

Description of a new endemic genus of the Namib Desert and adjacent biomes in Namibia (Tineoidea: Tineidae: Hapsiferinae)

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Abstract: The genus *Rooiklipia* **gen. nov.** is established to accommodate four species, collected in the Namibia: *R. michaelmeyi* **spec. nov.**, *R. neufferae* **spec. nov.**, and *R. vanbiljoni* **spec. nov.** Described from the Namib, *R. mirabib* (Mey, 2011) **comb. nov.** is the type species and is transferred from *Rhodobates* Ragonot, 1895 to the new taxon. The male and female genitalia, wing venation, adult moths, and distribution are illustrated. The species can be distinguished by small but constant differences in the male and female genitalia. The validity of the species is supported by molecular studies. *Rooiklipia* **gen. nov.** is placed in Hapsiferinae.

Key words: Lepidoptera, Afrotropical Region, Tineidae, Hapsiferinae, taxonomy, phylogeny, distribution.

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INTRODUCTION

Microlepidoptera were the target group of several expeditions and excursions carried out by the senior author in Namibia since 1992. Investigations of the collected material resulted in a series of book publications (Mey 2004; 2007, 2011) that led to a better knowledge of the hitherto unexplored fauna. Frequently visited places in Namibia were the Namib Desert and the mountains of the western escarpment from the Kaokoveld in the north to the Huib Hochplateau in the south. The area is well known for its richness of endemic plants and animals, which are adapted to the arid climate in a hilly environment (Mendelsohn et al. 2002). The Microlepidoptera follow this general distributional pattern of endemism. Of special interest are those endemic groups, which are restricted to the area and occur nowhere else, in contrast to widely distributed groups which have endemic species elsewhere but in addition also in the Escarpment or in the Namib Desert. Examples of these narrow endemics are the genera *Picronarycia* Mey, 2011 (Psychidae), *Namibicola* Mey, 2011 (Pyrallidae, Phycitinae) and *Namibiocossus* Mey 2015 (Cossidae). The new genus *Rooiklipia* **gen. nov.**, established herein, displays a similar distribution to these taxa, apparently demonstrating the significance of the area as a cradle of evolution of arid endemics.

METHODS AND MATERIALS

A total of 130 specimens of the new genus were examined. No specimens could be traced in the collections of the National Museum of Namibia, Windhoek, and in the

Ditsong National Museum of Natural History, Pretoria. The insects were collected at the lights on various localities in Namibia. Collecting at night was performed with a 12V battery-operated light-tower (2 x 15 Watt super-actinic light tubes, F. Weber Company, Stuttgart, Germany). The tower was in operation during the wind-free hours beginning long after sunset and finished 2–4 hours later, when the wind started blowing again (this time from the opposite direction). The specimens were picked up manually from the white gauze of the light-tower. At the Rooiklip farm light collecting was additionally performed by illuminating a white sheet by a 250 W HWL bulb. The lamp was powered by a Honda Ex 350 generator or by the mains.

Dissection of genitalia of the species was performed according to the procedure described by Robinson (1976). The genitalia and abdomens were embedded in Euparal after staining using Chlorazol Black. The cleaned abdomens of some individuals have been preserved in glycerine in polyethylene vials (Bioquip Products Inc.). Prior to embedding the cleaned genitalia on microscope slide or into glycerine vials, they were drawn using a camera lucida attached to a Leica MZ12 compound microscope. Photographic documentation of the imagines was done with Coolpix 990 camera (Nikon).

DNA extraction were performed with a NucleoSpin Tissue kit (Macherey-Nagel, Düren, Germany). The DNA barcode fragment was amplified using the primers LCO/Nancy. PCR mix and program follow Mey et al. (2021). Sequences were eye-checked under PhyDE 0.9971 (Müller et al., 2005). Representatives of the Hapsiferinae from Barcoding of Life Database (BOLD; <http://www.boldsystems.org/>) were downloaded and aligned by eye with our dataset. The dataset was analysed under RAxML with 1000 rapid bootstrap replicates.

The type specimens are provisionally deposited in the Museum für Naturkunde, Berlin (MFN). Holotypes will

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be transferred later to the National Museum of Natural History, Windhoek (NMNHW).

The terminology used in the descriptions of new species largely follows Robinson & Nielsen (1993).

RESULTS

Description of new taxa

Rooiklipia gen nov.

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Type species: *Rhodobates mirabib* Mey, 2011.

Gender of genus is feminine.

Adult facies (Figs 1–3): Forewing length 8–12 mm, wing span 19–26 mm. Head and scape snow-white, densely covered with hair-like scales; antennae bronze-grey, flagellomeres with one complete annulus of scales, labial palpi porrect, second segment with ventral tuft of lamellate scales and whiskers, some brown scales on lateral sides, third segment short, upright, acute; maxillary palpi, pilifers and proboscis absent; forelegs brown, middle and hind legs white, hind tibia with long hairs on dorsal margin, epiphysis present, spurs 0.2.4.; forewing show-white, costal margin at base thinly lined with black, hindwings pale grey, fringes white, wing venation with median cell in hindwings (Fig. 4).



Figure 1 – *Rooiklipia mirabib* (Mey, 2011), male, Rooiklip guest farm.



Figure 2 – *Rooiklipia michaelmeiyi* spec. nov., male holotype, Holstein guest farm.



Figure 3 – *Rooiklipia vanbiljoni* spec. nov., male paratype, Koiimasis guest farm.

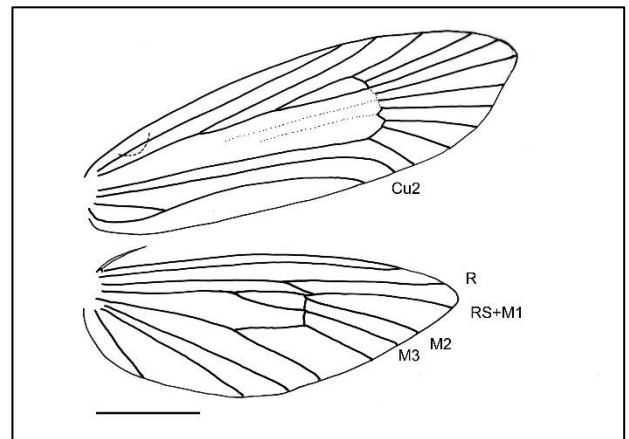


Figure 4 – *Rooiklipia michaelmeiyi* spec. nov., wing venation.

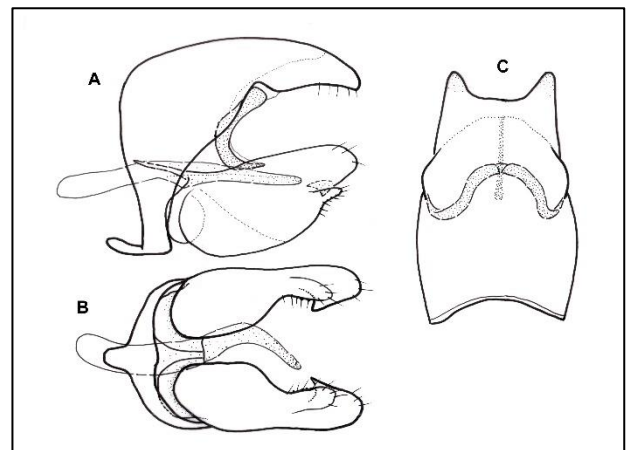


Figure 5 – *Rooiklipia mirabib* (Mey, 2011), male genitalia, A: lateral, B: ventral, C: dorsal.

Male genitalia (Figs 5–8): Segment VIII without coremata; vinculum and tegumen a complete ring, tegumen very large, plate-like and with fused uncus appearing as laterally protruding edges on apex, elongate subscaphium present, vinculum much smaller than tegumen, saccus present, vinculum produced distad ventrally, rounded and fused membranously with median sides of valvae and anellus region ventral of phallus; gnathos arms sickle-shaped, fused at tips by membranous band; valva broad, as long as tegumen, sacculus with a short, terminal process, valva apically rounded and with a

triangular prolongation directed ventrad or a simple incision; phallic apparatus long, dorso-ventrally compressed, slightly sinus-shaped in ventral view, cornuti absent.

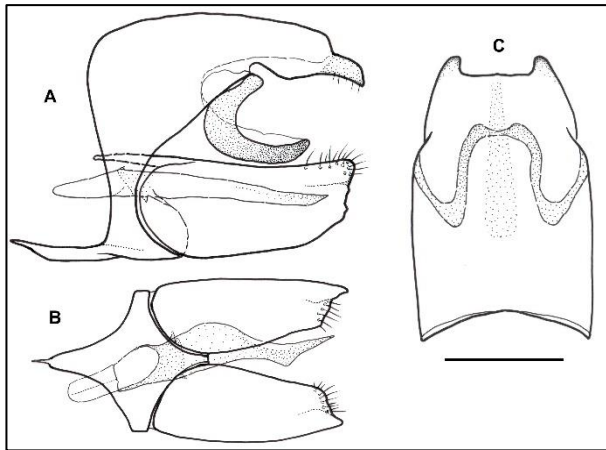


Figure 6 – *Rooiklipia michaelmeyei* spec. nov., male genitalia, A: lateral, B: ventral, C: dorsal.

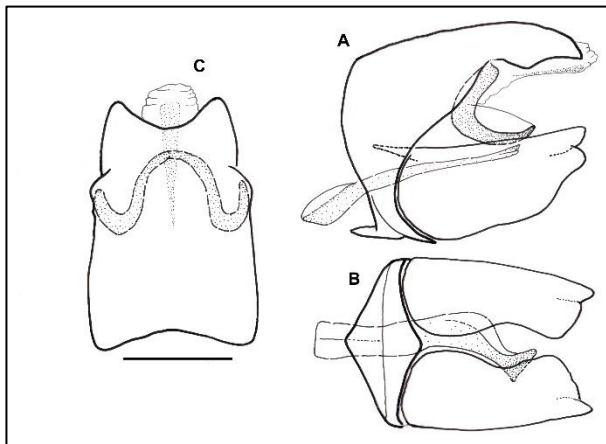


Figure 7 – *Rooiklipia vanbiljoni* spec. nov., male genitalia, A: lateral, B: ventral, C: dorsal.

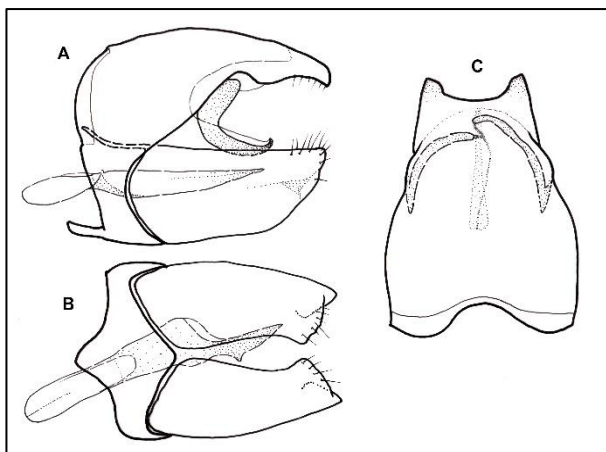


Figure 8 – *Rooiklipia neufferae* spec. nov., male genitalia, A: lateral, B: ventral, C: dorsal.

Female genitalia (Fig. 9): Segment VII with long, white scales covering tip of abdomen, segment VIII with sclerotized, plate-like tergum and sternum, forming a dorso-ventrally flattened pouch separated by pleural

membranes, apical margins with short bristles; oviscape of telescoping type, apophyses posteriores two times longer than apophyses anteriores, additional pair of apophyses present on ventral side subapically; ostium as flat opening in the middle near basal margin of sternum VIII, antrum of different form and size in species, corresponding in shape with apices of male phallus, ductus bursae short, bursa copulatrix small, signum absent.

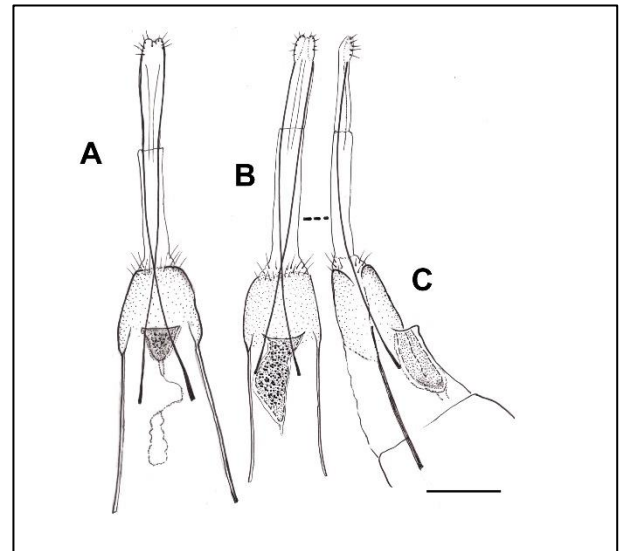


Figure 9 – *Rooiklipia* spec., female genitalia, A: *R. mirabilis*, ventral; B–C: *R. michaelmeyei* spec. nov., B: ventral, C: lateral.

Diagnostic characters

The compact segment IX, the large valvae, the broad gnathos arms and the simple phallus are plesiomorphic attributes of the male genitalia, which occur in similar expression in the other families of Tineoidea (Eriocottidae, Psychidae, Meessiidae) assigning the genus to one of the more ancestral groups in Tineidae. Also, the wing venation is in a primitive state with all radial and median veins in the forewings originating from the cell, presence of an accessory cell and complete Cu2, and in the hindwings with a median cell (branched M present in cell) and short Rs like a cross-vein to base of M1. The loss of pilifers, maxillary palpi and proboscis is taxonomically of low value since these reductions are commonplace in Tineidae (Robinson & Nielsen 1993). The presumed apomorphy of the new genus is the form of the male phallus, which is dorso-ventrally flattened and slightly curved in horizontal plane. The apical shape of the phallus corresponds with the form of the female antrum. The genus cannot be placed easily in any of the existing subfamilies because the array of characters does not fit completely to any of these. However, the medially fused valvae of the male genitalia observed in *Rooiklipia* gen. nov. is reminiscent of a similar character state in Hapsiferinae. Though mediated by membranous connections alone in *Rooiklipia* gen. nov. and not by lateral, sclerotized processes via a small anellus as in Hapsiferinae sensu stricto (Gaedike 2015), this structure can be interpreted as an ancestral state in the formation of the medially connected valvae of Hapsiferinae. Based on this feature, the new genus is tentatively included in this

subfamily. The sister genus is currently unknown. *Rhodobates* seems to be a more distantly related genus. It was transferred by Petersen (1987) to Hapsiferinae, a systematic position upheld by Gaedike (2015) in contrast to Robinson (2009), who placed the genus in Myrmecozelidae, a polyphyletic assemblage of various groups. The molecular results support the morphology-based conclusion of a position of *Rooiklipia* gen. nov. within Hapsiferinae (Fig.13).

The genus includes four externally not separable species. The main diagnostic trait of the males, the morphology of the tip of valvae, can be seen by brushing off the valval scales.

Biology: The larvae and biology are unknown. Adults were collected at various seasons from September to November and from January to April. Larvae of Tineidae are usually not associated with special host-plants. In Hapsiferinae, the larvae and biology of most species are largely unknown. The few available data points to a detritophagous life-style with a diverse food spectrum of dead, organic material or vegetable debris, including development of larvae in subterranean nests of rodents (Gozmány & Vári 1973).

Habitats: Species of *Rooiklipia* gen. nov. were collected in the Namib Desert (Fig. 10) and its transition zone with the eastern Pro-Namib for the first time. Initially, *R. mirabib* was suspected to represent an endemic taxon of the Namib Desert. Later, further populations of this species and two additional species were discovered occurring in the Escarpment (Fig. 11). These localities are situated partly in the Nama Karoo Biome. With records of *R. michaelmeyei* sp. nov. from near Kamanjab and Okahandja, the spectrum of habitats of the genus was widened to include localities in the Thornbush Savanna Biome in the interior of Namibia. A detailed account on these biomes and BIOTA observatories including ecological conditions and vegetation cover is provided by Jürgens *et al.* (2010).



Figure 10 – The inselberg Mirabib in the central Namib seen from the north.

Distribution (Fig. 12): Namibia, Central Namib, Escarpment mountains, Kunene and Otjozondjupa Regions.

Etymology: The name is derived from Rooiklip, name of

the guest farm and base camp of the author in Namibia. Two species of the genus occur sympatrically at this locality.



Figure 11 – Landscape at Rooiklip guest farm, dry season 2019, with Gamsberg (2349 m) in the background.

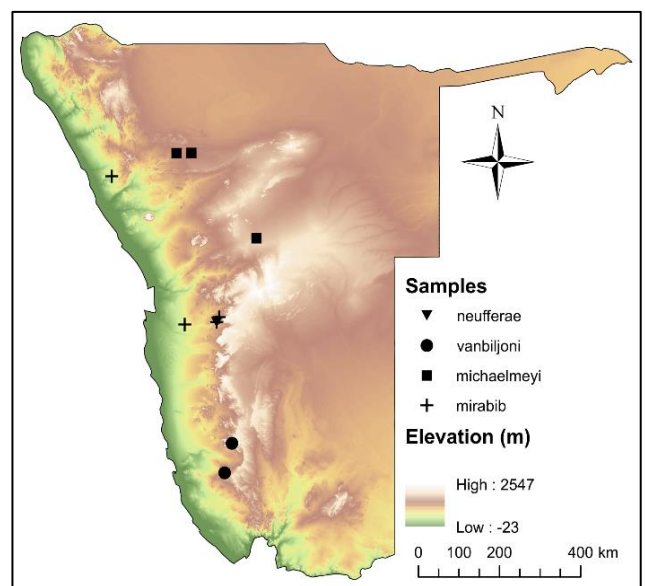


Figure 12 – Currently known distribution of *Rooiklipia* gen. nov. in Namibia.

Rooiklipia mirabib (Mey, 2011) (Figs 1, 5, 9A)

Rhodobates mirabib Mey, 2011, **comb. nov.** Esperiana Memoir 6: 166–168.

Type material: Holotype ♂, Namibia, Mirabib, Central Namib, 27.i.2009, LF, leg. W. Mey (NMNW). Paratypes 16 ♂, same data as holotype.

New material examined: 2♂, Namibia, Khomas, Windhoek District, near Gamsberg, Rooiklip Farm, 10–11.ix.2012, LF, leg. W. Mey; 2♂, same locality, 10–13.iv.2013, Lf, leg. W. Mey; 1♂, same locality, 10–11.iii.2014, leg. L. Kühne; 9♂ 6♀, same locality, 22–24.xi.2017, leg. W. Mey; 2♂, neighbouring farm Rooisand, BIOTA observatory, 23°17.755'S 16°06.693'E, 20.i.2007, LF, leg. W. Mey & K. Ebert; 1♂ (paratype), Namibia, Central Namib, Mirabib, 27.i.2009, Lf, leg. W. Mey, genitalia slide Mey 01/21, DNA Voucher MFNLEP416 (MfN) (BOLD process ID TINEI001-21, Genbank accession number MZ334982) (MFN).

Female genitalia (Fig. 9A): Ostium as flat opening in the middle of sternum VIII near basal margin, antrum of short, triangular form rounded towards ductus bursae, surface of inner side of antrum with granulated structure. Apophyses anteriores divided apically into short dorsal and lateral arms at point of fusion to tergum VIII, papillae analis round, with short sensillae.

Remarks: The hitherto unknown female is described here from Rooiklip (Fig. 11). In its original description the species was provisionally placed in *Rhodobates* Ragonot, 1895. The male genitalia were in agreement with the general features of the genus, but rather different in other features compared with the two species described from Africa (Gozmány & Vári 1973). The species is here transferred to *Rooiklipia* gen. nov.

***Rooiklipia michaelmeyei* spec. nov.** (Figs 2, 4, 6, 9B–C)

urn:lsid:zoobank.org:act:73F26272-B7D2-4A8B-80AA-5D8006620816

Holotype ♂: Namibia, Kunene, Outjo District, Otjikondo, Holstein Farm, 1200 m, 19°45'S 15°30' E, 13.iii.2005, LF, leg. W. Mey, genitalia slide Mey 57/19, DNA Voucher MFNLEP417, (no molecular data) (MFN).

Paratypes: 1♂, same data as holotype, genitalia slide Mey 03/21, DNA Voucher MFNLEP418, (no molecular data) (MFN); 1♀, Namibia, Kunene, Palmwag Lodge, 12.iii.2005, LF, leg. W. Mey, genitalia in glycerine vial (MfN); 1♀, Namibia, Otjozondjupa, Okahandja District, Erichsfelde Farm, BIOTA observatory, 1349 m, 21°35.447'S 16°56.174'E, 2.iii.2003, LF, leg. K. Vohland, genitalia slide Mey 7/21, DNA Voucher MFNLEP421, (BOLD process ID TINEI007-21, Genbank accession number MZ334981), (MFN); 2♀, same locality, 19–21.iii.2003, leg. W. Mey, genitalia slide Mey 14/21 (MFN).

Male facies (Fig. 2): Forewing length 9 mm (♂) – 10 mm (♀), wingspan 19–21 mm. External characters as in generic description; wing venation in Fig. 4.

Male genitalia (Fig. 6): Vinculum with long, triangular saccus, pointed at caudal tip; valvae truncate at apex, costal ridge elongated and separated by weak fold from broad sacculus on median side; phallus slightly longer than valvae, broad at base becoming narrower and slightly curved distally in horizontal plain, apex pointed, genital opening subapically on right side.

Female genitalia (Fig. 9B–C): Ostium as flat opening in the middle of sternum VIII near basal margin, antrum of elongate, asymmetrically triangular form acute towards ductus bursae, surface of inner side of antrum with granulated structure. Apophyses anteriores not divided apically; papillae analis elongate, with short sensillae.

Etymology: The species is dedicated to Michael Mey, brother of the first author, on occasion of his 60th birthday. He was the driver of the expedition team that camped at the Holstein farm in 2005, where the new species was discovered.

***Rooiklipia neufferae* spec. nov.** (Fig. 8)

urn:lsid:zoobank.org:act:E11E81FE-5438-4008-9883-F049DEA812A6

Holotype ♂: Namibia, Khomas, Windhoek District, near

Gamsberg, Rooiklip Farm, 1075 m, 10–11.ix.2012, LF, leg. W. Mey, genitalia slide Mey 02/21, DNA Voucher MFNLEP415, (BOLD process ID TINEI002-21, Genbank accession number MZ334983), (MFN).

Male facies: Forewing length 9 mm, wingspan 19 mm. External characters in agreement with generic description.

Male genitalia: (Fig. 8): Vinculum with short, triangular saccus, rounded on caudal margin; valvae broad at apex, costal ridge elongated and separated by weak fold from broad sacculus on median side, ventral corner of valvae on apex curved mediad, with a triangular sclerotization on distal margin; phallus longer than valvae, parallel-sided at base, bulbously enlarged at middle, ending in asymmetrically curved and knife-shaped apex in horizontal plane, apex pointed with subapical teeth, genital opening subapically on right side.

Etymology: The species is dedicated to Hannelore Neuffer, co-owner of the Rooiklip guest farm, for providing hospitality and support over many years.

***Rooiklipia vanbiljoni* spec. nov.** (Figs 3, 7)

urn:lsid:zoobank.org:act:A511DD64-4DA9-4BC9-B97A-4739C3579B19

Holotype ♂: Namibia, Karas, Lüderitz District, Tiras Mts, 1315 m, Koiimasis Farm, 8.iii.2014, LF, leg. W. Mey, genitalia slide Mey 04/21, DNA Voucher MFNLEP419, (BOLD process ID TINEI004-21, Genbank accession number MZ334984) (MFN).

Paratypes: 19♂, same data as holotype, genitalia slide Mey 35/20, Mey 5/21, DNA Voucher MFNLEP420 (BOLD process ID TINEI006-21, Genbank accession number MZ334985) (MFN); 2♂, Namibia, Karas, Lüderitz District, Aus, Klein-Aus Vista, 5.iii.2005, LF, leg. W. Mey (paratypes of *Rhodobates mirabib*), (MFN)

Male facies (Fig. 3): Forewing length 8–10 mm, wingspan 18–22 mm. External characters as in generic description and as photographed.

Male genitalia (Fig. 7): Distal margin of tegumen evenly excavate in dorsal view; vinculum with short saccus in lateral view, broad triangular in ventral view; valvae broad at apex, costal ridge elongate, separated apically by short incision from rounded apex of sacculus, ventral corner of valvae on apex curved mediad; phallus longer than valvae, parallel-sided at base, enlarged at middle, ending in asymmetrically curved, short apical plate in horizontal plane, with teeth at subapical corner, genital opening a long slit subapically on right side.

Etymology: The species is dedicated to Frans van Biljon, co-owner of the Rooiklip guest farm, for providing hospitality and help in many ways.

DISCUSSION

The establishment of the new genus with four included species is supported by the examination of morphological and molecular characters. Unfortunately, we could not include any sequences of *Rhodobates* in the analysis. The phylogenetic relationships of the species are shown in the cladogram of Fig. 13. *R. mirabib* is sister to all other *Rooiklipia* species and has the largest distribution range in

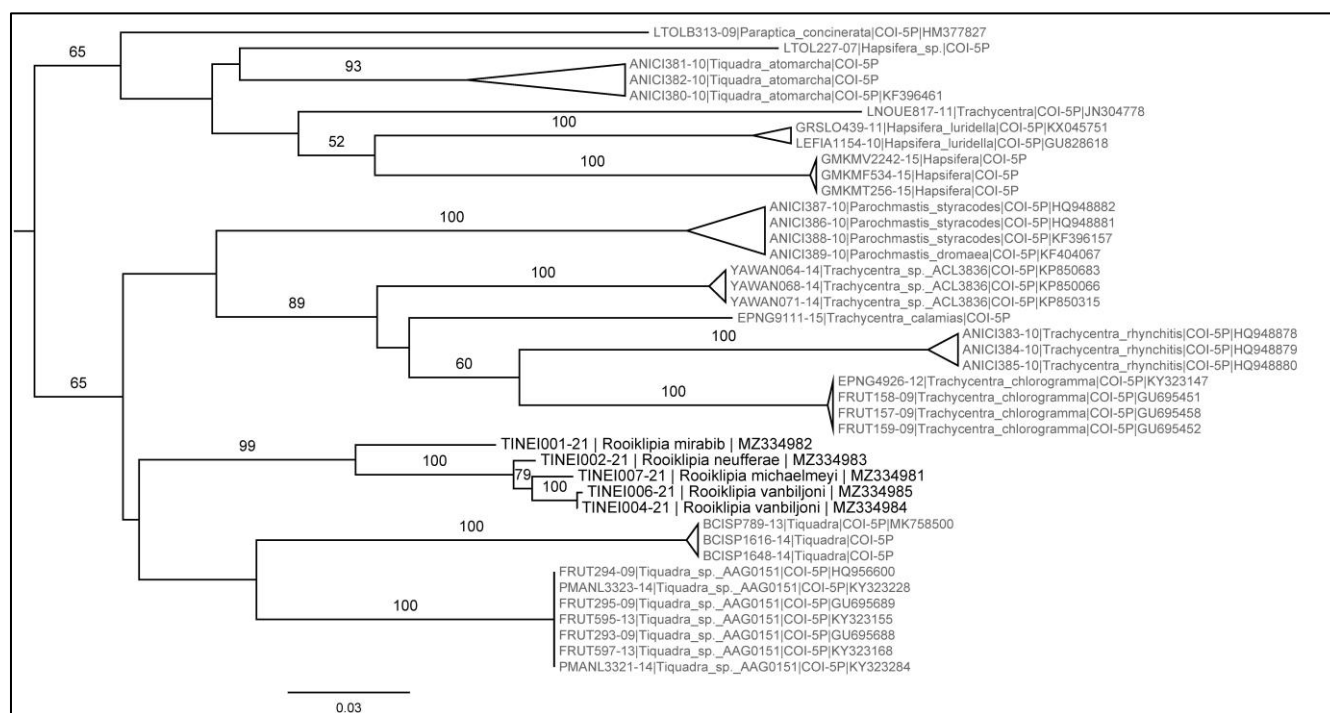


Figure 13 – Best RAxML tree topology of the COI-5P fragment, with bootstrap values displayed above nodes.

Namibia, while both *R. neufferae* sp. nov. and *R. vanbiljoni* sp. nov. appear to be confined to the Escarpment. New records will certainly lead to a better refinement of the range of the species.

The systematic position of *Rooiklipia* gen. nov. remains obscure. Within the family, it is included in Hapsiferinae based on characters of the male genitalia. Phylogenetic relationships among the Tineidae were explored by Regier *et al.* (2015) using up to 19 nuclear markers, but resulted in a surprisingly poorly supported phylogenetic tree.

This study included only two of the 10 genera currently placed in this subfamily (Petersen, 1991). A comprehensive study, sampling over the full diversity of tineids, including a large number of genetic markers, would be needed in order to place *Rooiklipia* gen. nov. and contribute to a more robust systematic framework for the family.

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