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Two New Species of Scincid Lizards (Squamata) from the Massif de Kopéto, New Caledonia

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Field research in the ultramafic peaks of northwest New Caledonia has resulted in the discovery of two new species of scincid lizard from the Massif de Kopéto. One is a surface active species of moderate size that on the basis of genetic and morphological criteria is recognized as the sister species to *Lioscincus steindachneri* Bocage (the type species of the genus). The other species belongs to the genus *Nannoscincus*, a group of diminutive, elongate, small-limbed, burrowing species. Both are so far only known from relatively high elevation closed forest on the Massif de Kopéto, an area actively mined for nickel. Both species are considered to be of particular conservation concern due to their apparently restricted distribution, and the potential threat to their preferred habitat from mining activities.

Prior to the 1980s, the herpetofauna of New Caledonia was very poorly known. Virtually all of the systematic and distributional data available were derived from the research of Roux (1913) or earlier workers, and additional small collections of material were made only sporadically in the intervening decades, resulting in the description of only a few new taxa (see review in Bauer and Sadlier 2000). During the period between 1980–2000 many new lizard species and several new genera were discovered and described, bringing the number of recognized lizard taxa in New Caledonia to 68, of which 61 are endemic (Bauer and Sadlier 2000). This increase resulted largely from an extensive program of targeted field research that sampled humid and sclerophyll forests as well as maquis vegetation at all elevations. Much of this field research focused on the rich lizard fauna found in the humid closed forests of the axial mountain chain that runs nearly the full length of the main island, the Grand Terre. Recent expeditions to mid- and high-elevation sites within the major forest blocks have led to the description of many new taxa with highly restricted distributions (e.g., Bauer et al. 1998, 2000; Sadlier et al. 1998; Sadlier and Bauer 1999, 2000), indicative of the extensive microendemism that characterizes most of the New Caledonian herpetofauna (Bauer and Sadlier 1993, 2000; Bauer 1999).

Despite this effort, much of New Caledonia remained herpetologically unexplored. In particular, the series of large, isolated ultramafic peaks on the northwest side of the island constituted one of the most poorly known areas in New Caledonia. These massifs are substantially drier than the axial ranges on metamorphic rock that parallel them to the east (Paris 1981; Sautter 1981) and they support a rich and distinctive flora (Jaffré 1974; Jaffré and Latham 1974). They are mostly covered by maquis shrubland, a vegetation formation that has evolved to cope with the toxic, mineral-rich

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soils, but at higher elevations have remnant patches of moist forest, characterized by numerous emergent *Araucaria* (Jaffré 1980; Morat et al. 1986; Jaffré et al. 1987).

In 2001 a field program was initiated in Province Nord, Grande Terre, to determine the lizard species composition and conservation significance in various habitats, including the remnant moist forests on the major ultramafic peaks in the northwest. These are, from south to north, the Massif du Boulinda (1330 m), the Massif de Kopéto (1083 m), the Massif de Koniambo (940 m), the Massif d'Ouazangou-Taom (1092 m), Mont Kaala (1079 m), Dôme de Tiébaghi (599 m), and Sommet Poum (414 m). Although maquis vegetation extends to the tops of nearly all these peaks, small and highly fragmented forest patches also remain despite often intensive mining activity. All of these massifs were visited by one or more of the authors during the period 2001–2003. This survey effort resulted in a number of significant finds, all of which indicate the lizard fauna of these ultramafic peaks has a complex evolutionary history similar to that of the fauna of the humid forests of the central and north-eastern ranges of New Caledonia.

Among the more interesting lizards obtained in the course of this research were specimens of two new species of skink in the genera *Lioscincus* and *Nannoscincus*, both of which were collected from, or in the immediate vicinity of, small patches of remnant high elevation (>700 m) forest on the Massif de Kopéto (Fig. 1), on the west of the Grande Terre.

The Massif de Kopéto, and the contiguous peak Paéoua (1144 m), are separated from the Massif de Koniambo to the north by the broad valleys of the Koné and Pouembout Rivers, from the Massif du Boulinda to the south by the deep valley of the Népouii



FIGURE 1. Map of New Caledonia showing location of Massif de Kopéto, type locality for *Lioscincus vivae*, sp. nov. and *Nannoscincus manautei* sp. nov.

River, and from the axial ranges by the low-lying, hill country around Forêt Plate. This area has been discussed and figured by Holloway (1979). Like other northwestern massifs, the vegetation of Kopéto exhibits distinct elevational stratification (Jaffré 1974; Jaffré and Latham 1974). Elevations above 700 m are characterized by maquis vegetation dominated by species of *Costularia*, *Hibbertia*, *Knightia*, *Dicranopteris*, *Gahnia*, and *Grevillea*, but patches of humid forest are also present (Fig. 2). These may be dominated by podocarps, myrtaceous or lauraceous trees, or by species of *Casuarina*, *Metrosideros*, *Nothofagus*, or *Araucaria*. The 20-year mean annual rainfall for the summit region of the Massif de Kopéto is 1830 mm (982–3288 mm), with a marked wet season from December to March (60% of annual rainfall, monthly mean 270.4 mm vs dry season monthly mean of 93.5 mm). Clouds to ground level enshroud the summit for 20% of the time. Temperatures average around 20°C, with extremes rarely dropping below 10°C or exceeding 30°C.

MATERIAL AND METHODS

MORPHOLOGY.— Specimens examined were from the collections of the Australian Museum (AMS), California Academy of Sciences (CAS), and Muséum National d'Histoire Naturelle, Paris



FIGURE 2. Isolated closed forest patch on the Massif de Kopéto typical of habitat in the area from which the types of *Lioscincus vivae*, sp. nov. and *Nannoscincus manautei*, sp. nov. were collected.

(MNHN). Radiographs were prepared using a Eresco AS2 X-ray machine to determine phalangeal formulae and the number of presacral vertebrae and postsacral vertebrae (complete original tails only) with exposures of 40 sec at 40 kV.

The full suite of morphological characters listed below was scored for each specimen. The following mensural features were recorded: snout to vent length (SVL), measured from tip of snout to caudal edge of anal scales; axilla to groin distance, measured from middle of base of forelimb to base of hindlimb; forelimb to snout length, measured from tip of snout to middle of base of forelimb; hindlimb length, measured from middle of base of hindlimb to tip of fourth toe including nail; tail length unless otherwise stated is measured from caudal edge of anal scales to tip of tail, on complete original tails only as determined by radiographs. Body measurements are expressed as percentages of snout to vent length in the taxon accounts.

Head scalation generally follows Taylor (1935) as described and figured by Sadlier (1986). The following meristic characters were recorded: midbody scale rows = number of longitudinal scale rows around body counted midway between axilla and groin; paravertebral scales = number of scales in a paravertebral row from first scale posterior to parietal scale (including nuchals) to last scale at level of vent opening; fourth finger and toe scales = number of dorsal scales on fourth digit of hand and foot, distal scale contains claw; basal scale is last largely undivided scale at, or proximal to, a point level with intersection of the third and fourth digits (variably present as a single large scale common to the base of the fourth, third, and second fingers in some *Nannoscincus*), basal scale of fourth toe broadly contacts basal scale of adjacent third toe; fourth finger and toe lamellae = number of ventral scales on fourth digit of hand and foot, distal scale contains claw and basal scale is last largely undivided scale at a point level with intersection of third and fourth digits. Bilateral scalation characters were scored on both sides and the mean value used. Means of variable mensural and meristic features are reported with their standard deviations.

MOLECULAR ANALYSIS.— As part of a broad-scale phylogenetic study of the endemic reptiles of New Caledonia, we obtained mitochondrial and nuclear DNA sequences (514 bp of ND2 and 830 bp of rag-1) from the majority of New Caledonian skink species (including all but one genus) and representatives of related lygosomine skink lineages from Australia, New Zealand, and Africa. This phylogenetic analysis includes representatives of all *Lioscincus* species with the exception of *L. greeri*. ND2 sequences are available for all *Nannoscincus* except *N. exos*. Molecular data were analyzed within maximum parsimony and Bayesian frameworks using PAUP* v4 b10 (Swofford 2000) and MrBayes v3 (Hulsenbeck and Ronquist 2001), respectively. Support for nodes on the optimal topologies was assessed using bootstrap and Bayesian posterior probability values.

SYSTEMATICS

Reptilia: Squamata: Scincidae

Lioscincus vivae Sadlier, Bauer, Whitaker, and Smith, sp. nov.

(Figs. 3–7)

TYPE MATERIAL.— **HOLOTYPE:** Muséum National d'Histoire Naturelle, Paris (MNHN) 2003.1003 (formerly AMS R163227): Adult female; New Caledonia, Province Nord, Massif de Kopéto, Mont Vert, 21°10'22.4"S 165°02'14.6"E (altitude 720m), collected by A. H. Whitaker and V.A. Whitaker, 25 October 2002. **PARATYPES:** Australian Museum (AMS) R163228: Adult female; same collection data as holotype. AMS R163122: Adult male; New Caledonia, Province Nord, Massif de Kopéto, Mont Vert, 21°10'22.0"S 165°02'10.9"E (altitude 720m), collected by A.H. Whitaker and V.A. Whitaker, 20 June 2002. California Academy of Sciences (CAS) 226163: Juvenile; New Caledonia, Province Nord, Massif de Kopéto, Papainda 21°10'33"S 165°01'04"E (altitude 860m) collected by T. Jackman, A. Bauer, R. Sadlier, S. Smith, and G. Watkins-Colwell, 21 January 2003.

ETYMOLOGY.— The specific epithet is a matronym honoring Vivienne ("Viv") Whitaker, who collected the holotype and two of the paratypes and who made a major contribution to our field research in northwestern Grand Terre. The name is feminine and is formed in the genitive singular.

DIAGNOSIS.— *Lioscincus vivae*, sp. nov. can be distinguished from all other members of its genus except *L. steindachneri* by the following combination of characters: frontoparietals fused; anterior loreal elliptical and in narrow contact with upper labials; lower eyelid with an obvious, centrally located semi-transparent disc; each parietal scale bordered by an upper secondary temporal scale and two more or less similar sized scales not noticeably larger than adjacent dorsal scales; body scales smooth.

Lioscincus vivae, sp. nov. is readily distinguished from *Lioscincus steindachneri* in having: anterior loreal contacting upper labials (vs usually present as a semilunar scale positioned off postero-dorsal edge of enlarged nasal scale and failing to contact labials); labials below eye separated from contact with lower eyelid by a complete subocular row of scales (vs fifth upper labial scale contacting lower eyelid); more paravertebral scale rows (62–65 vs 57–60); color pattern distinctly two-toned with a white midlateral stripe anteriorly with a white midlateral stripe on head and neck (males) or full length (females) of body (vs a pattern of transverse bars with no white midlateral stripe).

DESCRIPTION (based on holotype and three paratype specimens including one adult male, two adult females, and one juvenile; measurements are for adult specimens only).— *Measurements:* SVL 53.5–55.0 mm; distance from axilla to groin 50.9–54.5% of SVL (\bar{x} = 52.6); distance from forelimb to snout 40.0–43.0% of SVL (\bar{x} = 41.9); hindlimb length 50.9–52.3% of SVL (\bar{x} = 51.4);

tail length 210.9% of SVL (estimated from individual with most complete tail).

Scalation (Fig. 3): Nasals widely separated; frontonasal broader than long; prefrontals large and narrowly separated to narrowly contacting; supraciliaries usually 7 (fused to give 5 on left and 6 on right in AMS R163228); supraoculars four; frontoparietals fused; interparietal distinct; parietals each bordered by a upper secondary temporal scale and two more or less similar sized scales not noticeably larger than the adjacent dorsal scales; upper labials 7; lower labials 6; loreals two, anterior loreal contacting the upper labials narrowly; complete subocular row of 9–12 scales ($\bar{x} = 10.25 \pm 0.29$) between preocular and pretemporal scales; primary temporal single; upper and lower secondary temporals single; tertiary temporals one (50%), or two; postlabials two; postmental contacting first and second lower labial; chinshields 3, first pair in broad contact; body scales smooth, midbody scale rows 32–34 ($\bar{x} = 32.75 \pm 0.96$); paravertebral scales 62–65 ($\bar{x} = 62.75 \pm 1.5$); scales on top of fourth finger 12–14 ($\bar{x} = 12.75 \pm 0.96$); lamellae beneath fourth finger 23–24 ($\bar{x} = 23.4 \pm 0.48$); scales on top of fourth toe 17–19 ($\bar{x} = 18.0 \pm 1.00$); lamellae beneath fourth toe 41–47 ($\bar{x} = 43.5 \pm 1.91$).

Coloration (in life): There is marked sexual dimorphism between the adult male and the adult females, with the juvenile similar in coloration to adult females.

Adult male (Figs. 4–5): Dorsal surface of body and tail uniform reddish brown, with indistinct paler middorsal stripe two half scales wide (noted at time of capture but not evident in accompanying photograph). Head gray-brown with numerous scattered dark spots on the dorsal headshields. Dorsolateral margin with a concentration of fine dark longitudinal flecks from just above the ear to just past the hindlimb. Lateral surface of anterior half of body two-toned, mid brown above (not as red as dorsal surface) and pale gray below. Bold white midlateral stripe with narrow black margin above passing through the labials to the ear, and recommencing behind the ear but fading

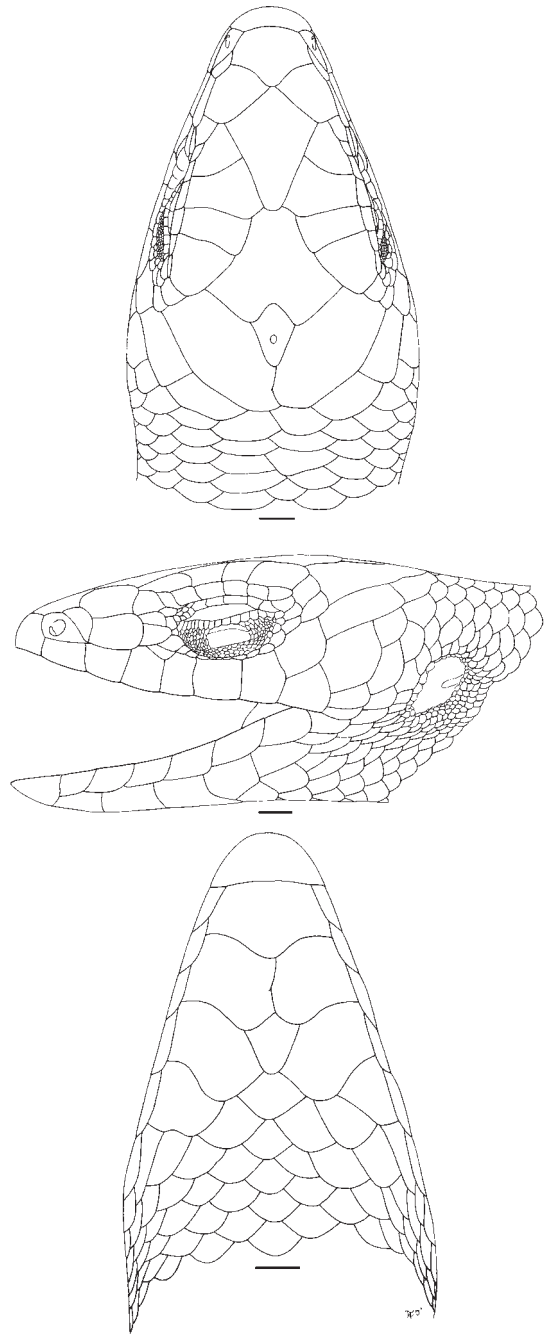


FIGURE 3. Dorsal (upper), lateral (middle), and ventral (lower) views of the headshields of holotype of *Lioscincus vivae*, sp. nov. (MNHN 2003.1003). Scale bar = 1 mm.



FIGURE 4 (above). Lateral view of a paratype of *Lioscincus vivae*, sp. nov. (AMR 163122) in life showing adult male color pattern and the long tail characteristic of the species.

FIGURE 5 (right). Lateral view of the head a paratype of *Lioscincus vivae*, sp. nov. (AMR 163122) in life.



towards the forelimb. Remainder of the lateral surface of the body (between the fore- and hindlimbs) grading from brown to gray (breaking into obscure pale blotches) towards the ventral surface. Side of head with numerous dark scattered spots to the headshields, and median and posterior labials each with large dark spots centered where the white midlateral stripe passes. Undersurface white, the throat and chest with fine, scattered, dark flecks.

Adult females (Figs. 6–7): Dorsal surface reddish brown (as for adult males, but lacking mid-dorsal stripe). Bold, white, dorsolateral stripe ($2/3$ scale width), dark-edged (broken) above from in front of the forelimb to just past the hindlimb. Lateral surface two-toned, dark brown above (darker than dorsal surface) and gray below, separated by a bold, broad ($1.5\text{--}2$ scales width), white, midlateral stripe passing through the labials to the ear, and recommencing behind the ear and passing above the forelimb to the hindlimb, and approximately a third of the way along the tail. The midlateral stripe is dark-edged above and below. Undersurface white, throat and chest with fine, scattered, dark flecks. In life the ventral surface has a faint yellow flush around the anal scales. Buccal cavity and tongue very pale, lacking any obvious dark pigmentation (condition not recorded for male and juvenile specimens).

Coloration of the single juvenile paratype is typical of adult females.



FIGURE 6 (above). Lateral view of the holotype of *Lioscincus vivae*, sp. nov. (MNHN 2003.1003) in life showing typical adult female color pattern.

FIGURE 7 (right). Lateral view of the head of the holotype of *Lioscincus vivae*, sp. nov. (MNHN 2003.1003) in life.



Osteology. Presacral vertebrae 28 ($n = 1$) or 29 ($n = 2$); phalangeal formula for manus and pes 2.3.4.5.3 and 2.3.4.5.4, respectively.

DISTRIBUTION AND HABITAT.— Known only from above 700 m on the Massif de Kopéto, from two sites approximately 2 km apart. Two individuals (MNHN 2003.1003 and AMS R163228) were collected amongst logs, ferns, and grasses on the margin of a narrow road through low, closed forest on a steep slope at Mont Vert, and another (AMS R163122) from beneath a stone in adjacent high elevation maquis. The juvenile specimen (CAS 226163) from Papainda was collected from a rock crevice in a road cutting in closed forest at the ecotone with maquis shrubland. The range of *L. vivae* may also include the Paéoua massif, as Paéoua and Kopéto share a similar habitat, are contiguous and together are isolated from all other neighboring peaks.

RELATIONSHIPS.— The new species is very distinctive in appearance and genetic data clearly

identify it as the sister species to *Lioscincus steindachneri* (type species for the genus). The relationship is supported by high bootstrap values and Bayesian posterior probabilities (100% and 1, respectively) in our analyses of all genera, and by a shared suite of unique apomorphies discussed above. ND2 mitochondrial sequence divergence between *L. vivae* and *L. steindachneri* (13.5%) is equivalent to mean pairwise congeneric species divergence within other New Caledonian skink genera (e.g., *Tropidoscincus* 11.5%, *Sigaloseps* 14.4%, *Marmorosphax* 12.1% and *Caledoniscincus* 12.9%). Phylogenetic analyses of genetic data from all New Caledonian genera indicate a revised *Lioscincus* will result in some taxa being assigned to new genera (Smith et al., unpublished data in preparation). The generic allocation of *L. vivae*, as the sister to the type species, however, will be unchanged.

***Nannoscincus manautei* Sadlier, Bauer, Whitaker, and Smith, sp. nov.**

(Figs. 8–9)

TYPE MATERIAL.— HOLOTYPE: MNHN 2003.1001 (formerly AMS R163229): Adult female; New Caledonia, Province Nord, Massif de Kopéto, Papainda, 21°10'38.5"S 165°01'15.4"E (elevation 800 m), collected by A.H. Whitaker and V.A. Whitaker, 25 October 2002. Paratype: AMS R163123: Adult female; same locality and collectors as holotype, 22 June 2002.

ETYMOLOGY.— The specific epithet honors our friend and colleague Joseph Manauté, now of the Direction des Ressources Naturelles de la Province Sud (Service des Parcs et Réserves Terrestres). When working for the Direction du Développement Economique et de l'Environnement (Service de l'Environnement) of the Assemblée de la Province Nord, Joseph was a strong proponent of the herpetological surveys that revealed this and many other new species. He remains a strong supporter of both scientific investigation and conservation in New Caledonia. The epithet is masculine and is formed in the genitive case.

DIAGNOSIS.— *Nannoscincus manautei* sp. nov. can be distinguished from all other members of the genus by the following combination of characters: frontoparietals fused; loreal single; left oviduct lost in females; lower labials five; lower eyelid with a semitranslucent window; ear opening minute; body scales smooth; adult dorsal color uniform brown; ear opening positioned three scales posterior to lower secondary temporal; longitudinal scale rows around the body 18–20; presacral vertebrae 32–33; phalangeal formula for pes 2.3.4.4.3.

The first five characters readily distinguish *N. manautei* from *N. gracilis*, *N. slevini*, and a new species from Pic Ningua in the southern ultramafic block, all of which have divided frontoparietals, two loreals (the anterior semilunar and usually failing to contact the labials), a right and left oviduct, and a 'scaled' lower eyelid.

Nannoscincus manautei shares the apomorphic character states of a single loreal, loss of the left oviduct, and reduction to five lower labials with a group of six other species (*N. mariei*; *N. greeri*; *N. rankini*; *N. humectus*, *N. hanchisteus*, and *N. exos*).

Three species, *N. humectus*, *N. hanchisteus*, and *N. exos*, have smooth body scales like *N. manautei*. The relatively uniform adult coloration of *N. manautei*, lacking obvious differentiation between dorsal and lateral surfaces, distinguishes it from these species, all of which are noticeably two-toned in having a distinctly lighter dorsal and darker lateral surface. *Nannoscincus manautei* can be further distinguished from *N. hanchisteus* and *N. exos* by the positioning of the ear opening three (vs two) scales posterior to the lower secondary temporal, and from *N. humectus* by having fewer lamellae beneath the 4th toe (12–13 vs 15–19) and fewer longitudinal scale rows around the body (18–20 vs 20–24).

The smooth body scales of *N. manautei* will distinguish it from *N. greeri*, *N. mariei*, and *N.*

rankini all of which have 3–4 fine striations down the body scales. *Nannoscincus manautei* most closely resembles *N. mariei* and *N. rankini*, both of which are relatively uniformly colored as adults. It can be further distinguished from *N. mariei* by the presence of a “windowed” (vs “scaled”) lower eyelid, fused (vs paired) frontoparietals, and the presence of a small external ear opening (lacking in *N. mariei*), and from *N. rankini* by the positioning of the ear opening three (vs two) scales posterior to the lower secondary temporal and in having fewer longitudinal scale rows around body (18–20 vs 22–24).

DESCRIPTION (based on holotype and paratype).— Measurements: SVL 31.0–34.0 mm; distance from axilla to groin 64.7–66.1% of SVL (\bar{x} = 65.4); distance from forelimb to snout 32.2–32.3% of SVL (\bar{x} = 32.25); hindlimb length 20.6–21.0% of SVL (\bar{x} = 20.8); tail length 103.2% of SVL or more (estimated from individual with most complete tail).

Scalation (Fig. 8): Nasals large and moderately separated; frontonasal broader than long; prefrontals very small and widely separated; supraciliaries seven, with the first supraciliary contacting frontal (thereby excluding contact between the prefrontal and first supraocular); frontal short almost as broad as long; supraoculars four; frontoparietals fused; interparietal distinct; parietals each bordered by a single nuchal and upper secondary temporal scale; upper labials six; lower labials five; primary temporal single; upper and lower secondary temporals single; tertiary temporals two; postlabials two; post temporals three (number of scales positioned posterior to lower secondary temporal and ear opening); postmental contacting first and second lower labial; chinshields three, first pair in broad contact; body scales smooth, midbody scale rows 18–20; paravertebral scales 53–56 (\bar{x} = 54.5); scales on top of fourth finger 4–5 (\bar{x} = 4.3 ± 0.57), scales at base of second, third, and fourth fingers variable, ranging from a single scale at the base of each digit, to two scales of

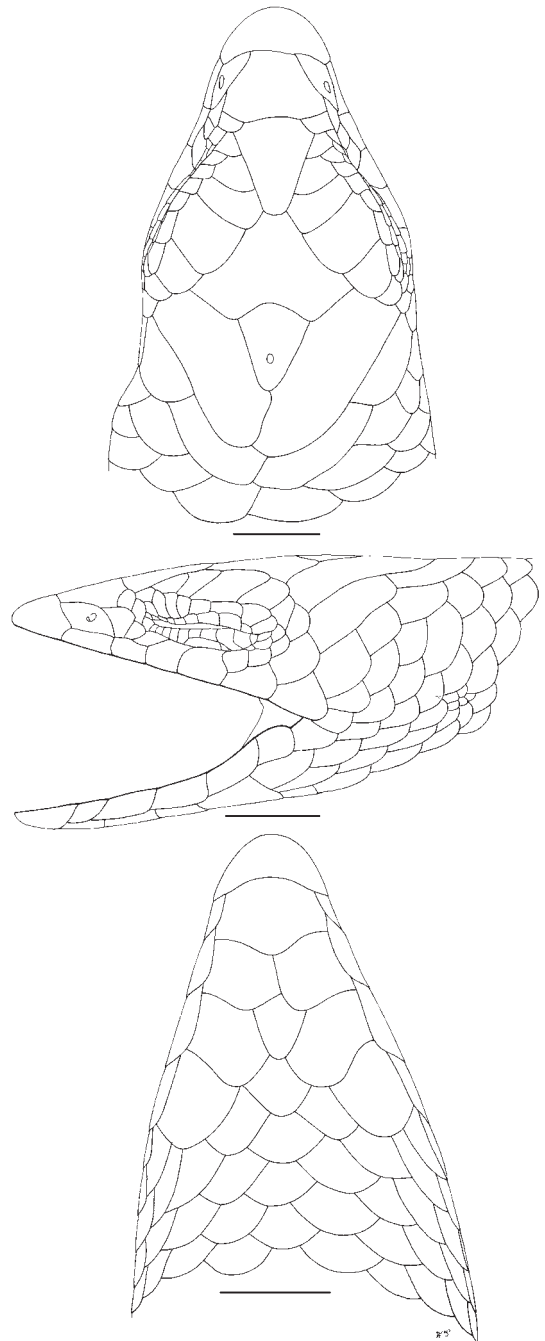


FIGURE 8. Dorsal (upper), lateral (middle), and ventral (lower) views of the head shields of holotype of *Nannoscincus manautei*, sp. nov. (MNHN 2003.1001). Scale bar = 1 mm.

equal size, to a small scale at the base of the second digit and an enlarged scale common to base of the third and fourth digits; lamellae beneath fourth finger 4; scales on top of fourth toe 6; lamellae beneath fourth toe 12–13 ($\bar{x} = 12.5 \pm 0.5$).

Coloration (in life; Fig. 9): Dorsal color mid brown overall, head and nape with pale spots centered on individual head shields and scales of the nuchal area, extending to upper labials on holotype. Lateral surface similar to dorsal uppermost, becoming progressively paler towards the venter. Dark markings along the ventrolateral margin between the forelimbs and jaw concentrated towards the center of each scale, and forming one to two obscure brown stripes running back obliquely from the rear and underside of the jaw. Lower labials with dark brown markings across the middle of each scale separated by lighter interspaces, dark markings extending to adjacent chinshields. Ventral surface pale with a concentration of scattered brown markings at edges and regular brown markings to the edge of the throat region.

Osteology: Presacral vertebrae 31–32 ($\bar{x} = 31.5 \pm 0.7$); phalangeal formula for manus and pes 2.3.4.4.3 and 2.3.4.4.3, respectively.

DISTRIBUTION AND HABITAT.— Known only from a single site above 700 m on the Massif de Kopéto. Both holotype and paratype were collected under logs and rocks embedded in a deep humus layer and overlain by thick leaf litter in a patch of moist closed forest characterized by emergent *Araucaria*. Another *Nannoscincus*, presumed to be the same species, was seen beneath a log in similar habitat approximately 1.8 km to the east. As for *Lioscincus vivae*, the range of *N. manautei* may also include the Paéoua massif.

RELATIONSHIPS.— *Nannoscincus* is a member of the Australasian *Eugongylus* group of lygosomine skinks (Greer 1979). It is distinguished from other genera in the group by a combination of morphological synapomorphies that includes: fusion of the atlantal arches and intercentrum of the first cervical vertebra into a single element; an elongate body with 29 or more presacral vertebrae; phalanges of digits of the forelimbs reduced, with a phalangeal formula of 2.3.4.4.3 or less for the manus (Sadlier 1990; Bauer and Sadlier 2000).

The generic status of a single Australian species referred to the genus, *N. maccoyi*, has recent-



FIGURE 9. Dorsal view of a paratype (AMS R163123) of *Nannoscincus manautei*, sp. nov., in life.

ly been re-evaluated (Sadlier et al., in review), leaving ten species, all endemic to the New Caledonian mainland, in two distinct species groups. One of these, the “*gracilis*” group (Sadlier 1990) includes *N. gracilis*, *N. slevini*, and an undescribed species from Pic Ningua, one of the northernmost peaks in the southern ultramafic block of New Caledonia. The species in this group are all superficially similar in that they have very elongate bodies and a markedly two-toned color pattern. They also share a suite of distinctive apomorphic characters, two of which, a reduction in the number of phalanges of the third and fourth fingers to yield the pedal phalangeal formula 2.3.3.3.3 and a generally highly elevated number of presacral vertebrae, are unique within *Nannoscincus*. The monophyly of the “*gracilis*” group is supported by moderate bootstrap support (67%) and high posterior probability (1) in analyses of mitochondrial DNA sequence data (Smith et al, unpublished data, in preparation).

The other group is a clade of six species (*N. mariei*; *N. rankini*; *N. greeri*; *N. hanchisteus*; *N. humectus*; and *N. exos*) characterized by three morphological synapomorphies (loss of the left oviduct in females; reduction in number of lower labial scales to five; and loss of the anterior loreal scale), and is referred to as the “*mariei*” species group (Sadlier et al. 2002). These features are also present in the species of *Nannoscincus* described here, which is, therefore, considered a member of the “*mariei*” group. It is superficially most similar to *N. rankini*, which is believed to be endemic to Mont Aoupinié, approximately 25 km east of Kopéto, in the more mesic central chain of mountains. ND2 divergence between *Nannoscincus manautei* and other members of the *mariei* group species, has a mean of 13.5% (vs 13.2% for comparisons among previously described members of the *mariei* group). However, mitochondrial ND2 sequence data analyzed using parsimony and Bayesian criteria (Swofford 2000; Hulsenbeck and Ronquist 2001) do not support the monophyly of the “*mariei*” group, but rather suggest they form a poorly resolved basal cluster of species within the genus. A further phylogenetic analysis of the genus *Nannoscincus* is currently being prepared for publication.

CONSERVATION

Nannoscincus manautei is known from a single location and *Lioscincus vivae* from two locations on the Kopéto massif. Both are likely to be found in other high elevation (>700 m) forest patches on, and associated with, the Kopéto-Paéoua massif. The individual size of these forest patches is extremely small. They are scattered across the top of the mountains, mostly on south-facing slopes, and often in and adjacent to gullies.

Our investigations on the northwestern ultramafic massifs have revealed that most of these peaks support endemic species of lizards that do not occur on adjacent mountains. Such is possibly the case with the species described here. Despite searches of comparable habitat on the Massif du Boulinda to the south and the Massif de Koniambo to the north, no additional sites for either species was located. On the next major massif to the east, Mont Aoupinié, *N. manautei* is replaced by the high-altitude species *N. rankini*, and it is very unlikely to occur in low altitude forests in the vicinity of Massif de Kopéto where it is replaced by other *Nannoscincus* species (nearest known localities *N. humectus* and *N. gracilis* at Forêt Plate, 500–600 m and 9 km to the northeast, or *N. hanchisteus* at Pindaï, <60 m and 18 km to the southwest). No comment is possible on the likelihood that *L. vivae* occurs at elevations significantly below 700 m.

The nickel mining operation on Kopéto is one of the most sophisticated and intensive in the region. The remnant areas of high altitude closed forest on the mountain have all been disturbed to different degrees by access roads, by the construction of containment ponds and waste rock dumps (often in gullies), and by wind-blown dust or excess run-off from actively mined surfaces (Fig. 10). Given the steep terrain and the small size of the remaining forest patches, mining activity through



FIGURE 10. Patch of gully forest (bottom center) on the Massif de Kopéto illustrating disruption of adjacent forest associated with recent mining activity (left).

or immediately adjacent to these forests has the potential to alter a significant proportion of the overall area of the habitat remaining for these lizard species.

Because of their apparently highly restricted distribution, the small size and fragmented nature of the remaining moist forest habitat on the Massif de Kopéto, and the potential threat to this habitat from established mining activities in areas immediately adjacent to the known habitat, both species would be ranked as Critically Endangered under the modified IUCN classification system used for the New Caledonian herpetofauna (total area of occupancy <math><100\text{ km}^2</math>, a single population and an apparent continuing decline in area, extent and/or quality of habitat) (Sadlier and Bauer 2003).

The survey effort in closed forests of the Kopéto massif undertaken in 2001–2003, or for that matter on any of the ultramafic massifs in the northwest of the island, can only be regarded as preliminary (about 1–3 calendar days or 2–8 person days per massif). Given the limited time spent surveying the individual peaks in this region it is possible these new species could have a somewhat wider range than is currently indicated, in which case their conservation status would need to be reviewed.

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LITERATURE CITED

- BAUER, A.M. 1999. The terrestrial reptiles of New Caledonia: the origin and evolution of a highly endemic herpetofauna. Pages 3–25 in H. Ota, ed., *Tropical Island Herpetofaunas: Origin, Current Diversity, and Conservation*. Elsevier, Amsterdam.
- BAUER, A.M., J.P.G. JONES, AND R.A. SADLER. 2000. A new high-elevation *Bavayia* (Reptilia: Diplodactylidae) from northeastern New Caledonia. *Pacific Science* 54:63–69.
- BAUER, A.M., AND R.A. SADLER. 1993. Systematics, biogeography and conservation of the lizards of New Caledonia. *Biodiversity Letters* 1:107–122.
- BAUER, A.M. AND R.A. SADLER. 2000. *The Herpetofauna of New Caledonia*. Society for the Study of Amphibians and Reptiles, Ithaca, New York. xii + 310 pp., 24 pls.
- BAUER, A.M., A.H. WHITAKER, AND R.A. SADLER. 1998. Two new species of the genus *Bavayia* (Reptilia: Squamata: Diplodactylidae) from New Caledonia. *Pacific Science* 52:342–355.
- GREER, A.E. 1979. A phylogenetic subdivision of Australian skinks. *Records of the Australian Museum* 32:339–371.
- HOLLOWAY, J.D. 1979. *A Survey of the Lepidoptera, Biogeography and Ecology of New Caledonia*. Dr. W. Junk, The Hague. xii + 599 pp.
- HULSENBECK, J.P., AND F. RONQUIST. 2001. MrBayes: Bayesian inference of phylogeny. *Bioinformatics* 17:754–755.
- JAFFRÉ, T. 1974. La végétation et la flore d'un massif de roches ultrabasiques de Nouvelle-Calédonie: le Koniambo. *Candollea* 29:427–456, 3 pls.
- JAFFRÉ, T. 1980. Étude écologique du peuplement vegetal des sols derivés de roches ultrabasiques en Nouvelle-Calédonie. *Travaux et Documents de l'ORSTOM* 124:1–274.
- JAFFRÉ, T., AND M. LATHAM. 1974. Contribution à l'étude des relations sol-végétation sur un massif des roches ultrabasiques de la côte Ouest de la Nouvelle-Calédonie: le Boulinda. *Adansonia*, série 2, 14:311–336, 4 folding pls.
- JAFFRÉ, T., P. MORAT, J.-M. VEILLON, AND H.S. MACKEE. 1987. Changements dans la végétation de la Nouvelle-Calédonie au cours du Tertiaire: la végétation et la flore des roches ultrabasiques. *Bulletin du Muséum National d'Histoire Naturelle, Paris*, 4e série, section B, *Adansonia* 9:365–391.
- MORAT, P., T. JAFFRÉ, J.-M. VEILLON, AND H.S. MACKEE. 1986. Affinités floristiques et considérations sur l'origine des maquis miniers de la Nouvelle-Calédonie. *Bulletin du Muséum National d'Histoire Naturelle, Paris*, 4e série, section B, *Adansonia* 8:133–182.
- PARIS, J.P. 1981. Géologie de la Nouvelle-Calédonie. *Mémoires du Bureau de Recherches Géologiques et Minières* 113:1–278, 2 separate maps.
- ROUX, J. 1913. Les reptiles de la Nouvelle-Calédonie et des Îles Loyalty. Pages 79–160 in F. Sarasin and J. Roux, eds., *Nova Caledonia, Zoologie*, Vol. 1(2). C.W. Kreidels Verlag, Wiesbaden.
- SADLER, R.A. 1986. A review of the scincid lizards of New Caledonia. *Records of the Australian Museum* 39:1–66.
- SADLER, R.A. 1990. The scincid lizard genus *Nannoscincus* Günther: a revaluation. *Memoirs of the Queensland Museum* 29:487–494.
- SADLER, R.A., AND A.M. BAUER. 1999. The scincid lizard genus *Sigaloseps* (Reptilia: Scincidae) from New Caledonia in the southwest Pacific: description of a new species and review of the biology, distribution, and morphology of *Sigaloseps deplanchei* (Bavay). *Records of the Australian Museum* 51:83–91.
- SADLER, R.A., AND A.M. BAUER. 2000. The scincid lizard genus *Marmorosphax* (Reptilia: Scincidae) from New Caledonia in the southwest Pacific: description of a new species restricted to high-altitude forest in the Province Sud. *Pacific Science* 54:56–62.

- SADLIER, R.A., AND A.M. BAUER. 2003. Conservation status of endemic New Caledonian lizards — an assessment of the distribution and threats to the species of lizard endemic to New Caledonia. http://www.amonline.net.au/herpetology/research/lizards_conservation_intro.htm.
- SADLIER, R.A., A.M. BAUER, AND S.A. SMITH. (In review). A new species of *Nannoscincus* Günther (Squamata: Scincidae) from high elevation forest in southern New Caledonia. *Records of the Australian Museum*.
- SADLIER, R.A., A.M. BAUER, AND A.H. WHITAKER. 2002. The scincid lizard genus *Nannoscincus* Günther from New Caledonia in the southwest Pacific: a review of the morphology and distribution of species in the *Nannoscincus mariei* species group, including the description of three new species from the Province Nord. *Zoologica Neocaledonia* 5, *Mémoires du Muséum National d'Histoire Naturelle, Paris* 187:269–276.
- SADLIER, R.A., A.H. WHITAKER, AND A.M. BAUER. 1998. *Lioscincus maruia*, a new species of lizard (Reptilia: Scincidae) from New Caledonia, southwest Pacific. *Pacific Science* 52:334–341.
- SAUTTER, G., coord. 1981. *Atlas de la Nouvelle Calédonie et Dépendances*. ORSTOM, Paris. [118] pp., 53 maps, 1 acetate overlay.
- SWOFFORD, D.L. 2000. PAUP*: *Phylogenetic Analysis Using Parsimony* (and Other Methods). Version 4.0. Sinauer, Sunderland, Massachusetts.
- TAYLOR, E.H. 1935. A taxonomic study of the cosmopolitan scincoid lizards of the genus *Eumeces* with an account of the distribution and relationships of its species. *University of Kansas Science Bulletin* 36:1–642.