, a fact that could be overlooked. Therefore, its length and width can be a variable and should not be considered alone as a key character to define a new species. The size of the tentacular suckers and trabaculae in this subgenus are noticeably smaller than in species of the subgenus *Chirothauma*.

*Distribution:* These specimens from the West Indian Ocean indicate that this species may be distributed throughout the Indo-Pacific region. The present specimens were captured in day time at a depth of 400 to 860m.

Subgenus *Chirothauma* Chun, 1910

*Chiroteuthis (Chirothauma) picteti* Joubin, 1894: 40, pl. 1-2; Pfeffer, 1912: 585-589; Okutani, et al., 1987: 150, text fig. 57.

*Chiroteuthis (Chirothauma) macrosoma* Goodrich, 1896: 12, pl. 3, figs. 51-57; Pfeffer, 1912: 590-91.

*Chiroteuthis (Chirothauma) imperator* Chun, 1910: 240, 241, 281, pls. 38-44; Pfeffer, 1912: 582-591; Sasaki, 1929: 305, pl. 24, figs. 9-10, text fig. 142; Adam, 1954: 157-158; Voss, 1963: 136-140, text figs. 30a; Young, 1991: 163-167, figs. 1 E-G, M, N.

*Chiroteuthis (Chirothauma) capensis* Voss, 1967: 76-79, pl. 4, figs. A-G, pl. 5, figs. A-G.

**Diagnosis:** Body long and slender, cylindrical anteriorly but abruptly tapered posteriorly, with swollen part in posterior end of fins; fins medium to large, heart-shaped; antitragus strongly developed and usually larger than tragus; club-area strongly trabeculated, with 60-85 trabeculae; sucker stalk bears raised keel which ends at base; 9-18 sharp teeth in distal margin, but central median tooth largest; eyeball has 22-27 photophores arranged in 3 rows of photophores; none or 2 ink sac photophores round or drop-like shape; chromatophores arranged in circular pattern.

**Type species:** *Chiroteuthis picteti* Joubin, 1894.

**Type locality:** Amboine Sea.

**Type depository:** Oceanographic Museum of Monaco.

***Chiroteuthis (Chirothauma) picteti picteti*** Joubin, 1894

*Chiroteuthis (Chirothauma) picteti* Joubin, 1894: 40; Pfeffer, 1912: 585-589.

**Diagnosis:** Mantle long and cylindrical anteriorly; 22-25 photophores arranged in 3 rows in eyeball; club-area not widened in center; stalk of tentacular suckers conical without wing-like keel; central tooth enlarged; arm suckers have 12 blunt teeth.

**Type species:** *Chiroteuthis picteti* Joubin, 1894.

**Type locality:** Amboine Sea.

**Type depository:** Oceanographic Museum of Monaco.

***Chiroteuthis (Chirothauma) picteti somaliensis*** n. subspec.

Figs. 3A-K, 5D-F; table 1

**Material examined:** Holotype: juvenile unsexed, 90 mm ML, 18/Jan./1993, No. 776, Sta. US1; night-time, depth 105-200 m. Paratypes: 1 juvenile unsexed, 70 mm ML, 18/Jan./1993, No. 763, Sta. US1; night-time, depth 0-150 m; 1 juvenile unsexed, 65 mm ML, 29/Jan./1993, No. 1109, Sta. GA2; night-time, depth 0-98 m; 1 juvenile unsexed, 50 mm ML, 27/Jan./1993, No. 1039, Sta. GA1, night-time, depth 105-200 m; 1 juvenile unsexed, 45 mm ML, 27/Jan./1993, No. 1017, Sta. GA1, daytime, depth 505-910 m. 5 specimens.

**Description:** Mantle medium to long, body slender and soft; muscular-mantle (MM) cylindrically-shaped about anterior margin of fins; vesiculated-mantle (VM) about 80% of FL (figs. 4A-B), abruptly narrowed and extending further to posterior mantle-fins insertion to form tail, usually broken; mantle produced antero-ventrally; fins thick and muscular, and in paralarval and juvenile specimens nearly round; FW about 45-54% ML, and FL about 47-66% ML and fused together for almost 80% of length; head long, 47-60% ML, cylindrical, but not wider than mantle; however, in females head grows thicker than wider, making eyes appear small; eye opening medium; 17 to 25 luminous organs on eyeball arranged in 3 rows, observed in specimens from 65 to 90 mm ML: 5-8 organs in external row, 7-10 in middle row and 3-7 in internal row (fig. 4D); funnel-groove absent; neck-head division not demarcated; olfactory papillae stalked, with sharp end (fig. 4K); nuchal cartilage oblong, non spatulate, four times long as wide (fig. 4I); funnel fused with mantle, its opening small; funnel cartilage small, auriform; tragus and antitragus both well-developed, but latter slightly stronger than tragus (fig. 4H); funnel organ with 2 oval ventral pads and broad, inverted, V-shaped member; arms long and unequal; AF: IV>III>II>I, arm IV longest, longer than mantle; all arms squarish in cross section; narrow keel present in arm III and in lesser degree in arm II, absent in arm I; arm IV without keel or

protective membrane, half-sabbard-like membrane is developed instead, usually wider proximally; arm suckers biserial, subglobular, small, decreasing in size distally; sucker size almost same in all arms, smallest in arm I; in specimen of 90 mm ML: on arm I: 50, arm II: 61, arm III: damaged, arm IV: 62; in specimen of 70 mm ML: arm I: 40, arm II: 45, arm III: 70, and arm IV: 50; row of 45-50 photophores on oral side of arm IV embedded on integument and alternating with suckers; size of photophores larger than sucker diameter in proximal part, but decreasing in size distally as suckers do; sucker has thin and simple stalk, 18 to 22 sharpened teeth on distal margin (fig. 4F), their number and sharpness decrease proximally, but never get blunt or round; tentacles about 1 to 6 times ML; stalk round; club-area 60-100% of ML (depending on preservation state of specimen), bordered with symmetrical, strongly trabeculated membrane, aborally rounded (fig. 5F); 65-70 pairs of tentacular suckers in 4 transversally arranged rows, based on thin but strong peduncles ornamented with small, wing-like membrane; internal suckers with stalk shorter than external ones (fig. 5D); sucker helmet-shaped with 13-15 sharp teeth on distal and lateral margins, arranged around larger tooth in center of distal margin; sucker ring has flat polygonal processes in proximal margin; internal ring and intermediate ring have rectangular processes forming brick-wall pattern, almost all of uniform size (fig. 5E); external ring not observed; bulb-like photophore with aboral opening and covered with dark pigmented tissue located in distal tip of club-area; gladius thin and long, pseudoconus slightly broad, depth equaling width; level-C in cross section sub-rectangular with narrow dorsal keel; ventrally wider than dorsal side; hard transparent tissue thin in all walls (fig. 4G); 2 round photophores on ink sac, apex of each vesicle pointing towards intestinal duct (fig. 4J); dark brown chromatophores forming circles covering whole body (fig. 4C).

*Type locality:* Somali Basin.

*Type depository:* Zoological Museum of Amsterdam (ZMA), University of Amsterdam.

*Etymology:* The name of this subspecies, *somaliensis*, is assigned based on its location, the Somali Basin.

*Remarks:* This subspecies is characterized by its well-defined tragus and centrally placed antitragus, long and thin nuchal cartilage, numerous sharp teeth in arm suckers, as well as the number of teeth and the proximal margin polygonal processes pattern in its tentacular suckers. This subspecies is assigned to *C. picteti* Joubin because of the closely related morphometry, and only differs in the sucker morphology.

10 specimens belonging to *C. imperator* Chun from 70 to 200 mm ML, from the collection of the late Dr. Madoka Sasaki of The University Museum (ZUMT) in the University of Tokyo, were examined and compared with the NIOP specimens. They were found to differ in several characters, not only in the fin size but in the funnel and nuchal cartilages' sizes, and the arm and club-area suckers' morphology.

The type specimen of *C. capensis* Voss and reference material from the South African Museum (SAM) labeled as *C. atlantica* (MacDonald & Clench) indicated that the striking characters of these specimens are the 3 bands of luminous organs on the eyeball, the absence of photophores on the ink sac, the higher number of teeth in the arm and club-area suckers, the larger photophore in the tip of the tentacle, and the elongate and slim mantle. The NIOP specimens, therefore, clearly differ from these species. Re-description of the species *C. capensis* is to be treated in a separate paper.

The type specimen of *C. macrosoma* Goodrich at the Calcutta Museum, India, was also examined by Dr. Gleadall (Feb. 1996, personal communication). According to Dr. Gleadall, the specimen is preserved in absolute alcohol and its condition is extremely fragile. Measurements and observation of its taxonomic characters were carried out. Analysis of this information indicates that *C. macrosoma* is synonymous with *C. picteti*.

A request for a loan of the *C. picteti* type specimen was made to the Oceanographic Museum of Monaco. However, according to Dr. C. Carpine, curator of the museum, the extreme fragility of the specimen makes it impossible to send it overseas.

The type specimen, *Chiroteuthis picteti* Joubin has been examined by Chun (1910) who indicated that it was similar to his species *C. imperator*,

except for the lumps in the arm and tentacular suckers, and the lack of a wing-like keel in the stalk of the tentacular suckers. Pfeffer (1912) also reviewed the *picteti* specimens, pointing out the evident morphometric differences of the 2 fragmented specimens used by Joubin, and raising the question of a possible mistake in the correlation of the correct mantle-head of each specimen. Both Chun and Pfeffer agreed that the 12 crenellated teeth on the distal margin of the arm suckers and the lack of a wing-like keel in the tentacular sucker stalk were important enough characters to separate *picteti* from *imperator*.

Joubin (1924) discussed the relationship between *picteti* with *imperator*, giving priority to his species. Adam (1954) studied 2 specimens from the type locality, the Amboine Sea, but identified them as *C. imperator* Chun. Voss (1963) examined 9 specimens from the Philippine Islands which were morphometrically related to those by Adam (1954), suspecting that *macrosoma* and *imperator* could be synonymous with *picteti*, although he never confirmed that suspicion because he did not examine any type specimens. Kubota, et al. (1981) examined 404 specimens from the northern and western coasts of Suruga Bay and concluded that the specimens belong to *imperator*, as they differed from the other specimens from the Indo-Pacific region by the fin width-length ratio. Nesis (1987) concluded that *imperator* and *macrosoma* are synonymous with *picteti*. However, Young (1991) still considered *imperator* a valid species and described its paralarval stages.

The specimens from the NIOP expedition corresponded to the morphometry of the specimens from Adam (1954) and Voss (1963), but differed in the arm and tentacular suckers' morphology and the number of teeth. It is now clear that the specimens from the NIOP collection are different from the ones in Japan and the North Pacific that typify *C. imperator* Chun. However, we should not rule out the existence of a third species that typifies *C. picteti* in the central Indo-Pacific and West Pacific regions. The specimens from the NIOP collection are a clear variant of *Chiroteuthis picteti* and are defined as a subspecies for the West Indian Ocean.

*Variation:* The half-sabbard-like extension gives the impression that arm IV is very wide when

observed ventrally, but examined in cross section (fig. 2E) it is triangularly shaped. This structure can easily be damaged by preservation. Its width varies depending on the species and the growth stage.

## DISCUSSION

Pfeffer (1912) emphasizes that a linear growth can not indicate maturity, since he found small specimens of the same species with high variability in their armature and mantle. He also mentioned that the fin, which is the least vesiculated part, is more reliable in indicating growth or identifying species. This fact probably led Kubota et al. (1981) to analyze morphometrically the specimens from Japan. Young (1991) mentioned that there are specimens which show a prolonged juvenile stage and others that are sexually defined at smaller sizes.

The specimens of *C. picteti somaliensis* show a lineal growth from 45-90 mm ML, except for one specimen of 70 mm ML, which shows variations in most of its indices, although its taxonomic characters fit with the other specimens in this collection. It is therefore probable that this is an artifact due to preservation. It was also observed that the fin indices are about 50-54% for small specimens and later only the mantle grows, thus reducing their proportion to 40-46%. In contrast to the specimens from Japan, the fin reaches 60% in a specimen of 70 mm ML and falls to 50-55% in specimens of 145-200 mm ML.

Judging by Pfeffer's (1912) and Young's (1991) observations and by the lack of large collections, it is premature to assume that some species consist of "normal" and "dwarf" populations. However, one way to characterize a species with a non-linear growth series, apart from morphometric analysis, is by close examination of their taxonomic characters and by re-evaluating some of them, such as the cushions in suckers (Salcedo-Vargas, 1995). Since it is now understood that cushions are indicators of age and/or lifestyle for some bathypelagic species, regardless of size of the specimen, and cannot be considered as a feature to define species, Chun's (1910) use of this feature to differentiate *picteti* from *imperator* is now

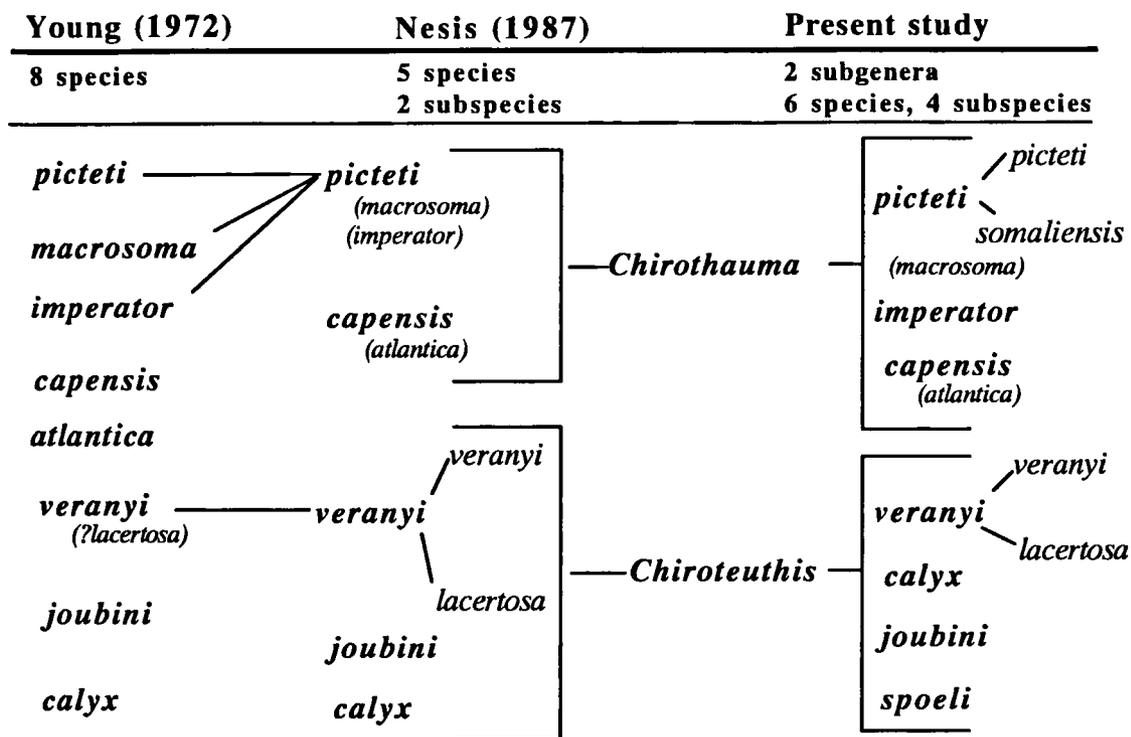


Fig. 6. Comparison of the taxonomic systems of Young (1972) and Nesis (1987) with the present arrangement.

invalid.

**Taxonomy:** The characterization of the genus *Chiroteuthis* d'Orbigny was improved by reconsidering the subgeneric division proposed by Chun (1910), and amending their diagnosis. Advances in the clarification of the *picteti-imperator* complex and the definition of a new species and subspecies also helped to make this improvement. The *Chiroteuthis* is divided by its general morphology into 2 subgenera: *Chiroteuthis* s.str. and *Chirothauma* Chun. The subgenus *Chiroteuthis* s. str. groups: *C. (C.) veranyi veranyi* (Férussac), *C. (C.) veranyi lacertosa* Verrill, and *C. (C.) calyx* Young mainly by features such as the shape of the eyeball's luminous organs and the morphology of the trabeculae of the club-area. The other species in this subgenus: *C. (C.) joubini* (Voss) and *C. (C.) spoeli* n. spec., differs mainly by the non-trabeculated fin-like membrane in the club-area and the 2 rows of photophores in the eyeball. The subgenus *Chirothauma* Chun is characterized by the 3 rows of luminous organs on the eyeball, and includes

three species and one subspecies: *C. (C.) imperator* Chun, *C. (C.) capensis* Voss, *C. (C.) picteti* Joubin and its subspecies, *C. (C.) picteti somaliensis* n. subpec. Taxonomic systems from Young (1972) and Nesis (1987) and the arrangement proposed in the present study are indicated in fig. 6.

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