

## A New Live-Bearing Species of Scincid Lizard (Reptilia: Scincidae) from New Caledonia, Southwest Pacific<sup>1</sup>

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**Abstract:** A new species of skink, *Kanakysaurus zebratus*, is described from the ultramafic Massif de Kopéto and Massif de Koniambo on the northwestern coast of Grande Terre, New Caledonia. Although this new species is similar in overall appearance to its congener *K. viviparus* from the far northwest of Grande Terre and the Îles Belep, it can be distinguished by features of scalation and coloration. It is also identified as being genetically distinct from and reciprocally monophyletic with respect to populations of *K. viviparus* from Rivière Néhoué (type population), the Îles Belep, and a recently discovered population from Sommet Poum (reported here for the first time). The population of *Kanakysaurus* on Dôme de Tiébaghi (5 km southeast of Rivière Néhoué) is problematic: in morphology it is closest to *K. viviparus*, but DNA sequence data group part of the population with *K. viviparus* and part with *K. zebratus*, n. sp. On Kopéto the new species was found only in maquis shrubland at 500–1,000 m in elevation and on Koniambo in *Gymnostoma*-dominated closed forest at 700 m. Adult females collected on the Massif de Kopéto in February during the height of the wet season had well-developed embryos, confirming a live-bearing mode of reproduction for the new species, and for the genus as a whole. The summit area of Kopéto is the site of a large nickel mine and substantial portions of the known range of the new species are projected to be cleared to extract nickel-bearing ore in the future; extensive development for nickel mining is also forecast in the immediate future for Koniambo. Because of the apparently restricted range and projected degradation of habitat of this new species, it is here regarded as assignable to IUCN Red List Category Endangered and considered a high priority for conservation management.

THE ISLAND OF New Caledonia has been identified as a biodiversity hot spot of inter-

national standing (Myers 1988, 1990, Mittermeier et al. 1996, 1999, Myers et al. 2000) and as one of the high-priority regions for conservation in the world. Its recognition as such stems from the exceptional diversity and level of endemism of the island's flora, particularly the humid forest (>2,100 taxa with 83% endemism) and the maquis minier, a shrubland vegetation mainly restricted to ultramafic substrates (>1,200 taxa with 90% endemism) (Jaffré et al. 2001).

The New Caledonian lizard fauna consists solely of skinks and geckos, with the number of described scincid and diplodactylid species in genera endemic to New Caledonia currently standing at approximately 80, with many additional species waiting to be described. The skinks belong to the essentially Australasian *Eugongylus* group, and all except three species in the two widespread genera

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(*Emoia* Gray and *Cryptoblepharus* Wiegmann) are part of an endemic New Caledonian radiation comprising 13 genera (Smith et al. 2007). Half of the 48 taxa of endemic skinks currently recognized have been described in the past 10 yr. This dramatic increase in both species richness and generic diversity of scincid fauna has resulted from extensive laboratory-based research investigating phylogenetic relationships using DNA sequence data (Smith et al. 2007, Sadlier et al. in press) and from extensive field research in recent years. However, the recent discovery of many new taxa in the field and data derived from ongoing molecular phylogenetic projects indicates that the number of species will increase by at least a further 35% (Bauer and Jackman 2006).

In particular, fieldwork undertaken on the ultramafic massifs along the west coast from Massif du Boulinda in the south to Sommet Poum in the far north of the island (Whitaker et al. 2004) and on other ultramafic mountains in the central regions of the island has resulted in the discovery of a number of new skink and gecko species, many of them endemic to single massifs. Most of the new species of skinks are localized endemics on these mountains—some are restricted to high-elevation humid forests (e.g., *Nannoscincus manautei* Sadlier, Bauer, Whitaker & Smith; *N. garrulus* Sadlier, Bauer & Smith; *Marmorosphax taom* Sadlier, Smith, Bauer & Whitaker; *M. boulinda* Sadlier, Smith, Bauer & Whitaker), and others occur in forest and/or maquis habitats, often over a broader altitudinal range (e.g., *Lioscincus vivae* Sadlier, Bauer, Whitaker & Smith; *Celatiscincus similis* Sadlier, Smith & Bauer). Similar patterns of localized endemism are found in geckos (Whitaker et al. 2004, Bauer et al. 2006a,b).

The uniqueness of the lizard fauna on the central and northwestern ultramafic massifs indicates a complex history for both the maquis shrubland and high-elevation humid forests to produce the level of regional microendemism recorded: four species appear to be endemic to Mount Taom and three to the Massif de Kopéto, and most other less well-studied massifs in the region have at least two endemic lizards. This field research

has also revealed a high level of lizard species richness for these massifs, particularly in the maquis shrublands, with 13 taxa recorded from mid- to high-elevation maquis on the Massif de Kopéto and 10 from high-elevation maquis on Mount Taom. In contrast the lizard fauna in the maquis shrubland on the southern ultramafic block appears to be relatively depauperate, with just seven species recorded collectively from sites in the extensively surveyed maquis shrubland in the region of Forêt Nord in the far south of the island (Sadlier and Shea 2004, 2006).

The central and northwestern ultramafic massifs are subject to a range of pressures that have degraded, or threaten to degrade, the small areas of habitat in which these highly restricted lizard species are found. Mining for nickel occurs on all the major ultramafic massifs on the northwestern coast and some of the smaller massifs. The size of these operations varies, and some are extensive and the level of development is escalating. None of the maquis shrubland or high-elevation humid forest on ultramafic massifs in the Province Nord is formally protected. These massifs are of high conservation significance for the lizard fauna of New Caledonia, and the reservation and management of appropriate areas of habitat is urgently required.

At the request of Société le Nickel (SLN), selected areas on the upper part of Massif de Kopéto were surveyed to detect the possible presence of lizard species of conservation significance. During the course of this work a new species in the recently erected genus *Kanakysaurus* was discovered in maquis shrubland at several sites across the massif from mid- to high elevation. This same species was later located on Massif de Koniambo during the course of survey work undertaken for Koniambo Nickel SAS. In overall morphology (size, shape, scalation) and pattern of coloration the new species is very similar to its recently described congener, *Kanakysaurus viviparus*, and also shares a live-bearing mode of reproduction.

Additional field research on Sommet Poum in the far north of Grande Terre, also at the request of SLN, has led to the dis-

covery of a new location for *K. viviparus*, an endangered species previously known from just four populations (Sadlier et al. 2004). On Sommet Poupou its habitat included maquis shrubland on “laterite cuirasse,” a habitat from which it has not previously been recorded.

## MATERIALS AND METHODS

### Morphology

Standardized collection abbreviations used are as follows: AMS (Australian Museum, Sydney), CAS (California Academy of Sciences, San Francisco), and MNHN (Muséum National d'Histoire Naturelle, Paris). The following characters were scored for each specimen where possible: snout to vent length, measured from tip of snout to caudal edge of anal scales; axilla to groin distance, measured from middle of base of the forelimb to middle of 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, measured from caudal edge of anal scales to tip of tail, on complete original tails only. Body measurements are expressed as percentages of snout to vent length (SVL) in the taxon accounts.

Head scalation generally follows Taylor (1935) as described and figured by Sadlier (1986). For characters used in Table 1 the abbreviation is given in parentheses: midbody scale rows (MBR), number of longitudinal scale rows around body counted midway between axilla and groin; dorsal scale rows (DSR), number of scales in a row from first scale posterior to parietal scale to last scale at the level of vent opening; fourth finger (FFS) and toe (FTS) scales, number of dorsal scales on fourth digit of hand and foot, distal scale contains claw and basal scale broadly contacts adjacent basal scale of third finger or toe; fourth finger (FFL) and toe (FTL) 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. Bilaterally scoreable scalation characters were scored on both sides and the mean value used; in the holotype description these values are presented as left/right values. Interpopulational meristic values were compared using *t*-tests.

Specimens were x-rayed for determining the number of premaxillary teeth, presacral and postsacral vertebrae, and phalangeal formula for the manus and pes; other skeletal details were determined by dissection.

### Molecular Phylogenetics

Genomic DNA was extracted, purified, and sequenced from 95–100% ethanol-preserved liver samples of *Kanakysaurus* from Massif de Kopéto, Massif de Koniambo, Sommet Poupou, Rivière Néhoué, and Dôme de Tiébaghi using protocols published by Sadlier et al. (2004). Mitochondrial ND2 (514bp) and nuclear RAG1 (830bp) were added to an existing data set (Sadlier et al. 2004), which was analyzed using maximum parsimony (MP) and Bayesian inference. Based on prior, higher-order studies of relationship among New Caledonian skinks (Smith et al. 2007), *Marmorosphax* spp. were used as outgroup taxa.

## RESULTS

### Systematics

The genus *Kanakysaurus* (Sadlier et al. 2004) was recently proposed to accommodate the new species *K. viviparus*, described from the far northwest of Grande Terre, and from Île Art and Île Pott in the Îles Belep. At that time an extensive combination of apomorphic character states diagnosed the genus. Most of these characters still serve to diagnose the genus inclusive of the new species described below; however, one unusual character, the degree of separation or contact between the parietal scales, shows variation between the two species. The modified diagnosis for the genus now is as follows: supranasal scale or postnasal suture absent; subocular scale row complete; primary temporal scales usually two; lower secondary temporal scales

TABLE 1

Differences in Number of Midbody Scale Rows (MBR), Dorsal Scale Rows (DSR), Fourth Finger (FFS) and Toe (FTS) Scales, and Fourth Finger (FFL) and Toe (FTL) Lamellae between Samples of *Kanakysaurus zebratus* from Massif de Kopéto, *Kanakysaurus* sp. from Dôme de Tiébaghi, and *Kanakysaurus viviparus* from Rivière Néhoué and Sommet Poum

Character <sup>a</sup>	<i>K. zebratus</i> Kopéto ( <i>n</i> = 11)	<i>Kanakysaurus</i> sp. Tiébaghi ( <i>n</i> = 3)	<i>K. viviparus</i> Néhoué ( <i>n</i> = 17)	<i>K. viviparus</i> Poum ( <i>n</i> = 6)
MBR				
Range	38–40	38	38–40	38–42
Mean ± SD	38.6 ± 0.93		38.7 ± 0.98	40.0 ± 1.26
$t = 0.43$ , $df = 26$ , $P < .671$				
DSR				
Range	72–81	66–69	65–72	66–70
Mean ± SD	75.7 ± 2.69	67.0 ± 1.73	69.2 ± 1.85	68.7 ± 1.51
$t = -7.58$ , $df = 26$ , $P < .000$				
FFS				
Range	10–11	9–11	9–11	9–10
Mean ± SD	10.3 ± 0.34	9.6 ± 0.89	9.9 ± 0.69	9.7 ± 0.52
$t = -1.603$ , $df = 26$ , $P = .121$				
FFL				
Range	16–20	14–17	13–17	14–16
Mean ± SD	17.5 ± 1.18	15.8 ± 1.30	15.2 ± 0.79	15.2 ± 0.52
$t = -6.254$ , $df = 26$ , $P = .000$				
FTS				
Range	15–18	14–15	14–16	14–17
Mean ± SD	16.7 ± 0.90	14.4 ± 0.55	14.8 ± 0.75	15.7 ± 1.21
$t = -6.688$ , $df = 26$ , $P = .000$				
FTL				
Range	31–34	26–29	26–32	28–31
Mean ± SD	32.3 ± 1.17	27.6 ± 1.14	28.7 ± 1.62	29.3 ± 0.88
$t = -6.244$ , $df = 26$ , $P = .00$				

<sup>a</sup>  $t$  values relate to independent  $t$ -tests between samples from the type localities (Kopéto and Néhoué) for each character.

usually two; parietal scales either failing to contact behind the interparietal (*K. viviparus*) or usually in narrow contact (*K. zebratus* [Figure 1]); lower eyelid with an obvious centrally located, semitransparent disk; ear lobules barely distinguishable from blunt conical scales around upper, lower, and posterior edges of ear opening; first and second pair of chinshields transversely enlarged, with the first pair in broad contact, members of the third pair divided such that five scales separate those members bordering the labials. Both species also share a live-bearing mode of reproduction.

*Kanakysaurus zebratus* Sadlier, Smith, Whitaker & Bauer, n. sp.

Figures 1–3

TYPE MATERIAL: Holotype: MNHN 2006.0393 (formerly AMS R167239), 1.5 km SW Mt. Tiaoué, Massif de Kopéto, Province Nord, New Caledonia, 21° 11' 02.1" S, 164° 59' 17.8" E, elevation 740 m, collected by A. H. Whitaker and V. A. Whitaker, 6 March 2006. Paratypes: AMS R167220–24, R167229, CAS 233598, 6 km NW Mt. Tiaoué, Massif de Kopéto, 21° 10' 11.0" S, 164° 59' 30.0" E, elevation 850 m; AMS R167234, 1.2 km SE Mt. Vert, Massif de Kopéto, 21° 10' 21.6" S, 165° 02' 19.0" E, elevation 780 m; AMS R167240, 2 km E Mt. Vert, Massif de Kopéto, 21° 10' 11.6" S, 165° 02' 56.4" E, elevation 480 m; AMS R167245, CAS 233599, Plateau between Rivière Salée and Ouénipa, Massif de Kopéto, 21° 12' 08.0" S, 165° 01' 04.4" E, elevation 540 m. All paratypes col-



lected by A. H. Whitaker and V. A. Whitaker between 28 February and 8 March 2006.

**ADDITIONAL SPECIMENS EXAMINED:** AMS R168063, R168069–70, ridge between Creek Taléa and Rivière Pandanus, Massif de Koniambo, Province Nord, New Caledonia, 20° 59' 43" S, 164° 47' 26" E, elevation 700 m, collected by A. H. Whitaker and R. A. Sadlier between 2 and 5 July 2007.

**ETYMOLOGY:** The species epithet is a masculine adjective and refers to the bold, zebra-like stripes that are particularly pronounced in the subadults and juveniles of the species.

**DIAGNOSIS:** *Kanakysaurus zebratus*, n. sp., can be distinguished from its congener *K. viviparus* by having more dorsal scales (72–81 versus 65–74) and in females, subadults, and juveniles a pattern of broad dark bands (4–5 scales wide at middorsum) across the body that are wider than the alternating pale interspaces, whereas the dark dorsal bands across the body in *K. viviparus* are narrower (1–3 scales wide at middorsum) and not substantially wider than alternating pale interspaces. A comparison of fourth finger lamellae, fourth toe scales, and fourth toe lamellae also revealed significant differences between the two species (see Table 1), but overlap in the range of these characters makes them of limited use in unequivocally diagnosing the two species from each other.

**DESCRIPTION:** The species is described from two adult males and five adult females (67–72 mm SVL), two subadults (43.5–56.5 mm SVL), and two juveniles (42 mm SVL). Measurements are given only for adults; otherwise description is based on all specimens except where indicated.

**Measurements:** Size 66–72 mm SVL; distance from axilla to groin 52.2–55.6% SVL ( $\bar{x}$  = 54.1); distance from forelimb to snout 37.5–42.0% SVL ( $\bar{x}$  = 40.1); hindlimb length 35.4–37.9% SVL ( $\bar{x}$  = 48.8); tail length of individual with most complete tail 147% SVL.

**Scalation** (Figure 1): Prefrontals large, narrowly to moderately separated; frontal longer than wide; frontoparietals divided; interparietal distinct; parietals in point to moderate contact behind interparietal, rarely separated ( $n$  = 1), parietals each bordered by

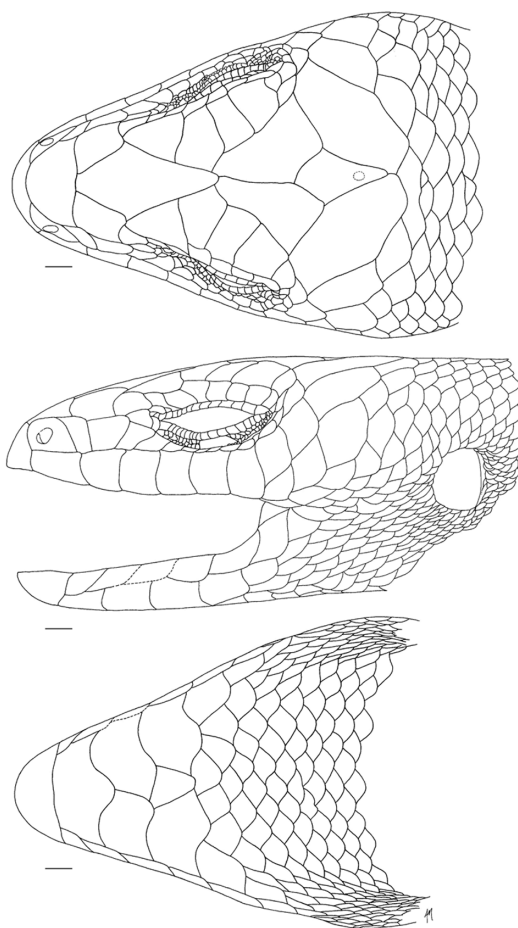


FIGURE 1. Dorsal (top), lateral (middle), and ventral (bottom) views of the head of holotype of *Kanakysaurus zebratus*, n. sp. (MNHN 2006.0393). Scale bar = 1 mm.

a transversely elongate upper secondary temporal scale and three smaller scales, two of which are slightly larger in size than adjacent body scales and another larger scale (sometimes divided) that lies behind interparietal and between (and contacting) both parietals; primary temporals usually two, the lower positioned partly between last two upper labials; upper secondary temporal single; lower secondary temporals two; tertiary temporals two (41%) or three; postlabials two, rarely fused to form a single scale (5%) in that region; nasals moderately large, moderately to widely separated; two loreals, anterior consid-

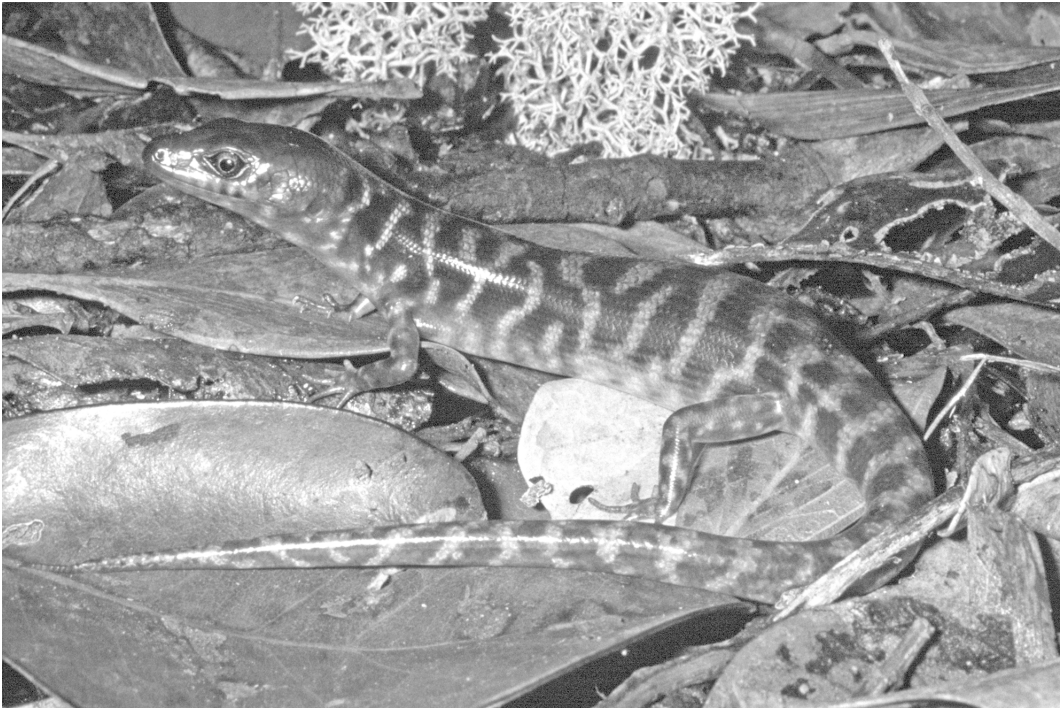


FIGURE 2. Adult female holotype (MNHN 2006.0393) of *Kanakysaurus zebratus*, n. sp., in life.

erably narrower than high; supraciliaries 7 (90%), rarely 8 or 9, fourth supraciliary usually noticeably larger than those preceding and interdigitating between first and second supraoculars; upper labials 7 with fifth positioned below eye and separated from lower eyelid by a complete row of 8–10 (usually 9–48%) subocular scales; lower labials 6, first two contacting postmental; chinshields three, first and second pair of chinshields transversely enlarged with members of first pair in broad contact and second pair separated by one scale, members of third pair divided such that usually five scales separate those members bordering labials, all chin scales flush with lower labials.

Lower eyelid with an obvious, centrally located, semitransparent disk. Ear opening moderately large, with no obvious enlarged lobules at edges, only a series of small, rounded scales along anterior edge of ear.

Body scales with 3–5 very faint keels dorsally and 3–4 weaker keels laterally, failing to

interrupt posterior edge of scale; midbody scale rows 38–40 ( $\bar{x}$  = 38.5, SD = 0.93); dorsal scale rows 72–81 ( $\bar{x}$  = 75.7, SD = 2.69); scales on top of fourth finger 10–11 ( $\bar{x}$  = 10.3, SD = 0.34); lamellae beneath fourth finger 16–20 ( $\bar{x}$  = 17.5, SD = 1.18); scales on top of fourth toe 15–18 ( $\bar{x}$  = 16.9, SD = 0.90); lamellae beneath fourth toe 31–34 ( $\bar{x}$  = 32.3, SD = 1.17), smooth, divided toward outer edge for basal third of third and fourth digits.

**DETAILS OF HOLOTYPE:** Adult female; size 69.0 mm SVL; distance from axilla to groin 36 mm; distance from forelimb to snout 27 mm; hindlimb length 25.5 mm; tail length 89 mm, regenerated. Midbody scale rows 40; dorsal scale rows 75; dorsal scales of fourth finger 11/10; lamellae of fourth finger 18/18; dorsal scales of fourth toe 18/17; lamellae of fourth toe 31/31.

**OSTEOLOGY:** Premaxillary teeth 11 ( $n$  = 8); presacral vertebrae 29; postsacral vertebrae 48–50 ( $n$  = 2); phalangeal formula for



FIGURE 3. Juvenile *Kanakysaurus zebratus*, n. sp. (AMS R167223), in life.

manus and pes 2.3.4.5.3 and 2.3.4.5.4, respectively; 2 pairs of mesosternal ribs contacting mesosternum.

**COLOR AND PATTERN:** Adult females (Figure 2): Dorsal surface mid- to dark brown with broad black markings (average 4–5 scales wide at middorsum), running transversely or obliquely across body to form a network pattern of alternating narrow light and wide dark bars that extend to side of body. Dark lateral markings bold over most of lateral surface and only becoming lighter in tone approaching venter, area between forelimb and ear opening predominantly black with scattered paler blotches. Dorsal surface of head and nape dark brown, and mainly unmarked; face similar but with dark central markings on primary and lower secondary temporal scales, posterior labial scales, and lower labials; rostral, nasal, and first lower labial scales noticeably darker than adjacent head scales. Dark markings of lower labials extending to adjacent chin scales but

varying in extent and intensity from bold to obscure, remainder of throat area gray with pale blotches, pale markings near forelimbs forming a transverse blotch across throat that is bordered behind by a dark transverse bar just in front of forelimbs (continuous with dark lateral markings on side of neck), which defines posterior edge of throat pattern.

Adult males: Similar to adult females but with dark dorsal and lateral bars being narrower (3–4 scales wide), lighter in tone, and less well defined; and dark markings on face and throat being gray and poorly defined.

Subadults and juveniles (Figure 3): Dorsal and lateral surfaces of body and tail similar in overall pattern to those of adult females in having a pattern of broad dark bars but with light interspaces of body being much paler and those on tail cream to nearly white. Dark markings of throat usually well defined and contrasting with lighter markings in this area (duller and more suffused in AMS R167241), giving a distinct marbled pattern.

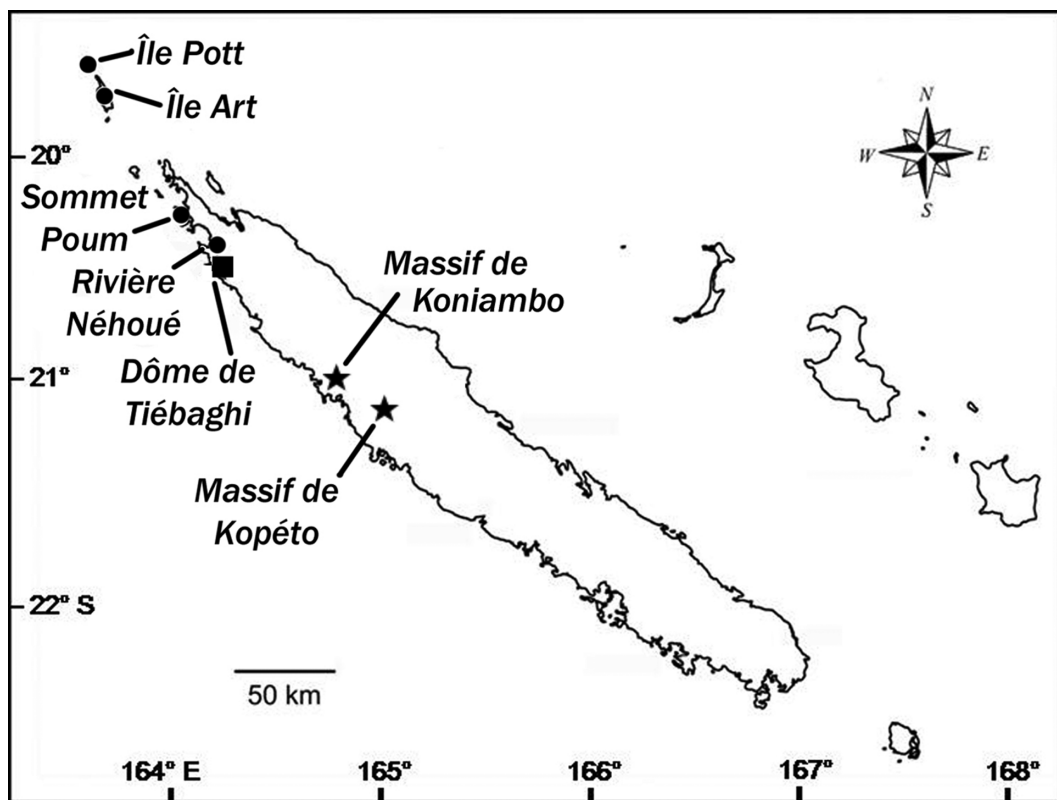


FIGURE 4. Distribution of *Kanakysaurus zebratus*, n. sp. (stars), *K. viviparus* (circles), and *K. viviparus* + *K. sp.* (square) in northwestern New Caledonia.

### *Distribution and Biology*

*Kanakysaurus zebratus* is currently known only from two locations on the northwestern coast of the Grande Terre of New Caledonia (Figure 4): the upper parts of the ultramafic Massif de Kopéto, south of the Pouembout Valley; and the upper parts of Massif de Koniambo north of the Pouembout Valley.

On Kopéto the species has been found at seven localized sites on the massif over a range of approximately 7.0 by 3.5 km and an altitudinal range of 480–860 m. At four of the sites the habitat comprises sparse maquis shrubland on a laterite cuirasse surface (Figure 5). Woody shrubs 1–3 m high dominate this vegetation formation, with ground cover consisting largely of leaf litter and rocks. At

the remaining three sites the habitat is maquis shrubland on outcropping and eroding peridotites (Figure 6). The woody vegetation at these sites is generally taller and more continuous, and there is a denser ground layer of sedges and ferns. Of the 17 individuals found, three were located during the day as they sheltered beneath large, loose rocks on the cuirasse surface (Figure 5); the remaining 14 were trapped. No active skinks were observed, either by day or night. However, some level of diurnal activity must occur because one of the trapped skinks was captured in a boulder pile between 1030 and 1730 hours on an overcast, showery day.

On Koniambo the species has been located at only a single site in *Gymnostoma*-dominated closed forest at 700 m. Four individuals were



FIGURE 5. Sparse maquis on cuirasse habitat of *Kanakysaurus zebratus*, n. sp., on Mount Tiaoué, Massif de Kopéto. One skink was found beneath the boulder at left of center.

recorded (one observation and three trap captures); all were from a small area of rocks in a boulder bank in the forest. None was collected from adjacent forest habitat away from the boulder bank, although a number of *Marmorosphax tricolor* (Bavay) were recorded.

Current information is inadequate to define the primary habitat for *Kanakysaurus zebratus* because of the small number of animals found. Although it has the appearance and behavior of a cryptozoic species with high moisture requirements, it has not been found in primary closed-forest habitats. It is remarkable that it has not been recorded from various remnants of high-elevation montane forests on the summits of either the Massif de Kopéto or Massif de Koniambo where *Marmorosphax tricolor* is abundant. *Marmorosphax tricolor* and *Kanakysaurus zebratus* are broadly sympatric on the summit of Massif de Kopéto and both occur in maquis

cuirasse habitats; however, despite their general similarity in morphology and habit, *M. tricolor* and *K. zebratus* have not yet been recorded syntopically, perhaps because of some subtle difference in their ecology and habitat. It is interesting to note that the species was not recorded during trapping undertaken in dense *Gleichenia* fernlands on laterite soils even though the thick vegetation and litter provide a suitably dark and humid environment.

Other lizard species recorded in the maquis shrubland habitat of *Kanakysaurus zebratus* on Massif de Kopéto include *Caledoniscincus atropunctatus* (Roux), *C. austrocaledonicus* (Bavay), *C. festivus* (Roux), *Lioscincus maruia* Sadlier, Whitaker & Bauer, *L. nigrofasciolum* (Peters), *L. vivae* Sadlier, Bauer, Whitaker & Smith, *Marmorosphax tricolor* (Bavay), *Tropidoscincus boreus* Sadlier & Bauer, *Bavayia* sp., *Eurydactylodes vieillardii* (Bavay), and *Rhacodactylus auriculatus* (Bavay).



FIGURE 6. Maquis on peridotite habitat of *Kanakysaurus zebratus*, n. sp., at Mount Vert, Massif de Kopéto. One skink was captured in a trap set among these outcrops.

*Kanakysaurus viviparus* Sadlier, Smith, Bauer & Whitaker, 2004

At the time of its initial description, *Kanakysaurus viviparus* was known from just four populations: Île Art and Île Pott in the Îles Belep, Rivière Néhoulé, and Dôme de Tiébaghi (Sadlier et al. 2004). Recent field research on Sommet Poup, 28 km north of Rivière Néhoulé, in the far north of Grande Terre, recorded a new population of *K. viviparus* at Paevala on the northern end of the summit plateau.

**MATERIAL EXAMINED** (7 specimens): AMS R167775 (18 September 2006), AMS R167776 (19 September 2006), 20° 14' 57" S, 164° 01' 33" E, maquis shrubland on cuirasse; AMS R167778 (17 September 2006), 20° 15' 02" S, 164° 01' 39" E, maquis shrubland on cuirasse; AMS R167777 (18 September 2006), AMS R167781 (24 September 2006), 20° 14' 53" S, 164° 01' 34" E, closed forest; AMS

R167779 (24 September 2006), 20° 14' 45" S, 164° 01' 34" E, closed forest; all specimens collected by A. H. Whitaker and V. A. Whitaker.

In morphology and coloration the specimens from Sommet Poup conformed closely to the original description for *K. viviparus* (Table 1).

On Sommet Poup *Kanakysaurus viviparus* was found at several sites across a range of about 800 m between 300 and 340 m elevation. The plateau surface is lateritic cuirasse almost entirely covered with maquis vegetation, the density and height of which varies from essentially bare boulder or pebble surfaces to impenetrable shrubland (height to 4 m). At Paevala there are small, isolated closed-forest patches (tree height 6–10 m), clearly remnants of what was once more widespread forest cover. The skinks were abundant in the closed forest remnants, living in deep boulder banks, beneath loose stones

and in deep accumulations of leaf litter. They were also present in lesser numbers in boulder areas beneath maquis shrubland. The closed-forest habitat occupied at Paevala is similar to that they inhabit on Île Art and at Dôme de Tiébaghi. The maquis cuirasse habitat is unlike any other site where *K. viviparus* occurs but is very similar to that occupied by *K. zebratus* on Massif de Kopéto.

### Molecular Phylogenetics

The monophyly of *Kanakysaurus* inclusive of *K. zebratus* is strongly supported by the combined analysis of the ND2 and RAG1 data (MP bootstrap 100%, posterior probability 1.00). Earlier data showed that the Dôme de Tiébaghi population of *K. viviparus* is genetically distinct from those on the Îles Belep and at Rivière Néhoué, but it was conservatively included within that species (Sadlier et al. 2004). Adding the new data from *K. zebratus* and from the Sommet Poupou population of *K. viviparus* to the genetic data set reveals two clades within *Kanakysaurus* (Figure 7), one comprising the populations of *K. viviparus* from Rivière Néhoué, Sommet Poupou, and the Îles Belep, as well as two individuals from the Dôme de Tiébaghi, which is strongly supported (MP bootstrap 100%, posterior probability 1.00), and the other including populations of *K. zebratus* from the Massif de Kopéto and Massif de Koniambo and additional specimens from Dôme de Tiébaghi. However, this latter sister-group relationship is not well supported (MP bootstrap 83%, posterior probability 0.79). Sequence difference between *Kanakysaurus viviparus* and *K. zebratus* is  $7.9 \pm 1.1\%$ , whereas that between *K. zebratus* populations from Kopéto and Koniambo and the three specimens from Tiébaghi (Figure 7: *K. sp.*) that constitute their sister-group is  $1.4 \pm 0.2\%$ .

### DISCUSSION

#### Status of Dôme de Tiébaghi *Kanakysaurus*

The low level of genetic divergence between *K. zebratus* and the clade of Dôme de Tiébaghi specimens constituting its sister-group su-

perficially suggests that they are conspecific, with Tiébaghi representing a relatively distant (85 km) northern population. However, the Tiébaghi specimens (all males) have both narrow (1–2 scales wide) and moderately broad (3–4 scales wide) transverse dorsal markings (versus 3–4 in male *K. zebratus*) and lack the intensity and continuity of breadth of the dark transverse bars seen in *K. zebratus*. Further, they do not share the elevated number of dorsal scale rows that characterizes both populations of *K. zebratus* (66–69 versus 72–81). Indeed, these specimens from Tiébaghi are morphologically indistinguishable from typical *K. viviparus* (Table 1). Thus these individuals are clustered with *K. zebratus* on the basis of mitochondrial DNA data and with *K. viviparus* on the basis of diagnostic morphological features (the RAG1 data alone were equivocal in the placement of these specimens). We suggest that this conflict in the data may be reflective of past mitochondrial introgression or that the problematic Tiébaghi specimens may share plesiomorphic morphological features with *K. viviparus* even though they share derived sequence characteristics with *K. zebratus*. Pending further investigation of Dôme de Tiébaghi populations, we refrain from assigning these specimens to species and refer to them simply as *Kanakysaurus* sp.

#### Conservation Status

Detailed information on population sizes or reproductive effort within generations is lacking for most New Caledonian lizard species, so the first-level criterion used in assessing conservation status is the extent of distribution—species with restricted ranges usually are those most susceptible to threats. We have here used a modified area of occupancy index adjusted for the total area of New Caledonia (Sadlier and Bauer 2003) wherein a species represented by a single locality record (0.5% or less of total landmass) is considered eligible to be placed in the Endangered category, or higher, in the presence of threats to the area of occupancy or extent and quality of habitat.

On the Massif de Kopéto *Kanakysaurus ze-*

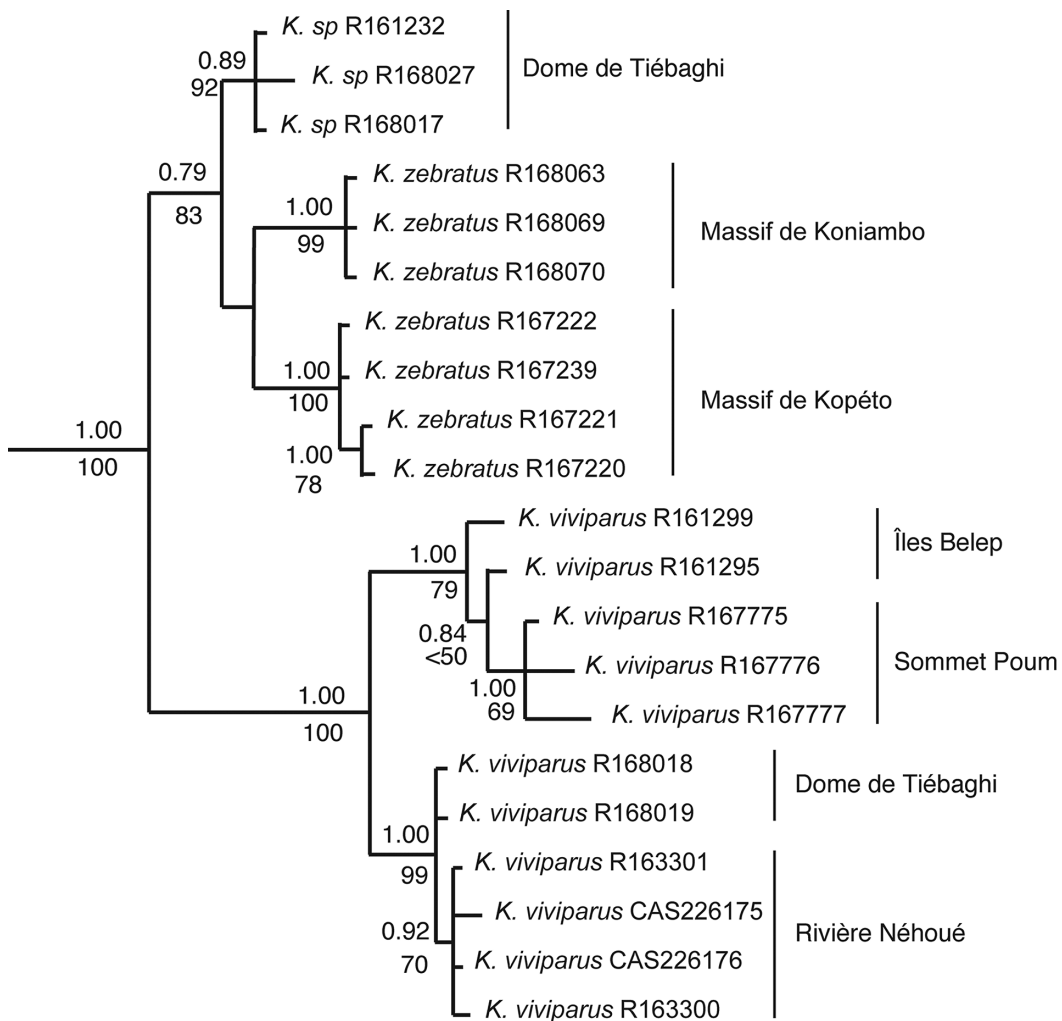


FIGURE 7. Phylogenetic relationships among populations of *Kanakysaurus*. Bayesian topology is shown with posterior probabilities above the branches and MP bootstraps below. For outgroups see Smith et al. (2007).

*bratus* is currently known only from maquis habitat on the upper parts. The opencast nickel mine operating on the summit of Kopéto is one of the most sophisticated and intensive in the region. With the entire area of the mountain above 700 m elevation held under mining lease and plans to extend the open pits in the near future there will be a substantial reduction in the extent of the relatively undisturbed maquis habitat of *K. zebratus* on the upper part of the massif and in particular of that on the cuirasse surfaces. To some ex-

tent mitigating this potential habitat loss is the fact that the mine site is very strictly controlled and managed, and access is restricted. This minimizes the risk to any remaining areas of habitat from threats such as wildfires and human disturbance that are important elsewhere in New Caledonia. On the Massif de Koniambo the situation is quite different: the species appears to have a much more restricted distribution, being known from a single location that is in close proximity to the main access route to the mine area. Despite



investigation of other habitats on the summit area of the massif, including maquis on cuirasse surfaces, no additional specimens were located.

Because of its apparently extremely restricted range and the threats to its preferred habitat at each location, *Kanakysaurus zebratus* currently meets the criteria for classification as Endangered both under IUCN (2001) and our modified (Sadlier and Bauer 2003) criteria, and we recommend that conservation of the species on each massif be treated as an equally high conservation priority. To fully assess the importance of the sites from which it is known, and to put in context the impact of proposed mine expansion at both sites on the conservation status of this species, further field research is required to determine its distribution in the region. South of the Pouembout Valley this includes investigation of the contiguous peak of Paéoua, immediately to the east of Kopéto, and the two lower plateaus to the west, Col de Tiaoué and Plateau de Tia, and north of the Pouembout Valley this should concentrate on additional survey work on Koniambo and the massifs to the north, including Taom and Kaala.

The discovery of the new population of *Kanakysaurus viviparus* at Sommet Poupou would normally lead to an improvement in its conservation status. However, because there are advanced plans for mining the entire summit plateau that will result in the removal of all known habitat for this species on the massif, its conservation status must remain Endangered. Similarly, an expansion of mining activity at the Dôme de Tiébaghi is proposed in the near future, resulting in a high level of conservation significance for this population (and *Kanakysaurus* sp.).

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