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A new species of reed snake, *Calamaria* Boie, 1827 from the Central Highlands of Vietnam (Squamata: Colubridae)

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Abstract: A new species of *Calamaria* Boie, 1827 is described based on a single specimen collected in evergreen forest at 1240 m elevation of Ta Dung Nature Reserve in Dak Nong Province, Central Vietnam. The new species is characterized by (1) rostral wider than high; (2) paraparietal surrounded by six shields and scales; (3) eye diameter larger than eye-mouth distance; (4) preocular present; (5) supralabials 5/4, 3-4/2-3 entering orbit; (6) maxillary teeth nine, modified; (7) infralabials 5/4, first three touching anterior chin shields; (8) mental touching tip of right anterior chin shield; (9) ventrals 1 + 174; subcaudal scales 18/17, divided; (10) preloacal plate single; (11) tail relatively short (6.2% of the total length), nearly as thick as body, slightly tapering, and ending in obtuse point; (12) dorsal scales reducing to six rows at position above 4th subcaudal, and to four rows above 13th subcaudal on tail; (13) dorsum dark with irregular yellow blotches; and (14) ventral side dark with few yellow blotches and bands. This is the sixth new *Calamaria* species described from Vietnam in the past thirteen years and the tenth species of *Calamaria* recorded from this country.

Keywords: *Calamaria* - Serpentes - taxonomy - Dak Nong Province - Vietnam.

INTRODUCTION

Calamaria Boie, 1827 is a burrowing, forest-dwelling snake genus, which represents one of the most successful Southeast Asian genera of colubrids. Reed snakes can be found from eastern China and the Ryukyu Islands in the north, through Vietnam, Laos, Cambodia, Thailand and the Malaysian Peninsula to Myanmar in the west, and southward to Sulawesi, Seram and the Philippines (Uetz *et al.*, 2018). Although being a diverse genus, *Calamaria* species exhibit a rather homogenous morphology. Inger & Marx (1965) recognized a total of 50 species of *Calamaria*, with nine taxa being described therein as new species or subspecies. Since their systematic review, ten new taxa have been discovered: *C. lovii*

ingermarxorum Darevsky & Orlov, 1992 from central Vietnam; *C. ingeri* Grismer, Kaiser & Yaakob, 2004 from West Malaysia; *C. thanhi* Ziegler & Le, 2005 from central Vietnam; *C. butonensis* Howard & Gillespie, 2007, and *C. longirostris* Howard & Gillespie, 2007 from Buton Island, Indonesia; *C. banggaiensis* Koch, Arida, McGuire, Iskandar & Böhme, 2009 from Banggai Island, Indonesia; *C. gialaiensis* Ziegler, Nguyen & Nguyen, 2008; *C. abramovi* Orlov, 2009; *C. sangi* Nguyen, Koch & Ziegler, 2009; *C. concolor* Orlov, Nguyen, Nguyen, Ananjeva & Ho, 2010, the latter four all being discovered in central Vietnam. In addition, *C. pfefferi* Stejneger, 1901 was recently listed as a synonym of *C. pavimentata* Duméril, Bibron & Duméril, 1854 (Wallach *et al.*, 2014).

During recent field surveys in the Central Highlands of Vietnam, an eye-catching, ground-dwelling snake was discovered. Morphological examination of the specimen from Ta Dung Nature Reserve in Dak Nong Province revealed it to be a representative of the genus *Calamaria*. Diagnostic characters are the dorsal scales in 13 rows throughout body, internasals and prefrontals fused, and parietal broadly in contact with supralabials (Inger & Marx, 1965). Because the specimen was neither assignable to any of the reed snakes known from Vietnam nor to species reported from neighboring countries, we herein describe it as a new species.

MATERIAL AND METHODS

Sampling: This study is based on a single specimen, which was euthanized in a closed vessel with a piece of cotton wool containing ethyl acetate (Simmons, 2002), fixed in 85% ethanol and subsequently stored in 70% ethanol. The specimen was deposited in the herpetological collection of the Institute of Ecology and Biological Resources (IEBR), Vietnamese Academy of Science and Technology, Hanoi, Vietnam.

Morphological examination: Identification of sex was performed by dissection (inspection of gonads). Snout-vent length and tail length were taken after preservation with a measuring tape. The number of ventral scales was counted according to Dowling (1951). The numbers of dorsal scale rows are given at one head length behind head, at midbody, and at one head length before vent. Maxillary teeth were counted by examining the right maxilla. Scalation and maxillary teeth numbers were studied using a binocular dissecting microscope. We herein use the term precloacal instead of anal. Bilateral values were given as left / right. Methods and comparisons followed Inger & Marx (1965), Ziegler *et al.* (2008), and Nguyen *et al.* (2009).

Abbreviations of morphological characters used in the text are as follows: – *Measures and ratios:* – SVL: snout-vent length (from tip of snout to anterior margin of cloaca). – TaL: tail length (from posterior margin of cloaca to tip of tail). – TL: total length (SVL + TaL). – TaL/TL: ratio tail length/total length.

RESULTS

Calamaria dominici Ziegler, Tran & Nguyen sp. nov. Figs 1–4

Holotype: IEBR A.2018.1, an adult female collected on 28 May 2017 at 11:30 on a forest path by Anh Vu Tran in evergreen mixed forest of broadleaf and conifer trees within Ta Dung Nature Reserve, Dak Nong Province, Central Highlands, Vietnam, at an elevation of 1240 m asl.

Diagnosis: A species of the genus *Calamaria* characterized by the combination of the following characters:

- (1) rostral wider than high;
- (2) paraparietal surrounded by six shields and scales;
- (3) eye diameter larger than eye-mouth distance;
- (4) preocular present;
- (5) supralabials 5/4, 3–4/2–3 entering orbit;
- (6) maxillary teeth nine, modified;
- (7) infralabials 5/4, first three touching anterior chin shields;
- (8) mental touching tip of right anterior chin shield;
- (9) ventrals 1 + 174; subcaudal scales 18/17, divided;
- (10) precloacal plate single;
- (11) tail relatively short (6.2% of the total length), nearly as thick as body, slightly tapering, and ending in obtuse point;
- (12) dorsal scales reducing to six rows at position above 4th subcaudal, and to four rows above 13th subcaudal on tail;
- (13) dorsum dark with irregular yellow blotches; and
- (14) ventral side dark with few yellow blotches and bands.

Description of holotype: Habitus vermiform; head indistinct from neck; pupil round; tail relatively short (6.2% of the total length), nearly as thick as body, slightly tapering, ending in obtuse point.

Size. SVL: 395 mm; TaL: 26 mm; TL: 421 mm; ratio TaL/TL: 0.06.

Dentition. Right upper maxilla with 9 modified maxillary teeth.

Body scalation. Dorsal scale rows 13–13–13, smooth. Dorsal scales reducing to six rows at position above fourth subcaudal, to five rows above 12th subcaudal, and to four rows above 13th subcaudal on tail.

174 ventrals (+ 1 preventral); 18/17 subcaudals, all paired, first pair not in contact, followed by tail tip; precloacal single.

Head scalation. Rostral wider than high, portion visible from above shorter than prefrontal suture. Prefrontal shorter than frontal, not entering orbit, and touching first two supralabials on right side and second and third supralabial on left side. Frontal hexagonal, nearly two times maximum width of supraocular. Paraparietal surrounded by six shields and scales. Length of parietal shorter than distance from posterior tip of frontal to posterior tip of rostral. Supraocular 1/1. Loreal 1/1. Preocular 1/1, distinctly higher than wide. Postocular 1/1, higher than wide, not as high as eye diameter. Eye diameter larger than eye-mouth distance. 5/4 supralabials, on left side third and fourth entering orbit, fifth longest; on right side second and third entering orbit, fourth longest. Mental triangular, touching tip of right anterior chin shields. 5/4 infralabials, first three touching anterior chin shields. First pair of chin shields in contact mesially, second pair touching anteriorly and separated posteriorly.



Fig. 1. Holotype of *Calamaria dominici* sp. nov. (IEBR R.2018.1) in life. Photos R. D. Babb.

Coloration (in life). Eye black; tongue grey anteriorly, pinkish-grey posteriorly; dorsum of body and tail dark purplish-black, iridescent; head with irregular small and few medium-sized yellow blotches; body with medium-sized to large yellow blotches, irregularly arranged, in part forming transverse or oblique rows, sometimes in zig-zag pattern; hind part of body dorsum and dorsal surface of tail less intensely blotched; venter purplish-black with irregular yellow transverse bands or blotches; chin and throat region dark with yellow reticulation or blotches and bands; lower tail surface dark with few yellow blotches or bands.

Coloration (in preservative). Ground colour purplish-black to brownish-black with whitish-cream pattern of irregularly arranged blotches.

Comparisons: Comparisons of the new species with its congeners took place based on the following references (Inger & Marx, 1965; Grismer *et al.*, 2004, Howard & Gillespie, 2007, Ziegler *et al.*, 2008; Koch *et al.*, 2009; Nguyen *et al.*, 2009; Orlov, 2009; Orlov *et al.*, 2010). In the following we first compare *Calamaria dominici* sp. nov. with the *Calamaria* species reported to occur in Vietnam:

Calamaria dominici sp. nov. already differs by its color pattern from the species known from Vietnam: *C. abramovi* has a black dorsum without spots, the venter is covered with yellow-orange spots; *C. buchi* is blackish above with each dorsal scale having small light spots and its ventral scales having dark outermost corners; *C. concolor* has a uniform, patternless light brown body dorsum and a cream venter; *C. gialaiensis* has a light greyish brown dorsum with an indistinct dark neck collar and few dark blotches along posterior vertebral region, two pairs of light blotches on the tail, as well as a yellowish beige ventral side, with dark outermost corners of ventrals and anterior subcaudals; *C. pavimentata* usually has narrow, dark, longitudinal stripes, and a solid black collar behind the neck; *C. sangi* has a greyish brown dorsum with fine dark mottling, as well as a yellowish beige ventral side, with dark transverse bands and a dark longitudinal stripe below the tail; *C. septentrionalis* has dorsal scales with many small light dots forming a network; *C. lovii ingermarxorum* has an immaculate grey-bluish dorsum with light spots on each side of the neck covering four scales; and *C. thanhi* has distinct transverse light body bands.

Calamaria dominici sp. nov. further differs from the



Fig. 2. Head views of the holotype of *Calamaria dominici* sp. nov. (IEBR R.2018.1) in life. Photos R. W. Van Devender.

species so far known from Vietnam in morphological characters:

Calamaria dominici sp. nov. differs from *C. abramovi* Orlov, 2009 by its rostral being wider than high (versus its height equal to width), by the dorsal scales reducing to four rows above 13th subcaudal on tail (versus above 20th subcaudal in the female holotype of *C. abramovi*), by 18/17 versus 20 subcaudals in females, and by having 13-13-13 versus 12-13-13 dorsal scale rows.

Calamaria dominici sp. nov. differs from *C. buchi* Marx & Inger, 1955 by having fewer ventral scales in females (1 + 174 versus 221-236 in *C. buchi*), by the rostral being wider than high (versus rostral higher than wide), by the dorsal scales reducing to four rows above 13th subcaudal on tail (versus above 3rd-4th subcaudal), by 18/17 versus 13-14 subcaudals in females, by having a ratio of tail length to total length of 6.2% (versus 3.9-4.1 in female *C. buchi*), and by the length of parietal being shorter than distance from posterior tip of frontal to posterior tip of rostral (versus length of parietal greater than distance from posterior tip of frontal to posterior tip of rostral).

Calamaria dominici sp. nov. differs from *C. concolor* Orlov, Nguyen, Nguyen, Ananjeva & Ho, 2010 by having paraparietal surrounded by six shields and scales

(versus by five shields and scales), and by the dorsal scales reducing to four rows above 13th subcaudal on tail (versus above 19th subcaudal in the male holotype of *C. concolor*).

Calamaria dominici sp. nov. differs from *C. gialaiensis* Ziegler, Nguyen & Nguyen, 2009 by having paraparietal surrounded by six shields and scales (versus by five shields and scales), and by tail ending in obtuse point (versus with rounded end).

Calamaria dominici sp. nov. differs from *C. lovii* Boulenger, 1887 by having a preocular scale (versus being absent in *C. lovii*), and by tail ending in obtuse point (versus with blunt end in the subspecies occurring in Vietnam, *C. lovii ingermarxorum*).

Calamaria dominici sp. nov. differs from *C. pavimentata* Duméril, Bibron & Duméril, 1854 by the rostral being wider than high (versus rostral as broad as high or slightly higher than broad), and by the tail ending in obtuse point (tail tip with sharp point in *C. pavimentata*).

Calamaria dominici sp. nov. differs from *C. sangi* Nguyen, Koch & Ziegler, 2009 by having fewer ventral scales (1 + 174 versus 2 + 190 in *C. sangi*), and by the dorsal scales reducing to six rows above 4th subcaudal on tail (versus above 8th subcaudal).

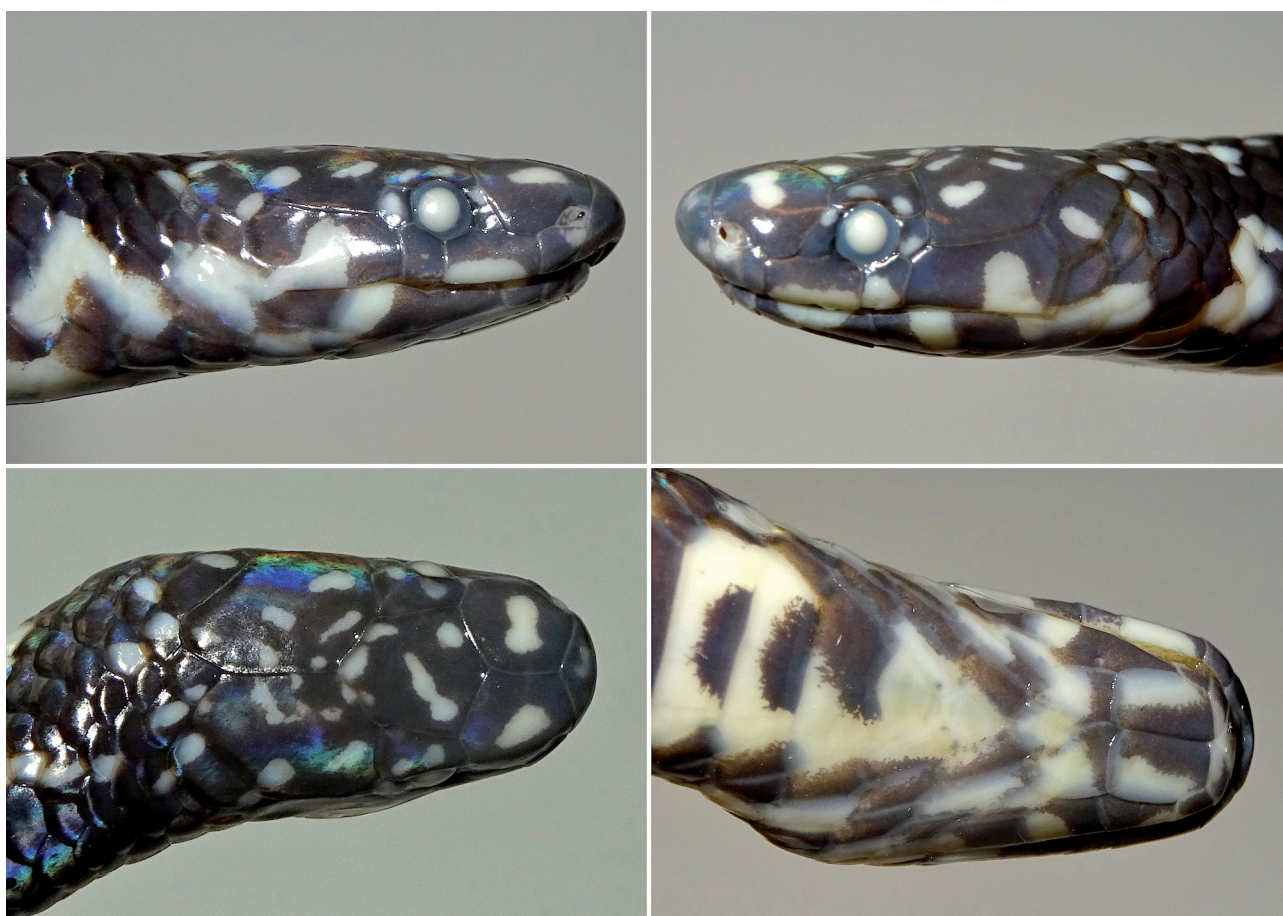


Fig. 3. Head views of the preserved holotype of *Calamaria dominici* sp. nov. (IEBR R.2018.1). Photos T. Ziegler.



Fig. 4. Dorsal and ventral views of the holotype of *Calamaria dominici* sp. nov. (IEBR R.2018.1). Photos R. W. Van Devender.

Calamaria dominici sp. nov. differs from *C. septentrionalis* Boulenger 1890 by 18/17 versus 6-11 subcaudals in females, by having a ratio of tail length to total length of 6.2% (versus 2.6-4.3 in female *C. septentrionalis*), and by the tail ending in obtuse point (versus tail tip rounded in *C. septentrionalis*).

Calamaria dominici sp. nov. differs from *C. thanhi* Ziegler & Le, 2005 by having a preocular scale (versus absent), by having fewer ventral scales (1 + 174 versus 198 in *C. thanhi*), and by the tail ending in obtuse point (tail tip with sharp point in *C. thanhi*).

Calamaria dominici sp. nov. differs from *C. yunnanensis* Chernov, 1962, a species reported from southern China, which was judged as a doubtful form by Inger & Marx (1965), but subsequently listed as valid by Yang & Inger (1986) and Zhao & Adler (1993), by having a preocular (versus being absent), and by lacking narrow, dark, elongated stripes along the body.

Calamaria dominici sp. nov. has a distinct preocular scale, which is lacking in the following species: *C. alidae* Boulenger, 1920, *C. apraeocularis* Smith, 1927, *C. banggaiensis* Koch, Arida, McGuire, Iskandar & Böhme, 2009, *C. butonensis* Howard & Gillespie, 2007, *C. ceramensis* De Rooij, 1913, *C. gracillima* (Günther, 1872), *C. javanica* Boulenger, 1891, *C. longirostris* Howard & Gillespie, 2007, *C. mecheli* Schenkel, 1901, *C. rebentischi* Bleeker, 1860, and *C. schmidtii* Marx & Inger, 1955.

Calamaria dominici sp. nov. has modified maxillary teeth and thus differs from the following species, which have unmodified maxillary teeth: *C. acutirostris* Boulenger, 1896, *C. curta* Boulenger, 1896, *C. lautensis* De Rooij, 1917, *C. leucogaster* Bleeker, 1860, and *C. ulmeri* Sackett, 1940.

Calamaria dominici sp. nov. has parapaternal surrounded by six shields and scales and thus differs from *C. albiventer* (Gray, 1835) (5), *C. bicolor* Duméril, Bibron & Duméril, 1854 (5), *C. bitorques* Peters, 1872 (5), *C. brongersmai* Inger & Marx, 1965 (5), *C. everetti* Boulenger, 1893 (5), *C. griswoldi* Loveridge, 1938 (5), *C. hilleniusi* Inger & Marx, 1965 (5), *C. joloensis* Taylor, 1922 (5), *C. lateralis* Mocquard, 1890 (5), *C. lumbricoidea* Boie, 1827 (4 or 5), *C. lumholtzi* Andersson, 1923 (5), *C. muelleri* Boulenger, 1896 (5), *C. palavanensis* Inger & Marx, 1965 (5), *C. prakkei* Lidth de Jeude, 1893 (5), and *C. suluensis* Taylor, 1922 (5).

Calamaria dominici sp. nov. differs from the following species by a distinctly higher ventral scale count in the female sex: *C. abstrusa* Inger & Marx, 1965 (145-152), *C. crassa* Lidth de Jeude, 1922 (158-164), *C. eiselti* Inger & Marx, 1965 (151-153), *C. linnaei* Boie, 1827 (148-166), and *C. melanota* Jan, 1862 (131-154).

Calamaria dominici sp. nov. differs from the following species by a distinctly higher subcaudal scale count in the female sex: *C. margaritophora* Bleeker, 1860 (8-11), *C. nuchalis* Boulenger, 1896 (9), and *C. sumatrana* Edeling, 1870 (10-14).

Calamaria dominici sp. nov. differs from *C. grabowskyi*

Fischer, 1885 by a distinctly lower subcaudal scale count in the female sex (20-28).

Calamaria dominici sp. nov. has the first three infralabials touching the anterior chin shields versus only two pairs of infralabials touching anterior chin shields in *C. borneensis* Bleeker, 1860.

In addition, *Calamaria dominici* sp. nov. differs from the remaining species at least by a distinct colour pattern: *C. battersbyi* Inger & Marx, 1965 (with narrow longitudinal stripes mid-dorsally), *C. oesemani* Inger & Marx, 1965 (with a continuous light stripe the entire length of the body), *C. doederleini* Gough, 1902 (with narrow dark brown crossbands on body and tail), *C. forcarti* Inger & Marx, 1965 (with narrow dark crossbands behind head, body without stripes, venter yellow), *C. gervaisii* Duméril, Bibron & Duméril, 1854 (usually with a dark-edged, interrupted, light stripe on first body scale row), *C. ingeri* Grismer, Kaiser & Yaakob, 2004 (with incomplete light transverse bands on body and tail), *C. modesta* Duméril, Bibron & Duméril, 1854 (with ventrals having dark pigment at least laterally), *C. schlegeli* Duméril, Bibron & Duméril, 1854 (dark above, light below, head yellow above and below or black above and yellow below, or intermediate conditions), *C. virgulata* Boie, 1827 (dorsally dark brown, each scale with a light network, with or without longitudinal dark stripes).

Etymology: Named *dominici* to honor Dominic T. Charles Scriven, founder of Wildlife at Risk (WAR), for his contribution towards wildlife conservation in Vietnam.

Suggested common names: Dominic's reed snake (English), Ran mai gam do-mi-nic (Vietnamese), Calamaire de Dominic (French), and Dominics Zwergschlange (German).

Distribution: *Calamaria dominici* is currently known only from the type locality (Fig. 5).

Natural history: The holotype was found in evergreen mixed forest of broadleaf and conifer trees. The snake was discovered on a forest path near a small creek, for about 50 m distance from a large creek (Figs 6-7). It was found, surface active, in a densely vegetated boggy area at 11:30. The surrounding habitat was primary forest consisting of dense understory punctuated with large boulders scattered over a ca. 20° slope that descended to a large creek. Dissection of the female holotype revealed ovaries with some eggs enlarge to 4 mm.

DISCUSSION

Calamaria are fossorial snakes and difficult to find. Thus, often only single individuals are available so that descriptions must be based on a single type specimen, as in the present case. Other such examples are *C. thanhi* and *C. abramovi* (Ziegler & Le, 2005; Orlov, 2009).



Fig. 5. Map of Vietnam with the type locality (large black dot) of *Calamaria dominici* sp. nov. in Ta Dung Nature Reserve, Dak Nong Province.



Fig. 6. Ta Dung Nature Reserve, Dak Nong Province, Central Highlands, Vietnam. Photo V. A. Tran.



Fig. 7. Habitat of *Calamaria dominici* sp. nov. in Ta Dung Nature Reserve, Dak Nong Province, Central Highlands, Vietnam. Photo R. D. Babb.

Inger & Marx (1965) defined the Great Sunda Archipelago, namely the Borneo-Sumatra region, as principle center of evolution and dispersal of the genus *Calamaria*, since it was home for more than 60% of the species known at that time. With six new *Calamaria* species having been described from Vietnam in the past 13 years, this country also seems to play a major role in reed snake diversification. With ten species of *Calamaria* recorded from Vietnam, this country now houses more than 16% of the 60 currently recognized species.

The megophryid anuran *Leptotalax tadungensis* Rowley, Tran, Le, Dau, Peloso, Nguyen, Hoang, Nguyen & Ziegler, 2016, now *Leptobranchella tadungensis* (see Chen *et al.*, 2018), is another recently described species from Ta Dung Nature Reserve, the type locality of *Calamaria dominici*. Also this recent frog discovery represents an endemic species for Ta Dung Nature Reserve (Rowley *et al.*, 2016). The conservation importance of this unique Nature Reserve is also underscored by the recent discovery of endemic plants such as *Aristolochia tadungensis* Do, Luu, Wanke & Neinhuis, 2015, a Pelican Flower from Ta Dung Nature Reserve (Do *et al.*, 2015).

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