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A new species of the genus *Scincella* (Squamata: Scincidae) from Mount Fansipan, Hoang Lien Son Range, northwestern Vietnam

SHINYA OKABE[1], MASAHARU MOTOKAWA[1], YUKI KOIZUMI[2], TRUONG QUANG NGUYEN[3,4] & TAO THIEN NGUYEN[4,5] & HAI TUAN BUI[5,*]

[1]*The Kyoto University Museum, Kyoto University, Kyoto 606–8501, Japan.*
yansi0678@gmail.com; https://orcid.org/0000-0002-6652-2210
motokawa.masaharu.6m@kyoto-u.ac.jp; https://orcid.org/0000-0002-5359-0070
[2]*Department of Zoology, Graduate School of Science, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan.*
yk.koizumi.12@gmail.com; https://orcid.org/0000-0002-4370-0133
[3]*Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, Cau Giay, Hanoi 10072, Vietnam.*
nqt2@yahoo.com; https://orcid.org/0000-0002-6601-0880
[4]*Graduate University of Science and Technology, Vietnam Academy of Science and Technology, Cau Giay, Hanoi 10072, Vietnam.*
nguyenthientao@gmail.com; https://orcid.org/0000-0002-5640-4536
[5]*Institute of Genome Research, Vietnam Academy of Science and Technology, Cau Giay, Hanoi 10072, Vietnam.*
[*]*Corresponding author: tuanhai@eulipotyphla.com; https://orcid.org/0000-0003-4065-7229*

Abstract

We describe a new species of the genus *Scincella* Mittleman, 1950 from northwestern Vietnam, based on a new collection of ground skinks from Mount Fansipan of the Hoang Lien Son Range in Lao Cai Province. *Scincella fansipanensis* **sp. nov.** is distinguished from other *Scincella* species in the Indochina region and southern China by body size (SVL), separation of prefrontals, number of midbody scale rows, paravertebral scale rows, nuchals and subdigital lamellae on toe IV, separation of toe from finger when limbs are adpressed along the body, and dorsal color pattern. The new species is further distinguished from its congeners by uncorrected genetic distances of 14.60–21.41% (COI gene). The new species is currently known only from high elevation areas of Mt. Fansipan in Vietnam.

Key words: Ground skink, genetic divergence, morphological characteristics, taxonomy, Lao Cai Province

Introduction

The skink genus *Scincella* Mittleman, 1950 currently comprises 39 species distributed across South, East, and Southeast Asia, and North and Central America (Uetz *et al*. 2023). The genus *Scincella* is characterized by the following combination of traits: lower eyelid with transparent or opaque window, supranasal absent, lamellae under the basal digits in one row, and the lower secondary temporal overlapping the upper one (Greer 1974; Greer & Shea 2003; Nguyen *et al*. 2010a).

At present, 13 species of *Scincella* are known from the Indochina region and four of them are widespread species: *S. doriae* (Boulenger) distributed in Sichuan and Yunnan provinces of China, northern Myanmar, and Da Nang and Dong Nai provinces of Vietnam, and probably in Thailand; *S. melanosticta* (Boulenger) distributed in Myanmar, southern Thailand, Cambodia, and in Quang Binh, Lam Dong and Ba Ria-Vung Tau provinces of Vietnam; *S. monticola* (Schmidt) distributed in Shaanxi, western Sichuan and northwestern Yunnan of China, as well as in Lang Son, Cao Bang and Dien Bien provinces of Vietnam (Nguyen *et al*. 2009; Pham *et al*. 2015); and *S. reevesii* (Gray) found in India, Nepal, southern China, Myanmar, Thailand, Cambodia, southwards to West Malaysia, as well as in Ha Giang, Cao Bang, Quang Ninh, Hai Phong, Hai Duong, Son La, Thanh Hoa, Ha Tinh provinces of Vietnam (Nguyen *et al*. 2009; Uetz *et al.* 2023). *Scincella rufocaudata* (Darevsky & Nguyen) is known from the Central Highlands of Vietnam, Cambodia and Laos (Teynié *et al*. 2004; S.V. Nguyen *et al*. 2009; Pham *et al*. 2015; Uetz *et al.* 2023); and *S. rupicola* (Smith) has been reported from Thailand, Laos, Cambodia, and Vietnam (Taylor 1963; Teynié *et al*. 2004; Nguyen *et al*. 2010a, b; Neang *et al*. 2018), although detailed localities from Vietnam have not

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been reported yet. *Scincella nigrofasciata* Neang, Chan & Poyarkov is endemic to Cambodia (Neang *et al*. 2018) and *S. ochracea* (Bourret) is distributed in Laos and Son La, Dien Bien and Lai Chau provinces of Vietnam (Bourret 2009; Pham *et al*. 2015). Remarkably, five species are endemic to Vietnam: *S. apraefrontalis* Nguyen, Nguyen, Böhme & Ziegler from Lang Son Province (Nguyen *et al*. 2010b); *S. badenensis* Nguyen, Nguyen, Nguyen & Murphy from Tay Ninh Province; *S. baraensis* Nguyen, Nguyen, Nguyen & Murphy from Binh Phuoc Province; *S. darevskii* Nguyen, Ananjeva, Orlov, Rybaltovsky & Böhme from Dien Bien Province; and *S. devorator* (Darevsky, Orlov & Ho) from Quang Ninh and Son La provinces (Nguyen *et al*. 2009; Uetz *et al.* 2023).

During our fieldwork in northwestern Vietnam, ten ground skinks were collected on Mt. Fansipan of Hoang Lien Son Range in Lao Cai Province. Closer morphological analysis revealed these skinks belong to an undescribed taxon of the genus *Scincella*, and we herein describe it as a new species.

Materials and methods

A field survey was conducted on Mt. Fansipan in the Hoang Lien Son Range in Lao Cai Province, northwestern Vietnam (Fig. 1A, B) from 30 April to 6 May 2022. Skinks were captured by hand during the day. After being photographed, they were anaesthetized and euthanized in a closed vessel with a piece of cotton wool containing ethyl acetate (Simmons 2002), then fixed in 10% formalin and subsequently stored in 70% ethanol.

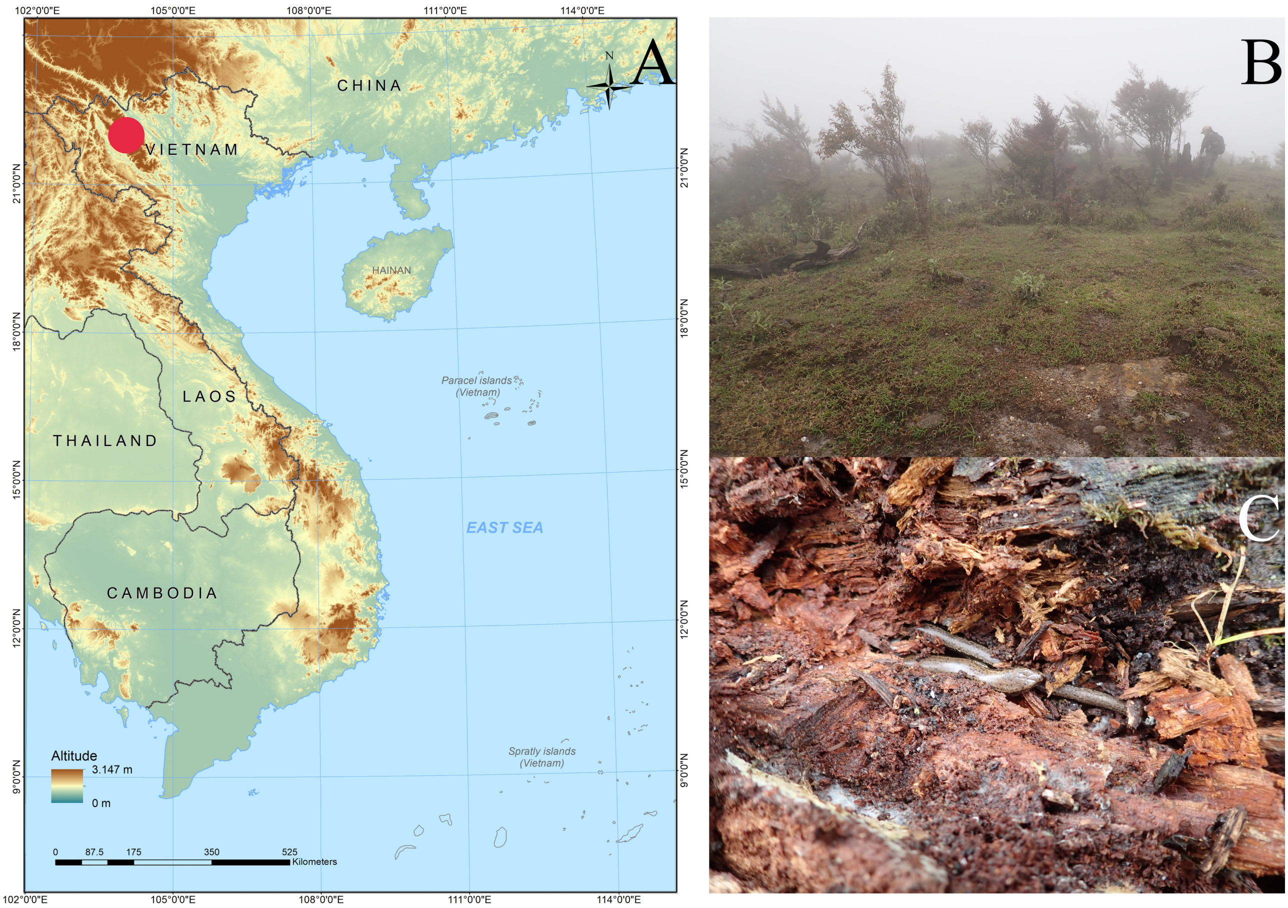

FIGURE 1. Map showing Mt. Fansipan (red circle), Hoang Lien Son Range, Vietnam (A), habitat at the type locality of *Scincella fansipanensis* **sp. nov.** (B), and an individual in life (IEBR R.5188) (C).

Tissue samples were preserved separately in 99% ethanol. Specimens were subsequently deposited in the collections of the Institute of Ecology and Biological Resources (IEBR), Hanoi, Vietnam.

DNA analysis. DNA was extracted from liver tissues from IEBR R.5185, 5187–5189 and 5192 preserved in 99% ethanol using the DNeasy® Blood & Tissue DNA kit (Qiagen), following the manufacturer's protocol.

Polymerase chain reaction (PCR) was performed under TaKaRa PCR Thermal Cycler Dise, using the Ex Taq Kit (TaKaRa Bio Inc.) to amplify partial fragments of mitochondrial DNA of the Cytochrome c oxidase subunit I (COI) gene. The primers used were LCO1490 (5'-GGTCAACAAATCATAAAGATATTGG-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') (Folmer *et al.* 1994). The PCR program to amplify COI sequences was as follows: 94°C for 1 min; 5 cycles at 94°C for 1 min, 45°C for 1 min 30 s, and 72 °C for 1 min; 35 cycles at 94°C for 1 min, 50°C for 1 min 30 s, and 72 °C for 1 min; followed by a final extension step at 72°C for 5 min (Hebert *et al*. 2003). The PCR products were purified using ExoSAP–IT Express PCR Product Cleanup Reagent (Thermo Fisher Scientific K.K.), and sequencing was conducted at Pre-mixed Sanger sequencing services (Azenta). The newly obtained sequences were deposited in GenBank (accession numbers: LC846671 – LC846675, Appendix 1). The sequences were aligned using ClustalW (Thompson *et al*. 1994) in MEGA X (Kumar *et al*. 2018) under the default set of parameters. The length of the sequences were 625–647bp and no indels were observed.

We reconstructed the COI gene tree using maximum likelihood (ML) and Bayesian inference (BI) methods. We also used GenBank sequences from 30 individuals of other taxa (Appendix 1). The data set used in this study consisted of 26 ingroup samples and four species, *Asymblepharus himalayanus* (Günther), *Plestiodon chinensis* (Gray), *P*. *elegans* (Boulenger), and *Sphenomorphus maculatus* (Blyth) were used as outgroup taxa (Nguyen *et al*. 2020; Koizumi *et al*. 2022). The best-fit substitution models for both analyses were selected based on the corrected Akaike information criterion (AIC; Sugiura 1978), and the greedy algorithm in PartitionFinder ver. 2.1.1 (Lanfear *et al*. 2017). The selected partition scheme and models for ML were TRNEF + G (1st position), TIM + I (2nd position), and TRN + G (3rd position). For BI analysis, selected partition scheme and models were the SYM + G (1st position), F81 + I (2nd position), and GTR + G (3rd position). The ML phylogenetic tree was reconstructed using the program IQtree on the IQ-TREE web server (Trifinopoulos *et al*. 2016) with branch support values evaluated by 10,000 ultrafast bootstrap (UFB) replicates (Hoang *et al*. 2017). The BI tree and posterior probabilities (PP) for branches were estimated using MrBayes v3.2 (Ronquist *et al*. 2012). We conducted four simultaneous Markov Chain Monte Carlo runs, each with four chains (three hot and one cold), for 500,000 generations, sampling trees every 100 generations. The runs were stopped when the average standard deviation of split frequencies was below 0.01. The first 25% of sampled trees were discarded as burn-in. We considered UFB values of ≥95% for ML and PP values of ≥0.95 for BI as strong support (Huelsenbeck & Rannala 2004; Minh *et al*. 2013; Hoang *et al*. 2017). Interspecific and intraspecific uncorrected *p*-distances for the COI sequence were calculated using MEGA X.

Morphological analysis. We measured and counted morphometric and meristic characters for the ten specimens from Mt. Fansipan. Fresh specimens were weighed (BW) to the nearest 0.01 g using a digital scale. For bilateral characters, we measured the left side where possible. Scale terminology followed T. Nguyen *et al*. (2010a, b) and Koizumi *et al*. (2022). The sex of each specimen was determined by cloacal probing. The 14 morphometric characteristics were taken with a digital caliper to the nearest 0.1 mm in the preserved specimens, some of them were measured under a microscope (Nikon SMZ 745): snout-vent length, from snout tip to cloaca (SVL); tail length, from cloaca to tail tip (TaL); distance from axilla to groin (AG); snout length, from tip of snout to the anterior corner of the eye (SL); distance from snout to the anterior margin of the tympanum (STL); maximum head height (HH); maximum head width (HW); distance from tip of snout to the junction of body and forelimb (SFIL); distance from the anterior corner of the eye to nostril (END); eye length (EL), distance from posterior corner of the eye to the anterior margin of tympanum (ETL); maximum diameter of the tympanum (TYD); forelimb length, from axilla to tip of finger IV (FIL); and hindlimb length, from groin to tip of toe IV (HIL). The following 20 meristic characters were examined: condition of lower eyelid, and prefrontals; the absence or presence of supranasal and postnasal; numbers of supraoculars, prenuchals, nuchals, loreals, supraciliaries, lobules, supralabials, infralabials, midbody scale rows, dorsal scale rows between dorsolateral stripes, paravertebral scale rows between the parietals and posterior margin of hindlimbs, ventral scale rows between the postmental and precloacal, enlarged precloacal, subdigital lamellae under finger IV and toe IV, and subcaudal scales. The collection site, Mt. Fansipan, is geographically close to China. Therefore, morphological comparisons were based on data from literature for the species from the Indochina region as well as from southern China (Günther 1864, 1896; Boulenger 1887a, b; Smith 1916, 1935; Schmidt 1925; Stejneger 1925; Bourret 1937; Taylor 1963; Ouboter 1986; Wang & Zhao 1986; Zhao *et al*. 1999; Chen *et al*. 2001; Darevsky *et al*. 2004; T. Nguyen *et al*. 2010a, b, c, d, 2011; Luu *et al*. 2013; Pham *et al*. 2015; Neang *et al*. 2018; S.N. Nguyen *et al*. 2019, 2020).

Results

Phylogenetic analyses. The ML tree (Fig. 2) was identical to the BI tree (not shown). The monophyly of the *Scincella* specimens from Mt. Fansipan was strongly supported (UFB≥95/PP≥0.95). Six species, *S. baraensis*, *S. doriae*, *S. melanosticta*, *S. modesta*, *S. potanini*, and *S.* cf. *rupicola*, respectively, formed monophyletic clades in both ML and BI trees (UFB≥95/PP≥0.95). The uncorrected intra- and interspecific *p*-distance for the COI gene are shown in Table 1. The results indicated minimal intraspecific genetic variation among the *Scincella* specimens from Mt. Fansipan (*p*-distance = 0.00–0.16%). However, they differed from the most closely related *Scincella* (*S. potanini*) by uncorrected *p*-distances of 14.60–15.16%, and with distances to other species reaching up to 21.41% (Table 1). For the species concept, we follow the general lineage concept (de Queiroz 2007). We therefore considered them as a distinct taxon and described it as a new species. In addition, the skink specimens from Mt. Fansipan also showed multiple morphological differences consistent with the phylogenetic delimitation of species from other congeners.

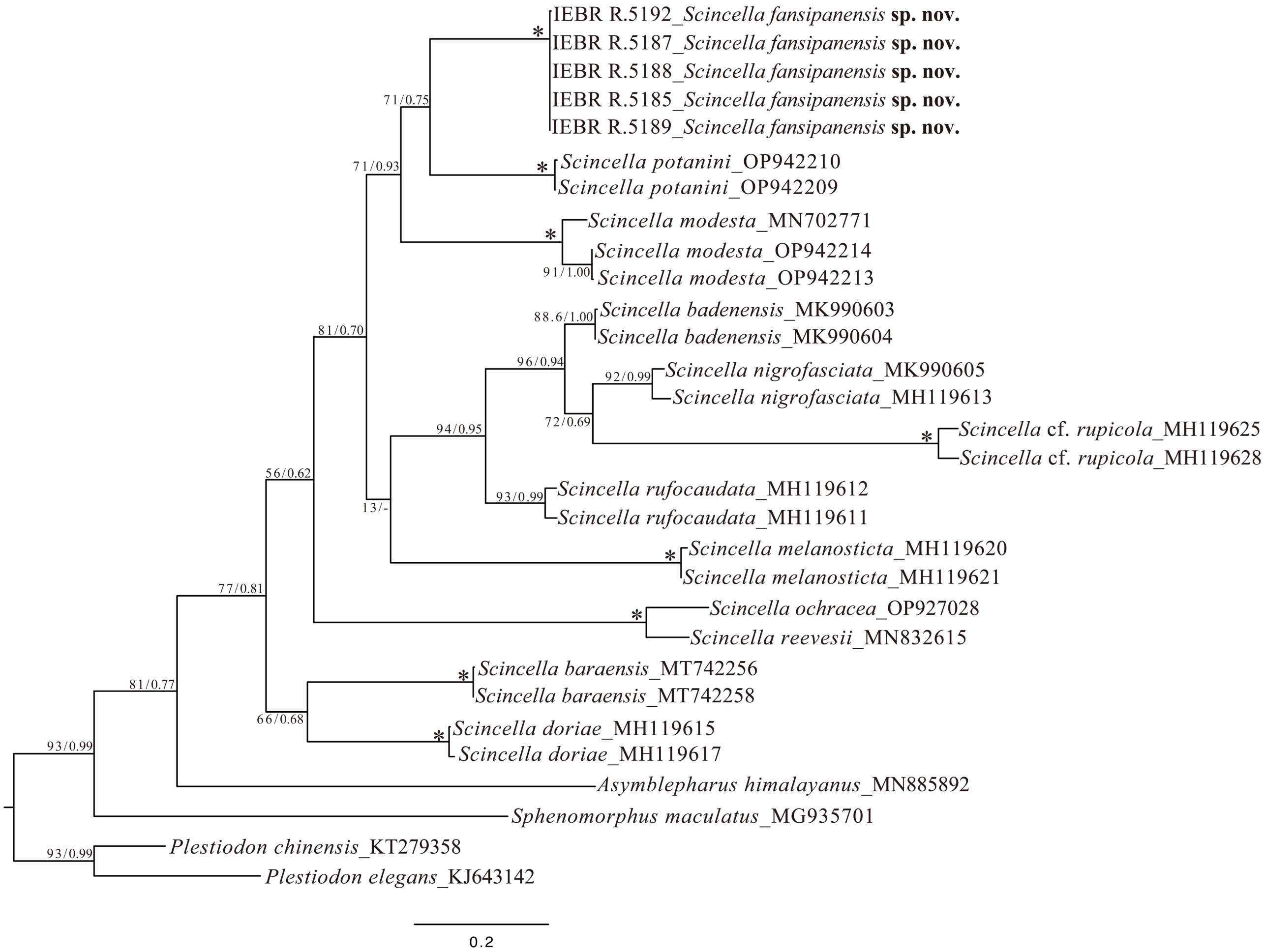

FIGURE 2. Maximum likelihood (ML) tree based on the COI sequences for *Scincella* species examined in this study. Ultrafast bootstrap values (UFB) and Bayesian posterior probability (PP) are shown at each node (UFB/PP). Asterisks show strong support (UFB≥95%/PP≥0.95).

Systematics

Scincella fansipanensis sp. nov.
(Figs. 3–5)

Holotype. IEBR R.5188, an adult male, collected on 2 May 2022 by S. Okabe from Mt. Fansipan, Hoang Lien Son Range, Lao Cai Province, Vietnam, 22.3269°N, 103.7756°E, at an elevation of 2347 m above sea level (a.s.l.).

TABLE 1. Uncorrected *p*-distance (%) for the cytochrome c oxidase subunit I sequences among the species in *Scincella* examined in this study (Min–Max).

Species	1	2	3	4	5	6	7	8	9	10	11	12
1. *Scincella fansipanensis* **sp. nov.**	0.00–0.16											
2. *Scincella badenensis*	16.59–16.93	0.30										
3. *Scincella baraensis*	18.29–18.85	18.02–18.47	0.15									
4. *Scincella doriae*	17.89–18.13	17.97–18.24	16.13–16.87	0.86								
5. *Scincella melanosticta*	18.60–19.42	19.20–19.51	19.05–19.20	17.90–19.03	0.92							
6. *Scincella modesta*	16.93–17.65	18.17–19.30	20.42–21.62	16.70–17.07	20.52–22.10	0.17–6.52						
7. *Scincella nigrofasciata*	15.50–16.13	9.91–11.06	17.72–18.89	16.59–18.07	19.60–20.28	17.65–19.24	3.53					
8. *Scincella ochracea*	20.62–21.25	19.52–19.82	19.97–20.12	22.55–22.73	21.13–21.59	22.01–22.26	19.67–19.75	-				
9. *Scincella potanini*	14.60–15.16	18.29–18.52	18.29–19.14	16.35–17.06	18.72–19.54	15.79–17.28	16.69–17.59	20.58–20.83	0.31			
10. *Scincella reevesii*	20.78–21.41	20.12	19.82–19.97	22.12–22.20	22.21–22.36	20.66–21.46	19.82–20.98	9.58	19.21–19.60	-		
11. *Scincella rufocaudata*	15.04–15.73	12.60	19.51–19.82	19.03–19.18	18.68–19.45	17.92–19.87	13.02–14.59	19.75–20.52	17.00–17.21	20.21–20.98	2.91	
12. *Scincella* cf. *rupicola*	18.85–19.49	17.74–18.20	20.34–21.56	19.97–20.48	21.28–21.60	21.69–22.42	16.59–17.13	21.87–22.02	18.35–18.69	20.95	18.47–19.56	4.28

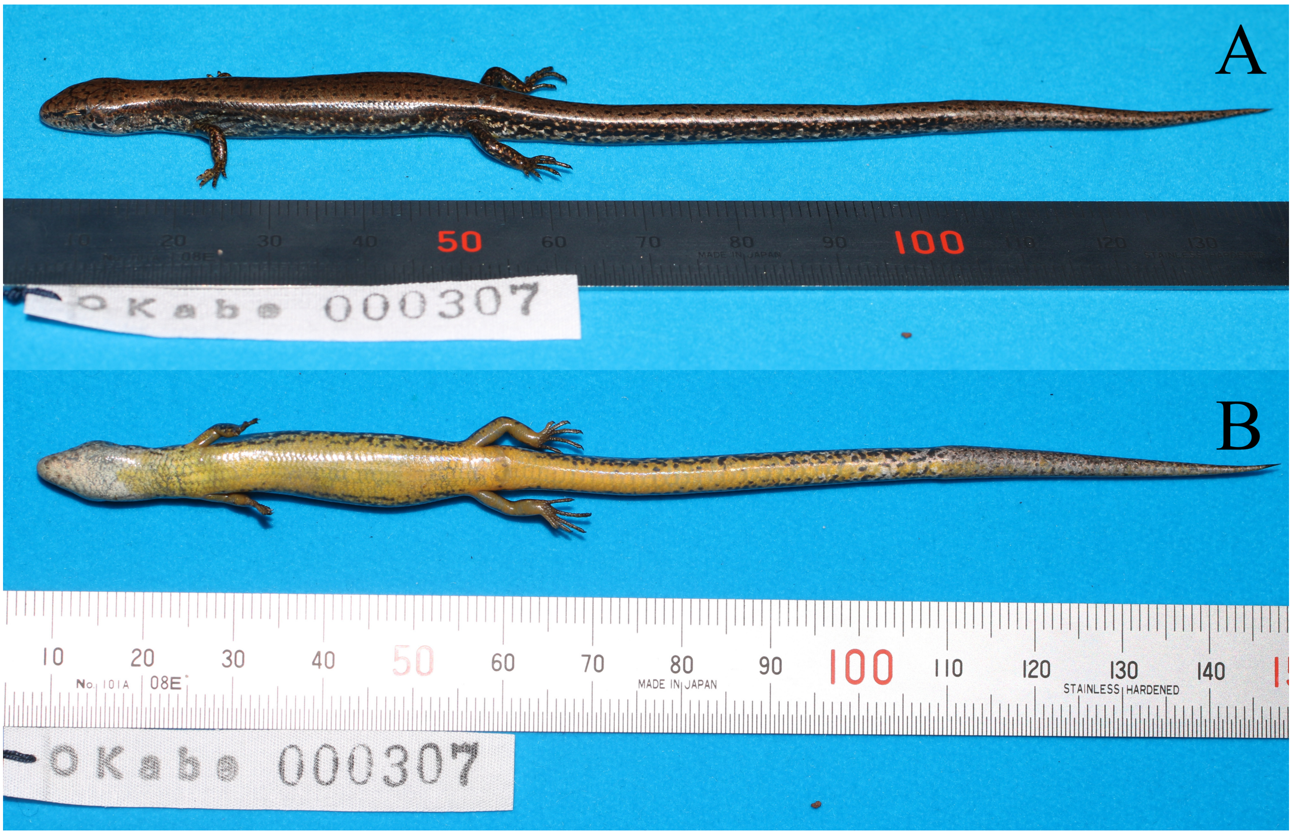

FIGURE 3. Dorsolateral (A) and ventral (B) views of *Scincella fansipanensis* **sp. nov.** (holotype, IEBR R.5188).

Paratypes. IEBR R.5185, 5186, 5189, 5191, 5192, adult females; IEBR R.5187 and 5193, adult males; IEBR R.5190 and 5194, juveniles; collected on 2 and 3 May 2022 by S. Okabe from Mt. Fansipan, Hoang Lien Son Range, Lao Cai Province, Vietnam, at 22.32699°N, 103.77486°E, 2366 m a.s.l. (IEBR R.5185, and 5186); 22.32693°N, 103.77569°E, 2347 m a.s.l. (IEBR R.5187); 22.32636°N, 103.77696°E, 2325 m a.s.l. (IEBR R.5189); 22.32651°N, 103.78013°E, 2298 m a.s.l. (IEBR R.5190); 22.32650°N, 103.77264°E, 2358 m a.s.l. (IEBR R.5191); 22.32636°N, 103.77696°E, 2325 m a.s.l. (IEBR R.5192, and 5193); and 22.32673°N, 103.78083°E, 2282 m a.s.l. (IEBR R.5194).

Diagnosis. *Scincella fansipanensis* **sp. nov.** is distinguished from other congeners by a combination of the following morphological characteristics: size medium (SVL up to 59.0 mm; AG up to 36.5 mm); 22 (rarely 24) midbody scale rows, smooth; 60–68 paravertebral scale rows; 58–64 ventral scale rows; prefrontals separated from each other; five (rarely six) supraciliaries; two to six nuchals; ear opening present, tympanum deeply sunk, without lobules; limbs short, toe separated from finger when limbs adpressed; toe IV with 10–12 subdigital lamellae, smooth; and dorsal surface of body with irregularly shaped dark spots.

Description of holotype. Adult male; SVL 51.7 mm; TaL 88.3 mm, tail regenerated; head longer than wide (STL 8.9 mm, HW 6.9 mm); snout round; lower eyelid with an undivided opaque window; body slender; tympanum round, deeply sunk with an oblique edge dorsally; ear opening without lobules. Head scales smooth; rostral visible from above, in contact with frontonasal; frontonasal wider than long; prefrontals separated from each other; no supranasal; no postnasal; four supraoculars; frontal large, narrowing posteriorly, longer than wide, length approximately 1.11 times of its distance from tip of snout, bordered anteriorly by frontonasal and prefrontals, laterally by first two supraoculars, and posteriorly by frontoparietals; a pair of frontoparietals in contact with the second to fourth supraoculars; interparietal narrow posteriorly, longer than wide; parietals in contact posteriorly, behind the interparietal; one pair of prenuchals; three nuchals in left side and four in right. Nostril in center of nasal; nasal in contact with the first supralabials, rostral, frontonasal, and anterior loreal; two loreals; six supraciliaries; two preoculars, lower one contacting first presubocular; two presuboculars, lower one in contact with fourth and fifth supralabials; two postsuboculars; one primary temporal, contact with sixth and seventh supralabials; two secondary

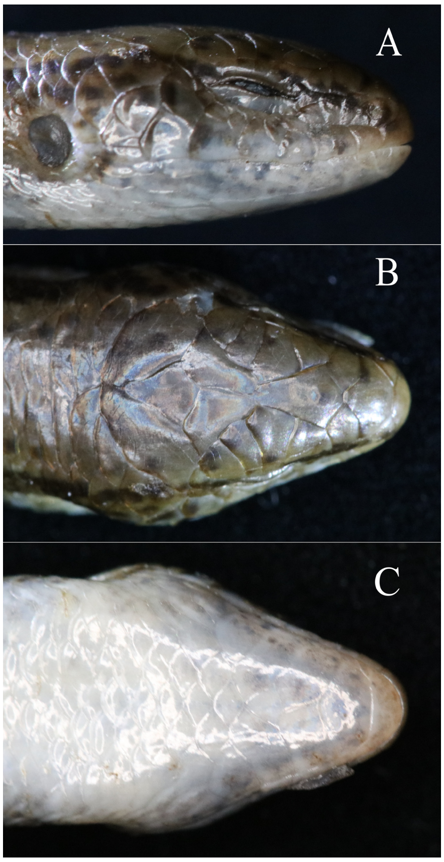

FIGURE 4. Lateral (A), dorsal (B), and ventral (C) views of the head of *Scincella fansipanensis* **sp. nov.** (holotype, IEBR R.5188).

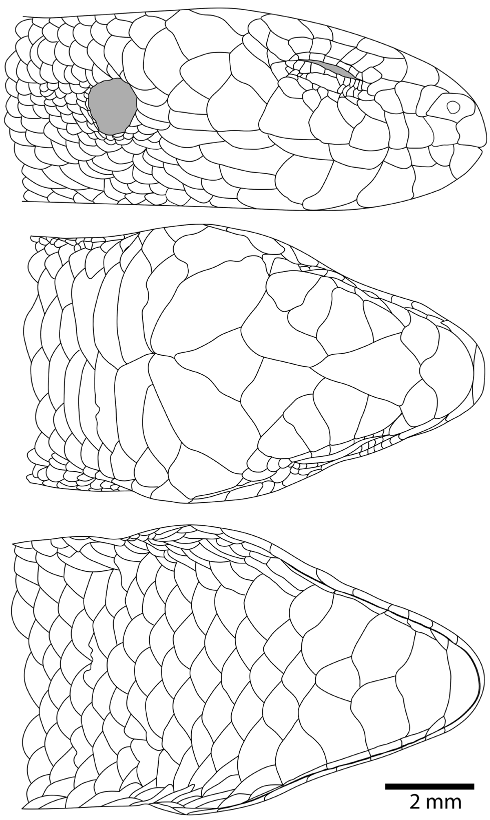

FIGURE 5. Lateral (A), dorsal (B), and ventral (C) views of the head scalation of *Scincella fansipanensis* **sp. nov.** (holotype, IEBR R.5188).

TABLE 2. Morphological characteristics of the holotype and paratypes of *Scincella fansipanensis* **sp. nov.** from northern Vietnam. Abbreviations are listed in the text.

Characters	IEBR R.5188 (Holotype)	IEBR R.5187 (Paratype)	IEBR R.5193 (Paratype)	IEBR R.5185 (Paratype)	IEBR R.5186 (Paratype)	IEBR R.5189 (Paratype)	IEBR R.5191 (Paratype)	IEBR R.5192 (Paratype)	IEBR R.5190 (Paratype)	IEBR R.5194 (Paratype)	Min-Max range		Mean±SD	
Sex	M	M	M	F	F	F	F	F	juvenile	juvenile	M (n = 3)	F (n = 5)	M (n = 3)	F (n = 5)
BW (g)	2.58	1.84	2.00	2.66	1.57	2.43	1.57	3.02	0.50	0.53	1.84–2.58	1.57–3.02	2.14±0.39	2.25±0.66
Morphometrics (in mm)														
SVL	51.7	48.9	48.7	55.4	43.8	53.5	43.5	59.0	32.1	31.0	48.7–51.7	43.5–59.0	49.8±1.7	51.0±7.0
TaL	88.3*	61.9*	49.5*	59.7*	63.5*	65.6*	78.8	58.0*	38.5	49.2	-	-	-	-
AG	29.8	28.3	28.9	33.4	25.8	32.0	26.7	36.5	17.8	17.1	28.3–29.8	25.8–36.5	29.0±0.8	30.9±4.5
SL	3.4	2.9	3.3	3.1	2.7	3.2	2.9	3.4	2.1	2.3	2.9–3.4	2.7–3.4	3.2±0.3	3.1±0.3
STL	8.9	8.0	8.7	8.4	7.8	8.5	7.5	8.7	5.6	5.7	8.0–8.9	7.5–8.7	8.5±0.5	8.2±0.5
HH	5.0	4.4	4.9	4.9	4.2	4.2	3.8	4.9	3.0	3.1	4.4–5.0	3.8–4.9	4.8±0.3	4.4±0.5
HW	6.9	5.7	6.3	6.5	5.7	6.0	5.4	6.4	4.1	4.3	5.7–6.9	5.4–6.5	6.3±0.6	6.0±0.5
SFlL	17.5	15.7	17.0	16.7	15.4	16.8	15.6	18.4	11.7	11.7	15.7–17.5	15.4–18.4	16.7±0.9	16.6±1.2
END	2.2	2.0	1.9	1.4	1.9	2.2	1.8	2.0	1.5	1.4	1.9–2.2	1.4–2.2	2.0±0.2	1.9±0.3
EL	2.6	2.3	2.5	2.5	2.4	2.5	2.5	2.1	1.9	1.9	2.3–2.6	2.1–2.5	2.5±0.2	2.4±0.2
ETL	3.2	3.4	3.5	3.3	3.1	3.4	3.1	3.7	2.1	2.4	3.2–3.5	3.1–3.7	3.4±0.2	3.3±0.3
TYD	1.1	1.2	1.1	1.1	1.2	1.2	1.2	1.2	0.9	0.9	1.1–1.2	1.1–1.2	1.1±0.1	1.2±0.1
FIL	10.2	10.6	9.5	10.5	9.1	10.5	8.8	10.6	6.1	6.4	9.5–10.6	8.8–10.6	10.1±0.6	9.9±0.9
HIL	14.5	14.8	13.7	14.7	12.6	14.0	11.9	13.9	8.2	8.2	13.7–14.8	11.9–14.7	14.3±0.6	13.4±1.1

*: regenerated tail.

TABLE 3. Meristic characteristics of the holotype and paratypes of *Scincella fansipanensis* **sp. nov.** from Vietnam.

Characters	IEBR R.5188 (Holotype)	IEBR R.5187 (Paratype)	IEBR R.5193 (Paratype)	IEBR R.5185 (Paratype)	IEBR R.5186 (Paratype)	IEBR R.5189 (Paratype)	IEBR R.5191 (Paratype)	IEBR R.5192 (Paratype)	IEBR R.5190 (Paratype)	IEBR R.5194 (Paratype)
Scalation										
lower eyelid	undivided opaque	undivided opaque	undivided opaque	undivided opaque	undivided opaque	undivided opaque	undivided opaque	undivided opaque	undivided opaque	undivided opaque
prefrontals	2, separated	2, separated	2, separated	2, separated	2, separated	2, separated	2, separated	2, separated	2, separated	2, separated
supranasals	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
postnasal	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
supraoculars	4	4	4	4	4	4	4	4	4	4
prenuchals	1 pair	1 pair	0	1 pair	1 pair	0	1 pair	1 pair	1 pair	1 pair
nuchals (L/R)	3/4	4/6	3/2	3/3	3/3	3/3	3/3	3/2	2/6	4/4
nasal fused to 1st supralabial	contact, but not fused	contact, but not fused	contact, but not fused	contact, but not fused	contact, but not fused	contact, but not fused	contact, but not fused	contact, but not fused	contact, but not fused	contact, but not fused
loreals	2	2	2	2	2	2	2	2	2	2
supraciliaries	6	5	5	5	6	5	5	5	5	5
lobules	0	0	0	0	0	0	0	0	0	0
supralabials	7	7	7	6	6	6	6	7	6	7
infralabials	6	6	6	6	6	6	6	6	6	6
midbody scale rows	22	22	24	22	22	24	22	22	22	22
dorsal scale rows between dorsolateral stripes	1/2+4+1/2	1/2+4+1/2	1/2+4+1/2	1/2+4+1/2	1/2+4+1/2	1/2+4+1/2	1/2+4+1/2	1/2+4+1/2	1/2+4+1/2	1/2+4+1/2
dorsal scales in comparison with lateral scales	slightly larger	similar	similar	similar	slightly larger	similar	slightly larger	similar	slightly larger	slightly larger
dorsal pattern	irregular dark spots	irregular dark spots	irregular dark spots	irregular dark spots	irregular dark spots	irregular dark spots	irregular dark spots	irregular dark spots	faint dark spots	irregular dark spots
paravertebral scale rows	68	62	61	65	60	67	67	67	67	64
ventral scale rows	63	59	58	60	61	64	63	60	62	61
enlarged precloacals	2	2	2	2	2	2	2	2	2	2
subdigital lamellae on finger IV	8	8	9	8	9	7	8	7	7	7
subdigital lamellae on toe IV	10	11	11	12	10	11	10	10	10	10
toes reach to fingers	separated	separated	separated	separated	separated	separated	separated	separated	separated	separated
fingers reaching to eye	no	no	no	no	no	no	no	no	no	no
subcaudal scales	-	-	-	-	-	-	75	-	-	83
size of subcaudals	enlarged	enlarged	enlarged	enlarged	enlarged	enlarged	enlarged	enlarged	enlarged	enlarged

TABLE 4. Morphological comparisons between *Scincella fansipanensis* **sp. nov.** and other *Scincella* species in Indochina and southern China (only adult specimens of *S. fansipanensis* **sp. nov.**, IEBR R.5185–5189 and 5191–5193, were used).

Characters	*Scincella fansipanensis* **sp. nov.**	*S. apraefrontalis*	*S. badenensis*	*S. baraensis*	*S. barbouri*	*S. darevskii*	*S. devorator*	*S. doriae*	*S. melanosticta*
SVL	43.5–59.0	36.1	47.8–64.4	46.8–49.2	38–48	88.6	52.1–58	58.6	43–57.4
TaL	49.5–88.3 (regenerated)	-	74.4	-	-	100.1 (regenerated)	65.7	82–101	63–88.9
prefrontals	separated	absent	contact	contact or separated	-	separated	separated	separated or contact	contact
supralabials	6 or 7	6	7 or 8	6 or 7	-	7	7	7	7
infralabials	6	5	6	7 or 8	-	7	6	-	6
supraoculars	4	4	4	4	4	5	4	4	4
supraciliaries	5 or 6	6	8–9	8	5 or 6	7	7 or 8	6–8	7–10
nuchals	2–6	2 or 3 pairs	0–1 pair	3pairs–3pairs+1	4-5 pairs	3 pairs	3 pairs	3–5 pairs	0
midbody scale rows	22 or 24	18	32–36	30	26–28	28	28–30	26–32	34–37
paravertebral scale rows	60–68	52	67–71	66–70	70–79	62	63–68	66–76	63–76
ventral scale rows	58–64	50	68–74	64–66	70–80	65	61–66	70–79	63–72
subcaudal scales	75 or 83	-	53+	57+	-	-	-	-	-
subdigital lamellae on toe IV	10–12	8/9	18–20	18–20	15–17	17	17–19	15–18	17–22
toes reach to fingers	separated	separated	reaching	separated or reaching	-	-	separated or reaching	separated or reaching	separated or reaching
dorsal scale rows between dorsolateral stripes	1/2+4+1/2	4	-	8	-	6	1/2+6+1/2	6	8
dorsal pattern	irregularly shaped dark spots	indistinct darker spots	no dark spot	faint black dots	five indistinct lines	a black line	dark irregular middorsal spots	irregular brown spots	irregular dark spots
literature	this study	T. Nguyen *et al.* 2010b	S.N. Nguyen *et al.* 2019	S.N. Nguyen *et al.* 2020	Stejneger 1925; Ouboter 1986	T. Nguyen *et al.* 2010a	Darevsky *et al.* 2004; T. Nguyen *et al.* 2011; Pham *et al.* 2015	Boulenger 1887; Taylor 1963; Ouboter 1986	Boulenger 1887; Taylor 1963; Neang *et al.* 2018

......*Continued on the next page*

TABLE 4. (Continued)

Characters	*S. modesta*	*S. monticola*	*S. nigrofasciata*	*S. ochracea*	*S. potanini*	*S. reevesii*	*S. rufocaudata*	*S. rupicola*
SVL	31.2–45.7	31.8–45.4	40.0–52.6	34.2–50.0	55	37.4–58.0	45.5–50.7	34–55.2
TaL	-	-	63.0–97.3	62.3–75.0	80	-	51.0	53.6–81.2
prefrontals	separated or contact	separated	contact	contact	-	contact or separated	separated	contact
supralabials	7 or 8	7	6 or 7	7 or 8	7	-	7	7
infralabials	6 or 7	6	6	5 or 6	7	-	6 or 7	6 or 7
supraoculars	4	4	2–4	4	4	-	4	4
supraciliaries	6	6 or 7	7 or 8	7 or 8	7	6 or 7	8	7–9
nuchals	3–4 pairs	3–4 pairs	0–1 pairs	0–3 pairs	3 pairs	0–1 pairs	0	0–1 pair
midbody scale rows	24–32	24	32–33	30–32	25–29	28–34	30–34	33–36
paravertebral scale rows	50–73	52–59	69–74	61–67	62–77	63–77	67–69	68–73
ventral scale rows	59–82	52–58	65–69	66–71	-	63–79	60–67	63–69
subcaudal scales	-	-	111	-	-	-	-	119
subdigital lamellae on toe IV	12–17	11–12	15–17	15–19	15–17	15–20	15–20	17–21
toes reach to fingers	reaching	separated	separated or reaching	separated	separated	separated or reaching	reaching	reaching
dorsal scale rows between dorsolateral stripes	6 or 1/2+6+1/2	4 or 1/2+4+1/2	8	1/2+6+1/2	1/2+4+1/2	8	10	8
dorsal pattern	indistinct lines of black dots	rows of darker spots	5–7 regular discontinuous stripes	a dark vertebral stripe	a median black line	small black spots	1–3 dark brown spots	dark blotches
literature	Günther 1864; Chen *et al*. 2001; Zhao *et al*. 1999	Schmidt 1925; T. Nguyen *et al*. 2010c, d; Pham *et al*. 2015	Neang *et al*. 2018	Bourret 1937; Pham *et al*. 2015	Günther 1896; Wang et al. 1986	Smith 1935; Chen *et al*. 2001	Luu *et al*. 2013; Neang *et al*. 2018	Smith 1916; Taylor 1963; Neang *et al*. 2018

temporals, lower secondary temporal overlapping the upper one, contacting seventh supralabials; seven supralabials, fifth below center of the eye; six infralabials; mental wider than long, in contact with the first infralabials; postmental undivided, in contact with first two infralabials; three pairs of chin shields, first pair medially in contact with each other. Dorsal scales smooth, slightly wider than ventral and lateral ones; 22 midbody scale rows; 1/2+4+1/2 scale rows between dark dorsolateral stripes; 68 paravertebral scale rows; 63 ventral scale rows; two enlarged precloacals, outer scales overlapped median ones; tail thick, widened until the tip, small scales around tail base. Limbs relatively short, pentadactyl; toe separated from finger when limbs adpressed along body; eight smooth subdigital lamellae under finger IV, ten under toe IV.

Coloration in life. The dorsal surface of head and body brown with irregularly shaped dark spots; dorsolateral stripe narrow, 1+1/2 scales wide, dark, and without paler spots; the upper part of flank dark brown with paler spots, faint in lower edge; the lower part of flank with a mosaic of black and paler spots; the venter yellowish cream.

Variation. Intraspecific variations of *Scincella fansipanensis* **sp. nov.** were as follows: none or one pair of prenuchals; two to six nuchals; five or six supraciliaries; six or seven supralabials; 22 or 24 midbody scale rows; 60–68 paravertebral scale rows; 58–64 ventral scales; seven to nine subdigital lamellae on finger IV and 10–12 on toe IV. For the morphological characteristics of the type series, see Table 2–3. The body color before preservation showed little variation, except in the arrangement of the irregularly shaped dark spots, which differed among individuals. One individual (IEBR R.5190) exhibited very few spots.

Distribution. This species is currently known only from Mt. Fansipan, Hoang Lien Son Range in Lao Cai Province, northwestern Vietnam, at high elevations from 2282 to 2366 m a.s.l.

Natural history. *Scincella fansipanensis* **sp. nov.** were found under fallen trees (Fig. 1C) in open areas or grassland during the day in May. The skinks appeared to be brumation, as they did not move or attempt to escape when the fallen trees were removed. The air temperature was not recorded at collecting site, however according to Dedov *et al*. (2020), it is usually approximately 10–12ºC from November to April and the minimum temperature is -3ºC in the area of Hoang Lien National Park. Only two other herpetofaunal species, one individual of the viper *Ovophis monticola* (Günther) and several individuals of the treefrog *Zhangixalus puerensis* (He), were found during the survey.

Etymology. The specific name "fansipanensis" is derived from Mt. Fansipan. As the common name, we suggest Fansipan ground skink (English) and Thằn lằn cổ fansipan (Vietnamese).

Comparisons. *Scincella fansipanensis* **sp. nov.** can be distinguished morphologically from other Indochinese and southern Chinese congeners as summarized in Table 4.

In our phylogenetic analysis, *Scincella fansipanensis* **sp. nov.** is closely related to *S. modesta* and *S. potanini*. It can be distinguished from *S. modesta* by having a larger SVL (43.5–59.0 mm vs. 31.2–45.7), fewer midbody scale rows (22 or 24 vs. 24–32), and by dorsal color pattern (with irregularly shaped dark spots vs. indistinct lines of black spots). It is distinguished from *S. potanini* by having fewer midbody scale rows (22 or 24 vs. 25–29), subdigital lamellae on toe IV (10–12 vs. 15–17), and in dorsal color pattern with (irregularly shaped dark spots vs. a median black line).

Scincella fansipanensis **sp. nov.** differs from *S. apraefrontalis*, *S. modesta*, and *S. monticola* by having a larger SVL (43.5–59.0 mm vs. 36.1, 31.2–45.7, and 31.8–45.4, respectively), and from *S. darevskii* by having a smaller SVL (43.5–59.0 mm vs. 88.6). *Scincella fansipanensis* **sp. nov.** is further distinguished from *S. apraefrontalis* by the presence of prefrontals (vs. absent), having a larger SVL (43.5–59.0 mm vs. 36.1), more midbody scale rows (22 or 24 vs. 18), paravertebral scale rows (60–68 vs. 52), ventral scale rows (58–64 vs. 50), subdigital lamellae on toe IV (10–12 vs. 8/9), and dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 4). It differs from *S. badenensis* prefrontals separated from each other (vs. in contact), fewer supralabials (6 or 7 vs. 7 or 8), more nuchals (2–6 vs. 0 or 1 pairs), fewer midbody scale rows (22 or 24 vs. 32–36), ventral scale rows (58–64 vs. 68–74), subdigital lamellae on toe IV (10–12 vs.18–20), toes separated from fingers when limbs adpressed along body (vs. reaching) and in dorsal color pattern (with irregularly shaped dark spots vs. none of dark spot); from *S. baraensis*, *S. darevskii* and *S. doriae* by having fewer midbody scale rows (22 or 24 vs. 30, 28, 26–32, respectively), ventral scale rows (58–64 vs. 64–66, 65, 70–79, respectively) and subdigital lamellae on toe IV (10–12 vs.18–20, 17, 15–18, respectively); from *S. barbouri* by having fewer midbody scale rows (22 or 24 vs. 26–28), fewer paravertebral scale rows (60–68 vs. 70–79), ventral scale rows (58–64 vs. 70–80), subdigital lamellae on toe IV (10–12 vs. 15–17), and dorsal color pattern (with irregularly shaped dark spots vs. five indistinct lines); from *S. devorator* by having fewer midbody scale rows (22 or 24 vs. 28–30), subdigital lamellae on toe IV (10–12 vs. 17–19) and dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 1/2+6+1/2); from *S. melanosticta* by having prefrontals separated from each other (vs. in contact), more nuchals (2–6 vs. none), fewer midbody scale rows (22 or 24 vs. 34–37), subdigital lamellae on toe IV (10–12 vs. 17–22) and dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 8); from *S. modesta* by having a larger SVL (43.5–59.0 mm vs. 31.2–45.7), fewer midbody scale rows (22 or 24 vs. 24–32), subdigital lamellae on toe IV (10–12 vs. 12–17), dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 6 or 1/2+6+1/2), toes separated from fingers when limbs adpressed along body (vs. reaching) and in dorsal color pattern (with irregularly shaped dark spots vs. indistinct lines of black dots); from *S. nigrofasciata* by having prefrontals separated from each other (vs. in contact), more nuchals (2–6 vs. 0 or 1 pairs), fewer midbody scale rows (22 or 24 vs. 32–33), paravertebral scale rows (60–68 vs. 69–74), ventral scale rows (58–64 vs. 65–69), subcaudal scales (75 or 83 vs. 111), subdigital lamellae on toe IV (10–12 vs. 15–17), dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 8), and in dorsal color pattern (with irregularly shaped dark spots vs. 5–7 regular discontinuous stripes); from *S. ochracea* by having prefrontals separated from each other (vs. in contact), fewer midbody scale rows (22 or 24 vs. 30–32), ventral scale rows (58–64 vs. 66–71), subdigital lamellae on toe IV (10–12 vs. 15–19), dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 1/2+6+1/2), and in dorsal color pattern (with irregularly shaped dark spots vs. a dark vertebral stripe); from *S. reevesii* by having more nuchals (2–6 vs. 0 or 1 pair), fewer midbody scale rows (22 or 24 vs. 28–34), fewer subdigital lamellae on toe IV (10–12 vs. 15–20), and fewer dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 8); from *S. rufocaudata* by having more nuchals (2–6 vs. none), fewer midbody scale rows (22 or 24 vs. 30–34), subdigital lamellae on toe IV (10–12 vs. 15–20), dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 10), toes separated from fingers when limbs adpressed along body (vs. reaching) and in dorsal color pattern (with irregularly shaped dark spots vs. 1–3 dark brown spots); and from *S. rupicola* by having prefrontals separated from each other (vs. in contact), more nuchals (2–6 vs. 0 or 1 pairs), fewer midbody scale rows (22 or 24 vs. 33–36), paravertebral scale rows (60–68 vs. 68–73), subcaudal scales (75 or 83 vs. 119), subdigital lamellae on toe IV (10–12 vs. 17–21), dorsal scale rows between dorsolateral stripes (1/2+4+1/2 vs. 8), toe separated from finger when limbs adpressed (vs. reaching), and in dorsal color pattern (with irregularly shaped dark spots vs. dark blotches).

Discussion

Mount Fansipan is the highest mountain of the Hoang Lien Son Range in the Indochina region with the peak of 3143 m a.s.l., and is the southeasternmost extension of the Himalayas (Sterling *et al*. 2006). The type series of *S. fansipanensis* was collected at the elevations between 2282 and 2366 m a.s.l. which is the highest elevation record of *Scincella* in the region. Of the total of 13 known species of *Scincella* in the Indochina, five (*S. apraefrontalis*, *S. badenensis*, *S. baraensis*, *S. nigrofasciata* and *S. rufocaudata*) occur below 513 m a.s.l., (T. Nguyen *et al*. 2010b; Luu *et al*. 2013; Neang *et al*. 2018; S.N. Nguyen *et al*. 2019, 2020). Another five species (*S. darevskii*, *S. devorator*, *S. melanosticta*, *S. monticola*, and *S. ochracea*) have an altitudinal range up to 1742 m a.s.l. in the Indochina region (Boulenger 1887a; Schmidt 1925; T. Nguyen *et al*. 2010a, c, d; Pham *et al*. 2015). Unfortunately, altitudinal ranges of the remaining three species (*S. doriae*, *S. reevesii* and *S. rupicola*) are unavailable for comparison.

The Hoang Lien Mountain Range is known as one of the centers of new species discoveries in Vietnam (Sterling *et al.* 2006), and our new discovery of *S. fansipanensis* highlights the high level of biodiveristy potential of montane tropical forests. The complex mountain topography in the region creates geographic isolation in high-altitude refugia, referred to as sky islands (He & Jiang 2014; Bui *et al*. 2020). Sky islands host many endemic species, and these organisms are isolated by surrounding environmental gradients (Heald 1951; He & Jiang 2014; Steinbauer *et al*. 2016; Flantua *et al*. 2020). Indeed, some species of the genus *Scincella* are distributed in high altitudes, such as *S. fansipanensis* (this study) and *S. potanini* (Zhao *et al*. 1999). This implies sky island is one of the important habitats for *Scincella* species.

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APPENDIX 1. Samples of *Scincella* species used in this study for molecular analyses.

Species	Voucher	GenBank accession number
Scincella fansipanensis **sp. nov.**	IEBR R.5185	LC846671
Scincella fansipanensis **sp. nov.**	IEBR R.5187	LC846672
Scincella fansipanensis **sp. nov.**	IEBR R.5188	LC846673
Scincella fansipanensis **sp. nov.**	IEBR R.5189	LC846674
Scincella fansipanensis **sp. nov.**	IEBR R.5192	LC846675
Scincella badenensis	ITBCZ 5993	MK990603
Scincella badenensis	ITBCZ 6262	MK990604
Scincella baraensis	ITBCZ 6534	MT742256
Scincella baraensis	ITBCZ 6536	MT742258
Scincella doriae	ZMMU R-13268-00505	MH119615
Scincella doriae	ZMMU R-13268-001062	MH119617
Scincella melanosticta	CBC01430	MH119620
Scincella melanosticta	ZMMU NAP-05519	MH119621
Scincella modesta	NB2017030715	MN702771
Scincella modesta	CIB 119024	OP942214
Scincella modesta	CIB 119023	OP942213
Scincella nigrofasciata	ITBCZ 6344	MK990605
Scincella nigrofasciata	CBC02545	MH119613
Scincella ochracea	sp3	OP927028
Scincella potanini	DL-KD202109071	OP942210
Scincella potanini	DL-KD202109072	OP942209
Scincella reevesii	NB2017030715	MN832615

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APPENDIX 1. (Continued)

Species	Voucher	GenBank accession number
Scincella rufocaudata	ZMMU NAP-06164	MH119612
Scincella rufocaudata	ZMMU NAP-06163	MH119611
Scincella cf. *rupicola*	Unvouchered	MH119625
Scincella cf. *rupicola*	Unvouchered	MH119628
Sphenomorphus maculatus	USNM:Herp:587038	MG935701
Plestiodon elegans	Unvouchered	KJ643142
Plestiodon chinensis	Unvouchered	KT279358
Asymblepharus himalayanus	Unvouchered	MN885892