



A new species of kukri snake (Squamata: Colubridae: *Oligodon* Fitzinger, 1826) from Con Dao Islands, southern Vietnam

SANG NGOC NGUYEN^{1,4}, VU DANG HOANG NGUYEN¹, SON HONG LE² & ROBERT W. MURPHY³

¹*Institute of Tropical Biology, Vietnam Academy of Science and Technology, 85 Tran Quoc Toan St., Dist. 3, Ho Chi Minh City, Vietnam. E-mail: ngocsangitb@yahoo.com*

²*Con Dao National Park, 29 Vo Thi Sau St., Con Dao Town, Ba Ria–Vung Tau Prov., Vietnam. E-mail: son@condaopark.com.vn*

³*Centre for Biodiversity and Conservation Biology, Royal Ontario Museum, 100 Queen's Park, Toronto, Canada M5S 2C6.*

E-mail: bob.murphy@utoronto.ca

⁴*Corresponding author*

Abstract

We describe a new kukri snake, *Oligodon condaoensis* **sp. nov.**, from Con Dao Islands, southern Vietnam based on the morphological characters of four specimens. It differs from other congeners by a combination of the following characters: medium size in adults (total length up to 552 mm); 17–17–15 dorsal scale rows; deeply forked hemipenes without spines and papillae, extending to subcaudal 13 or 14; 11–13 maxillary teeth, the posterior three being enlarged; cloacal plate undivided; head scalation complete; nasal divided; presubocular absent; 168–176 ventrals; 33–37 subcaudals; overall dorsal coloration dark gray, faint body stripes present or absent; and ventral coloration cream to dark gray without rectangular blotches. We also provide a list of 43 species of amphibians and terrestrial reptiles recorded from Con Dao Islands.

Key words: Hon Ba, hemipenis, Indochina, maxillary teeth, *Oligodon condaoensis* **sp. nov.**

Introduction

The Con Dao Islands, located in Ba Ria–Vung Tau Province in southern Vietnam, contains 14 islands and islets (Fig. 1). The total land area of the islands is 76.7 km² and the highest peak rises 690 m above sea level (Le 2004). The Pleistocene land-bridge islands have been isolated from mainland Indochina for only 10,000–15,000 years as a result of the post-glacial transgression (Darevsky 1999). Early studies of the herpetofauna of the islands dates to the end of the 19th Century when the endemic gecko, *Cnemaspis boulengeri* (Strauch 1887), was described. Smith (1921) conducted the first survey of terrestrial reptiles and amphibians. He recorded 14 species including three frogs and 11 reptiles, one of which was the new gecko, *Cyrtodactylus condorensis* (Smith). Nearly 80 years later, the second herpetological survey was carried out on the islands by Darevsky (1999), who recorded 16 species of reptiles but provided no data on amphibians. Subsequently, Honda *et al.* (2001) described the endemic lizard, *Dibamus kondaoensis* Honda, Ota, Hikida & Darevsky. At present, the Con Dao Islands appear to have 29 species of terrestrial reptiles and amphibians, including endemic *Cnemaspis boulengeri* and *Dibamus kondaoensis* (Honda *et al.* 2001; Nguyen *et al.* 2009; Strauch 1887). Thus, a high level of local endemism characterizes the insular herpetofauna.

The kukri snake genus *Oligodon* Fitzinger, 1826 includes 74 recognized species (Uetz & Hosek 2015, accessed on 3 March 2016), which occur throughout Central and Tropical Asia (David *et al.* 2008a). Twenty-one species of *Oligodon* occur in Vietnam (Uetz & Hosek 2015, Vassilieva 2015), six of which (29%) were described in last decade (David *et al.* 2008b, 2012; Vassilieva *et al.* 2013; Vassilieva 2015). *Oligodon cinereus* (Günther) and *O. fasciolatus* (Günther) were recorded from Con Dao Islands (Campden-Main 1970; Darevsky 1999; Smith 1943). Our field work in 2015 and 2016 on these islands discovered both of these species. However, four other specimens from the area are similar to each other in appearance but do not assign to any known species. Herein we describe the snakes as a new species.



FIGURE 1. Location of Con Dao Islands in southern Vietnam (red square in insertion) and main islands in Con Dao. 1, Tre Nho; 2, Tre Lon; 3, Hon Ba; 4, Con Son; 5, Hon Tai; 6, Bay Canh; 7, Hon Cau. The type locality of *Oligodon condaoensis* sp. nov. is indicated by red star. Modified from Google Maps.

Material and methods

Four field trips were conducted on Con Dao Islands in 2015 and 2016. Seven main islands and islets were surveyed, including Con Son, Bay Canh, Hon Cau, Hon Ba, Tre Lon, Tre Nho, and Hon Tai (Fig. 1).

Specimens were fixed in 90% ethanol and then transferred to 70% ethanol for storage in the Institute of Tropical Biology Collection of Zoology (ITBCZ), Ho Chi Minh City, Vietnam. The following morphological characters modified from David *et al.* (2008a,b, 2012), Neang *et al.* (2012), and Vassilieva (2015) were used: SVL, snout to vent length: measured from the tip of the snout to the vent; TaL, tail length: measured from the vent to the tip of the tail; TL, total length: sum of SVL and TaL; HL, head length: measured from the tip of the snout to the posterior margin of the mandible; HW, head width: measured at the widest part of the head immediately posterior to the eye; HH, head height: vertical height between upper and ventral surfaces of head measured at HW; IO, interorbital distance: shortest distance between outer margins of supraoculars; ED, eye diameter: horizontal diameter of eye; SnL, snout length: distance between the tip of the snout and anterior edge of eye; EN, eye to nostril: distance between anterior margin of eye and posterior margin of nostril; SL, supralabials: number of scales on upper lip; SL-Eye: number of SL entering orbit; InL, infralabials: number of scales on lower lip; MT, maxillary teeth: number of maxillary teeth on the right side of upper jaw; TP, temporal: number of scales immediately behind postocular between posteriormost SL and parietals; VS, ventral scales: counted from the first ventral scale which is wider than long to the vent excluding cloacal plate; DS, dorsal scale rows at neck (number of scale rows at one head length behind the head), at midbody (number of scale rows at a position corresponding to the midpoint of the ventral scale rows, VS/2), and at one head length prior to the vent; CP, cloacal plate: number of terminal ventral scales immediately anterior to vent; SC, subcaudal scales: number of subcaudal scales excluding the terminal scute; LHSC, length that the hemipenes extend in terms of numbers of subcaudal scales; HS, hemipenis shape. Values of paired characters are given in order of left and right.

Measurements (in millimeters), except for SVL and TaL, were taken with a digital caliper to the nearest 0.01 mm. Teeth were counted using a zoom stereo microscope at 7X–45X. The right hemipenis of each male was forcedly everted by injecting water before fixation.

For comparison, morphological characters of known species of *Oligodon* were taken from the literature (Boulenger 1894; Campden-Main 1970; David *et al.* 2008a,b, 2012; Leong & Grismer 2004; Neang *et al.* 2012; Pope 1935; Smith 1943; Vassilieva *et al.* 2013; Vassilieva 2015). Some characters were taken from specimens from Vietnam (Appendix 1).

Species description

Oligodon condaoensis sp. nov.

(Figs. 2 & 3)

Holotype. ITBCZ 2595, adult male, collected from Hon Ba Island, Con Dao District, Ba Ria–Vung Tau Prov., Vietnam; coordinates 8°39'03"N, 106°33'29"E; elevation 15 m a.s.l. by Sang Ngoc Nguyen on 24 October 2015.

Paratypes. ITBCZ 2596, adult male; ITBCZ 2597–8, two adult females; collected around the site of the holotype on Hon Ba Island by Sang Ngoc Nguyen on 24 and 25 October 2015.

Diagnosis. *Oligodon condaoensis* sp. nov. is distinguished from all of its congeners by a combination of the following morphological characters: (1) medium size in adults (total length up to 552 mm); (2) dorsal scale rows 17–17–15; (3) deeply forked hemipenes without papillae and spines, extending to SC 13 or 14; (4) maxillary teeth 11–13, the posterior three being enlarged; (5) cloacal plate undivided; (6) head scalation complete; (7) nasal divided; (8) presubocular absent; (9) ventrals 168–176; (10) subcaudals 33–37; (11) overall dorsal coloration dark gray, faint body stripes present or absent; (12) venter cream to dark gray without rectangular blotches.

Description of holotype. Adult male; body robust, rather elongate; SVL 461 mm; tail quite short (TL/SVL = 0.15) and robust, 70 mm in length; head short (HL/SVL = 0.04), faintly distinct from neck; eye small (ED/HH = 0.35) with round pupil, eye diameter equal to distance between eye and nostril; snout obtuse; large oval nostril piercing the upper part of nasal.

Head scalation. Rostral high 3.37 mm, wide 3.57 mm, thick and curved on to upper snout surface, well visible from above, pointed posteriorly, touching internasals, nasals, and first supralabial on each side; supralabials 8/8, the 4th and 5th bordering eye, the 7th being largest; 1/1 loreal; presubocular absent; nasal divided vertically; 1/1 preocular; 2/2 postoculars; 1+2/1+2 temporals, anterior one elongated; prefrontal large, somewhat hexagonal, wider than long; frontal large and pentagonal, slightly longer than wide; parietals larger than frontals, bordered laterally by the first and the upper second temporals and posteriorly by four small scales; 8/8 infralabials, first pair medially in contact with each other, first four InLs in contact with anterior chin shield, the 5th largest and touching posterior chin shield.

Body scalation. Dorsal scales smooth, in 17–17–15 rows; scale row reductions from 17 to 15 around the position corresponding to ventral 98th; vertebral scales similar to other dorsal scales in size and shape; ventrals 172; cloacal plate entire; subcaudals 37, all paired; terminal caudal scale forming a pointed cap.

Dentition. Maxillary teeth 13, curved posteriorly, the posterior three being enlarged (Fig. 2C); palatine and pterygoid teeth 7 and 14, respectively, slightly curved posteriorly (Fig. 2D).

Hemipenis. Hemipenis with two enlarged lobes, deeply forked at the level of 6th SC and tip of each organ reaching the SC 13th; proximal part with faint folds forming more or less hexagonal cells, these cells fainter at distal part (Fig. 2E–G).

Coloration. In life, overall dorsal coloration dark gray, including dorsal, lateral scales, and lateral sides of ventral scales. No distinct stripes or blotches. Head more or less uniform dark gray. Infralabials, lower part of supralabials, and rostral whitish. Underside of head and anterior part of body white to cream. The ventral color of body changes backwardly from cream anteriorly to dark gray dots or blotches and then to dark gray posteriorly, not forming rectangular blotches. Two white stripes along ventral-lateral part of ventral scales. Ventral surface of tail white with some gray dots. Pupil round and black. In alcohol, the pattern paler, becoming gray. Pupil white.

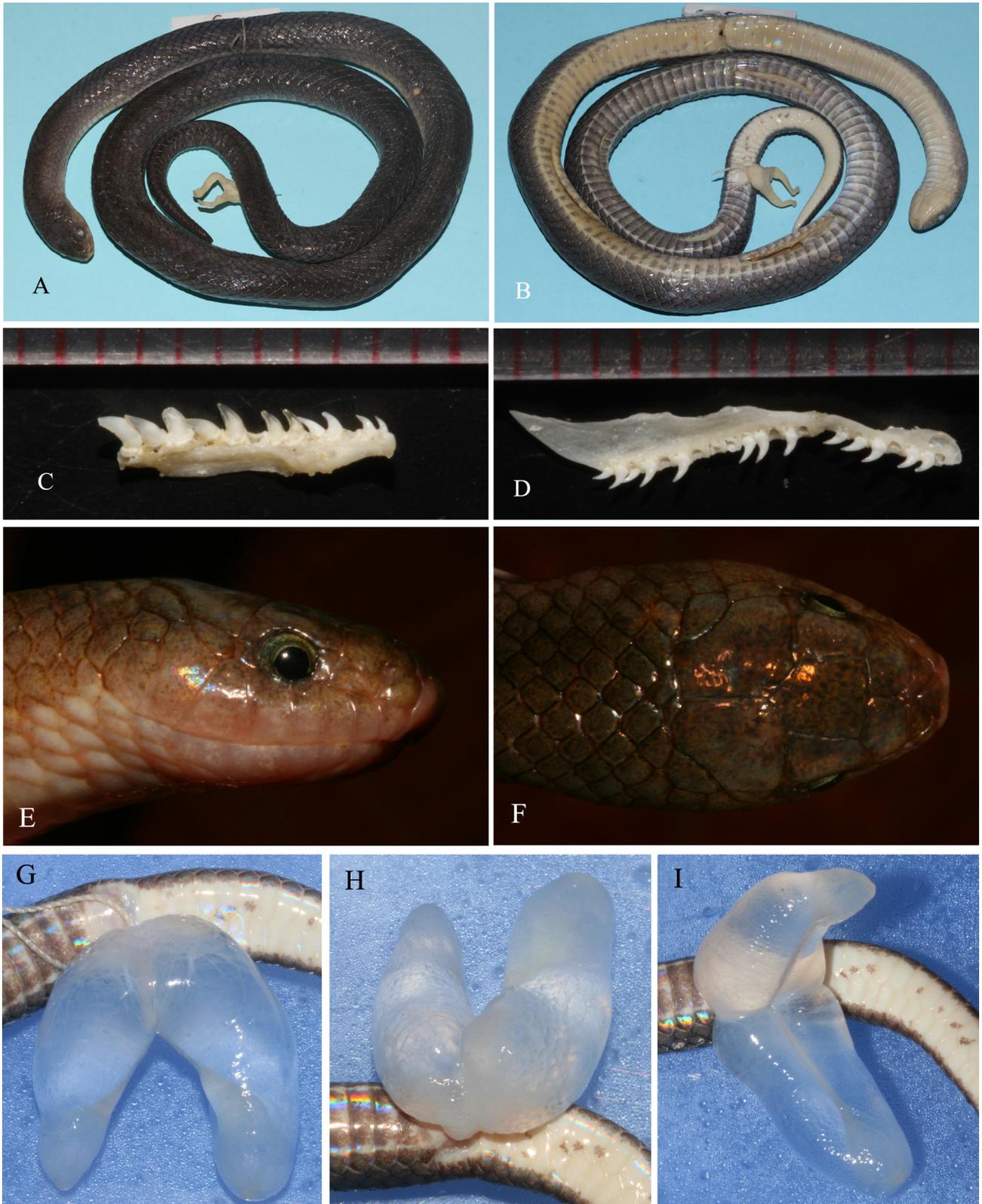


FIGURE 2. Holotype of *Oligodon condaoensis* sp. nov., ITBCZ 2595. A, dorsal view; B, ventral view; C, maxillary teeth; D, palatine and pterygoid teeth; E and F, lateral and dorsal views of head, respectively; G–I, right hemipenis showing large lobes without spines and papillae. Distance between two red consecutive bars on scale in C & D is 1 mm.

Variation. Table 1 summarizes variation in size and scalation. Head scalation complete but presubocular absent in all specimens. In the three paratypes, brighter longitudinal stripes are faint in life and in alcohol. A narrow grayish vertebral stripe extends from neck to the vent level, the width of this stripe is narrower than the

width of the vertebral scale but in the neck the stripe width expanding to about two dorsal scales; paravertebral stripes very faint; a faint but broad, grayish stripe extends up to the vent on dorsal scale rows 4–6. In general, the faint stripe pattern of the new species, if present, is as follows: lateral side of ventral scale and DS 1–3 dark gray or gray; DS 4–6 brighter; DS 7–8 dark gray or gray; and vertebral scale brighter (Fig. 3C). Paratypes ITBCZ 2597–8 with a dark oblique streak below the eye, on SL 5–6; frontal and parietals with faint blotches. Ventral pattern of paratype ITBCZ 2596 cream to white with few gray dots; paratypes ITBCZ 2597–8 similar to that of the holotype. Hemipenis of the paratype ITBCZ 2596 similar to that of the holotype. The palatine and pterygoid teeth of the paratypes ITBCZ 2596–8 are 6+12, 7+13, and 7+12, respectively. The posterior three maxillary teeth of the paratypes are also enlarged.

TABLE 1. Measurements (in mm) and scalation of the types series of *Oligodon condaoensis* sp. nov. See Material and Methods for abbreviations. Additional abbreviations are as follows: VerS: narrow and faint vertebral stripe; DorS: faint dorsal stripe.

	Holotype	Paratypes		
	ITBCZ 2595	ITBCZ 2596	ITBCZ 2597	ITBCZ 2598
Sex	Male	Male	Female	Female
SVL	461	481	401	395
TaL	70	71	58	57
TL	531	552	459	452
TaL/SVL	0.15	0.15	0.14	0.14
HL	16.53	17.16	15.53	14.87
HW	11.84	12.25	10.25	10.16
HH	8.30	8.86	6.90	7.04
IO	6.54	6.39	5.84	5.82
ED	2.87	2.87	2.62	2.61
SnL	4.68	4.70	4.32	4.01
EN	2.87	2.89	2.63	2.62
DS	17–17–15	17–17–15	17–17–15	17–17–15
VS	172	168	169	176
SC	37	37	33	34
SL	8/8	8/8	8/8	8/8
InL	8/8	8/7	8/7	8/8
SL-Eye	4–5/4–5	4–5/4–5	4–5/4–5	4–5/4–5
TP	1+2/1+2	1+2/1+2	1+2/1+2	1+2/1+2
MT	13	11	13	13
SHSC	13	14	–	–
HS	Forked	Forked	–	–
VerS	Absent	Present	Present	Present
DorS	Absent	Present	Present	Present

Natural history. All specimens were collected in the daytime, between 9:00 am and 12:00 pm. The animals were found active on the ground of evergreen forest (Fig. 3D) near by Hon Ba Forest Ranger Station. Two nights of searching in the area failed to find the snake. This infers that the new species is diurnal. Another species, *O. fasciolatus*, was recorded sympatrically with the new species.

Sexual dimorphism. The males are larger (SVL 461–481 mm vs. 395–401 mm) and darker than the females. The faint stripes on females are more visible than on the males. Tails in males are longer than in females (SC 37 vs. 33–34; TL/SVL 0.15 vs. 0.14).

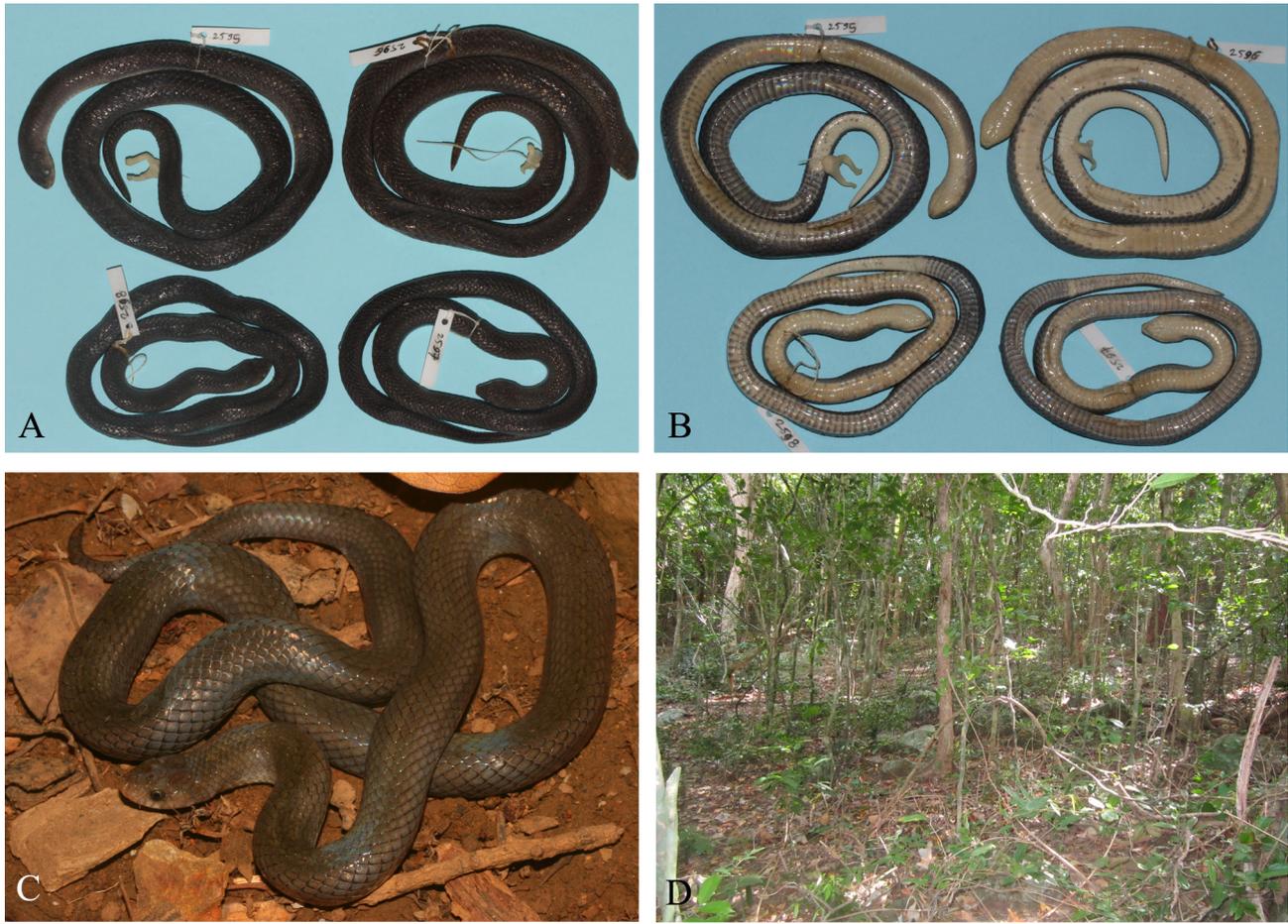


FIGURE 3. *Oligodon condaoensis* sp. nov. and its habitat. A & B, dorsal and ventral views of the type series; C, paratype ITBCZ 2597 in life, showing faint dorsal stripes; D, natural habitat on Hon Ba Islands.

Distribution. The new species is currently known only from Hon Ba Island, Con Dao District, Ba Ria–Vung Tau Prov., Vietnam.

Etymology. The specific epithet *condaoensis* is derived from Con Dao Islands, where the new species was discovered.

Comparisons. *Oligodon condaoensis* sp. nov. differs from all other congeners within the *Oligodon taeniatus* group, the *O. cinereus* group, the *O. cyclurus* group (David *et al.* 2008 a, b; Green *et al.* 2010; Neang *et al.* 2012), the *O. dorsalis* group (Smith 1943, Vassilieva 2015), and the *O. torquatus* group (Green *et al.* 2010, Smith 1943, Vassilieva 2015), and other species of the genus in Indochina by the combination of the following characters: body and head scalation, maxillary teeth, hemipenis, body size, and dorsal color pattern.

By having deeply forked hemipenis without obvious papillae, *O. condaoensis* sp. nov. differs from the *O. taeniatus* group (David *et al.* 2008b; Neang *et al.* 2012), including *O. barroni* (Smith), *O. devei* David, Vogel & Rooijen, *O. moricei* David, Vogel & Rooijen, *O. mouhoti* (Boulenger), *O. pseudotaeniatus* David, Vogel & Rooijen, and *O. taeniatus* (Günther), except for *O. moricei* in which males remain unknown (Table 2). The new species is also distinguishable from *O. barroni* by having a larger size (TL 552 mm vs. 401 mm), a higher number of ventrals (168–176 vs. 136–160), and different dorsal color pattern (gray or faint stripes vs. butterfly-like blotches on dorsum and tail); from *O. devei* by having a higher number of ventral scales (168–176 vs. 140–155), different body and head color pattern (uniform or faint vertebral stripe vs. broad and bright vertebral stripe, uniform or faint blotches vs. four or five major markings, respectively); from *O. moricei* by having a lower number of subcaudals (33–34 in females vs. 41), a lower number of infralabials (8 vs. 9), a higher number of maxillary teeth (13 in females vs. 12), and different dorsal color pattern (uniform or faint dorsal stripes vs. broad vertebral stripe, clear paravertebral and dorsolateral stripes); from *O. mouhoti* by having a bigger size (TL 552 mm vs. 339 mm), a higher number of ventrals (168–176 vs. 145–163), lower number of infralabials (8 vs. 9 or 10) and

maxillary teeth (11–13 vs. 14–16), a shorter hemipenis (extending to SC 13–14 vs. 18–19), and the absence of blotches on tail and clear marks on head (vs. presence); from *O. pseudotaeniatus* by having a bigger size (TL 552 mm vs. 320 mm), a higher number of ventrals (168–176 vs. 137–156), fewer maxillary teeth (11–13 vs. 15), and the absence of presubocular (vs. presence); from *O. taeniatus* by having a bigger size (TL 552 mm vs. 447 mm), fewer dorsal scale rows at neck and midbody (17–17–15 vs. 19–19–15), more ventrals (168–176 vs. 142–165), fewer infralabials (8 vs. 9), and the absence or faintness of body stripes (vs. presence).

TABLE 2. Morphological characters of *Oligodon condaoensis* **sp. nov.** in comparison with other *Oligodon* having hemipenis forked, the *O. taeniatus* group. For simplification, only main different characters between the new species and given species were shown. Detailed comparison was shown on Comparisons section. Data taken from David *et al.* 2008b and examined specimens. See Material and Methods for abbreviations.

Species/Characters	<i>O. condaoensis</i> sp. nov.	<i>O. baroni</i>	<i>O. deuvei</i>
TL max (mm)	552	401	
DS	17–17–15		
VS	168–176	136–160	140–155
SC in female	33–34		
InL	8(7)		
MT (13 in female)	11–13		
LHSC	13–14		
Hemipenis papillae	Absent	Present	Present
Blotches on head	Absent or faint	Present	Present
Vertebral stripe	Absent or faint	Absent	Broad
Main dorsum and tail pattern	Uniform or faint stripes	Blotches	Clear stripes

continued.

Species/Characters	<i>O. moricei</i>	<i>O. mouhoti</i>	<i>O. pseudotaeniatus</i>	<i>O. taeniatus</i>
TL max (mm)		339	320	447
DS				19–19–15
VS		145–163	137–156	142–165
SC in female	41			
InL	9	9–10		9
MT (13 in female)	12	14–16	15	14–17
LHSC		18–19		
Hemipenis papillae	?	Present	Present	Present
Blotches on head	Present	Present	Present	Present
Vertebral stripe	Broad			
Main dorsum and tail pattern	Clear stripes	Blotches (on tail)	Clear stripes	Clear stripes

Oligodon condaoensis **sp. nov.** differs from members of the *O. cinereus* group (David *et al.* 2008a, 2012; Green *et al.* 2010; Neang *et al.* 2012; Vassilieva 2015), including *O. albocinctus* (Cantor), *O. cinereus* (Günther), *O. inornatus* (Boulenger), *O. joynseni* (Smith), *O. maculatus* (Taylor), *O. melanozonatus* Wall, *O. nagao* David, Nguyen, Nguyen, Jiang, Chen, Teynie & Ziegler, *O. splendidus* (Günther), and *O. woodmasoni* (Sclater), by having a deeply forked hemipenis (vs. unforked) except for *O. melanozonatus*, in which the hemipenis is unknown. The new species also differs from *O. albocinctus* by dorsal scale rows (17–17–15 vs. 19–17[19]–15[17]), fewer ventrals and subcaudals (168–176 vs. 177–208, 33–37 vs. 40–69, respectively), more supralabials (8 vs. 7), a shorter hemipenis (extending to SC 13–14 vs. 24), dark uniform or faint body stripes (vs. cross-bars); from *O. cinereus* by having smaller size (TL 552 mm vs. 700 mm) and dorsal color pattern (dark uniform or stripes vs. cross-bars [based on *O. cinereus* from Con Dao Islands, as also mentioned by Smith 1943: 216–217 as form IV and Campden-Main 1970]); from *O. inornatus* by dorsal scale rows (17–17–15 vs. 15–15–15); from *O. joynseni* by having fewer

ventrals and subcaudals (168–176 vs. 186–197, 33–37 vs. 43–50, respectively) and dorsal color pattern (dark uniform or faint stripes vs. blotches and reticulated cross-bars); from *O. maculatus* by having more ventrals (168–176 vs. 156–164) and different dorsal color pattern (dark uniform or strips vs. dark blotches); from *O. melanozonatus* by having loreals (vs. absence), an entire cloacal plate (vs. divided), fewer subcaudals (33–37 vs. 42–45), higher numbers of supralabials, infralabials, and maxillary teeth (8, 8, and 11–13 vs. 6, 6, and 8, respectively); from *O. nagao* by having a smaller size (TL 552 mm vs. 786 mm), fewer ventrals (168–176 vs. 184–193), more maxillary teeth (11–13 vs. 9–10), and dorsal color pattern (dark uniform or stripes vs. blotches); from *O. splendidus* by having fewer scale rows at midbody (17 vs. 21), different supralabials entering the eye (SL 4–5 vs. 2–3), more infralabials (8 vs. 5), and shorter hemipenis (SC 13–14 vs. 19); from *O. woodmasoni* by having fewer ventrals (168–176 vs. 180–190) and more supralabials (8 vs. 6).

By having deeply forked hemipenis without spines, *O. condaoensis* **sp. nov.** is similar to members of the *O. cyclurus* group (David *et al.* 2008a, Green *et al.* 2010, Neang *et al.* 2012, Smith 1943, Vassilieva 2015), which includes *O. cattienensis* Vassilieva, Geissler, Galoyan, Poyarkov, Van Devender & Böhme, *O. chinensis* (Günther), *O. cyclurus* (Cantor), *O. fasciolatus* (Günther), *O. formosanus* (Günther), *O. juglandifer* (Wall), *O. kampucheaensis* Neang, Grismer & Dattray, *O. kheriensis* Acharji & Ray, *O. macrurus* (Angel), *O. ocellatus* (Morice), and *O. saintgironsi* David, Vogel & Pauwels. However, the new species can be distinguished from the following species by having 17 dorsal scale rows at midbody: *O. cyclurus* (19), *O. fasciolatus* (21), *O. formosanus* (19), *O. juglandifer* (19), *O. kampucheaensis* (15), *O. khariensis* (19), and *O. ocellatus* (19). It also differs from *O. cyclurus* by having smaller size (TL 552 mm vs. 710 mm), fewer dorsal scale rows on its neck (17 vs. 19), more maxillary teeth (11–13 vs. 9–10), arrangement of temporals (1+2 vs. 2+2), and dorsal color pattern (dark uniform or stripes vs. reticulate or narrow blotches); from *O. fasciolatus* by having smaller size (552 mm vs. 807 mm); fewer dorsal scale rows on the neck (17 vs. 21 or 23) and before the vent (15 vs. 17), more maxillary teeth (11–13 vs. 8–10), arrangement of temporals (1+2 vs. 2+2), and dorsal color pattern (dark uniform or stripes vs. reticulate or large blotches); from *O. formosanus* by having a smaller size (552 mm vs. 942 mm), fewer dorsal scale rows on the neck (17 vs. 19), fewer subcaudals (33–37 vs. 43–55) and infralabials (8 vs. 9), dorsal color pattern (dark uniform or stripes vs. reticulate) and hemipenis shape (no papillae vs. short papillae); from *O. juglandifer* by having fewer dorsal scale rows on the neck (17 vs. 19), fewer subcaudals (33–37 vs. 53–68), more supralabials (8 vs. 7), and dorsal color pattern (dark uniform or stripes vs. dark dots and cross-bars); from *O. kampucheaensis* by having more dorsal scale rows on the neck (17 vs. 15), fewer subcaudals (33–37 vs. 39), and dorsal color pattern (dark uniform or stripes vs. cross-bars); from *O. khariensis* by having fewer dorsal scale rows on the neck (17 vs. 19), fewer ventrals (168–176 vs. 196), and more maxillary teeth (11–13 vs. 8); and from *O. ocellatus* by having smaller size (552 mm vs. 852 mm), fewer dorsal scale rows on the neck (17 vs. 19), fewer infralabials (8 vs. 9 or 10), arrangement of temporals (1+2 vs. 2+2), and dorsal color pattern (dark uniform or stripes vs. reticulate or large blotches). *Oligodon condaoensis* **sp. nov.** differs from *O. cattienensis* by having more maxillary teeth (11–13 vs. 8–10), nasal (divided vs. entire), and dorsal color pattern (dark uniform or faint stripes vs. large blotches); from *O. chinensis* by having a smaller size (552 mm vs. 729 mm), more maxillary teeth (11–13 vs. 9–10), fewer subcaudals (33–37 vs. 47–64), and dorsal color pattern (dark uniform or faint stripes vs. black cross-bars); from *O. macrurus* by having more ventrals (168–176 vs. 143–152), fewer subcaudals (33–37 vs. 76–83), and much shorter hemipenis (SC 13–14 vs. 29); and from *O. saintgironsi* by having a smaller size (552 mm vs. 676 mm), fewer dorsal scale rows on the neck (17 vs. 19), fewer subcaudals (33–37 vs. 53–59), much shorter hemipenis (SC 13–14 vs. 27–28), and dorsal color pattern (dark uniform or faint stripes vs. reticulate or large blotches). Table 3 compares the new species and other members of the *O. cyclurus* group.

For members of the *O. dorsalis* group (Smith 1943, Vassilieva 2015), which includes *O. catenatus* (Blyth), *O. dorsalis* (Gray & Hardwicke), *O. eberhardti* Pellegrin, *O. erythrogaster* Boulenger, *O. hamptoni* Boulenger, *O. lacroixi* Angel & Bourret, and *O. macdougalli* Wall, *O. condaoensis* **sp. nov.** differs from *O. catenatus*, *O. dorsalis*, *O. eberhardti*, *O. erythrogaster*, and *O. hamptoni*, by having deeply a forked hemipenis (vs. unforked or slightly forked) and an entire cloacal plate (vs. divided). It also differs from *O. catenatus* by having more dorsal scale rows at midbody (17 vs. 13), more maxillary teeth (11–13 vs. 7), and fewer ventrals (168–176 vs. 186–208); from *O. dorsalis* by having more dorsal scale rows at midbody (17 vs. 15) and more maxillary teeth (11–13 vs. 6–7); from *O. eberhardti* by having more dorsal scale rows (17–17–15 vs. 13–13–13), more supralabials (8 vs. 6), and fewer ventrals (168–176 vs. 189–190); from *O. erythrogaster* by having more maxillary teeth (11–13 vs. 7–8) and fewer subcaudals (33–37 vs. 42–59); and from *O. hamptoni* by having more scale rows at midbody (17 vs. 15), and more

maxillary teeth (11–13 vs. 7) and more sublabials (8 vs. 5). The new species differs from *O. lacroixi* by having an entire cloacal plate (vs. divided), more scale rows at midbody (17 vs. 15), more supralabials (8 vs. 5), the presence of two internasals (vs. absent) and loreals (vs. absent); and from *O. macdougalli* by having an entire cloacal plate (vs. divided), the presence of loreals (vs. absent), more dorsal scale rows at midbody (17 vs. 13), fewer ventrals (168–176 vs. 200), and more supralabials (8 vs. 7).

TABLE 3. Morphological characters of *Oligodon condaoensis* **sp. nov.** in comparison with other *Oligodon* having hemipenis forked, the *O. cyclurus* group. For simplification, only main different characters between the new species and given species were shown. Detailed comparison was shown on Comparisons section. Data taken from Campden-Main 1969; David *et al.* 2008a, Neang *et al.* 2012; Pope 1935; Smith 1943; Vassilieva *et al.* 2013; and examined specimens. See Material and Methods for abbreviations; VerS, vertebral stripe; DorP, dorsal pattern; Div, divided; Ent, entire.

Oligodon	TL max	DS	VS	SC	Nasal	MT	TP
<i>condaoensis</i> sp. nov.	552	17–17–15	168–176	33–37	Div	11–13	1+2
<i>cattienensis</i>					Ent	8–10	
<i>chinensis</i>	729			47–64		9–10	
<i>cyclurus</i>	710	19–19–15				9–10	2+2
<i>fasciolatus</i>	807	21(23)–21–17				8–10	2+2
<i>formosanus</i>	942	19–19(17)–15		43–55			
<i>juglandifer</i>		19–19–15		53–68			
<i>kampucheaensis</i>	428	15–15–15		39			
<i>kheriensis</i>		19–19–15	196	38–43		8	
<i>macrurus</i>	480		143–152	76–83			
<i>ocellatus</i>	852	19–19–13					2+2
<i>saintgiroinsi</i>	676	19–17,18–15		53–59			2+3

continued.

Oligodon	SHSC	Papillae	VerS	DorP
<i>condaoensis</i> sp. nov.	13–14	Absent	Absent or faint	Uniform or stripes
<i>cattienensis</i>			Absent	Blotches
<i>chinensis</i>			Absent	Blotches
<i>cyclurus</i>			Absent	Reticulate or blotches
<i>fasciolatus</i>			Absent	Reticulate or blotches
<i>formosanus</i>		Present	Broad	Reticulate
<i>juglandifer</i>			Absent	Blotches
<i>kampucheaensis</i>			Absent	Crossbars
<i>kheriensis</i>			Absent	Uniform
<i>macrurus</i>	29		Absent	Reticulate
<i>ocellatus</i>			Absent	Reticulate or blotches
<i>saintgiroinsi</i>	27–28		Narrow	Blotches

Oligodon condaoensis **sp. nov.** differs from members of the *O. torquatus* group (Green *et al.* 2010, Smith 1943, Vassilieva 2015), which includes *O. cruentatus* (Günther), *O. planiceps* (Boulenger), *O. theobaldi* (Günther), and *O. torquatus* (Boulenger), by having a deeply forked hemipenis (vs. unforked) without papillae (vs. presence) and an entire cloacal plate (vs. divided). It also differs from *O. cruentatus* by lacking spines on hemipenis (vs. presence) and having fewer maxillary teeth (11–13 vs. 14–16); from *O. planiceps* by lacking spines on hemipenis (vs. presence), more dorsal scale rows at midbody (17 vs. 13), more ventrals (168–176 vs. 132–145), more subcaudals (33–37 vs. 22–27), and more supralabials (8 vs. 4 or 5); from *O. theobaldi* by lacking spines on hemipenis (vs. presence) and having fewer maxillary teeth (11–13 vs. 15–16); and from *O. torquatus* by having

more dorsal scale rows at midbody (17 vs. 15) and more ventrals (168–176 vs. 144–159), and fewer maxillary teeth (11–13 vs. 15–16).

Oligodon condaoensis **sp. nov.** differs from other congeners in Indochina (Vietnam, Laos, Cambodia, Thailand, Myanmar, Malaysian Peninsular, and southern China [Yunnan]) as follows: from *O. annamensis* Leviton by having more dorsal scale rows (17–17–15 vs. 13–13–13), more supralabials (8 vs. 6), more infralabials (8 vs. 6), and more maxillary teeth (11–13 vs. 8), and by dorsal color pattern (dark uniform or faint stripes vs. cross-bars); from *O. arenarius* Vassilieva by having deeply forked hemipenis (vs. unforked), a larger size (552 mm vs. 389 mm), more maxillary teeth (11–13 vs. 6–8), and more ventrals (168–176 vs. 131–144); from *O. booliati* Leong & Grismer by having more supralabials (8 vs. 6 or 7), more ventrals (168–176 vs. 143–153), fewer subcaudals (33–37 vs. 54–60), and different dorsal color pattern (dark uniform or faint stripes vs. cross-bars); from *O. jintakunei* Pauwels, Wallach, David & Chanhme by having more dorsal scale rows at midbody (17 vs. 15), fewer ventrals (168–176 vs. 189), entire cloacal plate (vs. divided), and dorsal pattern (dark uniform or faint stripes vs. cross-bars) (see from Vassilieva 2015); from *O. octolineatus* (Schneider) by having a smaller size (552 mm vs. 780 mm), more supralabials (8 vs. 6), the 4th and 5th supralabials entering the eye (vs. SL 3rd and 4th), fewer subcaudals (33–37 vs. 43–61), and different dorsal color pattern (dark uniform or faint stripes vs. clear and broad stripes); from *O. purpurascens* (Schlegel) by lacking of presubocular (vs. 1–2 presuboculars), having fewer dorsal scale rows at midbody (17 vs. 19 or 21) and fewer subcaudals (33–37 vs. 40–60), fewer temporals (1+2 vs. 2+3 or 2+2), a smaller size (TL 552 mm vs. 790 mm), and different dorsal color pattern (dark uniform or faint stripes vs. cross-bars); and from *O. vertebralis* Günther by having more supralabials (8 vs. 7) and the SL 4th and 5th entering the eye (vs. SL 3rd and 4th), more dorsal scale rows at midbody (17 vs. 15), and an entire cloacal plate (vs. divided).

Discussion

Among 21 species of *Oligodon* recorded from Vietnam (Uetz & Hosek 2015, Vassilieva 2015), six were discovered in last decade (David *et al.* 2008a, b, 2012; Vassilieva *et al.* 2013; Vassilieva 2015). This suggests that the diversity in *Oligodon* remains underestimated. The description of *O. condaoensis* **sp. nov.** increases the number of species of *Oligodon* from Vietnam to 22 species, much more diverse than those in other countries in the Indochina region. Based on the morphology of hemipenis, the new species should be a member of the *O. cyclurus* group.

Many authors (for example, Campden-Main 1970; Darevsky 1999; Honda *et al.* 2001; Nguyen *et al.* 2009; Smith 1921, 1943; Strauch 1887) have mentioned the herpetofauna of Con Dao Islands and a total of 29 of terrestrial reptiles and amphibians have been recorded as noted above. However, it seems that more species remain to be discovered. Including *Oligodon condaoensis* **sp. nov.**, we report 43 species including 13 amphibians and 30 terrestrial reptiles (Appendix 2).

Acknowledgement

We would like to thank M.Sc. Tran Dinh Hue, Vice-director of Con Dao National Park, for his permission and arrangement to work there. We wish to thank brothers in Ong Dung, Ben Dam, Co Ong, Hon Cau, Bay Canh, Hon Tai, Hon Ba, Tre Lon, and Tre Nho Forest Ranger Stations for their help in the field. This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 106-NN.05-2015.08 and Nagao Natural Environment Foundation.

References

- Boulenger, G.A. (1894) *Catalogue of the snakes in the British Museum. Vol. 2. Colubridae Aglyphae*. The Trustees, London, 382 pp + 20 pls.
- Campden-Main, S.M. (1970) *A field guide to the snakes of South Vietnam*. Smithsonian Institution, Washington, 114 pp.
- David, P., Vogel, G. & Pauwels, O.S.G. (2008a) A new species of the genus *Oligodon* Fitzinger, 1826 (Squamata: Colubridae) from southern Vietnam and Cambodia. *Zootaxa*, 1939, 19–37.
- David, P., Vogel, G. & Rooijen, J.V. (2008b) A revision of the *Oligodon taeniatus* (Günther, 1861) group (Squamata:

- Colubridae), with the description of three new species from the Indochinese region. *Zootaxa*, 1965, 1–49.
- David, P., Nguyen, T.Q., Nguyen, T.T., Jiang, K., Chen, T., Teynie, A. & Ziegler, T. (2012) A new species of the genus *Oligodon* Fitzinger, 1826 (Squamata: Colubridae) from northern Vietnam, southern China and central Laos. *Zootaxa*, 3498, 45–62.
- Darevsky, I.S. (1999) The herpetofauna of some offshore islands of Vietnam, as related to that of the adjacent mainland. In: Ota, H. (Ed.) *Tropical Island Herpetofauna: Origin, Current Diversity, and Conservation*. Elsevier, Amsterdam, pp. 27–42.
- Fitzinger, L.I. (1826) *Neue Classification der Reptilien nach ihren Natürlichen Verwandtschaften. Nebst einer Verwandtschafts-Tafel und einem Verzeichnisse der Reptilien-Sammlung des K. K. Zoologischen Museum's zu Wien*. J. G. Heubner, Wien, Vii + 66 pp.
- Green, M.D., Orlov, N.L. & Murphy, R.W. (2010) Toward a phylogeny of the kukri snakes, genus *Oligodon*. *Asian Herpetological Research*, 1, 1–21.
- Honda, M., Ota, H., Hikida, T. & Darevsky, I.S. (2001) A new species of the worm-like lizard, *Dibamus* Dumeril & Bibron 1839 (Squamata: Scincidae), from Vietnam. *Tropical Zoology*, 14, 119–125.
<http://dx.doi.org/10.1080/03946975.2001.10531146>
- Le, T. (2004) *Geography of provinces and cities in Vietnam. Vol. 5. Provinces and cities in south Central and southeast*. Giao Duc, Ho Chi Minh, 416 pp. [in Vietnamese]
- Leong, T.M. & Grismer, L.L. (2004) A new species of kukri snake, *Oligodon* (Colubridae) from Pulau Tioman, West Malaysia. *Asiatic Herpetological Research*, 10, 12–16.
- Neang, T., Grismer, L.L. & Daltry, J.C. (2012) A new species of kukri snake (Colubridae: *Oligodon* Fitzinger, 1826) from the Phnom Samkos Wildlife Sanctuary, Cardamom Mountains, southwest Cambodia. *Zootaxa*, 3388, 41–55.
- Nguyen, S.V., Ho, C.T. & Nguyen, T.Q. (2009) *Herpetofauna of Vietnam*. Edition Chimaira, Frankfurt am Main, 768 pp.
- Pope, C.H. (1935) *The Reptiles of China*. The American Museum of Natural History, New York, 604 pp.
- Smith, M.A. (1921) Reptiles and batrachians collected on Pulo Condore. *Journal of the Natural History Society of Siam*, 4, 93–97.
- Smith, M.A. (1943) *The Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese subregion. Reptiles and Amphibians. Vol. III. Serpentes*. Taylor and Francis Ltd, London, 525 pp.
- Strauch, A. (1887) Bemerkungen über die Geckoniden-Sammlung im zoologischen Museum der Kaiserlichen Akademie der Wissenschaften zu St.-Petersburg. *Memoires de L'Academie Imperiale des Sciences de St.-Petersbourg*, Serie VII, 35, 1–72.
- Vassilieva, A.B. (2015) A new species of the genus *Oligodon* Fitzinger, 1826 (Squamata: Colubridae) from coastal southern Vietnam. *Zootaxa*, 4058 (2), 211–226.
<http://dx.doi.org/10.11646/zootaxa.4058.2.4>
- Vassilieva, A.B., Geissler, P., Galoyan, E.A., Poyarkov, N.A., van Devender, R.W. & Bohme, W. (2013) A new species of kukri snake (*Oligodon* Fitzinger, 1826; Squamata: Colubridae) from the Cat Tien National Park, southern Vietnam. *Zootaxa*, 3702 (3), 233–246.
<http://dx.doi.org/10.11646/zootaxa.3702.3.2>
- Uetz, P. & Hosek, L. (Eds.) (2015) The Reptile Database. Available from: <http://www.reptile-database.org/> (accessed 3 March 2016)

APPENDIX 1. Specimens examined.

- Abbreviations: ITBCZ, Institute of Tropical Biology Collection of Zoology, Vietnam; ROM, Royal Ontario Museum, Canada.
- Oligodon barroni*: 1 specimen, ROM 32464 (Krong Pa, Gia Lai Prov., Vietnam).
- Oligodon chinensis*: 3 specimens, ROM 34540 (Chi Linh, Hai Duong Prov., Vietnam), ROM 35626 (Quang Thanh, Cao Bang Prov., Vietnam), and ROM 31032 (Tam Dao, Vinh Phuc Prov., Vietnam).
- Oligodon cinereus*: 1 specimen (in zoological collection at Con Dao National Park; Con Son, Con Dao, Ba Ria—Vung Tau Prov., Vietnam).
- Oligodon fasciolatus*: 7 specimens, ITBCZ 269 & 336 (Hon Chong, Kien Giang Prov., Vietnam), ITBCZ 2623 (Con Son, Con Dao, Ba Ria—Vung Tau Prov., Vietnam), ITBCZ 2860 (Hon Ba, Con Dao, Ba Ria—Vung Tau Prov., Vietnam), and three specimens in zoological collection at Con Dao National Park (Con Son, Con Dao, Ba Ria—Vung Tau Prov., Vietnam).
- Oligodon formosanus*: 4 specimens, ROM 35806 (Chi Linh, Hai Duong Prov., Vietnam), ROM 35629–30 (Quang Thanh, Cao Bang Prov., Vietnam), and ROM 30939 (Ba Be, Cao Bang Prov., Vietnam).
- Oligodon ocellatus*: 1 specimen, ROM 32261 (Yor Don, Dac Lac Prov., Vietnam).
- Oligodon taeniatus*: 1 specimen, ITBCZ 1227 (Ta Kou Nature Reserve, Binh Thuan Prov., Vietnam).
- Oligodon* sp.: 1 juvenile specimen, ITBCZ 904 (Nui Chua National Park, Ninh Thuan Prov., Vietnam).

APPENDIX 2. List of amphibians and terrestrial reptiles recorded from Con Dao Islands.

Four herpetological field trips in 2015 and 2016 were conducted on seven main islands of Con Dao, including 1, Tre Nho; 2, Tre Lon; 3, Hon Ba; 4, Con Son; 5, Hon Tai; 6, Bay Canh; and 7, Hon Cau. (Fig. 1). A total of 13 amphibians and 30 terrestrial reptiles were recorded from the area as follows:

	Species name	Recorded locality						
		1	2	3	4	5	6	7
Class AMPHIBIA								
Family Bufonidae								
1	<i>Duttaphrynus melanostictus</i> (Schneider)				✓			
Family Microhylidae								
2	<i>Kaloula pulchra</i> Gray				✓			
3	<i>Microhyla berdmorei</i> (Blyth)				✓			
4	<i>Microhyla</i> cf. <i>mukhlesuri</i> Hasan, Islam, Kuramoto, Kurabayashi & Sumida				✓			
5	<i>Microhyla heymonsi</i> Vogt				✓		✓	
Family Dicroglossinae								
6	<i>Fejervarya cancrivora</i> (Gravenhorst)			✓				
7	<i>Fejervarya limnocharis</i> (Gravenhorst)				✓			
8	<i>Hoplobatrachus rugulosus</i> (Wiegmann)				✓			
9	<i>Occidozyga martensii</i> (Peters)				✓			
Family Ranidae								
10	<i>Hylarana erythraea</i> (Schlegel)				✓			
Family Rhacophoridae								
11	<i>Polypedates leucomystax</i> (Gravenhorst)			✓	✓			✓
12	<i>Theلودerma vietnamense</i> Poyarkov, Orlov, Moiseeva, Pawangkhanant, Ruangsuwan, Vassilieva, Galoyan, Nguyen & Gogleva			✓	✓			
Family Ichthyophiidae								
13	<i>Ichthyophis bannanicus</i> Yang				✓			
Class REPTILIA								
Family Agamidae								
14	<i>Calotes versicolor</i> (Daudin)		✓	✓	✓	✓	✓	✓
15	<i>Draco maculatus</i> (Gray)				✓			
16	<i>Leiopeltis</i> cf. <i>guttata</i> Cuvier (*)				✓			
Family Gekkonidae								
17	<i>Cnemaspis boulengerii</i> Strauch	✓		✓	✓	✓	✓	✓
18	<i>Cyrtodactylus condorensis</i> (Smith)	✓	✓	✓	✓	✓		✓
19	<i>Gehyra mutilata</i> (Weigmann)	✓		✓	✓	✓	✓	✓
20	<i>Gekko gecko</i> (Linnaeus)		✓		✓		✓	✓
21	<i>Hemidactylus frenatus</i> Duméril & Bibron		✓	✓	✓		✓	
22	<i>Hemidactylus platyurus</i> (Schneider)				✓			

.....continued on the next page

APPENDIX 2. (Continued)

Species name	Recorded locality						
	1	2	3	4	5	6	7
Family Dibamidae							
23	<i>Dibamus kondaoensis</i> Honda, Ota, Hikida & Darevsky			✓			
Family Scincidae							
24	<i>Dasia olivacea</i> Gray			✓			
25	<i>Eutropis multifasciata</i> (Kuhl)			✓		✓	✓
26	<i>Lipinia vittigera</i> (Boulenger)			✓			
27	<i>Lygosoma bowringii</i> (Günther)			✓			
28	<i>Scincella</i> cf. <i>melanosticta</i> (Boulenger)					✓	
Family Varanidae							
29	<i>Varanus nebulosus</i> (Gray)			✓	✓	✓	✓
Family Typhlopidae							
30	<i>Argyrophis diardii</i> (Schlegel)						✓
31	<i>Indotyphlops braminus</i> (Daudin)			✓			
Family Cylindrophiiidae							
32	<i>Cylindrophis jodiae</i> Amarasinghe, Ineich, Campbell & Hallermann			✓			
Family Xenopeltidae							
33	<i>Xenopeltis unicolor</i> Reinwardt					✓	
Family Colubridae							
34	<i>Ahaetulla prasina</i> (Boie)			✓	✓		
35	<i>Boiga cyanea</i> (Duméril, Bibron & Duméril)			✓			✓
36	<i>Chrysopelea ornata</i> (Shaw)			✓	✓		✓
37	<i>Dryocalamus davisonii</i> (Blanford)				✓	✓	
38	<i>Lycodon capucinus</i> (Boie)				✓		✓
39	<i>Oligodon condaoensis</i> Nguyen, Nguyen, Le & Murphy				✓		
40	<i>Oligodon cinereus</i> (Günther)				✓		
41	<i>Oligodon fasciolatus</i> (Günther)				✓	✓	
42	<i>Pareas margaritophorus</i> (Jan)				✓		
43	<i>Xenochrophis flavipunctatus</i> (Hallowell)				✓		

(*) Probably introduced from mainland; this species has been bred on the islands and it is possible some specimens escaped. Individuals and burrows were observed in nature.