

New Records and Range Extensions of *Dendrelaphis nigroserratus* Vogel, Van Rooijen and Hauser, 2012 (Squamata: Colubridae) from Thailand

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ABSTRACT.– The original description of the colubrid snake *Dendrelaphis nigroserratus* Vogel, Van Rooijen and Hauser, 2012 was mainly based on specimens from the mountains of Thailand's Tak Province. Other localities were poorly documented. We here report nearly twenty new records, extending the range of the species some 480 km to the south in Surat Thani Province, 70 km to the north in Mae Ramat District, Tak Province, and 30 km to the east in Kamphaeng Phet Province. The records also confirm the validity of the range localities in Phetchaburi and Kancharaburi Province. We present the variability of various characters of 12 new DOR specimens and new data on the natural history.

KEY WORDS: geographic distribution, herpetofauna, Tenasserim Range

INTRODUCTION

Bronzeback snakes of the genus *Dendrelaphis* Boulenger, 1890 are slender, diurnal and arboreal snakes widespread in South and South-east Asia and Australasia, as far to the east as New Guinea and northern Australia. They reach a length of no more than 175 cm. The systematics of the genus had been seriously understudied as was evidenced by considerable confusion with regard to the identification of taxa (Vogel and Van Rooijen, 2007). Over the past twenty years, a dozen new species have been described, many of them following re-examination of specimens in museum collections. Recently, DNA gene sequencing has revealed cryptic species, such as *D. vogeli* Jiang et al., 2020. The total

number of valid species is now forty-seven (Uetz and Hošek, 2021).

One of the more recent additions to the genus is *D. nigroserratus* Vogel, Van Rooijen and Hauser, 2012, from Myanmar and Thailand, a relatively large-sized species with a conspicuous black zigzag pattern on the neck resembling saw-teeth. Otherwise, most of its morphological characteristics are very similar to those of *D. cyanochloris* Wall, 1921, which was in 2012 considered widespread in much of South and Southeast Asia, including most of Thailand, but is now believed to consist of a number of cryptic species (Jiang et al., 2020). Because of their similar meristics and scalation, Pauwels et al. (2003) had considered specimens of *D. nigroserratus* as merely color and pattern variants of *D. cyanochloris*. On the other

hand, due to the oblique-barred neck pattern, specimens had also been misidentified as *D. striatus* (Cohn, 1905).

In the description of *D. nigroserratus*, its much larger size, the high incidence of a paired central postparietal shield and the serrated neck pattern were stressed as discriminating it from *D. cyanochloris* (Vogel et al., 2012). Of more than ten records of the

new species, most were from the mountains of Umphang and Phop Phra District in Tak Province in north-western Thailand, whereas two records from more southern localities were poorly documented and in need of confirmation. It was assumed that the species had a rather restricted distribution in western Thailand and adjacent areas in southeastern Myanmar (Vogel et al., 2012, see also Fig. 1).



FIGURE 1. Dot map of known localities of *Dendrelaphis nigroserratus*. *Black dots*: localities mentioned in Vogel et al. (2012) and Vogel and Hauser (2014). 1. Phop Phra District, Tak Province, 2. Umphang District, Tak Province (including holotype QSMI 1282 and paratype ZFMK 92809), 3. Sangkhlaburi District, Kanchanaburi Province, 4. Kaeng Krachan District, Phetchaburi Province, 5. Mergui, Tanintharyi Region, Myanmar (paratype BMNH 1946.1.6.13). *Red dots*: new localities (this paper): 6. Mae Ramat District, Tak Province, 7. Khlong Lan District, Kamphaeng Phet Province, 8. Thong Pha Phum District, Kanchanaburi Province (confirmation), 9. Kaeng Krachan and Tha Yang districts, Phetchaburi Province (confirmations), 10. Kraburi District, Ranong Province, 11. Phanom District, Surat Thani Province, 12. Suan Phueng District, Ratchaburi Province.

We herein report some twenty new records of *D. nigroserratus*, which represent considerable range extensions and provide new data on the variability of its morphological characters as well as on its natural history.

MATERIALS AND METHODS

Living snakes were recorded during field trips by taking photographs and depositing them as vouchers in collections of research institutes and natural history museums. DOR specimens were collected, photographed, examined and skinned or preserved in 70 % ethanol. Ventral shields were counted according to Dowling (1951). Dried tissue samples (such as dried skin) and fresh tissue samples were preserved in 95 % ethanol for future gene sequencing. For more details about the examination and morphology, see Hauser (2019).

Museum and other abbreviations

AUP, School of Agriculture and Natural Resources, University of Phayao, Phayao, Thailand; BMNH, The Natural History Museum, London, United Kingdom; DOR, Dead on Road, road-killed specimen; IRSNB, Institut Royale des Sciences Naturelles de Belgique, Brussels, Belgium; QSMI, Queen Saovabha Memorial Institute, Thai Red Cross Society, Bangkok, Thailand; SHPC, Sjon Hauser's Private Collection, Chiang Mai, Thailand.

RESULTS

Range extensions

Mae Ramat District, Tak Province

On 2 October 2019, AUP02406, a fresh DOR specimen, was spotted, photographed and collected by one of us (SH) on Highway 1175 stretching through a patchwork of deciduous and evergreen forest and agricultural land. The locality was 27 km east

of Mae Ramat Town at an elevation of about 650 m asl in Mae Ramat District, Tak Province (no. 6 in Fig. 1). It was later examined and skinned. The characteristic black saw-tooth neck pattern, olive green upperside of the head, the paired central postparietal shield and the robust size identified it as *D. nigroserratus* (Table 1). This record extends the range of the species about 70 km to the north compared to the most northern locality in Phop Phra District, Tak Province, as listed in Vogel et al. (2012) and Vogel and Hauser (2014).

Khlong Lan District, Kamphaeng Phet Province

In the morning of 6 July 2015, specimen AUP02402, a juvenile of about 40 cm total length, was observed and photographed by one of us (PP) in dipterocarp forest (*Dipterocarpus alatus* and *D. costatus*) with large bamboo clumps in Khlong Lan National Park at an elevation of about 250 m in Kamphaeng Phet Province, about 2 km west from the park headquarters. The specimen was crossing a rocky stream. The black saw-tooth pattern on the neck and the olive-green upperside of the head identify it as *D. nigroserratus* (Fig. 2). Compared to Phop Phra District as documented earlier, Khlong Lan is an extension of the species' range to the east of about 30 km (no. 7 in Fig. 1).

Kraburi District, Ranong Province

On 13 December 2020, one of us (AM) came across the dead and partly decomposed body of an about 120 cm long snake (AUP02412). It was identified as *D. nigroserratus* by its serrated neck pattern and the olive-green upperside of the head. This observation was in the Thung Raya-Na Sak Wildlife Sanctuary, about 2 km south/southeast from the parking lot at the Bok Krai waterfall, Kraburi District, Ranong Province. The corpse was found on a steep soil and rocky slope shelf at a stream channel amidst a riparian plant community in evergreen forest at 132 m asl. This record

TABLE 1. Data of 12 new records of dead on road snakes identified as *Dendrelaphis nigroserratus*. For abbreviations of preserved specimens and vouchers photographs (AUP, QSMI, SHPC) see: Material and Methods.

<i>Dendrelaphis nigroserratus</i>	district	elev. (m)	SEX	SVL (mm)	TaL (mm)	TOTL (mm)	R	PV	V	SCp	AS	DSR
AUP02401	UMP	1100	fem			1630					div	
QSMI-13.08.04-07	UMP	950	male	839	409	1248	0.328	2	192	152	div	
SHPC13.08.04-10	UMP	850	fem?	644	289	933	0.31	2	202	152	div	19-15-11
QSMI-13.09.10-10	UMP	1050	juv.					2	207	145	div	
QSMI-14.09.10-05	PHP	1100	male	551	259	810	0.32	3	194	162	div	
SHPC15.10.21-04B	UMP	750				1600						
SHPC16.05.31-11	UMP	1002	juv.	494	219	713	0.307		200	154		
AUP02405	UMP	600	male?	1095	442	1537	0.288	1	198	129	div	21-15-11
AUP02406	MRM	650	?	995	428	1423	0.301	2	200	141	div	19-15-11
AUP02407	UMP	1100	fem?	958	420	1378	0.305	2	196	135	div	20-15-11
AUP02410	UMP	1275	male?	681	350	1031	0.339	2	190	151	div	18-15-11
AUP02411	TPP	333	male	959	494	1453	0.34	2	195	160	div	15-15-11

Districts: MRM – Mae Ramat District, Tak Province; PHP – Phop Phra District, Tak Province; TPP – Thong Pha Phum District, Kanchanaburi province; UMP – Umphang District, Tak Province. Other abbreviations: AS – anal shield; div – divided; elev. (m) – elevation in meter above sea level; fem – female; juv. – juvenile; DSR – dorsal scale rows one head length before the head, at midbody and one head length before the vent; PV – pre-ventral; R – ratio TaL /TOTL; number of SCp – subcaudal pairs; SVL – snout-vent length; TaL – tail length; TOTL – total length; V – number of ventral shields counted according to Dowling (1951).

extends the range of the species as far to the south as 10.35 degree northern latitude, some 300 km to the south of Kaeng Krachan National Park, the southern limit of its hitherto known range (no. 10 in Fig. 1).

Phanom District, Surat Thani Province

On 13 July 2020, specimen AUP02408 was spotted and photographed by one of us (HN) in lowland evergreen forest at 70 m asl in Khao Sok National Park, Phanom District, Surat Thani Province. The locality was 0.4 km southeast from the park headquarters. The total length of the snake was estimated to be about 80 cm. The expanded neck showed the characteristic black saw-tooth pattern, the upperside of the head was olive green and the central postparietal shield was paired (Figs. 3 and 4). Compared to Kaeng Krachan District, Phetchaburi Province, the most southern

locality of its hitherto known range, this record extends the species' range more than 450 km (no. 11 in Fig. 1).

Range confirmations

Kaeng Krachan District, Phetchaburi Province, was reported as a locality of *D. nigroserratus* in Vogel et al. (2012). However, this locality was just based on pictures on a website of a specimen eating a frog and two photographs in a popular magazine (Seesook, 2000) without any further details on habitat and locality.

We here confirm the locality with three more reports from Phetchaburi Province. On the sunny morning of 26 April 2017, one of us (TS) spotted specimen AUP02403 in a bamboo clump near a natural pool in evergreen forest at about 900 m in Kaeng Krachan National Park, about 20 km west



FIGURE 2. AUP02402, a juvenile *Dendrelaphis nigroserratus* from the Khlong Lan National Park in Kamphaeng Phet Province. Inset: Details of the head in lateral view of the same specimen. Photographs by Parinya Pawangkhanant.

from the Park Headquarters, Kaeng Krachan District. The specimen was photographed in situ (Fig. 5). The black saw-tooth-necked pattern and the olive bronze color of the upperside identified it as *D. nigroserratus*. The specimen had a length of about 100 cm.

On 1 July 2017 18:00 h, one of us (TS) spotted an estimated 120 cm long specimen in evergreen forest with bamboo in the Kaeng Krachan National Park. The specimen was resting on bamboo hanging over a road (documented with voucher photographs of specimen AUP02404). The locality was 30 km from the park headquarters, at an elevation of 940 m.

On 1 September 2020, around 23:00 h, the same author (TS) observed and photographed an approximately 160 cm long specimen (AUP02409) resting in a tree, 2.5 m above the ground. The locality was in dry dipterocarp forest near a stream, at an elevation of 200 m, in Tha Yang District, Phetchaburi Province, about 20 km southeast of the Kaeng Krachan National Park's Headquarters. For the locality of these three specimens see no. 9 in Fig. 1.

Thong Pha Phum District, Kanchanaburi Province

Kroeng Kra Wia waterfall, Sangkhlaburi District, Kanchanaburi Province, was given as a locality of the new species in Vogel et al. (2012). It was based upon the description of



FIGURE 3. AUP02408, a *Dendrelaphis nigroserratus* from Phanom District, Surat Thani Province. Photograph by Hammarach Nomsian.

specimen IRSNB 15294 in Pauwels et al. (2003) as a *Dendrelaphis* specimen with ‘all meristic characters perfectly concurring with those of *D. cyanochloris*’, but with exactly the same (serrated neck) coloration as a *Dendrelaphis* specimen from Kaeng Krachan National Park shown in photographs published in Seesook (2000). Vogel et al. (2012) therefore identified specimen IRSNB 15294 as *D. nigroserratus*, but they did not re-examine the materials for confirmation of the identification and therewith the validity of the locality.

On 6 November 2020, one of us (SH) collected a road-killed adult *D. nigroserratus* only 4 km south of the Kroeng Kra Wia waterfall in Thon Pha Phum District, Kanchanaburi (no. 8 in Fig. 1). Specimen AUP02411 is a large specimen (153 cm) showing the black saw-toothed pattern on the

neck, the upperside of the head olive green, and a paired central postparietal shield (see also Table 1.). As it was a male, relatively intact, freshly road-killed specimen, the hemipenes could be everted, the first time the species’ hemipenes have been documented (Fig. 6). The habitat consists of mixed (deciduous and evergreen) forest with much bamboo at 250 m asl.

New locality.— Suan Phueng District, Ratchaburi Province

Recently, an adult *D. nigroserratus* was observed and photographed by one of us (PP) in evergreen forest at 900 m asl near the Myanmar border in Suan Phueng District, Ratchaburi Province, central Thailand. This is the first provincial record for Ratchaburi which bridges the gap between the records in the provinces of Kanchanaburi and Phetchaburi (no. 12 in Fig. 1).



FIGURE 4. Details of the head of AUP02408, a *Dendrelaphis nigroserratus* from Phanom District, Surat Thani Province. The white asterisks mark the two paired central post-parietal shields. Photograph by Hammarach Nomsian.

In addition to the given range extensions, ten new records of DOR specimens of the species were from the Phop Phra and Umphang districts in southern Tak Province (no. 1 and 2 in Fig. 1). Morphological data of these specimens and of the above mentioned two roadkills from Mae Ramat and Thong Pha Phum are listed in Table 1.

Morphology

We compared the data on morphology of 12 new specimens of *D. nigroserratus* from Tak and Kanchanaburi provinces (see Table 1) with 30 specimens of the recently described new species *D. vogeli* Jiang et al., 2020 from northern Thailand in the private collection of the first author. Before the publication of Jiang et al., 2020, these thirty specimens had been identified as *D. (cf.) cyanochloris*.

Size.—The new records show that *D. nigroserratus* is a large *Dendrelaphis* species, with hitherto the 1,630 mm total length of specimen AUP02401 from Umphang as the maximum length. However, 1,300 mm was found as the maximum total length among the 30 specimens of *D. vogeli* (SH, unpublished data). Moreover, the total length of six out of 12 specimens of *D. nigroserratus* exceeded the maximum of *D. vogeli*, thus confirming the large size of *D. nigroserratus* compared to the latter.

Central postparietal shields.— In all specimens of *D. nigroserratus* in which the postparietal area could be clearly distinguished, the central postparietal area consisted of a symmetric pair of scales.



FIGURE 5. AUP02403, an adult *Dendrelaphis nigroserratus* from Kaeng Krachan National Park, Phetchaburi Province. Photograph by Ton Smits.

Color of the upper side of the head.— In all specimens (both living specimens and listed DORs) this character was distinctly olive green – bronze green. As in all other bronzeback species known to occur in Thailand the upperside is brown, bronze brown, copper brown or reddish brown (see pictures in Cox et al., 2012) the olive green color is in combination with the saw-toothed neck pattern a reliable character to identify the species in the field. This character has not been noticed by Vogel et al. (2012).

Anatomy of the hemipenis.— The hemipenes could be everted in specimen AUP02411. The organs are not forked. The distal part is covered with dozens of tiny spines, the somewhat larger, slightly curved spines restricted to the apical region. The most

proximal part is smooth and no papillae or other ornaments could be distinguished. The sulcus spermaticus is single (not branched), relatively broad without well-developed lips (see Fig. 6).

Natural history

Food.— The bowels of one DOR specimen (AUP02406) contained a small agamid (*Calotes* spec.). In addition to the picture of a *D. nigroserratus* in Kaeng Krachan National Park eating a frog this is all we know about its feeding habits. In Vogel et al. (2012) the frog was identified as Wallace Flying Frog (*Rhacophorus nigropalmatus*), but since *R. nigropalmatus* has never been recorded in the Kaeng Krachan National Park, the frog is more likely *R. kio*.



FIGURE 6. Hemipenes of specimen AUP02411, a *Dendrelaphis nigroserratus* from Thong Pha Phum District, Kanchanaburi Province. Photograph by Sjon Hauser.

Habitat.— Our records show that the species is often seen near streams and in adjacent habitats where bamboo abounds.

Defensive behavior.— When threatened *D. nigroserratus* nearly always exhibits a strong defense by S-coiling the anterior part of the body and flattening the neck, thereby maximizing the exposure of the black saw-tooth pattern. This posture is often combined with frequent flicking of the bright red tongue and with strikes and fierce biting.

DISCUSSION

Until now *Dendrelaphis nigroserratus* was only known from four localities in Thailand, all along the country's western border with Myanmar in the southern part of the Dawna Hills (Phop Phra and Umphang) and its continuation to the south in the Tenasserim Range (Sangkhlaburi and Kaeng Krachan). Our new records extend the species' range further to the north in the Dawna Hills to near latitude 17°N and much further to the south in

the Tenasserim Range through Kraburi as far as Phanom at a latitude of about 8°N, just north of the Gulf of Phangnga. Most of the northern records (in Phop Phra and Umphang) reported by Vogel et al. (2012) were from elevations above 900 m, but records from 700-800 m were mentioned in Vogel and Hauser (2014). The present study confirms the presence of the species at much lower elevations, such as 650 m in Mae Ramat, 600 m in Umphang and as low as 250 m in Khlong Lan. Except for three records in the mountains of Kaeng Krachan and Suan Phueng at approximately 900 m, all records south of Umphang were at low elevations (330 m for Thong Pha Phum, 200 m for Tha Yang, 132 m for Kraburi and 70 m for Khao Sok NP). These data suggest that the species occupies relatively high elevations in northern Thailand, but further to the south, it is more often recorded at low elevations. The relation between the elevation of the habitat and the latitude has also been noticed for other snake species, such as the natricids *Rhabdophis*

nigrocinctus and *R. chrysargos*, the colubrid *Boiga cyanea*, the pareid *Pareas macularius*, and the viperid *Trimeresurus popeiorum* (PP, SH and TS, unpublished data). It may be due to the considerably longer dry season without notable rain fall at low elevations in the north (compared to high elevations in the north as well as low elevations in the south) but also due to rampant habitat destruction at low elevations in the north. It is even possible that different cryptic species with different geographic ranges are involved, but this seems to us unlikely in regard to *D. nigroserratus*.

Dendrelaphis nigroserratus is associated with the karstic formations which abound in the Dawna Hills and Tenasserim Range, but we doubt this is of importance for explaining its presently known distribution. The species is also associated with mountain streams and bamboo clumps.

In the North (parts of Tak and Kamphaeng Phet provinces) it is sympatric and often syntopic with its (much smaller) congener *D. vogeli* (Hauser, unpublished data) and locally with *D. walli* (Smits et al., in preparation). In the south, including Phetchaburi Province, the most southern province of the central region, it is sympatric and syntopic with *D. cf. cyanochloris*, *D. formosus*, *D. striatus*, *D. caudeolineatus*, *D. haasi* and probably *D. kopsteini*.

Dendrelaphis pictus and *D. subocularis* are sympatric within much of the range of *D. nigroserratus*, but probably seldom share their habitat with *D. nigroserratus*.

We hypothesize that the species' large size and its fierce defensive response have co-evolved, and that the characteristic saw-toothed neck pattern is a more effective warning signal compared to the blue glitterings of the interstitial skin and the edges of the scales exposed in the flattened neck of most congeners.

We do not wish to predict further extensions of the species' range in the near future. However, we herein stress the importance of more intensive and diverse surveying for a better appreciation of a region's biodiversity. Until recently, Northern Thailand's herpetofauna has been extremely underexplored. This was realized following a pioneer study of the central Thai province of Phetchaburi (Pauwels et al., 2003), when the authors could not find a province (or sub-region) in the North well enough explored for meaningful comparisons with the herpetofauna of Phetchaburi. The underexploration of the region has been stressed in only few studies (e.g., Pauwels et al., 2001; Chuaynkern et al., 2014; Hauser, 2019). Only following the completion of the highway from Mae Sot to Umphang in the late 1990s and one of us (SH) beginning to screen this road for DOR-snakes, *D. nigroserratus* was discovered there. There have been several surveys in the South (e.g., Frith, 1977; Pauwels et al., 2000; Grossmann and Tillack, 2001a; 2001b). This region was seriously underexplored as well. Over the past few years, surveying of this region was intensified by professional herpetologists and dedicated amateurs, which resulted in the considerable range extension of *D. nigroserratus*.

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