

A new species of *Dibamus* Duméril & Bibron 1839 (Squamata: Dibamidae) from a hill station in Peninsular Malaysia

Evan S. H. Quah^{1*}, Shahrul Anuar M. S.^{1,2}, L. Lee Grismer³ & Rupert Grassby-Lewis⁴

Abstract. A new species of worm-like lizard, *Dibamus floweri*, is described from Fraser's Hill, Pahang, in the central highlands of Peninsular Malaysia based on the following unique combination of characters: maximum SVL of 112 mm; tail length 11.4–15.2% of SVL; labial and nasal sutures absent; rostral suture present but incomplete; a single postocular; four scales bordering the posterior edge of first infralabial; no enlarged, medial, sublabial scale; 21 scale rows around midbody; 23 scale rows around the body immediately posterior to head; 21 scale rows around the body immediately anterior to vent; 175–194 ventral scales; 23–46 subcaudal scales and light coloured bands on body. *Dibamus floweri*, new species, is the third species of dibamid discovered in Peninsular Malaysia and is the first montane species. Its discovery underscores the importance of uplands regions as important habitats for herpetological diversity and their understudied nature.

Key words. herpetofauna, montane, new species, taxonomy, conservation, systematics

INTRODUCTION

The lizards of the genus *Dibamus* Duméril & Bibron, 1839, form a small group of rare and little-known species found at scattered locations across Vietnam, Cambodia, Thailand, Peninsular Malaysia, Borneo, and Indonesia (Darevsky, 1992; Das & Lim, 2003, 2005, 2009; Das & Yaakob, 2003; Diaz et al., 2004; Greer, 1985; Honda et al., 1997, 2001; Ineich, 1999; Neang et al., 2011; Taylor, 1962). The genus is also found as far west as the Nicobar Islands of India and has been recorded from the Philippines and New Guinea farther east (for recent review, see Neang et al., 2011). Their worm-like appearance and their burrowing lifestyle beneath leaf-litter, rocks, and rotting logs have contributed to them being mistaken for earthworms or blind snakes. However, *Dibamus* species can be identified by their large head plates; degenerate, vestigial eyes covered by scales; and the lack of external ear openings, all of which are adaptations for a fossorial lifestyle (Grismer, 2011). Only males bear traces of hind limbs that are reduced to flap-like structures near the base of the tail above the vent (Greer, 1985; Grismer, 2011).

In Peninsular Malaysia, there are two species of *Dibamus*: *D. booliati* Das & Yaakob, 2003 and *D. tiomanensis* Diaz, Leong, Grismer & Yaakob, 2004. Recent field work in the highlands of Peninsular Malaysia has resulted in the discovery of another population of *Dibamus* at Fraser's Hill, Pahang that could not be ascribed to either of those species or any other species in the genus. The individuals from Fraser's Hill bear a unique suite of characters separating them from all other known species of *Dibamus* and as such are described here as a new species.

MATERIAL & METHODS

Collected specimens were photographed prior to euthanasia with ethyl 3-aminobenzoate methanesulfonate (C₉H₁₁NO₂.CH₄O₃S), after which liver samples were taken and stored in 100% undenatured ethanol. Specimens were then set in 10% formalin and later transferred into 70% denatured ethanol for storage. The type series is deposited at the La Sierra University Herpetological Collection (LSUHC), La Sierra University, Riverside, California, USA and the Lee Kong Chian Natural History Museum (ZRC), National University of Singapore, Singapore. Notes on colouration and pattern were taken from digital images of living and preserved specimens. Morphometric and meristic characters were examined under a Olympus SZ51 dissecting microscope and the following characters were measured with a Mitutoyo digimatic caliper to the nearest 0.1 mm: snout to vent length (SVL: measured from tip of snout to vent); tail length (TL: measured from vent to tip of non-regenerated tail); head length (HL: measured from posterior edge of supralabial to tip of snout); head width (HW: measured at angle of jaws); eye to nostril distance (EN: distance between anteriormost edge of eyes to posteriormost edge of nostrils); eye to snout distance (ES: distance between anteriormost edge

¹School of Biological Sciences, Universiti Sains Malaysia, 11800 Minden, Penang, Malaysia; Email: evanquah@yahoo.com, evanquah@usm.my (*corresponding author)

²Center for Marine and Coastal Studies, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia; Email: anuarusm@gmail.com, sanuar@usm.my

³Department of Biology, La Sierra University, 4500 Riverwalk Parkway, Riverside, California 92515, USA; Email: lgrismer@lasierra.edu

⁴Durrell Institute of Conservation and Ecology, University of Kent, Canterbury. CT2 7NZ, United Kingdom; Email: rupertjordan@gmail.com

of eyes and tip of snout); internasal distance (IN: distance between nostrils); interorbital distance (IO: shortest distance between orbits); frontal scale width (FSW: widest transverse distance of frontal scale); frontal scale length (FSL: longest longitudinal distance of frontal scale); frontonasal scale width (FNSW: widest transverse distance of frontonasal scale); frontonasal scale length (FNSL: longest longitudinal distance of frontonasal scale); interparietal scale width (IPW: widest transverse distance of interparietal scale); width of nuchal scale contacting posterior interparietal (NW: greatest width of any scale contacting interparietal); relative size of frontal scale (proportion of frontal scale width to width of frontonasal); relative size of the interparietal (proportion of interparietal scale width to width of nuchal scale contacting posterior interparietal); body width (BW: greatest width of body at midbody); tail width (TW: width at the base of tail); midbody scale rows (MBSR: number of scales around midbody); anterior transverse scale rows (ATSR: number of scales just posterior to head); posterior transverse scale rows (PTSR: transverse scale row just anterior to vent); ventrals (VEN: number of scales between mental and vent); subcaudals (SC: number of scales from vent to tip of tail); and vestigial hind limb length. Measurements follow Neang et al. (2011). Character states and geographical distributions for species of *Dibamus* were obtained from Taylor (1962, 1963); Greer (1985); Daresky (1992); Das (1996); Honda et al. (1997, 2001); Diaz et al. (2004); Das & Lim (2003, 2005, 2009); and Das & Yaakob (2003). The detailed descriptions of the other species provided by the literature above enabled us to ascertain the identity of this new population as being distinct without physically examining comparative material that was not available to us. In addition, one of the authors (LLG) has previously described two other species of *Dibamus* and examined comparative material.

SYSTEMATICS

Dibamidae Boulenger, 1884

Dibamus Duméril & Bibron, 1839

Dibamus floweri, new species

Flower's blind lizard
(Figs. 1, 2; Table 1)

Material examined. Holotype, LSUHC 12481, male collected by Rupert Grassby-Lewis on 26 July 2015 from Fraser's Hill, Pahang, Peninsular Malaysia at approximately 2100 hrs at (3°42'53.0"N 101°44'58.6"E), approximately 1,500 m above sea level.

Paratype. The female paratype ZRC 2.7240 was collected by Evan Quah and Alex Figueroa on 7 February 2017 along the Gap road below Fraser's Hill at approximately 1000 hrs at (3°41.912'N, 101°43.920'E), 1,207 m above sea level.

Diagnosis. *Dibamus floweri*, new species, differentiated from all other congeners by this combination of characters: maximum SVL of 112 mm; tail length 11.4–15.2% of



Fig. 1. (A) Holotype of *Dibamus floweri*, new species (LSUHC 12481) from Fraser's Hill, Pahang (Photograph by Rupert Grassby-Lewis). (B) Paratype of *Dibamus floweri*, new species (ZRC 2.7240) from Fraser's Hill, Pahang at ease (C) Paratype of *Dibamus floweri*, new species (ZRC 2.7240) from Fraser's Hill, Pahang when agitated. Note the rugose appearance of the skin. Photographs by Evan Quah.

SVL; labial, nasal sutures absent; rostral suture present but incomplete; single postocular; four scales bordering posterior edge of first infralabial; no enlarged, medial, sublabial scale; 21 midbody scale rows; 23 transverse scale rows just posterior to head; 21 transverse scale rows just anterior to vent; 175–194 ventral scales; 23–46 subcaudal scales; relative size of frontal to frontanasal 1.1–1.5; relative size of interparietal to surrounding scales 1.3–1.8; and light coloured bands on the body. These characters are scored across all nominal species of *Dibamus* in Table 2.

Description of holotype. SVL 112 mm; tail 17 mm (15.2% of SVL); head slightly longer (HL 2.66 mm) than wide (HW 2.48 mm); snout bluntly rounded, projecting beyond jaw; teeth small, acute; ES 1.93 mm; EN 1.49 mm; IN 0.83 mm; IO 1.31 mm; labial and nasal sutures absent; rostral suture present but incomplete; rostral pad with numerous, evenly distributed papillae; single postocular scale; the rostral pad is bordered posteriorly by single supralabial and ocular scale; eyes barely visible below ocular scale; three scales posterior to supralabial; frontal relatively large, 1.1 times its width of frontonasal; frontonasal three times wider than long; interparietal bordered posteriorly by three smaller nuchal scales; relative size of interparietal to nuchal scale

Table 1. Measurements of the holotype and paratype of *Dibamus floweri*, new species.

<i>Dibamus floweri</i> , new species from Fraser's Hill, Pahang	Holotype LSUHC 12481	Paratype ZRC 2.7240
Sex	Male	Female
Number of postoculars	1	1
Number of scales behind supralabial	3	3
Number of scales on posterior edge of infralabial	4	4
Number of ventral scales (VEN)	194	175
Number of subcaudal scales (SC)	46	23
Relative size of frontal (see methods)	1.1	1.5
Relative size of interparietal (see methods)	1.3	1.8
SVL (mm)	112	70
Tail length(% of SVL)	15.2	11.4
Tail length (mm)	17	8
Hind limb length (mm)	3.9 R&L	–
Enlarged median sublabial	no	no
Presence of band: present (+), absent (–)	+	+
Labial suture (LS): complete (+), incomplete (–), absent (0)	0	0
Nasal suture (NS): complete (+), incomplete (–), absent (0)	0	0
Rostral suture (RS): present, complete or incomplete (+), absent (–)	+	+
HL	2.66	2.44
HW	2.48	2.36
HD	1.82	2.22
EN	1.49	1.35
ES	1.93	1.72
IN	0.83	0.79
IO	1.31	1.13
FSW	1.69	1.56
FSL	1.06	0.74
FNSW	1.56	1.03
FNSL	0.51	0.47
IPW	1.02	0.86
NW	0.76	0.48
MBSR	21	21
ATSR	23	23
PTSR	21	21
TW	3.11	2.41
BW	3.55	2.94

1.3; mental triangular, bordered by first infralabial on each side; five scales contacting first infralabial, a medial scale behind the mental and four other scales posterior to the infralabial (Fig. 2).

Body wormlike, almost cylindrical: midbody width 3.55 mm; tail width 3.11 mm (BW/TW = 1.14); body scales smooth, subcycloid; 21 midbody scale rows; 23 scale rows just posterior to head; 21 scale rows anterior to vent; scales near vent thick; 46 subcaudals; 194 ventrals; vestigial hind limbs present, flap-like, flattened, curved inward, lacking toe pads, covered by imbricating scales (Fig. 2E); four scales between base of hind limbs; three large dorsal scales on distal portion of hind limb; length of right and left hind limbs 3.9 mm; tail tip blunt, covered by a single rounded scale, not terminating in a spine. All meristic data listed in Table 1.

Colouration in life. The labial and nasal scales are beige to opaque; dorsum, flanks and tail gray-brown; ventral surface lighter; anal region dull-white. Slightly beyond midway down the body is a broad silver-gray band, approximately 10–12 body scales in length that encircles the body (Fig. 1A).

Colouration in preservation. Rostral and mental pads opaque, gray or blue; dorsum and flanks pale-brown; ventral surface lighter brown; tail darker brown; subcaudal region lighter brown. The body band gray; body scales are brownish, dark centrally and transparent on posterior edges (Fig. 2).

Variation. The female paratype is similar to the holotype in morphology (Table 1) with the major difference being the absence of the two, short, flap-like hind limbs in the female which are only present in males and higher number of ventral (194 vs. 170) and subcaudal (46 vs. 23) scales in males which may be sexually dimorphic. The paratype also

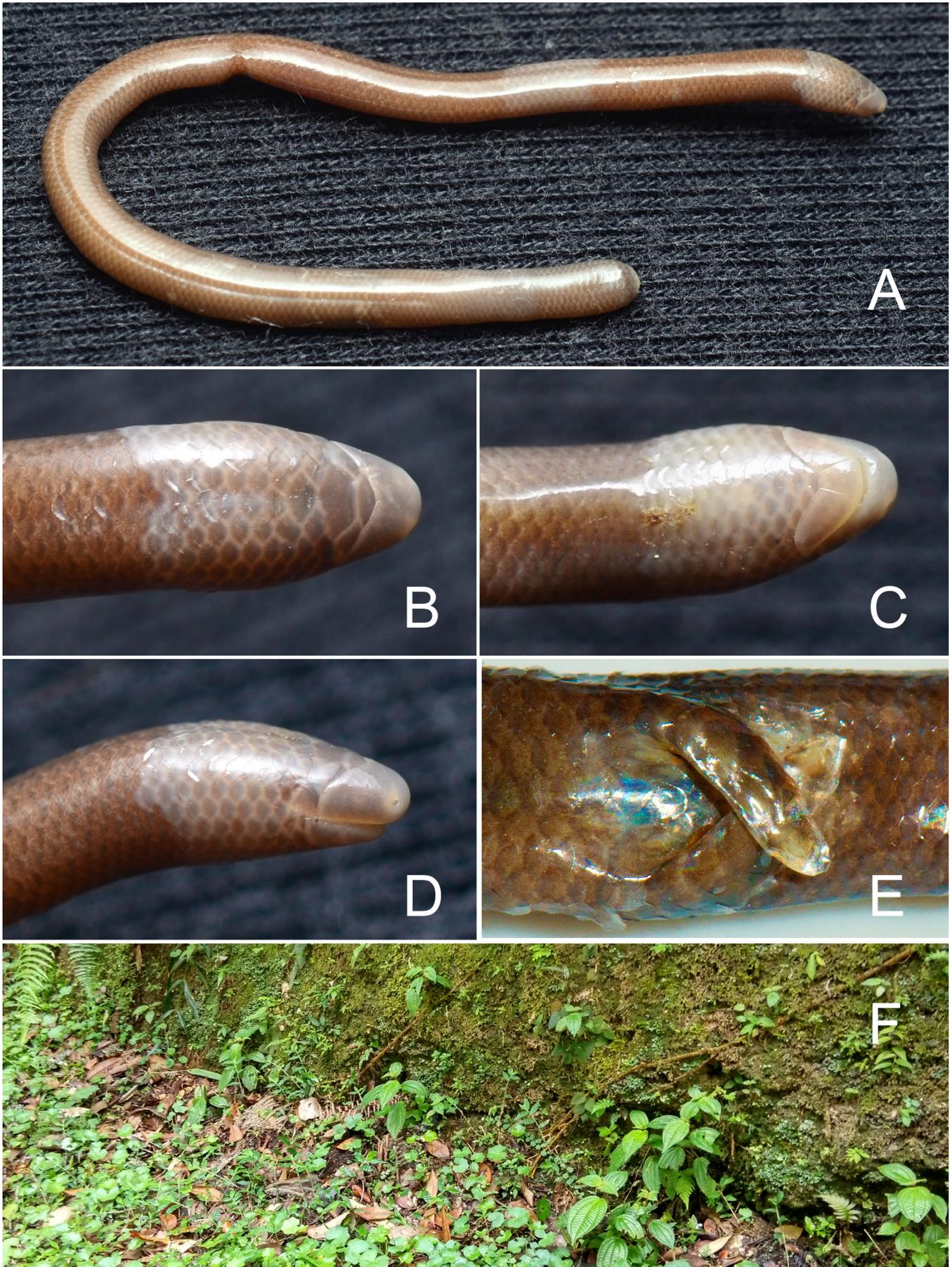


Fig. 2. (A) Full body; (B) Dorsal view of the head; (C) Ventral view of the head; (D) Lateral view of the head of the female paratype of *Dibamus floweri*, new species (ZRC 2.7240). (E) Hind limbs of the male holotype of *Dibamus floweri*, new species (LSUHC 12481). (F) Leaf litter microhabitat at Fraser's Hill, Pahang where the paratype of *Dibamus floweri*, new species, was found.

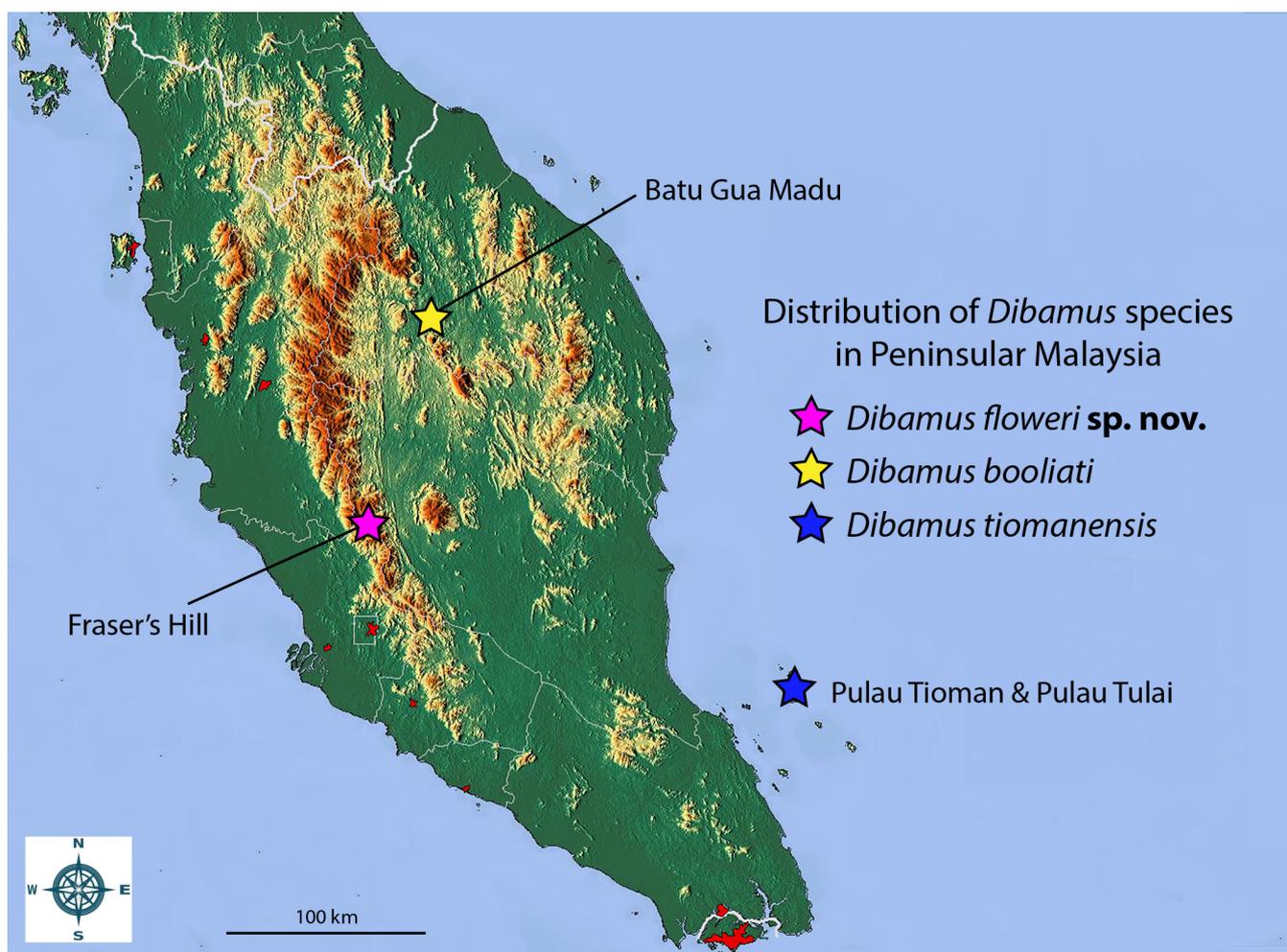


Fig. 3. Distribution of *Dibamus* species in Peninsular Malaysia.

differs from the holotype in the location of the band of the body, which is on the posterior end of the body and the tail. It was observed that the paratype could alter the width of the band when it felt threatened (Fig. 1B, C). In addition, when in preservation the head of the paratype lightened compared to the rest of the body and an additional body band became visible on the anterior quarter of the body.

Comparisons. The absence of a labial and nasal suture in *Dibamus floweri*, new species, distinguishes it from *D. alfredi* Taylor, 1962; *D. bogadeki* Darevsky, 1992; *D. booliati* Das & Yaakob, 2003; *D. dalaiensis* Neang, Holden, Eastoe, Seng, Ith & Grismer, 2011; *D. deharvengi* Ineich, 1999; *D. dezwaani* Das & Lim, 2005; *D. ingeri* Das & Lim, 2003; *D. kondaoensis* Honda, Ota, Hikida & Darevsky, 2001; *D. nicobaricum* (Steindachner, 1867); *D. novaeguineae* Duméril & Bibron, 1839; *D. somsaki* Honda, Nabhitabhata, Ota, & Hikida, 1997; *D. tebal* Das & Lim, 2009; *D. tiomanensis* Diaz, Leong, Grismer & Yaakob, 2004; and *D. vorisi* Das & Lim, 2003. The presence of an incomplete rostral suture further distinguishes it from *D. celebensis* Schlegel, 1858; *D. leucurus* (Bleeker, 1860); *D. seramensis* Greer, 1985; *D. smithi* Greer, 1985; and *D. taylori* Greer, 1985. The presence of four scales on the posterior edge of the infralabial distinguishes it from *D. bourreti* Angel, 1935 (four vs. two); *D. greeri* Darevsky, 1992 (four vs. one and

three); and *D. montanus* Smith, 1921 (four vs. two). Other differences between the new species and other congeners are presented in Table 2.

Among the Peninsular Malaysian species, *D. floweri*, new species, is further differentiated from both *D. booliati* and *D. tiomanensis* by the presence of an incomplete rostral suture as opposed to its absence in the other two species. It is also differentiated from *D. tiomanensis* by the lower number of midbody scale rows (21 vs. 25–26), lower number of subcaudal scales in both males (46 vs. 50) and females (23 vs. 45–48), and the presence of bands of the body versus their absence in *D. tiomanensis* (Diaz et al., 2004). From *D. booliati*, *D. floweri*, new species differs by the higher number of midbody scale rows (21 vs. 20), lower number of subcaudals in females (23 vs. 24–39) and the presence of the body band being on the posterior region of the body versus the band being in the neck region (Das & Yaakob, 2003). In addition, *D. tiomanensis* is restricted to the islands of Tioman and Tulai off the east coast of Peninsular Malaysia while *D. booliati* is a lowland species collected at 121 m a.s.l. in elevation near a limestone cliff at Batu Gua Madu, Kelantan. By comparison, *D. floweri*, new species, is a montane species that has so far only been recorded above 1,200 m a.s.l. in elevation at Fraser's Hill, Pahang.

Table 2. The measurements of morphological characters for comparison of all nominal species of *Dibamus* from Southeast Asia (modified from Greer, 1985; Diaz et al., 2004; Das & Lim, 2009; Neang et al., 2011). Numbers of specimens are given in parentheses. Band (B)= Band present (+), absent (-); Labial suture (LS)= complete (+), incomplete (-), absent (0); Nasal suture (NS)= complete (+), incomplete (-), absent (0); Rostral suture (RS)= present, complete or incomplete(+), absent (-), Enlarge medial sublabial (EMS)= present (+), absent (-). Entries for mid-body scale rows and subcaudal scales are as follows from top to bottom: range, mean and sample size.

Species of <i>Dibamus</i>	Number of post-oculars	Number of scales on edge of infralabials	Number of scales of posterior of interparietal	Mid-body scale rows	Number of subcaudal scales		Relative size of		Max. SVL	TL (% of SVL)	B	LS	NS	RS	EMS
					Male	Female	Frontal	Interparietal							
<i>floweri</i> , new species	1(2)	4(2)	3(2)	21	46	23	1.1–1.5	1.3–1.8	112	11.4–15.2	+	0	0	+	-
<i>alfredi</i>	2(4)	3(3) 4(1)	?	20–21 20.3 3	46–47 46.5 2	41–47 43.5 2	1.4–2.0	1.7–2.2	135	17–18	-	-	-	-	-
<i>bogadeki</i>	1(1)	2(1)	?	23 23 1	51 51 1	? ?	? ?	? ?	177	22.5	+	+	+	-	?
<i>booliati</i>	1(2)	4(2)	4(2)	20 20 1	? ?	24–39 31.5 1	? ?	? ?	102.7	9.4–13.0	+	-	-	-	-
<i>bourreti</i>	1(1)	2(1)	?	24 24 1	? ?	52+ 52+ 1	2.3	4.5	151	23+	? ?	? ?	?	+	-
<i>celebensis</i>	2(10) 3(3)	3(6) 4(7)	3	26–30 27.4 13	38–40 39.3 3	35–40 38 4	1.2–2.3	1.0–2.9	188	10–13	? ?	? ?	? ?	-	-
<i>dalaiensis</i>	1(4)	3(4)	4(3) 3(1)	20 20 4	50 50 1	48–52 49.3 3	1.4–1.5 1.4	1.3–1.8 1.5	127.6	18–22	(+,-)	+	+	+	+
<i>deharvengi</i>	1(1)	2(1)	?	16 16 1	57 57 1	? ?	1.3	1.4	92	22.4	? ?	+	+	+	-
<i>dezwaani</i>	2	4	?	22 22 1	? ?	37	? ?	? ?	123.1	12.75	-	+	+	+	-
<i>greeri</i>	1(3)	1 & 3(2)	?	20 20 1	53 53 1	54 54 1	? ?	? ?	86	23–28	+	? ?	-	+	-

Species of Dibamus	Number of post-oculars	Number of scales on edge of infralabials	Number of scales of posterior of interparietal	Mid-body scale rows	Number of subcaudal scales		Relative size of		Max. SVL (% of SVL)	TL	B	LS	NS	RS	EMS
					Male	Female	Frontal	Interparietal							
ingeri	2(3)	3(1)	?	20 20 1	36 36 1	?	1.5	1	96	14.8	+	+	+	?	-
kondaensis	2(1)	3(1)	3	23 23 1	59 59 1	?	1.03	1	112.4	19.4	-	+	+	+	-
leucurus	1(23)	3(21) 4(2)	?	20-23 21 23	48-52 49.5 2	41-47 43.5 4	1.2-4.2	1.0-3.1	136	16-20	-	?	?	-	-
montanus	1(2)	2(2)	?	22 22 2	49 49 1	43 43 1	2	2.2	130	15-18	-	?	?	+	-
nicobaricum	1(6)	4(6)	?	23-25 24.6 6	34-38 35.6 3	31-36 34.3 3	?	?	134.7	8.7-18.3	+	+	+	+	-
novaeguineae	2(92) 3(2)	3(53) 4(41) 5(1)	3	22-26 24.5 107	42-45 43 6	37-42 39.6 9	1.0-3.0	0.7-2.4	158	10-19	-	+	+	-	-
seramensis	4(1)	4(1)	?	33 33 1	? 40 40	40 40 1	0.7	1.2	203	11	?	?	?	-	-
smithi	1(1) 2(4)	2(5)	?	18-19 18.8 5	59 59 1	59-61 60 3	1.5-2.3	1.3-2.0	108	21-24	?	?	-	-	-
somsaki	1(4)	2(4)	4	18-19 18.5 4	44-58 51 2	27-57 42 2	1.1-1.3	1.0-2.2	106	18-24	?	+	+	+	-
taylori	3(13) 4(6)	2(2) 3(14) 4(4)	?	22-28 23.4 22	41-55 48.4 5	41-52 48 7	0.2-1.3	1.0-1.2	169	14-19	?	?	?	-	-
tebal	2	4	3	24 24 1	42 42 1	? 42 42	14	0.1	133.5	18.65	-	+	+	+	-

Species of <i>Dibamus</i>	Number of post-oculars	Number of scales on edge of infralabials	Number of scales of posterior of interparietal	Mid-body scale rows	Number of subcaudal scales		Relative size of		Max. SVL	TL (% of SVL)	B	LS	NS	RS	EMS
					Male	Female	Frontal	Interparietal							
tiomanensis	1(3)	4(3)	4	25–26 25.3 3	50 50 1	45–48 46.5 2	1.2	1.8	123	15–16	–	+	+	–	–
vorisi	2(2)	3(2)	?	20 20 2	33 33 1	11 11 1	1.2	1	90.1	6.1–16.8	–	–	–	+	–

Etymology. The specific epithet, *floweri*, is in honour of Major Stanley Smyth Flower, who was one of the pioneers for herpetological discoveries in the Malay Peninsula. He made many notable discoveries over the course of his explorations in the region and his natural history observations well over a century ago were very detailed and contributed tremendously to improving our understanding of the ecology and behaviour of many species to this day.

Distribution. *Dibamus floweri*, new species, is presently known only from Fraser’s Hill, Pahang, Peninsular Malaysia at elevations between 1,207 and 1,500 m (Fig. 3).

Natural history. Both specimens were found while digging through leaf litter that had accumulated along the banks of roads. The holotype was discovered at night in a drainage ditch along Jalan Girdle in a damp and shaded area. The paratype was uncovered during the day underneath approximately 3 cm beneath the soil (Fig. 2F), and in the same pile of leaf-litter, the skink, *Larutia miodactyla* (Boulenger, 1903) was also found. When handled, both specimens flared up their body scales, giving them a wrinkled appearance (Fig. 1C). This behaviour is interpreted as a defensive, anti-predator mechanism employed by *Dibamus* to mimic a possible non-palatable species of worm (Darevsky, 1992). The other two Peninsular Malaysian species, *D. booliati* and *D. tiomanensis* display the same behaviour when agitated (Das & Yaakob, 2003; Diaz et al., 2004; Grismer, 2011).

DISCUSSION

Southeast Asia is the centre of diversity for *Dibamus* (Angel, 1935; Darevsky, 1992; Das & Lim, 2003, 2005, 2009; Das & Yaakob, 2003; Diaz et al., 2004; Greer, 1985; Honda et al., 1997, 2001; Ineich, 1999; Neang et al., 2011; Taylor, 1962) and many of the species described in the last two decades have been discovered either through field surveys into unexplored regions (Das & Yaakob, 2003; Diaz et al., 2004; Honda et al., 1997; Neang et al., 2011) or through careful re-examination of material stored in museum collections (Das & Lim, 2003, 2005, 2009; Honda et al., 2001). The discovery of *Dibamus floweri*, new species, increases the number of known species in the genus to 23. In the process of describing the new species, we also noted the variability of the light bands in individual specimens of *Dibamus*, and how the width of the band could change in living specimens and additional bands could also appear after preservation (Figs. 1B, 1C & 2A). Given this variability, the diagnostic value of light bands to distinguish different species in the genus is diminished. However, when taken in combination with other discrete morphological characters, it is still useful in separating *Dibamus floweri*, new species from its congeners and warrants its recognition as a distinct species (Table 2).

Dibamus floweri, new species, is also the first montane species of *Dibamus* discovered in Peninsular Malaysia and is yet another notable herpetological discovery from the upland regions of Peninsular Malaysia in recent times. The many mountains scattered around the country have yielded a bounty of herpetological discoveries in the recent years

(Chan et al., 2010, 2014; Davis et al., 2016; Grismer et al., 2012, 2013a, b, 2014a, b, 2015a, b, 2016; Grismer & Quah, 2015; Loredó et al., 2013; Matsui et al., 2009, 2014; Wood et al., 2008, 2009), and Fraser's Hill is no exception. During the colonial era (1900s–1950s) it was a site for many early explorers and naturalists who made collections here (see Leong & Lim, 2003) and as a result, it became the type locality for some species such as *Cnemaspis flavolineata* and *Larutia miodactyla* (Grismer, 2011). A surge in herpetological interest over the last two decades in the country has led to the discovery of even more new species at this locality. The frog, *Ansonia jeetsukumarani* and the lizards, *Acanthosaura titiwangsaensis*, *Pseudocalotes drogon*, *Cyrtodactylus australotitiwangaensis*, and *Tytthoscincus bukitensis* were described based on material first collected at Fraser's Hill (Grismer, 2007, 2011; Grismer et al., 2012, 2016; Wood et al., 2008, 2009). Recent interest in leaf litter-dwelling herpetofauna have yielded discoveries like *D. floweri*, new species, and other species of semi-fossorial reptiles such as two new species of skinks (Grismer et al., 2017) and a new species of calamariid snake (Quah et al., in prep) that are in the process of being described. We are certain that with additional thorough field surveys, many more species stand to be discovered in the coming years. Fortunately, Fraser's Hill is one of the better managed upland areas in Peninsular Malaysia as opposed to places like Cameron and Genting Highlands that are getting ravaged by human development and pollution. Amphibians and reptiles found at Fraser's Hill would be afforded better protection than their congeners in some other upland areas in the country.

ACKNOWLEDGEMENTS

For assistance in the field we would like to thank Alex Figueroa, Mary-Ruth Low, Paul Freed, Barbara Freed, Bernhard Schubert, and Attila Kobori. We would also like to thank Perry L. Wood Jr. for helping us obtain some of the literature needed during the examination of the new material. Research by LLG was supported in part by a grant from the College of Arts and Sciences, La Sierra University, Riverside, California and from a National Geographic Society Explorers Grant (9277-15), while research by Shahrul Anuar was supported by a Universiti Sains Malaysia Grant (RUI and RUT Grants). We are grateful to the Department of Wildlife and National Parks, Peninsular Malaysia for issuing us a research permit [JPHL&TN(IP): 100-6/1/14(39)] to conduct research. Lastly, we also thank Kelvin K.P. Lim and Jose Christopher E. Mendoza for reviewing the manuscript and providing us valuable feedback to improve the quality of the publication.

LITERATURE CITED

- Angel F (1935) Un lézard nouveau de la famille des dibamidés. Bulletin du Muséum national d'histoire naturelle, Paris (sér.2), 7: 354–356.
- Bleeker P (1860) Reptilien van Agam aangeboden door E.W.A. Ludeking. Natuurkundig Tijdschrift voor Nederlandsch Indie, Batavia, 20: 325–329.
- Boulenger GA (1884) Synopsis of the families of existing Lacertilia. The Annals and Magazine of Natural History, 14(5): 117–122.
- Boulenger GA (1903) Anthropological and zoological results of an expedition to Perak and the Siamese Malay States, 1901–1902 undertaken by Nelson Annandale and Herbert Robinson. Report on the batrachians and reptiles. Part I. Fasciculi Malayenses, 1: 130–176.
- Chan KO, Grismer LL, Anuar S, Quah ESH, Muin MA, Savage AE, Grismer JL, Norhayati A, Remegio AC & Greer LF (2010) A new endemic Rock Gecko *Cnemaspis* Strauch 1887 (Squamata: Gekkonidae) from Gunung Jerai, Kedah, northwestern Peninsular Malaysia. Zootaxa, 2576: 59–68.
- Chan KO, Wood PL Jr., Anuar S, Muin MA, Quah ESH, Sumarli AX & Grismer LL (2014) A new species of upland Stream Toad of the genus *Ansonia* Stoliczka, 1870 (Anura: Bufonidae) from northeastern Peninsular Malaysia. Zootaxa, 3764(4): 427–440.
- Darevsky IS (1992) Two new species of worm-like lizard *Dibamus* (Sauria: Dibamidae) with remarks of the distribution and ecology of *Dibamus* in Vietnam. Asiatic Herpetological Research, 4: 1–12.
- Das I (1996) The validity of *Dibamus nicobaricum* (Fitzinger in Steindachner, 1867) (Squamata: Sauria: Dibamidae). Russian Journal of Herpetology, 3: 157–162.
- Das I & Lim KKP (2003) Two new species of *Dibamus* (Squamata: Dibamidae) from Borneo. Raffles Bulletin of Zoology, 51: 137–141.
- Das I & Lim KKP (2005) New species of *Dibamus* (Squamata: Dibamidae) from Pulau Nias, Indonesia. Russian Journal of Herpetology, 39: 113–117.
- Das I & Lim KKP (2009) A new species of *Dibamus* (Squamata: Dibamidae) from Pulau Simeuleu, Mentawai Archipelago, Indonesia. Zootaxa, 2088: 15–23.
- Das I & Yaakob NS (2003) A new species of *Dibamus* (Squamata: Dibamidae) from Peninsular Malaysia. Raffles Bulletin of Zoology, 51: 143–147.
- Davis HR, Grismer LL, Klabacka RL, Muin MA, Quah ESH, Anuar S, Wood PL Jr. & Sites JW (2016) The phylogenetic relationships of a new Stream Toad of the genus *Ansonia* Stoliczka, 1870 (Anura: Bufonidae) from a montane region in Peninsular Malaysia. Zootaxa, 4103(2): 137–153.
- Diaz RE, Leong MT, Grismer LL & Yaakob NS (2004) A new species of *Dibamus* (Squamata: Dibamidae) from West Malaysia. Asiatic Herpetological Research, 10: 1–7.
- Duméril AMC & Bibron G (1839) Erpétologie Générale ou Histoire Naturelle Complète des Reptiles. Volume 5. Roret/Fain et Thunot, Paris, 871 pp.
- Greer AE (1985) The relationships of the lizard genera *Anelytropsis* and *Dibamus*. Journal of Herpetology, 19: 116–156.
- Grismer LL (2007) A new species of small montane forest floor skink (Genus *Sphenomorphus* Fitzinger 1843) from southern peninsular Malaysia. Herpetologica, 63: 544–551.
- Grismer LL (2011) Lizards of Peninsular Malaysia, Singapore and Their Adjacent Archipelagos. Edition Chimaira, Frankfurt am Main, 728 pp.
- Grismer LL & Quah ESH (2015) The rediscovery of *Sphenomorphus malayanus* Doria, 1888 (Squamata: Scincidae) from the Titiwangsa Mountain Range of Peninsular Malaysia and its re-description as *S. senja* sp. nov. Zootaxa, 3931(1): 63–70.
- Grismer LL, Quah ESH, Wood PL Jr., Anuar S, Muin MA, Davis HR, Murdoch ML, Grismer JL, Cota M & Cobos AJ (2016) Dragons in the mist: three new species of *Pseudocalotes* Fitzinger (Squamata: Agamidae) from the sky island archipelago of Peninsular Malaysia. Zootaxa, 4136(3): 461–490.
- Grismer LL, Shahrul A, Muin MA, Quah ESH & Wood PL Jr. (2013a) Phylogenetic relationships and description of a new upland species of bent-toed gecko (*Cyrtodactylus* Gray, 1827) of the *C. sworderi* complex from northeastern Peninsular Malaysia. Zootaxa, 3616(3): 239–252.

- Grismer LL, Wood PL Jr., Quah ESH, Shahrul A, Muin MA, Sumontha M, Norhayati A, Bauer AM, Wangkulangkul S, Grismer JL & Pauwels OSG (2012) A phylogeny and taxonomy of the Thai-Malay Peninsula bent-toed geckos of the *Cyrtodactylus pulchellus* complex (Squamata: Gekkonidae): combined morphological and molecular analyses with descriptions of seven new species. *Zootaxa*, 3520: 1–55.
- Grismer LL, Wood PL Jr., Anuar S, Muin MA, Quah ESH, McGuire JA, Brown RM, Ngo VT & Pham HT (2013b) Integrative taxonomy uncovers high levels of cryptic species diversity in *Hemiphyllodactylus* Bleeker, 1860 (Squamata: Gekkonidae) and the description of a new species from Peninsular Malaysia. *Zoological Journal of the Linnaean Society*, 169: 849–880.
- Grismer LL, Wood PL Jr., Anuar S, Quah ESH, Muin MA, Maketab M, Chan KO, Sumarli AX, Loredó AI & Heinz HM (2014a) The phylogenetic relationship of three new species of the *Cyrtodactylus pulchellus* complex (Squamata: Gekkonidae) from poorly explored regions in northeastern Peninsular Malaysia. *Zootaxa*, 3764(4): 427–440.
- Grismer LL, Wood PL Jr., Shahrul A, Riyanto A, Norhayati A, Muin MA, Sumontha M, Grismer JL, Chan KO, Quah ESH & Pauwels OSG (2014b) Systematics and natural history of Southeast Asian Rock Geckos (genus *Cnemaspis* Strauch, 1887) with descriptions of eight new species from Malaysia, Thailand, and Indonesia. *Zootaxa*, 3880(1): 1–147.
- Grismer LL, Wood PL Jr., Anuar S, Quah ESH, Muin MA, Chan KO, Sumarli AX & Loredó AI (2015a) Repeated evolution of sympatric, paleoendemic species in closely related, co-distributed lineages of *Hemiphyllodactylus* Bleeker, 1860 (Squamata: Gekkonidae) across a sky-island archipelago in Peninsular Malaysia. *Zoological Journal of the Linnaean Society*, 174: 859–876.
- Grismer LL, Wood PL Jr., Lee CH, Quah ESH, Anuar S, Ngadi E & Sites Jr. (2015b) An integrative taxonomic review of the genus *Bronchocela* (Kuhl, 1820) from Peninsular Malaysia with descriptions of new montane and insular endemics. *Zootaxa*, 3948(1): 1–23.
- Grismer LL, Wood PL Jr., Quah ESH, Shahrul A, Ehwan N, Nur Amalina MI & Norhayati A (2017) Systematics, ecomorphology, cryptic speciation and biogeography of the lizard genus *Tytthoscincus* Linkem, Diesmos & Brown (Squamata: Scincidae) from the sky-island archipelago of Peninsular Malaysia. *Zoological Journal of the Linnaean Society*, zlx067. <https://doi.org/10.1093/zoolinnean/zlx067>
- Honda M, Nabhitabhata J, Ota H & Hikida T (1997) A new species of *Dibamus* (Squamata: Dibamidae) from Thailand. *Raffles Bulletin of Zoology*, 45: 275–279.
- Honda M, Ota H, Hikida T & Daresky IS (2001) A new species of the worm-like lizard, *Dibamus* Dumeril & Bibron 1839 (Squamata: Dibamidae), from Vietnam. *Tropical Zoology*, 14: 119–125.
- Ineich I (1999) Une nouvelle espèce de *Dibamus* (Reptilia, Squamata, Dibamidae) du Vietnam. *Bulletin de la Société de Zoologie de France*, 124(3): 279–286.
- Leong TM & Lim KKP (2003) Herpetofaunal records from Fraser's Hill, Peninsular Malaysia with larval descriptions of *Limnonectes nitidus* and *Theloderma asperum* (Amphibia: Ranidae and Rhacophoridae). *The Raffles Bulletin of Zoology*, 51: 123–136.
- Loredó AI, Wood PL Jr., Quah ESH, Anuar S, Greer LF, Ahmad N & Grismer LL (2013) Cryptic speciation within *Asthenodipsas vertebralis* (Boulenger, 1900) (Squamata: Pareasidae), the description of a new species from Peninsular Malaysia, and the resurrection of *A. tropidonotus* (Lidth de Jude, 1923) from Sumatra: an integrative taxonomic analysis. *Zootaxa*, 3664(4): 505–524.
- Matsui M, Belabut DM & Ahmad N (2014) Two new species of fanged frogs from Peninsular Malaysia (Anura: Dicroglossidae). *Zootaxa*, 3881(1): 75–93.
- Matsui M, Belabut DM, Norhayati A & Yong HS (2009) A new species of *Leptotalax* (Amphibia, Anura, Megophryidae) from Peninsular Malaysia. *Zoological Science*, 26: 243–247.
- Neang T, Holden J, Eastoe T, Seng R, Ith S & Grismer LL (2011) A new species of *Dibamus* (Squamata: Dibamidae) from Phnom Samkos Wildlife Sanctuary, southwestern Cardamom Mountains, Cambodia. *Zootaxa*, 2828(1): 58–68.
- Schlegel H (1858) *Handleiding Tot de Beoefening der Dierkunde 2. Natuurkundige Leercursus, Koninlijke Militaire Akademie*, 628 pp.
- Smith MA (1921) New or little-known reptiles and batrachians from Southern Annam (Indochina). *Proceeding of the Zoological Society of London*, 1921: 423–440.
- Steindachner F (1867) *Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B. von Wüllerstorff-Urbair* (Zoologie), 1(3): 1–98.
- Taylor EH (1962) New oriental reptiles. *University of Kansas Science Bulletin*, 43: 209–263.
- Taylor EH (1963) The lizards of Thailand. *University of Kansas Science Bulletin*, 44: 687–1077.
- Wood PL Jr., Grismer LL, Norhayati A & Senawi J (2008) Two new species of torrent-dwelling toads *Ansonia* Stoliczka, 1870 (Anura: Bufonidae) from Peninsular Malaysia. *Herpetologica*, 64(3): 321–340.
- Wood PL Jr., Grismer JL, Grismer LL, Norhayati A, Chan KO & Bauer AM (2009) Two new montane species of *Acanthosaura* Gray, 1831 (Squamata: Agamidae) from Peninsular Malaysia. *Zootaxa*, 2012: 28–46.