

A New Genus and Species of Live-Bearing Scincid Lizard (Reptilia: Scincidae) from New Caledonia

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ABSTRACT.—A new genus and species of lizard is described from far northern New Caledonia and the Îles Belep, to the north of the New Caledonian mainland. In overall appearance and biology, it is most similar to the forest-dwelling species of the endemic New Caledonian genus *Marmorosphax* and shares with those skinks a live-bearing mode of reproduction. However, the new species is highly divergent in its scalation and includes a combination of character states not seen in any other New Caledonian species. The new species has been recorded mainly from dry forest habitats in the far north of the region, including dry closed forest on the Îles Belep, dry riverine forest adjacent to the Rivière Néhoué, and dry closed forest on Dome de Tiébaghi. The forests in which this new species is found are now present as relictual patches as a result of historical factors or more recent anthropogenic impacts. The taxonomic uniqueness of this species, in combination with its restricted distribution and threats to its preferred habitat, make it a high priority for conservation management.

New Caledonia is a French island territory in the Coral Sea in the southwest Pacific Ocean. The New Caledonian mainland (16,648 km²), also known as the Grande Terre, lies at the southern margin of the tropics and reaches elevations of more than 1600 m. It has been identified as a biodiversity hotspot (Myers, 1988, 1990; Myers et al., 2000). The New Caledonian region is both floristically and faunistically distinctive (Morat et al., 1986; Bauer, 1999; Bauer and Sadlier, 2000) and harbors a number of phylogenetically interesting taxa such as *Amborella*, the sister taxon to remaining flowering plants (Mathews and Donoghue, 1999), and the endemic and monotypic avian family Rhynochetidae.

High levels of endemism, approaching 100% in some less vagile taxa, characterize many invertebrate groups in New Caledonia (Holloway, 1979; Chazeau, 1993; Haase and Bouchet, 1998). Among vertebrates, lizards exhibit similarly high levels of endemism (Bauer and Sadlier, 1993, 2000; Adler et al., 1995) with 14 of 17 genera in the region strictly endemic, and an additional skink genus, *Caledoniscincus*, nearly so. By comparison, there are no known endemic lizard genera in the adjacent island groups of Vanuatu, Fiji, or Samoa, all of which share a different, and much more recent, geological origin than New

Caledonia (Avias, 1973; Holloway, 1979; Kroenke, 1984, 1996). Several genera of skinks and geckos, including *Caledoniscincus*, *Nannoscincus*, and *Baoyia*, are particularly species rich and appear to have radiated in situ (Bauer, 1989).

As a result of lineage splitting in association with the geological evolution of the Grande Terre, New Caledonian lizards are typified by high levels of intransland microendemism (Bauer and Sadlier, 2000). The already limited distributions of many taxa have been further fragmented by more recent natural and human-mediated changes in vegetation. This is particularly true of dry forest formations. Sclerophyll forests, for example, are now recognized as the most threatened terrestrial habitat on the island (Bouchet et al., 1995).

Recent studies have started to document the reptile fauna of these restricted dry forest habitats. Surveys at Presqu'île de Pindai in 1995 (Jourdan et al., 2000, 2001) and in 1996 (Conservation International, 1998) and at Tiéa near Pouembout (Barre et al., 2001) not only produced the first comprehensive inventory of lizard species for sclerophyll habitat in New Caledonia but also identified several species known only from this habitat type (Bauer et al., 1998; Sadlier et al. in Bauer and Sadlier, 2000; Sadlier et al., 2002).

As part of a project to investigate the lizard fauna of poorly known areas and habitats of the northwest of New Caledonia, including its offshore islands, several dry closed forest sites were selected. The new scincid lizard described here

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TABLE 1. Differences in the 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 three samples of *Kanakysaurus viviparus* (two from the mainland and one from the Îles Belep).

	Rivière Néhoué (N = 17) mean ± SD (range)	Dôme de Tiébaghi (N = 1) range	Îles Belep (N = 5) mean ± SD (range)
MBR	38.7 ± 0.98 (38–40)	38	42 ± 1.41 (40–44)
DSR	69.2 ± 1.85 (65–72)	66	71.6 ± 3.36 (66–74)
FFS	9.9 ± 0.69 (9–11)	10–11	10.1 ± 0.22 (10–11)
FFL	15.2 ± 0.79 (13–17)	17	15.2 ± 0.57 (14–16)
FTS	14.8 ± 0.75 (14–16)	15	14.7 ± 0.57 (14–16)
FTL	28.7 ± 1.62 (26–32)	28–29	27.2 ± 1.25 (26–29)

was located in forest at two sites on the mainland just north of Koumac, the Rivière Néhoué and Dôme de Tiébaghi, and from two islands, Île Art (Aar) and Île Pott (Phwoc), in the Îles Belep to the north of the Grande Terre. In overall morphology (size, shape, and coloration) and habits, the new species bears most resemblance to the widespread closed forest dependent species *Marmorosphax tricolor* and, like that species, exhibits viviparity, a reproductive mode rare among New Caledonian lizards. However, the new species possesses an impressive array of unusual apomorphies in scalation that do not allow it be placed in any existing genus of scincid lizards.

MATERIALS AND METHODS

Abbreviations.—Specimen collection abbreviations are prefixed as follows: Australian Museum, Sydney (AMS); Muséum National d'Histoire Naturelle, Paris (MNHN); California Academy of Sciences, San Francisco (CAS); Museum of Comparative Zoology, Harvard University, Cambridge (MCZ); Raffles Museum of Biodiversity Research, Singapore (ZRC).

Morphology.—The following characters were scored for each specimen where possible: snout-vent length (SVL), 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 hind limb; forelimb to snout length, measured from tip of snout to middle of base of forelimb; hind limb length, measured from middle of base of hind limb 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 SVL in the taxon account.

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; paravertebral scales (DSR), number of scales in a paravertebral row from first scale posterior to

parietal scale (including nuchal 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. Bilateral scalation characters were scored on both sides and the mean value used; in the holotype description these values are presented as left/right values. Sexual dimorphism in paravertebral scales (the scalation character that is most frequently sexually dimorphic in skinks) was assessed using independent two-sample *t*-test in the largest single sample from a single location. Variation between populations for certain scalation characters was assessed using independent two-sample *t*-tests.

Specimens were radiographed using an Eresco AS2 X-ray machine to determine phalangeal formulae and the number of presacral vertebrae and postsacral vertebrae (complete original tails only) at exposures of 30 sec at 30 kV.

Molecular Methods and Phylogenetic Analysis.—As part of a broad-scale phylogenetic study of the endemic reptiles of New Caledonia, we have 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. Results are presented here for all populations of the new species and selected representatives of other endemic New Caledonian genera. The lygosomine genera *Panaspis* and *Tropidophorus* were included as outgroups.

Amplification was conducted using Eppendorf Taq polymerase and an Eppendorf Mastercycler thermocycler. Primers for RAG-1 were derived from Groth and Barrowclough (1999), and an additional reverse primer was designed to pair with R13 (primer sequence—5'-AAA GCA AGG

ATA GCG ACA AGA G-3'). ND2 was amplified using L4437b (Macey et al., 1997) and ND2r102 designed for this study (primer sequence—5'-CAG CCT AGG TGG GCG ATT G-3'). After initial denaturation at 94°C for 2 min, each cycle consisted of denaturation at 94°C for 45 sec, annealing at 52°C for 45 sec, and extension at 72°C for 1 min, for 34 cycles. Negative controls were run for all amplifications. Amplified products were purified from solution using the GFX purification kit (Amersham Biosciences). Products were sequenced using either the ABI BigDye v2.0 sequencing kit or DYEnamic ET terminator sequencing kit (Amersham Biosciences). Sequence products were electrophoresed on an ABI 373a stretch gel sequencer for 17 h. Sequences were edited using Sequence Navigator (ABI) and aligned by eye using Se-Al v1.0 (A. Rambaut, Evolutionary Biology Group, University of Oxford, Oxford, U.K., 1995).

The combinability of gene partitions was assessed in two ways. We applied the incongruence length difference (ILD) test (Mickey and Farris, 1981; Farris et al., 1995) implemented in PAUP*, and the partitioned Bremer index (Baker and Desalle, 1997) implemented using TreeRot v 2a (M. D. Sorenson, Boston University, Boston, MA, 1999). Parsimony analyses were done using PAUP* v 4.0 b10 (D. L. Swofford, Sinauer Assoc., Inc., Sunderland, MA, 1999). Tree searches were conducted using an heuristic algorithm (with 1000 random addition sequence replicates for maximum parsimony, MP). We also analyzed the data using Bayesian methods. It is possible to incorporate different models of evolution for different gene partitions in Bayesian analysis (using MrBayes, Huelsenbeck and Ronquist, 2001). To determine the appropriate partitioning strategy for these data, we compared results determined under a number of partitioning strategies. The trees with the highest cumulative likelihood resulted from a strategy in which all data were included in a single partition evolving under the GTR + g model. Using this model, Markov chains were run for 1500000 generations, and trees were sampled every 100 generations. Convergence was assessed by inspection of traces of each parameter, all parameters converged before generation 5000 so the first 500 trees were discarded as burn-in.

RESULTS

Kanakysaurus Sadlier, Whitaker, Bauer and Smith, gen. nov.

Type species.—*Kanakysaurus viviparus*, here described.

Diagnosis.—*Kanakysaurus* can be distinguished from all other genera in the *Eugongylus* group of Greer (1979) by the following combination

of derived character states: supranasal scale or postnasal suture absent; subocular scale row complete; primary temporals two; lower secondary temporals usually two; parietals separated from contacting medially by interparietal scale; lower eyelid with an obvious, centrally located semitransparent disc; ear lobules barely distinguishable from blunt conical scales around upper, lower, and posterior edges of ear opening; live-bearing mode of reproduction.

Kanakysaurus may be distinguished from all other New Caledonian lygosomine skink genera by the medial separation of the parietals by the interparietal. The presence of a complete subocular row of scales and divided frontoparietal scales will further distinguish *Kanakysaurus* from *Phoboscincus*, *Geoscincus*, *Lacertoides*, *Tropidoscincus*, *Emoia*, *Simiscincus*, *Caledoniscincus*, *Cryptoblepharus*, *Sigaloseps* (variable in *Sigaloseps deplanchei*), *Graciliscincus*, most *Lioscincus*, and most *Nannoscincus*. All *Nannoscincus*, including those with divided frontoparietals, have the subocular labial scales contacting the lower eyelid, and this along with their diminutive size and highly elongate bodies will distinguish them from *Kanakysaurus*. Similarly the only *Lioscincus* with divided frontoparietals (*L. greeri* and *L. nigrofasciolatum*) have the subocular labial scales contacting the lower eyelid. Only *Marmorosphax*, "*Lygosoma*" *euryotis*, and an undescribed *Lioscincus* from Mt. Kopéto have a row of scales below the eye that separate the lower eyelid from contacting the adjacent upper labial scales. The species of *Marmorosphax* are superficially most similar to *Kanakysaurus*, being similar in size, coloration, and overall body shape. These species are readily distinguished from *Kanakysaurus* by the condition of the frontoparietal scales (fused) and the parietal scales (meeting medially). The species of *Marmorosphax* are also characterized by the shape of the anterior loreal scale which is reduced to a semilunar scale failing to contact the labials. This scale is larger and contacts the upper labials in *Kanakysaurus*.

Derivatio Nominis.—The generic name is masculine and is derived from the name of New Caledonia in the indigenous Melanesian languages, "Kanyak" and the Latinized version of the Greek word *sauros*, meaning lizard.

Recognized Species.—*Kanakysaurus viviparus*, sp. nov.

Kanakysaurus viviparus, sp. nov. Sadlier, Whitaker, Bauer and Smith
Figures 1–5

Type Material.—Holotype: MNHN 2003. New Caledonia, Province Nord, Rivière Néhoué, 20°25'16"S 164°13'10"E, (R. A. Sadlier, A. M.

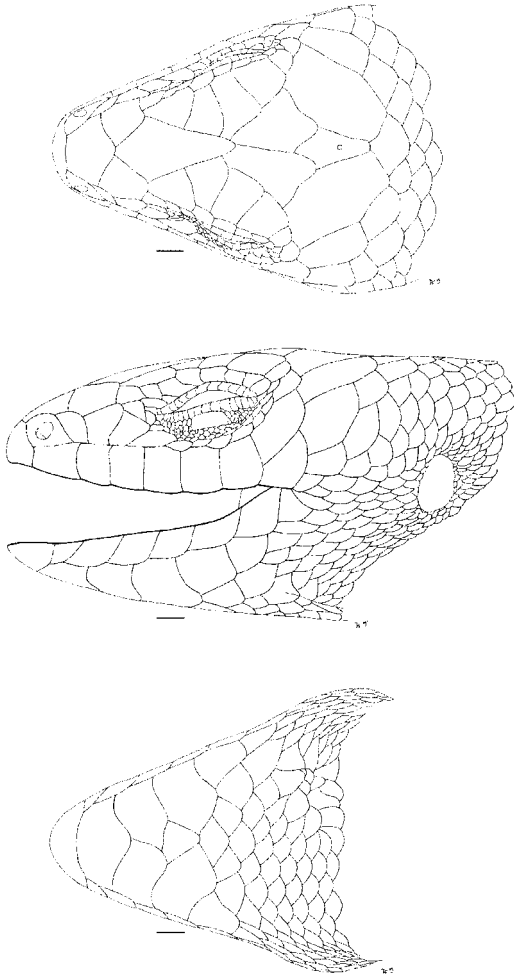


FIG. 1. Lateral, dorsal, and ventral views of the head of holotype of *Kanakysaurus viviparus* n. sp. (MNHN 2003.1004).

Bauer, S. Smith, T. Jackman, and G. Watkins-Colwell, 22 January 2003).

Paratypes.—AMS R162914–17, CAS 226177–79, MCZ R183657, same location, collectors and date as holotype; AMS R162918–20, CAS 226176, same location and collectors as holotype (24 January 2003); AMS R162921, same location and collectors as holotype (25 January 2003); AMS R163300–01, CAS 226174–75 New Caledonia, Province Nord, Rivière Néhoué, 22°25'12"S 164°13'04"E (A. Whitaker and V. Whitaker, 29 September 2001); AMS R161232 New Caledonia, Province Nord, Dôme de Tiébaghi, 20°27'38"S 164°11'11"E (A. Whitaker and V. Whitaker, 17 October 2001); AMS R161295–97, CAS 226180 New Caledonia, Province Nord, Wène Cogat

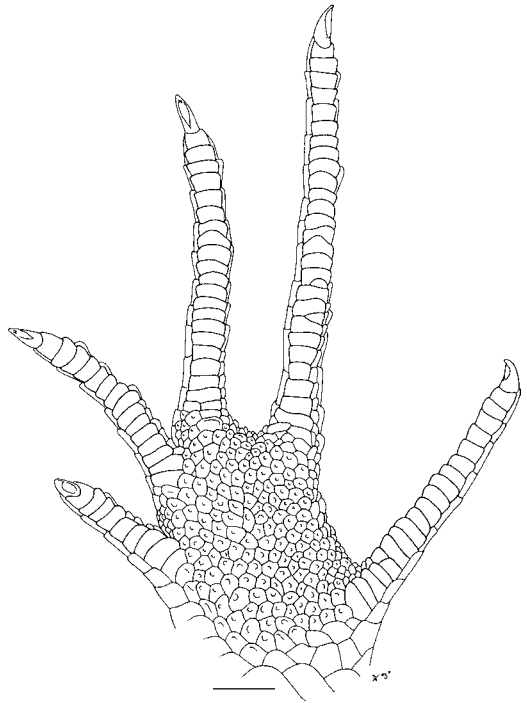


FIG. 2. Left pes of holotype of *Kanakysaurus viviparus* n. sp. (MNHN 2003.1004).

(northern plateau), Île Art, Îles Belep, 19°42'47"S 163°39'38"E (A. Whitaker and V. Whitaker, 25 May 2002); AMS R161299 New Caledonia, Province Nord, Pânan, Île Pott, Îles Belep, 19°34'56"S 163°34'59"E (A. Whitaker and V. Whitaker, 28 May 2002).

Etymology.—The specific epithet is the Latin adjective *viviparus* meaning live-bearing, in reference to the reproductive mode of this species.

Diagnosis.—See generic diagnosis.

Description.—The species is described on the basis of eight adult males and four adult females (61–83 mm SVL), 10 subadults (47–59 mm SVL), and one juvenile (35 mm SVL); measurements are given only for the adults, a newborn (AMS R162920) included in the type series is not used in the measurements and meristics, otherwise the description is based on all specimens unless indicated.

Adult size 61.5–73.0 mm SVL; distance from axilla to groin 50.7–58.0% SVL (mean = 53.7); distance from forelimb to snout 35.5–42.3% SVL (mean = 39.9); hind-limb length 33.6–39.8% SVL (mean = 36.2); tail length of individual with most complete tail 133.3% SVL.

Scalation is illustrated in Figures 1 and 2. Prefrontals large, narrowly to moderately separated (77%) or narrowly contacting; frontal longer than wide; frontoparietals divided; inter-



FIG. 3. Holotype of *Kanakysaurus viviparus* n. sp. (MNHN 2003.1004), an adult male, from Rivière Néhoué.

parietal distinct; parietals failing to meet behind interparietal, parietals each bordered by a transversely elongate upper secondary temporal scale and three smaller scales, two of which are similar in size to adjacent body scales and another larger scale (sometimes divided) that lies behind the interparietal and between (and contacting) both parietals; primary temporals usually two (96%), or rarely one, the lower positioned partly between the last two upper labials; upper secondary temporal single; lower secondary temporals two (78%), or a single larger scale; tertiary temporals usually two (61%), or either fragmented to form three scales (24%) or fused to form a single scale; postlabials two (89%), or fragmented to form three scales in that region; nasals moderately large, moderately to widely separated; two loreals, anterior considerably narrower than high; supraciliaries 7 (87%), rarely 8 (7%) or 6, the fourth supraciliary usually noticeably larger than those preceding and interdigitating between the first and second supraoculars; upper labials 7 with fifth below center of eye, separated from lower eyelid by a complete row of 7–10, usually 8 (43%) or 9 (33%), subocular scales between preocular and pretemporal scales; lower labials 6, first two contacting postmental; large chinshields three either side, first pair in broad contact, second pair separated by one scale, third pair divided such that five scales separate those scales bordering the labials either side, all chin scales in full contact with lower labials.

Lower eyelid with an obvious, centrally located, semitransparent disc. Ear opening moderately large, with no obvious enlarged lobules at the edges, only a series of small, rounded lobules along the anterior edge of the 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 38–44 (mean \pm SD = 39.4 ± 1.75); paravertebral scales 65–74 (69.6 ± 2.5); scales on top of fourth finger 9–11 (9.9 ± 0.68); lamellae beneath fourth finger 13–17 (15.3 ± 0.85); scales on top of fourth toe 14–16 (14.8 ± 0.7); lamellae beneath fourth toe 26–32 (28.4 ± 1.6), smooth, divided towards outer edge for the basal third of the digit (Fig. 2). There was

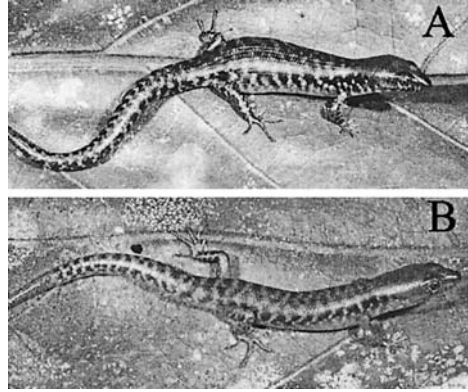


FIG. 4. Adult female (AMS R162917) and subadult (AMS R162915) *Kanakysaurus viviparus* n. sp., from Rivière Néhoué.

no sexual dimorphism between 9 males and 7 females (adults and subadults) from the mainland population at Néhoué in the number of midbody or paravertebral scale rows.

Premaxillary teeth 11 ($N = 4$); presacral vertebrae 29 ($N = 18$), rarely 30 ($N = 2$) or 28 ($N = 1$); postsacral vertebrae 49 for individual with most complete tail; phalangeal formula for manus and pes 2.3.4.5.3 and 2.3.4.5.4, respectively; two pairs of mesosternal ribs contacting mesosternum.

There is marked sexual dimorphism between adult males and adult females, with juveniles and subadults most similar in color and pattern to adult females. Individuals of both sexes had a distinctive orange-red iris and bright yellow color to the outer edge of the ciliary scales of the upper and lower eyelids.

In adult males (Fig. 3), body and tail light brown overall (occasionally darker), with a pat-

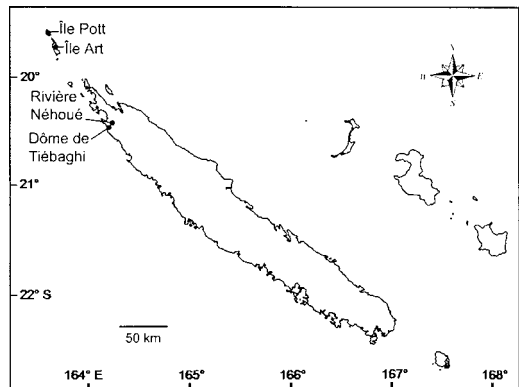


FIG. 5. Distribution of *Kanakysaurus viviparus* n. sp. (closed circles) in northern New Caledonia.

tern of obscure light and dark transverse markings on the dorsal surface and extending to the adjacent upper lateral area. Darker markings of the lateral surface highly variable, boldest around area of forelimb, but overall the intensity and extent of these markings is considerably less than that of adult females, most noticeably on the lower lateral region of the body and neck. Lower lateral area either side of forelimb is pale and flesh colored (similar to subadults of both sexes), with a yellow flush on posterior half of the body.

In adult females (Fig. 4), dorsal surface of the body with a pattern of transversely aligned light and dark markings (1–2 scales wide). Dark markings black in color and forming a network pattern across the body and down the sides, becoming bolder and more concentrated on the upper side of the body along the dorsolateral margin (in some individuals the dark coloring covers most of the upper lateral surface forward to the ear). Pale markings light to mid brown (almost golden) in color on dorsal surface, but noticeably paler (even whitish) and sometimes narrower on lateral surface. Dorsal and lateral surface of head and nape dark brown, and mainly unmarked, except for dark central markings to the subocular and posterior labial scales, lower labials, and head shields behind eye; neck similar in color and pattern to lateral surface of body. Chinshields with dark brown markings to the center of each scale and in some individuals similarly colored dark blotches with pale (same color as venter), narrow interspaces across the throat.

Subadults (Fig. 4) are similar in overall pattern and color to adult females, except the intensity and extent of the dark markings is generally not as bold as females, and the lower lateral surface of the body and neck either side of forelimb is pale, flesh colored, and without prominent dark markings.

Details of Holotype.—Adult male; size 71.5 mm SVL; distance from axilla to groin 37 mm; distance from forelimb to snout 27 mm; hindlimb length 24 mm; tail length 90 mm, regenerated. Midbody scale rows 40; paravertebral scale rows 70; dorsal scales of fourth finger 9; lamellae of fourth finger 15; dorsal scales of fourth toe 15/14; lamellae of fourth toe 26.

Geographic Variation.—The species is represented by three discrete populations, two on the mainland as represented by the sample from the Rivière Néhoué and the individual from Dôme de Tiébaghi, and an island population from the Îles Belep represented by the sample from Île Art and the individual from Île Pott (Fig. 5). The values for variable scalation characters recorded for each population are presented in Table 1. The mainland population from the Rivière Néhoué has significantly fewer midbody scales (mean

38.7 vs. 42.0, $t_{21} = -6.17$ $P < 0.01$), and paravertebral scales (mean 69.1 vs. 71.6, $t_{21} = -2.20$ $P < 0.05$) than the sample from the Îles Belep. For these same characters the single individual from Dôme de Tiébaghi is most similar to the geographically proximate sample from the Rivière Néhoué. In coloration the single subadult female from the Îles Belep is much more darkly marked than females from the mainland, with the paler midbrown interspaces between the transverse black markings reduced to a single scale in width.

Genetic and Phylogenetic Results.—No conflict between gene partitions was indicated by either ILD tests or partitioned Bremer index; thus, data were combined for all following analysis. Maximum parsimony and Bayesian analyses resulted in a tree with the same topology (Fig. 6). Monophyly of *Kanakysaurus* relative to representatives of other genera is strongly supported (MP bootstrap 99%, posterior probability 1.0). This result is also supported by our analysis of all New Caledonian skink genera (S. A. Smith, R. A. Sadlier, T. R. Jackman, and A. M. Bauer, unpubl.). Within *Kanakysaurus*, there is strong support for the sister-group relationship of the two populations on the Îles Belep. These form a clade that is the sister group to the Rivière Néhoué population, and the individual from Dôme de Tiébaghi is the sister taxon to the Belep + Néhoué clade. This pattern of intraspecific variation is discordant with the morphological data, which groups the two mainland localities together. Such discordance may be common and can result in alternative interpretations of species delimitations (Wiens and Penkrot, 2002) although in this instance we do not believe that available evidence from either data source supports the recognition of more than a single species of *Kanakysaurus*. Uncorrected sequence difference (P) between individuals of *Kanakysaurus viviparus* ranges between 0 and 3.40% for the complete dataset, and between 0 and 7.87% for ND2 alone. Using the calibration of Macey et al. (1997), the level of genetic difference in ND2 between Dôme de Tiébaghi and the remaining populations (the deepest split within the lineage) suggests a divergence date of approximately 60,000 ybp, whereas the Belep-Néhoué split is about 20,000 ybp.

Distribution and Habitat.—*Kanakysaurus viviparus* is known from only four localities (Fig. 5), Rivière Néhoué and Dôme de Tiébaghi just north of Koumac, and Île Art and Île Pott, in the Îles Belep. The southernmost point of Île Art is approximately 45 km north of the northern tip of the Grande Terre, and Île Pott lies about 3 km north of Île Art, approximately 65 km from the Grande Terre. All of the areas where *K. viviparus* has been found receive more rainfall than most

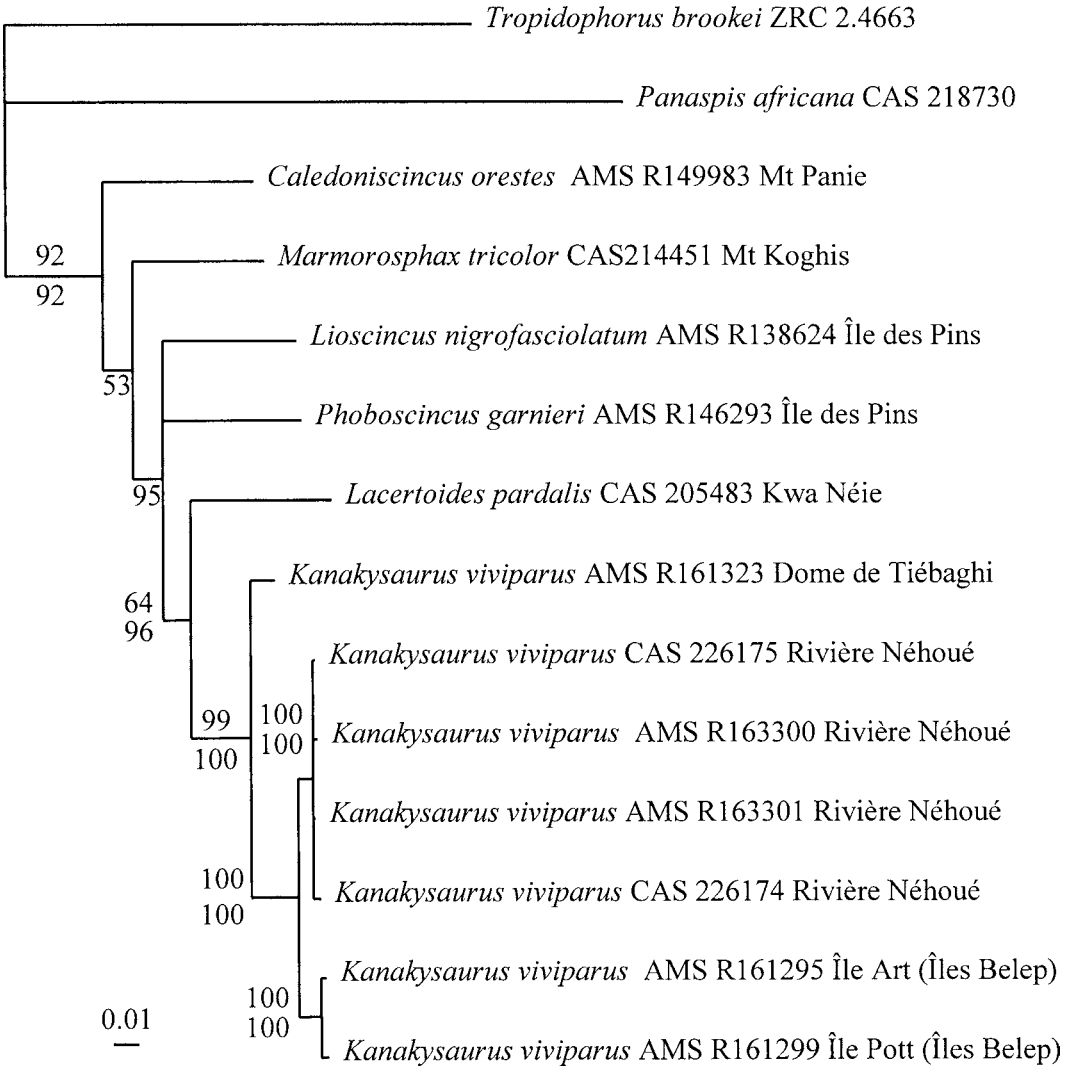


FIG. 6. Bayesian phylogeny of *Kanakysaurus viviparus* populations. Identical tree topology was recovered by MP analysis. Posterior probability from Bayesian and bootstrap support from MP analysis are given above and below branches, respectively.

other low to middle elevation regions of north-western New Caledonia (Sautter, 1981).

At Rivière Néhoué the species occurs in gallery forest (Fig. 7) on deep alluvial soils adjacent to the river at an elevation of < 10 m. The site is flood prone. The habitat is typified by a relatively complete canopy, sparse understory vegetation, deep leaf litter, and numerous logs and debris on the forest floor. All specimens were located sheltering under logs on soil. The single individual seen on Île Pott was collected beneath a coconut log on soil in supralittoral scrub at an abandoned coconut plantation. It was within 20 m of the shore. Two localities, the northern plateau of Île Art at 240 m and a gully on the

western slopes of Dôme de Tiébaghi at 340 m, are on ultramafic surfaces. At both sites the skinks (5 on Île Art, 2 on Tiébaghi) were found only within deep piles of peridotite boulders and rubble beneath dry closed-forest characterized by a dense canopy, thick understory and deep leaf litter.

Reproductive Biology.—Three specimens (AMS R1612914, AMS R1612917 and CAS 226179) collected in January 2003 are gravid females. Each female has three young, filling most of the body cavity. All embryos are heavily pigmented, and embryos in two females have very little remaining yolk (Fig. 8), suggesting that they are near to full term. The relatively large volume of



FIG. 7. Dry closed forest at Rivière Néhoué, habitat of *Kanakysaurus viviparus*.

yolk remaining in the third specimen suggests that *Kanakysaurus* is probably not significantly matrotrophic. The length of the only fully visible embryonic skull, measured from radiographs, is 7.69 mm. The presumed neonate has a head length of 10.46 mm, and snout-vent length of 36 mm.

DISCUSSION

Biogeography.—Biogeographic patterns in northwestern New Caledonia and the Îles Belep are poorly understood, as extensive collections from these areas have only recently become available. Indeed, the only previously published herpetological record from the Beleps is that of Jouan (1864), based on a second hand observation of a large gecko, almost certainly a species of *Rhacodactylus* (Bauer, 1990; Bauer and Sadlier, 2000). In addition to *Kanakysaurus*, recent fieldwork by A. H. Whitaker has confirmed the existence of several species of *Rhacodactylus*, as well as a number of other geckos and skinks, including several additional new species.

Our broad study of almost all New Caledonian lizard species has shown that, like *Kanakysaurus*, most taxa represented on the Îles Belep share their closest affinities with populations on the northwestern Grande Terre (unpubl.). The Îles Belep were probably sporadically connected to the mainland during Plio-Pleistocene glacial periods (Bauer and Sadlier, 2000) when sea levels in the region were as much as 100 m lower than those at present (Holloway, 1979). The most recent connection may have been about 10–20,000 ybp (Bauer and Sadlier, 2000), which is consistent with our dating of the separation between the Néhoué and Belep populations of the new species. The historical basis for the initial divergence of the Dôme de Tiébaghi population is unclear but may well be associated with climatic

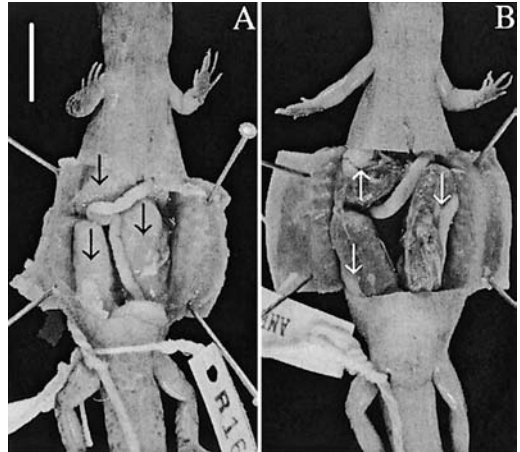


FIG. 8. Abdomen of two gravid female *Kanakysaurus viviparus*: (A) AMS R162917 and (B) CAS 226179 demonstrating varying degrees of yolk supply exhaustion. Each female is carrying three embryos. Arrows indicate remaining yolk mass. Scale bar = 10 mm.

changes during the Pleistocene, which have been implicated in the establishment of existing plant distribution patterns (Pintaud et al., 2001).

Reproductive Biology.—Some aspects of reproduction in *Kanakysaurus* are characteristic of those seen in many New Caledonian skink species. Clutch size is comparable to the 2–3 typical for most *Caledoniscincus*, *Cryptoblepharus*, *Emoia*, *Nannoscincus*, *Sigaloseps*, *Tropidoscincus*, and “*Lygosoma*” *euryotis* (Sadlier, 1986; Bauer and Sadlier, 1994, 2000). Although our sample size is limited, and specimens were collected only during January, May, and September–October, the implied pattern of reproductive activity, spring breeding with oviposition/parturition during the wet southern summer (November–February), is similar to that of many other New Caledonian lizards (Sadlier, 1989; Bauer and Vindum, 1990; Bauer and Sadlier, 2000). Given the relatively equitable temperatures at low elevations in New Caledonia year round, it seems most likely that this restriction of breeding activity reflects seasonal variation in rainfall and humidity, which is typically pronounced (Sautter, 1981).

Although seasonality and clutch size of *Kanakysaurus* are typical, reproductive mode is not. Approximately 20% of the more than 100 independent evolutionary derivations of viviparity among squamates have occurred within the Scincidae (Blackburn, 1982; Stewart and Thompson, 1996), but live bearing is uncommon among New Caledonian skinks. Shea (1987) reviewed the reproductive mode of skinks at that time assigned to the genus *Leiolopisma* (sensu Greer, 1974), including species from New Caledonia. At

the time only a single viviparous species had been recorded from New Caledonia, *L. (now Marmorosphax) tricolor* (Roux, 1913; Meier, 1979; Sadlier, 1986), and for most species, reproductive mode was unknown. A second member of the genus *Marmorosphax* has since been described (Sadlier and Bauer, 2000), and although its reproductive mode has not been confirmed, it is assumed to be viviparous. In addition, viviparity has been confirmed in one species of the paraphyletic genus *Lioscincus*, (*Lioscincus tillieri*; Sadlier and Bauer, 1999). Among extralimital members of the *Eugongylus* group of lygosomine skinks (sensu Greer, 1979), viviparity is more widespread, characterizing all but one member of the New Zealand skink fauna, *Oligosoma suteri* (Whitaker, 1968; Towns, 1975; Smith, 2001) and representatives of the Australian genera *Niveoscincus* and *Pseudemoia* (Harrison and Weekes, 1925; Weekes, 1929, 1930; Stewart and Thompson, 1994, 1996, 1998; Thompson and Stewart, 1994).

Unfortunately, existing molecular data provide no strong support for particular patterns of intergeneric relationships among most New Caledonian skinks (S. A. Smith, R. A. Sadlier, T. R. Jackman, and A. M. Bauer, unpubl.). Thus it remains unclear whether *Kanakysaurus*, *Marmorosphax* and *Lioscincus* (part) form a monophyletic group or whether viviparity has arisen three times independently. There is, however, strong evidence that these genera are outside of the New Zealand taxa *Oligosoma* and *Cyclodina* (Smith, 2001) and represent one or more autochthonous derivations of viviparity within New Caledonia.

Conservation.—*Kanakysaurus viviparus* is known only from dry closed forest habitat at two locations in the far north of the main island and on two islands in the Îles Belep. Each of these sites represents an isolated subpopulation. The full extent of dry closed-forest habitat remaining in the far north of New Caledonia within the potential range of the species is unknown, only that it occurs as scattered remnants and that these remnants are under pressure from a range of threats. The habitat and behavior of *K. viviparus* strongly suggests it requires high humidity to compensate for high cutaneous water loss; hence, any processes that open and dry the forest are a threat. Each of the four sites where *K. viviparus* has been recorded is under pressure. Although the forest at Rivière Néhoué is managed as a recreational reserve, and *K. viviparus* appears to be relatively abundant there, the area is small and it has high human use. The isolated dry forest remnant on the western slopes of Dôme de Tiébaghi is possibly at risk from activities associated with nickel mining on the peak. However, two similar forested gullies around the perimeter of the plateau have been set aside as botanical reserves. On the Îles Belep the dry

forest is at risk from the relatively frequent burning of adjacent shrublands and savannah woodland. Finally, all localities are at serious risk from infestation by the introduced ant (*Wasmannia auropunctata*), which is known to greatly reduce skink abundance (Jourdan et al., 2000, 2001). *Wasmannia* is already present at Rivière Néhoué but its occurrence at the other localities is uncertain.

Based on a modification of IUCN criteria for assigning taxa to conservation status (Sadlier and Bauer, 2003) *K. viviparus* is conservatively regarded as Endangered. However, any escalation of human activity that further threatens its preferred habitat would place the species in a higher category of risk. A further consideration is that its known occurrence lies outside designated fauna reserves. Field research to determine this lizard's distribution is required to fully assess the importance of each of the sites from which it is known.

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