

A new species of *Scolecoseps* (Reptilia: Scincidae) from coastal north-eastern Mozambique

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Abstract

Seven specimens of *Scolecoseps* Loveridge, 1920 from the vicinity of Palma on the north coast of Mozambique are compared morphologically with other known material of this genus. The new material can be distinguished morphologically from all other *Scolecoseps* by the presence and position of certain head scales, particularly a supraciliary and four small suboculars, a small mental and high subcaudal counts. It is described as a new species, *Scolecoseps broadleyi* sp. nov. The new species is found in coastal savannah habitat under leaf litter of *Berlinia orientalis* trees, in sandy soils in close proximity to large wetlands. Its currently known distribution is south of the range of *Scolecoseps litipoensis* Broadley, 1995 and north of that of *Scolecoseps boulengeri* Loveridge, 1920. We provide a review of the available literature for the genus *Scolecoseps* and highlight the necessity for additional research on these poorly known fossorial skinks.

ZooBank— *Scolecoseps broadleyi*:

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Keywords

arenosols; coastal savannah habitat; fossorial; sandy soils; skinks

Introduction

Africa has a diverse fossorial skink fauna, with various lineages displaying limb loss and eye-reduction. The genera *Melanoseps* Boulenger, 1887, *Feylinia* Gray, 1845, *Typhlacontias* Bocage, 1873 and *Sepsina* Bocage, 1866 form a clade, sometimes referred to the subfamily Feylininae, of mainly legless scincines (Pyron et al. 2013) that inhabit diverse habitats, from forest to arid savannah, and even desert in the southern half of the continent. Although not speciose (five to eight species per genus), cryptic diversity within these genera continues to be discovered (Haacke 1997; Broadley 2006; Broadley et al. 2006). The serpentine habitus of *Feylinia* and *Typhlacontias* is shared with *Scolecoseps*, as is the unusual feature of a nostril that pierces the rostral and is connected by a sulcus to its posterior edge. Little is known about the three currently recognised species of *Scolecoseps* that inhabit the East African coastal region and appear to occur in very low densities, with two of the three species described from only single specimens.

When erecting *Scolecoseps*, Loveridge (1920) distinguished it from *Melanoseps* by the position of the nostril, which in the latter is pierced between the rostral and first

supralabial. The type species, *Scolecoseps boulengeri*, was based on a series of seven specimens collected from Lumbo on the north coast of Mozambique, and Laurent (1964) recorded six other specimens from Porto Amelia [= Pemba], 230 km farther north. Loveridge (1942) later referred *Melanoseps acontias* Werner (1913), based on a brief description of a single specimen from Dar es Salaam, Tanzania, to his genus *Scolecoseps*, because of the nostril condition. Werner's (1913) specimen was subsequently destroyed during World War II (Hallerman 1998). Witte & Laurent (1943) reviewed African fossorial skinks allied to *Scelotes* and recognised the two species of *Scolecoseps*, differentiating them on relative rostral length and number of supralabials below the eye (one in *S. boulengeri* and three in *Scolecoseps acontias*). On these features, Loveridge (1955) tentatively assigned a juvenile skink from Kilwa (230 km south of Dar es Salaam) to *S. acontias*. After investigating skull osteology and external morphology in the Scincidae, Greer (1970) suggested that *Scolecoseps* was probably derived from ancestral *Scelotes* stock via *Melanoseps*. Broadley (1995) described *Scolecoseps litipoensis* on the basis of a single specimen from Litipo Forest in south-eastern Tanzania, and considered that it showed some affinities with the forest dwelling *Melanoseps*. He also noted that Loveridge's juvenile Kilwa specimen displayed a number of unusual features, and suggested that "When adult specimens become available, this may prove to be another undescribed taxon". In summary, three species of *Scolecoseps* are currently recognised to occur along the East coast of Africa, from Lumbo in Mozambique north to Dar es Salaam in Tanzania. No molecular data exists for the genus, but because of morphological similarity the genus is usually considered to be related to the genera *Melanoseps*, *Feylinia*, *Typhlacontias* and *Sepsina*, which are sometimes placed in the Feylininae (e.g. Broadley 2006; Broadley et al. 2006).

During an environmental impact assessment, seven specimens of a putative new species of fossorial skink were collected near Palma, Mozambique, just south of the Rovuma River. The collection of these specimens and their taxonomic status is discussed below.

Materials and methods

Three specimens were collected by hand in December 2011 during digging activities in Palma District. Subsequently, specifically targeted active searching and trapping (see below) led to the collection of four additional specimens in this area. All specimens were euthanised by freezing and preserved in 99% ethanol. Liver samples were obtained from three adults and preserved in 99% ethanol. Specimens were deposited in the herpetological collections of the Natural History Museum of Zimbabwe, Bulawayo, Zimbabwe (NMZB) and Port Elizabeth Museum, Bayworld, South Africa (PEM).

We inspected photographs of Laurent's (1964) specimens of *S. boulengeri* from Porto Amelia (= Pemba, northern Mozambique), deposited in the Dundo Museum, Angola and provided by colleagues, to confirm their identity.

Pitfall trapping and targeted active searching

During the herpetological surveys 17 drift fence trap arrays were deployed at various times and locations over a span of three years (Fig. 1). Each trap array included three drift fence arms (0.4 m high × 10 m long) radiating outwards from a central pitfall trap (sunken 25 l plastic bucket). Each fence arm terminated in a funnel trap, with two dual-ended funnel

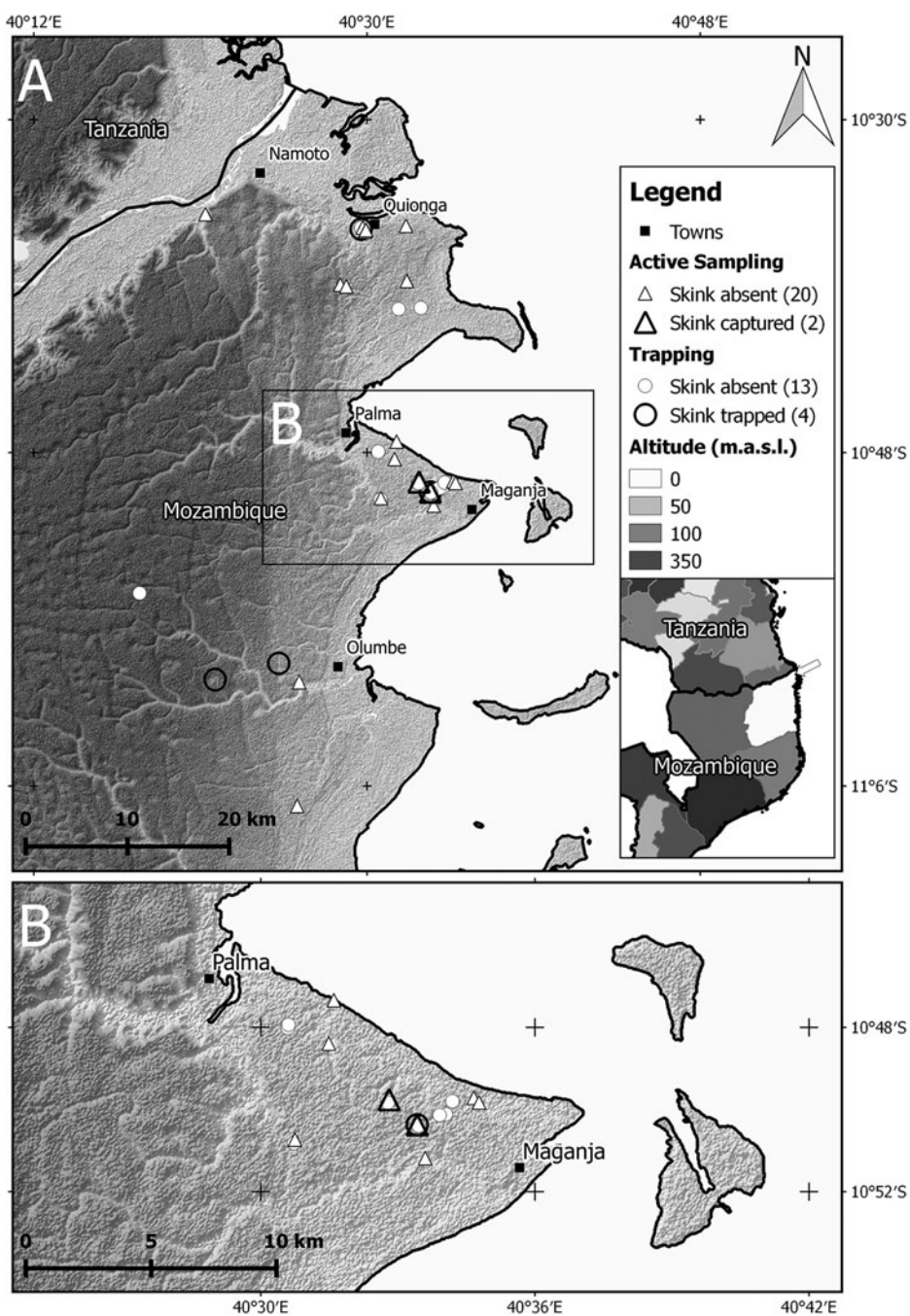


Figure 1. Spatial location and geographical context of the targeted trapping and active searching effort for the undescribed skink (2011–2013). The successful active searching and trap locations are differentiated by size from the unsuccessful attempts.

traps placed midway on either side of each arm. The complete trap array therefore consisted of six dual-ended funnel traps, three terminal funnel traps, and a central pitfall trap. Seven additional modified drift fence funnel trap arrays were later deployed

specifically to trap *Scolecoseps*. The likelihood of capturing this species was increased by adding one additional pitfall trap (5-litre bucket) along each drift fence arm, and also replacing the terminal funnel trap with a large pitfall trap (sunken 25-litre bucket). Each modified trap array therefore consisted of four large pitfalls, three small pitfalls and six dual-ended funnel traps. The total trapping effort in the Palma District amounted to 127 trap array nights, with trap arrays set at 17 different locations.

Targeted active searching involved finding suitable locations (soft sandy soil covered with leaf litter under a *Berlinia orientalis* tree) and carefully removing and storing the leaf litter to one side of a 1.5 m × 1 m area. The soil in this area was then carefully raked using hand-held rakes to a depth of 30 cm to reveal reptiles. Once searching was completed the soil was returned, compressed slightly and the stored leaf litter cover replaced to minimise disturbance. A total of 20 targeted active searching sites were intensively sampled in this manner (Fig. 1).

Geographic distribution

The harmonised world soil database (FAO 2009) and the rivers of Africa (derived from the World Wildlife Fund's HydroSHEDS drainage direction layer and a stream network layer; FAO 2010) shape files were obtained online to investigate soil affiliations and potential geo-graphical barriers to dispersal for *Scolecoseps*. All mapping was performed with Quantum GIS (www.qgis.org) using the WGS 84 co-ordinate system and the UTM 36S projection.

Morphology

All specimens were photographed in a private laboratory (LV) using a Canon 6D, MP-E 65 mm lens mounted on Stackshot macro rail (www.cognisys-inc.com). Images were combined using Helicon Focus software (www.heliconsoft.com) to obtain high magnification images. Scaled drawings of adult head shields were made and allowed the description of several pholidosis characters. Head shield nomenclature follows Loveridge (1920) and Broadley (1995). For body length measurements, specimens were placed on their backs on laminated 2 mm graph paper and photographed from above, because specimens had been preserved in small tubes and could not be straightened out for measuring with a ruler. The resulting images were calibrated with ImageJ (Schindelin et al. 2015) and measurements made using the linear segment tool, which yielded repeatable measurements (five measurements of the same individual [PEM R22698]; mean ± SD: 78.971 mm ± 0.146). The diameter at midbody was measured using a vernier calliper. Comparative data consulted for the diagnosis of the new species were obtained from Werner (1913), Loveridge (1920), Loveridge (1942), Loveridge (1955) and Broadley (1995).

Results

Collection of specimens

Despite the intensive trapping effort, only four *Scolecoseps* specimens were captured by the pitfall traps (not in funnel traps). The deployed trap arrays were very effective at capturing other herpetofauna and a total of 460 amphibians, 67 snakes and 48 lizards were captured representing 17, 16 and 7 species respectively for the complete trapping

effort. Apart from the original three *Scolecoseps* specimens captured by targeted active searching, no additional specimens were observed through this method. However, the rare worm lizard *Chirindia swynnertoni* and the thread snake *Myriopholis longicauda* were both collected during these active searches. The low capture rate of *Scolecoseps* specimens from both trapping and active searching activities, despite the successful capture of other herpetofauna with these methods, suggests that this *Scolecoseps* species occurs at very low densities.

Generic assignment

No phylogeny incorporating *Scolecoseps* tissues is available and the generic assignment of the Palma specimens is consequently based on morphological similarity. They conform to *Scolecoseps*, because they have no external limbs or limb vestiges (present to varying degrees in *Sepsina*), have exposed eyes (indistinct and beneath the head shields in *Feylinia* and *Typhlacontias*), lack movable lower eyelids (present in *Acontias*), have the rostral bordered by a pair of internasals (bordered by a single internasal in *Acontias*), and possess a nostril situated deep within a very large rostral and connected to the posterior border of the rostral by a sulcus (Loveridge 1920; situated between rostral and first supralabial in *Melanoseps*).

External scalation of the new material distinguishes it from all three currently recognised species of *Scolecoseps* (see Diagnosis below) and we therefore take this opportunity to describe it as a new species.

***Scolecoseps broadleyi* sp. nov.**

Holotype—An unsexed adult, NMZB 17985, from near Maganja, Palma District, Cabo Delgado Province, Mozambique (10°50'08.2" S, 40°33'25.4" E), collected by L. Verburgt on 9 December 2011.

Paratypes—Six individuals, comprising three adults and three juveniles, all collected by L. Verburgt within 30 km of the holotype location, in the Palma District of Cabo Delgado Province, Mozambique, between 9 December 2011 and 22 February 2014 (Table 1): NMZB 17986, same details as holotype; NMZB 17987, from near Palma, Cabo Delgado Province, Mozambique (10°49'36.2" S, 40°32'43.6" E), collected on 11 December 2011; PEM R22697, same details as holotype, but collected 24 August 2013; PEM R22698, collected near Quionga, 20 km north of Palma (10°35'55.4" S, 40°29'40.8" E) on 4 December 2013; PEM R22699, collected 15 km inland from Olumbe, 20 km S of Palma (10°59'23.8" S, 40°25'13.8" E) on 21 February 2014; and PEM R22696, collected 10 km inland from Olumbe, 20 km south of Palma (11°00'15.6" S, 40°21'47.5" E) on 22 February 2014.

Diagnosis—The new species is most similar in colouration and body measurements to *S. boulengeri*, but differs from that species by possessing a single supraciliary and four small suboculars (all absent in *S. boulengeri*; Loveridge 1920). It differs from *S. litipoensis* in having the anterior supraciliary fused with the anterior supraocular, and having rows of dark spots on the dorsum (two supraciliaries and a uniformly black dorsum in *S. litipoensis*; Broadley 1995). From both of these species it differs in having a relatively smaller mental, with its posterior border not corresponding with the suture between the rostral and first labial (Fig. 2).

Table 1. Morphological measurements (mm), pholidosis characters and collection location for seven *Scolecoseps* specimens.

	NMZB 17985 Holotype	NMZB 17986 Paratype	NMZB 17987* Paratype	PEM R22697 Paratype	PEM R22698 Paratype	PEM R22699 Paratype	PEM R22696 Paratype
Date collected	9/12/2011	9/12/2011	11/12/2011	24/8/2013	4/12/2013	21/2/2014	22/2/2014
Method	Soil raking	Soil raking	Soil raking	Pitfall trap	Pitfall trap	Pitfall trap	Pitfall trap
Location	10°50'08.2" S 40° 33'25.4" E	10°50'08.2" S 40° 33'25.4" E	10°49'36.2" S 40° 32'45.6" E	10°50'08.2" S 40° 33'25.4" E	10°35'55.4" S 40° 29'40.8" E	10°59'23.8" S 40° 25'13.8" E	11°00'15.6" S 40° 21'47.5" E
Sex				Female	Male		Male
Life stage	Adult	Juvenile	Juvenile	Adult	Adult	Juvenile	Adult
Full body length	117	48	48	129	115	52 [#]	110 [#]
Snout-vent length	84	35	35	91	79	42	96
Tail length	33	13	13	38	36	10 [#]	14 [#]
Tail % Snout-vent length	39.3	37.1	37.1	41.8	45.6	na [#]	na [#]
Midbody diameter (width)	3.2	-	-	3.8	3.3	-	4.8
Midbody diameter (height)	-	-	-	3.5	2.9	-	3.6
Ventral scales	129	127	-	127	124	119	123
Subcaudal scales	61	58	-	61	58	35 [#]	15 [#]
Midbody scale rows	18	-	-	18	18	18	18

[#] measurements not complete, because of truncated tail

* This specimen is very fragile, because of a leaking container that caused it to dry out

It differs from the type of *S. acontias* in not having the frontal fused with the interparietal (Witte & Laurent 1943). The juvenile skink from Kilwa (MCZ 52483) that Loveridge (1955) assigned to *S. acontias* has 18 midbody scale rows, 120 ventrals, 49 subcaudals, two supraoculars, two supraciliaries and two supralabials anterior to the subocular, with 12 brown dorsal stripes. The new species differs from this specimen and all other congeners by also possessing a higher number of subcaudal scales (58–61 compared with 49–57).

Description of holotype—Measurements are provided in Table 1. Snout conical, strongly projecting; length of rostral 22% of head length; nostril connected to the posterior border of the rostral by a slightly curved sulcus that is slightly shorter than the distance from the nostril to the tip of the snout; internasals in broad, slightly oblique contact, separating rostral from frontonasal, which is more than twice as broad as long; frontal much smaller than frontonasal, with a curved posterior edge; interparietal very large (the largest head shield), wider than long, five-sided, with a well developed parietal pit and bordered posteriorly by paired parietals that are narrow, band-like and in median contact behind the interparietal; parietals in contact with a pair of narrow, curved nuchals. Scallation around the orbit is complex; the preocular contacts anteriorly the enlarged first supralabial, and dorsally intrudes into the supranasal-frontonasal suture; two enlarged supraoculars, the anterior one largest, which enter the orbit, dorsally intruding into the frontal-frontonasal suture, and posteriorly contacting the interparietal, posterior supralabial, and small supraciliary; posterior supraocular is elongate and contacts both the interparietal and parietal; four small suboculars barely separate the 3rd supralabial from the eye; five supralabials, the first largest, and at least three times larger

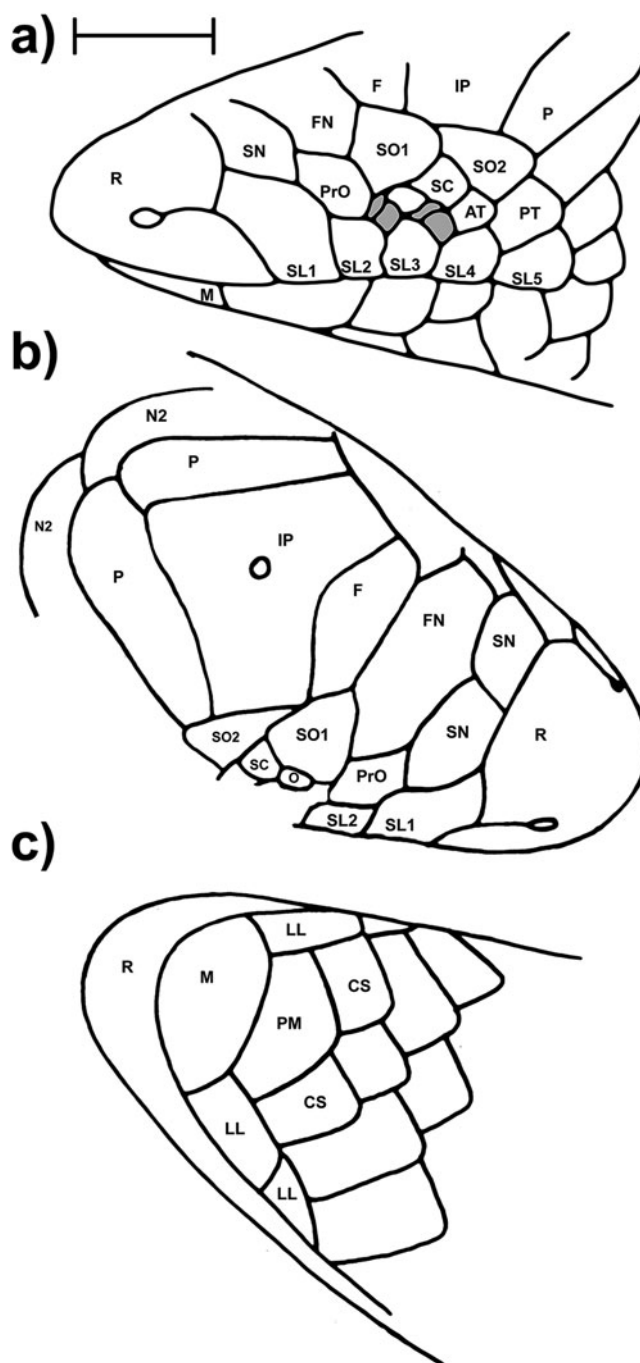


Figure 2. *Scolecoseps broadleyi* sp. nov. Holotype, NMZB 17985, head shields: dorsal (A), lateral (B) and ventral (C). The line indicates 1 mm to scale. Key to the head shields: AT = anterior temporal, CS = chin shield, F = frontal, FN = frontonasal, IP = interparietal, LL = lower labial, M = mental, N = nuchal, O = ocular, P = parietal, PM = postmental, PrO = preocular, PT = posterior temporal, R = rostral, Sc = supra-ciliary, SL = supralabial, SN = supranasal, SO = supraocular. The four grey shields are suboculars.

than other supralabials; two temporals, anterior much smaller than posterior, interspersed between fourth and fifth supralabials, supraciliary and posterior supraocular. Mental enlarged, but not extending back to the suture between rostral and first supralabial, bordered posteriorly by a large postmental, which in turn is bordered by three chin shields, the two outer ones largest; four elongate infralabials, the first being the largest (Fig. 2). Body cylindrical, without external limbs; body scales hexagonal, smooth, broader than long, subequal on dorsal and ventral surfaces, with 129 ventral scales along ventral midline (between postmental and anal scales) arranged in 18 longitudinal rows throughout the length of the body; anal shield divided and not conspicuously larger than surrounding scales; tail undamaged, cylindrical, with 61 subcaudal scales in ventral midline, 39.3% of snout-vent length, narrowing slightly to a bluntly rounded tip; scale row fusion occurs in the cloacal region, reducing to 12 rows around middle of tail.

In life—pale beige above, yellow below, all scales with a dark centre and forming 12 longitudinal stripes on the upper surface. The dark scale centres are smallest along the top of the body, front fifth of the ventrum and last third of the body, with the intervening ventrum uniform yellow. The dark scale centres are also larger on the lateral surfaces, particularly on the last third of the body and tail tip, giving the tail a darker appearance (Fig. 3). In fixative the yellow colour, particularly on the belly, is lost.

Variation in paratypes—Variation in mensural characters of the paratypes is presented in Table 1. All paratypes share with the holotype the same colour pattern, number of midbody scale rows, and head scale configuration, except for PEM R22698, which has five small suboculars on the left side of the head (four on the right). Ventrals 119–129, subcaudals 58–61 (original tails). Length of intact tails relative to snout-vent length 40.2% ($n = 5$).

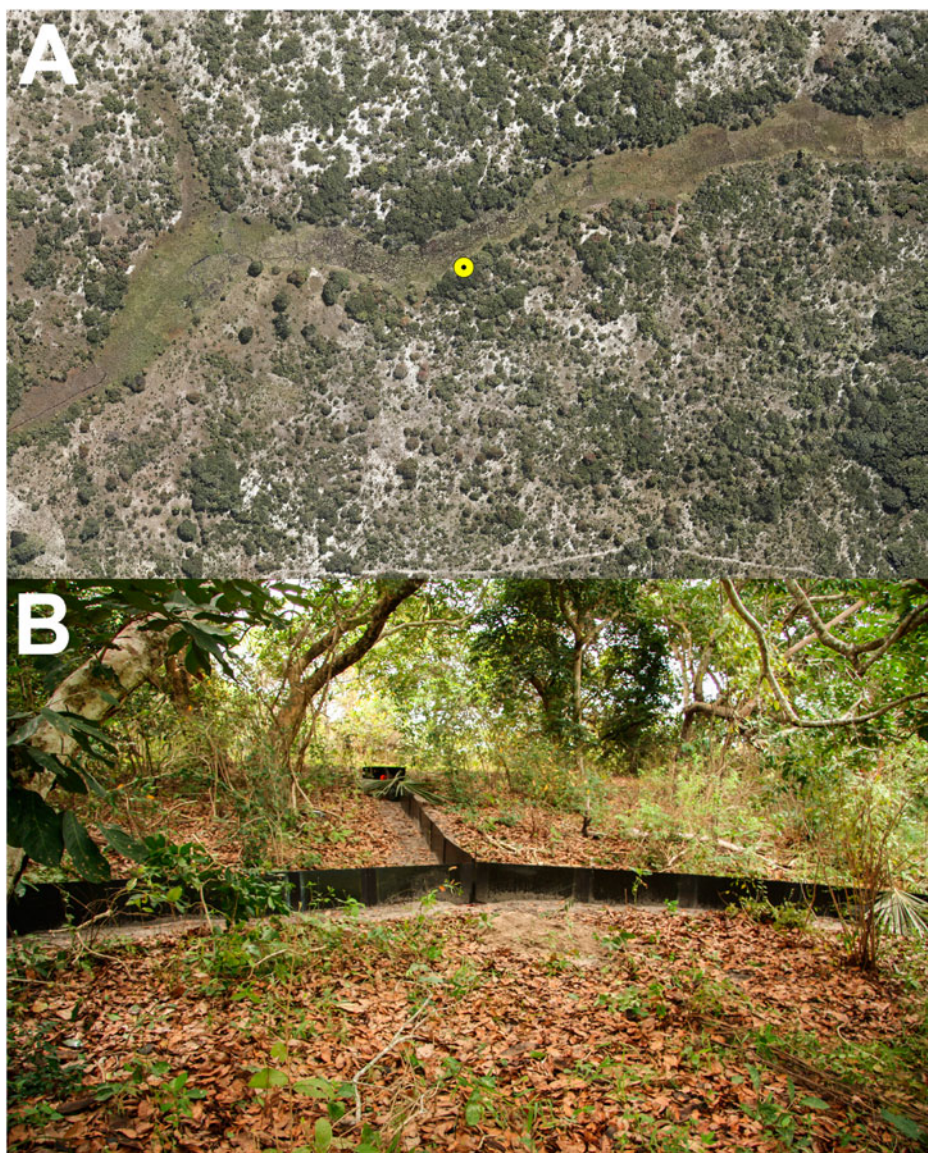


Colour online, B/W in print

Figure 3. *Scolecoseps broadleyi* sp. nov. A) Holotype, NMZB 17985 in life and B) ventral view after preservation; C) Paratype, PEM R22697 in life and D) Paratype, PEM R22698, showing head shields.

Etymology—Named in honour of Donald George Broadley in recognition of his numerous contributions to African herpetology. Don assisted greatly with the description of this new species.

Distribution—This species is known from five localities in coastal northern Mozambique (Fig. 1). All specimens were found on sandy soils with weak soil development in coastal woodland dominated by *B. orientalis*, in close proximity to wetlands (Fig. 4). It is likely that the geographical distribution of fossorial skinks is constrained by suitable soil



Colour online, B/W in print

Figure 4. A) Aerial imagery of the type locality (yellow dot) and B) habitat photograph showing drift fence trap array. Holotype NMZB 17985 and paratype NMZB 17986 were collected by raking the soil under the *Berlinia orientalis* leaf litter in the foreground of B, whereas paratype PEM R22697 was captured in the central pitfall bucket of the drift fence trap array (also shown in B).

conditions and restricted by geographical barriers, such as large river valleys with soils rich in clay content. *Scolecoseps broadleyi* sp. nov. is therefore expected to be confined to loose soil along approximately 135 km of the coastline of extreme northern Mozambique, from the Messalo River in the south to the Rovuma River in the north (see Discussion below).

Conservation status—The known and predicted geographic range of the species does not fall into any protected areas, although the Quirimbas National Park is situated approximately 44 km south of the Messalo River. Although wetlands in the region are often disturbed for rice cultivation by local villagers (e.g. Fig. 4A), and the areas adjacent to these wetlands are often cleared for agricultural fields (usually cassava, *Manihot esculenta*), the banks of the wetlands are generally left intact, because they are sloped and prone to erosion if cleared, and are therefore unsuitable for agriculture. Consequently, these wetlands are mostly buffered by a broad strip of natural vegetation that includes the only habitat in which *S. broadleyi* has been found, despite much active searching and trapping in other habitats (Fig. 1). It is therefore likely that the habitat of the species is not under immediate threat and is also fairly extensive. Nevertheless, because of uncertainty regarding the true geographic distribution of the species, we recommend a status of ‘Data Deficient’ under the IUCN Red List criteria (IUCN 2012).

Discussion

Our knowledge of *Scolecoseps* is currently limited to a slowly unfolding awareness of diversity in the genus (Loveridge 1920, 1942; Broadley 1995). In the specimens of *Scolecoseps* recorded from Porto Amelia [= Pemba], Mozambique, by Laurent (1964) we confirm that the mental is large (the posterior border of the mental aligns with the suture between the rostral and first upper labial) and conforms to the condition recorded for *S. boulengeri* by Loveridge (1920), and is unlike that for Palma material here recognised as *S. broadleyi* sp. nov. Laurent’s (1964) records extend the distribution of *S. boulengeri* 230 km north of Lumbo, the type locality. However, many fossorial skinks display microendemism, and we recommend that searches for fresh material of *Scolecoseps* from Lumbo and Pemba be undertaken to confirm conspecificity of the material.

Virtually nothing is known about the natural history of *Scolecoseps*. In general, knowledge of the factors that influence the occurrence of fossorial reptiles is rare (Maritz & Alexander 2009). All *Scolecoseps* currently known are restricted to coastal areas from Lumbo in the south, to Dar es Salaam, Tanzania in the north (Fig. 5). Nearly all recorded localities for *Scolecoseps* are characterised by the presence of arenosols (sandy soils featuring very weak or no soil development; FAO 2009) along the coastline. An exception is the type locality of *S. litipoensis*, because the holotype was described as inhabiting “clay loam soil with leaf litter” (Broadley 1995), i.e. cambisols (weakly to moderately developed soils; FAO 2009; Fig. 5).

The distribution of different soil types can be expected to influence the distribution of small, slender-bodied fossorial skinks like *Scolecoseps* (Fig. 5), and the vertisols (dark coloured cracking and swelling clays; FAO 2009) associated with the Nacutamelu River just north of Pemba may act as a geographical barrier to the southern dispersal of *S. broadleyi* sp. nov. It is unlikely, however, that the Messalo River acts as a dispersal barrier, because of the lack of associated well-developed fluvisols (young soils in alluvial deposits; FAO 2009). The relatively narrow, low-volume rivers that cross the arenosols north of the Messalo River may dry up episodically or seasonally, thereby allowing

migration of small skinks. These rivers also do not extend into the lixisols (soils with subsurface accumulation of low activity clays and high base saturation; FAO 2009) in the West, and this may also allow migration on the cambisols around the sources of the rivers.

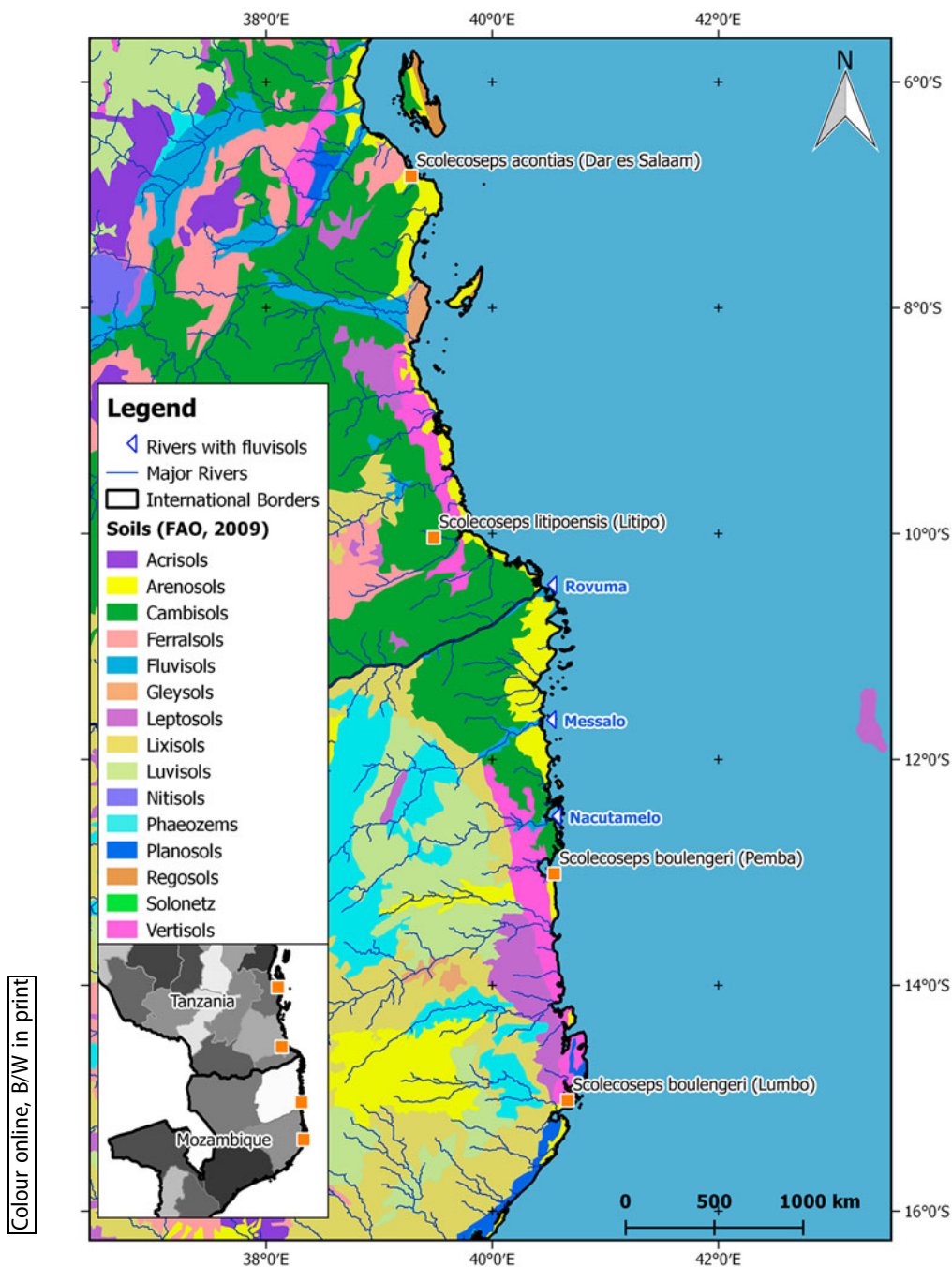


Figure 5. Soil map of the known localities of all described *Scolecoseps* species. Major rivers with extensive fluvisols that may act as geographic barriers to dispersal for *S. broadleyi* sp. nov. are indicated and named.

Although southern Africa, with extensive sandy areas associated with both the extended coastline and semi-arid interior, has both a speciose and phylogenetically diverse fossorial skink fauna (Branch 1998), it is increasingly evident that unappreciated complexity in this fauna also occurs in sparsely vegetated, sandy areas farther north (Haacke 1997; Broadley 2006; Wagner et al. 2012). Previously unknown diversity of other fossorial and semi-fossorial reptiles in coastal Northern Mozambique has recently been uncovered, e.g. the amphisbaenian *Zygaspis maraisi*, Broadley & Measey 2016; and two undescribed species of snake-eyed skink, *Panaspis*, Medina et al. 2016. Additional studies on the diversity, phylogenetic relationships, and biology of fossorial skinks, particularly of the *Feylinia-Melanoseps-Sepsina-Scolecoseps* assemblage, are required.

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