

A new species of karst-associated kukri snake (Reptilia: Squamata: Colubridae: *Oligodon* Fitzinger, 1826) from southern Thailand

Parinya Pawangkhanant, Nikolay A. Poyarkov, Harry Ward-Smith, Rupert Grassby-Lewis, Montri Sumontha, Nikita S. Kliukin, Sabira S. Idiitullina, Alexei V. Trofimets, Chatmongkon Suwannapoom, Justin L. Lee

Table S1. List of sequences and corresponding voucher specimens of *Oligodon* and outgroup taxa used in this study. Numbers (column one) included in this table do not match those in other tables or figures in the text. Acronyms not described in materials and methods include ISS, field tags of Sabira S. Idiitullina; NAP, field tags of Nikolay A. Poyarkov; RAP, field tags of R. Alexander Pyron; RS, field tags of Ruchira Somaweera; NP, national park; NR, nature reserve; WP, wildlife park; WS, wildlife sanctuary. Explanations for other acronyms are unknown.

No.	Sample ID	GenBank Accession Nos.	Species/OTU	Country	Locality	Reference
1	CHS850	MK194265; MK201568; MK065694	<i>Oligodon albocinctus</i>	China	Yunnan Prov., Gongshan	Li et al. (2020)
2	CHS892	MK065720; MK194292; MK201586	<i>Oligodon albocinctus</i>	China	Xizang (Tibet), Motuo, Linzhi	Li et al. (2020)
3	MZMU1302	OP060994	<i>Oligodon albocinctus</i>	India	Mizoram	Malsawmdawngliana et al. (unpublished)
4	ZMMU Re-14304	MN395601; MN396762	<i>Oligodon annamensis</i>	Vietnam	Dak Lak Prov., Chu Yang Sin NP	Nguyen et al. (2020)
5	CESS 563	OQ099837	<i>Oligodon arnensis</i>	India	Karnataka, Bangalore	Lee et al. (2023)
6	RAP 483	KC347327; KC347365; KC347464	<i>Oligodon arnensis albiventer</i>	Sri Lanka	Southern Prov., Hambantota Distr.	Pyron et al. (2013)
7	ROM32464	HM591523	<i>Oligodon barroni</i>	Vietnam	Gia Lai Prov., Krong Pa	Green et al. (2010)
8	SYNU 1907027	MW489824	<i>Oligodon bivirgatus</i>	China	Hainan, Shangxi NR	Qian et al. (2021)
9	RS-OC	KC347328; KC347366	<i>Oligodon calamarius</i>	Sri Lanka	Kandy Dist.	Pyron et al. (2013)
10	CHS 703	MK194159; MK201481	<i>Oligodon cf. catenatus</i>	China	Guangdong Prov., Heishiding	Li et al. (2020)
11	ROM 35626	HM591526	<i>Oligodon chinensis</i>	Vietnam	Cao Bang Prov., Quang Thanh	Green et al. (2010)
12	NCBS NRC-AA-019	MZ675817	<i>Oligodon churahensis</i>	India	Himachal Pradesh, Chamba Distr.	Mirza et al. (2021)
13	CBC02891	OP752585	<i>Oligodon cinereus</i> clade 1	Cambodia	Kampong Speu Prov., Kirirom NP (7)	Yushchenko et al. (2023a)
14	ROM37092	HM591504	<i>Oligodon cinereus</i> clade 1	Vietnam	Dong Nai Prov., Cat Tien NP (5)	Green et al. (2010)
15	ZMMU Re-13443	OP752589, OP752604	<i>Oligodon cinereus</i> clade 1	Vietnam	Binh Phuok Prov., Bu Gia Map NP (6)	Yushchenko et al. (2023a)
16	ZMMU Re-13866	OP752579, OP752594	<i>Oligodon cinereus</i> clade 1	Vietnam	Dong Nai Prov., Cat Tien NP (5)	Yushchenko et al. (2023a)
17	CAS215261	HM591508	<i>Oligodon cinereus</i> clade 2	Myanmar	Shan St., Kalaw (8)	Green et al. (2010)

No.	Sample ID	GenBank Accession Nos.	Species/OTU	Country	Locality	Reference
18	CAS210159	HM591505	<i>Oligodon cinereus</i> clade 2	Myanmar	Sagaing Div.; Alaungdaw Kathapa NP (9)	Green et al. (2010)
19	CHS190	MK193970; MK201321; MK065403	<i>Oligodon cinereus</i> clade 3	China	Hainan Isl. (18)	Li et al. (2020)
20	KIZ09105	MW172834; MW165436	<i>Oligodon cinereus</i> clade 3	China	—	Xu et al. (2021)
21	ROM32462	HM591501	<i>Oligodon cinereus</i> clade 2	Vietnam	Hai Duong Prov., Chi Linh (10)	Green et al. (2010)
22	ROM29552	HM591502	<i>Oligodon cinereus</i> clade 2	Vietnam	Vinh Phuc Prov., Tam Dao NP (11)	Green et al. (2010)
23	ROM30969	HM591503	<i>Oligodon cinereus</i> clade 2	Vietnam	Nghe An Prov., Pu Mat NP (12)	Green et al. (2010)
24	CAS205028	HM591507	<i>Oligodon cinereus</i> clade 4	Myanmar	Rakhine St., Rakhine Yoma Mts. (4)	Green et al. (2010)
25	CAS213271	HM591517	<i>Oligodon cruentatus</i>	Myanmar	Yangon Div., Hlaw Ga NP	Green et al. (2010)
26	CAS204963	HM591535	<i>Oligodon cyclurus</i>	Myanmar	Ayeyarwady Reg., Mwe Hauk	Green et al. (2010)
27	ZMMU R-13364	MN395603; MN396764	<i>Oligodon eberhardti</i>	Vietnam	Phu Tho Prov., Xuan Son NP	Nguyen et al. (2020)
28	CHS668	MK194135; MK201461; MK065563	<i>Oligodon fasciolatus</i>	China	Yunnan Prov.	Li et al. (2020)
29	ROM35629	HM591533	<i>Oligodon formosanus</i>	Vietnam	Cao Bang Prov., Quang Thanh	Green et al. (2010)
30	ZMMU Re-16489	PP505901, PP512966	<i>Oligodon huahin</i>	Thailand	Phetchaburi, Kaeng Krachan NP (16)	This paper
31	AUP SP116	PP505902, PP512964	<i>Oligodon huahin</i>	Thailand	Ratchaburi, Suan Phueng (17)	This paper
32	AUP SP025	PP505903, PP512965	<i>Oligodon huahin</i>	Thailand	Ratchaburi, Suan Phueng (17)	This paper
33	CBC01701	OP752587, OP752602	<i>Oligodon inornatus</i>	Cambodia	Pursat Prov., Samkos WS (26)	Yushchenko et al. (2023a)
34	ZMMU Re-16480	OP752588, OP752603	<i>Oligodon joynsoni</i>	Thailand	Chiang Rai Prov., Doi Tung (22)	Yushchenko et al. (2023a)
35	KIZ09128	MW090142; MW133299	<i>Oligodon joynsoni</i>	China	Yunnan Prov., Xishuanhbanna NP (23)	Xu et al. (2021)
36	OK-1	MN418885	<i>Oligodon kheriensis</i>	India	—	Nath et al. (unpublished)
37	CHS304	MK194038; MK201386; MK065470	<i>Oligodon lacroixi</i>	China	Yunnan Prov.	Li et al. (2020)
38	KIZ011002	MW090139; MW133296	<i>Oligodon lipipengi</i>	China	Tibet, Medog	Che et al. (2020)
39	ZMMU Re-14503	OP752566; OP752577	<i>Oligodon macrurus</i> 'arenarius'	Vietnam	Ba Ria-Vung Tau Prov., Binh Chau-Phuoc Buu NR	Yushchenko et al. (2023a)
40	ZMMU Re-11561	OP752565; OP752576	<i>Oligodon macrurus</i> 'macrurus'	Vietnam	Ninh Thuan Prov., Nui Chua NP	Yushchenko et al. (2023a)
41	TNHC59846	HM591511	<i>Oligodon maculatus</i>	Philippines	Mindanao, Barangay Baracatan	Green et al. (2010)
42	WII-ADR980	ON262767, ON241309	<i>Oligodon melaneus</i>	India	Assam, Barendgabri	Das et al. (2022)
43	KIZ014591	MW090140; MW133297	<i>Oligodon nagao</i>	China	Guangxi Prov., Nonggang NR (19)	Xu et al. (2021)
44	ROM32261	HM591534	<i>Oligodon ocellatus</i>	Vietnam	Dak Lak Prov., Yok Don NP	Green et al. (2010)
45	UMMZ201913	HM591519	<i>Oligodon octolineatus</i>	Brunei	Tutong Distr., 3 km E of Tutong	Green et al. (2010)
46	CHS683	MK194147; MK065575	<i>Oligodon ornatus</i>	China	Jiangxi Prov., Jinggangshan	Li et al. (2020)

No.	Sample ID	GenBank Accession Nos.	Species/OTU	Country	Locality	Reference
47	PSUZYC R732	PP505899, PP512962	<i>Oligodon phangan</i>	Thailand	Surat Thani Prov., Ko Pha Ngan Isl. (15)	This paper
48	PSUZYC R733	PP505900, PP512957	<i>Oligodon phangan</i>	Thailand	Surat Thani Prov., Ko Pha Ngan Isl. (15)	This paper
49	CAS213379	HM591506	<i>Oligodon cf. phangan</i>	Myanmar	Yangon Div.; Mingalardon, Hlawga WP (13)	Green et al. (2010)
50	AUP TS2605	PP505898, PP512963	<i>Oligodon cf. phangan</i>	Thailand	Krabi Prov., Ko Phi Phi Don Isl. (14)	This paper
51	CAS213822	HM591514	<i>Oligodon planiceps</i>	Myanmar	Magwe Div., Shwe Set Taw WS	Green et al. (2010)
52	QSMI 1508	PP505904, PP512958	<i>Oligodon promsombuti</i>	Thailand	Suratthani Prov.; Khao Phanom Wang (24)	This paper
53	SIEZC 20201	MN395604; MN396765	<i>Oligodon rostralis</i>	Vietnam	Lam Dong Prov., Bidoup–Nui Ba NP	Nguyen et al. (2020)
54	CUHC 7904	OQ092426; OQ116817	<i>Oligodon russelii</i>	Pakistan	Punjab Prov., Kallar Kahar	Lee et al. (2023)
55	QSMI 1506	PP505897, PP512961	<i>Oligodon saiyok</i>	Thailand	Kanchanaburi Prov., Sai Yok Distr. (3)	This paper
56	KIZ YPX16834	MW199837; MW199094	<i>Oligodon</i> sp.	China	—	Li et al. (2020)
57	ZMMU Re-17697	PP505895, PP512959	<i>Oligodon speleoserpens</i> sp. nov.	Thailand	Trang Prov., Tham Khao Ting Cave (1)	This paper
58	ZMMU Re-17696	PP505896, PP512960	<i>Oligodon speleoserpens</i> sp. nov.	Thailand	Satun Prov., Tham Le Stegodon Cave (1)	This paper
59	CAS204855	HM591509	<i>Oligodon splendidus</i>	Myanmar	Mandalay Reg., Kyauk Se	Green et al. (2010)
60	RAP 504	KC347329; KC347367	<i>Oligodon sublineatus</i>	Sri Lanka	Kandy Dist.	Pyron et al. (2013)
61	ROM32260	HM591521	<i>Oligodon taeniatus</i>	Vietnam	Dak Lak Prov., Yok Don NP	Green et al. (2010)
62	CESS 180	OQ099836	<i>Oligodon taeniolatus</i>	India	Kerala, Paramikulam	Lee et al. (2023)
63	RS 136	KC347330; KC347368	<i>Oligodon taeniolatus ceylonicus</i>	Sri Lanka	Polonnaruwa Dist.	Pyron et al. (2013)
64	CAS213896	HM591516	<i>Oligodon theobaldi</i>	Myanmar	Magwe Div., Shwe Set Taw WS	Green et al. (2010)
65	NCBS-NRC-AA-021	MZ675819	<i>Oligodon cf. tillacki</i>	India	Maharashtra	Mirza et al. (2021)
66	CAS215976	HM591513	<i>Oligodon torquatus</i>	Myanmar	Mandalay Div., Min Gone Taung WS	Green et al. (2010)
67	ZMMU Re-16687	OQ116823; OQ116816	<i>Oligodon transcaspicus</i>	Iran	Razavi Khorasan Prov., Bazangan Lake	Lee et al. (2023)
Outgroups						
68	—	KP684155	<i>Hebius vibakari</i>	—	—	—
69	—	GQ181130	<i>Oreocryptophis poryphyraceus</i>	—	—	—

Table S2. Primers for PCR and sequencing used in this study.

Gene	Primer name	Reference	Sequence
12S-rRNA	12S2LM	Green et al. (2010)	5' -ACACACCGCCCGTCACCCT-3'
	16S5H	Green et al. (2010)	5' -CTACCTTTGCACGGTTAGGATACCGCGGC-3'
16S-rRNA	16S1LM	Green et al. (2010)	5' - CCGACTGTTGACCAAAAACAT-3'
	16SH1	Green et al. (2010)	5' -CTCCGGTCTGAACTCAGATCACGTAGG-3'
<i>cyt b</i>	H14910	Burbrink et al. (2000)	5' -GACCTGTGATMTGAAAAACCAACGTT-3'
	THRSN2	Burbrink et al. (2000)	5' -CTTTGGTTTACAAGAACAATGCTTTA-3'

Table S3. Morphological comparisons between *Oligodon speleoserpens* **sp. nov.** and other species of *Oligodon* native to Thailand. Abbreviations for characters can be found in the materials and methods. Data for other species are based on the literature sources listed in the materials and methods. An asterisk is placed next to the number of maxillary teeth in *O. huahin* (data from Pauwels et al. 2017) because it is inconsistent with the rest of the *O. cinereus* species group, with our counts suggesting higher numbers.

Character	<i>O. speleoserpens</i> sp. nov.	<i>O. annamensis</i>	<i>O. barroni</i>	<i>O. catenatus</i>	<i>O. "cinereus"</i>	<i>O. deuvei</i>	<i>O. fasciolatus</i>	<i>O. huahin</i>	<i>O. inornatus</i>	<i>O. jintakunei</i>	<i>O. joynsoni</i>
TaiLLR	13.6–13.7 (m)	16.5–19.7 (m)	17.0–18.9 (m)	11.4–15.3 (m)	11.9–15.6 (m)	15.8–17.2 (m)	15.5–21.6 (m)	12.3–13.9 (m)	12.8–14.3 (m)	17.4 (m)	12.4–14.4 (m)
	13.9 (f)	11.6–13.5 (f)	13.7–14.9 (f)	10.2–12.4 (f)	9.4–13.3 (f)	13.2–14.9 (f)	11.6–15.8 (f)	—	11.5–12.0 (f)	—	12.5–12.9 (f)
MT	8	7–8	10–12 (13)	7–9	10–13	12–15	8–10	12 (6*)	10–11	6	11–12
DSR	19(17)–17–15	13–13–13	17–17–15	13–13–13	17–17(15)–15(13)	17–17–15	21/23–21/19–17/15	17–17–15	15–15–15	15–15–15	17–17–15
VEN	189–190 (m)	146–157 (m)	136–147 (m)	179–208 (m)	155–182 (m)	140–147 (m)	160–186 (m)	166–173 (m)	169–173 (m)	189 (m)	186–198 (m)
	193 (f)	155–170 (f)	141–160 (f)	187–212 (f)	162–186 (f)	147–155 (f)	163–196 (f)	—	171–173 (f)	—	193–200 (f)
SC	47–54 (m)	43–46 (m)	36–48 (m)	31–41 (m)	31–45 (m)	36–47 (m)	43–61 (m)	35–41	38–43 (m)	46 (m)	43–50 (m)
	48 (f)	30–34 (f)	28–35 (f)	27–43 (f)	27–42 (f)	31–38 (f)	34–48 (f)	—	31–36 (f)	—	37–41 (f)
CP	Single	Single	Single	Divided	Single	Single	Single	Single	Single	Divided	Single
SL	8	6 (5)	7–8	6 (5)	7–8	7 (8)	8	7–8	7–8	7	7–8
SL-eye	4+5	3+4	3+4–4+5	3+4 (2+3)	3+4–4+5	3+4	4+5 (3+4)	4+5 (4)	2+3–3+4	3+4	3+4–4+5
IL	9	6	8–9 (7)	6 (7)	7–8 (9)	8–9	8–9	8 (7)	8 (7)	7	9 (8)
LOREAL	1	0	1	0 (1)	1	1	1	1	1	1	1
PrO	1 (2)	1	1	1	1 (2)	1	1	1 (2)	1	1	1
PrsO	1	0	0	0	0–1	0 (1)	1 (0)	0–1	0	0	1 (0)
PtO	2	1	2	1	2 (1)	2 (1)	2	2	2	1	2
Ate	1	1	1	1 (2)	1–2	1 (2)	2–3 (1)	1	1	1	2 (1)
Pte	2	2	2	2	2–3	2	2–3	2	2	1	2

Table S3. (continued)

Character	<i>O. mouhoti</i>	<i>O. ocellatus</i>	<i>O. phangan</i>	<i>O. promsombuti</i>	<i>O. pseudotaeniatus</i>	<i>O. purpurascens</i>	<i>O. sai yok</i>	<i>O. signatus</i>	<i>O. taeniatus</i>	<i>O. theobaldi</i>
TailLR	17.2–18.5 (m)	11.6–14.2 (m)	16.6 (m)	13.6 (m)	20.1–20.5 (m)	18.0–23.1 (m)	12.8 (m)	22.2–32.8 (m)	16.5–20.4 (m)	13.4–20.4 (m)
	12.2–13.1 (f)	10.6–11.4 (f)	12.9 (f)	—	14.0 (f)	14.5–20.2 (f)	11.6 (f)	24.7–25.2 (f)	12.8–15.1 (f)	10.9–13.4 (f)
MT	14–16	9	12	12	15	9–10	13	7–8	15–18	14–17
DSR	17–17–15	19–17–15(13)	17–17–15	17–17–15	17–17–15	21/19–19/21–17/15	17–17–15	15–17/15–17/15	19–19–15	17–17–15
VEN	145–152 (m)	159–166 (m)	166 (m)	177 (m)	137–143 (m)	164–181 (m)	187 (m)	144–150 (m)	142–159 (m)	160–173 (m)
	154–163 (f)	157–180 (f)	163 (f)	—	156 (f)	168–195 (f)	181 (f)	155–160 (f)	151–165 (f)	162–175 (f)
SC	39–43 (m)	32–44 (m)	42 (m)	40 (m)	44–46 (m)	50–52 (m)	43 (m)	48–59 (m)	38–48 (m)	32–45 (m)
	29–33 (f)	26–33 (f)	33 (f)	—	34 (f)	41–56 (f)	38 (f)	49–51 (f)	31–39 (f)	29–42 (f)
CP	Single	Single	Single	Single	Single	Single	Single	Single	Single	Divided
SL	8	8 (7)	8 (7)	8	8	8 (6–7)	8	7	8	8 (9)
SL-eye	4+5	4+5	4+5 (4)	4+5	4+5	4+5 (4, 5)	4+5	3+4	4+5	4+5 (5+6)
IL	9–10	9–10	8	8	8–9	9 (8)	8	7–8	9	8–9 (10)
LOREAL	1	1	1	1	1	1	1	1	1	1
PrO	1	1	1	2	1	1–2 (3)	1	1	1	1
PrsO	0–1	0–1	0	0	1	1–3	0	0	0	0
PtO	2	2 (1, 3)	2	2	2	2 (3)	2	1	2	1–2
Ate	1 (2)	1–3	1	1	1	2	1	1	1	1
Pte	2	2	2	1	2	3 (2)	2	2	2 (1)	2

Table S4. Genetic differentiation of *Oligodon* within the *O. cinereus* species complex. Uncorrected p distances (given as percentages) between sequences of 12S–16S rRNA (below the diagonal), *cyt b* (above the diagonal), and intraspecific genetic p distances of *Oligodon* species (on diagonal, highlighted in gray; 12S–16S/*cyt b*) included in phylogenetic analyses.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 <i>O. speleoserpens</i> sp. nov.	0/0	7.74	—	9.68	—	9.46	—	9.14	9.25	9.25	8.82	8.6	8.17	—	10.75
2 <i>O. saiyok</i>	3.13	—	—	7.24	—	6.45	—	7.2	7.31	7.31	7.1	6.02	6.67	—	9.46
3 <i>O. cinereus</i> clade 4 (Rakhine)	2.56	2.85	—	—	—	—	—	—	—	—	—	—	—	—	—
4 <i>O. cinereus</i> clade 1 (s. str.)	3.35	4.63	3.49	0.9/1.4	—	7.17	—	7.35	7.46	7.46	6.81	6.38	6.31	—	10.68
5 <i>O. cinereus</i> clade 2 (Shan)	2.86	3.14	2.29	4.79	—	—	—	—	—	—	—	—	—	—	—
6 <i>O. cinereus</i> clade 2 (Sagaing)	2.85	2.56	0.85	3.77	3.14	—	—	5.59	5.59	5.59	4.73	4.52	4.52	—	8.82
7 <i>O. cinereus</i> clade 2 (N Vietnam)	4.47	3.99	3.04	5.59	4.39	3.14	0.4/—	—	—	—	—	—	—	—	—
8 <i>O. phangan</i> s. str.	4.56	4.84	3.13	3.77	4.86	2.85	5.42	0.6/0.2	0.11	0.11	4.73	4.73	4.73	—	8.82
9 <i>O. cf. phangan</i> (Myanmar)	3.99	3.70	1.99	3.70	3.71	2.28	4.66	1.71	—	0.11	4.73	4.73	4.73	—	8.82
10 <i>O. cf. phangan</i> (Krabi)	3.99	4.27	2.56	3.85	4.29	2.28	4.85	0.57	1.71	—	4.84	4.73	4.84	—	8.92
11 <i>O. huahin</i>	4.65	4.37	3.23	4.46	4.95	3.32	5.80	3.04	1.33	3.04	1.5/0	4.95	4.09	—	9.03
12 <i>O. nagao</i> and <i>O. cinereus</i> clade 3 (China)	3.61	3.32	2.18	3.35	3.90	2.18	3.52	2.37	1.23	2.37	2.56	0.2/—	3.01	—	9.68
13 <i>O. joysoni</i>	3.99	3.56	2.99	3.74	4.71	2.85	4.95	2.85	1.57	2.85	2.33	1.90	1.7/—	—	8.39
14 <i>O. promsombuti</i>	4.44	3.23	3.23	4.64	4.86	2.82	3.36	2.82	2.02	3.23	1.75	2.69	1.41	—	—
15 <i>O. inornatus</i>	3.13	3.42	2.85	3.06	3.43	3.13	4.47	3.13	3.13	2.56	4.46	2.47	3.56	4.44	—