



Description before extinction: a new genus and ninth species of indigenous Polydesmida from Madagascar (Polydesmida: Dalodesmidae)

TIZIANO GOLLES^{1,2,*}, JEHOON YOO^{1,2,3} & THOMAS WESENER^{1,4}

¹Zoological Research Museum Alexander Koenig (ZFMK), Leibniz Institute for the study of biodiversity change (LIB), Section Myriapoda, Adenauerallee 127, D-53113 Bonn, Germany.

²University of Bonn, Regina-Pacis-Weg 3, 53113 Bonn, Germany.

³✉ protoss.yoo@gmail.com; <https://orcid.org/0009-0007-6374-3660>

⁴✉ t.wesener@leibniz-lib.de; <https://orcid.org/0000-0002-2028-3541>

*Corresponding author: ✉ gollestiziano98@gmail.com; <https://orcid.org/0009-0005-5792-1796>

Abstract

Madagascar's microendemism is not restricted to large rainforests, but also still exists in small, isolated fragments of natural vegetation. One such fragment is the Lavasoa-Ambatotsirongorongo protected area in southeastern Madagascar, where less than 92 ha of humid forest continue to face deforestation, but to which several species are endemic and critically endangered, including three species of millipedes. Here, we describe *Alafanahydesmus lavasoa* **gen. nov., sp. nov.** (Polydesmida: Dalodesmidae), a locally endemic Polydesmida only found in the Lavasoa-Ambatotsirongorongo area. With our here described addition, Polydesmida remain rare on Madagascar, with only four genera and nine known species, all belonging to the family Dalodesmidae. *Alafanahydesmus lavasoa* **gen. nov., sp. nov.** shares its small size (10–25 mm) and light/brown colouration with *Dalodesmus* Cook, 1896, *Eutubercularium* Brölemann, 1916, and *Phymatodesmus* de Saussure & Zehntner, 1897, but differs conspicuously in somatic (paraterga projecting weakly before tergite 6, elongated shape of metatergal tubercles, paraprocts (pa) with dorsal setose knobs) and sexual characters (stoutly fused femorites and a unique five-branched gonopod with a retrorse branch). Here, we describe *Alafanahydesmus lavasoa* **gen. nov., sp. nov.** integratively, providing the first molecular data for Malagasy Dalodesmidae—via partial cytochrome c oxidase I (COI) sequences (GenBank PX922879–PX922581) and pioneer the first microcomputed tomography (μ CT) images for a member of the family, alongside with multilayer photographs and scanning electron microscopy images.

Key words: biodiversity, cytochrome *c* oxidase I gene, Lavasoa, μ CT, microendemism

Introduction

Madagascar is a country globally recognised for its exceptional concentration of terrestrial endemism, with several animal groups showing outstandingly restricted distributions (Omollo *et al.* 2024). The island pattern of microendemism has been linked to historical fragmentation of river catchments and refugial areas during palaeoclimatic fluctuations, processes that shape and favour the emergence of narrowly distributed taxa (Vences *et al.* 2009; Wilme *et al.* 2006). Unfortunately, Madagascar is also classified as one of the world's most threatened biodiversity hotspots, representing high endemic richness suffering from habitat loss and degradation, mainly driven by anthropogenic activities such as deforestation and land-use change (Myers *et al.* 2000; Gould & Sauther 2007; Irwin *et al.* 2010; Tsiavahananahary *et al.* 2025). Between the mid-20th century and the early 21st century, Madagascar experienced a loss of 40–45% of its original forest cover, with the ongoing fragmentation exacerbating the extinction risk for forest-dependent and microendemic taxa (Schwitzer *et al.* 2014; Murphy 2015; Vieilledent *et al.* 2018; Tsiavahananahary *et al.* 2025).

The Lavasoa-Ambatotsirongorongo massif, located in southeastern Madagascar, houses fragments of isolated humid forests, situated in between spiny forest vegetation and littoral forests (Thiele *et al.* 2013). These woodlands previously covered a significantly wider area, but the rapid increase of deforestation during the last century reduced them to just a mosaic of small fragments. Currently, the remaining humid forests are confined to just three principal

locations, Lavasoa, Bemanasa, and Ambatotsirongorongo; combined amounting to less than 92 ha of rainforest (Roberts *et al.* 2023). Despite their small size, their geographical isolation plays a key role in forming highly distinctive biological assemblages (Antonelli *et al.* 2022). Remarkably, the remaining 54 ha of the Lavasoa forest fragment alone harbours an exceptionally high lemur density, surpassing that of the much larger Andohahela National Park, and hosts narrowly endemic taxa like the mouse lemur (Hotaling *et al.* 2016), currently reported only in this region (Thiele *et al.* 2013; Hotaling *et al.* 2016; Eppley *et al.* 2020; Roberts *et al.* 2023).

The unique and highly threatened fauna of the Lavasoa massif also includes diverse habitat-restricted millipede species, among them the IUCN critically endangered *Sphaeromimus lavasoa* Wesener in Wesener *et al.*, 2014 (Wesener & Rudolf 2020a), *Granitobolus endemicus* Wesener in Wesener *et al.*, 2009 (Wesener & Rudolf 2017), and *Zoosphaerium alluaudi* (de Saussure & Zehntner, 1902) (Wesener & Rudolf 2020b), underlining the conservation importance of these forest patches for Malagasy Diplopoda (Wesener 2009; Wesener & Enghoff 2022). The millipede fauna of Madagascar is highly diverse and plays important ecological roles within the forest leaf litter environment, where many lineages are characterised by restricted habitat ranges, as a consequence of reduced dispersal potential and niche habitats (Wesener & Enghoff 2022). Such traits promote strong microendemism but concurrently render these taxa remarkably susceptible to habitat fragmentation and environmental disturbances. Among these, the order Polydesmida still remains mostly undocumented and undescribed on Madagascar, and recent systematic research continues to reveal undescribed species linked to highly localized habitats (Wesener *et al.* 2025). Despite recent taxonomic progress, the Malagasy Polydesmida fauna remains strongly species-poor compared to other tropical regions (Hilgert *et al.* 2019), an uncommon pattern that most likely reflects both historical undersampling and other biogeographic constraints (Enghoff 2003; Wesener *et al.* 2025). Currently, the indigenous Polydesmida fauna of Madagascar comprises only eight species documented across three genera, six in *Dalodesmus* Cook, 1896, and one each in *Eutubercularium* Brölemann, 1916, and *Phymatodesmus* de Saussure & Zehntner, 1897 (Wesener *et al.* 2025).

In this study, we describe integratively a new, fourth genus from the Lavasoa forest complex, including diagnostic morphological data and a comparative systematic context to support future biogeographic and conservation assessments.

Material and methods

Photography: Multi-layer photographs of the specimens were taken with a MicroPublisher 5.0 camera mounted on an RTV Leica Z6 Apo stereo microscope. Images were taken prior to dissection to record the habitus and diagnostic external characters. Thereafter, the morphological structures relevant for species diagnosis and delimitation were dissected under a ZEISS Discovery.V12 stereo microscope with a ZEISS Plan S 1.0x FWD 81mm optic.

Scanning electron microscopy (SEM): After dissection the isolated morphological structures were put from 96% ethanol into 100% ethanol twice for an hour each and then air dried overnight, mounted on aluminium SEM stubs using double adhesive Teflon, and sputtered three times with approximately 100 nm of gold in a vacuum using a Cressington 108 Auto vacuum coating system, with argon used as the air replacement. The sputtered samples were then observed and photographed using a Tescan CLARA scanning electron microscope located at the Bonn Institute for Organismic Biology.

Micro-computed tomography (μ CT): Scans of one male paratype specimen were acquired using a Bruker SkyScan 1272 micro-CT scanner at the ZFMK. The specimen was scanned to obtain additional morphological data and to document diagnostic characters potentially relevant for species delimitation. Scanning was performed using an X-ray source voltage of 45 kV and a current of 200 μ A, with an exposure time of 700 ms. Image stacks were acquired with an isotropic voxel size of 4.000051 μ m. This stack is available at Zenodo (Vehof *et al.* 2026). Reconstruction of the Z-stack was carried out using NRecon software (v2.2.0.6, Bruker micro-CT, Kontich, Belgium 2024). The reconstructed image stacks were subsequently processed for three-dimensional visualisation and analysis. Volume rendering and surface reconstruction were performed in 3D Slicer (v5.10.0, Fedorov *et al.* 2012). Semi-automatic segmentation was conducted using the Segment Editor module, applying a lower threshold value of 40.00 to reduce scanning artefacts and background noise. The segmentation was further refined using smoothing with a kernel size of 3.0 mm and removal of small isolated islands. The resulting three-dimensional models were used for morphological analysis and visualisation.

Specimens and image plates: All collected specimens were, according to the research and export agreement, shared between depositories on Madagascar and Germany. More than half of the specimens collected in 2007 were already deposited at the University of Antananarivo. Image stacking (Z-stack) was performed to increase depth of field before final processing and plate assembly. The SEM and multi-layer images were then processed using Adobe Photoshop (version 26.1.0) and Adobe Illustrator (version 29.1). The SEM images of the gonopod branches have been colour coded as follows: #c72828 for sl, #1a803b for db, #622e88 for rb and #f0c300 for pb. Colour coding was applied consistently across all SEM plates to facilitate comparison of homologous structures, and the selected colour codes were chosen to maximise contrast and to remain distinguishable under common colour-blind limitations.

Map: The distribution map was made using Google Earth Pro (version 7.3.6.10441) and QGIS (version 3.22.16, Dawson *et al.* 2026). Forest boundaries and sampling localities were first delineated and georeferenced in Google Earth Pro and subsequently imported into QGIS, where they were converted into separate vector layers. Satellite imagery from ESRI World Imagery was used as a basemap (ESRI *et al.* 2021). City locations were obtained from the Natural Earth Data “Populated Places” dataset (1:10m scale; Cultural vectors, Kelso & Patterson 2010), imported into QGIS for cartographic processing, and spatially filtered and refined to include Madagascar only. The final map layout was exported at high resolution and further processed for publication in Adobe Photoshop (version 25.5.1) and Adobe Illustrator (version 28.3).

DNA extraction, amplification, sequencing, and analysis: The specimens were directly preserved in 96% ethanol. Walking legs were dissected from the specimens under a ZEISS Discovery.V12 stereo microscope with ZEISS Plan S 1.0x FWD 81mm optic and moved to Eppendorf tubes filled with 96% ethanol. The DNA extraction and PCR protocol to analyse the COI barcoding gene was similar to that employed in earlier studies (Wesener 2015; Sagorny & Wesener 2017; Wesener 2019; Wilbrandt *et al.* 2015), and utilised the degenerate HCO-JJ/LCO-JJ primer pair (HCOJJ AWACTTCVGGRTGVCCAAARAATCA / LCOJJ CHACWAAYCATAAAGATATYGG) (Astrin & Stüben 2008). The three new sequences have been uploaded to GenBank under the accession code PX922879–PX922581. Sequences were aligned by hand in Bioedit (Hall 1999). Unfortunately, no high-quality COI sequences for the family Dalodesmidae are available, neither for Madagascar nor for the world (GenBank search on 22.01.2026). Our three new sequences were therefore deposited on GenBank for future studies, but no analyses could be conducted.

Abbreviations:

CT = computed tomography

SEM = scanning electron microscopy

ZFMK = Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Germany

M = male

F = female

Results

Taxonomy

Order Polydesmida Pocock, 1887

Family Dalodesmidae Cook, 1896

Remarks: The species described here can be identified as a member of the family Dalodesmidae by the following characters: metazona setose and often tuberculate (Fig. 7A, C); paraterga visible (Figs 4C, 7A, B); coxites of gonopods short, medially fused, while telopodites are much longer than coxites, slender, a setose prefemorite area separated from femorite area, acropodite branching distally, with the solenomere being a distal branch (Fig. 8A–E).

Genus *Alafanahydesmus* new genus

Type species: *Alafanahydesmus lavasoa* sp. nov.

Etymology: The generic name is derived from the Malagasy words *ala* (forest) and *fanahy* (soul, spirit, inner essence), combined with the suffix *-desmus*, commonly used for Polydesmida. The name is treated as masculine.

Distribution: Currently only known from south-eastern Madagascar, the isolated rainforest of the Lavasoa-Ambatotsirongorongo area (Fig. 1).

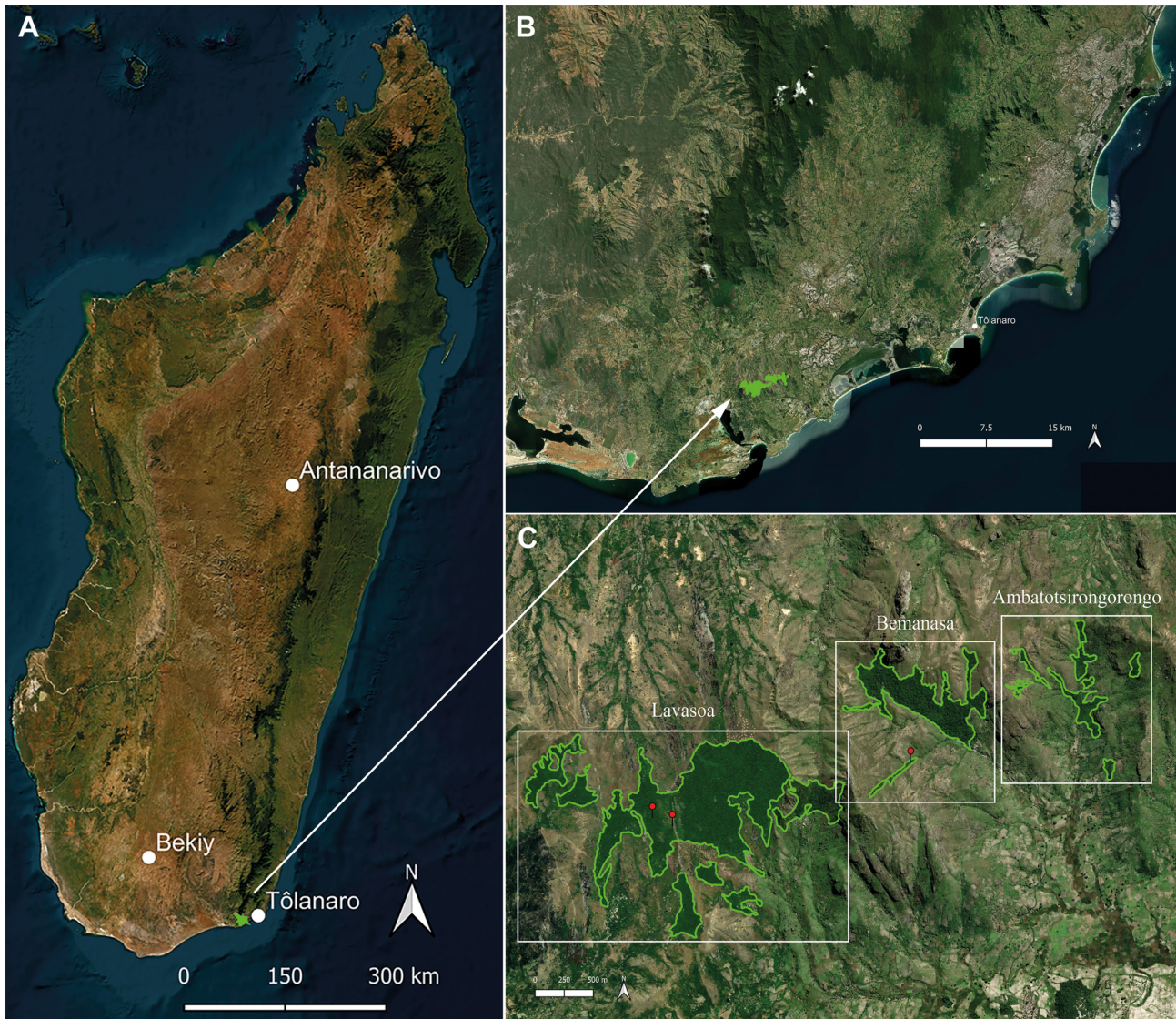


FIGURE 1. Map. Location of surveyed forest fragments in southeastern Madagascar. Location of the study area near Tôlanaro (Fort Dauphin) is shown relative to Madagascar, with major cities indicated. **A.** Overview map of Madagascar showing the position of the study area. **B.** Regional view of southeastern Madagascar highlighting surveyed forest fragments. **C.** Detailed map showing forest boundaries (Lavasoa, Bemanasa, and Ambatotsirongorongo) and *Alafanahydesmus lavasoa* gen. nov., sp. nov. collection sites (red pins), delineated on ESRI World Imagery basemaps from January 2026.

Diagnosis: *Alafanahydesmus* gen. nov. differs in numerous somatic and gonopod characteristics from the other three known genera of the family Dalodesmidae in Madagascar: *Dalodesmus*, *Eutubercularium* and *Phymatodesmus*. The paraterga are only weakly developed, narrow, and barely projecting posteriorly starting with tergite 6 in *Alafanahydesmus* gen. nov. (Fig. 4B), differing from the species of both *Dalodesmus* and *Eutubercularium* in which the paraterga are conspicuous and greatly expanded. The paraterga of *Phymatodesmus* resemble those of *Alafanahydesmus* gen. nov. closest, but are narrower and never project posteriorly. The surface structures of the metaterga in *Alafanahydesmus* gen. nov. are elongated (Figs 4B, 7A, C), while they are circular in *Phymatodesmus*

and rounded in *Dalodesmus* and *Eutubercularium*. *Alafanahydesmus* **gen. nov.** differs from both *Dalodesmus* and *Eutubercularium* in the telson, where the paraprocts carry 2+2 setae on distinct knobs (knobs absent from the latter two genera), a character only shared with *Phymatodesmus*.

In body size, *Alafanahydesmus* **gen. nov.** is with a male length of around 15 mm right between the smaller size of *Phymatodesmus* (10 mm) and the larger sizes of *Dalodesmus* and *Eutubercularium* (18–25 mm).

Alafanahydesmus **gen. nov.** differs in the gonopods, showing stout, fused femorites, followed by each acropodite with five branches (Fig. 8A–E), strongly different from *Dalodesmus* with their elongated femorites. The presence of a retrorse branch (Fig. 8A–E) is unique for Malagasy Dalodesmidae.

Alafanahydesmus lavasoa new species

Figures 2–8

Etymology: Lavasoa, noun in apposition, after the type locality.

Material examined: 1 M holotype, **ZFMK MYR14588** (SEM voucher, GenBank PX922579), Madagascar, Province Toliara, Lavasoa-Ambatotsirongorongo Reserve, Grande Lavasoa, Transect 15, 25.0886° S 46.7395° E, 682 m, rainforest, coll. M. Einhaus & FL. Ravololoniaina, 15.iv.2025.

Paratypes: 1 M, **ZFMK MYR14544** (CT scan voucher), same data as holotype; 1 M, **ZFMK MYR14569**, same data as holotype; 1 F, **ZFMK MYR14566** (GenBank PX922581), Madagascar, Province Toliara, Lavasoa-Ambatotsirongorongo Reserve, Bemanasa (Petit Lavasoa), Transect 11, 25.0850° S 46.7613° E, 335 m, rainforest, coll. M. Einhaus & FL. Ravololoniaina, 08.iv.2025; 1 M, **ZFMK MYR14567** (GenBank PX922581), Madagascar, Province Toliara, Lavasoa-Ambatotsirongorongo Reserve, Grande Lavasoa, Transect C1, path to cave, 25.0892° S, 46.7411° E, 660 m, rainforest, coll. M. Einhaus, 10.iv.2025; 1 F, **ZFMK MYR13919**, Madagascar, Province Toliara, Lavasoa-Ambatotsirongorongo Reserve, Grande Lavasoa, 25.0862° S, 46.7489° E, 680 m, rainforest, coll. T. Wesener & K. Schütte, 14.vi.2007; 1 F and 6 immature, **University of Antananarivo**, same data as previous; 1 M + 3 F, **University of Antananarivo**, Madagascar, Province Toliara, Lavasoa-Ambatotsirongorongo Reserve, Bemanasa (Petit Lavasoa), Transect 11, 25.0784° S, 46.7578° E, 335 m, rainforest, coll. T. Golles & FL. Ravololoniaina, ii.2026; 1 M, **University of Antananarivo**, Madagascar, Province Toliara, Lavasoa-Ambatotsirongorongo Reserve, Grande Lavasoa, Transect 14, 25.0852° S, 46.7487° E, 373m, rainforest, coll. T. Golles & FL. Ravololoniaina, ii.2026.

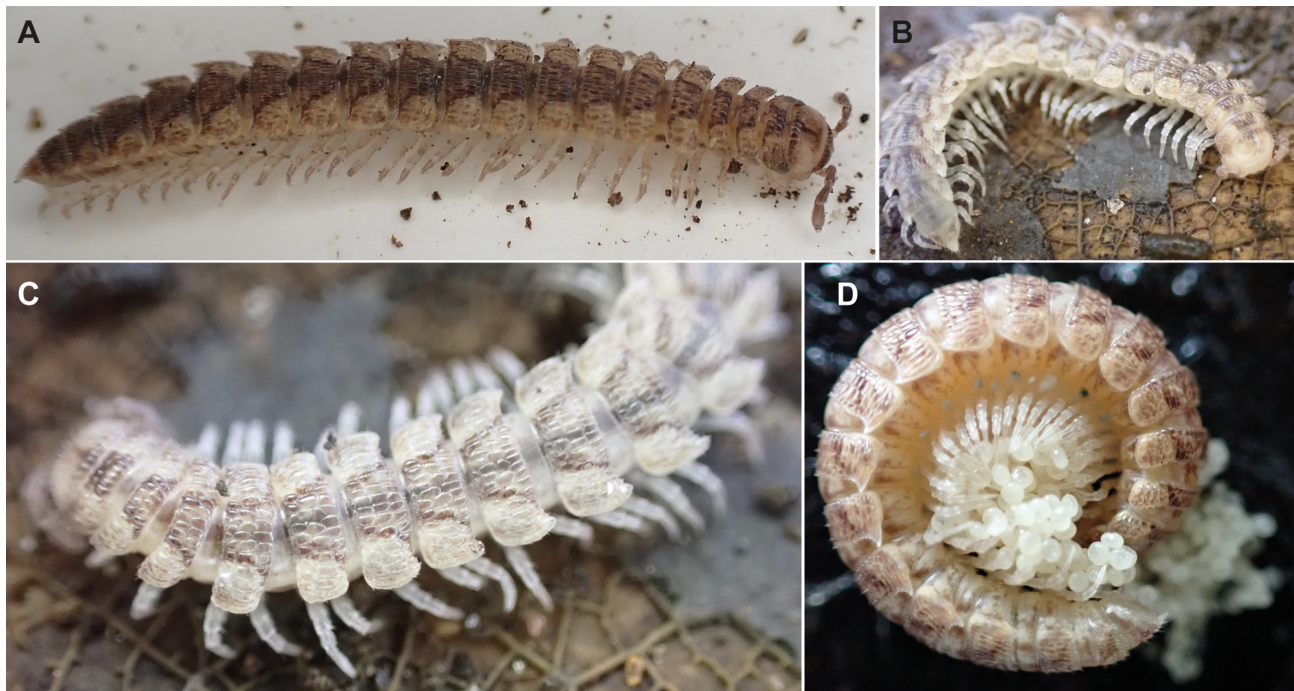


FIGURE 2. *Alafanahydesmus lavasoa* **gen. nov., sp. nov.**, Living specimens, at type locality Lavasoa. Photos taken by Moritz Einhaus in 2025. **A.** Adult female walking, dorsolateral view. **B.** Anterior half of body and head, lateral view. **C.** Midbody segments and legs, close anterodorsal view. **D.** Rolled-up female showing egg-care behaviour, lateral view. Not to scale.

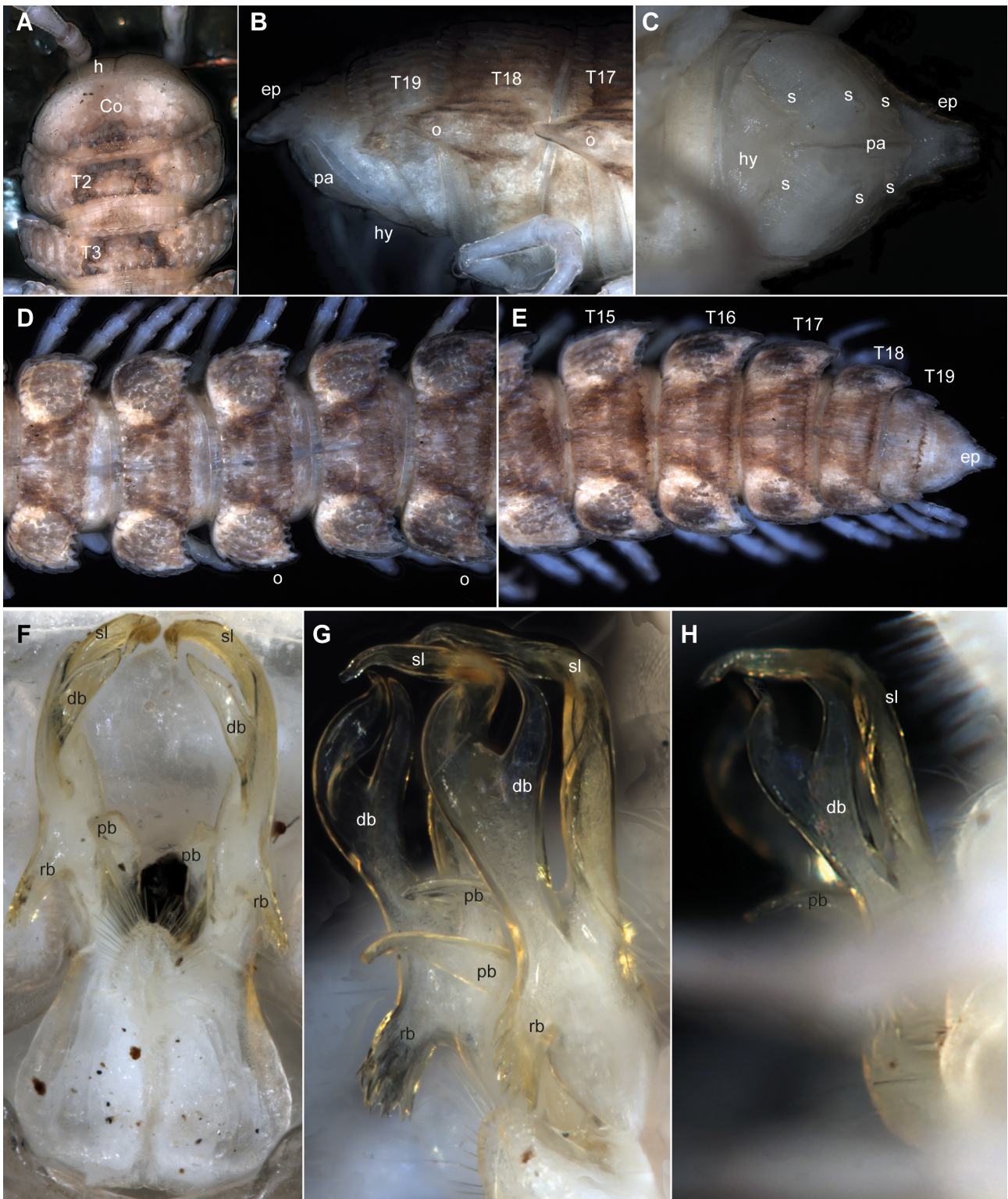


FIGURE 3. *Alafanahydesmus lavasoa* gen. nov., sp. nov., holotype male (ZFMK MYR14588), focus-stacked images. **A.** Head and first segments, dorsal view. **B.** Telson, lateral view. **C.** Telson, ventral view. **D.** Mid-body, dorsal view. **E.** Posterior half of body, dorsal view. **F.** Gonopods, ventral view. **G.** Gonopods, ventrolateral view. **H.** Gonopods, lateral view. Not to scale. **Abbreviations:** Co = collum; db = dichotomous branch; ep = epiproct; h = head; hy = hypoproct; o = ozopore; pa = paraproct; pb = paramedian branch; rb = retrorse branch; sl = subsecuriform solenomere; T = tergite.

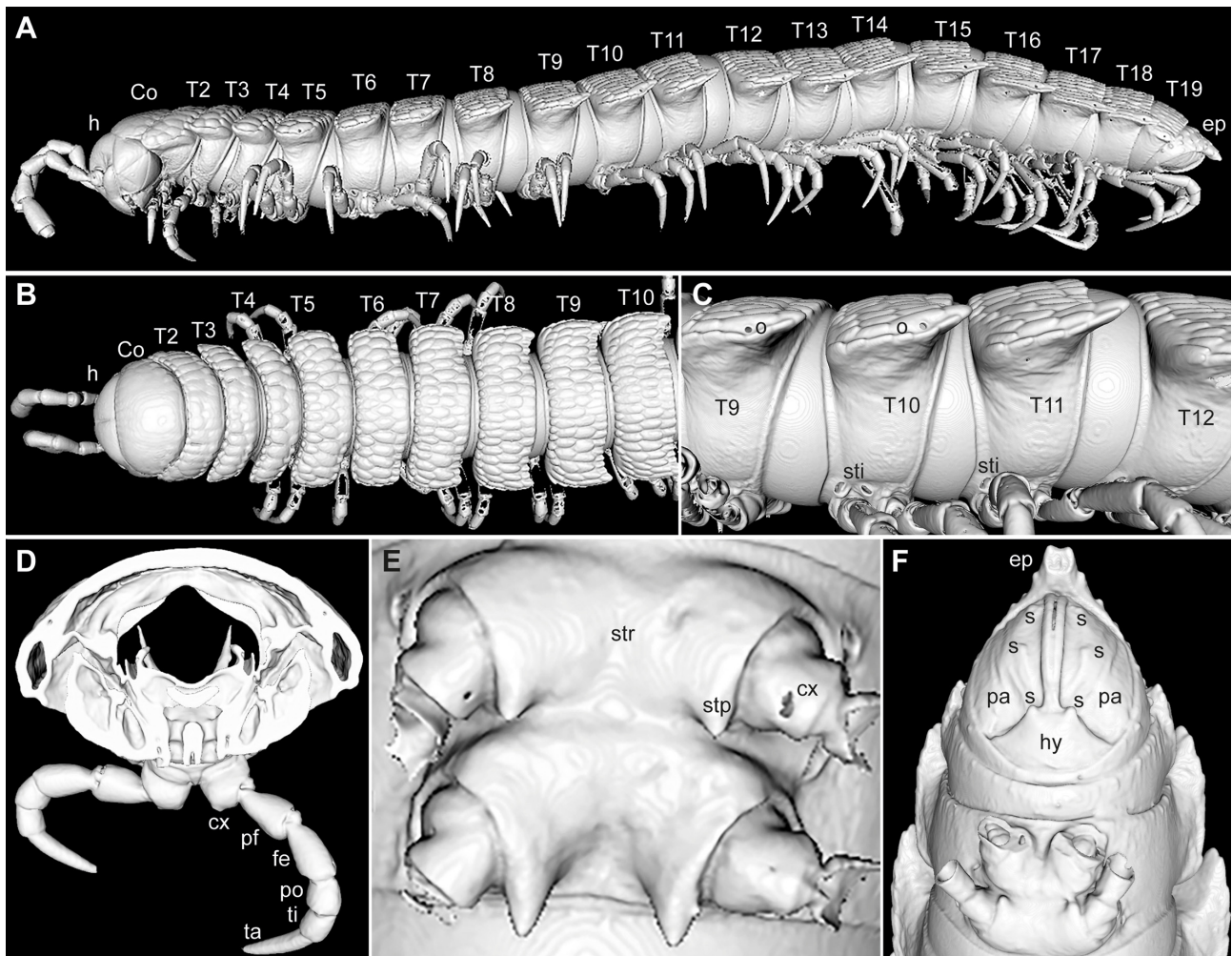


FIGURE 4. *Alafanahydesmus lavasoa* gen. nov., sp. nov., Micro-CT scans, paratype male, (ZFMK MYR14544). **A.** Lateral view. **B.** Anterior body half, showing detailed tergite pattern, dorsal view. **C.** Segments T9–T12 with stigma openings, ozopores, and lateral tergite projections, lateral view. **D.** Isolated second thoracic segment bearing reduced second leg pair. **E.** Close-up of sternite with posterior sternite processes, ventral view. **F.** Telson and associated structures, ventral view. Not to scale. **Abbreviations:** Co = collum; cx = coxa; ep = epiproct; fe = femur; h = head; hy = hypoproct; o = ozopore; pa = paraproct; pf = prefemur; po = postfemur; sti = stigma opening; s = setae; stp = sternite process; str = sternite; T = tergite; ta = tarsus; ti = tibia.

Diagnosis: See generic diagnosis above. When/if more species of *Alafanahydesmus* gen. nov. become known in the future, the shape of the branches on the gonopod will most likely be the most important species-specific characters, as these are commonly used to distinguish Polydesmida species in other genera.

Description: *Number of body segments and measurements:* Body with 20 segments including telson (Figs 2A, 4A). Body length of male holotype ca 15.5 mm, width of midbody pro- and metazona 1.6 and 2.5 mm, respectively. Length of female 22.7 mm, width of metazona 3.4 mm.

Coloration in living specimens (Fig. 2A–D) in a pattern with different brown tones, ranging from pale beige to light brown. Metazona slightly darker than prozonae (pz), producing a faint annulated appearance, with subtle and regularly spaced darker longitudinal lines along the median dorsal region accentuating the segmentation (Fig. 2A–D). Epicranium dark brown. Legs semi-translucent, tarsi (ta) noticeably darker (Fig. 2A). Antennae (ant) darkest in antennomeres (a) 3–5, gradually lighter distally and proximally (Fig. 2A). In ethanol, brown colours fade slightly (Fig. 3A–D).

Head (h) finely and uniformly microgranulate with sparse and short setae (s) (Fig. 5A–D). Epicranial suture thin but distinct, traversing between antennal bases (Figs 3A, 5A). Genae broad and angular, ventrally delimited from the gnathochilarial stipes (stg) by a small but distinct ridge (Fig. 5C, D). Labrum (lb) with one row of 2+2 setae, three labral teeth, without a visible median emargination (Fig. 5A–D).

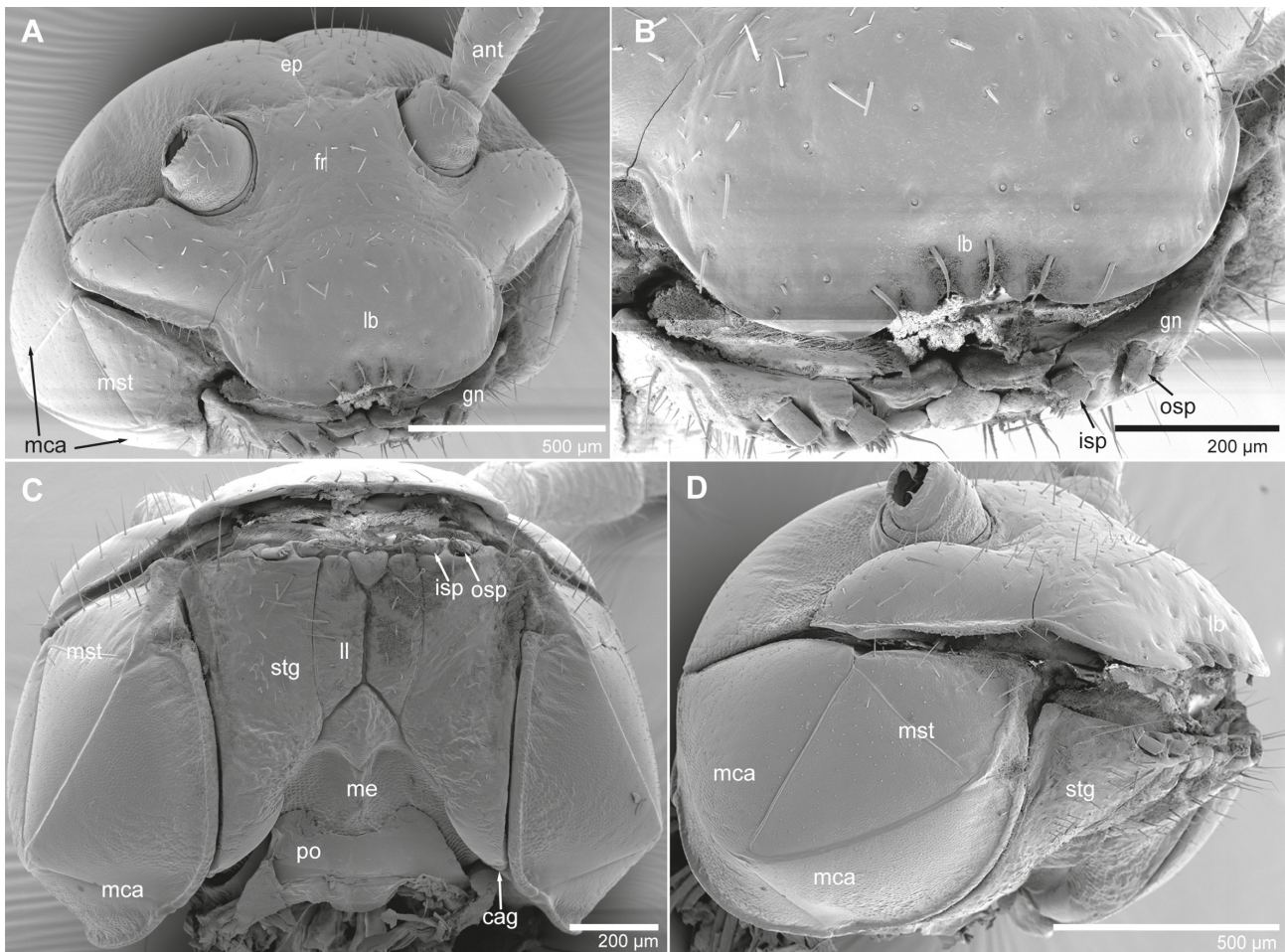


FIGURE 5. *Alafanahydesmus lavasoa* gen. nov., sp. nov., holotype male (ZFMK MYR14588), scanning electron micrographs. **A.** Head, anterior view. **B.** Labrum, anterior view. **C.** Gnathochilarium, ventral view. **D.** Left corner of head, lateral view, antenna removed. Scale bars indicated in each figure. **Abbreviations:** ant = antenna; cag = cardo of gnathochilarium; ep = epicranium; fr = frons; gn = gnathochilarium; isp = inner stipital palp of gnathochilarium; lb = labrum; ll = lamella lingualis; mca = mandibular cardo; me = mentum of gnathochilarium; mst = mandibular stipes; osp = outer stipital palp of gnathochilarium; po = postmentum; stg = stipes of gnathochilarium.

Gnathochilarium (gn) with lateral stipes of length similar to lamellae linguales + mentum (me) (Fig. 5C), median edge slightly concave, width about 2 times wider than lamellae linguales (ll) (Fig. 5C), setae along the antero-lateral margin longer than others (Fig. 5C). Postmentum with 2 paramedian distal lobes, slightly shorter than median region (Fig. 5C). Mentum concave, posteriorly with a dividing ridge running medially, anterior convex and placoid shaped with median ridge becoming thicker anteriorly (Fig. 5C). Lamellae linguales about 3 times longer than wide, lateral edge longer than median edge, this latter being slightly convex, 11 setae, one of which is positioned slightly behind the anterior edge (Fig. 5C). Inner stipital palp (isp) with 10 or 11 sensory cones (Fig. 5B). Outer stipital palp (osp) slightly longer and narrower than inner stipital palp and with 5 sensory cones (Fig. 5B). Setae of both lamellae linguales and lateral stipes of gnathochilarium larger and longer in anterior regions compared to posterior regions and compact; mentum and stipites well developed (Fig. 5C), densely microgranulate, with short setae along margins (Fig. 5C); stipes expanded laterally and clearly visible in frontal and ventral views (Fig. 5C, D). Gnathal elements tightly appressed, forming a continuous ventral plate beneath the head capsule (Fig. 5C).

Antennae clavate, *in situ* reaching approximately to segment 4 when extended dorsally (Fig. 2A). In length, antennomere 6>3>4>2>5>1>7 (Fig. 6A). Antennomere 6 slightly enlarged, bearing a distinct cluster of sensory cones distolaterally (Fig. 6A, B). Antennal sockets anterolateral; interantennal isthmus narrow, slightly wider than the diameter of the antennal socket (Fig. 5A). Antennomere 5 laterally with a field of spiniform sensilla basiconica (sbs) and bacilliform sensilla basiconica (sbb) arranged in 3 or 4 rows (Fig. 5A, C); antennomere 6 laterally with a

larger field of bacilliform sensilla basiconica arranged in five dense rows (Fig. 6B). Disc with four apical cones (ac) and no additional sensilla (Fig. 6A, B).

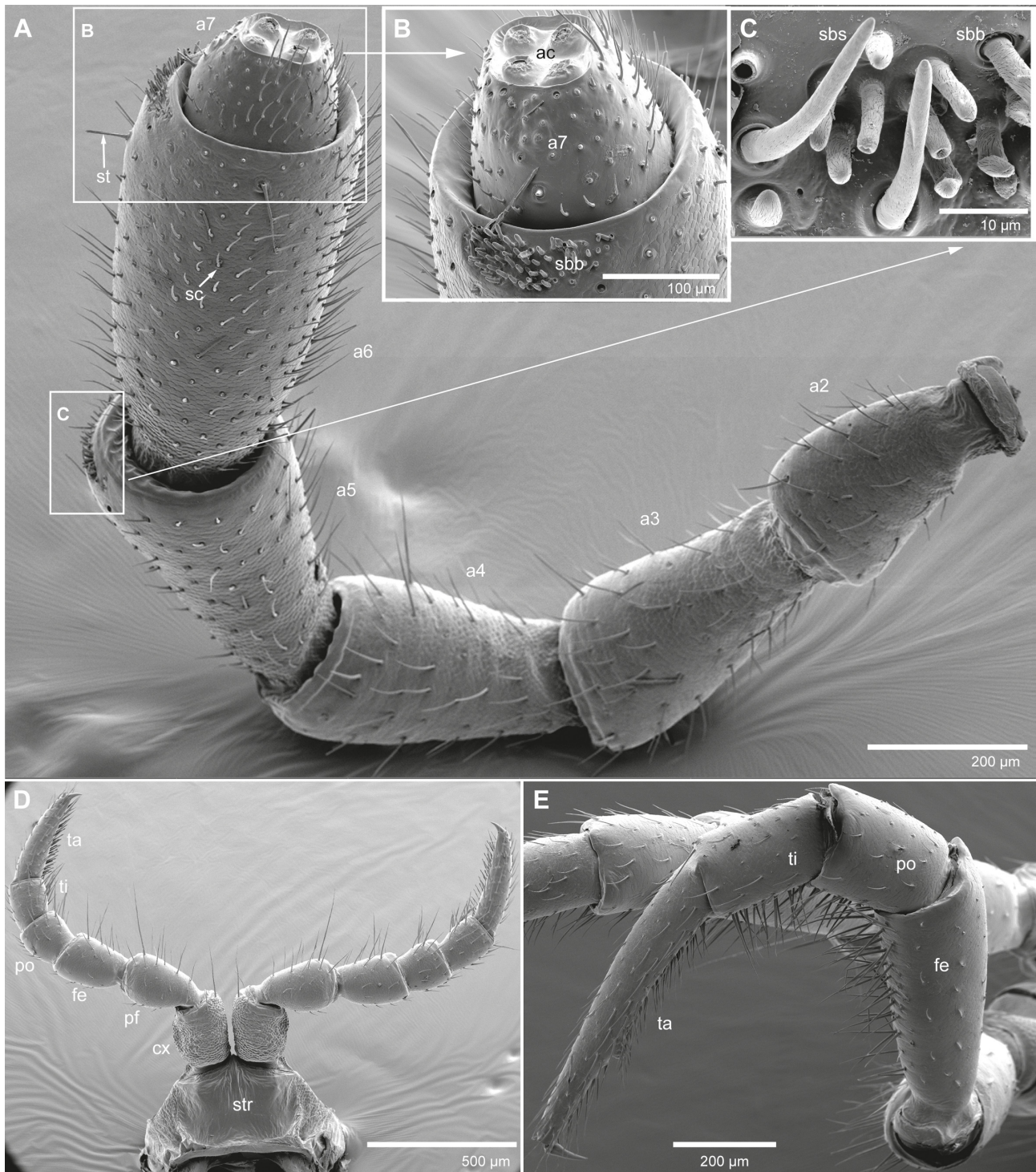


FIGURE 6. *Alafanahydesmus lavasoa* **gen. nov., sp. nov.**, holotype male (ZFMK MYR14588), scanning electron micrographs. **A.** Right antenna, ventral view. **B.** Detail of antennomeres 6, 7 and disc, lateral view. **C.** Detail spiniform sensilla basiconica and bacilliform sensilla basiconica, lateral view. **D.** Leg pair 1, posterior view. **E.** Posterior left leg (segment 11), posterior view. Scale bars indicated in each figure. **Abbreviations:** a = antennomere; ac = apical cone; cx = coxa; fe = femur; pf = prefemur; po = postfemur; sbb = sensilla basiconica bacilliformia; sbs = sensilla basiconica spiniformia; sc = sensilla chaetica; st = sensilla trichodea; str = sternite; ta = tarsus; ti = tibia.

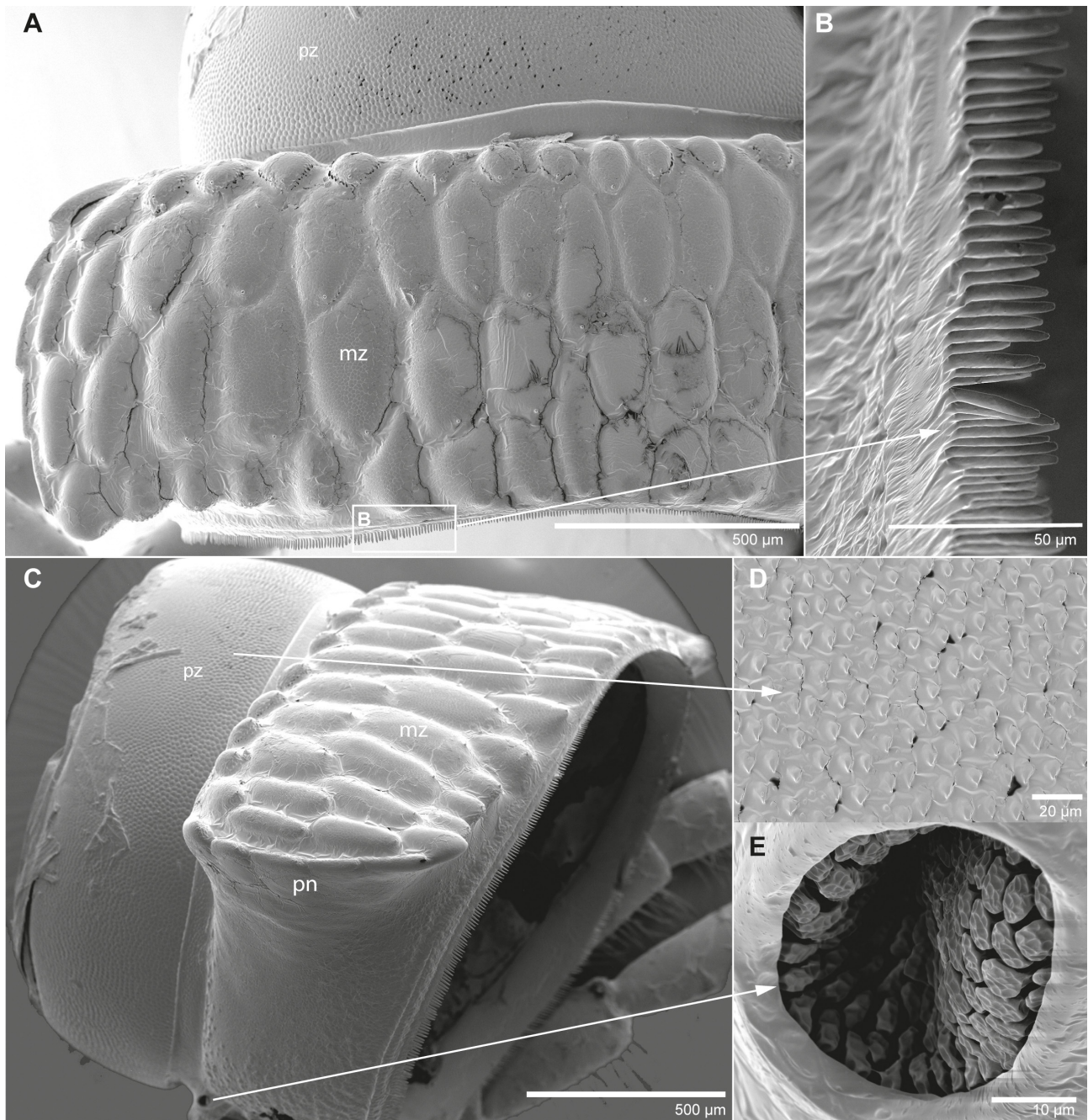


FIGURE 7. *Alafanahydesmus lavasoa* **gen. nov., sp. nov.**, holotype male (ZFMK MYR14588), scanning electron micrographs. **A.** Midbody segment, dorsal view. **B.** Detail of limbus, dorsal view. **C.** Midbody segment, lateral view. **D.** Detail of prozonite surface. **E.** Detail of ozopore. Scale bars indicated in each figure. **Abbreviations:** mz = metazonite; pn = paranotum; pz = prozonite.

Body segments in width, collum (Co) = head < segment 2 < 3 < 4 < 5–16; body gradually tapering anteriorly starting with segment 5 and posteriorly with segment 16 (Figs 2A, 3E, 4B). Collum suboval, laterally rounded, without distinct lateral lobes; surface smooth to faintly microgranulate (Figs 3A, 4B). Tergite 2 concave anteriorly and encompassing collum (Figs 3A, 4B). In tergites (T) 7–17, metaterga evenly convex posteriorly (Figs 2A, 4B), with neither keels nor carinae (Figs 4A, C, 7C), with 4 rows of tubercles (Figs 4B, 7A). Paraterga width about 1/4 as wide as metazonite (mz) (Figs 3D, E, 4B), tips projecting weakly posteriad starting with tergite 6 (Fig. 4B). Ozopores (o) opening laterally on paranota (pn) 5, 7, 9, 10, 12, 13, 15–18 (Fig. 4A, C); pore orifice circular, recessed, with a thickened rim and a deeply structured internal atrium visible in cross section (Figs 4C, 7E). Stricture between pro- and metazona narrow but distinct, shallowly impressed, forming a continuous circumferential groove

(Figs 2C, 3A, B, D, E, 4A–C, 7A, C). Metazona strongly sculptured, with coarse polygonal to elongate tuberculate relief forming a reticulate pattern (Figs 4B, 7A, C), contrasting with the smoother, finely microgranulate prozona (Fig. 7A, C, D).

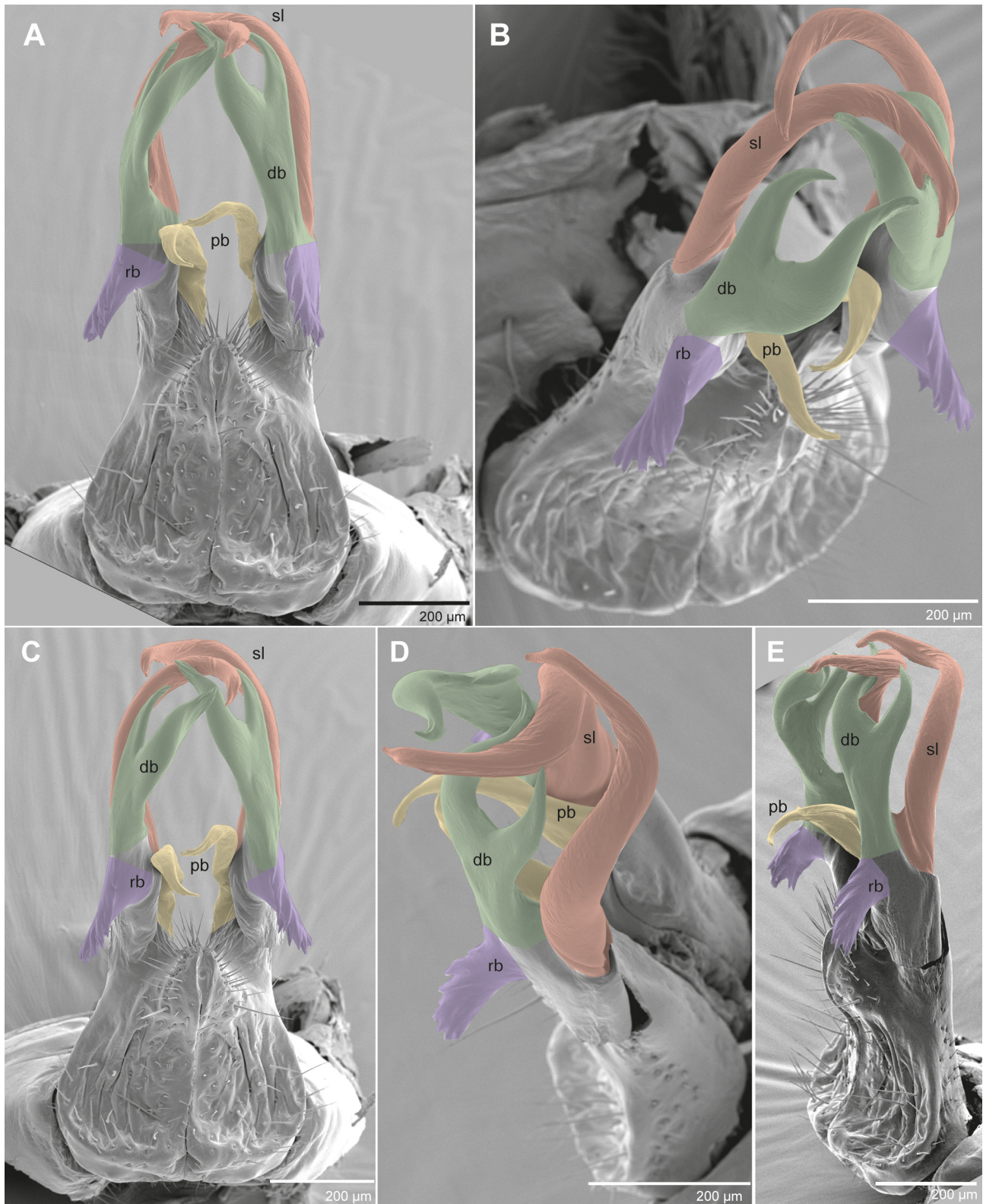


FIGURE 8. *Alafanahydesmus lavasoa* gen. nov., sp. nov., holotype male (ZFMK MYR14588). SEM images of gonopod: **A.** Posterior view; **B.** Distolateral view; **C.** Posterior view (slightly tilted); **D.** Distolateral view (opposite side); **E.** Lateral view. Scale bars: 200 µm. **Abbreviations:** db = dichotomous branch; pb = paramedian branch; rb = retrorse branch; sl = solenomere branch.

Limbus thin and entire, composed of closely spaced, elongate, parallel lamellae, with neither crenulations nor denticles (Fig. 7A, B).

Sternites in posterior body half with a finger-like triangular projection (stp), mainly on posterior sternite (Fig. 4E). Projection as long as coxa (cx) (Fig. 4E).

Telson (Figs 3B, C, 4A, F): Epiproct (ep) short, conical, rounded at apex, with 4 setae/spinnerets. Hypoproct (hy) trapeziform, with two lobular projections each carrying a long seta. Paraprocts moderately convex, each with two setae on short projections, both located in dorsal half.

Legs: First two leg-pairs shorter than subsequent legs (Figs 2A, B, 4A). In leg 1, tarsus > prefemur (pf) > femur (fe) = coxa > postfemur (po) = tibia (ti) (Fig. 6D). Tarsus 4 times, and femur 1.3 times longer than wide (Fig. 6D). Tarsal claw 1/9 the length of tarsus, simple and mostly straight, with slight curvature, setal brush composed of setae with expanded spoon-like tips (Fig. 6D). In leg 2, tarsus > prefemur > femur > tibia > coxa > post femur (Fig. 4D). Tarsus 4 times, and femur 1.5 times longer than wide (Fig. 4D). Midbody legs subequal to body height, without sphaerotrichomes, but with ventrally sparse and short setae on all podomeres (Fig. 4E); claws short, simple and minute in length (Fig. 4E). Tarsus > femur = prefemur > tibia = coxa > postfemur. Tarsus 6.5 times, femur 2 times longer than wide (Fig. 4E).

Male sexual characters: Gonopodal aperture subovate, taking up about 3/5th of width of metazonum 7.

Gonopods (Figs 3F–H, 8A–E) complex, five-branched and strongly three-dimensional. Coxites robust and fused proximally, forming a broad sac-like gonocoxal frame densely covered with robust setae; median suture distinct. Coxal surface irregularly wrinkled, without evident coxal processes. Prefemoral region fused, short and stout, clearly distinct from the coxites, bearing a dense fringe of long, flexible setae distally; prefemur not elongated, acting as a proximal support for acropodital complex. Acropodite quadripartite, divided into: (1) a subsecuriform solenomere (sl), elongate, robust and strongly curved, rising dorsally before recurving distally into a hook-like formation; distal portion smoothly rounded, with neither visible serrations nor denticles; (2) a dichotomous branch (db), well developed, arising near base of solenomere, elongate and stout, curving distad; (3) a paramedian branch (pb), arising mesally from the acropodite, shorter and more slender than dichotomous branch, gently curved inward and tapering toward a blunt distal end; positioned beneath solenomere in frontal view; (4) a retrorse branch (rb), arising proximally, directed proximally and ventrally, lamellar to weakly lobate distally, with smooth margins and without evident denticulation. Distal elements overlapping *in situ*, forming a compact and interlocking configuration in frontal view, but clearly separated in lateral and oblique aspects.

Female characters: Sternite 2 with epigyne projecting mesally of both coxae. Projection well rounded, about as wide and as long as coxa and not more than 1/10th segment width.

Behavioural note: Egg parental care could be photographically observed (Fig. 2D), with a total of four adult females remaining closely associated with egg masses. Based on the photographs, the egg number is at least 200, up to 400. Whitish eggs are the size of the width of the paraterga (Fig. 2D).

Ecology: In a photographic transect study of the Lavasoa-Ambatotsirongorongo forest in spring 2025 (Einhaus 2025), only 4% of the documented 936 Diplopoda specimens were Polydesmida. Aside from the here described *Alafanahydesmus lavasoa* **gen. nov., sp. nov.**, a handful of females and immatures of an undetermined species of *Dalodesmus* were found. Our initial collection attempts in June 2007 (beginning of the dry season) only revealed a single sample with half-grown juveniles and females. The newly conducted collections, in the middle of the rainy season, revealed sexually mature individuals, females with eggs and mature males.

Discussion

Lack of sequence data in the Dalodesmidae: Polydesmida are only rarely found in Madagascar, which has brought us difficulties in the molecular analysis of the specimens used for this study. While the family Dalodesmidae is much more common in South Africa, and especially Australia and Tasmania, no high-quality sequence data is available in GenBank. With our sequences of *Alafanahydesmus lavasoa* **gen. nov., sp. nov.** obtained here we now have uploaded the first known molecular data of a member of the family from Madagascar. While the presence of just three sequences of a single species makes any comparisons or even a phylogenetic analysis, both on Madagascar and globally, inconclusive, they will hopefully be useful for future studies on this biographically interesting family.

The diversity of Polydesmida on Madagascar: In this study, we have described a new genus and species of the family Dalodesmidae Cook, 1896, *Alafanahydesmus* **gen. nov.**. The presence of a retrorse branch, a brush-like appendage on the gonopods, as well as other characters, give strong support to the establishment of our new genus.

The low Polydesmida diversity (only 4% of the 936 millipede specimens found) observed at Lavasoa, reflects the known species lists of Madagascar, in which the Spirostreptida, Spirobolida and Sphaerotheriida are dominant groups, together accounting for 90% of the known species (Wesener & Enghoff 2022). Even with the new description here, only nine indigenous Polydesmida species are presently known from Madagascar. While such a low diversity in the globally dominant (Hilgert *et al.* 2019) Polydesmida might be partly reflected in the more seasonal life cycle of the group (unlike e.g. Sphaerotheriida, mature Polydesmida live only for a few weeks to a month), this cannot be used to explain the low diversity of the group in Lavasoa-Ambatotsirongorongo, as *Alafanahydesmus* **gen. nov.** was clearly reproductively active, unlike our earlier collection attempts in June 2007 (beginning of the dry season), which only recovered females and immatures but no mature males. Interestingly, introduced pantropical Polydesmida species were not found in Lavasoa-Ambatotsirongorongo, unlike in similar disturbed forests close to Andasibe (central eastern Madagascar), where they were dominant (Spelzhausen *et al.* 2020).

The Red List status of *Alafanahydesmus lavasoa*, **gen. nov., **sp. nov.****

The three other millipede species restricted or nearly restricted to the Lavasoa-Ambatotsirongorongo forest, *Sphaeromimus lavasoa*, *Granitobolus endemicus*, and *Zoosphaerium alluaudi* have been evaluated by the IUCN criteria and are classified as critically endangered (Wesener & Rudolf 2017; 2020a, 2020b). The main reasons for their threatened status are their very small distribution area, and ongoing rapid forest destruction (Antonelli *et al.* 2022). There is no reason to doubt that *Alafanahydesmus lavasoa* **n. gen., sp. nov.** is as forest dependent and therefore as threatened as the aforementioned taxa. An IUCN assessment of this species is urgently needed, so that its threat status can be monitored. Aside from forest destruction, reforestation efforts have introduced invasive Polydesmida species, non-autochthonous to Madagascar, to another rainforest on Madagascar (Spelzhausen *et al.* 2020), a second potential critical threat to the species described here. Currently, no introduced millipede species are known from the Lavasoa-Ambatotsirongorongo area.

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