



A new species of kukri snake (Colubridae: *Oligodon* Fitzinger, 1826) from the Phnom Samkos Wildlife Sanctuary, Cardamom Mountains, southwest Cambodia

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Abstract

A new species of kukri snake *Oligodon* Fitzinger, 1826 is described from the Phnom Samkos Wildlife Sanctuary, Cardamom Mountains, southwest Cambodia. *Oligodon kampucheaensis* sp. nov. differs from other Indochinese and Southeast Asian species of *Oligodon* by having 15–15 dorsal scale rows; 164 ventral scales; 39 subcaudal scales; anal plate undivided; deep bifurcated hemipenes, lacking papillae and spines extending to subcaudal scale 11; 17 transverse cream and black-edged bands on body; three bands on tail; eight or nine scales long between dorsal bands; white ventrolateral spots on the lateral margin of every dark brown squarish or subrectangular ventral blotch. The hemipenial characters place it as the tenth species of the *O. cyclurus* group but it has a lower dorsal scale count than other species in this group. The discovery of this species from the Phnom Samkos Wildlife Sanctuary increases the number of kukri snakes for Cambodia to ten and indicates the importance of additional field studies in the Cardamom Mountains.

Key words: hemipenis, herpetofauna, Indochina, natural history, systematics

Introduction

Cambodia's herpetofauna has received less attention than most other countries in tropical Southeast Asia— a region known for its rich biodiversity. Little work took place after the first major studies by Bourret (1936) and Saint Girons (1972), largely due to Cambodia's prolonged political conflict from 1975 to 1998. Only recently have field investigations, aimed at protecting and conserving the last extensive forest blocks in the biodiversity hotspots of the Cardamom Mountains and northeast Cambodia, rekindled interest in the amphibian and reptile faunas of Cambodia (see references below).

The Cardamom Mountains cover an area of approximately 20,000 km² in southwest Cambodia and include the Phnom Samkos Wildlife Sanctuary (PSWS) in the northwest near the Cambodia-Thai border, the Central Cardamoms Protected Forest in the centre, the Phnom Aural Wildlife Sanctuary in the northeast, and the southern Cardamoms Protected Areas to the south, as well as Kirirom, Bokor and Botum-Sakor National Parks (Fig. 1). The majority of these protected areas have been subject to herpetological inventories in recent years (Daltry 2002; Daltry & Mombert 2000; Daltry & Traeholt 2003; Daltry & Wüster 2002; David *et al.* 2008a; Grismer *et al.* 2007a,b, 2008a,b, 2010, 2011; Mahony 2011; Malhotra *et al.* 2011; Neang *et al.* 2010, 2011a,b; Ohler *et al.* 2002; Stuart & Emmett 2006; Stuart & Platt 2004; Wood *et al.* 2010). In northeast Cambodia, the main focus of attention has been on Seima Protected Forest in Mondulakiri province and Virachey National Park in Ratanakiri and Stung Treng provinces, where recent herpetofaunal studies were undertaken by Geissler *et al.* (2012); Stuart *et al.* (2006, 2010) and Rowley *et al.* (2010).

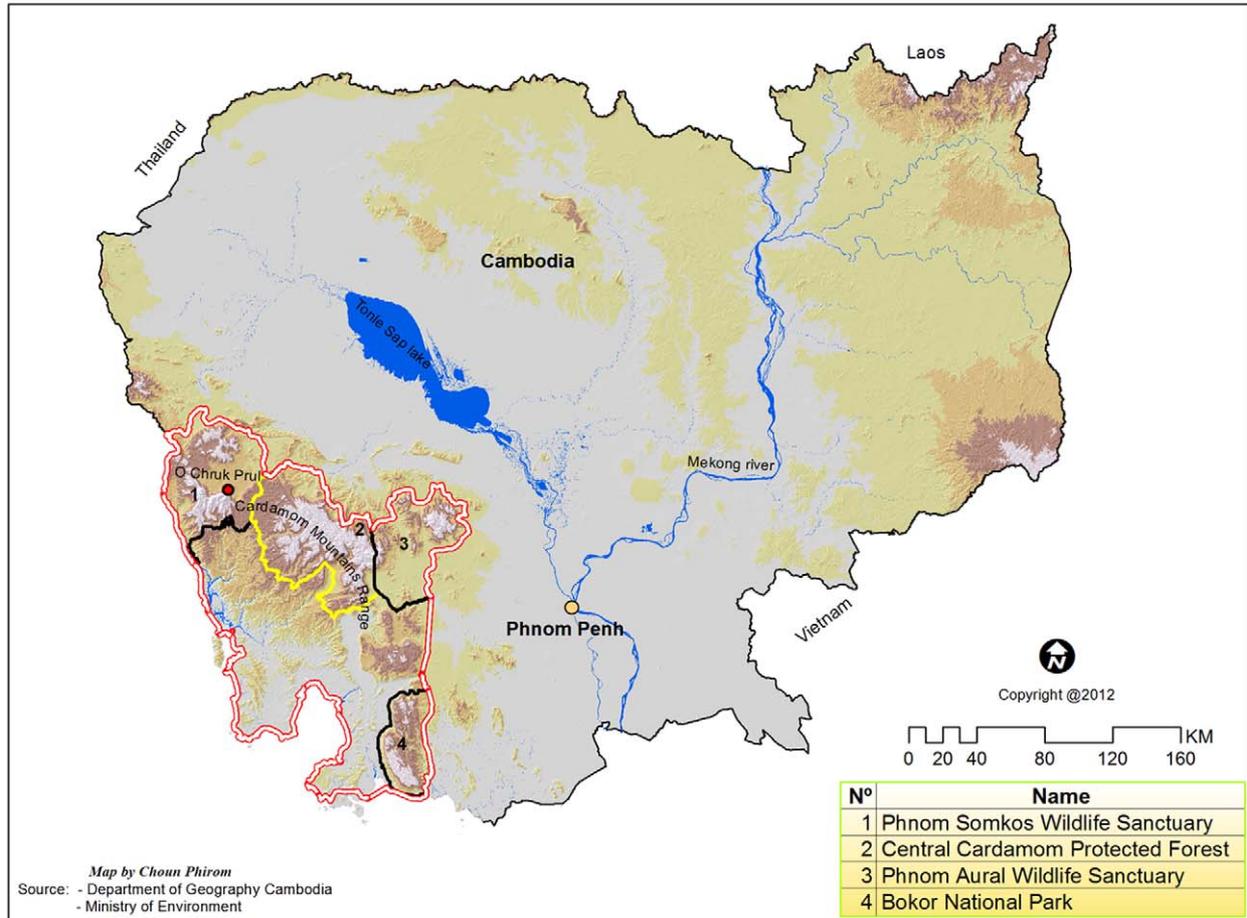


FIGURE 1. Map of Cambodia, illustrating the type locality of *Oligodon kampucheaensis* sp. nov. from the Phnom Samkos Wildlife Sanctuary, northwestern Cardamom Mountains, Cambodia.

These field expeditions in both southwest and northeast Cambodia resulted in the description of five new species of snakes: *Lycodon cardamomensis* Daltry & Wüster, 2002; *Oligodon deuvei* David, Vogel & Rooijen, 2008; *Cryptelytrops cardamomensis*; *C. rubeus* Malhotra, Thorpe, Mrinalini & Stuart, 2011; and *O. saintgironsi* David, Vogel & Pauwels, 2008. David *et al.* (2008b) described *O. deuvei* based on specimens collected by Sergeant Poilane in 1932, Jean Deuve in 1961 from Vietnam and Laos, and new material (LSUHC 07883) collected in Cambodia's PSWS (David *et al.* 2008b; Grismer *et al.* 2008a). In addition, David *et al.* (2008a) described *O. saintgironsi* on the basis of historical material collected from Vietnam circa 1930–40 and Cambodia with no precise date or locality.

Past descriptions, combined with the latest series of newly described species in the genus *Oligodon* Fitzinger, 1826, raised the total number of kukri snakes (*Oligodon*) from Cambodia to nine species (Bourret 1936; David *et al.* 2008a,b; Grismer *et al.* 2008b; Saint Girons 1972; Smith 1943; Stuart *et al.* 2006; Stuart & Emmett 2006; Wagner 1975). Two more species, namely *O. eberhardti* Pellegrin, 1910 and *O. catenatus* (Blyth, 1854) have also been postulated to occur in Cambodia based on their distribution in adjacent areas of Indochina (Smith 1943; Pauwels *et al.* 2003). The nine species (see Discussion) of *Oligodon* recorded from Cambodia comprise approximately 13% of the current total of 70 species in Southeast Asia (Leviton 1953; Uetz 2011).

Of all of the protected areas in Cambodia, the Phnom Samkos Wildlife Sanctuary (3,338 km²) has received the most attention in terms of herpetofaunal inventories (Grismer *et al.* 2007a,b, 2008a,b, 2010; Neang *et al.* 2010, 2011a,b; Wood *et al.* 2010; and references herein). Since 2000, 40 amphibian and 81 reptile species have been recorded at the site (Grismer *et al.* 2008b; Neang *et al.* 2010, 2012, Neang, unpublished data). The Sanctuary's diverse herpetofauna reflects its diverse elevation (from 90 to 1,717 m above sea level), geology, hydrology and vegetation types, many of which are still intact (Webb 2005). During a herpetofaunal field study between 25–31 January 2011 in the wildlife sanctuary, 10 amphibians and 16 reptiles were collected. Of these, a single kukri snake

specimen was collected that could not be assigned to any known species and is described here as new while the other species recorded will be reported elsewhere.

Methods and materials

Visual searches of amphibians and reptiles were conducted during the day and night from 25 to 31 January 2011 in semi-evergreen forest in the Phnom Samkos Wildlife Sanctuary. After the specimen was captured during the day on 27 January, the air temperature and relative humidity at 1 m above ground near the animal were measured by using a thermo-hygrometer-pen type with integral probe: SKU 5590 (R.P. Electronics, Vancouver). The specimen was photographed prior to euthanasia after which liver tissue was taken and stored in 97 % ethanol. The specimen was preserved in 10% formalin for seven days before being washed in water for 12 hours and then transferred to 70% ethanol for long-term storage in the zoological collection of the Center for Biodiversity Conservation (CBC) at the Royal University of Phnom Penh. Morphometric and meristic data were taken under a Nikon SMZ 645 dissecting microscope and measured by using a digital caliper to the nearest 0.1 mm. Data taken were: snout to vent length (SVL)—measured from the tip of the snout to the vent; tail length (TL)—measured from the vent to the tip of the tail; TL/SVL—ratio of TL/ SVL; head width (HW)—measured at the widest part of the head immediately posterior to the eye; head length (HL)—measured from the tip of the snout to the posterior margin of the mandible; head depth (HD)—vertical height between upper and ventral surfaces of head measured at HW; interorbital distance (IO)—shortest distance between outer margins of supraoculars; eye diameter (ED)—horizontal diameter of eye; snout length (SnL)—distance between the tip of the snout and anterior edge of eye; eye to nostril (EN)—distance between anterior margin of eye and posterior margin of nostril; nostril distance (ND)—horizontal distance between nostrils; dorsal scale rows at neck (DSN)—number of scale rows at one head length behind the head; midbody scale rows (MSR)—number of scale rows at midbody; dorsal scale rows anterior to the vent (DSV)—number of dorsal scale rows at one head length prior to the vent; dorsal scale rows (DSR)—referred to as a general scale formula in the form “DSN-MSR-DSV”. Ventral scales were counted according to Dowling (1951). The terminal scale was excluded from the subcaudal count: ventral scales (VS)—number of scales from the second ventral scale posterior to gulars to the vent excluding anal plate; Anal plate (AP)—number of terminal ventral scales immediately anterior to vent; subcaudal scales (SC)—number of paired subcaudal scales excluding the terminal scute; supralabials (SL)—number of scales on upper lip; SL-Eye—number of SL entering orbit; infralabials (InL)—number of scales on lower lip; maxillary teeth (MT)—number of maxillary teeth on the right side of upper jaw; temporal (TP)—number of scales immediately behind postocular between posteriormost SL and parietals; body bands (BB)—number of crossbands extending across the back and down to the sides but not encircling the body; bands on tail (BT)—number of crossbands on the tail; length that the hemipenes extend in terms of numbers of subcaudal scales (LHSC); hemipenis shape (HS); number of scales long covered by each band (NSB). Values of paired characters are given in left and right order.

For comparisons, morphometric, meristic and color pattern characters of previously published *Oligodon* species were taken from the literature (Angel 1927; Campden-Main 1970; David *et al.* 2008a,b, 2011; Grismer *et al.* 2008a; Leong & Grismer 2004; Leviton 1953; Orlov *et al.* 2010; Pauwels *et al.* 2002; Pellegrin 1910; Schleich & Kästle 2002; Smith 1943; Stuart *et al.* 2006; Stuart & Emmett 2006; Taylor 1965; Tillack & Günther 2009; Wagner 1975; Whitaker & Captain 2000) and some data on characters were obtained from examination of Cambodian specimens as reported in Appendix. Museum acronyms used are: CBC—Centre for Biodiversity Conservation at the Royal University of Phnom Penh, Cambodia; LSUHC—La Sierra University Herpetological Collections, La Sierra, Riverside, California, USA and FMNH—The Field Museum of Natural History, Chicago, USA. Other abbreviations are AD/MZ—Dr. Abhijit Das (collection), Mizoram, Aizawl city, India and AD/AR—Dr. Abhijit Das (collection), Arunachal Pradesh, Lower Dibang Valley District, India.

Systematics

Oligodon kampucheaensis sp. nov.

Figs. 1–4; Tables 1–5.

Holotype. CBC 01464; adult male collected by Thy Neang, Seiha Hun and Moeun Meang on 27 January 2011 at Chruk Prul stream at N 12°11'55.1", E 103°03'35.3", 330 m above sea level in the Phnom Samkos Wildlife Sanctuary, Cardamom Mountains, Pursat Province, southwest Cambodia.

Diagnosis. *Oligodon kampucheaensis* sp. nov. is distinguished from all of its congeners by the following combination of characters: MT 11; frontal and prefrontal separated; 1/1 anterior and 2/2 posterior TP; SL 8/8, 4th and 5th contacting orbit; InL 8/8; TL/SVL 0.178; DSR 15–15–15; VS 164; SC 39; anal plate undivided; deep bifurcated hemipenes, lacking papillae and spines, extending to SC 11; 17 transverse cream, black-edged bands that do not encircle body and three cream, black-edged bands on tail; no dorsal stripes, blotches or reticulated black crossbars on body; eight or nine scales long between crossbands, except for seven scales long between 5th and 6th and 10 scales long between 11th and 12th crossband; white ventrolateral spots on lateral margins of every dark brown squarish or subrectangular ventral blotch. For differential comparisons with congeners, see Comparisons section below.

Description of holotype. Adult male; head elongate, HL 14.2 mm, HW 9.1 mm, slightly flattened, HD 7.2 mm, not notably wider than neck; body robust, subcylindrical; SVL 363.2 mm; tail thick, robust, TL 64.8 mm; TL/SVL ratio 0.178; snout, elongate, about one third of HL, SnL 4.2 mm; EN 2.7 mm; ND 3.7 mm, slightly narrower than SnL; rostral shield large, thick, in contact with first supralabial and nasal laterally and internasals posteriorly; rostral shield slightly widened, 1.3 times wider than high, posteriorly pointed and intruding into the anterior suture between internasals; internasals paired, in broad contact, 1.9 mm in width, more than twice as wide as long (0.9 mm), separated by a median suture; prefrontals large, 2.6 mm in width, 2.1 mm in length, forming butterfly shape, separated by suture; suture between internasals (0.8 mm) shorter than that between prefrontals (1.1 mm); frontal large, pentagonal, posteriormost portion pointed, contacting parietal; supraocular large, elongate, pentagonal, narrower anteriorly; parietals form heart shape; suture between parietals (3.8 mm) slightly shorter than length of frontal (4.1 mm); nasal elongate, subrectangular, vertically divided, anterior part larger, in contact with rostral shield anteriorly, 1st and 2nd SL ventrally, internasal and prefrontal dorsally, loreal posteriorly; nostrils in posterior part of anterior nasal; 1/1 moderately sized, subrectangular loreal; 1/1 vertically elongate, rectangular preocular; pupil round, ED 2.4 mm; presubocular absent; 2/2 large rectangular postoculars, lower one on right side smaller, subtriangular; 1/1 large rectangular anterior temporal; 2/2 posterior rectangular temporal, upper twice as wide as lower; SL 8/8, 1st and 2nd contacting nasal, 2nd and 3rd contacting loreal, 3rd and 4th contacting preocular, 4th and 5th contacting orbit, 7th largest; InL 8/8, 1st pair in contact, 1–4 in contact with anterior chin shield, 5th largest, touching posterior chin shield, 8th InL separated from ventral scale by four scale rows; anterior chin shield twice the length of the posterior chin shield.

Maxillary teeth: 11, in size 1<2<3<4<5<6<8<9<10<<11, all curving backward, sharp, blade-like posterior edge, diastema between 10th/11th.

Body scalation: DSR: 15–15–15; DSN measured at 12th VS; MSR measured at 83rd VS; DSV measured at 157th VS; scale reduction from 17 scale rows at 9th VS to 15 scale rows at 10th VS; eight or nine scales between crossbands, except seven scales between 5th and 6th crossband and 10 scales between 11th and 12th crossband; all dorsal scales small, subrectangular and smooth; VS 164 (excluding 1 preventral), angulate laterally; SC 53, all paired; anal undivided. Hemipenes covered by lobes, deeply bifurcated at the level of 6th SC; tip of each organ reaching SC 11 (possibly not fully everted; Fig. 2).

Color. In life (Fig. 3), the specimen was reddish-maroon on head, dorsum, and flanks, this background color extending all the way onto edges of ventrals. It had 17 transverse cream colored, black-edged dorsal bands, extending ventrally to the first or second dorsal scale row, three cream dorsal bands edged in black on tail; scattered black-edged scales on body and tail; parts of each scale with dull reddish brown, minute speckling on a red background; creamy orange on rostral shield; part of nasals, edges of internasals and prefrontals, preoculars, 1st through 4th SL, and part of 5th SL white; a creamy crescent marking extended over frontal, and supraocular to posterior corner of eye, extending ventrally as a large indistinct creamy, oblique streak terminating at the lower margin of 8th SL; large inverted V-shape extends posteriorly, crossing the parietal and touching posterior margin of posterior temporal and

downward to 6th VS; large red streak below eye on 5th and 6th SL bordered by white stripes anteriorly and posteriorly; anterior half of 8th SL red, posterior half bearing an indistinct creamy streak; white ventrolateral spots on lateral margins of every dark brown squarish or subrectangular ventral blotch (observed in life and preservative). In preservative (Fig. 4), one-fifth of anterior venter is white, posterior four-fifths pinkish-white; dark brown blotches on belly, more indistinct squarish anteriorly and darker subrectangular in shape posteriorly on the lateral edges of approximately every second or third of ventral scale; posterior part of subcaudal region lacks blotches.



FIGURE 2. Preserved hemipenes of the holotype CBC 01464 *O. kampucheaensis* sp. nov. Photograph by Thy Neang.

Natural history. The holotype of *Oligodon kampucheaensis* sp. nov. was found on the ground beside a dried puddle on a logging road in lowland, disturbed evergreen forest. Although most members of the genus are typically nocturnal (Whitaker & Captain 2004; Green *et al.* 2010), this snake was found basking at 8:25 am during the relatively cool period of the early dry season. The air temperature was 26.3° C and relative humidity 94%.

Etymology. The specific epithet is in reference to the country Kampuchea (Cambodia) in which the type locality is located and to which this species is presumed to be endemic.

Comparisons. *Oligodon kampucheaensis* sp. nov. is compared here to three tentative groups within *Oligodon*: the *O. taeniatus* group, *O. cinereus* group and the *O. cyclurus* group (David *et al.* 2008a,b, 2011; Green *et al.* 2011; Smith 1943; Wagner 1975), most of which occur in Indochina (Cambodia, Vietnam and Laos), and, to Southeast Asian species that are similar in color and crossbar pattern and have similar dorsal scale row numbers to the new species, although many of the latter occur outside of the Indochinese biogeographical boundaries.

Oligodon kampucheaensis sp. nov. differs from most species of *Oligodon* by having white ventrolateral spots on the lateral margins of every dark brown squarish or subrectangular ventral blotch. The new species is further distinguished from all other nominal species in Indochina and Southeast Asia by the following unique combination of morphological characters.

TABLE 1. Comparison of morphological and color pattern characters of *Oligodon kampucheaensis* **sp. nov.** and species of the *O. taeniatus* group. The table is modified from David *et al.* (2008b). See Materials and Methods for an explanation of abbreviations. The additional abbreviations are: B—dorsal blotches (present +, absent-); VST—vertebral stripe (present +, absent-); PVST—paravertebral stripe (present +, absent-); HS—hemipenis shape (bifurcated = +; non-bifurcated = -). Rare characters are given in brackets. * eight or nine scales long between crossbands, except for seven scales long between 5th and 6th and 10 scales long between 11th and 12th crossband.

Species/ characters	<i>O. kampucheaensis</i> sp. nov.	<i>O. barroni</i>	<i>O. deuvei</i>	<i>O. moricei</i>	<i>O. mouhoti</i>	<i>O. pseudotaeniatus</i>	<i>O. taeniatus</i>
TL/SVL	0.178	0.137–0.189	0.132–0.172	0.133	0.121–0.185	0.140–0.205	0.128–204
TP	1+2	1+2	1+2	1+2	1+2	1+2	1+2
SL-Eye	4+5	3+4,4+5	3+4,4+5	4+5	4+5	4+5	4+5
SL	8	7	7 (8)	8	8	8	8
InF	8	8–9	8–9 (7)	9	9–10	8–9	9
MT	11	10–13	12–15	12	14–16	15	14–18
DSN	15	17	17	17	17	17	19
MSR	15	17	17	17	17	17	19
DSV	15	15	15	15	15	15	15
VS	165	136–160	140–155	175	145–163	137–156	142–165
SC	39	28–48	31–47	41	29–43	34–46	31–48
AP	1	1	1	1	1	1	1
BB	17	-	-	-	-	-	-
BT	3	-	-	-	-	-	-
NSB	*8–9 (7,10)	-	-	-	-	-	-
DB	-	+	-	-	-	-	-
VST	-	-	+	+	+	+	+
PVST	-	-	+	+	+	+	+
HS	+	+	+	?	+	+	+
LHSC	11	10–13	14	?	18–19	14–16	14–16

TABLE 2. Comparison of morphological and color pattern characters of *Oligodon kampucheaensis* **sp. nov.** and species of the *O. cinereus* group. Character states for the other species were taken from David *et al.* (2011); Pauwels *et al.* (2003); Pellegrin (1910); Schleich & Kästle (2002); Smith (1943); Wagner (1975); and Whitaker & Captain (2004). See Materials and Methods for an explanation of abbreviations. The additional abbreviations are: AP—anal plate (single = 1; divided = 2); RBCB—reticulated-black crossbars (present +, absent–).

Species/ characters	<i>O. Kampuchea ensis</i> sp. nov.	<i>O. inornatus</i>	<i>O. cinereus</i>	<i>O. joynseni</i>	<i>O. melanozonatus</i>	<i>O. albocinctus</i>	<i>O. splendidus</i>
TL/SVL	0.178	0.130–0.166	0.116–0.176	0.124–0.175	0.195	0.180–0.258	0.137–0.141
TP	1+2	1+2	1+2	1(2)+2	1+2	1+2	2+3
SL–Eye	4+5	4+5	4+5/3+4	4+5	3+4	3+4	4+5
SL	8	7–8	8 (7)	8	6	7	8
InF	8	8	8	8	6	8–9	5
MT	11	10–11	10–13	11–12	8	10–12	10–11
DSN	15	15	17	17	?	19	?
MSR	15	15	17	17	17	17 (19)	21
DSV	15	15	15	15	?	15 (17)	?
VS	165	169–174	156–182	186–197	171–173	177–208	169–193
SC	39	31–43	33–42	43–50	42–45	40–69	35–47
AP	1	1	1	1	2	1	1
BB	17	–	–	–	–	19–27	–
BT	3	–	–	–	–	4–8	–
NSB	*8–9 (7,10)	–	–	–	–	8–9	–
RBCB	–	+	+	+	+	–	–
DB	–	–	+	+	–	–	+
HS	+	–	–	–	?	–	–
LHSC	11	12–13	12–18	12–18	?	24	19

TABLE 3. Comparison of morphological and color pattern characters of *Oligodon kampucheaensis* **sp. nov.** and other species of the *O. cycleturus* group. The table is modified from Campden-Main (1970); David *et al.* (2008a, 2011); Smith (1943); and Wagner (1975). See Materials and Methods for explanation of abbreviations.

Species/ characters	<i>O. kampu cheaensis</i> sp. nov.	<i>O. cycleturus</i>	<i>O. fasciolatus</i>	<i>O. chinensis</i>	<i>O. ocellatus</i>	<i>O. saintgironsi</i>	<i>O. formosanus</i>	<i>O. macrurus</i>	<i>O. kheriensis</i>	<i>O. juglandifer</i>
TL/SVL	0.178	0.127– 0.156	0.155–0.216	0.152–0.195	0.112–0.141	0.161–0.203	0.149–0.195	0.157	0.121– 0.161	?
TP	1+2	2+2	2+2	1+2	2+2	2+3	1+2/1+2	1+2	1+1/2+2	?
SL-Eye	4+5	4+5	4+5	4+5	4+5	4+5	3+4,4+5	?	4+5	3+4
SL	8	8 (7)	8	8	8 (7)	8	7–8 (6)	7–8	8	7
InF	8	8	8	9(8)	9–10	9	9	8	8	?
MT	11	9–10	8–10	9–10	9–11	10–12	10–11	13	8	10–12
DSN	15	19	21–23	17	19	19	19	?	19	19
MSR	15	19	21	17	19	17–18	19	17	19	19
DSV	15	15	17	15	15 (13)	15	17 (15)	?	17	15
VS	165	160–173	160–196	175–206	152–180	166–170	155–189	143–152	196	162–208
SC	39	30–48	34–61	47–64	26–44	53–59	43–55	76–83	38–43	53–68
AP	1	1	1	1	1	1	1	1	1	1
BB	17	–	–	–	–	–	–	?	–	–
BT	3	–	–	–	–	–	–	?	–	–
NSB	*8–9 (7,10)	–	–	–	–	–	–	?	–	–
RBCB	–	+	+	+	+	+	+	+	–	+
DB	–	+	+	+	+	+	–	–	–	+
VST	–	–	–	–	–	+	+	–	–	–
HS	+	+	+	+	+	+	+	+	?	+
LHSC	11	15–18	14–21	12–13.0	15–17	27–28	15–18	29	?	?



FIGURE 3. Holotype CBC 01464 of *O. kampucheaensis* sp. nov. in life. Photograph by Thy Neang.

From the *O. taeniatus* group (Table 1), it differs in possessing DSR 15–15–15 (vs. 17–17–15 in *O. barroni* (Smith, 1916) from Cambodia, Thailand and Vietnam, *O. deuvei* David, Vogel, & Rooijen, 2008 from Cambodia and Vietnam, *O. moricei* David, Vogel & Rooijen, 2008 from southern Vietnam, *O. mouhoti* (Boulenger, 1914) from Cambodia, Eastern Thailand and southern Vietnam and *O. pseudotaeniatus* David, Vogel & Rooijen, 2008 from Thailand, and vs. 19–19–15 in *O. taeniatus* (Günther, 1861) from Cambodia, Thailand, southern Vietnam and Laos; having transverse cream body and caudal bands edged in black (vs. no cream bands edged in black); lacking dorsal stripes (vs. dorsal stripes present, except in *O. barroni*) and lacking dorsal blotches (vs. blotched in *O. barroni*), having deep bifurcated hemipenes with no papillae (vs. deep bifurcated hemipenes with large papillae in all members of the *O. taeniatus* group except *O. moricei* [unknown]).

From all species of the *O. cinereus* group (Table 2), *O. kampucheaensis* sp. nov. differs in having deeply bifurcated hemipenes (vs. non-bifurcated hemipenes). With DSR 15–15–15, the new species is separated from *O. cinereus* (Günther, 1864) from Cambodia, Thailand, Laos, India, Bangladesh, Myanmar, Malaysia and China, *O. joynsoni* (Smith, 1917) from northwestern Thailand and *O. melanozonatus* Wall, 1922 from India and China, all of which have DSR 17–17–15. It is distinguished from *O. albocinctus* (Cantor, 1839) from India, Nepal, Bangladesh, Myanmar and China which has DSR 19–17(19)–15(17) and separated from *O. splendidus* (Günther, 1875) from Myanmar that has DSR ?–21–?. Among the *O. cinereus* group, *O. kampucheaensis* sp. nov. is superficially similar to *O. inornatus* (Boulenger, 1914) from Cambodia and Eastern Thailand in having DSR 15–15–15, but differs in its higher TL/SVL ratio (0.178 vs. 0.130–0.166), having transverse cream, black-edged bands (vs. a uniform, dark pattern); fewer VS (164 vs. 169–174). *Oligodon kampucheaensis* sp. nov. is similar to *O. albocinctus* in having transverse cream, black-edged bands on the body and tail and having eight or nine scales between each crossband, but differs in having the 4th and 5th SL contacting the orbit (vs. 3rd and 4th), higher SL (8 vs. 7), fewer VS (164 vs. 177–208) and white ventrolateral spots on the lateral margins of every dark brown squarish or subrectangular ventral blotch (vs. absent in *O. albocinctus*). The new species also differs from *O. woodmasoni* (Sclater, 1891) in this group from India by having fewer DSR 15–15–15 (vs. 17), more SL (8 vs. 6), fewer VS (164 vs. 180–190) and deep bifurcated hemipenes (vs. non-bifurcated) (see Smith 1943).

Oligodon kampucheaensis sp. nov. is similar to species in the *O. cyclurus* group (Table 3) in its deeply bifurcated hemipenes which also lack papillae (except *O. formosanus* (Günther, 1972) which has papillae and spines (Smith 1943; David *et al.* 2011), but differs in its markedly fewer DSR 15–15–15 (vs. [19,21,23]–[17,18,19,21]–[13,15,17]) and DSR ?–17–? in *O. macrurus* (Angel, 1927); lacking reticulated black

crossbars on the body, lacking solid black or dark brown dorsal blotches, having transverse cream, black-edged bands on body and tail, having 3 temporals (vs. > 4 , except 3 in *O. chinensis* (Günther, 1864) and *O. formosanus*). The new species also differs from *O. kheriensis* Acharji & Ray, 1936 from India and Nepal and *O. juglandifer* Wall, 1909 from India in its fewer DSR 15–15–15 (vs. ?–19–?), higher TL/SVL (0.178 vs. 0.121–0.161 in *O. kheriensis*), fewer SC (39 vs. 53–68) and more SL (8 vs. 7 in *O. juglandifer*) (see Smith 1943).

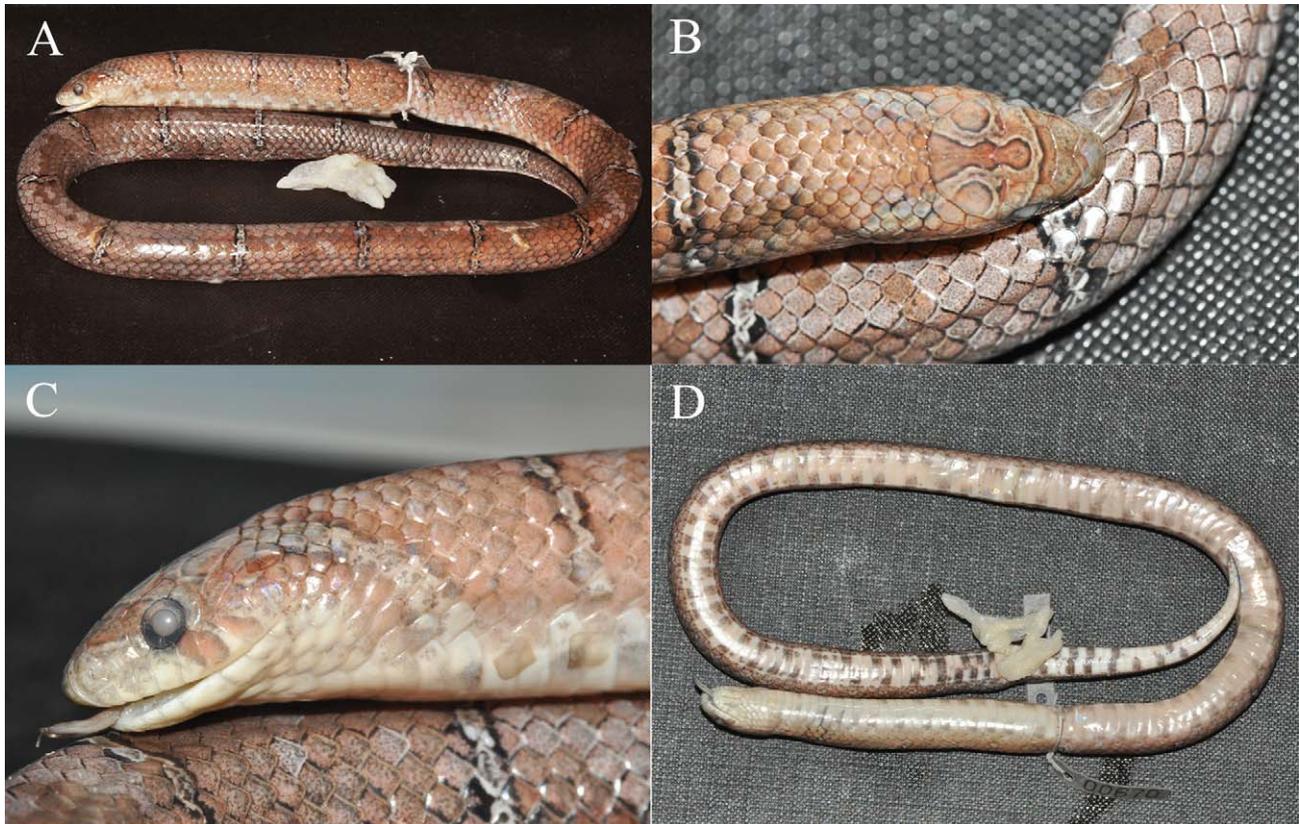


FIGURE 4. Preserved holotype CBC 01464 *O. kampucheaensis* sp. nov. A. dorsal and lateral; B. dorsal head; C. lateral head; D. ventral view. Photograph by Thy Neang.

Oligodon kampucheaensis sp. nov. obviously differs from *O. purpurascens* (Schlegel, 1837) from southern Thailand, East and West Malaysia, Singapore and Indonesia by its DSR 15–15–15 (vs. [19,21]–[19,21]–[15,17]), fewer TP (1+2 vs. 2+3 or 2+2); transverse cream, black-edged bands on body (vs. blotched) (Taylor 1965; Tillack & Günther 2009). It differs from *O. signatus* (Günther, 1864) from West Malaysia, Singapore and Indonesia in having a lower TL/SVL ratio (0.178 vs. 0.222–0.328), 4th and 5th SL contacting orbit (vs. 3rd and 4th), more SL (8 vs. 7), and fewer SC (39 vs. 47–59). It differs from *O. booliati* Leong & Grismer, 2004 from West Malaysia in having DSR 15–15–15 (vs. 17–17–15), lower TL/SVL (0.178 vs. 0.282–0.338), 4th and 5th SL touching orbit (vs. 3rd and 4th), more SL (8 vs. 6 or 7), more VS (165 vs. 143–153) and fewer SC (39 vs. 54–60); it differs from *O. cruenatus* (Günther, 1868) from Myanmar and *O. theobaldi* (Günther, 1868) from Thailand, Myanmar and India in its fewer DSR 15–15–15 (vs. 17–17–15), fewer MT (11 vs. 14–16), having a single anal plate (vs. divided) and having deep bifurcated hemipenes (vs. non-bifurcated) (Table 4).

Oligodon kampucheaensis sp. nov. can be further distinguished from *O. catenatus* (Blyth, 1854) from India, Myanmar, Vietnam, southern China and Laos, *O. annamensis* Leviton, 1953 from Vietnam, and *O. eberhardti* Pellegrin, 1910 from Vietnam, Laos and China, *O. mcdougalli* Wall, 1905 and *O. planiceps* (Boulenger, 1888) from Myanmar which have DSR 13–13–13 (vs. 15–15–15 in *O. kampucheaensis* sp. nov.). The new species also differs from *O. jintakunei* Pauwels, Wallach, David & Chanhom, 2002 from Thailand and *O. lacroixi* (Angel & Bourret, 1933) from northern Vietnam which have fused frontal and prefrontal (vs. frontal and prefrontal separated) and a divided anal plate (vs. undivided) (Table 5).

In having DSR 15–15–15, the new species is similar to *O. brevicauda* Günther, 1862 from India, *O. hamptoni* Boulenger, 1900 from northern Thailand and Myanmar, and *O. pulcherrimus* Werner, 1909 and *O. praefrontalis*

Werner, 1913 from Indonesia, but is distinguished from these in having the frontal and prefrontal separated (vs. frontal and prefrontal fused) and a single anal plate (vs. divided, except in *O. praefrontalis*). The new species differs from *O. praefrontalis* in having separated frontal and prefrontal scales (vs. frontal and prefrontal fused), fewer VS (164 vs. 193) and an undivided anal plate (vs. divided) (see Pauwels *et al.* 2002; Tillack & Günther 2009).

TABLE 4. Comparison of morphological and color pattern characters of *Oligodon kampucheaensis* **sp. nov.** with *O. purpurascens*, *O. signatus*, *O. booliati*, *O. cruentatus*, *O. theobaldi*. The characters and data for other species were taken from Das (2010); David & Vogel (2012); Leong & Grismer (2004); Smith (1943); Taylor (1965); Tillack & Günther (2009); and Tweedie (1983). See Materials and Methods for abbreviations.

Species/ characters	<i>O. kampucheaensis</i> sp. nov.	<i>O. purpurascens</i>	<i>O. signatus</i>	<i>O. booliati</i>	<i>O. cruentatus</i>	<i>O. theobaldi</i>
TL/SVL	0.178	0.145–0.231	0.222–0.328	0.282–0.338	0.183	0.137
TP	1+2	2+3,2+2	1+2 (1 or 3)	1+2		?
SL-Eye	4+5	4+5 (5)	3+4	2+3, 3+4	4+5	4+5
SL	8	8	7	6–7	8	8
InF	8	9	7–8	7	5	?
MT	11	9–10	7–8	?	14–16	15–16
DSN	15	19–21	15–17	17	?	?
MSR	15	19–21	15–17	17	17	17
DSV	15	15–17	15	15	?	?
VS	165	160–210	141–160	143–153	148–173	164–180
SC	39	37–60	47–59	54–60	27–40	30–42
AP	1	1	1	1	2	2
BB	20	13–23	15–20	19–22	–	–
HS	+	?	?	?	–	–

With the exception of DSR 15–15–15, *O. kampucheaensis* **sp. nov.** differs from *O. annulifer* (Boulenger, 1893) from Brunei and Malaysia in having a lower TL/SVL ratio (0.178 vs. 227–0.247), more MT (11 vs. 7), and 4th and 5th SL touching orbit (vs. 3rd and 4th) in *O. annulifer* (see Tillack & Günther 2009); it is separated from *O. dorsalis* Gray & Harwicke, 1835 from Thailand, Myanmar, Bangladesh and India in lacking a vertebral stripe (vs. present), having more MT (11 vs. 6–7) and a single anal plate (vs. divided) (see Smith 1943); it is distinguished from *O. erythrorhachis* Wall, 1910 from India in having loreal (vs. loreal absent), having more MT (11 vs. 7–8), and having a single anal plate (vs. divided). In having deep bifurcated hemipenes, *O. kampucheaensis* **sp. nov.** clearly differs from *O. melaneus* Wall, 1909, and *O. nikhili* Whitaker & Dattatri, 1982, both from India, *O. waandersi* Bleeker, 1860, *O. petronellae* Roux in De Rooij, 1917 and *O. wagneri* David & Vogel, 2012, all from Indonesia, *O. ornatus* Van Denburgh, 1909 from Taiwan & China, and *O. torquatus* (Boulenger, 1888) from Myanmar which have non-bifurcated hemipenes (see Smith, 1943 and David & Vogel, 2012). Finally, *O. kampucheaensis* **sp. nov.** is distinguished from *O. sublineatus* Duméril, Bibron & Duméril, 1854 from Sri Lanka by having more MT (11 vs. 6–8), having a single anal plate (vs. divided) and having deep bifurcated hemipenes without spines (vs. bifurcated at tip with spines) (see Smith 1943).

Discussion

Although hemipenial morphology has long been considered to be an important diagnostic character in the classification of *Oligodon* (David *et al.* 2008a,b; David *et al.* 2011, 2012; Dowling & Savage 1960; Green *et al.* 2010; Smith 1943), many species still have not been assigned to any group due to the lack of specimens with known hemipenial morphology (David *et al.* 2008b; Pauwels *et al.* 2002; Smith 1943). Additional adult male specimens are thus needed for hemipenis based-classification. Dorsal scale rows also tend to be highly variable among species

TABLE 5. Comparison of morphological and color pattern characters of *Oligodon kampucheaensis* sp. nov. and other species from Indochina and Thailand which have fused internasal and prefrontal scales (except species with DSR 13–13–13). Characters states for the other species were taken from Leviton (1953); Orlov *et al.* (2010); Pauwels *et al.* (2002); and Smith (1943). See Materials and Methods for an explanation of abbreviations. The additional abbreviations are: FbInPr—fusion between internasal & prefrontal (fused = +; not fused = -; WS—white ventrolateral spots on every lateral margins of dark brown squarish or subrectangular ventral blotches (present +; absent -).

Species/ characters	<i>O. kampuchea</i> <i>ensis</i> sp. nov.	<i>O. catenatus</i>	<i>O. jintakunei</i>	<i>O. lacroixi</i>	<i>O. eberhardti</i>	<i>O. annamensis</i>	<i>O. mcdougalli</i>	<i>O. platiceps</i>
TL/SVL	0.178	0.126–0.133	0.211	0.142	0.177	0.131	?	0.106
TP	1+2	1+2	1+1	1+2	?	1+2	?	?
FbInPr	-	+	+	+	+	-	-	-
SL	8	6	7	5	6/6	6	7	5 (4)
InF	8	6	7	6	6/6	6	7	?
MT	11	7	6	8–12	?	8	?	10
DSN	15	13	15	15	13	13	?	?
MSR	15	13	15	15	13	13	13	13
DSV	15	13	15	15	13	13	?	?
VS	165	186–212	189	162–178	189–190	159–170	200	132–145
SC	39	34–43	46	25–33	37	30–44	39	22–27
AP	1	2	2	2	2	1	2	2
BB	17	-	11	-	-	10	-	-
BT	3	-	3	-	-	?	-	-
NSB	*8–9 (7,10)	-	-	-	-	?	-	-
RBCB	-	-	-	-	-	?	-	+
DB	-	-	-	-	-	-	-	-
VST	-	+	-	-	-	-	+	-
PVST	-	+	-	+	-	-	-	-
WS	+	-	-	-	-	-	?	?
HS	+	-	?	?	?	?	-	-
LHSC	11	7	?	?	?	?	?	?

that share similar hemipenial characters. For example, dorsal scale rows at midbody for members of the *O. taeniatus* group range from 17–19, in known members of the *O. cyclurus* group from 17–21, and in members of the *O. cinereus* group from 15–21 (see Tables 1, 2 & 3). *Oligodon kampucheaensis* **sp. nov.** can be assigned to the *O. cyclurus* group because it has deeply bifurcated hemipenes lacking papillae and spines and differs from all other conspecifics with similar hemipenes in having 15 (vs. >17) dorsal scale rows.

The description of *O. kampucheaensis* **sp. nov.** increases the number of new snake species reported from Cambodia during the last ten years to six (see Introduction). It also increases the Cambodian total of *Oligodon* to ten species, which now includes four species in the *O. taeniatus* group (*O. barroni*, *O. devei*, *O. mouhoti* and *O. taeniatus*), four in the *O. cyclurus* group (*O. fasciolatus*, *O. ocellatus*, *O. saintgironsi* and *O. kampucheaensis* **sp. nov.**) and two in the *O. cinereus* group (*O. inornatus* and *O. cinereus*). That *O. kampucheaensis* **sp. nov.** was discovered at low elevation (330 m above sea level) suggests the species could occur elsewhere in similar forest habitats in Cambodia. *Oligodon catenatus* and *O. eberhardti* were postulated to occur in Cambodia by Smith (1943) and Pauwels *et al.* (2003) based on their distribution in neighboring countries, but this has yet to be confirmed. Future field studies near the borders between Cambodia, Vietnam and Laos and other poorly surveyed areas may yield other species of *Oligodon*. The discovery of *O. kampucheaensis* **sp. nov.** demonstrates the value of Cambodia's protected areas for biodiversity conservation and the importance of continuing field investigations in the Cardamom Mountains to determine the diversity, status and ecology of their herpetofauna.

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APPENDIX. Specimens examined.

Oligodon taeniatus: CBC 00562; *Oligodon inornatus*: CBC 001701, FMNH 263391; *Oligodon fasciolatus*: FMNH 267730, LSUHC 08482; *Oligodon ocellatus*: FMNH 263011, all are from Cambodia. *Oligodon albocinctus*: AD/MZ 09, AD/AR 18 from India.