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A new genus and species of Sternaspidae (Annelida: Polychaeta) from the deep eastern Atlantic

Dieter FIEGE^{1,*} & Ruth BARNICH²

¹Forschungsinstitut und Naturmuseum Senckenberg Frankfurt,
Sektion Marine Evertibraten II, D-60325 Frankfurt am Main, Germany.

²Thomson Environmental Consultants, Compass House, Surrey Research Park,
Guildford, GU2 7AG, United Kingdom.

*Corresponding author: Dieter.Fiege@senckenberg.de

²Email: Ruth.Barnich@thomsonec.com

¹[urn:lsid:zoobank.org:author:80EC529E-71F4-4EB1-B22E-8861128AE8D6](https://zoobank.org/author/80EC529E-71F4-4EB1-B22E-8861128AE8D6)

²[urn:lsid:zoobank.org:author:F1E3AEB7-0C77-41BB-8A6C-F8B429F17DA1](https://zoobank.org/author/F1E3AEB7-0C77-41BB-8A6C-F8B429F17DA1)

Abstract. Based on specimens recently collected in sediments from 2700 m depth off Mauritania (Northwest Africa; type locality) and from 2700–4400 m depth off Angola (Southwest Africa), a new genus and species, *Mauretanaspis longichaeta* gen. et spec. nov., is described. The new genus and species are characterized by a unique combination of characters: ventro-caudal shield covered by firmly adhering sediment, lateral margins strongly bent and merging into integument; introvert hooks tapering; eight pre-shield segments; absence of peg chaetae; exceptionally long posteriormost lateral chaetae equaling body length; posterior shield chaetae equaling shield length. A comparative table of characters for all currently recognised sternaspid genera and a key to all species with ventro-caudal shield covered by firmly adhering sediment are provided.

Keywords. *Mauretanaspis longichaeta* gen. et spec. nov., taxonomy, deep sea, Atlantic.

Fiege D. & Barnich R. 2020. A new genus and species of Sternaspidae (Annelida: Polychaeta) from the deep eastern Atlantic. *European Journal of Taxonomy* 699: 1–13. <https://doi.org/10.5852/ejt.2020.699>

Introduction

Sternaspidae Carus, 1863 represents an enigmatic polychaete taxon characterized by the presence of a unique bilaterally symmetrical ventro-caudal shield. The taxonomy of Sternaspidae has received specific attention during recent years following the first revision of the group by Sendall & Salazar-Vallejo (2013). Their morphological study resulted in the distinction of three genera (*Sternaspis* Otto, 1821, *Caulleryaspis* Sendall & Salazar-Vallejo, 2013 and *Petersenaspis* Sendall & Salazar-Vallejo, 2013) and a rapid increase of the number of species from 13 to 44, including the species described herein (Fiege 2016, 2019). With *Sternaspis monroi* Salazar-Vallejo, 2014, recently synonymized with *S. sendalli* Salazar-Vallejo, 2014 (Drennan *et al.* 2019), the actual number of species comes to 43.

Table 1. Deep-water Sternaspidae known to date.

Species	Distribution	Depth (m)
<i>Caulleryaspis fauchaldi</i> Salazar-Vallejo & Buzhinskaja, 2013	NE Pacific, Oregon to Southern California	1387–2800
<i>Caulleryaspis gudmundssoni</i> Sendall & Salazar-Vallejo, 2013	N Atlantic, Iceland	452–1207
<i>Caulleryaspis nuda</i> Salazar-Vallejo & Buzhinskaja, 2013	NE Pacific, off Oregon	2519
<i>Mauretanaspis longichaeta</i> gen. et spec. nov.	NE and SE Atlantic, off Mauritania and Angola	2700–4400
<i>Sternaspis annenkovae</i> Salazar-Vallejo & Buzhinskaja, 2013	NW Pacific, east of northern Kurile Island	3980–4070
<i>Sternaspis maior</i> Chamberlin, 1919	E Pacific, Central Gulf of California	180–1143
<i>Sternaspis maureri</i> Salazar-Vallejo & Buzhinskaja, 2013	E and SW Pacific	795–6489
<i>Sternaspis princeps</i> Selenka, 1885	SW Pacific, New Zealand	1274
<i>Sternaspis rietschi</i> Caullery, 1944	Arafura Sea, off Wokam Island	1788
<i>Sternaspis sendalli</i> Salazar-Vallejo, 2014	Southern Ocean and Antarctic Peninsula	200–1500
<i>Sternaspis uschakovi</i> Salazar-Vallejo & Buzhinskaja, 2013	N Pacific, Okhotsk Sea, California, Gulf of California	592–2548
<i>Sternaspis williamsae</i> Salazar-Vallejo & Buzhinskaja, 2013	NE Pacific, Oregon to California	1000–2800

Twelve of these are known to occur in deep waters (Table 1). Our present knowledge of the morphology, anatomy, biology and phylogeny of the group was summarized by Fiege (2016, 2019). A recent study by Drennan *et al.* (2019) investigated the phylogenetic relationships using molecular markers both within Sternaspidae as well as their position among the Polychaeta as a major taxon. Their molecular data of three genes (16S, 18S and CO1) places Sternaspidae next to Scalibregmatidae Malmgren, 1867 and these two families as a sistergroup of Cirratuliformia Fauchald, 1977 while other phylogenetic analyses using a higher number of genes paired Sternaspidae with Fauveliopsidae Hartman, 1971 (e.g., Rousset *et al.* 2007; for details see Fiege 2019 and Drennan *et al.* 2019). The latter authors also revealed a genetic connectivity among some species of *Sternaspis* across the Pacific. These molecular results also cast some doubt on the significance of the shield morphology for species distinction.

Below, we present a morphological description of a new genus and species, *Mauretanaspis longichaeta* gen. et spec. nov., recently collected in sediments from 2700 m depth off Mauritania (Northwest Africa) and from 2700–4400 m off Angola (Southwest Africa). Unfortunately, the material was not suitably preserved for a molecular analysis, but the unique combination of morphological characters allows a clear distinction from other sternaspid genera and species described to date. As mentioned by Drennan *et al.* (2019), the genera *Sternaspis* and *Caulleryaspis* are in need of revision, but we believe that the characters observed in our specimens are sufficient to establish a new genus and species.

The diagnostic characters of all sternaspid genera described so far, including the new genus established herein, are summarized in Table 2 and a key to all sternaspid species with a ventro-caudal shield covered by firmly adhering sediment is provided below.

Material and methods

The specimens were collected in deep-sea mud in a depth of about 2700 m during a benthic survey to the Block C9 area off Mauritania and in depths between about 2700–4400 m off Angola. Sampling was carried out in 2018 by the French environmental consultancy CREOCEAN on behalf of TOTAL. Specimens were sampled using a 0.25 m² box core (Grey O'Hara), sieved on a semi-automatic table, fixed in 4% formalin in seawater and later transferred to 70% ethanol for preservation. Morphological studies were carried out using a Leica MZ8 and Leica M 125C stereo microscope. Photographs were taken with a Canon EOS 5D Mark II camera equipped with a 65 mm MP-E lens and a DMC 4500 Leica camera attached to the stereo microscope. Measurements were taken using an ocular micrometer. Counting of segments starts with chaetiger 1, i.e., pro- and peristomium are not included. The holotype is deposited at

Table 2. Distinctive characters of sternaspid genera (modified after Salazar-Vallejo 2017).

Characters/Genera	<i>Sternaspis</i> Otto, 1821	<i>Caulleryaspis</i> Sendall & Salazar-Vallejo, 2013	<i>Petersenaspis</i> Sendall & Salazar-Vallejo, 2013	<i>Mauretanaspis</i> gen. nov.
Introvert hooks	Tapering	Tapering	Subdistally expanded (spatulate)	Tapering
No. pre-shield segments	7	7	8	8
Shield structure	With ribs and/or concentric lines	With or without faint ribs or concentric lines	With faint ribs, without concentric lines	Indistinct
Sediment firmly adhered to shield	Absent	Present or absent	Absent	Present
Peg chaetae	Present	Present or indistinct	Absent	Absent

the Muséum national d'histoire naturelle, Paris (MNHN) and the paratype at the Senckenberg Museum Frankfurt (SMF). Additional material is deposited at the Senckenberg Museum Frankfurt, Muséum national d'histoire naturelle, Paris, Museo Nacional de Ciencias Naturales, Madrid (MNCN) and the Research Collection of the Department of Biology of the University of Aveiro, Marine Invertebrates (COBI at DBUA) as indicated under 'Material examined' below.

Results

Taxonomy

Phylum Annelida Lamarck, 1809
Class Polychaeta Grube, 1850
Family Sternaspididae Carus, 1863

Mauretanaspis gen. nov.

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Table 2

Type species

Mauretanaspis longichaeta gen. et spec. nov. designated herein.

Diagnosis

Sternaspidids with introvert hooks tapering. Eight segments between gonopodial lobes and shield (i.e., pre-shield region). Ventro-caudal shield densely covered with firmly adhering fine sediment, which cannot be brushed off. Due to sediment cover no shield structures like ribs or concentric rings visible except median suture. Shield with lateral margins strongly bent towards dorsal side, merging into integument. Peg chaetae absent.

Etymology

The genus name is a combination of the Latin name for the type locality off the Northwest African state Mauritania (i.e., *Mauretania*, Lat.) and the Greek word '*aspis*' (= 'shield'); gender: feminine.

Remarks

Mauretanaspis gen. nov. differs in the combination of characters from the other genera of Sternaspididae. The shield is completely and firmly covered by sediment, as in several species of *Caulleryaspis*, but it has eight pre-shield segments; peg chaetae (i.e., a dense group of short chaetae covered by a common sheath) are absent, while *Caulleryaspis* has seven pre-shield segments and peg chaetae are present. In *Caulleryaspis nuda* peg chaetae are absent, but according to Drennan *et al.* (2019) this species possibly belongs to the genus *Sternaspis* (see 'Discussion'). *Petersenaspis* has eight pre-shield segments and

peg chaetae are absent, as in *Mauretanaspis* gen. nov., but the shield is not covered by sediment and the introvert hooks are subdistally expanded or spatulate while hooks in *Mauretanaspis* gen. nov. are tapering (Table 2).

Mauretanaspis longichaeta gen. et spec. nov.

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Figs 1–4, Table 1

Etymology

The species epithet is a combination of the Latin ‘*longus*’ (= ‘long’) and the Greek ‘*chaeta*’ (= ‘bristle’) characterizing the striking length of the posteriormost lateral chaetae of the ventro-caudal shield.

Material examined

Holotype

NORTHEAST ATLANTIC – **Off Mauritania** • 1 complete specimen (body slightly contracted, introvert fully everted, length 5.0 mm, width 1.6 mm, abdomen length 3.0 mm, left shield plate length 1.2 mm, width 0.9 mm); Block C9, stn C9-15 (B3); 18°21.27' N, 17°57.44' W; depth 2712 m; 24 Oct. 2018; deep-sea mud, box core; MNHN-IA-TYPE 2005.

Paratype

NORTHEAST ATLANTIC – **Off Mauritania** • 1 complete specimen (introvert partly retracted, length 3.5 mm, width 1.8 mm, abdomen length 1.0 mm, left shield plate length 1.2 mm, width 1.2 mm); Block C9, stn C9-15 (B1); 18°21.27' N, 17°57.44' W; depth 2712 m; 24 Oct. 2018; deep-sea mud, box core; SMF 27777.

Other material

NORTHEAST ATLANTIC – **Off Mauritania** • 1 spec. (bad condition, anterior end retracted, length n.d., width 2.6 mm, abdomen length 3.7 mm, left shield plate length 1.6 mm, width 1.0 mm); Block C9, stn C9-20 (B1); 18°26.91' N, 17°59.25' W; depth 2714 m; 27 Oct. 2018; deep-sea mud, box core; SMF 27776.

SOUTHEAST ATLANTIC – **Off Angola** • 1 spec. (juvenile with capillary chaetae in pre-shield segments, without gonopodial lobes, anterior end missing, length n.d., width 0.35 mm); stn S48-03A; 6°53.107' S, 10°30.762' E; depth 2935 m; 7 Sep. 2018; box core; MNHN-IA-PNT 120 • 1 spec. (juvenile, anterior end damaged, length n.d., width 0.65 mm, left shield plate length 0.5 mm); stn S48-08A; 6°59.047' S, 10°36.748' E; depth 2736 m; 9 Sep. 2018; box core; SMF 28061 • 1 spec. (gonopodial lobes present, length 3.2 mm, width 1.1 mm, left shield plate length 1.1 mm); stn S48-09C; 7°4.931' S, 10°13.003' E; depth 4373 m; 14 Sep. 2018; box core; SMF 28062 • 1 spec. (juvenile, body wall translucent, with chaetae in some abdominal segments, without gonopodial lobes, length 2.5 mm, width 0.9 mm); stn S48-14C; 7°10.998' S, 10°13.064' E; depth 4363 m; 14 Sep. 2018; box core; MNCN 16.01/18762 • 1 spec. (strongly bent and wrinkled, gonopodial lobes not seen, posteriormost lateral chaetae ca 4 × length of body, length n.d., width n.d., left shield plate length 1.0 mm); stn S48-23A; 7°23.159' S, 10°24.921' E; depth 4375 m; 15 Sep. 2018; box core; MNCN 16.01/18763 • 1 spec. (juvenile, body wall translucent, anterior end missing); stn S48-23B; 7°23.159' S, 10°24.921' E; depth 4375 m; 15 Sep. 2018; box core; DBUA0002349.01 • 1 spec. (anterior end retracted, gonopodial lobes retracted but visible, length n.d., width n.d., left shield plate length 1.0 mm); stn S48-26C; 6°58.715' S, 10°17.741' E; depth 4191 m; 10 Sep. 2018; box core; DBUA0002349.02.

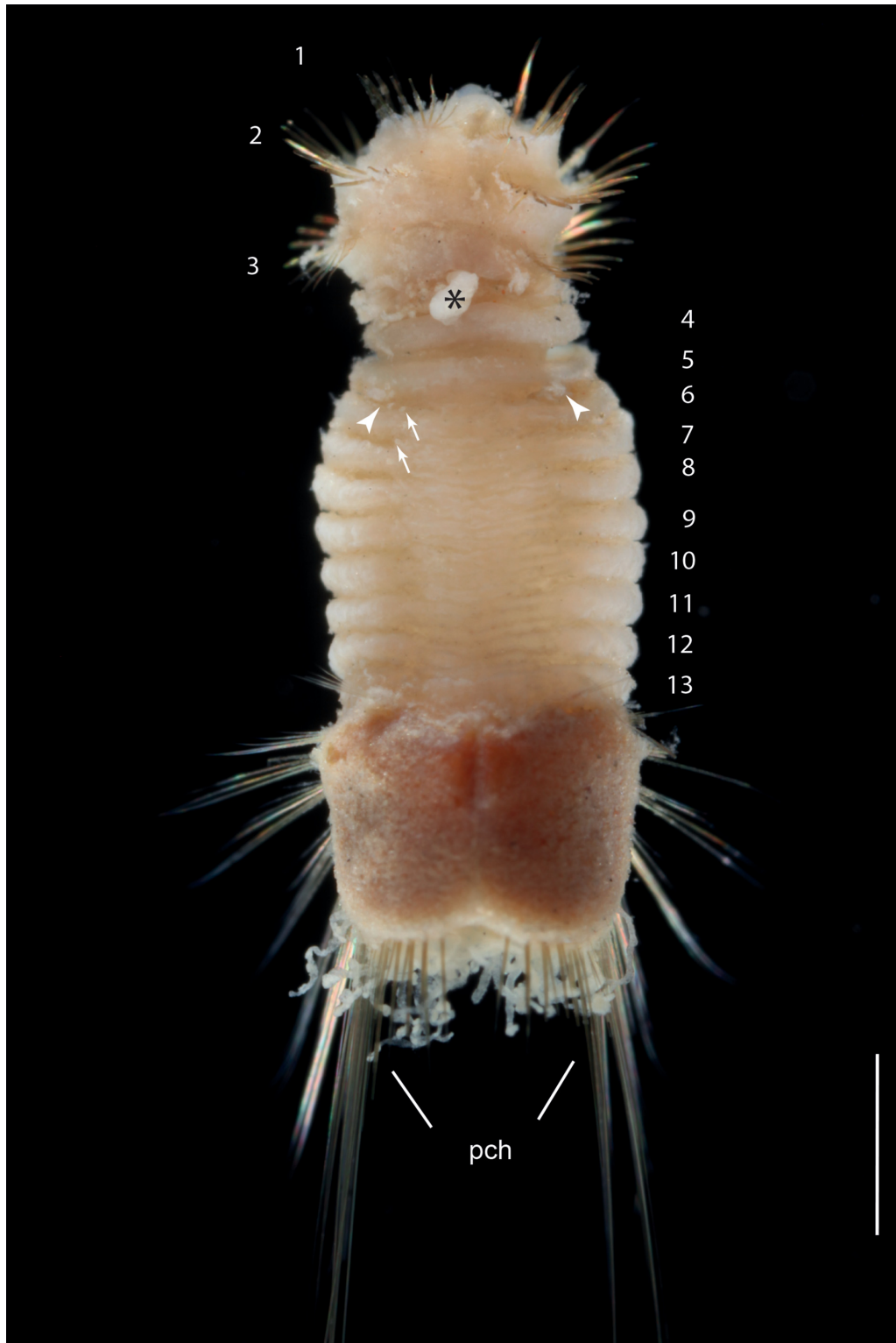


Fig. 1. *Mauretanaspis longichaeta* gen. et spec. nov., holotype (MNHN-IA-TYPE 2005), ventral view. Abbreviation: pch = posterior shield chaetae; * = body damaged with oesophagus protruding; numbers 1–13 = anterior and pre-shield segments; arrowheads = gonopodial lobes; arrows = body papillae. Scale bar: 1 mm.

Description

Based on holotype (Figs 1, 2A–C, 3A–C), complete specimen (body slightly contracted but introvert fully everted), complemented by paratype (Fig. 4A–C) where indicated.

BODY COLOUR. Pale yellow.

PROSTOMIUM. Small hemispherical cupule, pale, semi translucent. Eyes absent.

PERISTOMIUM. Surrounding mouth projecting to level of prostomial cupule, about $1.5 \times$ diameter of prostomium. Mouth small, round.

INTROVERT. First three chaetigers each with 15–17 hooks on either side (segment 1: left 9+6 small, right 8+8; 2: left 9+7, right 9+8; 3: left 9+6, right 8+7); hooks golden, tapering to blunt transparent tip; decreasing gradually in length and diameter from dorsal to ventral in each fascicle. Ventralmost 6–8 hooks small to minute. Hooks equally spaced in fully everted introvert (Figs 1, 2A–C, 3A, 4A). Minute drop-shaped papillae in single rows parallel to segmental folds dorsally in segments 1–3. Body damaged ventrally on segments 3–4 with oesophagus protruding (Figs 1, 2C, 3A). Gonopodial lobes small, digitiform, protruding ventrolaterally from intersegmental groove between segments 5 and 6 (Figs 1, 4A–B).

ANTERIOR ABDOMEN (PRE-SHIELD REGION). Comprising eight segments. Body papillae minute, round, forming single rows close to intersegmental folds, sometimes obscured by sediment particles (Figs 1, 4B). Most pre-shield segments of holotype with smooth median surface on ventral side, possibly abraded, and few, short, filamentous papillae on lateral sides; in paratype median surface papillated (Figs 1, 4A). Few filamentous papillae among adhering sediment particles on segments anterior to branchial plates.

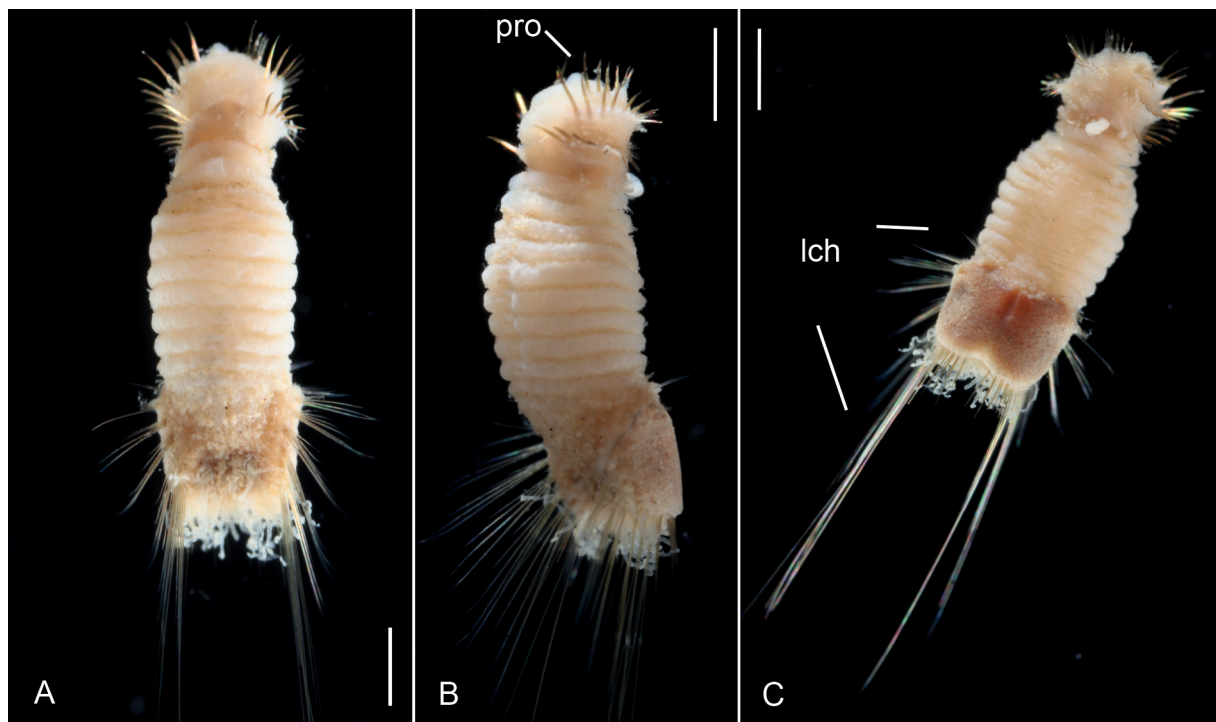


Fig. 2. *Mauretanaspis longichaeta* gen. et spec. nov., holotype (MNHN-IA-TYPE 2005). **A.** Dorsal view. **B.** Lateral view, right side. **C.** Ventral view showing length of posteriormost lateral chaetae. Abbreviations: lch = lateral chaetae; pro = prostomium. Scale bars: 1 mm.

VENTRO-CAUDAL SHIELD. Densely covered by fine, firmly adhering sediment particles. Shield colour light brown, obscured by dense cover of sediment. Colour most intense around anterior end of median suture (sediment abraded in holotype, not abraded in paratype) (Figs 3B, 4A). No structures (ribs, concentric rings) visible due to sediment cover. Anterior margins slightly rounded, anterior depression shallow, covered by sediment; anterior keels faintly visible (Fig. 3B), not exposed. Lateral margins rounded, strongly bent towards dorsal side, not forming free, stiff or pliable margins, but rather merging into integument. Posterior fan and lateral notch not discernible due to sediment cover; shallow median notch (more pronounced in paratype (Fig. 4A, C)). Suture defined in anterior $\frac{1}{3}$ of shield, moderately deep with distinct lateral borders (Figs 3B, 4A).

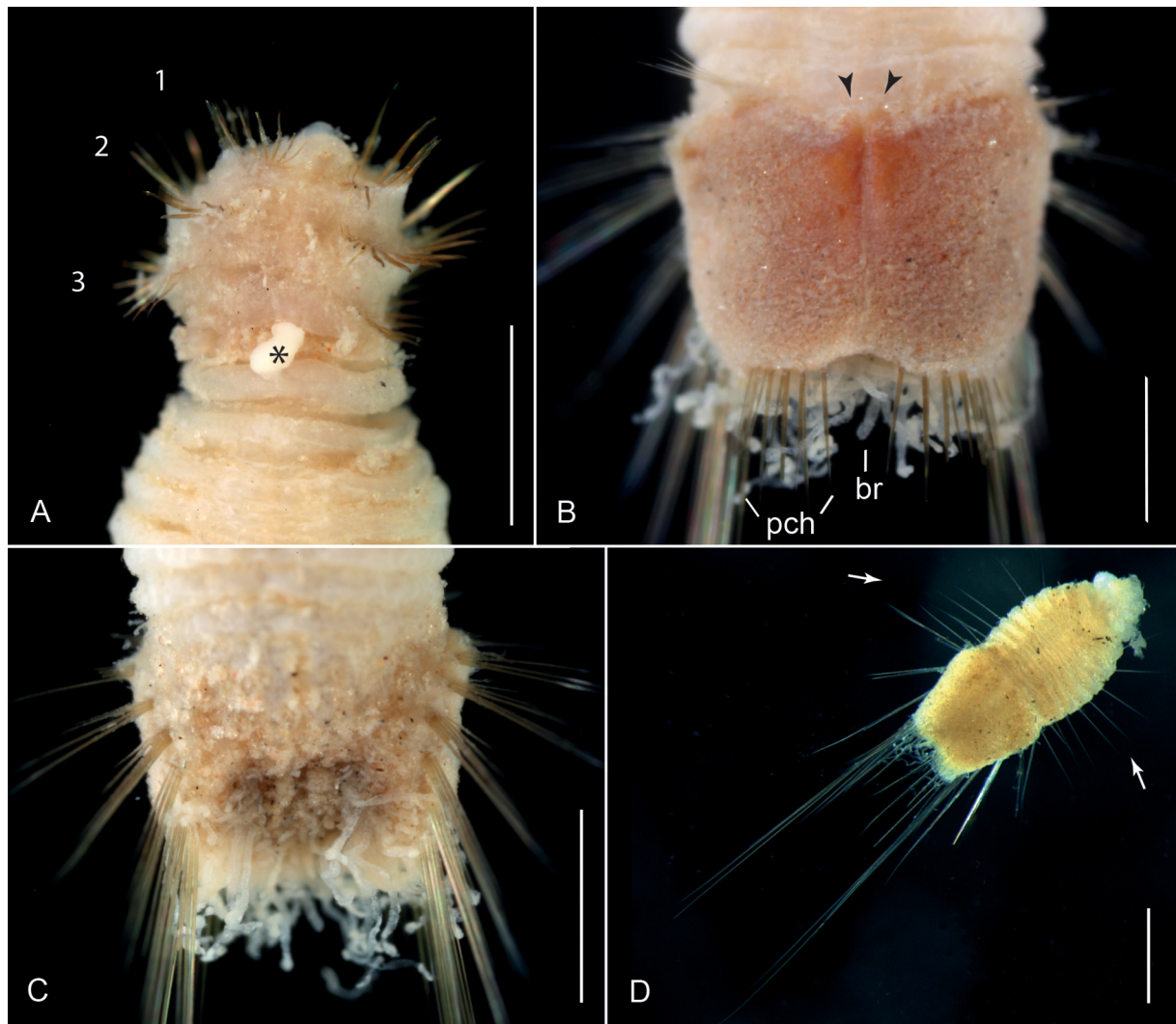


Fig. 3. *Mauretanaspis longichaeta* gen. et spec. nov. A–C. Holotype (MNHN-IA-TYPE 2005). A. Anterior end (introvert) with tapering hooks, ventral view. B. Ventro-caudal shield, ventral view. C. Posterior end, showing brownish branchial region, dorsal view. D. Juvenile specimen collected off Angola (MNHN-IA-PNT 120) (anterior end damaged, gonopodial lobes not developed), ventral view. Abbreviations: br = branchial filament; pch = posterior shield chaetae. Numbers 1–3 = anterior segments with hooks; * = body damaged with oesophagus protruding; arrowheads = anterior keels of shield; arrows = chaetae of pre-shield segments. Scale bars: A–C = 1 mm; D = 0.5 mm.

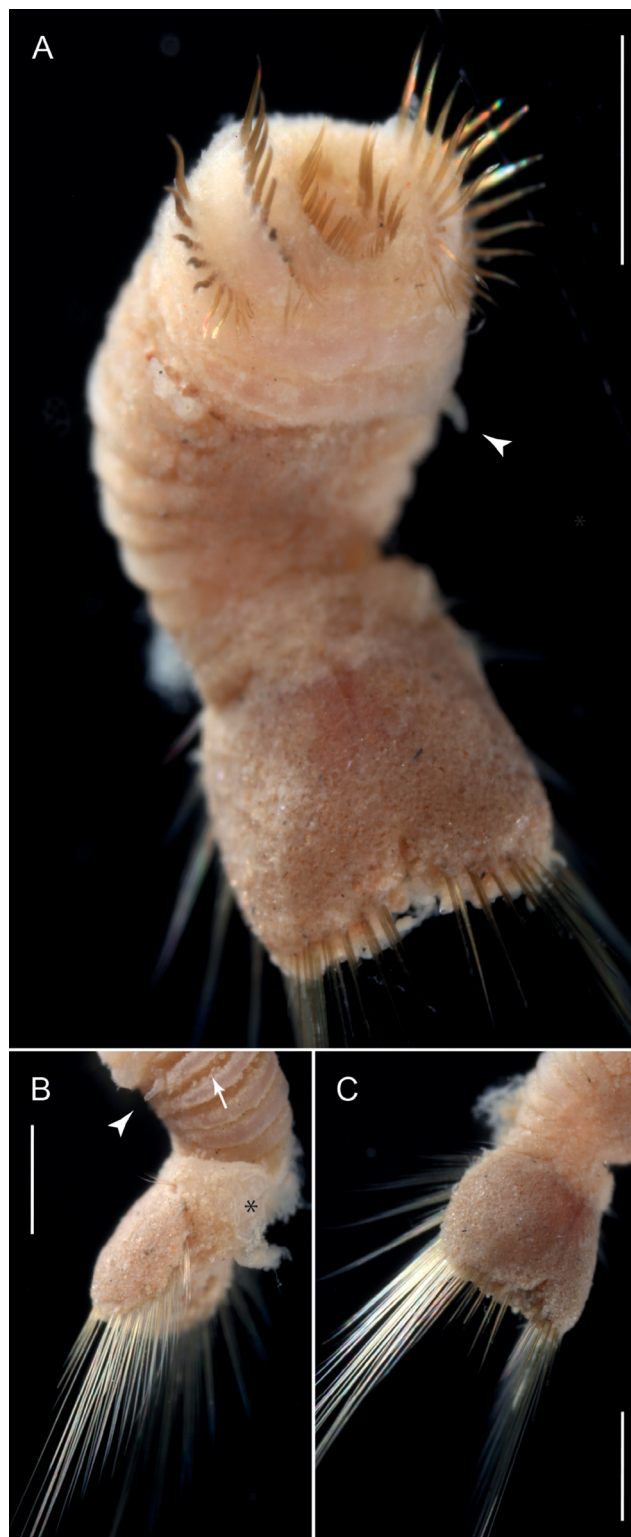


Fig. 4. *Mauretanaspis longichaeta* gen. et spec. nov., paratype (SMF 27777). **A.** Entire specimen, ventral view. **B.** Pre-shield and abdominal region, ventrolateral view. **C.** Abdominal region, showing arrangement of lateral and posterior shield chaetae, ventral view. Arrowheads = gonopodial lobes; arrow = body papillae; * = body damage on dorsal side. Scale bars: 1 mm.

MARGINAL SHIELD CHAETAE. Yellow; 20 lateral fascicles, i.e., 9–11 fascicles per side, with 4–6 capillary chaetae each. Chaetae arranged in oblique rows, increasing gradually in length posteriorly within each fascicle and among fascicles (Figs 2C, 3C, 4B–C); chaetae of posteriormost lateral fascicle very long, equalling body length (Figs 2C, 3D). Six pairs of fascicles posterior to shield (i.e., posterior shield chaetae), each with 1–3 (mostly 2) yellow capillaries of varying length and different strength (Figs 3B, 4A, C); lateralmost longest, equalling length of shield. Peg chaetae absent.

BRANCHIAL FILAMENTS. Numerous, increasing in length posteriorly, opaque, coiled to various extent.

BRANCHIAL PLATES. Brownish, forming ovoid to trapezoidal region, densely covered by filaments, filamentous papillae and sediment grains (Fig. 3C).

Distribution

Northeast to Southeast Atlantic, from off Mauritania to Angola, in deep-sea mud, in depths of 2700–4400 m.

Remarks

Mauretanaspis longichaeta gen. et spec. nov. can be distinguished from all other known species of Sternaspidae by the following combination of characters: introvert hooks tapering, tips transparent; pre-shield region with eight segments; ventro-caudal shield densely covered with fine, firmly adhering sediment obscuring shield structures except median suture. *Mauretanaspis longichaeta* gen. et spec. nov. is the only sternaspid with chaetae in posteriormost lateral fascicles equalling body length. In one specimen collected off Angola (MNCN 16.01/18763), posteriormost lateral chaetae even measure about 4 × the length of the body.

Several specimens from off Angola (SMF 28062, MNCN 16.01/18762, MNCN 16.01/18763, DBUA0002349.01) show black pigment presumably from surrounding sediment included in sediment cover and among sand grains in the branchial region. Black particles are scattered on the shield forming spots of different sizes.

We compared our material to a specimen collected off Northwest Africa in 1320 m depth and identified as *Sternaspis scutata* (Ranzani, 1817) by Kirkegaard (2001: 396). The specimen, deposited in the collections of the Natural History Museum of Denmark (NHMD 662048), was not available for study, but pictures of it were kindly made available to us by S. Salazar-Vallejo. Unfortunately, the animal is in very bad condition: anterior hooks tapering to fine tips, number of pre-shield segments and gonopodial lobes not distinguishable, shield completely covered by fine sediment obscuring surface structures, shield without free margins, length of lateral and posterior shield chaetae indeterminable. It remains uncertain whether the sediment can be removed from the shield without damaging it, but with regard to shield characters visible in the pictures available, the specimen appears incorrectly identified as *Sternaspis scutata*. However, due to its bad condition we cannot identify it any further.

Identification key to Sternaspidae with sediment particles firmly attached to ventro-caudal shield (Caulleryaspis (in part) and Mauretanaspis gen. nov.) (adapted from Salazar-Vallejo 2017)

1. Shield with anterior depression deep; peg chaetae robust 2
 - Shield with anterior depression shallow; peg chaetae absent 3
2. Shield with anterior margins angular; peg chaetae forming thick, large spines
 - *Caulleryaspis gudmundssoni* Sendall & Salazar-Vallejo, 2013 (N Atlantic, Iceland)

- Shield with anterior margins rounded; peg chaetae forming thin, small spines
....*Caulleryaspis fauchaldi* Salazar-Vallejo & Buzhinskaja 2013 (NE Pacific, Oregon to California)
- 3. Seven pre-shield segments; chaetae in posteriormost lateral fascicles about length of shield*Caulleryaspis laevis* (Caullery, 1944) (Indo-Pacific, Indonesia)
- Eight pre-shield segments; chaetae in posteriormost lateral fascicles equalling body length
.....*Mauretanaspis longichaeta* gen. et spec. nov. (NE and SE Atlantic, Mauritania to Angola)

Discussion

Kobayashi *et al.* (2018) and Drennan *et al.* (2019) used molecular techniques to study the taxonomy and systematics of Sternaspidae, but the definition of most sternaspid taxa still relies on morphological characters with the enigmatic ventro-caudal shield being the most prominent. Three genera and respective body patterns were distinguished by Sendall & Salazar-Vallejo (2013) in their revision of *Sternaspis*. Their definitions were based on morphological characters of the shield, the introvert hooks and the number of pre-shield abdominal segments. Ventro-caudal shields are described as “stiff” for *Sternaspis* and *Petersenaspis* with loose sediment cover easily brushed off, while shields in *Caulleryaspis* are described as “soft” and easily bent or pliable with sediment firmly adhered. In this case the sediment cover obscures surface structures from observation, i.e., ribs and concentric lines as described for *Sternaspis* and ribs only for *Petersenaspis*.

The ventro-caudal shield consists of a framework of fibres and mineralized iron (Bartolomaeus 1992), providing it with a certain degree of firmness. According to Sendall (2006: 19), the distinction between its stiff- or softness is best tested by trying to bend its margin. In *Mauretanaspis longichaeta* gen. et spec. nov. the shield margins merge into the integument without forming free margins and thus the shield cannot be tested for its firmness. We consider this character of limited value for a generic distinction, supporting a view that has recently been suggested by Drennan *et al.* (2019) based on molecular results.

With our definition of *Mauretanaspis* gen. nov. we agree with Drennan *et al.* (2019) and consider the adherence of sediment to the ventro-caudal shield, i.e., ‘firmly adherent’ (not removable) versus ‘loosely attached’ (easily brushed off), more meaningful for the distinction among genera in combination with other characters as mentioned in Table 2. Following the results of Drennan *et al.* (2019), *Caulleryaspis nuda* Salazar-Vallejo & Buzhinskaja, 2013 is excluded from the identification key, because the combination of the shield characters ‘soft, pliable margin’ and ‘loosely adhered layer of sediment’ are not distinctive enough to include this species in the genus *Caulleryaspis* (see Drennan *et al.* 2019). Likewise, *Caulleryaspis villamari* Salazar-Vallejo & Buzhinskaja, 2013 and *C. nana* (Zhadan, Tzetlin & Salazar-Vallejo, 2017) were described with ventro-caudal shield free of sediment particles leaving weakly developed shield structures visible. Therefore, the placement of these two species in *Caulleryaspis* appears questionable and consequently they are not included in the identification key presented above.

Due to their small size and the lack of indications of sexual maturity, all our specimens of *Mauretanaspis longichaeta* gen. et spec. nov. might be considered juveniles. However, sexually mature females in specimens of comparable size were reported for *Caulleryaspis nana*, a species occurring in shallow waters of the South China Sea. A progenetic origin was hypothesized accordingly (Zhadan *et al.* 2017). A comparison of the chaetation of *Mauretanaspis longichaeta* gen. et spec. nov. with other sternaspids shows that number and development of chaetae is comparable to larger specimens of other species and that the striking length of the posteriormost lateral chaetae is unique. Typically, juvenile characters for Sternaspidae appear to be a distinctive papillation of the body with longer papillae including the surface of the ventro-caudal shield as shown by Zhadan *et al.* (2017) for *Sternaspis papillosa* Zhadan, Tzetlin & Salazar-Vallejo, 2017. Our animals show only minute body papillae, comparable to those found in presumed adults of other sternaspid species, another argument in favour of establishing the new genus

and species. We only consider the smallest specimens examined, i.e., from stations S48-3A (MNHN-IA-PNT 120), S48-8A (SMF 28061), S48-14C (MNCN 16.01/18762) and S48-23B (DBUA0002349.01) off Angola, as juveniles because of the absence of gonopodial lobes which we see as an indication that these specimens are indeed not yet sexually mature.

Acknowledgements

Our sincere thanks go to Tony Savaira at TOTAL E&P Mauritania (Nouakchott, Mauritania) and Tatiana Gusachenko at TOTAL headquarters (Paris, France) for allowing us to study these highly interesting deep-sea polychaetes from Block C9 off Mauritania. We are deeply indebted to the benthic ecologist team at CREOCEAN (Montpellier, France) for collecting the samples and especially to Romain Le Gall, Sébastien Thorin and Eric Dutrieux for entrusting the marine team at THOMSON ENVIRONMENTAL CONSULTANTS (Guildford, UK) to provide a biodiversity assessment of the sampled area off Mauritania and likewise entrusting Daniel Martín and João Gil (both Blanes, Spain) with the analysis of samples taken off Angola. RB wishes to thank her colleagues at THOMSON for help in extracting and discussing the identity of these fascinating animals. We also thank Danny Eibye-Jacobsen (Copenhagen) and Sergio Salazar-Vallejo (Chetumal) for information and pictures of the specimen identified as *Sternaspis scutata* by Kirkegaard (2001). Last but not least, we thank João Gil and an anonymous reviewer for their thoughtful comments which helped to improve the manuscript, and Daniel Martín and João Gil for generously providing us with the interesting specimens collected off Angola.

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Manuscript received: 11 March 2020

Manuscript accepted: 3 July 2020

Published on: 10 August 2020

Topic editor: Rudy Jocqué

Desk editor: Eva-Maria Levermann

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Jahr/Year: 2020

Band/Volume: [0699](#)

Autor(en)/Author(s): Fiege Dieter, Barnich Ruth

Artikel/Article: [A new genus and species of Sternaspidae \(Annelida: Polychaeta\) from the deep eastern Atlantic 1-13](#)