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A new *Nucras* Gray, 1838 (Squamata: Lacertidae) from the Strandveld of the Western Cape, South Africa

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Abstract

A striking new sandveld lizard of the *Nucras tessellata* group is described from the Lambert's Bay Strandveld of the Western Cape Province, South Africa. It is sister to the clade *N. livida* + *N. tessellata*, and is phenetically most similar to *N. tessellata*, from which it differs in its more elongate body and possibly increased number of presacral vertebrae and patternless orange dorsal coloration. The form *elegans*, described as a species by Andrew Smith (1838), but treated as an infrasubspecific variant by Broadley (1972), also exhibits weak patterning, but is likely a regional color variant. *Nucras aurantiaca* **sp. nov.** is the ninth member of the genus found in southern Africa. Its discovery in the well-collected coastal Western Cape suggests that further herpetofaunal surveys are needed in this region, which is threatened by agricultural activity and tourism-related development.

Key words: Sandveld lizard, Lambert's Bay, description, molecular phylogeny

Introduction

The lacertid genus *Nucras* Gray (sandveld lizards) was reviewed in a pre-phylogenetic context by Boulenger (1917, 1921), and subsequently the *N. tessellata* group was revised by Broadley (1965, 1972). Based on morphological data, Arnold (1989a, 1991) considered *Nucras* as the sister to remaining members of what he considered "advanced lacertids," a group equivalent to the Tribe Eremiadini (as presently construed), which includes all sub-Saharan African taxa, as well as a diversity of North African, Arabian, and Asian genera (Hipsley *et al*. 2009). Molecular phylogenetic data reveal the Eremiadini to be divided into a primarily southern African clade and a primarily northern clade, with its greatest diversity in and near the Horn of Africa (Engleder *et al*. 2013). Despite its relatively high diversity in southern Africa (eight of 10 recognized species occur in the region), *Nucras* has its affinities with the northern clade and is sister to the clade (*Latastia* Bedriaga (*Philochortus* Matschie (*Pseuderemias* Boettger, *Heliobolus* Fitzinger))) and together this group is sister to the central African *Poromera* Boulenger (Mayer & Pavlicev 2007; Hipsley *et al*. 2009; Greenbaum *et al*. 2011; Kapli *et al*. 2011; Engleder *et al*. 2013; Edwards *et al*. 2013a, b).

Edwards *et al*. (2013b), in the context of an ecomorphological study, presented the first phylogenetic tree for the genus, incorporating eight species, including all of those occurring in southern Africa (except the rare *N. caesicaudata* Broadley, 1972), as well as the East African *N. boulengeri* Neumann, 1900, which was recovered as sister to its remaining congeners. Most *Nucras* are similar in appearance and taxonomic problems remain, particularly in *N. tessellata* (Smith, 1838), *N. ornata* (Gray, 1864), and *N. holubi* (Steindachner, 1882), which will require more comprehensive molecular sampling to resolve (Bates *et al*. 2014). Although putatively new species are known to exist in Zambia (Broadley & Berry 2009; Bauer *et al*., unpublished) and Angola (Broadley 1972;

Branch & Tolley 2017), no new *Nucras* species have been described since 1972. We here describe a distinctive new *Nucras* from Lambert's Bay in South Africa. This discovery is unexpected, given both the conspicuousness of these relatively large diurnal lacertids and the intensive sampling that has characterized the near-coastal regions of the Western Cape Province (Branch 2014).

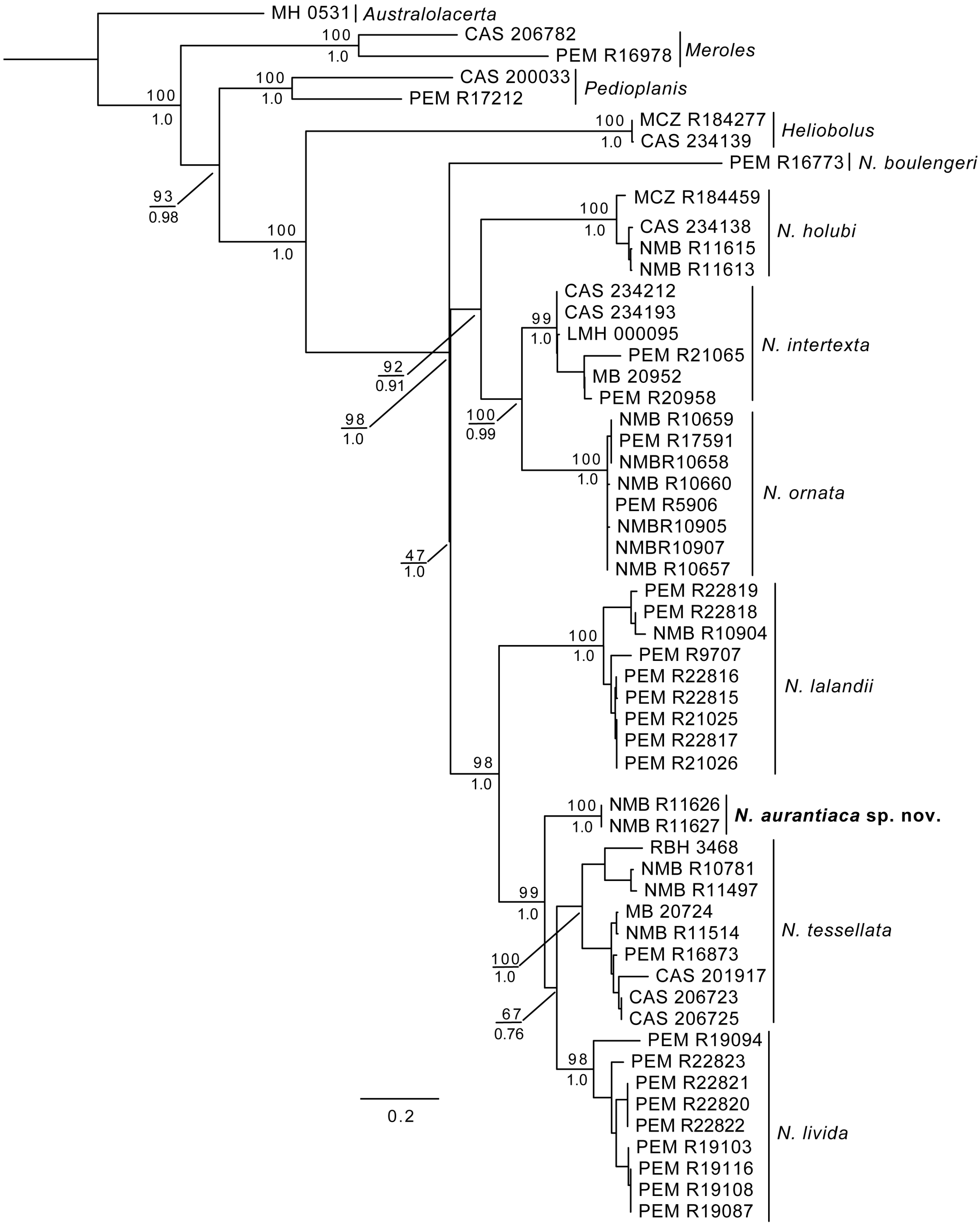

FIGURE 1. Concatenated mitochondrial RaxML generated phylogram of the genus *Nucras* and outgroups used in this study. Bootstrap support (above) and posterior probabilities (below) are shown for species level and more inclusive nodes.

Material and methods

Specimens. Standard institutional codes used in this paper are: BMNH (The Natural History Museum, London, United Kingdom), CAS (California Academy of Sciences, San Francisco, USA), MCZ (Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA), NMB (National Museum, Bloemfontein, South Africa), NMW (Naturhistorisches Museum Wien, Vienna, Austria), PEM (Port Elizabeth Museum, Port Elizabeth, South Africa, and USEC (University of Stellenbosch Ellerman Collection, Stellenbosch, South Africa). Additional tissue samples were derived from the collections of Vincent Egan (LMH), Marius Burger (MB), Michael Cunningham (MH), and RBH (Raymond B. Huey). Comparative specimens examined morphologically are listed in Appendix 1.

Morphology. The following mensural features were recorded to the nearest 0.1 mm using digital calipers: SVL (snout-vent length), TrW (trunk width), TailL (tail length), TailW (maximum tail width), AGL (axilla-groin length), HumL (humerus length), ForeL (forearm length), FemL (femur length), CrusL (crus + manus length, from elbow to tip of 4th finger), PesL (pes length from heel to tip of 4th toe), HeadL (head length), HeadW (head width), HeadD (head depth), CSn (collar-snout length), OrbD (eye diameter = width of eye), NEye (nostril-to-eye distance), EyeE (eye-to-ear distance), EarD (maximum height of ear opening), EarW (maximum width of ear opening). Details of pholidosis, including head scalation and femoral pore disposition, were also recorded. Comparisons were made with all other described species of *Nucras* based on material listed in the Appendix and with literature sources (e.g., Broadley 1972). Data from the types of *Lacerta elegans* Smith (see Discussion) were based on photographs and radiographs of the specimens and on information provided by Boulenger (1920).

Micro-computed (micro-CT) scans were obtained using a GE Phoenix v|tome|x L240 dual tube CT instrument (Phoenix X-ray; General Electric Sensing & Technologies, Wunstorf, Germany) located at the CT facility at Stellenbosch University using an x-ray tube voltage of 120 kV at 80 µA. A spatial resolution of 20 µm was obtained in the micro-CT images. Data sets were reconstructed with the system-supplied software, yielding 3D data that were subsequently analyzed using Volume Graphics VGStudioMax 3.0 (Volume Graphics, Heidelberg, Germany).

Molecular data. Tissue samples were taken from thigh (holotype) and abdominal muscle (paratype) of the new species. Samples from other species of *Nucras* were taken from liver and tail tissue at the time of collection. Specimens were collected by the authors under permits issued by the relevant conservation authorities in the Republic of Namibia, Zambia, and in South Africa in Limpopo, Western Cape, Eastern Cape and Northern Cape provinces. Additional samples were obtained from colleagues and institutions listed in Table 1.

Sequence data were generated for 48 individuals from seven additional *Nucras* species, (*N. boulengeri*, *N. holubi*, *N. intertexta* (Smith), *N. ornata*, *N. lalandii* (Milne-Edwards), *N. tessellata*, *N. livida* (Smith)). ND2 and 16S sequence data were downloaded from GenBank for five outgroup taxa belonging to the southern African radiation of Eremiadinae (Engleder *et al.* 2013): *Australolacerta australis* (Hewitt), *Meroles knoxii* (Milne-Edwards), *Pedioplanis laticeps* (Smith), *P. namaquensis* (Duméril & Bibron), and *Heliobolus lugubris* (Smith). De novo sequences were also generated for *Meroles suborbitalis* (Peters), resulting in a final dataset of 56 individuals (see Table 1 for GenBank accession numbers).

Genomic DNA was extracted using the Qiagen DNAeasy Kit from whole tissues consisting of tail tips, liver or skeletal muscle stored in 95% EtOH. PCR amplification was performed on an Eppendorf Mastercycler gradient thermocycler using the primers METF1 (5'-AAGCTTTCGGGCCCATACC-3') (Macey *et al.* 1997), and CO1R1(5'-AGRGTGCCAATGTCTTTGTGRTT-3') (Arèvalo *et al.* 1994). PCR products were visualized using 1.5% agarose gels before being purified with the AMPure magnetic bead solution kit (Agencourt Bioscience, Beverley, MA, USA). Cycle Sequencing was performed using the BigDye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, CA, USA) and then purified using the CleanSeq magnetic bead kit (Agencourt Bioscience, Beverley, MA, USA). Sequences were analyzed on an ABI 3730xl DNA analyzer and subsequently assessed in Geneious v6.1.5. An initial sequence alignment was constructed using MUSCLE v3.8.31 and then manually adjusted by eye.

Phylogenetic Analysis. For phylogenetic tree reconstruction, we used 1680 base pairs (bp) derived from three mitochondrial markers (16S, ND2 and ND4). Variable and parsimony informative sites were summarized using the tool AMAS (Alignment Manipulation and Summary) (Borowiec 2016). Maximum likelihood (ML) and Bayesian inference (BI) analyses were performed on the CIPRES Science Gateway v3.3 (Miller *et al*. 2010). Analyses were

TABLE 1. Samples used in molecular phylogenetic analysis with associated GenBank accession numbers. Specimen collection standard abbreviations are detailed in Material and Methods. All localities are in the Republic of South Africa unless otherwise indicated. Provincial abbreviations: EC = Eastern Cape, KZN = KwaZulu-Natal, LIM = Limpopo, MPU = Mpumalanga, NC = Northern Cape, NW = Northwest, WC = Western Cape.

					GenBank Accession Numbers		
Taxon	Specimen	Locality	Latitude	Longitude	ND2	16SrRNA	ND4
Nucras aurantiaca **sp. nov.**	NMB R11626	Lamberts Bay, WC	32°05'04.36"S	18°21'26.9"E	MH023414	MH023413	—
Nucras aurantiaca **sp. nov.**	NMB R11627	Lamberts Bay, WC	32°05'04.36"S	18°21'26.9"E	MH023415	—	—
Nucras boulengeri	PEM R16773	Klein's Camp, TANZANIA	01°49'16.2"S	35°14'30.5"E	MG846513	MG846603	—
Nucras holubi	CAS 234138	Farm Pylkop, LIM	22°45'52"S	29°44'28"E	MG846533	MG846601	MG846580
Nucras holubi	MCZ R184459	Farm Celine, LIM	22°41'29"S	29°31'42"E	MG846532	MG846582	MG846563
Nucras holubi	NMB R11613	E of Tshipise, LIM	22°38'28"S	30°18'50"E	MG846534	MG846596	MG846577
Nucras holubi	NMB R11615	E of Tshipise, LIM	22°38'28"S	30°18'50"E	MG846515	MG846597	MG846578
Nucras intertexta	LMH 000095	Bergplaats, LIM	24°00'1.9"S	29°58'56.6"E	MG846550	MG846583	MG846564
Nucras intertexta	MB 20952	Farm Blackridge, NC	28°49'02"S	22°32'42"E	MG846542	MG846587	MG846568
Nucras intertexta	CAS 234193	Lajuma, LIM	23°02'21"S	29°26'59"E	MG846541	MG846602	MG846581
Nucras intertexta	CAS 234212	Lajuma, LIM	23°02'10"S	29°25'41"E	MG846540	—	—
Nucras intertexta	PEM R20958	Farm Mansfield, NC	27°41'28"S	23°25'00"E	MG846525	—	—
Nucras intertexta	PEM R21065	1 km SE Majankeng, NW	27°07'04"S	23°57'31"E	MG846543	—	—
Nucras lalandii	NMB R10904	Bamboesberg, EC	31°36'52"S	26°18'50"E	MG846549	MG846591	MG846572
Nucras lalandii	PEM R21025	1 km S Siphepheto, EC	30°33'03"S	28°50'22"E	MG846548	MG846590	MG846571
Nucras lalandii	PEM R21026	1 km S Siphepheto, EC	30°33'03"S	28°50'22"E	MG846544	—	—
Nucras lalandii	PEM R22815	1 km S Siphepheto, EC	30°32'08"S	28°49'38"E	MG846547	MG846589	MG846570
Nucras lalandii	PEM R22816	1 km S Siphepheto, EC	30°32'08"S	28°49'38"E	MG846546	—	—
Nucras lalandii	PEM R22817	25 km SW Cedarville, EC	30°32'07"S	28°49'37"E	MG846545	—	—
Nucras lalandii	PEM R22818	Bamboesberg, EC	31°36'52"S	26°18'50"E	MG846516	MG846592	MG846573
Nucras lalandii	PEM R22819	1.5 km E Toisekraal, EC	31°49'45"S	26°45'36"E	MG846560	MG846593	MG846574
Nucras lalandii	PEM R9707	Mtentu River, EC	31°09'19"S	29°44'44"E	MG846517	—	—
Nucras livida	PEM R19087	Farm Kareehoek, NC	30°10'37"S	23°28'54"E	MG846535	MG846588	MG846569
Nucras livida	PEM R19094	~44 km SW Strydenburg, NC	30°08'27"S	23°15'31"E	MG846536	—	—
Nucras livida	PEM R19103	Farm Goodhope, NC	30°07'28"S	23°18'48"E	MG846519	—	—
Nucras livida	PEM R19108	Farm Kareehoek, NC	30°10'37"S	23°28'54"E	MG846537	—	—
Nucras livida	PEM R19116	Farm Goodhope, NC	30°07'28"S	23°18'48"E	MG846538	—	—
Nucras livida	PEM R22820	Farm Suurhoek, EC	32°51'37"S	24°27'25"E	MG846520	MG846594	MG846575

......*continued on the next page*

TABLE 1. (Continued)

Taxon	Specimen	Locality	Latitude	Longitude	GenBank Accession Numbers		
					ND2	16SrRNA	ND4
Nucras livida	PEM R22821	Farm Matjiesfontein, EC	32°50'50"S	24°25'12"E	MG846521	—	—
Nucras livida	PEM R22822	Farm Matjiesfontein, EC	32°50'06"S	24°26'28"E	MG846539	—	—
Nucras livida	PEM R22823	Farm Tierberg, WC	33°09'12"S	22°15'56"E	MG846518	MG846595	MG846576
Nucras ornata	NMB R10657	Manyiseni region, KZN	26°54'55"S	32°03'04"E	MG846529	—	—
Nucras ornata	NMB R10659	Usutu Gorge, KZN	26°51'58"S	32°09'17"E	MG846551	—	—
Nucras ornata	NMB R10660	1.5 km SE Ekuhlehleni, KZN	26°51'38"S	32°03'08"E	MG846552	—	—
Nucras ornata	NMBR10658	Manyiseni region, KZN	26°54'55"S	32°03'04"E	MG846527	—	—
Nucras ornata	NMBR10905	Manyiseni region, KZN	26°54'55"S	32°03'04"E	MG846528	—	—
Nucras ornata	NMBR10907	Manyiseni region, KZN	26°54'55"S	32°03'04"E	MG846530	—	—
Nucras ornata	PEM R17591	N of Swaziland border, MPU	25º05'27"S	31º59'23"E	MG846526	—	—
Nucras ornata	PEM R5906	Manyiseni region, KZN	27°04'45"S	32°02'25"E	MG846531	—	—
Nucras tessellata	MB 20724	Farm Donkiedam, NC	30°55'27"S	19°02'51"E	MG846557	MG846586	MG846567
Nucras tessellata	RBH 3468	Kgalagadi Transfrontier Park, NC	26°24'12.1"S	20°41'1.46"E	MG846524	MG846604	—
Nucras tessellata	CAS 201917	Richtersveld National Park, NC	28º 6' 40" S	17º 1' 10" E	MG846522	—	MG846561
Nucras tessellata	CAS 206723	Groenriviermond, NC	30º 51' 29" S	17º 34' 43" E	MG846553	—	MG846562
Nucras tessellata	CAS 206725	Groenriviermond, NC	30º 51' 29" S	17º 34' 43" E	MG846555	—	—
Nucras tessellata	NMB R10781	Farm Good Hope, NC	29°52'04"S	22°33'22"E	MG846559	—	—
Nucras tessellata	NMB R11497	Farm Leeubergrivier, NC	30°27'48"S	19°26'52"E	MG846523	MG846598	—
Nucras tessellata	NMB R11514	Farm Narosies, NC	30°33'03"S	19°34'53"E	MG846558	MG846599	MG846579
Nucras tessellata	PEM R16873	Farm Loerkop, NC	30°39'23"S	19°20'33"E	MG846554	MG846584	MG846565
Australolacerta australis	MH 0531	Buffelshoek Corner, WC	33°28'19"S	19°23'41"E	DQ871094	DQ871152	—
Heliobolus lugubris	CAS 234139	Farm Pylkop, LIM	22°45'52"S	29°44'28"E	DQ871084	DQ871142	—
Heliobolus lugubris	MCZ R184277	Kamanjab, NAMIBIA	19°37'47"S	14°48'56"E	DQ871083	DQ871141	—
Meroles knoxii	CAS 206782	Port Nolloth, NC	29°15'11.4"S	16°52'40.8"E	DQ871088	DQ871146	—
Meroles suborbitalis	PEM R16978	Farm Kamans, NC	30°35'17"S	18°50'49"E	MG846556	MG846585	MG846566
Pedioplanis laticeps	PEM R17212	Bezantsgat Farm, NC	32°29'34"S	19°35'34"E	DQ871067	DQ871125	—
Pedioplanis namaquensis	CAS 200033	Richtersveld National Park, NC	28°14'58"S	16°56'41"E	DQ871043	DQ871101	—

performed on each individual gene and on the concatenated set of mitochondrial genes. Each dataset was partitioned using PartitionFinder v1.1.1 (Lanfear *et al*. 2012), employing the partitioning schemes supported by the Bayesian Information Criterion (BIC) score for each analysis. The analysis resulted in four partitions for the concatenated mtDNA analysis: 1.) The first codon position of ND2 and the third codon of ND4. 2.) The second codon position of ND2. 3.) The third codon position of ND2 and the second codon position of ND4. 4.) The first codon position of ND4 and the entire 16S gene. All ML partitions were run under the GTR+Γ model of evolution using RAxML v8.1.24 (Stamatakis 2014) for 1,000 rapid nonparametric bootstrap replicates. The BI PartitionFinder analysis resulted in the same partitioning scheme recovered for the ML analysis (Partitions 1–4, listed above) and were run using the GTR+I+Γ (Partition nos. 1 and 2) and HKY+Γ (Partition no. 2) and GTR+ Γ (Partition no. 4) models of evolution. MrBayes v3.2.6 (Ronquist & Huelsenbeck 2003) was used to perform the BI analysis and run for 50,000,000 generations sampling every 10,000 generations. Convergence of the Markov chains was assessed by eye using Tracer v1.6 (Rambaut *et al.* 2014) and the initial 25% of trees were discarded as burn-in.

Results

Molecular phylogenetics. Final alignments for the three mitochondrial markers used were as follows: ND2, 403 bp (226 variable, 193 parsimony informative); ND4, 732 bp (329 variable, 278 parsimony informative); 16S, 547 bp (157 variable, 123 parsimony informative).

There were no conflicts in the topologies between the BI and ML analyses and both analyses retrieved generally high nodal support (bootstraps—BS; posterior probabilities—PP) throughout their respective trees. *Nucras boulengeri* is sister to all other *Nucras* species (BS = 98%, PP = 1.0). Among the remaining named taxa there are two major clades (although this split received nodal support only under BI), one including *N. holubi*, and its sister taxa *N. intertexta* and *N. ornata* (BS = 100%, PP = 0.99), and the other comprising *N. lalandii*, and its sister clade, which includes *N. tessellata* and *N. livida* (BS = 99%, PP = 1.0). Within the latter clade the new species from Lambert's Bay represent a divergent lineage sister to *N. tessellata* + *N. livida*, although the pairing of the latter two species was unsupported (BS = 67%, PP = 0.76). Pairwise corrected ND2 distances from the Lambert's Bay specimens were 10.5–14.3% (mean 12.19%) to *N. tessellata*, 11.3–14.0% (mean 12.47%) to *N. livida*, and 14.3–19.0 (mean 15.77%) to *N. lalandii*.

***Nucras aurantiaca* sp. nov.**

Lambert's Bay Sandveld Lizard
Figs. 2–3, 4D.

Holotype: NMB (National Museum, Bloemfontein) R11626, adult female. Republic of South Africa, Western Cape Province, Lamberts Bay, Bosduifklip Restaurant (32°05'04.36"S, 18°21'26.9 E). Collected in 2005 by farm workers and sent to Cape Nature Conservation by Kobus Engelbrecht and thence to the University of Stellenbosch.

Paratype: NMB (National Museum, Bloemfontein) R11627, gravid adult female, same data as holotype.

Diagnosis: A moderately sized (SVL at least 75 mm) *Nucras* distinguished from all congeners by having an attenuate body with 28 presacral vertebrae and an extremely long tail (to at least 3.2 times SVL), 39–41 dorsal scale rows across midbody, enlarged plates on the preaxial face of the forearm, parietal window in interparietal scale absent or very tiny, 25 subdigital lamellae under digit IV of the pes, a total of 27 femoral pores with a diastema of 1–2 poreless scales separating left and right series, dorsal coloration orange (limbs) to orangey-brown (trunk), with no longitudinal stripes and a series of very pale gray transverse marks along the vertebral midline.

It differs from *N. lalandii* in having enlarged plates on the preaxial face of the forearm, from *N. boulengeri* in having more than 24 subdigital lamellae and granules present between the suborbital and supraciliary scale rows; from *N. taeniolata* (Smith, 1838) and *N. livida* in a lower number of midbody scale rows (39–41 *versus* 42–52 and 44–56, respectively; data from Broadley 1972); from *N. caesicaudata* and *N. taeniolata* in larger size (to at least 75 mm SVL *versus* maxima of 65 mm and 70 mm, respectively); from *N. scalaris* Laurent, 1964 in lacking a bold pattern of dark crossbands on the trunk; and from all other congeners in lacking any trace of spots, dashes, reticulations, or longitudinal color pattern elements. Vertebral counts have not been previously reported for *Nucras* spp., but among the few species sampled, *N. aurantiaca* **sp. nov.** can be distinguished by its presacral count of 28 (see **Osteology** and **Discussion**).

Description: Measurements (holotype, followed parenthetically by paratype): SVL 75.2 (67.2) mm, TrW 8.4 (7.6) mm, TailL (regenerated) 157.0 (88.4, broken) mm, TailW 5.4 (5.8) mm, AGL 46.3 (39.2) mm, HumL 5.4 (5.9) mm, ForeaL 12.6 (damaged, not recorded), FemL 6.9 (8.3) mm, CrusL 8.5 (9.2), PesL 14.1 (damaged, not recorded), HeadL 12.5 (12.6) mm, HeadW 7.9 (7.7) mm, HeadD 7.0 (6.4) mm, CSn 18.2 (18.4) mm, OrbD 2.2 (2.1) mm, NEye 4.2 (4.1) mm, EyeE 4.7 (5.9) mm, EarH 2.4 (2.0) mm., EarW 1.2 (1.1).

Both the holotype and paratype were kept alive in captivity for some period and damage to the digits (Fig. 2) was probably sustained during this time. In the holotype digits II and III of the left manus, I–III of the right manus, and digit V of the right pes are affected. All digits in the paratype damaged except digit V of right pes. Both specimens with an abdominal incision from the fixation process, holotype with incision in left thigh from tissuing.

Body slender and elongate (AGL/SVL 0.62), trunk much longer than hind limbs (AGL/FemL 1.57), tail more than twice as long as SVL (TailL/SVL 2.09), slender and tapering (a photograph of a wild individual [Fig. 2B] shows an apparently original tail at least 3.2 times SVL). Limbs short, pes longer than shank or femur (PesL/FemL 2.04; PesL/CrusL 1.69). Head small (HeadL/SVL 0.17), distinct from neck, slightly elongate (HeadW/HeadL 0.63), not strongly depressed (HeadD/HeadL 0.56). Snout blunt, short (NEye/HeadL 0.34), about twice eye diameter (NEye/OrbD 1.91). Eye relatively large (OrbD/HeadL 0.18); lower eyelid scaly, with four large translucent/semi-opaque scales surrounded by a rim of small granules. Margin of eyelids pigmented dark brown. Eye-to-ear distance more than twice diameter of eye (EyeE/OrbD 2.14).

FIGURE 2. Preserved type specimens of *Nucras aurantiaca* **sp. nov.** A) Holotype specimen NMB R11626 in oblique dorsal (left) and ventral (right) views. B) Paratype specimen in oblique dorsal view.

Ear opening vertical, taller than wide (EarH/EarW 2.0), without projecting lobules, bordered posteriorly by a series of tiny granules and anteriorly by a series of larger, elongate scales and anterior to this a vertical row of enlarged juxtaposed scales; tympanic shield oval, 8–10 times the size of cheek granules. Rostral wider than deep; loreal region flat to very slightly concave. Supralabials 7/7 (7/6), first shortest, fifth largest and in subocular position, 2–4 subequal in height and intermediate between first and fifth. Infralabials 6/6 (6/6), all longer than tall.

Nostrils subcircular, surrounded by enlarged supranasal, and two postnasals, each approximately one third the size of supranasal. Two loreal scales, anterior rhomboidal, bordering both postnasals, second and third supralabials, prefrontal, frontonasal and posterior loreal, which is roughly hexagonal, four times larger than anterior loreal, and borders the prefrontal, first supraciliary, two preocular scales, supralabials three and four (loreals fused on left side of paratype). Supranasals in broad contact with one another; frontonasal shield-shaped, roughly semicircular anteriorly, gabled posteriorly, wider than long; prefrontals in contact with one another anteriorly. Frontal scale nearly twice as wide anteriorly as posteriorly, lateral terminus of frontal-frontoparietal suture coincident with border between second and third supraorbitals. Supraorbital scales four, second and third much larger than first and fourth, 10 supraciliary scales, smallest at midorbit. Parietals roughly rectangular with slight forward projection wedging between frontoparietal and fourth supraciliary. Interparietal scale narrow and elongate, separating posterior half of frontoparietals from one another and completely separating left and right parietals (elongate but 3–4 times broader anteriorly than posteriorly, not extending anteriorly to separate frontoparietals, which are in broad median contact with one another); parietal window tiny (absent); occipital scale very small, pentagonal, only about 4–5 times size of nuchal granules. Surface sculpturing evident on dorsal head shields from midorbit posteriorly. 4/5 (3/2) supratemporal scales, anteriormost thin and elongate, posterior ones only slightly larger than granular scales of cheek region, but more elongate.

Mental subtriangular, broader than deep, bordered posteriorly by a pair of small chin shields in midline contact with one another and bordering first and narrowly second infralabials. Second set of chin shields larger and also in contact with each other medially and second and third infralabials laterally; third pair larger still and separated from one another posteriorly by several small throat scales (in point contact with each other anteriorly but otherwise separated from one another by two narrow scales), bordering infralabials three and four. Fourth pair of chin shields twice as large as third and widely separated from one another, bordering infralabials four through six. A relatively indistinct gular fold present, scales anterior to this longitudinally elongate and angled medially; scales between gular fold and collar chiefly transversely elongate. Collar border comprising a series of enlarged scales, the largest in median position and rhomboidal in shape.

Dorsal pholidosis homogeneous, comprising 39 (41) longitudinal rows of small granules, becoming slightly larger and more flattened on flanks. Six longitudinal rows of transversely widened ventral plates plus one ventrolateral row of smaller plates on each side. 29 (28) transverse rows of ventral plates between axilla and groin.

Femoral pores 13 on left thigh and 14 on right thigh, with left and right series separated by a diastema of a single poreless scale in the holotype and two scales in the paratype. Scales in row immediately posterior to femoral pore row oval, approximately same size as pore-bearing scales. Scales of rows anterior to pores much larger, one (distal) to three (proximal) rows between pore-bearing scales and enlarged preaxial plates. Large, roughly circular patch of precloacal plates anterior to cloaca, constituent scales extremely large, largest bordering posterior margin, bordered laterally and anteriorly by five (four) scales each approximately one eighth to one third as large, a semi-circular series of much smaller scales bordering the precloacal plates laterally and anteriorly.

Preaxial surface of forelimb with a series of transversely enlarged scales; postaxial surface covered by smaller, flattened juxtaposed to subimbricate scales. Preaxial aspect of thigh with large transverse plates, continuing on to shank and dorsum of pes, postaxial aspect with small flattened juxtaposed scales, granular on shank. Scales on the sole small, smooth,granular. Digits of pes 4>3>5>2>1, all clawed, bearing a series of smooth narrow subdigital lamellae: (L/R) I–8/8, II–13/13, III–18/18, IV–25/damaged, V–14/14.

Posterior 94.1 mm of tail regenerated. Original portion tail of holotype with approximately 30 elongate rectangular scales per whorl at level of knee of adpressed hindlimb. Dorsal scales strongly keeled, becoming more weakly keeled ventrolaterally. Mid-ventral subcaudals with pointed, posteriorly directed apex and strongly unicarinate, but bordered by a series of smoother scales laterally. Posterior to this level all caudal scales strongly keeled and approximately equal in size; scalation of regenerate similar to original.

Coloration (in life) (based on photographs, Fig. 3A–B). Dorsum pale orangey-brown, with greyish overtones on forebody, nape and occiput. A series of weakly delineated, short, transverse grey markings along the vertebral midline of forebody. Flanks a pale creamy orange, abruptly changing to white at ventrolateral margins of trunk. Head pale greenish-brown with darker irregular blotches; lateral surfaces of head lighter greyish brown. Labial scales chiefly white, rostral with orangey tinge, anterior labial scales with a diffuse light brown marking in posterodorsal quadrant. Dorsal surfaces of fore- and hindlegs bright orange. Original portion of tail pale orangey-brown, distal regenerated portion of tail greyish. A photograph of a wild individual (Fig. 3B) shows an original tail that is bright orange and the overall body coloration is much more vibrant than in the captive life photo of the holotype (Fig. 3A), suggesting that the duller appearance may be an artifact of captivity. However, such differences could also reflect sexual dimorphism (although the sex of the camera trapped individual is not known).

FIGURE 3. Life photos of *Nucras aurantiaca* **sp. nov.** A) Holotype specimen NMB R11626 from Lambert's Bay in captivity. B) Camera trap photo of a wild individual from Farm Fonteintjie. Note the brighter orange coloration of the wild specimen and the extremely elongate original tail.

Coloration (in preservative). Holotype (MNB 11626). Pale orange to straw, suffused with grey from just posterior of forelimb insertions to dorsum of head. Venter cream. Limbs orangey-red with scattered darker pigment flecking. Tail more-or-less uniform pale orange. Lateral surfaces of head pale greyish, labials cream. Paratype (NMB 11627) similar except nape, crown and occiput a darker grey.

Osteology: The female holotype of *Nucras aurantiaca* **sp. nov.** possesses 28 presacral vertebrae in comparison to 26 for the scanned representatives of its closest relatives, *N. livida* and *N. tessellata*, and 31 for *N. lalandii*, the next most closely related taxon (Fig. 4). There are 19 caudal vertebrae in the original portion of the tail.

Etymology: The specific epithet *auriantiaca* refers to the conspicuous, mostly unmarked orange dorsal coloration of the new species.

Distribution and Natural History: In addition to the type locality, a specimen of the new species was photographed by a Reconyx PC900 HyperFire (Reconyx, Inc., Holmen, Wisconsin, USA) camera trap set by one of us (CB) on the Farm Fonteintjie (-31.935, 18.41067), ~20 km NNE of Bosduifklip, Western Cape on 8 December 2011 at 14h20 at 32° C (Fig. 3B). The two localities for *Nucras aurantiaca* **sp. nov.** fall within the Lambert's Bay Strandveld vegetation type (Mucina & Rutherford 2006) in the Fynbos Biome (Figs. 5–6), although both records are close to the western border of the Leipoldtville Sand Fynbos vegetation type. Lambert's Bay Strandveld occupies a relatively small (451 km^2) area of mostly consolidated sand dunes supporting evergreen sclerophylous shrubs and an understory of succulent shrubs. The region, stretching from Donkin's Bay in the north to Elands Bay in the south, is below 180 m elevation and receives 125–200 mm of winter rainfall. *Nucras tessellata* has been characterized as being associated with rocky terrain (Burger 2014) or "hard substrates" (Broadley 1972), so the occurrence of *N. aurantiaca* **sp. nov.** on loose, sandy substrates is a potential ecological difference between the two. Branch (1998) depicted the range of *N. tessellata* as including that of *N. aurantiaca* **sp. nov.**, but the quarter degree square maps of Visser (1984) and Burger (2014) show no records from the particular quarter degree squares from which the new species has been recorded (Fig. 5A).

Discussion

The pattern of relationships we retrieved for *Nucras* was identical to that reported by Edwards *et al.* (2013b), except that *N. taeniolata* was not represented in our genetic samples. Edwards *et al*. (2013b), found it to be more closely related to *N. tessellata* than is *N. livida* and it may thus be inferred that it is not especially close to the new species. Further, *N. taeniolata* is both morphologically and geographically very distinct from *N. aurantiaca* **sp. nov.** Edwards *et al*. (2013b) found high support for all of their interspecific relationships, probably because of their inclusion of two nuclear markers, which provided stability, particularly in the more basal branches of the tree.

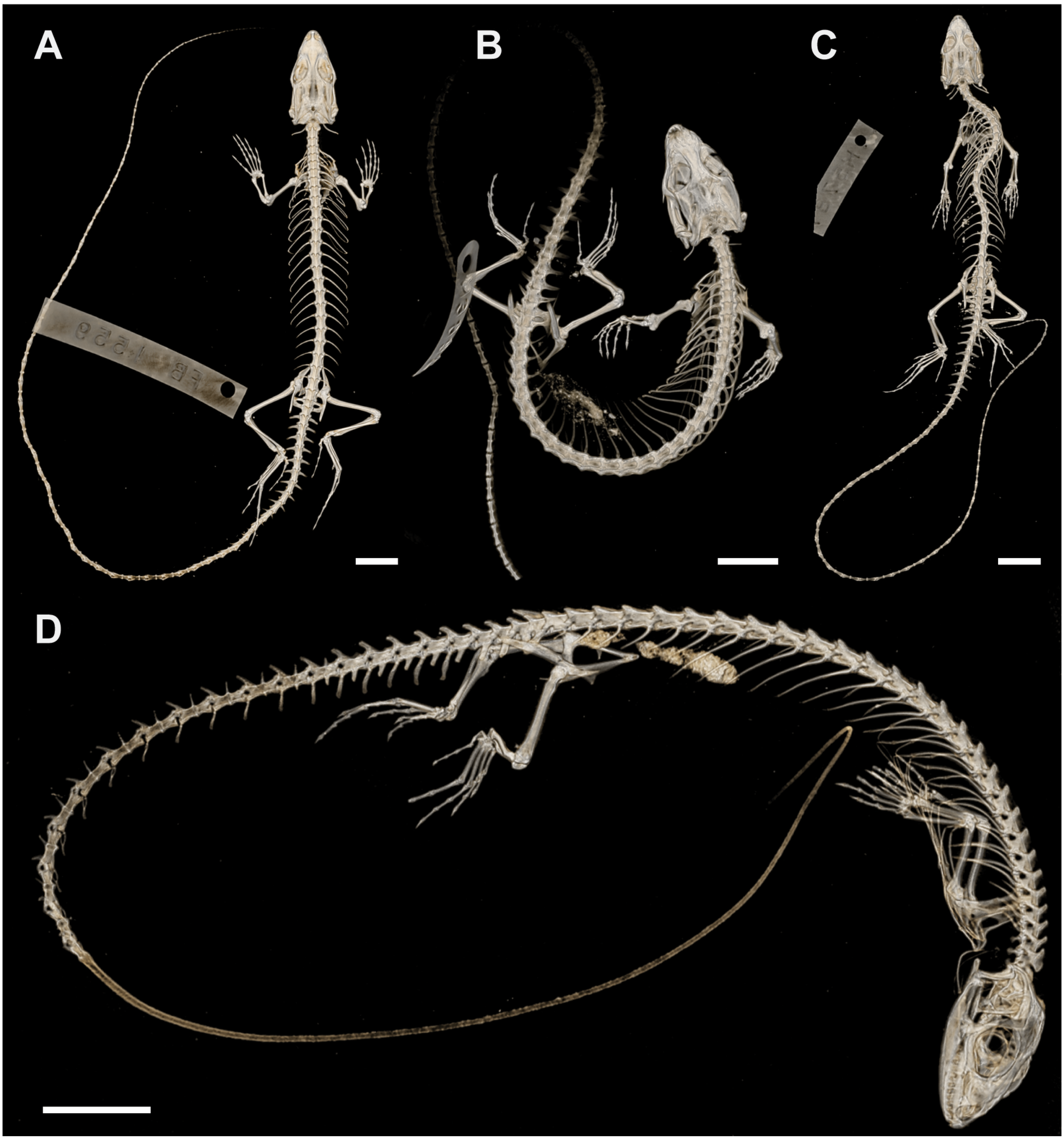

FIGURE 4. Micro-CT-scans of the skeletons of selected *Nucras* spp. A) *N. tessellata*, USEC/H 1559 (26 presacral vertebrae). B) *N. lalandii*, USEC/H 3892 (31 presacral vertebrae). C) *N. livida*, USEC/H 5787 (26 presacral vertebrae). D) *N. aurantiaca* **sp. nov.**, NMB R11626 (28 presacral vertebrae). Scale bars = 10 mm. Note the variation in trunk length and presacral vertebral number across taxa.

Nucras aurantiaca **sp. nov.** is a member of the *Nucras tessellata* group *sensu* Broadley (1972). It is phenetically most similar to *N. tessellata* with which it shares an elongate body, extremely long tail and orange coloration (at least on the posterior portion of the body). Micro-CTscans (Fig. 4) reveal that the holotype of the new species possesses two more presacral vertebrae than both the *N. tessellata* and *N. livida* specimens examined. Although the new species appears more attenuate than either of these species, it should be noted that 1) in most lacertid taxa females have more presacral vertebrae than males (typically a modal difference of a single vertebra), and 2) even within sexes there may be variation of up to four (although more often two or three) presacrals (Arnold 1989b, 1991; Van Damme & Vanhooydonck 2002). However, in contrast to most other African lacertid genera, intraspecific variation in presacral vertebrae in *Nucras* has not been investigated and the taxonomic significance, if any, of the vertebral count differences reported here remains unknown.

Broadley (1972) recognized three subspecies in *N. tessellata*: the nominate form, *N. t. livida* (since elevated to full species; Branch & Bauer 1995), and an unnamed Angolan form. Within *Nucras t. tessellata* he recognized two varieties, *elegans*, and "variety T." Although var. *elegans* is largely patternless, as is *N. aurantiaca* **sp. nov.**, it still retains a pair of white, black-bordered streaks on the neck (*fide* Boulenger 1917, 1921; FitzSimons 1943). This color pattern was reported by Broadley only in the southwestern Cape (Caledon) and inland in the Northern Cape (Calvinia, Williston, Marydale). It should be noted that Broadley used *elegans* in an infrasubspecific context, referencing *Lacerta elegans* Smith, 1838, which he placed in the synonymy of *N. t. tessellata*, following earlier authors (e.g., Boulenger 1920). The type locality of this nominal taxon is "Little Namaqualand and the country towards the Orange River" (Smith 1838). An examination of the two female syntypes of *L. elegans* reveals that all color has faded and any trace of patterning on the neck is no longer visible in BMNH 1946.8.6.10, whereas the head has been partially skeletonized in BMNH 1946.8.6.11 and the nape and neck cannot be assessed. These specimens differ from the holotype and paratype of *N. aurantiaca* **sp. nov**. in having 45–47 midbody scale rows (*versus* 39–41), 29–30 (*versus* 27) precloacal pores, 32–33 (*versus* 28–29) transverse rows of ventral plates between the axilla and groin, and 29–30 (*versus* 25) subdigital lamellae on digit IV of the pes. In addition, based on radiographs of the *L. elegans* types, both specimens have 27 (*versus* 28) presacral vertebrae. Although the status of *elegans* remains uncertain (Burger 2014), based on the types its distribution lies to the north of that of *N. aurantiaca* **sp. nov.**, in the area occupied by typical *N. tessellata*; and its high scale counts are generally consistent with those of the typical form (Broadley 1972). Indeed, Smith (1849) himself ignored *Lacerta elegans* in his later enumeration of South African lacertids, suggesting that he did not consider it valid. Certainly as a varietal term as used by Broadley (1972), *elegans* seems to be an uncommon pattern class rather than an evolutionary coherent unit.

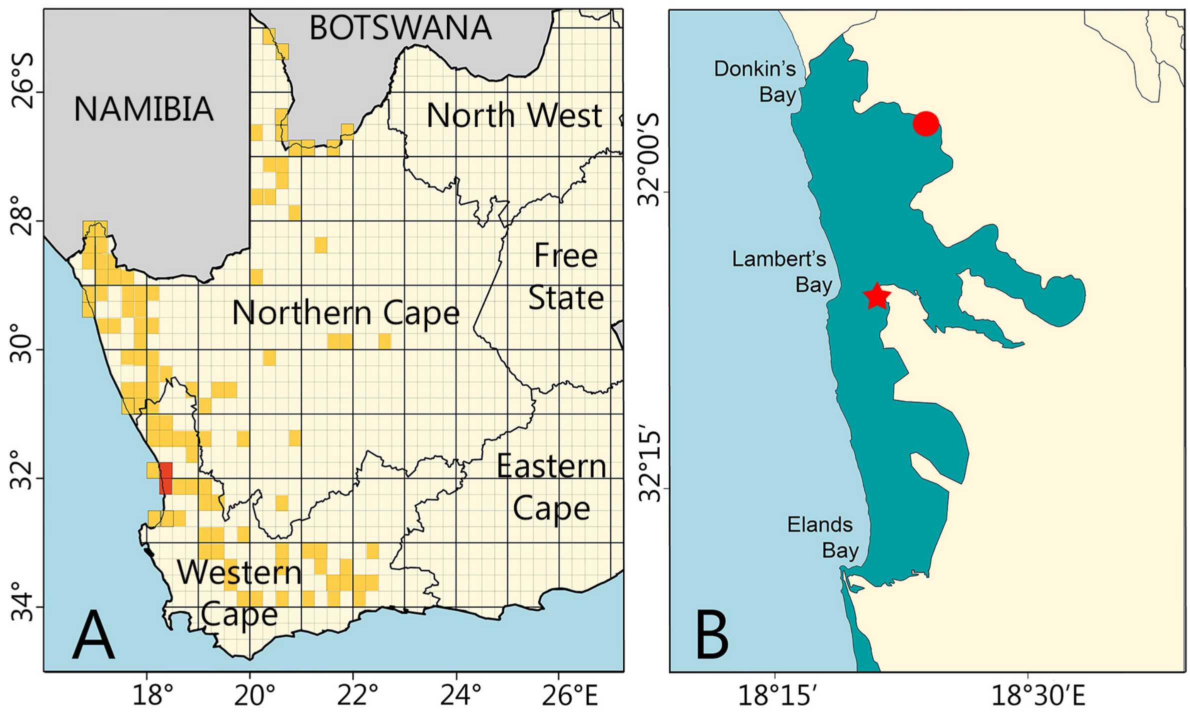

FIGURE 5. Map of A) the distribution by quarter degree squares of *Nucras tessellata* in South Africa—yellow squares circles (from Bates *et al.* 2014, including virtual records but excluding questionable records) and *Nucras aurantiaca* **sp. nov.**—red squares; and B) close-up of the region of Lambert's Bay Strandveld vegetation type (teal coloration) occupied by *N. aurantiaca* (based on Mucina & Rutherford 2006). Red star is the type locality of *N. aurantiaca* **sp. nov.**, red dot is the camera trap locality for the species.

Nucras aurantiaca **sp. nov.** is the ninth species of southern African sandveld lizard and the 23rd reptile species endemic to the Western Cape Province (Turner 2017). The coast of the Western Cape continues to yield interesting new reptile discoveries (Bauer *et al*. 2003; Heinicke *et al*. 2017; Heinicke & Bauer 2018). Despite being a herpetofaunally rich area (Meyer *et al*. 2010; Branch 2014) and the site for a series of studies on the ecology, behavior and physiology of cordylid lizards (Bauwens *et al.* 1999; Mouton *et al*. 2000; Nieuwoudt *et al*. 2003a, b, c; Costandius *et al.* 2006; Broeckhoeven & Mouton 2015) and psammophine snakes (Cottone & Bauer 2008a, b, 2013), few studies (e.g., Burrage 1978; Cordes & Mouton 1996) have specifically reported on herpetofaunal diversity in the region. The southern part of the Lambert's Bay Strandveld lies within the proposed Sandveld Core Corridor of the Greater Cedarberg Biodiversity Corridor (Meyer *et al*. 2010) and a small part of this is currently included in the Elandsbaai Nature Preserve. Furthermore, the extreme southern extent of this vegetation type would be included in a planned expansion of the Verlorenvlei Protected Area, although this would only protect chiefly estuarine habitat. The more northern portions of the Lambert's Bay Strandveld, with the only two records of *Nucras aurantiaca* **sp. nov.**, are currently unprotected, despite the area being recognized as possessing significant conservation value (Turner 2017). The West Coast region of the Western Cape is subject to a considerable number of threats, but agricultural activity and development associated with tourism are among the greatest affecting the new species. However, nothing is known of habitat use or preference, and any meaningful evaluation of the conservation status of *N. aurantiaca* **sp. nov.** will be dependent on the collection of more distributional and biological data. At present, given that the extent of occurrence and area of occupancy of the species (assuming its restriction to a single vegetation type) are below the Endangered threshold, and that the existence of threats suggests a decline in the extent and or quality of habitat, we propose a preliminary IUCN threat category of Endangered B1a,b(iii) + 2ab(iii).

FIGURE 6. Habitat of *Nucras aurantiaca* **sp. nov.** near camera trap recording site on Farm Fonteintjie, Western Cape Province. Photo by Chris Broeckhoven.

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APPENDIX 1. Comparative material (underlined specimens were Micro-CT-scanned).

Nucras boulengeri: CAS 64108, 85733, 150948, 153696, 227755, 227761, 227768, 227876, 227880, MCZ R-39963.

Nucras caesicaudata: MCZ R-173550.

Nucras holubi: CAS 234138, MCZ R-21584–85.

Nucras intertexta: CAS 214642, 234193, 234212, MCZ R-173548, R-190426, NMW 35352.1,2.

Nucras livida: USEC/H 3896, 5787, 5788, 5801.

Nucras lalandii: BMNH 66.6.18.12, CAS 85865, 106010, 156722, 173931, MCZ R-21580–83, USEC/H 3891, 3892, 5725.

Nucras ornata: BMNH 1946.8.6.75, CAS 85818, 85842, 86023, 160756, 160807–09, 160916, 195466–68, 234249, MCZ R-44518, R-50999–1001, R-52110.

Nucras scalaris: MCZ R-74121.

Nucras taeniolata: CAS 259341.

Nucras tessellata: BMNH 1946.8.6.3, 1946.8.6.10–11, CAS 200048, 201917, 206723–28, 206820, MCZ R-41891, R-173549, R-188284, NMW 35727.1, USEC/H 766, 1155, 1317, 1559, 1585, 1614–16, 3893–95, 4180.