THE RAFFLES BULLETIN OF ZOOLOGY 1999 **47**(2): 309-332

A REVISION OF THE GENUS *MACROCALAMUS* (SERPENTES: COLUBRIDAE), WITH DESCRIPTION OF A NEW SPECIES AND A KEY TO THE GENUS

Gernot Vogel
Society for Southeast Asian Herpetology, Im Sand 3, D-69115 Heidelberg, Germany

Patrick David
Laboratoire des Reptiles et Amphibiens, Muséum National d'Histoire Naturelle, 25 rue Cuvier, F-75005 Paris, France

ABSTRACT. - The Asian snake genus *Macrocalamus* (Serpentes, Colubridae), endemic to Peninsular Malaysia, is revised based on the examination of 119 preserved specimens in conjunction with observations on living, freshly collected animals. The species *M. lateralis* was previously reported as having a red or yellow venter, with or without ventrolateral stripes. It is shown that a positive correlation exists between the colour of the venter, the occurrence of the ventrolateral stripes, and morphological and meristic data. Therefore, the yellow-bellied form is considered to be specifically distinct from the red-bellied form. The hemipenes of two species (*M. lateralis, M. schulzi*, new species) are described for the first time. *Macrocalamus tweediei*, previously known from only three specimens, is redefined on the basis of nine recently collected animals. A key to the genus and new biological data are provided.

INTRODUCTION

Southeast Asia is especially rich in colubrid snake genera and species (see, for example, Welch, 1988). The genus *Macrocalamus* was erected by Günther (1864) to accommodate his new species *Macrocalamus lateralis*. Until now, three species of this poorly known genus of small, secretive, terrestrial montane snakes, were recognized (Welch, 1988). This genus, endemic to the mountains of Peninsular Malaysia, has no synonym. The type species, *Macrocalamus lateralis*, was regarded as a rare snake until Smedley (1932) found it to be common at high elevations in the hills of western Malaysia. Two species, *Macrocalamus tweediei* Lim, 1964 and *Macrocalamus jasoni* Grandison, 1972, were later described from a few specimens and are still poorly known. None of the three species has synonyms. There are few relevant references dealing with these animals, and little information is published on their variation and biology.

Received 1 Apr 1998 Accepted 8 Oct 1998

An examination of preserved specimens of *Macrocalamus*, including freshly collected animals still bearing their natural colours, led us to reconsider the variability of the nominal species *M. lateralis*, and the systematics of this genus. In addition we were also able to see nine recently collected *Macrocalamus tweediei*, a species for which Tweedie (1983) mentioned only three known specimens. This taxon is here redefined.

Hemipenes of *M. lateralis* and *M. schulzi*, new species are described for the first time. The currently known distribution of all species is also given, as well as a summary of their natural history.

MATERIALS AND METHODS

Morphometric, meristic and colouration characters were obtained by the examination of 119 preserved specimens, the list of which is given in Appendix I. Colouration of living specimens was taken from slides or from freshly collected material. The colour of the venter in life is an important character in our study. The form with the red venter is hereafter referred to as the "red venter" *lateralis*; the other form is called "yellow venter" *lateralis*.

We examined 18 characters: body colour and pattern (dorsal colour; ventral colour; number and percentage of specimens having ventrolateral stripes; number and percentage of specimens having a median stripe beneath the tail); morphometric characters (snout-vent length; tail length; ratio tail length/total body length); and meristic characters (number of ventrals [according to the Dowling's method (Dowling, 1951)]; number of subcaudals [terminal scute not included in the number]; number of dorsal scale rows at mid-body; number of supralabials [on left and right sides of head, respectively]; presence of subocular; number of supralabials entering orbit; number of preoculars [left / right]; number of postoculars [left / right]; number of temporals [left / right]; number of infralabials [left / right].

When appropriate, we give the range limits, mean value (x) and standard deviation (s). We did not use values published in the literature for the nominal species *lateralis*, as two species were confused, but we included data taken from the descriptions of *M. tweediei*.

In the species accounts, we mention primary references, then all chresonyms and literature citations. The chresonymy of each species is followed by a diagnosis and a description of the species with its known morphological and meristic variation.

Museum abbreviations follow Leviton et al. (1985): BM: British Museum of Natural History, now the Natural History Museum, London. - MNHN: Muséum national d'Histoire naturelle, Paris. - MTKD: Staatliches Museum für Tierkunde, Dresden. - ZFMK: Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn. - ZMB: Zoologisches Museum für Naturkunde der Humboldt-Universität zu Berlin, Berlin. - ZRC: Zoological Reference Collection, National University of Singapore, Singapore.

RESULTS

The data obtained from the examination of the specimens (listed in Appendix) are reported in Tables 1-3.

Table 1. Variation of morphological characters in the genus *Macrocalamus*.

Tn : total number of specimens examined; **n** : number of specimen for a given character; **TL :** total length (mm); **VLS %** : percentage of specimens having ventrolateral stripes; **TS %** : percentage of specimens having a median stripe beneath the tail; **tL/TL** : ratio tail length/total body length, by sex (limits of range, mean value x, standard deviation s).

Taxon	Tn	Dorsal colour	Ventral colour (in life)	Venter speckled	TL range (mm)	VLS %	TS %	Ratio tL/TL Total	M	F
lateralis "red venter"	47	dark brown, speckled or ocellated	pink to reddish	no	84-300	100	57.4 (1)	0.087 - 0.161 x = 0.117 (s = 0.0236) n = 42 (2)	0.122 - 0.161 x = 0.147 (s = 0.0109) n = 13	0.087 - 0.114 x = 0.100 (s. = 0.0058) n = 24
lateralis "yellow venter"	56	pale to , dark brown uniform	pale to bright yellow	no	128-391	0	19.6 (3)	0.087 - 0.156 x = 0.126 (s = 0.0197) n = 50 (2)	0.130 - 0.156 x = 0.144 (s = 0.0081) n = 25	0.087 - 0.119 x = 0.108 (s = 0.0078) n = 24
BM 1968-764	1	dark brown	yellow	strongly	194	100	100	-	0.149	-
tweediei	12 (4)	black	black and yellow	no	136-500	0	0	0.112 - 0.164 x = 0.135 (s = 0.0146) n =9 (2)	0.164 - - n = 1	0.112 - 0.150 x = 0.132 (s = 0.0116) n = 7
jasoni	3	black	black	no	— 755	0	0	-(5)	-(5)	0.080 - 0.100 x = 0.090 (s = 0.0078) n = 3

(1) In several specimens, the stripe beneath tail is faint.
(2) This value includes unsexed specimens.
(3) The stripe beneath tail is always incomplete and faint to very faint.
(4) The two types of *M. tweediei* plus a third specimen mentioned by Lim (1967) and Tweedie (1983) could not be examined in the present study. However, we include data given by these authors, as no confusion between other species is likely to occur.
(5) No male known.

DISCUSSION

As shown in Tables 1-3, the genus *Macrocalamus* is homogeneous in scalation and meristic data, with marked differences only in colouration and patterns. This apparent homogeneity led previous authors to consider that *Macrocalamus lateralis* was a quite variable snake, with either a yellow or reddish-orange venter, and with or without ventrolateral stripes and a median stripe beneath the tail. Smedley (1932: 119) considered that these differences were ontogenetic, with the lateral lines and red venter colour characteristic of young specimens. Subsequent authors merely mentioned two colouration variants, without further discussion (see, for example, Tweedie, 1983).

With the exception of the specimen BM 1968.764, which is discussed below, these data show that for all other specimens of the nominal species *lateralis* examined, a correlation exists between the venter colour, the dorsal markings, the presence or absence of ventrolateral stripes, and significant morphometric and meristic characters. However, after only some

Table 2. Variation of body meristical data in the genus *Macrocalamus*.

Co (m) : number of dorsal scale rows at midbody; **Ventrals** and **Subcaudals** by sex (limits of range, mean value x, standard deviation s, number of specimens n).

		Ventrals			Subcaudals		
Taxon	**Co (m)**	Total	M	F	Total	M	F
lateralis "red venter"	15	104 - 132 x = 116.1 (s = 6.15) n = 45 (1)	104 - 115 x = 110.1 (s = 2.96) n = 13	115 - 132 x = 120.3 (s = 4.11) n = 25	18 - 27 x = 22.2 (s= 2.95) n = 45 (1)	20 - 27 x = 25.4 (s = 2.02) n = 13	18 - 23 x = 20.3 (s = 1.35) n = 26
lateralis "yellow venter"	15	114 - 134 x = 123.7 (s = 6.15) n = 54 (1)	114 - 125 x = 119.4 (s = 2.91) n = 28	119 - 134 x = 129.5 (s = 4.33) n = 13	17 - 31 x = 25.1 (s = 3.04) n = 51 (1)	23 - 31 x = 27.5 (s = 1.62) n = 26	17 - 27 x = 22.5 (s = 1.92) n = 23
BM 1968-764	15	- -	124 -	- -	- -	29 -	- -
tweediei	15	128 - 147 x = 136.2 (s = 5.13) n = 11 (1)	128 - 134 x = 131.0 - n = 2	132 - 147 x = 137.6 (s = 5.00) n = 8	24 - 32 x = 27.3 (s = 2.33) n = 10 (1)	31 - 32 x = 31.5 - n = 2	24 - 28 x = 26.3 (s = 1.16) n = 7
jasoni	15	- - n = 3	- -	131-133 x = 131.7 (s = 0.94) n = 3	- - -	- - -	19-22 x = 20.7 (s = 1.25) n = 3

(1) This value includes unsexed specimens.

Table 3. Variation of meristic head data in the genus *Macrocalamus*.

Tn : total number of specimens; **N SpL %** : percentage of specimens with the indicated number of supralabials; **Pre-Oc** : number of preoculars

		N SpL %			
Taxon	**n**	7	7 & 8	8	**PreOc**
lateralis "red venter"	47	0	0	100	1
lateralis "yellow venter"	56	0	0	100	1 (2 (a))
BM 1968-764	1	0	0	100	1
tweediei	11	72.7	9.1	18.2	1
jasoni	3	0	0	100	1

(a) : two preoculars on left side in ZRC 2.2773.

months in preservative, the bright red colour of the "red venter" *lateralis* vanishes and becomes whitish, very pale pink or even pale yellow. It thus appears to be identical with the venter colour of the "yellow venter" *lateralis*. Nevertheless, both, the examination of about 20 freshly collected specimens (out of a total of 47) still bearing their natural colour, and the mention of "red venter" reported on tags of another 10 preserved specimens, allow us to unambiguously associate the red colour with the presence of ventrolateral lines.

The "red venter" form is associated with: (1) the constant presence of ventrolateral stripes and paravertebral the dorsal rows made of either black spots or of white, black-edged ocelli; (2) a lower mean value of ventral number; and (3) a marked sexual dimorphism in relative proportions of body. The "yellow venter" form is characterized by: (1) a constant absence of ventrolateral stripes; (2) a totally uniform dorsum; (3) a higher mean value of ventral number; and (4) a smaller difference in relative proportions of the body according to the sex. These conditions are summarized in Table 4.

A median stripe beneath tail is frequently present in "red venter" *lateralis* and rarely in "yellow venter" *lateralis*. This stripe beneath the tail is also present in one specimen of *Macrocalamus tweediei* described by Lim (1964) but absent in the other.

These data also demonstrated that the colour of the venter is not related to the age or the size of animals, contrary to the statement of Smedley (1932) and Lim (1967). The smallest measured "yellow venter" form (ZFMK 51160) has a total length of 128 mm, whereas the smallest "red venter" form is 84 mm long (BM 1974.3900). On the other hand, the largest "red venter" form is 300 mm long (BM 1946.1.7.23), versus 399 mm for the largest "yellow venter" form (ZMFK 16684). Adults of the red bellied *lateralis* are smaller than those of the yellow-bellied form (see Table 5 and Pl. 5), but the colour of the venter is not related to the age of the animal. We examined large adults of both forms with their respective bright venter colour.

Lastly, both forms occur sympatrically on the Cameron Highlands in the area of Tanah Rata and on Mt. Batu Berinchang, without obvious ecological differences.

The specimen BM 1968.764 does not fit with any other taxon. It was found on Mount Tahan (Gunong Tahan), about 60 km airline east from Cameron Highlands, and has both dark ventrolateral lateral stripes and a yellow venter that is finely but heavily speckled with black. So, it differs in the pattern of its venter both from "red venter" *lateralis* (venter not yellow nor speckled, lateral stripes always present) and "yellow venter" *lateralis* (venter not speckled, no lateral stripe). It also differs from *lateralis* "red venter", which has ventrolateral stripes, by a higher number of ventrals. Although it comes from a different area belonging to a disjunct mountain range, we refrain from formally recognizing it at the present time, pending the examination of further specimens.

The holotype of *M. lateralis* has both lateral stripes and a tail stripe according to Günther's (1864) description. The same author described it as having a whitish venter. We could see that the pink or red colour typical of *M. lateralis* became creamy white or pale yellow in preservative. Therefore, we consider the taxon with a yellow venter and no ventrolateral stripes, occurring in sympatry with the red-bellied form, to be specifically distinct from this red-bellied form. It represents a new taxon that we describe as *Macrocalamus schulzi* (see later).

Systematics of the genus *Macrocalamus*

Macrocalamus Günther, 1864

"*Macrocalamus*" Günther, 1863: 3 (nomen nudum).
Macrocalamus Günther, 1864: 198. - Type species. *Macrocalamus lateralis* Günther, 1864 by monotypy.

Comments. - The taxon was first mentioned by Günther (1863) without any diagnosis or description of the sole species included, making the name a *nomen nudum*. The first valid diagnosis appeared in Günther (1864). This genus has no junior synonym. Its relationships within the family Colubridae are unclear. According to V. Wallach (pers. comm.), *Macrocalamus* has strong tracheal lung, similar to *Pseudorabdion* and *Calamorhabdium*, both members of the Calamariinae (or Calamariini). In English, they are called "Mountain reed snakes" (Tweedie, 1983).

Diagnosis. - A colubrid snake genus characterized by: a cylindrical body, a head triangular, depressed, barely distinct from a thick neck with tapered preocular region and snout, 15 smooth dorsal scale rows, without apical pits throughout the body, internasals fused with prefrontals and a very elongate loreal.

Description. - Other characters of the body include: anal entire; subcaudals paired; tail short, rather thick and terminating in an acute, spiny scale.

Rostral higher than broad, triangular, well visible from above, totally separating the nasals from each other and contacting the prefrontals that are significantly notched by the rostral on their anterior margin; internasals fused with prefrontals; nasals entire, rather small, roughly pentagonal; nostril piercing shield between the lower margin of the nasal and the upper margin of the 1st supralabial; one pair of large prefrontals, followed by an hexagonal, elongated frontal, pointing caudally, that is located between one undivided supraocular on each side; a very large parietal separated from the 7th supralabial by the anterior temporal; one elongated loreal between the nasal and the preocular; 8 (rarely 7) supralabials, first very small, second and third always in contact with the loreal, fourth and fifth always entering orbit; 1 preocular (2 preoculars on left side in one specimen of *M. schulzi* [ZRC 2.2773] due to the division of the 4th supralabial); 1 postocular; no subocular; 1 squarish anterior temporal and 2 superposed posterior temporals, the superior one much longer than inferior; 7 infralabials.

A summary of the morphological and meristical characters in the genus *Macrocalamus* is given in Table 6. Living or freshly preserved specimens of *M. lateralis* and *M. schulzi* can easily be distinguished by the colouration of their venters. A comparison of venter colouration of *M. lateralis*, *M. schulzi* and *M. tweediei* can be found on Pl. 5 & 6.

Hemipenes. - The hemipenis of *Macrocalamus schulzi* is described later. We also examined hemipenes of *M. lateralis* (ZFMK 62496; SVL 141 mm; hemipenis length 9 mm) and *M. tweediei* (ZFMK 62497; SVL 280 mm; hemipenis length 11 mm). Both were prepared from preserved specimens according to the method described in Pesantes (1994) and Ziegler & Böhme (1997). These hemipenes do not differ conspicuously from those of *M. schulzi*. The hemipenes of *M. tweediei* are relatively smaller. In both *M. tweediei* and *M. lateralis* the calyculate surface extends more proximal on the truncus. However, because of the small

size and the delicate genital preparation of the hemipenes in these two species, some better preparations are required before more conclusive statements can be done.

Range. - Malaysia: Endemic to the mountain ranges of central Malaysia.

Biology. - This genus of small, terrestrial and secretive snakes inhabits tropical montane wet forests of Malaysia between ca. 1000 and nearly 2000 m above sea level. They are mostly found under moss, decaying logs, and in the litter on the floor of wet montane forest and in clearings, fields, and the vegetation along forests paths. These snakes seem to be restricted to moist areas. Most animals were encountered at night or basking in the early morning, but a large number were collected dead on roads. Members of the genus *Macrocalamus* feed mainly on invertebrates, earthworms and insects, although *M. tweediei* is known to take small lizards. All species seem to be oviparous. Little has been recorded on breeding habits; one female of *M. schulzi* (MNHN 1997.3270) kept in captivity laid four eggs in late August 1995. *Macrocalamus* spp. are reported as being very common in Cameron Highlands.

Macrocalamus lateralis Günther, 1864
(Pls. 2, 5-8)

"*Macrocalamus lateralis*" Günther, 1863: 3 (nomen nudum). - Type locality. "India".

Macrocalamus lateralis Günther, 1864: 199, pl. 18: fig. D. - Type locality. "From the continent", restricted by Tweedie (1963: 101) to Cameron Highlands, Pahang, Malaysia. - Holotype. BM 1946.1.7.23, adult male; coll. unknown.

Macrocalamus lateralis: Boulenger, 1894: 327, 1912: 153, fig. 47; Flower, 1899: 673; Smith, 1930: 57 (*part.*); Smedley, 1931: 50, 1932 (*part.*): 118; Tweedie, 1954: 53 (*part.*), 1957: 55 (*part.*), 1983: 60, fig. 13d (*part.*); Lim, 1964: 100 (*part.*), 1967 (*part.*): 122 & 124; Grandison, 1972: 90 (*part.*), 1978: 289; Welch, 1988: 75 (*part.*); Manthey & Grossmann: 365 (*part.*), 366: fig. 273.

Comment. - This species was described from a single specimen of unknown locality. The holotype has an anomalous head scalation, the loreals being fused with the prefrontals. Although it is a male, its numbers of ventrals and subcaudals are more typical of females. Günther (1864) and Boulenger (1894) stated that the holotype of *M. lateralis*, a male, had 118 ventrals. In the genus *Macrocalamus*, the Dowling's method for counting ventrals usually gives a value similar, or only one scale less, compared with other pre-Dowling methods. We examined this specimen and it appears that the value given by these two authors is incorrect; we found that the holotype has 114 ventrals, whatever the method used for their counting.

Diagnosis. - A *Macrocalamus* species characterized by both a red, pink or orange venter in life, the presence of one pair of dark ventrolateral stripes made by the dark colour of ventral plates tip, and dorsal colour brown with, at least on the anterior part of body, two discontinuous dorsal rows made of white, dark edged ocelli that are sometimes reduced to small black spots; often a median black stripe beneath the tail.

Description and variations. - Maximum known total length 298 mm (SVL 262 mm, tail length 36 mm; holotype), but usually much less; tail length / total length ratio 0.09-0.16 ($x = 0.12$; $s = 0.0236$), 0.12-0.16 in males ($x = 0.15$; $s = 0.011$), 0.09-0.11 in females ($x = 0.10$; $s = 0.006$); ventrals 104-132 ($x = 116.1$; $s = 6.15$), 104-115 in males ($x = 110.1$; $s = 2.96$), 116-132 ($x = 120.3$; $s = 4.11$) in females; subcaudals 18-27 ($x = 22.2$; $s = 2.95$), 20-27 in males ($x = 25.4$; $s = 2.02$), 18-23 in females ($x = 20.3$; $s = 1.35$).

The holotype has a rather abnormal morphology and scalation. Its tail is complete, its tail length/total length ratio (0.122) is lower than in other males (n = 14), all of which are greater than 0.135. Its number of subcaudals is also rather low, with 20 plates vs. 23 or more for other males. The holotype is also the largest specimen known.

An elongated loreal always present except in the holotype; 8 supralabials, second, third and fourth in contact with the loreal, fourth and fifth always entering orbit, seventh largest; scalation otherwise as given for the genus.

Upper surfaces in life and alcohol pale to dark brown or greyish-brown, usually with one discontinuous dorsal on each side of the back row made of white, dark edged, elongated ocelli located one or two scale rows from the vertebral row; the white ocelli are sometimes much reduced, appearing as black spots that are better defined on anterior part of body; each lower side of body marked with a ventrolateral dark stripe made by the dark tips of every ventral plate, bordered above by a pale line made by the pale colour of the lowest row of dorsal scales, making the dark stripe quite vivid. Some animals have a pale streak running from the parietals, or sometimes only from the posterior temporals, that extends to the ventrals; in a fewer animals this streak is followed by two short, parallel and similarly coloured streaks on each side that are indifferently dark edged; frequently a dark median, zigzag-like stripe beneath the tail. The venter is vividly pink, coral red or orange in life, becoming pale pink, very pale yellow or creamy white in preservative; sometimes a few dark, scattered spots on venter. The colouration of juvenile and adults is similar.

Table 4. Characteristic variation in relation to the venter colour of *M. lateralis*

Venter colour	Dorsal pattern	Ventrolateral stripes	Ratio tl/TL male/female	Mean number of ventrals	Number of ventrals in males
reddish	speckled or ocellated	present	0.147 / 0.100	116.1	104-115
yellowish	uniform	absent	0.144 / 0.108	124.0	114-125

Range. - Malaysia: Pahang: Cameron Highlands (Tanah Rata, Mt. Batu Berinchang), Bukit Fraser (formerly Fraser's Hills); Perak: Bukit Larut (formerly Maxwell's Hills).

Biological data. - This terrestrial, secretive, forest litter species has been found in tropical wet forests from 1100 to 1500 m elevation. Lim (1967) mentioned an elevation of 6300 ft [1920 m], but it is possible that this record refers to *M. schulzi*. Lim (1964) found specimens under logs on Mt. Batu Berinchang. Lim (1967) often found specimens basking on the road in early morning. According to Tweedie (1954, 1983) and Lim (1967), this species feeds on worms, slugs, insects and their larvae, but these observations may also apply to *M. schulzi*. In captivity, our specimens accepted crickets. Nothing is known about the breeding habits of this species. It is regarded as common in its range, and Lim (1967) described it as being one of the most common snakes on Mt. Batu Berinchang. As most of the examined specimens previously labelled in collections as *M. lateralis*, are in fact *M. schulzi*, it is likely that *M. schulzi* is the most common species.

Macrocalamus cf. *lateralis*

Macrocalamus lateralis: Smith, 1922: 266, 1930: 57 (*part.*).

Comments. - Smith (1922, 1930) described under the name *Macrocalamus lateralis* a single specimen with a dark ventrolateral stripes, a median stripe below the tail, a yellow venter (like *M. schulzi*) and a high number of ventrals. We examined this animal (BM 1968.764) and it differs from both *M. lateralis* and *M. schulzi*. Because of these differences, and its disjunct distribution, we cannot presently assign it to any taxon. We list it here under the name *Macrocalamus* cf. *lateralis* pending the examination of further specimens from Gunong Tahan, and we do not consider it in the chresonymy and in the distribution of *M. lateralis*.

Description. - Only a single male specimen is known, with the following characters: total length: 194 mm (svl 165 mm, tail length 29 mm); tail length / total length ratio 0.149; ventrals 125; subcaudals 29. Otherwise, head and body scalation like *M. lateralis* and *M. schulzi*.

Upper surface dark brown, nearly uniform; faint oblique yellow bands on the neck sides and anterior part of body; each side of body marked with a ventrolateral black stripe made by the dark tips of every ventral plate, bordered dorsally by a pale line due to the pale colour of the lowest row of dorsal scales; venter dark, dirty yellow, finely but heavily speckled with minute black spots on the anterior margin, the middle and the outer tips of each ventrals, making the venter dark and dirty-looking; a dark median, zigzag stripe beneath the tail.

Range. - Malaysia: Pahang: Bukit Tahan (Mt. Tahan).

Biological data. - Nothing is known about this animal, except that it was caught between 1650 m and 1750 m above sea level.

Macrocalamus jasoni Grandison, 1972
(Pls. 13-16)

Macrocalamus jasoni Grandison, 1972: 88, fig. 4. - Type locality. "On track below camp 5 at about 5800 ft, Gunong Benom, C. Pahang, West Malaysia" = Mt. Benom, 1770 m, Pahang, Malaysia. - Holotype. BM 1967.2283, adult female, London; coll.: John A. Bullock, 9 Apr.1967. - Paratypes. BM 1967.2284, female, from Gunong Benom, 6500 ft [1980 m], and BM 1967.2285, female, from Gunong Benom, 5800 ft [1770 m].

Macrocalamus jasoni: Grandison, 1978: 289; Tweedie, 1983: 61; Welch, 1988: 75; Manthey & Grossmann: 367, fig. 136.

Comments. - This species is known only from three female specimens.

Diagnosis. - A large and stout *Macrocalamus* species characterized by a deep black upper surface marked with a pair of orange dorsal stripes and a bright yellow venter, with tip of ventrals marked with black.

Description and variations. - Maximum known total length 752 mm (SVL 692 mm, tail length 60 mm; BM 1967.2283); tail length / total length ratio for the three known females 0.08-0.10 (x = 0.090; s = 0.008); ventrals 131-133 (x = 131.7; s = 0.94); subcaudals 19-22 (x = 20.7; s = 1.25).

Head more or less triangular, quite elongate and narrow, much depressed, not distinct from a thick neck and with a rounded snout.

An elongate loreal always present; 8 supralabials, second, third and fourth in contact with the loreal, fourth and fifth entering orbit, seventh largest; scalation otherwise as given for the genus.

Upper surfaces deep iridescent black, marked on each side with a reddish-brown or rusty stripe extending from the nape to the tip of the tail where they meet; these dorsal stripes are located on the 5-7th dorsal rows and are about 1.5 to 2 scales wide; they are sometimes interrupted by a length of 1 or 2 scales; a short diffuse, yellowish-brown streak runs on the 2nd and 3rd dorsal rows on the anterior part of the body, for a length of about 25 ventrals; some scattered scales of flanks tinted with yellow. Upper head surface dark reddish-brown with a lighter snout tip; supralabials, mental and chin shields yellow or yellowish-brown marked with black; a black spot on the 3rd and 7th pairs of infralabials; lower part of neck yellow, up to the middle of the flank; venter bright yellow, with outer tips of ventrals black; venter either totally uniform or with ventrals widely marked with black along the middle throughout the body length, or only anteriorly, giving the appearance of a broad, discontinuous median stripe that is best defined anteriorly.

Range. - Malaysia: Pahang: Gunung Benom (Mt. Benom). Known only from the type locality.

Biological data. - All known animals were found in damp habitat in leaf litter on the floor of a montane wet forest or crossing a track, between 1770 and 1980 m. The natural diet is unknown. The holotype was gravid when collected in early April.

Macrocalamus schulzi, new species

(Pls. 1, 4-5, 9-12. Figs. 1-2)

Macrocalamus lateralis (non *Macrocalamus lateralis* Günther, 1864): Smith, 1930: 57 (*part.*); Tweedie, 1954: 53 (*part.*), 1957: 55 (*part.*), 1983: 60 (*part.*); Lim, 1964: 100 (*part.*), 1967 (*part.*): 122 & 124; Lardner, 1994: 7.
Macrocalamus cf. *lateralis*: Manthey & Grossmann: 366, fig. 274.

Material examined. - Holotype. - ZFMK 51159, Bonn; adult male, from Tanah Rata (ca 4°29'N, 101°23'E), Cameron Highlands, Pahang, Malaysia; coll. Klaus-Dieter Schulz, Jun./Jul.1989, deposited Sep.1989.

Paratypes (7 specimens). - MNHN 1997.3269, MTKD 39360, SMF 78368, all adult males from Cameron Highlands, Pahang, Malaysia; ZRC.2.3697, MNHN 1997.3268, ZFMK 65036, adult females, same locality; ZMB 49143, juvenile, from Mt. Batu Berinchang, Cameron Highlands, Pahang, Malaysia.

Diagnosis. - A species of *Macrocalamus* characterized by a yellow, unspeckled venter, the yellow colour being present both in young and adult specimens and retained in preservative, uniform dorsal colouration, the complete absence of ventrolateral stripes, and the number of ventrals ranging in males from 114 to 125.

It differs from *Macrocalamus lateralis*, its presumed nearest relative, which has both ventrolateral stripes and a pink to pale red venter in life, a speckled or ocellated dorsum, at least on its anterior half, and the number of ventrals ranging in males from 104 to 115.

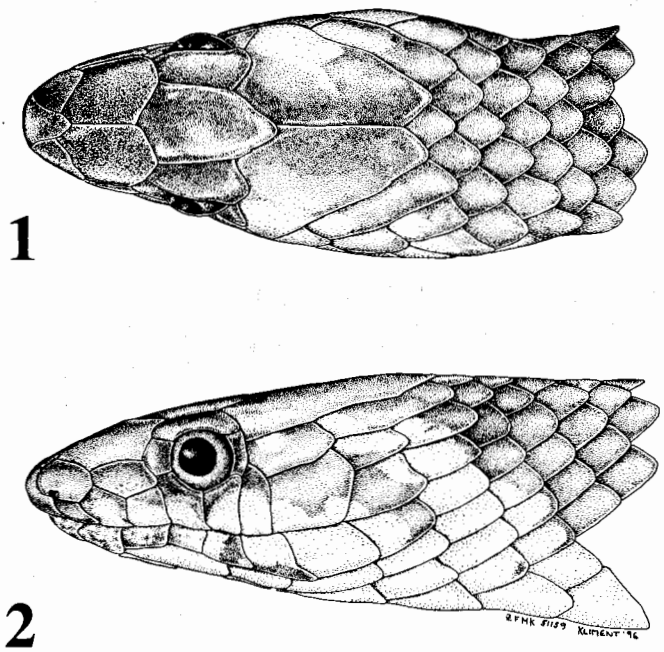
The background colour of *M. tweediei* and *M. jasoni* is deep coal black above and black and yellow below.

Description of the holotype. - Head triangular strongly tapering in dorsal view, not distinct from neck; body round, covered with smooth scales; 15 dorsal scale rows behind head, 15 at midbody and 15 before vent; 123 ventrals, 29 paired subcaudals plus the terminal scute; anal entire.

Rostral much higher than broad, triangular and largely visible from above, totally separating the nasals each from another, and reaching the prefrontals that are significantly notched by the rostral on their anterior margin; internasals absent; nasals entire, pentagonal; nostril piercing the lower margin of the nasal, adjacent to the upper margin of the 1st supralabial; one pair of large prefrontals; a hexagonal, elongated frontal, pointing caudally, located between an undivided supraocular on each side; two very large parietals separated from the supralabials by the temporals; 1 elongated loreal, twice as long as wide; 1 preocular; 1 postocular; no subocular; 1 squarish anterior temporal and 2 posterior temporals, the upper one being much longer; 8 supralabials, 2nd, 3rd and 4th in contact with the loreal, 4th and 5th entering the orbit, 7th the largest; 7 infralabials; first pair of infralabials in contact, 6th the largest.

Total length 383 mm, snout-vent length 326 mm, tail length 57 mm; tail length / total length ratio 0.149.

Dorsal surface uniformly brown; some scales lighter on their anterior edge and darker on the posterior one; outer dorsal scale row pale yellow, mottled below with brown; venter yellow; tips of ventrals light brown, forming a broad, indistinct ventrolateral stripe beginning on 6th ventral; 4th ventral with two brown spots; tail uniformly brown above, subcaudals



Figs. 1-2. *Macrocalamus schulzi*, new species (ZFMK 16684). 1. dorsal view of the head. 2. lateral view of the head; drawing by Petr Kliment.

yellow below and brown laterally, entirely brown on the posterior part of the tail; head brown above, with a light temporal streak extending from the parietals to the throat; two oblique yellow stripes, parallel to the temporal streak, extending on the neck from the top of the back down to the ventrals, the second barely distinct; throat uniformly yellow.

Description of the paratypes. - A summary of morphological and meristic data of the paratypes is given in Table 6.

All other morphological, colouration and scalation features agree with those of the holotype. There is little variation in the colouration except for the juvenile (ZMB 49143), which is described separately below. In all other paratypes, the dorsal colour is chestnut brown. The temporal streak is present in all paratypes; the two oblique, parallel yellow streaks on neck side are present, some specimens showing the remaining of a faint third streak. The venter colour is identical with that of the holotype, except for the dark markings on the throat. Lower surface of tail identical with that of the holotype, except for MTKD 39360, which has a very faint median stripe.

The juvenile (ZMB 49143) is slightly different from the other paratypes, having a more vivid pattern. The dorsal colour is dark brown. The temporal streak is present. Instead of the two to four oblique lateral streaks on the neck in adults, there are 12 oblique parallel streaks, the last one ending at the level of ventral 39. These streaks are followed by light spots forming the dorsolateral row on 5th dorsal scale rows extending up to the tip of tail. There is no median stripe beneath the tail.

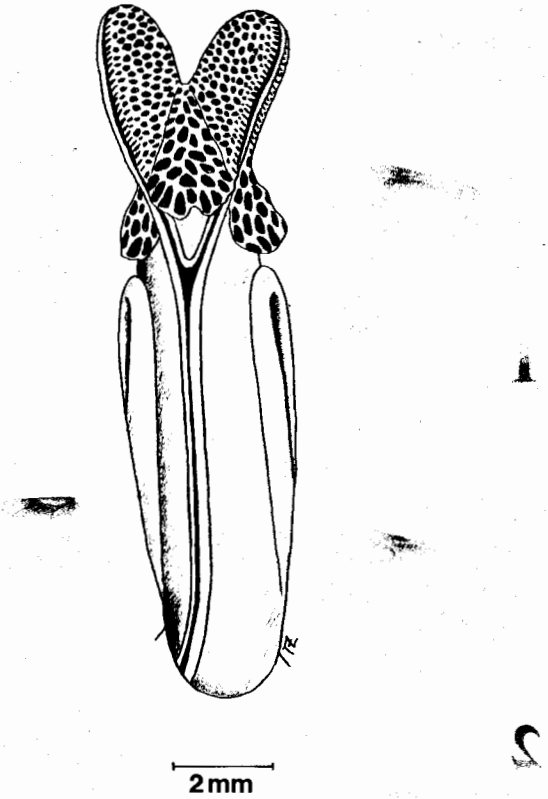


Fig. 3. *Macrocalamus schulzi*, new species (ZFMK 16684), hemipenis; drawing by Thomas Ziegler.

Variation (48 specimens). - Maximum total length reaching at least 400 mm; largest measured specimen 399 mm (ZFMK 16684; SVL 342 mm), but one damaged specimen (SMF 78390) with a snout-vent length above 350 mm was examined; tail length / total length ratio 0.09-0.16 (x = 0.127; s = 0.0196), 0.13-0.16 in males (x = 0.144; s = 0.008), 0.09-0.12 in females (x = 0.108; s = 0.008); ventrals 114-134 (x = 123,2; s = 5.9), 114-125 in males (x = 119.4; s = 2.9), 119-134 (x = 129.5; s = 4.3) in females; subcaudals 17-31 (x = 25.1; s = 3.07), 23-31 in males (x = 27.4; s = 1.6), 17-27 in females (x = 22.5; s = 1.9).

An elongated loreal always present; 8 supralabials, second, third and fourth in contact with the loreal, fourth and fifth always entering orbit, seventh largest; one preocular (2 preoculars on left in specimen ZRC 2-2773 due to the division of the 4th supralabial); scalation otherwise as given for the genus.

Colouration in preservative. - Upper surface reddish-brown to dark brown, totally uniform or sometimes with irregular faint black transverse markings; from two to four oblique yellow bands on the side of the neck and forepart of body, sometimes very vivid, the last two often barely visible, depending on the age of specimens; no ventrolateral black stripe, or a faint, irregular darker markings on tips of ventrals; sometimes a faint dark median, zigzag-like stripe beneath the tail; venter yellow or yellowish-brown, becoming creamy white with time, entirely uniform.

Colouration in life. - The colouration in life is identical to the preceding, except that the venter is bright yellow.

Description of the hemipenis (Fig. 3). - From ZFMK 16684 (SVL 320 mm; terminology following Böhme, 1988). Fully everted hemipenes elongate, total length 15-16 mm, apically folded and bilobed only along its distal part; pedicel and truncus largely without ornamentation but exhibiting unique bilateral concave bulges that narrow proximally; apex covered with numerous calyces that become smaller towards the tips of the short lobes; basal region of lobes with lateral enlargements of the calyculate surface; *sulcus spermaticus* bifurcate for about 1/3 of its length, with the branches terminating laterally at the tips of the lobes.

Etymology. - We are pleased to name this new taxon in honour of Mr. Klaus-Dieter Schulz (Würselen, Germany), who collected and sent us specimens that allowed us to determine this new species, and for his major contribution to the knowledge of the snake fauna of Southeast Asia, especially of the genus *Elaphe*.

Range. - Malaysia: Pahang: Cameron Highlands (Tanah Rata, Mt. Batu Berinchang). This species is currently known only from wet, forested mountains between 1000 and 1800 m.

Biological data. - This secretive terrestrial species was collected under sphagnum moss and in the litter on the floor of montane tropical wet forests, under wet moss and vegetation among terrace fields, and on forest roads or along their sides. Most specimens are seen crawling at night. Lardner (1994) observed most of its specimens crawling at night on roads or along their sides. Members of this species are frequently found on dead on roads in the morning. In the same biotope, scincid lizards *Larutia trifasciata* and earthworms were observed. The natural diet is not well known. Specimens mentioned by Lim (1967) as *M. lateralis*, but most likely referable to the present species, contained insect larvae and cockroaches. Another snake, also probably belonging to this species, had eaten an earthworm (Smedley, 1932). In captivity, our specimens refused crickets, earthworms and baby mice.

Table 5. Morphological and meristical data of paratypes of *M. schulzi*.

SVL: snout-vent length (mm); **tL**: tail length (mm); **tL/TL**: tail length/total body length ratio; **Ven**: number of ventrals; **Sc**: number of subcaudals; **Co (m)**: number of dorsal scale rows at midbody; **Largest InL**: largest infralabials.

Collection number	Sex	Dorsal colour	Ventral colour	Lateral stripe	SVL (mm)	tL (mm)	Ratio tL/TL	Ven	Sc	Co (m)	Largest InL
MTKD D 39360	M	brown	yellowish	no	236	36	0.132	119	28	15	6
MNHN 1997.3269	M	brown	yellowish	no	245	41	0.143	115	27	15	6
SMF 78368	M	brown	yellowish	no	320	-	-	125	-	15	6
ZRC.2.3697	F	brown	yellowish	no	329	36	0.099	132	23	15	6
MNHN 1997.3268	F	brown	yellowish	no	310	40	0.114	133	24	15	6
ZFMK 65036	F	brown	yellowish	no	309	36	0.104	134	22	15	6
ZMB 49143	F	dark brown	yellowish	no	124	14	0.101	132	23	15	6

One adult displayed a rather surprising strong constriction behaviour when coiled around a thumb (B. Lardner, pers. comm.). One female (MNHN 1997.3270), kept in captivity by one of us (GV), laid 4 eggs on August 28th 1995.

This species is common in the Cameron Highlands (Lardner, 1994). A specimen (ZMB 57220) was removed from the stomach of a *Maticora intestinalis* (ZMB 57221) found dead on the road in the Cameron Highlands, between Tanah Rata and Berinchang, after a heavy rainshower (Grossmann, pers. comm.). About half of the *Macrocalamus* body was hanging out of the *Maticora*'s mouth.

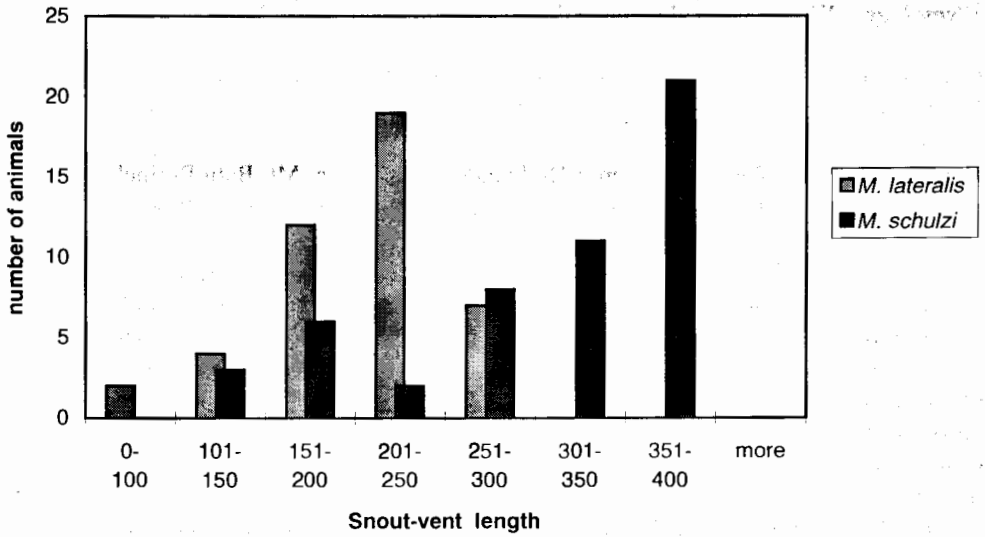


Fig. 4. Snout-vent length of *Macrocalamus lateralis* and *M. schulzi*.

Macrocalamus tweediei Lim, 1964

(Pls. 3, 5)

Macrocalamus tweediei Lim, 1964: 100, fig. 1, pl. 2. - Type locality. "Gunong Brinchang, Cameron Highlands, Pahang, at an elevation of 6000 ft" = Mt. Batu Berinchang in Pahang, 1830 m. - Holotype. R 57,656, male, Institute for Medical Research, Kuala Lumpur, now ZRC.2.2174, Zoological Reference Collection, Singapore; coll. Lim Boo Liat & H. E. McClure, 2 Oct. 1959. - Paratype. R 54,070, Institute for Medical Research, Kuala Lumpur, now FMNH 109868, Field Museum of Natural History, Chicago, female, from the same locality as holotype, elevation 1500 m; coll. Phang Ong Wah & M. Nadchatram, 10 Nov.1958.

Macrocalamus tweediei: Grandison, 1972: 90, 1978: 289; Sly, 1976: 156; Tweedie, 1983: 60; Welch, 1988: 75; Manthey & Grossmann: 366, fig. 275.

Comments. - This species was previously known from three specimens (Tweedie, 1983). Nine freshly collected specimens were examined in this study. The species is redescribed and its variation is redefined.

Diagnosis. - A *Macrocalamus* species characterised by an uniform deep black dorsal colour and a black and yellow or white chequered venter; no ventrolateral stripe; usually 7, sometimes 8 supralabials.

Description and variations. - The body is round, cylindrical and covered with smooth scales on 15 dorsal rows throughout; head more or less triangular, rounded, depressed, not distinct from a thick neck, anal entire; subcaudals paired; tail short, rather thick and ended by an acute, spiny scale.

A large species, reaching about 500 mm in total length; tail length / total length ratio 0.112-0.165 ($x = 0.135$; $s = 0.0146$), 0.164 in one male, 0.115-0.15 in eight females ($x = 0.132$; $s = 0.011$); ventrals 128-147 ($x = 136.2$; $s = 5.13$), 128-134 in two males ($x = 131.0$), 132-147 ($x = 137.6$; $s = 5.00$) in eight females; subcaudals 24-32 ($x = 27.3$; $s = 2.33$), 31-32 in males ($x = 31.5$; $s = 0.5$), 24-28 in females ($x = 26.3$; $s = 1.16$).

Rostral higher than broad, triangular, well visible from above, totally separating the nasals from each other, and contacting the prefrontals that are significantly notched by the rostral on their anterior margin; internasals fused with prefrontals; nasals entire, rather small, roughly pentagonal; nostril piercing the lower margin of the nasal and the upper margin of the 1st supralabial; one pair of large prefrontals; one very elongate loreal present between the nasal and the preocular; 7 supralabials (in 8 specimens), 7, 8 (in specimen SMF 78389) and 8 (in two specimens, ZRC.2.3700, ZMB 56887), first very small, second and third always in contact with the loreal, sometimes the fourth also in contact with the loreal, fourth and fifth always entering orbit, sixth largest (when there are 7 supralabials) or seventh largest (8 supralabials); 1 preocular; 1 undivided supraocular; 1 postocular; no subocular, one undivided supraocular; frontal hexagonal, elongated, pointed caudally; 1 anterior and 2 posterior temporals, the upper the larger of the two; 7 infralabials.

Upper surfaces in life uniformly deep coal black; venter also deep black, marked or chequered with large yellow square blotches, either placed alternately with each other on each side of the venter, or confluent into a single series of ventral markings, 2 to 3 ventrals wide and separating each other by 2 or 3 ventrals; head black with lateral yellow markings extending onto supralabials and infralabials, then towards venter, sometimes meeting ventrally. In alcohol, the sole difference is that the ventral yellow blotches become whitish.

Table 6. Summary of morphological and meristical characters in *Macrocalamus*

TAXON	TAIL LENGTH / TOTAL LENGTH RATIO			VENTRALS			SUBCAUDALS		
	General	Males	Females	General	Males	Females	General	Males	Females
lateralis	0.087 - 0.161	0.122 - 0.161	0.087 - 0.114	104 - 132	104 - 115	116 - 132	18 - 27	20 - 27	18 - 23
schulzi	0.087 - 0.156	0.130 - 0.156	0.087 - 0.119	114 - 134	114 - 125	119 - 134	17 - 31	23 - 31	17 - 27
tweediei	0.112 - 0.164	0.164	0.112 - 0.150	128 - 147	128 - 134	132 - 147	24 - 32	31 - 32	24 - 28
jasoni	-	-	0.080 - 0.100	131 - 133 (1)	-	131 - 133 (1)	19 - 22 (1)	-	19 - 22 (1)

(1) No male known.

The colouration of the two juveniles that we examined (ZFMK 65037, SVL 120 mm; SMF 78389, SVL 119 mm) is entirely similar to that of the adult. According to Sly (1976), the colouration of the ventral surface of a juvenile (size not reported) was uniformly black with the posterior margin of the ventral scales edged with yellowish-orange. Its throat was somewhat mottled. Sly believes that the chequered pattern of the venter had not yet developed, and the mottling of the throat gave the impression that the chequered pattern found in adults was beginning to develop in that region.

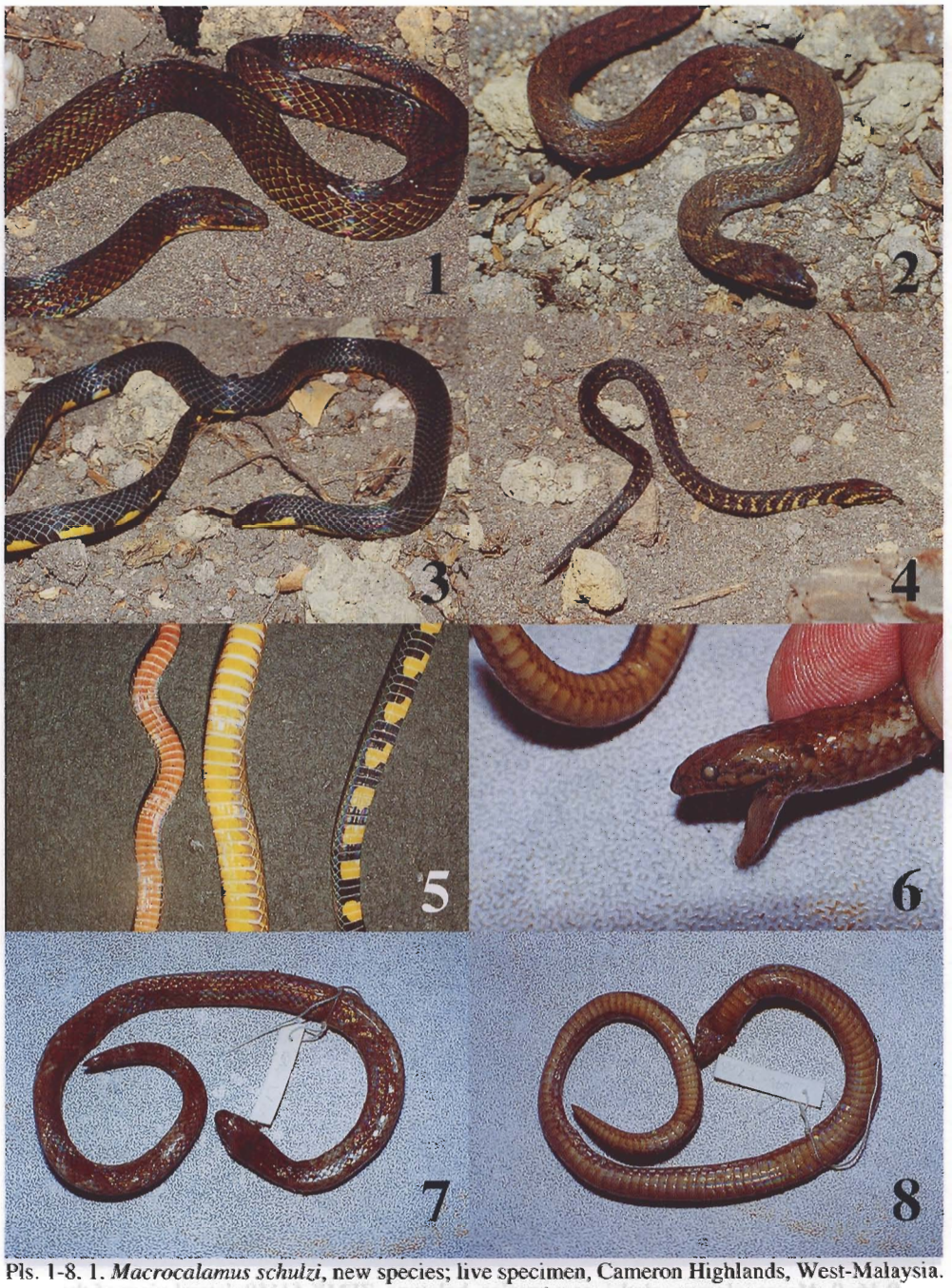
Range. - Malaysia: Pahang: Mt. Batu Berinchang, in Cameron Highlands; Selangor: Jabatan Talikom station, Mt. Ulu Kali, Genting Highlands.

Biological data. - This species has been found between 1500 and 1800 m in wet montane forests, under logs besides a mountain stream, and on a forest track. A juvenile described by Sly (1976) was collected on a road. This secretive, sluggish snake is associated with fairly damp biotopes. In captivity, we observed one specimen coiling itself around a soaked pad. It fed upon young house geckos, while refusing crickets, baby mice and earthworms. Nothing is known about its breeding habits. This species occurs in sympatry with *M. schulzi* and *M. lateralis* on Mt. Batu Berinchang.

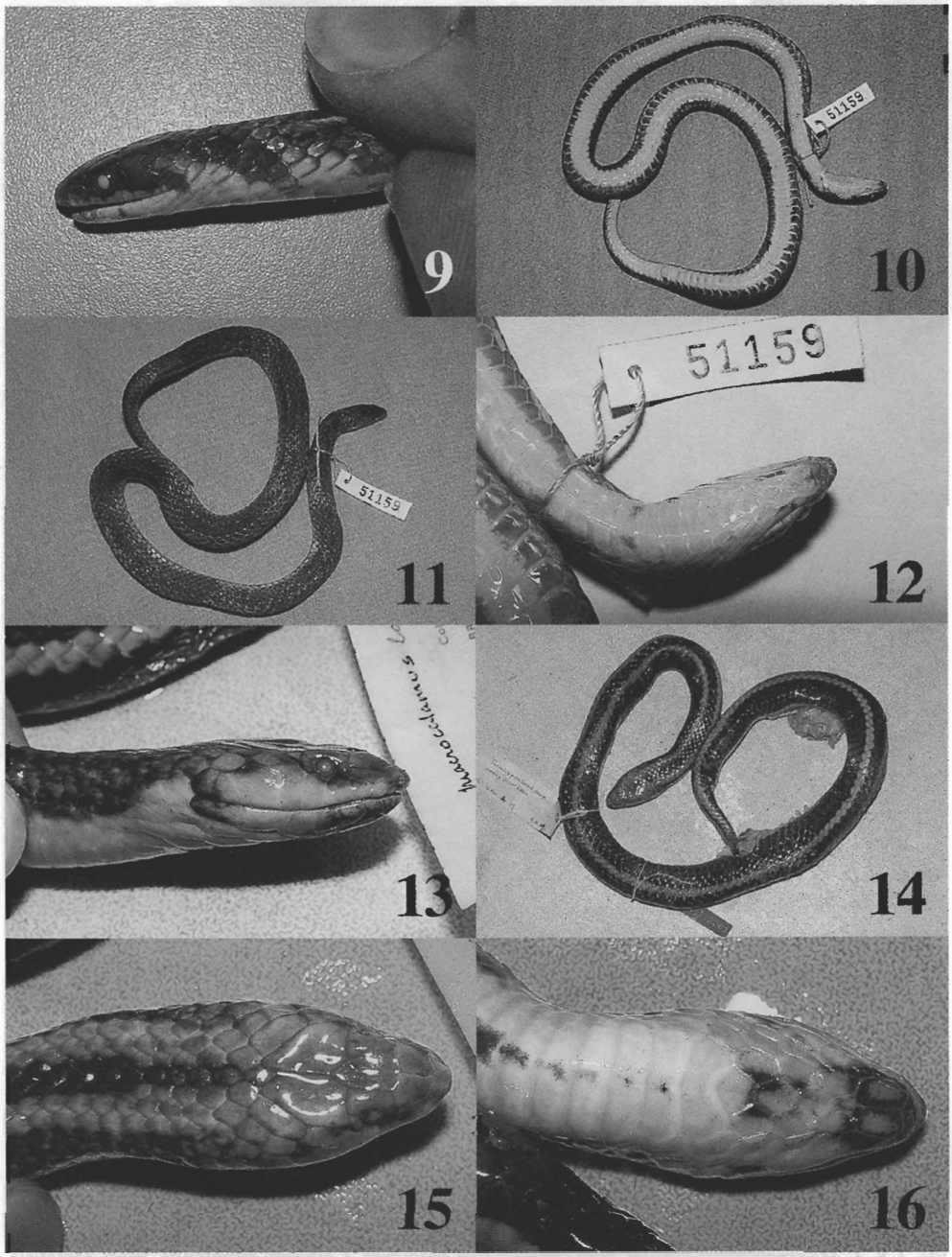
Relationships of the genus *Macrocalamus*

The position of the genus within the Colubridae is controversial. It is placed either in the subfamily Lycodontinae (Dowling & Duellman, 1978, in tribe Lycodontini; Dowling, m.s., 1988) or Calamariinae (McDowell, 1987). Tweedie (1983) considers it to be related to the genus *Calamaria*, and calls its members "Mountain reed snakes".

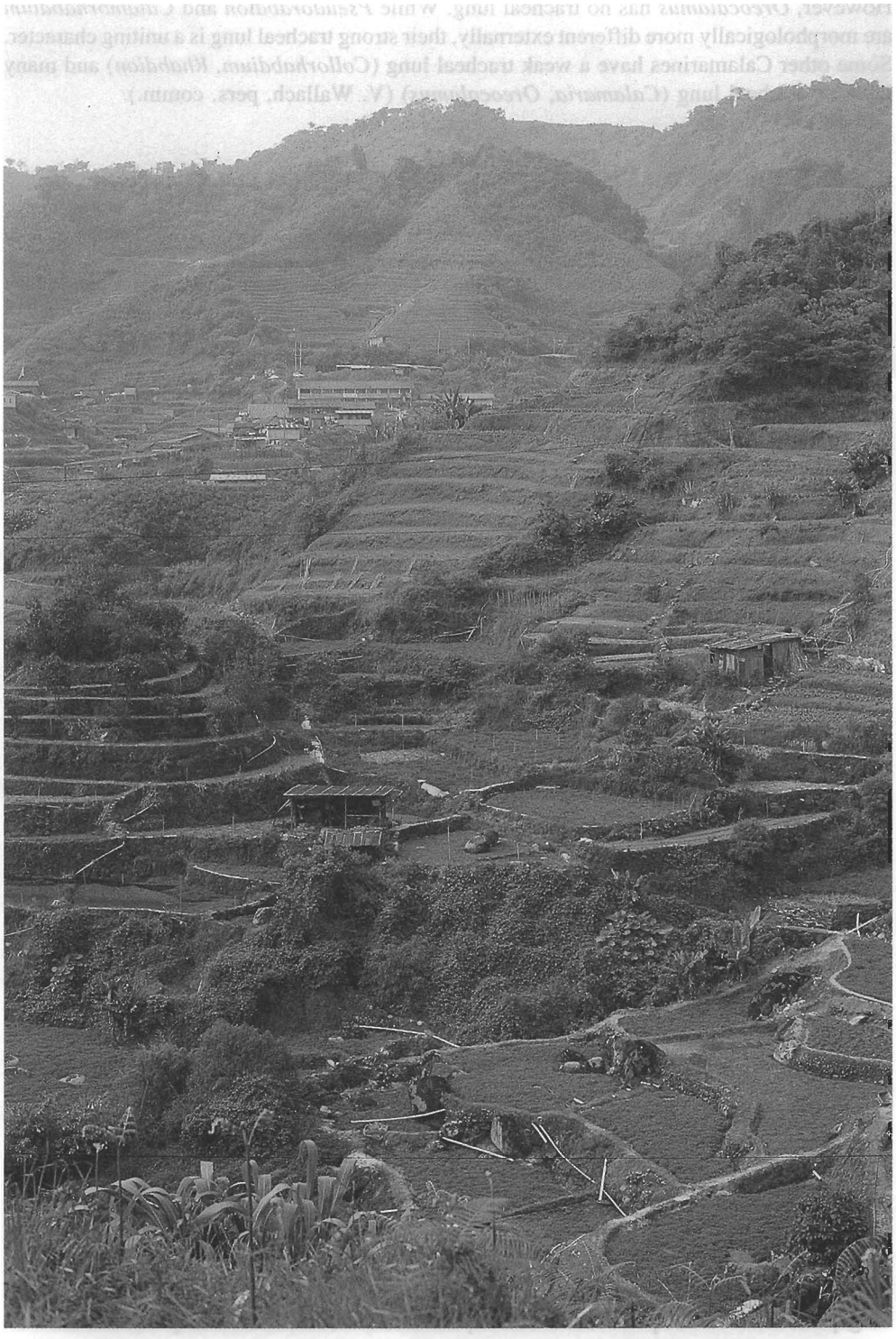
The closest relative to *Macrocalamus*, at least on the basis of morphology and pholidosis, seems to be the genus *Oreocalamus* Boulenger, 1899. The sole known species of this genus, *Oreocalamus hanitschi* Boulenger, 1899 (Boulenger, 1899: 453. Type locality: Kina Balu, 4200 feet), is endemic to the Federation of Malaysia and is currently known from Mt. Kinabalu, Mt. Lumatu (both Sabah on Borneo Island) and Gunong Brinchang, now Mt. Batu Berinchang, in the Cameron Highlands (Pahang, Malaysia) (Lim, 1972; Tweedie, 1983). The habitus and scalation of this genus is similar to *Macrocalamus*, from which it differs by the number of dorsal scale rows (17 at midbody) and the presence of a pair of internasal shields. In *Oreocalamus*, the first upper labial may either be distinct or united to the nasal. Quite interestingly, a dark, median zigzag-like stripe beneath the tail is present like in



Pls. 1-8. 1. *Macrocalamus schulzi*, new species; live specimen, Cameron Highlands, West-Malaysia. 2. *Macrocalamus lateralis*; live specimen, Cameron Highlands, West-Malaysia. 3. *Macrocalamus tweediei*; live specimen, Cameron Highlands, West-Malaysia. 4. *Macrocalamus schulzi*, new species; young live specimen, Cameron Highlands, West-Malaysia. 5. Comparison of the bellies of the three *Macrocalamus* species from Cameron Highlands, West-Malaysia. From left to right: *Macrocalamus lateralis*, *M. schulzi*, *M. tweediei*. 6. BM 1946.1.7.23, *Macrocalamus lateralis*, holotype; lateral view of the head. 7. BM 1946.1.7.23, *Macrocalamus lateralis*, holotype; dorsal view. 8. BM 1946.1.7.23, *Macrocalamus lateralis*, holotype; ventral view. (Photos by Gernot Vogel).



Pls. 9-16. 9. ***Macrocalamus schulzi***, new species, holotype, ZFMK 51159, lateral view of the head. 10. ***Macrocalamus schulzi***, new species, holotype, ZFMK 51159, ventral view. 11. *Macrocalamus schulzi*, new species, holotype, ZFMK 51159, dorsal view. 12. *Macrocalamus schulzi*, new species, holotype, ZFMK 51159, ventral view of the head. 13. BM 1967.2283 *Macrocalamus jasoni*; holotype; lateral view of the head. 14. BM 1967.2283 *Macrocalamus jasoni*; holotype; dorsal view. 15. BM 1967.2283 *Macrocalamus jasoni*; holotype; dorsal view of the head. 16. BM 1967.2283, *Macrocalamus jasoni*; holotype; ventral view of the head. (Photos by Gernot Vogel).



Pl. 17. Biotope of *Macrocalamus schulzi*, new species, Cameron Highlands, West-Malaysia. This species was commonly found under the moss along the fields. (Photo by Gernot Vogel)

Macrocalamus. A review of the genus *Oreocalamus* will be given in a forthcoming paper. However, *Oreocalamus* has no tracheal lung. While *Pseudorabdion* and *Calamorhabdium* are morphologically more different externally, their strong tracheal lung is a uniting character. Some other Calamarines have a weak tracheal lung (*Collorhabdium*, *Rhabdion*) and many have no tracheal lung (*Calamaria*, *Oreocalamus*) (V. Wallach, pers. comm.).

IDENTIFICATION KEY TO THE GENUS *MACROCALAMUS*

1 Upper surface deep coal black, with or without a pair of yellow dorsal stripes; venter at least partially deep black 2
- Upper surface pale to dark brown, reddish-brown or greyish-brown, never deep black and without dorsolateral stripes; venter colour never black 3

2 Venter chequered deep black and yellow; dorsal surface uniform, without stripes; usually 7 (rarely 8) supralabials ..... *Macrocalamus tweediei*
- Venter uniformly bright yellow or orange; dorsal surface with a pair of bright yellow dorsal stripes; 8 supralabials ..... *Macrocalamus jasoni*

3 Venter uniform, without any marking 4
- Venter heavily speckled with black ..... *Macrocalamus* cf. *lateralis*

4 A pair of dark ventrolateral stripes; venter bright red, orange or pink in life, creamy white or pale pink in alcohol; upper surface marked with dorsolateral ocelli; often a median stripe under the tail; 115 or fewer ventrals in males; total length less than 300 mm ..... *Macrocalamus lateralis*
- No ventrolateral stripes; venter bright yellow in life, yellowish-brown in alcohol; upper surface uniform, lacking ocelli; median stripe beneath the tail usually absent, rarely present and faint in very large specimens; 114 or more ventrals in males; total length up to 400 mm ..... *Macrocalamus schulzi*, new species

ACKNOWLEDGEMENTS

We are much indebted to Prof. Alain Dubois, Director of the Laboratoire de Zoologie (Reptiles & Amphibiens), to Dr. Ivan Ineich and Mr. Olivier Pauwels, Laboratoire de Zoologie (Reptiles & Amphibiens), Muséum National d'Histoire Naturelle (Paris), to Dr. Wolfgang Böhme, Zoologisches Forschungsinstitut und Museum Alexander Koenig (Bonn) and to Mr. Van Wallach, Museum of Comparative Zoology, Harvard University (Cambridge), for their careful reading of the manuscript, their constructive comments and their technical support.

We are pleased to thank Mr. Petr Kliment, who kindly executed the drawings of preserved animals, Dipl.-Biol. Thomas Ziegler, Zoologisches Forschungsinstitut und Museum Alexander Koenig (Bonn), for the preparation, the description and the drawing of hemipenes and Nicola Lutzmann for his efforts with the live specimens.

For the loan of preserved specimens, we are grateful to Drs. Wolfgang Böhme, Zoologisches Forschungsinstitut und Museum Alexander Koenig (Bonn), Rainer Günther, Zoologisches Museum für Naturkunde der Humboldt-Universität zu Berlin (Berlin), Colin J. McCarthy, The Natural History Museum (London) and Mr. Kelvin Lim, National University of Singapore. Mr. Lim also provided us with unpublished data, and his kind help was instrumental in our research.

LITERATURE CITED

Böhme, W., 1988. Zur Genitalmorphologie der Sauria: funktionelle und stammesgeschichtliche Aspekte. *Bonn. zool. Monogr.*, **27**: 1-176.

Boulenger, G. A., 1894. *Catalogue of the Snakes in the British Museum (Natural History). Volume II. Containing the conclusion of the Colubridae aglyphae.* London, British Museum (Natural History): i-xii + 1-382, 25 fig., pl. 1-20.

Boulenger, G. A., 1899. Descriptions of three new reptiles and a new batrachian from Mount Kina Balu, North Borneo. *Ann. Mag. nat. Hist.*, **7** (4): 451-454.

Boulenger, G. A., 1912. *A vertebrate fauna of the Malay Peninsula from the Isthmus of Kra to Singapore, including the adjacent islands. Reptilia and Batrachia.* London, Taylor & Francis: i-xiii + 1-294.

Dowling, H. G., 1951. A proposed standard system of counting ventrals in snakes. *Brit. J. Herpetol.*, **1** (5): 97-99.

Dowling, H. G., 1988. *A new classification of the Serpentes. Part 1. Prodromus.* Washington, Herpetological library, U.S. National Museum of natural History: 1-39. Unpublish ms.

Dowling, H. G. & W. E. Duellman, 1978. *Systematic herpetology. A synopsis of families and higher categories.* New York, H.I.S.S. Publications: i-vii + 1-118.3 + i-viii.

Flower, S. S., 1899. Notes on a second collection of reptiles made in the Malay peninsula and Siam, from November 1896-September 1898, with a list of the species recorded from those countries. *Proc. Zool. Soc. London*, **1899**: 600-696, pl. 36-37.

Grandison, A. G. C., 1972. The Gunong Benom expedition. 5. Reptiles and amphibians of Gunong Benom with a description of a new species of *Macrocalamus*. *Bull. Brit. Mus. nat. Hist., (Zool.)*, **23** (4): 45-101.

Grandison, A. G. C., 1978. Snakes of West Malaysia and Singapore. *Ann. naturhistor. Mus. Wien*, **81**: 283-302.

Günther, A. C. L. G., 1863. Third account of new species in the collection of the British Museum. *Ann. Mag. Nat. Hist.*, **3** (12): 348-365, pl. 5-6.

Günther, A. C. L. G., 1864. *The reptiles of British India.* London, Ray Society: i-xxvii + 1-452, pl. 1-26.

Lardner, B., 1994. Cameron Highlands - en klassik ormlokal i Malaccahalvöns bergstrakter. *Snoken*, **24** (3): 6-12.

Leviton, A. E., R. H. Gibbs, Jr., E. Heal & C. E. Dawson, 1985. Standards in herpetology and ichthyology: part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia*, **1985** (3): 802-832.

Lim, B. L., 1964. *Macrocalamus tweediei*, a new species of Reed snake from Malaya. *Bull. Singapore natl. Mus.*, **32** [1963]: 99-102, pl. 2. Note: Although dated on December 1963, this volume was published in 1964 according to indications mentioned on its cover.

Lim, B. L., 1967. Snakes collected in Gunong Brinchang, Cameron Highlands, Pahang. *Malayan Nat. J.*, **20**: 121-127.

Lim, B. L., 1972. A genus of snakes (*Oreocalamus*) new to Malaya. *Sarawak Mus. J.*, **18**: 410-411.

Manthey, U. & W. Grossmann, 1997. *Amphibien & Reptilien Südostasiens.* Münster, Natur und Tier-Verlag: 1-512.

Mcdowell, S. B., 1987. Systematics. In: R. A. Seigel, J. T. Collins & S. S. Novak (eds.), *Snakes. Ecology and evolutionary biology*, New York, Macmillan Publishing Co.: 3-50.

Pesantes, O. S., 1994. A method for preparing the hemipenis of preserved snakes. *J. Herpetol.*, **28** (1): 93-95.

Sly, G. R., 1976. New locality records for some Peninsular Malaysia Amphibia, Reptilia, and Mammalia. *Malayan Nat. J.*, **29** (3): 155-157.

Smedley, N., 1931. Notes on some Malaysian snakes. *Bull. Raffles Mus.*, **5**: 49-54.

Smedley, N., 1932. Amphibians and reptiles from the Cameron Highlands, Malay Peninsula. *Bull. Raffles Mus.*, **6** [1931]: 105-123, pl. 2.

Smith, M. A., 1922. On a collection of reptiles and batrachians from the mountains of Pahang, Malay Peninsula. *J. fed. Malay States Mus.*, **10**: 263-282.

Smith, M. A., 1930. The Reptilia and Amphibia of the Malay Peninsula. *Bull. Raffles Mus.*, **3**: i-xviii + 1-149.

Tweedie, M. W. F., 1954. *The Snakes of Malaya*. Singapore, Government Printing Office: 1-139, pl. 1-12.

Tweedie, M. W. F., 1957. *The Snakes of Malaya*. 2nd edition. Singapore, Government Printing Office: 1-143, pl. 1-16.

Tweedie, M. W. F., 1983. *The Snakes of Malaya*. 3rd edition. Singapore, Singapore National Printers: 1-167, pl. 1-12.

Welch, K. R. G., 1988. *Snakes of the Orient: a checklist*. Malabar, Florida, Robert F. Krieger Publ. Co: i-vii + 1-183.

Ziegler, T. & W. Böhme, 1997. Genitalstrukturen und Paarungsbiologie bei squamaten Reptilien, speziell den Platynota, mit Bemerkungen zur Systematik. *Mertensiella*, **8**: 1-210.

Appendix: specimens examined

Macrocalamus jasoni BM 1967.2283 (holotype), Camp V, Mt. Benom, State of Pahang, 1770 m. - BM 1967.2284 (paratype), Mt. Benom, State of Pahang, 1980 m. - BM 1967.2285 (paratype), Mt. Benom, State of Pahang, 1770 m.

Macrocalamus lateralis BM 98.9.22.37-38, Larut Hills (= Bukit Larut), State of Perak, 1340 m (Flower's specimens). - BM 1900.6.14.17-18, Larut Hills (= Bukit Larut), State of Perak, 1070 m-1370 m. - BM 1900.7.18.2, Larut Hills (= Bukit Larut), State of Perak, 1220 m. - BM 1904.9.9.6, Maxwell's Hill (= Bukit Larut), State of Perak, 1220 m. - BM 1946.1.7.23, without locality (holotype). - BM 1974.3893-3895, Cameron Highlands, State of Pahang. - BM 1974.3900-3902, Taiping, Maxwell's Hill (= Bukit Larut), State of Perak. - MNHN 1997.3265, Cameron Highlands, State of Pahang. - MTKD 39362, Cameron Highlands, State of Pahang. - SMF 78386-78388, Cameron Highlands, State of Pahang. - ZFMK 62496, Cameron Highlands, State of Pahang. - ZFMK 16517-16518, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 32301, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 53106, Tanah Rata, Cameron Highlands, State of Pahang, 1500 m. - ZMB 30293, Taiping, Bukit Larut, State of Perak. - ZMB 52099, Maxwell Hill (= Bukit Larut) near Taiping, State of Perak. - ZMB 52123, Maxwell Hill (= Bukit Larut) near Taiping, State of Perak, 1100 m. - ZMB 56889-56890, before Bala's, on the Mt. Batu Berinchang, Cameron Highlands, State of Pahang, between 1550 m and 1600 m. - ZRC.2.2762, Fraser's Hills (= Bukit Fraser), State of Pahang, 1220 m. - ZRC.2.2763-2765, Fraser's Hills (= Bukit Fraser), State of Pahang. - ZRC.2.2768, Cameron Highlands, State of Pahang. - ZRC.2.2771-2772, Cameron Highlands, State of Pahang. - ZRC.2.2774, Tanah Rata, Cameron Highlands, State of Pahang, 1370 m. - ZRC.2.2778, Cameron Highlands, State of Pahang. - ZRC.2.2780, Cameron Highlands, State of Pahang, 1370 m. - ZRC.2.2783, Maxwell's Hill (= Bukit Larut), Taiping (?), State of Perak. - ZRC.2.2784, Maxwell's Hill (= Bukit Larut), State of Perak, 1370 m. - ZRC.2.2785, Maxwell's Hill (= Bukit Larut), State of Perak, 1070 m. - ZRC.2.2786, Maxwell's Hill (= Bukit Larut), State of Perak, 1370 m. - ZRC.2.2787, Maxwell's Hill (= Bukit Larut), State of Perak. - ZRC.2.2788, Larut Hills (= Bukit Larut), State of Perak, 1370 m. - ZRC.2.3405, Fraser's Hill (= Bukit Fraser), road to Richmond House, State of Pahang. - ZRC.2.3701, Cameron Highlands, State of Pahang.

Macrocalamus cf. *lateralis* BM 1968.764, Camp Padang, Mt. Tahan, State of Pahang.

Macrocalamus schulzi BM 1974.3891-3892, Cameron Highlands, State of Pahang. - BM 1974.3896-3897, Cameron Highlands, State of Pahang. - BM 1974.3898-3899, Tanah Rata, Cameron Highlands, State of Pahang. - MNHN 1997.3268, Cameron Highlands, State of Pahang (paratype). - MNHN 1997.3269, Cameron Highlands, State of Pahang (paratype). - MNHN 1997.3270, Cameron Highlands, State of Pahang. - MTKD 39360, Cameron Highlands, State of Pahang. - SMF 78368, Cameron Highlands, State of Pahang (paratype). - SMF 78390-78392, Cameron Highlands; State of Pahang. - ZFMK 16519, Mt. Batu Berinchang, State of Pahang. - ZFMK 16681, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 16682-16684, Mt Batu Berinchang, State of Pahang. - ZFMK 32297-32300, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 32302, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 36516, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 48527-48528, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 48597, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 51159-51160, Tanah Rata, Cameron Highlands, State of Pahang. - ZFMK 53102, Mt. Batu Berinchang, Cameron Highlands, State of Pahang, 1800 m. - ZFMK 53104-53105, Tanah Rata, Cameron Highlands, State of Pahang, 1500 m. - ZFMK 65036, Cameron Highlands, State of Pahang (paratype). - ZMB 49143, Mt. Batu Berinchang, Cameron Highlands, State of Pahang (paratype). - ZMB 54329-54330, Cameron Highlands, State of Pahang. - ZMB 56891-56894, between the entrance of Tanah Rata, above Mt. Batu Berinchang, and the beginning of Tringkap, Cameron Highlands, State of Pahang, between 1500 m and 1650 m. - ZRC.2.2513, Cameron Highlands, Boh tea estate, Prakash Division, State of Pahang, about 4°27'N - 101°26'E, above 1370 m. - ZRC.2.2766-2767, Tanah Rata, Cameron Highlands, State of Pahang. - ZRC.2.2769-2770, Tanah Rata, Cameron Highlands, State of Pahang, 1200-1500 m. - ZRC.2.2773, Tanah Rata, Cameron Highlands, State of Pahang, 1435 m. - ZRC.2.2775, Telom Valley, Cameron Highlands, State of

Pahang. - ZRC.2.2776, Tanah Rata, Cameron Highlands, State of Pahang, 1280 m. - ZRC.2.2777, Tanah Rata, Cameron Highlands, State of Pahang. - ZRC.2.2779, Tanah Rata (agricultural area, new clearings), Cameron Highlands, State of Pahang, 1280 m. - ZRC.2.2781, Tanah Rata, Cameron Highlands, State of Pahang, 1370 m. - ZRC.2.2782, Cameron Highlands, State of Pahang. - ZRC.2.3697, Cameron Highlands, State of Pahang (paratype). - ZRC.2.3698-3699, Cameron Highlands, State of Pahang.

Macrocalamus tweediei MNHN 1997.3266-3267, Cameron Highlands, State of Pahang. - MTKD 39361, Cameron Highlands, State of Pahang. - SMF 78389, Cameron Highlands, State of Pahang. - ZFMK 62497, Cameron Highlands, State of Pahang. - ZFMK 65037, Cameron Highlands, State of Pahang. - ZMB 56887-56888, behind Mt. Batu Berinchang, Cameron Highlands, State of Pahang, 1500 m. - ZRC.2.3700, Cameron Highlands, State of Pahang.