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A new species of *Ninoe* (Annelida: Lumbrineridae) from the continental shelf off southern Namibia

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Research Article

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Abstract

Despite an increase in the number of new lumbrinerid descriptions globally and over recent decades, no new lumbrinerid species have been described from southern Africa over the last 40 years. This suggests that species richness in the region is currently underestimated, and that continued research would result in the discovery of more undescribed species. Here, a new species is described from grab samples collected off southern Namibia at >100 m depth. *Ninoe namibiensis* sp. nov. is characterized by simple multidentate hooded hooks with a long hood that only appears after chaetiger 18, branchiae from chaetiger 1–2 to 38 (with up to 7 filaments) and maxillary apparatus: MX III with one prominent tooth followed by a knob and MX IV unidentate with finely denticulate cutting edge (11 small teeth). A key to the *Ninoe* from southern Africa is provided.

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Introduction

The Lumbrineridae Schmarda, 1861 have more than 200 valid species across 19 genera and are a globally abundant and diverse family of polychaetes that are common in the muddy and sandy bottoms of continental shelves (Carrera-Parra, 2006; Gómez *et al.*, 2016; Zanol *et al.*, 2021). Lumbrinerids are typically burrowers but can also be found in association with other invertebrate groups (i.e. sponges, bryozoans and sea urchins), and are regarded as having a simple body shape and reduced external features (Carrera-Parra & Orensanz, 2002; Aguirrezabalaga & Carrera-Parra, 2006; Carrera-Parra, 2006). *Ninoe* Kinberg, 1865 is a genus that comprises 32 valid species, easily recognized by the branchiae associated with the parapodia on anterior segments (Carrera-Parra, 2006; Read & Fauchald, 2018). Characteristics associated with its maxillary apparatus such as pigmentation, placement and arrangement of teeth may further diagnose species within this genus (Carrera-Parra, 2006).

At least 13 valid lumbrinerid species are known to occur in Namibia (see Day, 1967; Miura, 1980; Read & Fauchald, 2022). Among them, only one species belonging to this family has ever been described from Namibian waters, *Ninoe desbruyeresi* Miura, 1980 (see Day, 1967; Miura, 1980; Read & Fauchald, 2022). Considering that over the last two decades alone six new genera have been erected and more than 40 new species described globally within Lumbrineridae (Aguirrezabalaga & Carrera-Parra, 2006; Cai & Li, 2011; Carrera-Parra *et al.*, 2011; Martins *et al.*, 2012; Arias & Carrera-Parra, 2014; D'Alessandro *et al.*, 2014; Kurt-Sahin *et al.*, 2016; Katsiaras *et al.*, 2018; Borisova & Budaeva, 2020; Borisova & Budaeva, 2022), at least four of which belong to *Ninoe* (Carrera-Parra, 2001; Hernandez-Alcantra *et al.*, 2006), the diversity within this region may be underestimated. Further, exploitation of mineral resources, especially the extraction of diamonds off southern Namibia, continues to reveal species that cannot be identified using local or regional guides thereby highlighting the limited research conducted in describing faunal communities in this region and the anticipation that many more undescribed species may be found (see Glasby & Alvarez, 1999; Hutchings & Kupriyanova, 2018; Simon *et al.*, 2022). Here, a new species of *Ninoe* is described from samples collected during a survey conducted by Anchor Environmental Consultants (Pty) Ltd and Debmarine Namibia. This species represents the first new record of *Ninoe* from Namibia in four decades.

Methods and materials

Materials were collected from 9 stations during a benthic grab-sampling survey conducted along the southern coast of Namibia in October 2019 (Table 1). A Van Veen grab with a sample area of 0.2 m^2 which penetrates to 20 cm depth was used to collect sediment samples. The samples were sieved through a 1 mm sieve bag and rinsed with filtered seawater. Freshly collected specimens were sorted under a dissecting microscope and preserved in 90% ethanol. Fixed individuals were stained with rose Bengal and examined under either a compound

Table 1. Characteristics of the sample sites in southern Namibia where *Ninoe namibiensis* sp. nov. were collected

Station	Collection date	Latitude S	Longitude E	Depth (m)	Sediment characteristics
CD 28E	28 October 2019	28.6261138	15.8689785	136	Silt & very fine sand
CD 31C	27 October 2019	28.6391129	15.8238850	146	Silt & very fine sand
CD 31I	27 October 2019	28.6391220	15.8238748	146	Silt & very fine sand
CD 35C	1 November 2019	28.5967718	15.8119674	141	Silt to very fine sand
CD 35H	1 November 2019	28.5967448	15.8119570	141	Silt
CD 36H	28 October 2019	28.6237034	15.8197956	142	Silt
CD 37H	28 October 2019	28.6187059	15.8237768	140	Silt
CD 38C	28 October 2019	28.6137020	15.8108804	140	Silt to fine sand
CD 38H	28 October 2019	28.6137387	15.8107886	140	Silt to fine sand

(Leica DM 1000) or dissecting microscope (Leica MZ75). To better examine the details of the jaw structure, the maxillae and mandible were extracted by making an anteroventral dissection, placed on a temporary mount and examined under a compound and dissecting microscope. Photographs were taken of preserved individuals using a Leica MC190 HD camera attached to a Leica DM4B LED compound microscope and a Leica S9i dissecting microscope. Permanent slides of parapodia were prepared in DPX mounting medium and sealed with clear nail varnish. Morphological line drawings were prepared using a camera lucida attached to a dissecting microscope. Associated camera software, Leica LAS EZ. V1.5.0, was used to take length and width measurements of specimens on each photograph. Tissue samples preserved in 99% ethanol were submitted to the African Centre for DNA Barcoding for sequencing. For scanning electron microscopy (SEM), specimens were dehydrated through a series of washes in 80 and 100% ethanol for a few hours respectively, then one wash in hexamethyldisalazane (HDMS) for 15 min, without critical point drying. The specimens were then left overnight for residual HMDS to evaporate off. Specimens were placed directly into the environmental chamber and scanned using the Iziko South African Museum's Hitachi TM4000 Plus Desktop SEM. All the material collected on behalf of Debmarine Namibia was deposited at the Iziko South African Museum, Cape Town. We describe the holotype with variation in paratypes indicated in parentheses where different. Body length measurements begin at the anteriormost point of the prostomium.

Results

Systematics

Family LUMBRINERIDAE Schmarda, 1861
Genus *Ninoe* Kinberg, 1865
Ninoe namibiensis sp. nov.
(Figures 1–3)

Material Examined

Holotype: Complete specimen, silt and very fine sand, 136 m depth (SAMC-A094450), preserved in ethanol. Off southern Namibia, SE Atlantic Ocean (28.626°S 15.868°E), 28 October 2019, Coll. Anchor Environmental Consultants (Pty) Ltd, det. S. Sedick, D. Clarke. Paratypes: Complete specimens (2), silt, 140–146 m depth (SAMC-A094456, SAMC-A094457), dried and prepared for scanning electron microscopy. Off southern Namibia, SE Atlantic Ocean (28.6137°S 15.8107°E), 28 October 2019, Coll. Anchor Environmental Consultants (Pty) Ltd, det. S. Sedick, D.Clarke. Additional material: (8) incomplete specimens (SAMC-A094451) and 1 complete specimen (SAMC-MB-A094460), preserved in ethanol, data as for holotype.

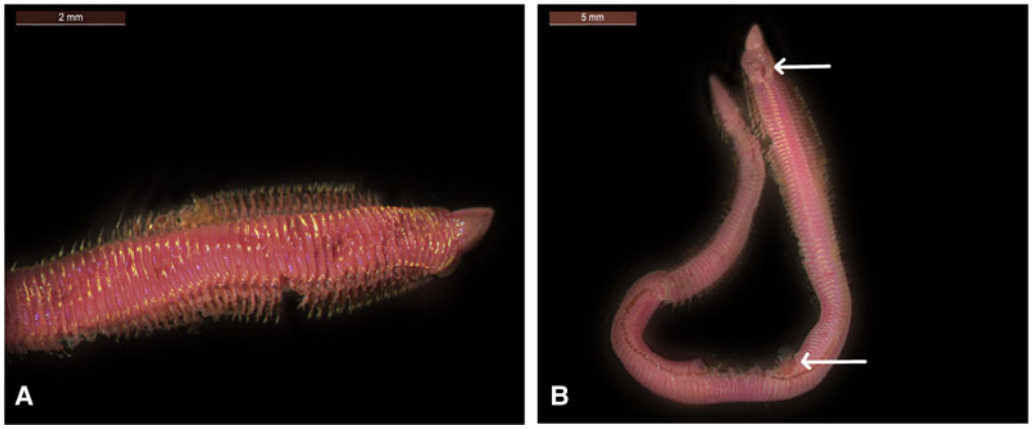

Fig. 1. *Ninoe namibiensis* sp. nov. (A) Anterior end, dorsal view, stained with rose Bengal; (B) whole specimen, ventral view, showing dissection scars for jaw examination and tissue sampling for DNA sequencing. All from holotype.

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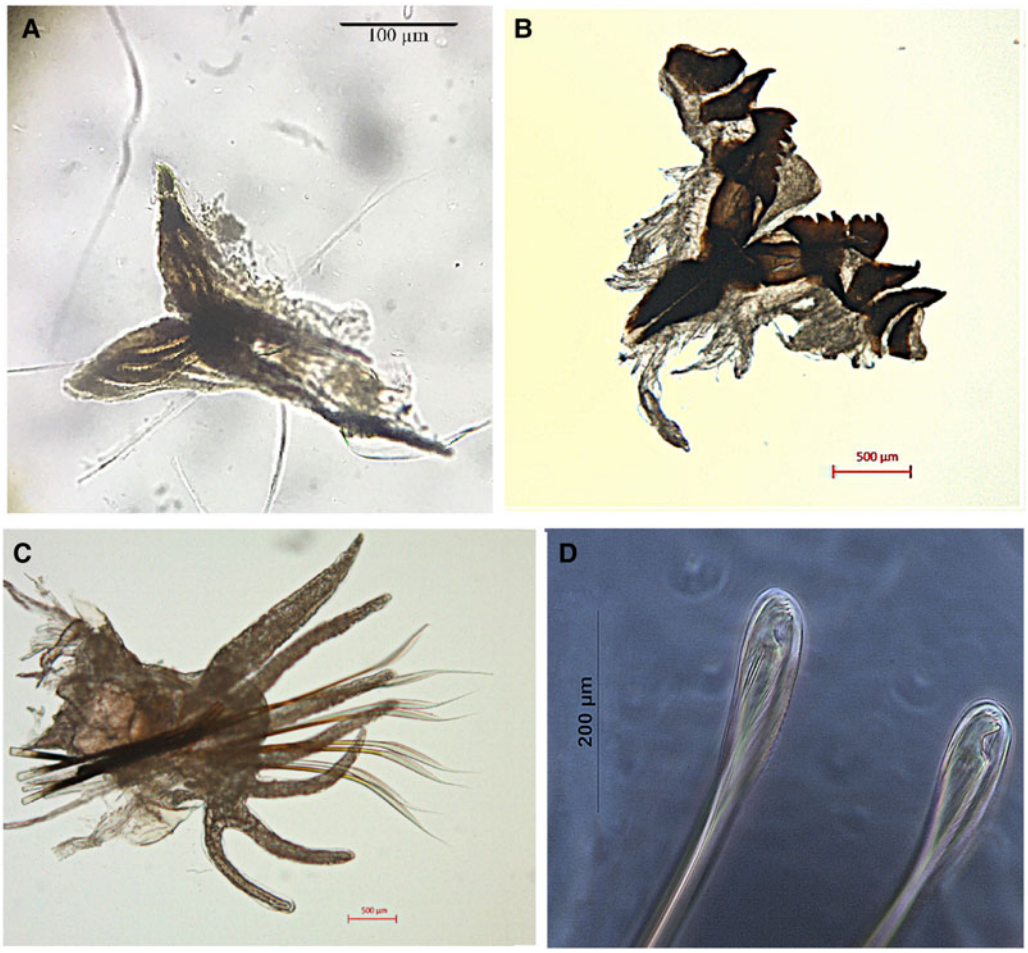

Fig. 2. *Ninoe namibiensis* sp. nov. Dorsal view of (A) mandible, (B) maxillae and (C) parapodium with maximum number of branchiae from chaetiger 19 showing limbate chaetae, aciculae, branchiae, posterior chaetal lobe. (D) Multidentate hooded hook with short hood from posterior chaetiger. A from paratype, B–D from holotype.

Diagnosis

Ninoe namibiensis sp. nov. is characterized by a prostomium that is longer than broad, simple multidentate hooded hooks (SMHH) with long hood appearing after chaetiger 18, branchiae from chaetigers 1–2 to 38 (with up to 7 filaments) and maxillary apparatus: MX III with a prominent tooth followed by a knob and MX IV unidentate with a finely denticulate cutting edge (11 teeth).

Description

Live specimens iridescent light brown but pale after preservation. Holotype complete with 178 chaetigers: 35 mm long and 2 mm wide at chaetiger 10, including parapodia (20–25 mm for 102–130 chaetigers) (Figures 1A, B & 3A). Body long, slender. Prostomium with pointed distal end, longer than broad. Dorsal longitudinal furrows diverge posteriorly (dorsal slitlike organs sensu Orensanz, 1990), 3/4 length of prostomium (Figures 1A & 3A). No eyes. Peristomium two apodous rings, distinct dorsally and laterally, first ring dorsally 1.5 times wider than the second ring (Figures 1A, 3A & 4A). Maxillary apparatus: MI unidentate, curved, MII with 6 teeth, MIII unidentate, 1 prominent tooth followed by a knob, no cutting edge, MIV unidentate with finely denticulate cutting edge comprising 11 small teeth (10–12 small teeth) (Figures 2B & 3F). Mandibles slender, anterior ends slightly flared (Figure 2A). Parapodia well-developed, single lobe, prechaetal lobe low and rounded throughout, post-chaetal lobe tapering. Branchiae attached posterior to chaetae from chaetiger 1–2 to 38, 2–7 filaments from chaetiger 3 onward (2–4 to 32–40; 2–7 filaments from chaetiger 3–4 onwards) (Figure 2C). Limbate chaetae with well-developed brim from chaetiger 1–37, up to 12 per parapodia in anterior body region (Figures 2C, 3D & 4B) becoming thinner and filliform capillary chaetae from chaetiger 15, extending to posteriormost chaetigers (limbate from chaetiger 1–2, 8–12 per parapodia; capillary chaetae from chaetiger 15–16) (Figures 3E & 4B). Simple multidentate hooded hooks (SMHH) with long hood from chaetiger 18–41, 4–5 small teeth and one prominent tooth (18–34, 5–6 small teeth) (Figure 3B). SMHH with short hood from chaetiger 42 with 6–8 small teeth (from chaetiger 35) (Figures 2D & 3C). Chaetae after branchial region with 1 winged limbate chaetiger, 2–3 filiform chaetae, 1–2 SMHH with short hood having 9 small teeth. Posterior chaetae with 4 SMHH with short hood having 6–8 small teeth. Aciculae black, tapering to a point, up to three in anterior parapodia, 1–2 in midbody and posterior parapodia (Figure 2C). Pygidium with two anal cirri, unarticulated, swollen base.

DNA Barcode

Southern Namibia: Minimal infraspecific variation observed. A total of 22 individuals, including the holotype and paratypes were sequenced. Sequences trimmed to 549–673 bp fragment of the universal COI gene. Edited and uploaded to the Barcode of Life Database (BOLD) and blasted on GenBank using the BLAST algorithm. Queried sequences were matched with low identity.

Habitat

Muddy sediments, 136–146 m.

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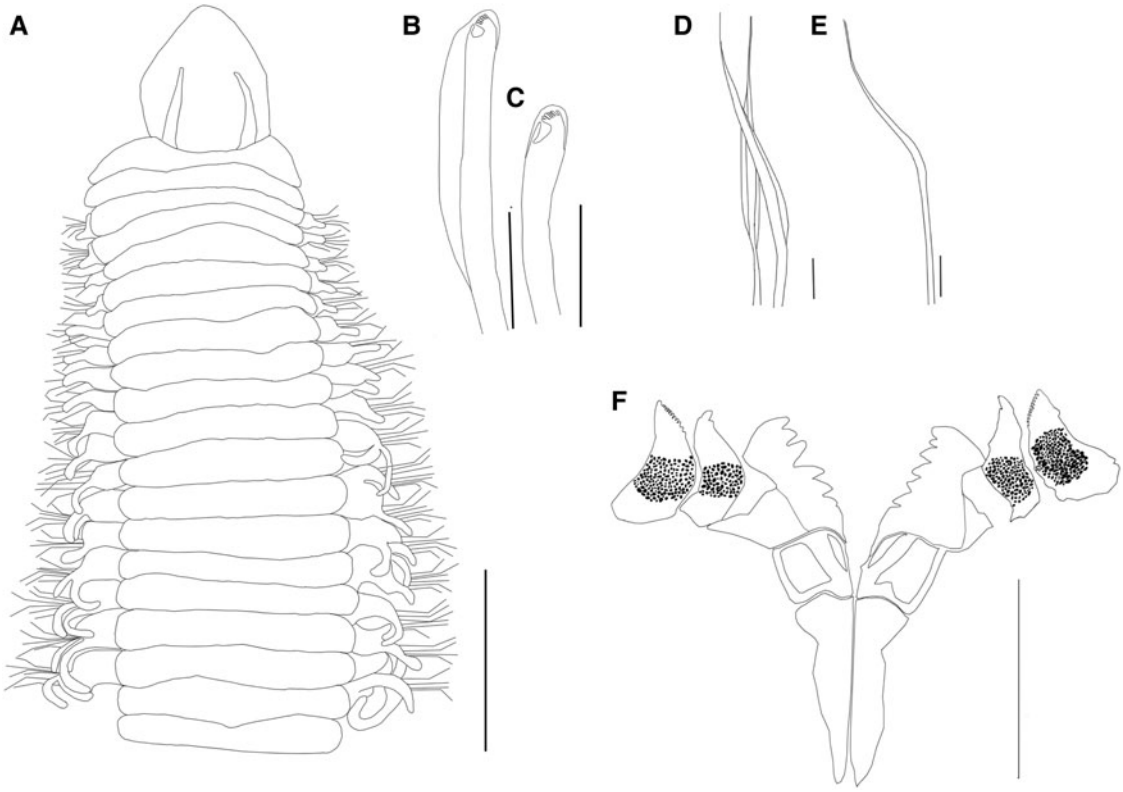

Fig. 3. *Ninoe namibiensis* sp. nov. (A) Anterior end, dorsal view indicating dorsal slit-like organs; (B) multidentate hooded hook with long hood from branchial region; (C) multidentate hooded hood with short hood from posterior chaetiger; (D) limbate chaetae from anterior region; (E) extended filiform limbate chaetae from posterior region; (F) maxillae. Scale: A = 1 mm; B, C = 200 µm; D, E = 20 µm; *F* = 500 µm. All from holotype.

Distribution

Southern Namibia, SE Atlantic Ocean.

Etymology

This species was named after the region where it was discovered.

Remarks

Ninoe desbruyeresi, *Ninoe dibranchia* Hartman & Fauchald, 1971, *Ninoe digitissima* Augener, 1918, *Ninoe falklandica* Monro, 1936, *Ninoe saeva* Intes & Le Loeuff, 1975, *Ninoe oculata* Kinberg, 1865, *Ninoe nigripes* Verrill, 1873 and *Ninoe lagosiana* Augener, 1918 all either have a type locality or are distributed in the Atlantic Ocean. While they may all resemble each other at the generic level, at the species level some of the differences between these and *N. namibiensis* sp. nov. become obvious: *N. dibranchia* has two different types of branchiae (i.e. small, triangular lobe with vascular loop and, papillated tufts with a vascular loop); *N. digitissima* is yellow-grey to brown with yellow-brown needle-like aciculae; *N. falklandica* has anterior parapodia that appear to have two bundles of chaetae; *N. oculata* has two eyes and no obvious dorsal slitlike organs (Kinberg, 1865; Augener, 1918; Monro, 1936; Hartman & Fauchald, 1971); whereas the new species has only one type of branchiae (i.e. finger-like projections that extend from the posterior parapodial lobe), is pale after preservation, has one to three black aciculae in parapodia, is without eyes and with obvious distinct dorsal slit-like organs.

The differences between the remaining species and *N. namibiensis* sp. nov. are subtle and require closer examination. While *N. desbruyeresi* is described from the same region but in sediments at a greater depth (>1000 m), it differs from the former in having a more conical prostomium, mandibles with shorter shafts and u-shaped tips, unidentate maxillary apparatus (MX III & MX IV), SMHH with long hood appearing on chaetiger 1 and four SMHH with long hood appearing in parapodia with the maximum number of branchiae (Miura, 1980). The new species has a subglobular prostomium, mandibles with long shafts and flared, pigmented tips, and maxillary apparatus that are crenulate with small teeth.

Ninoe saeva differs from the new species in that branchiae appear later (on 4th chaetiger), SMHH with long hood appear earlier (on chaetiger 12) and bear 6 teeth, SMHH with short hood have about ten teeth (Intes and Le Loeuff, 1975). The branchial region for the new species begins on chaetiger 1–2 and persists to chaetiger 38, SMHH with long hood appear after chaetiger 18 (4–5 small teeth and one prominent tooth) and SMHH with short hood have 9 small teeth.

Ninoe lagosiana and *N. nigripes* are both pigmented in the anterior region and have chaetae with a black core from the base to near the tip and mandibles with two internal black bands, respectively (Verrill, 1873; Augener, 1918) whereas *N. namibiensis* is pale after preservation and unpigmented. The branchiae begin later in both the former species (on the 15th and 3rd chaetiger, respectively with up to five branchial filaments) whereas the branchiae of the new species begin on the first or second chaetiger and have up to seven branchial filaments. SMHH with short hood are comb-like in *N. lagosiana* having 12 marginal teeth whereas *N. namibiensis* has up to 9 apical teeth.

Despite the extensive sampling survey that was conducted, it seems that the new species is found almost exclusively in unconsolidated sediments at greater sampling depths (>100 m). This is consistent with the most recent descriptions of new species of *Ninoe* from elsewhere in the world. For example, *Ninoe jessicae* Hernández-Alcántara *et al.*, 2006 and *Ninoe marthae* Hernández-Alcántara *et al.*, 2006 from the Mexican Pacific were recorded in silty sands and muddy sands at depths of 20–120 m and, 85 and 600–2700 m, respectively (Hernández-Alcántara *et al.*, 2006). Similarly, *Ninoe vargasi* Carrera-Parra, 2001 and *Ninoe wardae*

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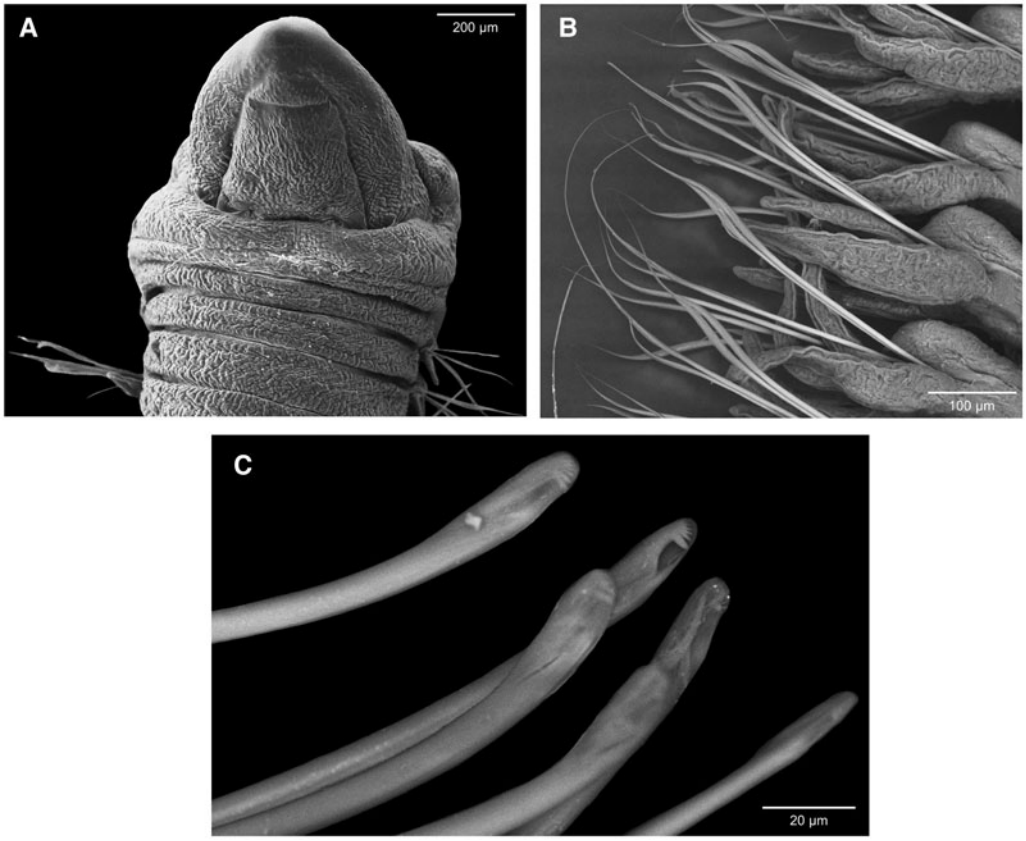

Fig. 4. *Ninoe namibiensis* sp. nov. Dorsal view of (A) anterior end indicating dorsal slit-like organs; (B) four parapodia from anterior body showing postchaetal parapodial lobes, branchiae and limbate chaetae; (C) multidentate hooded hooks with short hood from branchial region, chaetiger 19. All from paratype.

Carrera-Parra, 2001 were described from the Grand Caribbean in sediments at depths of 22–221 and 175 m, respectively (Carrera-Parra, 2001). This, together with the fact that the deeper waters around southern Africa are under-sampled (Griffiths *et al.*, 2010) suggests that there may be more undescribed taxa off the southern African coast.

Key to *Ninoe* Species from Southern Africa

With the new species reported here, there are now two *Ninoe* species that are indigenous to southern Africa. Below we provide a key to the *Ninoe* fauna of southern Africa:

(1) Simple multidentate hooded hooks with long hood present from chaetiger 1…*Ninoe desbruyeresi* Miura, 1980
- Simple multidentate hooded hooks with long hood present on or after chaetiger 18…**2**

(2) Prostomium longer than broad, simple multidentate hooded hooks with long hood appear on chaetiger 18, simple multidentate hooded hooks with short hood having nine apical teeth, branchia begin on first or second chaetiger and end on chaetiger 38….*Ninoe namibiensis* sp. nov.
- Prostomium conical, simple multidentate hooded hooks with long hood appear on chaetiger 37, simple multidentate hooded hooks with short hood comb-like with 12 marginal teeth, branchia begin on the 15th chaetiger and end on chaetiger 36…..*Ninoe lagosiana* Augener, 1918

Data availability. The authors confirm that the data used to support this study are available.

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Author contributions. SS and DC examined specimens and compiled the description of the new species. AB and KG conducted all fieldwork and preliminary labwork (sorting samples, preliminary identification and preservation of specimens). All authors contributed to the design of the study. All authors have read and approved the final version of the manuscript.

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Conflict of interest. The authors confirm that there are no conflicts of interest.

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