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First Record of the Annam Kukri Snake *Oligodon annamensis* Leviton, 1953 (Squamata: Colubridae) From Thailand

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ABSTRACT. – I report the first documentation of the rare Kukri Snake species *Oligodon annamensis* Leviton, 1953 from Thailand based on a previously unidentified specimen collected in 1987 from the tropical rain forests of Chanthaburi Province, southeastern Thailand. This species was previously known from only four specimens collected at three localities in the Langbian Plateau of southern Vietnam and the Cardamom Mountains of western Cambodia. This new specimen extends the distribution of *O. annamensis* approximately 90.4 kilometers northwest from the nearest location in Phnom Samkos Wildlife Sanctuary, Pursat Province, Cambodia.

KEYWORDS: Reptilia, Cardamom mountains, biodiversity, Southeast Asia, taxonomy

INTRODUCTION

The Kukri Snakes of the genus *Oligodon* Fitzinger, 1826 represent one of the most species-rich snake lineages in Southeast Asia. While mostly considered harmless, these colubrids are known for their enlarged blade-like maxillary teeth, which can inflict significant mechanical injury (Taylor, 1965; Wüster and Cox, 1992). The teeth are used to slice open the shells of reptile and bird eggs, which are thought to represent the main food source for members of the genus (Wall, 1923; Minton and Anderson, 1963; Coleman et al., 1993; Green, 2010). Recent studies have also documented large *Oligodon* using their teeth to 'eviscerate' frogs and toads (Bringsøe et al., 2020; Bringsøe and Holden, 2021; Bringsøe et al., 2021). Of the approximately 90 recognized species of *Oligodon*, a total of 21 species are thought to inhabit Thailand and six are considered endemic (Pauwels et al., 2021; Uetz et al., 2022). Several *Oligodon* found in Thailand are recent additions to the country's snake fauna, either described as new species or documented as range extensions (Sumontha et al., 2017; Pauwels et al., 2017; Pauwels et al., 2021). Other taxa, namely *Oligodon catenatus* Blyth, 1854, *Oligodon dorsalis* Gray, 1835, and *Oligodon theobaldi* Günther, 1868 are thought to inhabit Thailand, but the basis for their occurrence has been called into question by some authors (Pauwels and David, 2005). In this paper, I add the species *Oligodon annamensis* Leviton, 1953 to the snake fauna of Thailand, based on a single specimen collected from Chanthaburi Province.

Oligodon annamensis was described based on a juvenile female holotype (USNM 90408), collected from "Station Agricale, Blao, Haut Donai, Annam" [= now Bao Loc, Lam Dong Province] in the Langbian Plateau of southern Vietnam (Leviton, 1953). Seven years later, Leviton (1960) reported the first male specimen of the species (MNHN-RA-0000.8815), collected from the same locality as the holotype, and provided a brief description of its hemipenes. While Leviton refrained from allocating *O. annamensis* to any previously defined species-group of *Oligodon*, he noted that the forked (=bilobed) shape of the organ resembled those found in the *Oligodon cyclurus-taeniatus* group (Smith, 1943). No additional records of *O. annamensis* were reported in the literature until Neang and Hun (2013) discovered a third specimen of the species (CBC 01899) from Phnom Samkos Wildlife Sanctuary in the Cardamom Mountains of Cambodia. This new specimen represented a significant westward extension for the species (approximately 600 km west of the type locality). Finally, Nguyen et al. (2020) provided a revised diagnosis for *O. annamensis* and reported on a fourth specimen (ZMMU Re-14304), collected during April 2012 from Chu Yang Sin National Park, Dak Lak Province, Vietnam. These authors were able to assess the phylogenetic position of the species using mtDNA sequences from the Cambodian and Dak Lak Province material. They recovered both specimens in a clade containing *Oligodon octolineatus* (Schneider, 1801) and the newly described *Oligodon rostralis* Nguyen, Tran, Nguyen, Neang, Yushchenko, and Poyarkov, 2020, which was sister to all other members of the *Oligodon cyclurus-taeniatus* group, confirming the suspicions of Leviton (1960). Since then, no other specimens of *O. annamensis* have been reported, and the species remains one of the most poorly documented of all Kukri Snakes in the Indochinese region.

TABLE 1. Morphological data on all known specimens of *Oligodon annamensis*, including the newly reported specimen from Chanthaburi Province, Thailand (UF 69743). Abbreviations used for morphological characters are explained in the materials and methods section.

Specimen	ZMMU Re-14304	CBC 01899	MNHN-RA-0000.8815	USNM 90408	UF 69743
Sex	M	M	M	F	F
SVL	331	152	111	220	135
TailL	81	35	22	29	21
TotalL	412	187	133	249	156
TailLR	19.7	18.7	16.5	11.6	13.5
DSR	13-13-13	13-13-13	13-13-13	13-13-13	13-13-13
VEN	157	148	146	170	155
SC	43	46	46	30	34
TOTAL	201	195	193	201	190
SCR	21.4	23.6	23.8	14.9	17.9
CP	Divided	Divided	Divided	Divided	Divided
LOREAL	Absent	Absent	Absent	Absent	Absent
SL	6	6/5	6	6	6
SL-eye	3-4	3-4/2-3	3-4	3-4	3-4
IL	6	6	6	6	6
IL-CS	1-4	1-3	1-4	1-4	1-3
NASAL	Entire	Entire	Entire	Entire	Entire
PreOc	1	1	1	1	1
PreSubOc	0	0	0	0	0
PostOc	1	1	1	1	1
ATemp	1	1	1	1	1
PTemp	2	1	2	2	2
Source	Nguyen et al. (2020)	Neang and Hun (2013)	Leviton (1960)	*This study*	*This study*

During a cursory examination of Southeast Asian snake material housed at the Florida Museum of Natural History, University of Florida, Gainesville, Florida, USA (UF), I encountered an unidentified *Oligodon* (UF 69743) from Chanthaburi Province, Thailand collected in 1987. Subsequent morphological examination of this specimen identified it as an immature *O. annamensis*, representing the fifth specimen known to science and the first documented record of this species from the country. A detailed description of this specimen is provided below.

MATERIALS AND METHODS

I compared the morphological features of the Thai specimen (UF 69743) with the holotype (USNM 90408) of *O. annamensis* and three additional specimens reported in the literature (Leviton, 1953; Leviton, 1960; Neang and Hun, 2013; Nguyen et al., 2020). For the Thai specimen, I determined sex by investigating a ventral incision performed on the specimen before my examination, which exposed the presence of ovaries. Body measurements such as Snout-Vent-Length (SVL), Tail Length (TailL) and Total Length (TotalL) were taken using a flexible ruler. Additional abbreviations for morphological features described in the results and in Table 1 are as follows: tail length-total length ratio given as a percent (TailLR); head length, measured from the anterior margin of the jawbone (rictus) to the tip of the rostral scale (HeadL); head width, measured from the widest point between the head (HeadW); snout length, measured from the anterior point of the eye to the tip of the rostral scale (SnL); snout width, measured as a straight-line distance between the median of both nostrils (SnW); eye diameter, measured horizontally from both posterior and anterior margins of the eye (EyeD); interorbital distance, the straight-line distance between both eyes at the border of the supraoculars (IOD); frontal length, the maximum length of the

frontal scale (FrontalL); frontal width, the maximum width of the frontal scale (FrontalW); number of ventral scales (VEN); number of subcaudals scales (SC); the total number of body scales (TOTAL); subcaudal ratio, namely the ratio between the number of subcaudals and the total number of body scales given as a percent (SCR); cloacal plate single or divided (CP); loreal scale present or absent (LOREAL); number of supralabials (SL); number of supralabials in contact with the eye (SL-eye); number of infralabials (IL); number of internasals in contact with the upper chin shields (IL-CS); nasal scale entire or divided (NASAL); number of preocular scales (PreOc); number of presubocular scales (PreSubOc); number of postocular scales (PostOc); number of anterior temporal scales (ATemp); and number of posterior temporal scales (PTemp). Dorsal scales were counted anteriorly at one head length behind the head, at midbody (namely halfway between the terminus of the head and the vent), and posteriorly at one head length anterior to the cloacal plate (given as anterior-midbody-posterior in the description). Terminology used for head scale suture angles follows Kaiser et al. (2019). Ventral scales were counted according to Dowling (1951). The tail tip was not included in the number of subcaudal scales. Counts for head scales are given in left/right order. The number of total body scales is the sum of the number of ventral scales, the cloacal plate (considered a single scale regardless of whether the plate is undivided or divided), and the number of subcaudal scales. Acronyms for museum and natural history collections are listed as follows: CBC: Centre for Biodiversity Conservation of the Royal University of Phnom Penh, Phnom Penh, Cambodia – MNHN: Muséum National d'Histoire Naturelle, Paris, France – UF: Florida Museum of Natural History, University of Florida, Gainesville, Florida, USA – USNM: National Museum of Natural History, Smithsonian Institution, Washington, District of Columbia, USA – ZMMU: Zoological Museum of Lomonosov Moscow State University, Moscow, Russia.

RESULTS

The specimen (UF 69743; Figures 1 and 2) from Chanthaburi Province, Thailand was collected on 24 April 1987 by non-marine malacologist Fred G. Thompson (1934-2016). The locality provided in his field notes was "Nam Tok Makok, Khao Sabap National Park (12º34'30" N, 102º15'00" E, 250 meters elevation)". Khao Sabap National Park was the previous name for what is now known as Namtok Phlio National Park, which preserves several waterfalls and mountainous streams extending from the larger Khao Sa Bap, an isolated fragment associated with the western end of the Cardamom Mountains. The specimen was collected in the afternoon by sifting through leaf litter at the base of a large tree. Unidentified until now, UF 69743 unambiguously matches the species diagnosis of *Oligodon annamensis*

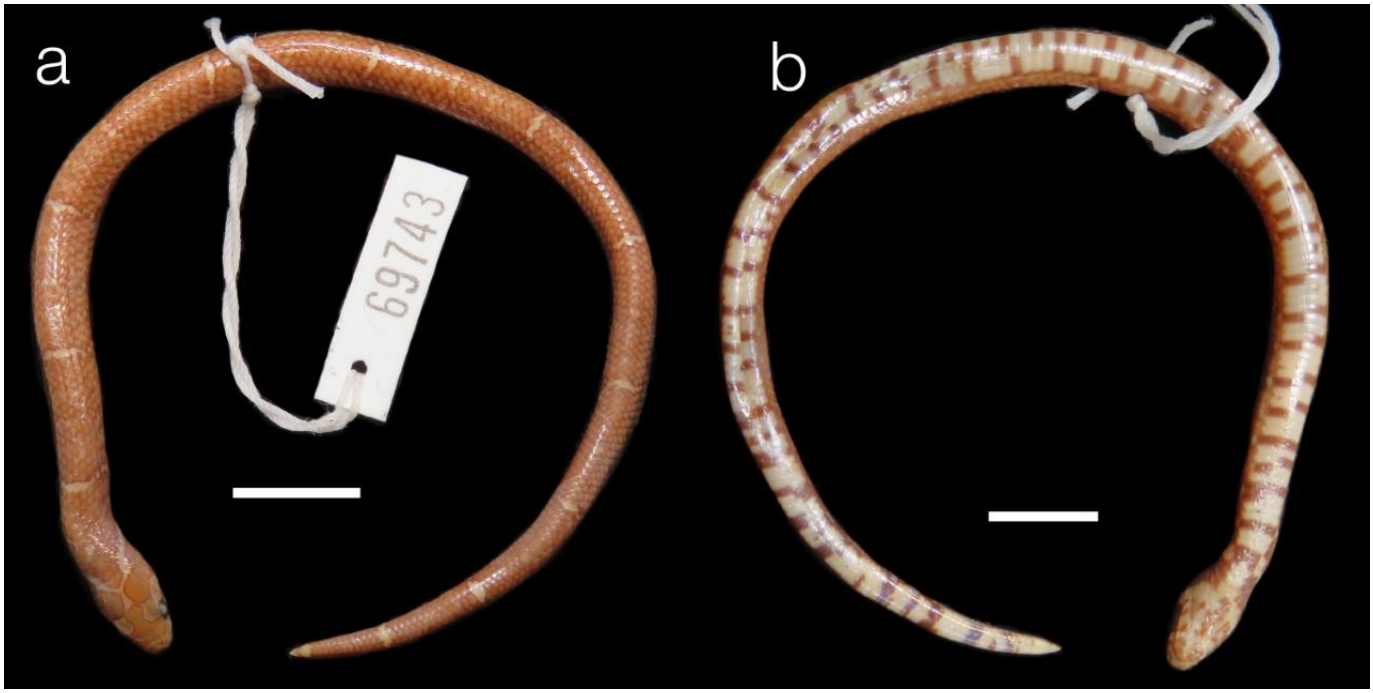

FIGURE 1. The new specimen of *Oligodon annamensis* from Chanthaburi Province, Thailand (UF 69743) in dorsal (A) and ventral (B) views. Scale bars equal 10 mm. Photos by Justin L. Lee.

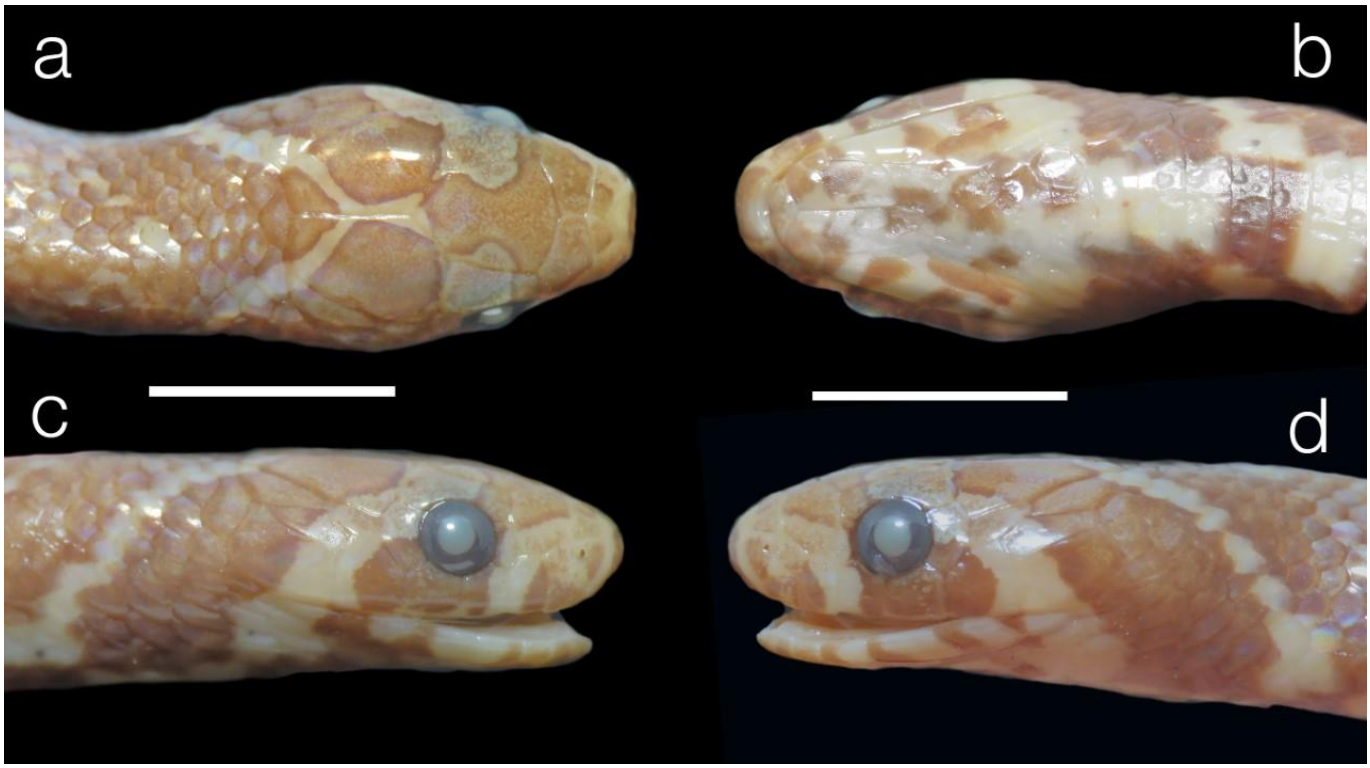

FIGURE 2. The new specimen of *Oligodon annamensis* from Chanthaburi Province, Thailand (UF 69743). Detail of the head in dorsal (A), ventral (B) and lateral (left, C; right, D) views. Scale bars equal 5 mm. Photos by Justin L. Lee.

by possessing the following characters: a small head with a non-protrusive snout, 13-13-13 dorsal scale rows, six supralabials, six infralabials, one preocular and postocular each, no loreal or presubocular scale, internasals separated from prefrontals, and a color pattern in preservative consisting of a ochre brown dorsum with 9+3 beige crossbars edged in dark-brown and a ventral surface with dark-brown quadrangular-shaped bars (Leviton, 1953; Nguyen et al., 2020). Additional comparisons between specimens of *O. annamensis* are provided in Table 1. A detailed description of the Thai specimen is provided below:

Oligodon annamensis Leviton, 1953
(Figs. 1–2 and Table 1)

Holotype. — USNM 90408, an immature female collected on 11 March 1933 by Mr. Eugéne Poliane from "Station Agricale, Blao, Haut Donai, Annam" [= now Bao Loc, Lam Dong Province, Vietnam, approximately 800 meters elevation (Fig. 3)].

Referred specimens. — MNHN-RA-0000.8815, an immature male collected on the same locality as the holotype during December 1958 by Mr. Tan Ngoc Trung (erroneously attributed to the same collection date and collector as the holotype by Nguyen et al., 2020). ZMMU Re-14304, an adult male collected on 14 April 2012 by Dr. Nikolay A. Poyarkov Jr from Chu Pan Phan Mountain, Chu Yang Sin National Park, Khue Ngoc Dien Commune, Krong Bong District, Dak Lak Province, Vietnam (12º 23' 42" N, 108° 21' 1.08" E, 1050 meters elevation). CBC 01899, an immature male collected on 26 April 2012 by Dr. Hun Seiha from Phnom Samkos Wildlife Sanctuary, Pursat Province, Cambodia (12° 10' 8.4" N, 102° 58' 19.56" E, 916 meters elevation) (Fig. 3).

New specimen. — UF 69743, an immature female collected on 24 April 1987 by Dr. Fred G. Thompson from "Nam Tok Makok, Khao Sabap National Park, Chanthaburi Province, Thailand (12º 34' 30" N, 102º 15' 00" E, 250 meters elevation)" [= now Makok Waterfall, Namtok Phlio National Park, Chanthaburi Province, Thailand] (Fig. 3).

Description of the new specimen. — SVL 135 mm; TailL 21 mm; TotalL 156 mm; TailLR 0.135; HeadL 8.0 mm; HeadW 5.4 mm; SnL 2.8 mm; SnW 2.4 mm; EyeD 1.9 mm; FrontalL 3.4 mm, FrontalW 2.7 mm; IOD 3.8 mm; HeadL/W 0.67; SnL/HL 0.35; EyeD/SnL 0.66; EyeD/HeadL 0.23; FrontalL/W 1.27; IOD/HeadW 0.70; SnW/IOD 0.62; SnW/HeadW 0.44.

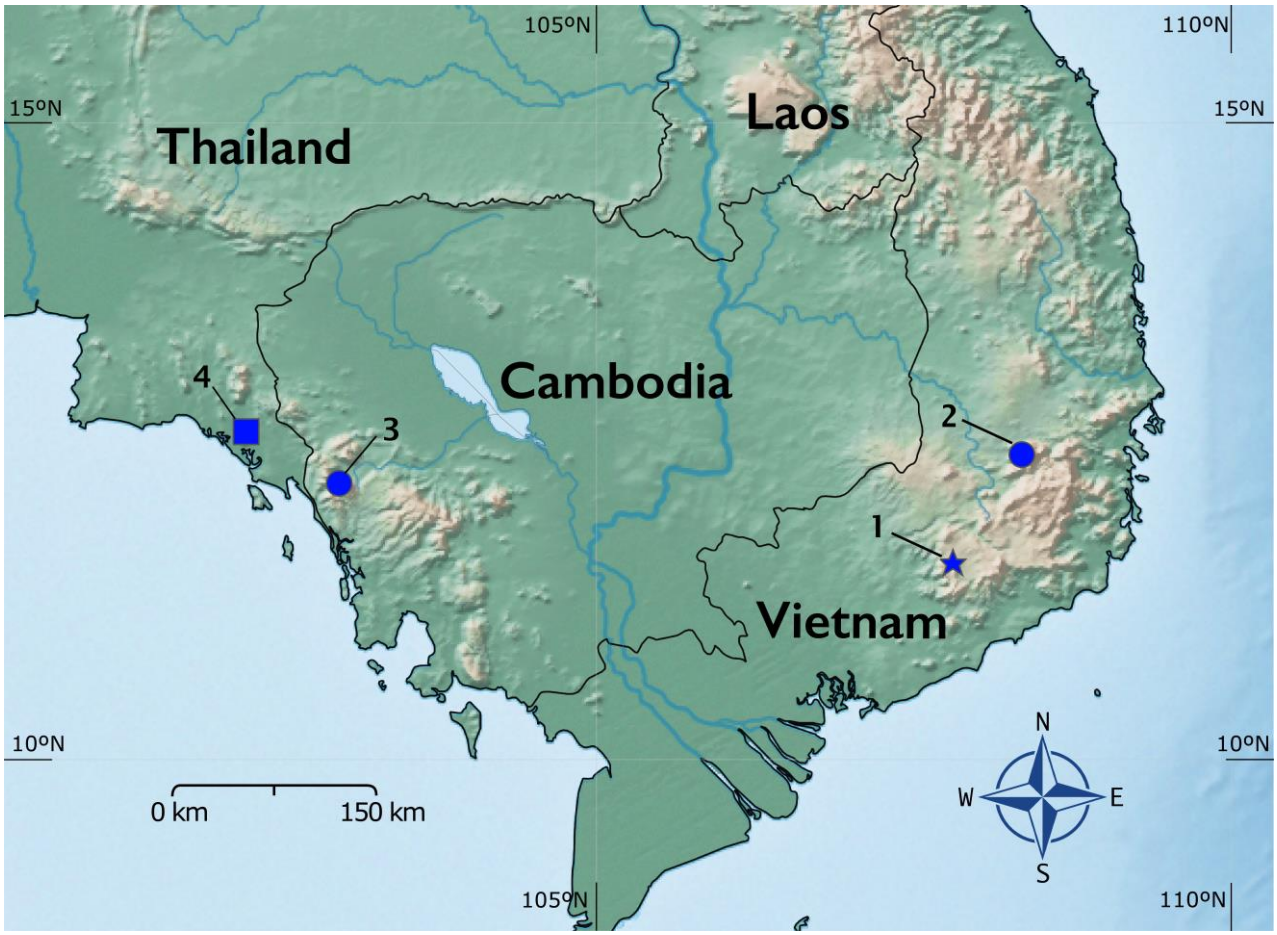

FIGURE 3. Current known distribution of *Oligodon annamensis*, showing 1: The type locality, Bao Loc, Lam Dong Province, Vietnam (blue star); 2: record from Nguyen et al. (2020) from Chu Yang Sin National Park, Dak Lak Province, Vietnam; 3: record from Neang and Hun (2013) from Phnom Samkos Wildlife Sanctuary, Pursat Province, Cambodia; and 4: new record from Namtok Phlio National Park, Chanthaburi Province, Thailand (blue square). Base map created using simplemappr.net.

Body robust, subcylindrical; head slightly distinct from neck, ovoid in dorsal view; snout slightly elongate ending at a blunt truncate point; snout width narrower than rest of head; tail short, tapering gradually to a sharp pointed tip; nostrils subelliptical shaped, pointed laterally; eyes round, large compared to head with round pupils; rostral scale medially splitting internasals, portion visible from above 2.3 times wider than long; posterior scale suture of rostral with internasals "deep-V" shaped, the vertex of the rostral rising far onto the dorsal surface of the head in-line with the nostrils (narrow obtuse angle); internasals separated from prefrontals, each subrectangular shaped and wider than long; prefrontals subpentagonal shaped, 1.4 times wider than long, in contact with frontal, preocular, second supralabial, and nasal; frontal subhexagonal and shield shaped, 1.3 times longer than wide, 6.9 times longer than prefrontal suture; frontal in contact with supraoculars, prefrontals and parietals; anterior angle formed by suture of frontal bordering prefrontals a broad obtuse angle (~133º), eyes placed posterior to the anterior edge of the frontal; posterior angle formed by the sutures producing the posterior vertex of the frontal a narrow obtuse angle (~100º); supraoculars subrectangular shaped, 1.9 times longer than wide, around two-thirds as long as frontal and one-third its width; parietals subpentagonal, 1.6 times longer than wide, widest anteriorly; parietal suture 0.7 times shorter than frontal; parietals contacting frontal, supraoculars, first postocular, both temporal scales and five total occipital scales; anterior parietal angle formed by the sutures between the parietal/frontal and the suture between the supraocular/parietal a broad obtuse angle (~130º) with the lateral ray of the angle pointing posterolaterally; nasal scale subtriangular, divided below the nostril, in contact with the first two supralabials, internasalss, prefrontals, and rostral; supralabials 6/6, third and fourth contacting the eye; sixth supralabial largest, with the subsequent scales decreasing in size; infralabials 6/6, first pair contacting medially, first three pair of scales contacting the anterior chin shields; fourth infralabial the largest,

second infralabial the smallest; preocular 1/1; loreal absent; postoculars 1/1; temporal formula 1+2, anterior temporal contacting the fifth supralabial only, posterior temporals bordering fifth and sixth supralabials. Mental scale triangular, wider than long; anterior chin shields slightly longer than wide; posterior chin shields approximately equal in length to anterior chin shields; chin shields and first infralabials separated by mental groove; two gular scales posterior to the chin shields, followed by two preventral scales.

Dorsal scales 13-13-13, all smooth; ventrals 155; subcaudals 34, all paired; cloacal plate undivided; total body scales 190 (including the cloacal plate); subcaudal ratio 0.179; maxillary teeth not examined.

After approximately 35 years in ~70% ethanol, the dorsal ground color is ochre brown with subdued darker reticulations along the edges of the dorsal scales; nine distinct beige crossbars along the body all narrowly edged with dark brown with a few indistinct bars interspaced between these; three additional crossbars along the tail, the last bar barely separated from the tail tip; all crossbars approximately 1.0-1.5 dorsal scales in width, widest along the vertebral region of the tail. Three beige chevrons present along the head, all with dark-brown edges. The first chevron originating on each flank of the neck before intersecting along the median between the two parietal scales forming an inverted "Y"-shaped nuchal marking; an additional chevron present as a beige and dark-brown edged streak extending from the margins of the frontal scale and extending behind the eye along the top of the postocular, anterior temporal, first half of the posterior temporal, and the fifth and sixth supralabials before ending along the gular scales of the throat; a dark-brown temporal streak extending from the frontal to the throat between these two chevrons; the final chevron present as a streak along the infralabials before extending along the second and third supralabials, nasal, and outer margins of the rostral. Remaining portion of head brown, with small lighter vermiculations across head scales. Ventral underside of head beige with irregular-shaped brown spotting across most of throat. Ventral surface of body and tail with dark-brown quadrangular-shaped bars each around one ventral-scale in length; some ventral bars incompletely shaped forming smaller spots; lateral margins of ventral scales ochre brown.

DISCUSSION

The addition *Oligodon annamensis* to the snake fauna of Thailand brings the total number of *Oligodon* species known from the country to twenty-two (fide. Pauwels et al., 2021). It remains difficult to ascertain the true number of *Oligodon* species known from the country due to a lack of confirmed voucher material for some taxa (Pauwels and David, 2005). The discovery of *O. annamensis* in Namtok Phlio National Park, Chanthaburi Province, Thailand extends the known distribution of this species 90.4 km west of the nearest known locality in Phnom Samkos Wildlife Sanctuary, Pursat Province, Cambodia (Neang and Hun, 2013). Furthermore, this specimen significantly lowers the known vertical distribution of this species to 250 meters elevation, with all other records ranging from 800–1050 meters. The count of 155 ventral scales for UF 69743 is lower than the counts for all other known specimens of *O. annamensis* and is significantly lower than the 170 ventral scales possessed by the only other known female of this species (USNM 90408). However, when combining the number of ventral and subcaudal scales, the total number of body scales for UF 69743 is 190 and is only three scales different from the previous lowest number of total body scales for the species (193 total scales; MNHN-RA-0000.8815). Thus, the difference in the number of ventrals and subcaudals in UF 69743 is likely a reflection of intraspecific variation and a low sample size. No notable differences in morphology or color pattern were noted between specimens from the Langbian Plateau and the Cardamom Mountains. Combined with the low genetic divergence between samples from either location (0.9% based on 12s–16s rRNA fide. Nguyen et al., 2020), little evidence exists for further taxonomic revision within this species.

Namtok Phlio National Park preserves an isolated fragment of forest habitat associated with the larger Cardamom Mountains and is notable for being the type locality of the Bent-toed Gecko *Cyrtodactylus intermedius* Smith, 1917 (restricted to the Thai Cardamom Mountains by Murdoch et al., 2019). Other snake species commonly associated with the Cardamom Mountain range such as *Lycodon cardamomensis* Daltry and Wüster, 2002 have also been recorded in the park's boundaries (Pauwels et al., 2005). The national park and surrounding preserved tracts of the Thai Cardamom Mountains in Chanthaburi Province have been investigated previously by herpetologists (Smith and Kloss, 1915; Taylor, 1962; Taylor, 1963; Taylor, 1965; Soderberg, 1967; Bauer and Das, 1998; Chan-ard et al., 1999), although none of these authors mention *O. annamensis* in their reports. The paucity of specimens across its range suggests that this species is very secretive and may be difficult to detect in the field. This status is shared by many other Southeast Asian Kukri Snakes known from only their name-bearing types or very few specimens,

such as *Oligodon hamptoni* Boulenger, 1918 (Lee et al., 2021), *Oligodon jintakunei* Pauwels, Wallach, David, Chanhome, 2002, *Oligodon moricei* David, Vogel, and van Rooijen, 2008, *Oligodon rostralis* Nguyen, Tran, Nguyen, Neang, Yuschenko, and Poyarkov, 2020, and the recently described *Oligodon teyniei* David, Hauser, and Vogel, 2022. A combination of low population densities, lack of routine survey efforts, and specific microhabitat preferences are all potential reasons for the apparent rarity of different *Oligodon* species in this region, along with other poorly understood snake genera. Although infrequently encountered, it is possible that future herpetological investigations may find *O. annamensis* in other portions of the Cardamom Mountains in Thailand, particularly in larger stretches of preserved rain forest habitats such as Khao Soi Dao Wildlife Sanctuary in Chanthaburi Province as well as Khao Ang Rue Nai Wildlife Sanctuary in Chachoengsao Province, Khao Chamao-Khao Wong National Park in Rayong/Chonburi Provinces, and adjacent portions of Trat Province near the Cambodian border.

In recent years several snake species hitherto undescribed or unknown from the country have been found within Thailand's political boundaries (Sumontha et al., 2017; Pauwels et al., 2017; Hauser, 2018; Smits and Hauser, 2019; Vogel and David, 2019; Sumontha et al., 2020; David et al., 2021; Pauwels et al., 2021; Pawangkhanant et al., 2021; Hauser et al., 2022). The addition of *O. annamensis* continues this trend of new discoveries and emphasizes that knowledge of the country's snake fauna is still far from complete, even in areas that have historically received attention from herpetologists.

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