Volume 18, Nomor 1, Juni 2009 **ISSN 0215-191X**

ZOO INDONESIA

Jurnal Fauna Tropika

Akreditasi : 119/AKRED/LIPI/P2MBI/06/2008 (Predikat B)

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Zoo Indonesia	Volume 18 (1)	1-43	2009	ISSN 0215-191X

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Flannery, T. 1990. Mammals of New Guinea. Robert Brown & Associates. New York.

Nelson, M.E & L.D Mech. 1987. Demes with a Northeastern Minesota Deer Population. In: B.D Chepko-Sade & Z Tanghapin (edits.) Mammalian Dispersal Pattern-The Effect of Social Structure on Population Genetics. University of Chicago Press. 230-243.

Youngson, R.W. 1970. Rearing red deer calves. Journal of Wildlife Management 34:467-470.

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MORPHOLOGICAL VARIATIONS OF SUMATRAN TORENT FROGS, *Huia sumatrana* (Yang, 1991) AND *H. modiglianii* Doria, Salvidio and Tavan, 1999

Hellen Kurniati

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ABSTRAK

Kurniati, H. 2009. Variasi morfologi Kongkang Sumatra, *Huia sumatrana* (Yang, 1991) dan *H. modiglianii* Doria, Salvidio and Tavan, 1999. Zoo Indonesia 18(1):9-20. *Berdasarkan kajian koleksi Kongkang Sumatra, Huia sumatrana di Museum Zoologicum Bogoriense (MZB), Indonesia; beberapa individu spesimen mempunyai kesamaan morfologi dengan jenis H. modiglianii pada jumlah pola garis (ban) di bagian paha atas, bentuk moncong dan pola warna di bagian punggung dan mandibular. Perbedaan morfologi dari sibling H. sumatrana yang dekat dengan H. modiglianii untuk sementara diberi nama H. cf sumatrana.*

Kata kunci: *Kodok, Sumatra, spesimen MZB*, *Huia*, *Huia sumatrana.*

ABSTRACT

Kurniati, H. 2009. Morphological variations of Sumatran Toren frogs, *Huia sumatrana* (Yang, 1991) and *H. modiglianii* Doria, Salvidio and Tavan, 1999. Zoo Indonesia 18(1):9-20. *Based on an examination specimens of the Sumatran Torrent Frog, Huia sumatrana in Museum Zoologicum Bogoriense (MZB), Indonesia, several individuals were found to possess morphological characters similar to those of H. modiglianii, including the number of crossbars on the thigh, snout morphology, and dorsal and ventral pattern and coloration. A similar degree of morphological variation in H. sumatrana that close to H. modiglianii tentatively is named as H. cf sumatrana.*

Keywords: *Frog, Sumatra, MZB specimens*, *Huia*, *Huia sumatrana.*

INTRODUCTION

Two species of torrent frogs are reported to occur in Sumatra, i.e., *Huia sumatrana* (Yang 1991) and *H. modiglianii* (Doria *et al*. 1999; IUCN 2009). *Huia modiglianii* was first described by Doria *et al*. (1999) on the basis of two adult specimens (male & female) of MSNG (Museo Civico di Storia Naturale "G. Doria" of Genova), collected by Elio Modiglianii in January 1891 at Si Rambe, North Sumatra; one immature specimen (male) from Batjan Batu, North Sumatra by F.C.van Heurn in June 1919 (ZMA 5091-Zoological Museum of Amsterdam) and one adult specimen (male) from Pajinggahan, North Sumatra by M. Weber (ZMA 5094, undated). These four specimens were differentiated based on seven diagnostic characters (Table 1).

Currently, MZB has 76 numbered collections that contain 112 specimens of *Huia* from Sumatra, in which all were labeled as *Huia sumatrana*. Some individuals, however, possess a larger

number of crossbars on the dorsal surface of the thigh. Based on the description of Doria *et al*. (1999) these MZB collections have morphological characters consistent with the description of *H. modiglianii*, and thus were examined more closely to determine whether they were indeed the latter species.

MATERIALS & METHODS

Specimens of 30 adult individuals of *Huia* from North Sumatra, West Sumatra, Jambi, Bengkulu and Lampung Provinces (Appendix I) were examined. Individuals having six crossbars on the upper surfaces of the thigh were more carefully examined as *H.* cf *sumatrana*. Measurements of preserved specimens were made with digital calipers to the nearest 0.1 mm following the system of Yang (1991). Abbreviations and measurement used are snout - vent length (SVL); length of head (LH); width of head (WH); diameter of tympanum (DT); diameter of eye (DE) and length of tibia (LT). Variation in the number of crossbars on the thigh was compared by assigning the specimens into three groups; groups 4 and 5 for *H. sumatrana* and group 6 for *H*. cf *sumatrana*/*H. modiglianii*.

Measurements of morphology versus number of crossbars on thigh was analyzed using Minitab version 13. For morphological comparisons, two individuals of *Huia* from MZB specimens, *H. sumatrana* and *H*. cf *sumatrana* were used to examine seven morphological characters that was used by Doria *et al*. (1999; Table 2; Figures 2, 6 & 7). The specimens being used were: (1) *H. sumatrana*; MZB number: Amp 3914; Sex: female; Date: 5 September 1994; Location: Wai Ratai, Pantai Cermin, Lampung Province; Collector: Ezwar Roezzaman. (2) *H.* cf *sumatrana*; MZB number: Amp 3461; Sex: female; Date: 23 March 1998; Location: Kubu Perahu, Bukit Barisan Selatan, Lampung Province; Collector: Andiek F.

RESULTS & DISCUSSIONS

Specimens Examination

Results of examination of *H. sumatrana* specimens in Museum Zoologicum Bogoriense (MZB), Indonesia, which was similar to *H. modiglianii*, showed that some characters were not consistent with the type specimens of *H. modiglianii* described by Doria *et al*. (1999). In fact, the only distinct morphological character between *H .modiglianii* and *H.* cf *sumatrana* in the MZB collections involves the number of crossbars on thigh and tibia; six other characters could not be used to distinguish between these two species of *Huia* from Sumatra (Tables 2 & 3).

Table 1. Principal characters distinguishing *H. modiglianii* from *H. sumatrana* (Doria *et al*. 1999).

No	Principal characters	*H. modiglianii*	*H. sumatrana*
1	Central tympanic margin with raised rim	present	absent
2	Extent of webbing of fourth toe	To distant subarticular tubercle	Fully webbed
3	Crossbars on thigh	6	4
4	Crossbars on tibia	6	3
5	Outer metatarsal tubercle	absent	present
6	Disk size of toes *vs*. fingers	smaller	equal
7	Length of first finger when adpressed to second finger	shorter	longer

Table 2. Principal characters to distinguish *H. modiglianii*, *H.* cf *sumatrana* and *H. sumatrana* from MZB specimens.

No	Principal characters	*H. modiglianii* (Doria *et al*. 1999)	*H.* cf *sumatrana* (MZB)	*H. sumatrana* (MZB)
1	Tympanic margin with raised rim	present	absent	absent
2	Extent of webbing of fourth toe	At distant subarticular tubercle	fully	fully
3	Crossbars on thigh	6	6	4-5
4	Crossbars on tibia	6	4-6	2-4
5	Outer metatarsal tubercle	absent	present	present
6	Disk size of toes versus fingers	Smaller	equal	equal
7	Length of first finger when ad pressed to second finger	Slightly shorter	Slightly shorter	Slightly shorter
8	Dorsal	Dark brown and rough	Dark brown and rough	Light brown and smooth
9	Mandible pattern	Highly blotched	Highly blotched	Blotched
10	Snout	Pointed	Pointed	More pointed

Based on six individuals of *H.* cf *sumatrana* (2 females; 4 males) and 24 individuals of *H. sumatrana* (6 females; 18 males), all adults females of *H.* cf *sumatrana* and *H. sumatrana* have no raised circum-tympanic rim (Figure 1). However all adult males of the two groups have a raised circum-marginal tympanic rim (Figure 2). Doria *et al*. (1999) stated that their adult female *H. modiglianii* (MSNG 49745) had a raised circum-marginal tympanum rim (Figure 3), although no such descriptive term was used for any adult male. Characters distinguishing *H. modiglianii* from*, H.* cf *sumatrana* and *H. sumatrana* were the number of crossbars on thigh and tibia and morphology of dorsal and ventral skin (Table 2). Based on these characters, *H.* cf *sumatrana* more resembles to *H. modiglianii* and can be separated from *H. sumatrana*. In the coloration and texture of preserved specimens, *H.* cf *sumatrana* has dark brown and rough dorsal skin (Figures 4, 5 & 6), and blotched ventral skin, especially on the sides of the mandible (Figures 4, 5 & 7). However, *H. sumatrana* has light brown and smooth dorsal skin and few blotches on its ventral skin, and a mandible mostly free of blotching (Figures 6 & 7).

Results of morphometric analysis showed that HL/SVL for females was significantly different between *Huia* with 4 crossbars on thigh (SVL, 63.371 ± 6.269 mm; LH, 23.586 ± 1.620 mm) and *Huia* with 6 crossbars on thigh (SVL, 54.667 ± 1.021 mm; LH, 21.767 ± 0.462 mm) ($p < 0.05$) (Table 4 & Figure 8). In the shape of the snout, analysis showed that *H. sumatrana* had more pointed snout rather than that of *H.* cf *sumatrana* (Figures 1 & 6 A & B). However, for males, there was no significant difference among *Huia* with 4, 5 and 6 crossbars respectively, on the thigh (Table 5; Figure 9). On the basis of morphological variations and the coloration of the dorsal and ventral skin, sibling *H. sumatrana* which referred to *H.* cf *sumatrana* could be a hybrid group of *H. sumatrana* and *H. modiglianii*, as the group was significantly different from *H. sumatrana* on the basis of number of crossbars on thigh, head length and snout morphology. However the group was

significantly different from *H. modiglianii* on the basis of rising of circum-tympanum, webbing on fourth toe, presenting of outer metatarsal tubercle, disk size of toes to those of fingers and length of first finger to second finger.

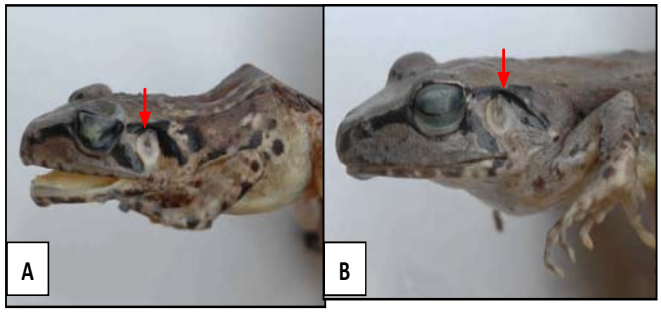

Figure 1. Lateral view of adult female *H.*cf *modiglianii* (A) and adult female *H. sumatrana* (B). The arrow showed circum tympanum does not raise rim. (A) MZB Amp. 3461; (B) MZB Amp. 3914 (Photo: A. Riyanto).

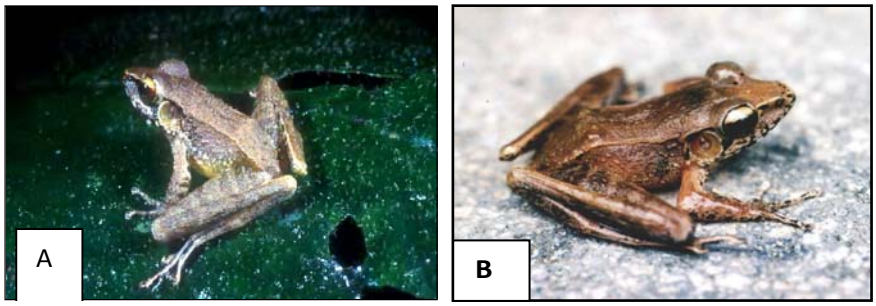

Figure 2. Adult male of *Huia* from Kerinci Seblat National Park area (A) *Huia* from Bukit Tapan (Jambi); 550 m asl; with six crossbars on thigh. (B) *Huia* from Ketenong (Bengkulu); 1300 m asl; with four crossbars on thigh. These two *Huia* with tympanum raised rim (Photo: (A)J. Holden; (B) H. Kurniati).

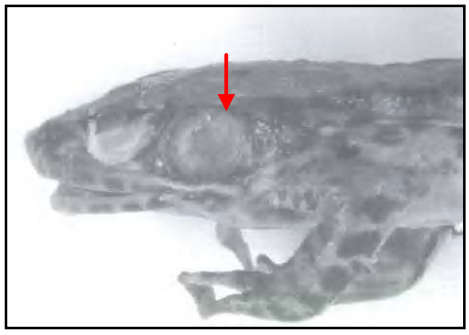

Figure 3. Particular head of female-paratype of *H. modiglianii* (MSNG 49745). The arrow showed circum tympanum raised rim. Image courtesy from Doria *et al*. (1999).

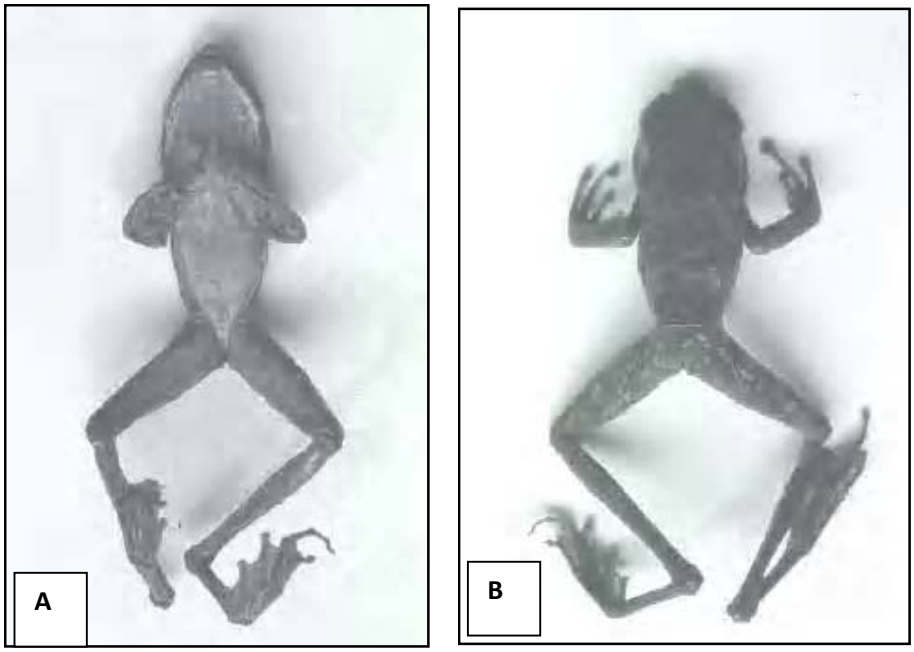

Figure 4. Ventral view (A) and dorsal view (B) of female-paratype of *H. modiglianii* (MSNG 49745). Images courtesy from Doria *et al*. (1999).

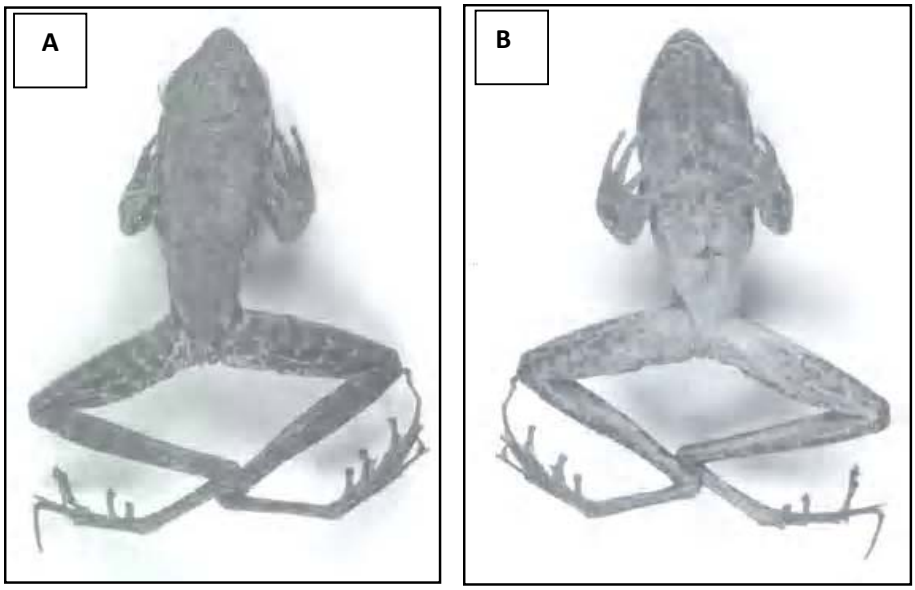

Figure 5. Dorsal view (A) and ventral view (B) of male-holotype of *H. modiglianii* (MSNG 29363). Images courtesy from Doria *et al*. (1999).

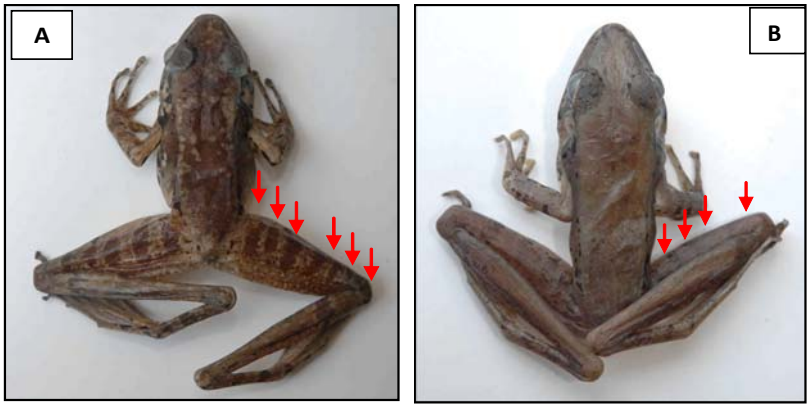

Figure 6. Dorsal view of adult female *H. modiglianii* (A) and adult female *H. sumatrana* (B). The arrows showed the number of crossbars on thigh. (A) MZB Amp. 3461; (B) MZB Amp. 3914 (Photo: A. Riyanto).

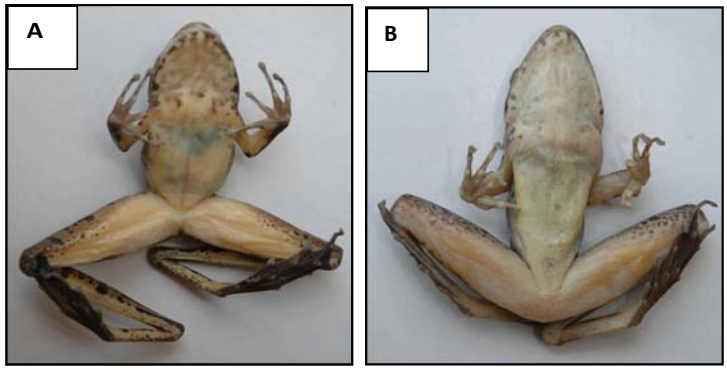

Figure 7. Ventral view of adult female *H. modiglianii* (A) and adult female *H. sumatrana* (B). (A) MZB Amp. 3461; (B) MZB Amp. 3914 (Photo: A. Riyanto).

Distribution, habitat & possibility of hybridization

H. sumatrana is endemic to the mountains of western Sumatra. The species occurs in Aceh, North Sumatra, West Sumatra, Bengkulu and Lampung Provinces (IUCN 2008; Figure 10); however *H. modiglianii* is known only from three sites in the vicinity of Lake Toba, North Sumatra, Si Rambé, Bantjan Batu and Pajinggahan (Doria *et al*. 1999; IUCN 2008). The *H. sumatrana* inhabits clean torrents and fast-flowing streams in forest and open areas near the forest at altitude from 200 m to more than 1,200 m asl (IUCN 2008; Kurniati 2008; Mistar 2003); however *H. modiglianii* found at 400 m asl at Batjan Batu and 1370 m asl at Si Rambe (Doria *et al*. 1999). Based on information on collecting localities of specimen, *H.* cf *sumatrana* lives sympatric with *H. sumatrana* at Payakumbuh, West Sumatra (about 500 m asl), Lembah Anai, West Sumatra (about 1000 m asl). In Kerinci Seblat National Park, Jambi, Central Sumatra, *H.* cf *sumatrana* also found in the same habitat of *H. sumatrana* at Bukit Tapan (550 m asl; Kurniati 2008). Specimen of MZB Amp. 3461 was found at 700 m asl in Kubu Perahu, Lampung Province (Endarwin 2006).

Based on morphological characters, *H.* cf *sumatrana* stands in between *H. sumatrana* and *H. modiglianii* (Table 2). The most possibility to explain taxonomy status of *H.* cf *sumatrana* is hybridization between the two species. Natural hybridization between two frog species usually occurs at narrow overlap zone of the two species (Mallet 2007); this phenomenon has been well documented on clawed frogs *Xenopus laevis* and *.X. muelleri* in Africa (Fischer *et al*. 2000), *Crinia laevis* complex in Australia (Littlejohn *et al.* 1971), leopard frogs *Rana blairi* and *R. sphenocephala* in Europe (Parris *et al*. 1999; Parris 2000; 2001).

Based on distribution of *H. sumatrana* and *H. modiglianii* (Figure 10), distribution zone of *H. modiglianii* is inside distribution zone of *H. sumatrana*; the two species have no evident to have spatial contact zone. Based on vertical distribution, *H. sumatrana* inhabits riverine habitat at elevation 200-1200 m asl (IUCN 2008; Kurniati 2008; Mistar 2003), *H. modiglianii* inhabits at elevation 400-1370 m asl (Doria *et al*. 1999); however *H.* cf *sumatrana* was found at elevation 550-1000 m asl. Hybridization and speciation of genus *Huia* in Sumatra seems to be close to gradient model hypotheses (Moritz *et al*. 2000), which elevation 550-1000 m asl is hybridization zone between *H. sumatrana* and *H. modiglianii* (Figure 11); however genetic study is needed to give evidence of the hypotheses.

Table 4. One-way ANOVA analysis for six characters of female *Huia* vs. number of crossbar on thigh.

Characters	Group number of crossbar on thigh	N	Mean	SD	p
WH/SVL	4	7	0.33286	0.01380	0.412
	6	3	0.34000	0.00000	
LH/SVL	4	7	0.37286	0.01604	0.043*
	6	3	0.40000	0.01732	
DT/DE	4	7	0.59429	0.06188	0.199
	6	3	0.53333	0.0665	
LT/SVL	4	7	0.70429	0.03910	0.202
	6	3	0.74333	0.04509	

* Significant at the $p < 0.05$ level

Table 5. One-way ANOVA analysis for six characters of male *Huia* vs. number of crossbar on thigh.

Characters	Group number of crossbar on thigh	N	Mean	SD	p
WH/SVL	4	13	0.34769	0.02713	0.360
	5	6	0.33667	0.01751	
	6	5	0.33200	0.00837	
LH/SVL	4	13	0.43308	0.01494	0.174
	5	6	0.43167	0.02229	
	6	5	0.41600	0.01517	
DT/DE	4	13	0.9677	0.1037	0.095
	5	6	0.9767	0.0327	
	6	5	0.8600	0.1223	
LT/SVL	4	13	0.73846	0.02075	0.865
	5	6	0.74333	0.02066	
	6	5	0.74600	0.04980	

Table 3. Measurement of holotypes and paratypes of *H. modiglianii* and *H. sumatrana* with specimens from MZB.

Measurement	*H. modiglianii* Holotype MSNG 29363	*H. modiglianii* Paratype MSNG 49745	*H. modiglianii* Paratype ZMA 5091	*H. sumatrana* Holotype FMNH 209922	*H. sumatrana* Paratype ZMA 5090	*H.* cf *sumatrana* MZB Amp. 3461	*H. sumatrana* MZB Amp. 3914
Age and sex	Adult male	Adult female	Immature male	Adult male	Adult female	Adult female	Adult female
SVL (mm)	31.76	55.09	24.55	30.35	66.00	53.5	70.2
Length of head (mm)	13.05	21.55	10.90	12.71	24.80	22.3	24.8
Width of head (mm)	10.42	18.63	8.55	10.34	21.02	18.6	22.5
Ration SVL *vs.* Length of head	0.41	0.39	0.44	0.42	0.38	0.42	0.35
Ratio Width of head *vs.* SVL	0.33	0.34	0.35	0.34	0.32	0.35	0.32
Diameter of tympanum (mm)	3.11	3.24	2.45	3.48	4.18	4.5	5.3
Diameter of eye (mm)	4.34	7.04	3.5	4.39	7.55	8.1	8.5
Ratio diameter of tympanum *vs.* diameter of eye	0.72	0.46	0.70	0.79	0.55	0.56	0.62
Length of tibia (mm)	22.08	38.81	19.70	22.78	46.42	42.1	48.6
Ratio length of tibia *vs.* SVL	0.70	0.70	0.80	0.75	0.70	0.79	0.69
Diameter of disk of third finger (mm)	1.25	2.70	1.07	1.00	1.38	1.6	1.5
Ratio diameter of disk of third finger *vs.* diameter of tympanum	0.40	0.83	0.31	0.29	0.33	0.36	0.28

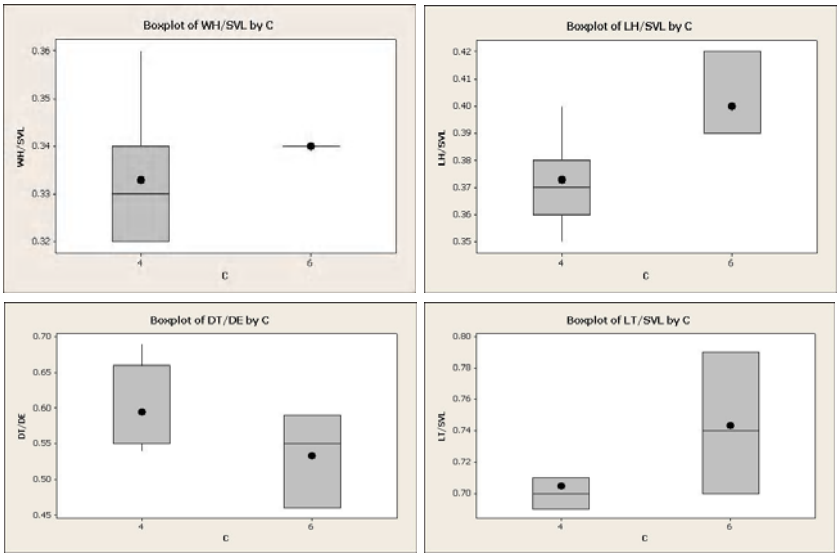

Figure 8. Morphometric result of female *H. sumatrana*, *H.* cf *sumatrana* included *H. modiglianii* paratype (MSNG 49745) and *H. sumatrana* paratype (ZMA 5090; Table 3) using one-way ANOVA analysis. C: number of crossbars on thigh; 4: number for *H. sumatrana*; 6: number for *H.* cf *sumatrana* and *H. modiglianii*.

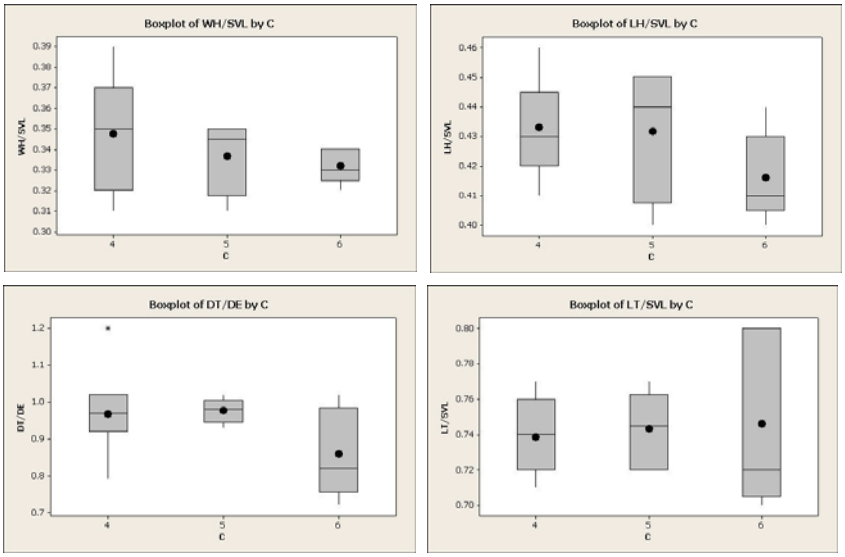

Figure 9. Morphometric result of male *H. sumatrana*, *H.* cf *sumatrana* included *H. modiglianii* holotype (MSNG 29363) and *H. sumatrana* holotype (FMNH 209922; Table 3). C: number of crossbars on thigh; 4 & 5: numbers for *H. sumatrana*; 6: number for *H.* cf *sumatrana* and *H. modiglianii*.

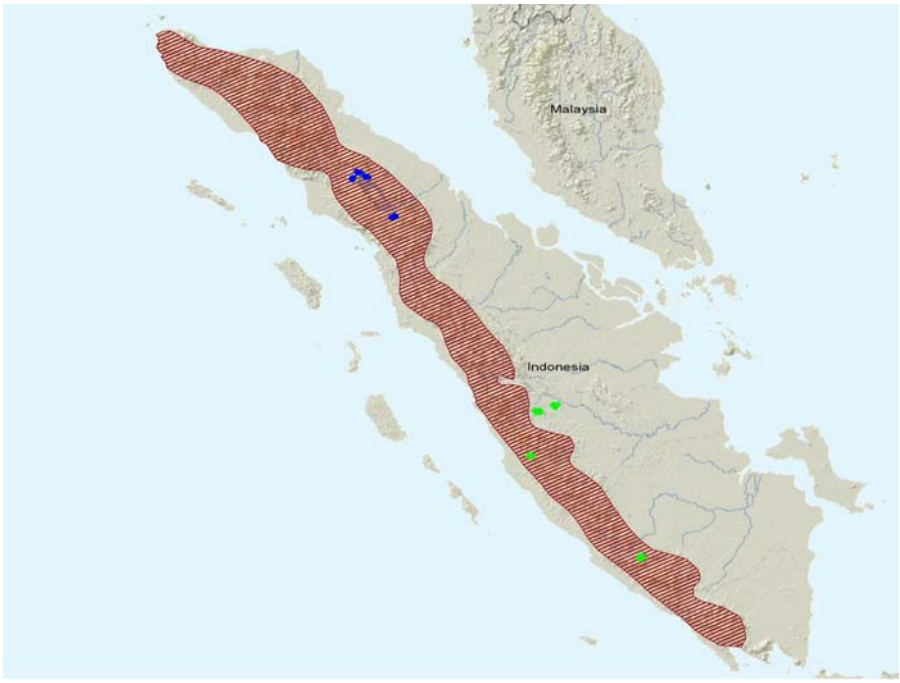

Figure 10. Distribution of *H. sumatrana* (red area), *H. modiglianii* (blue dots) and *H*. cf *sumatrana* (green dots). Map courtesy from IUCN (2008).

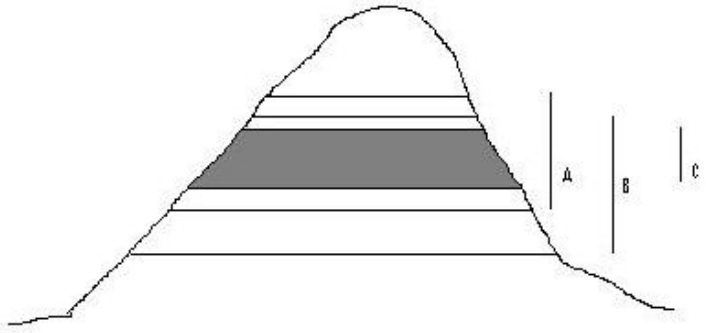

Figure 11. (A) Vertical distribution of *H. modiglianii*, 400-1370 m asl; (B) Vertical distribution of *H. sumatrana*, 200-1200 m asl; (C) vertical distribution of *H*. cf *sumatrana*, 550-1000 m asl (dark area).

ACKNOWLEDGEMENT

Special thanks are given to Awal Riyanto S.Si of Indonesian Institute of Sciences for his help on taking photograph. Many thanks are also given to Dr. Claudio Ciofi of University of Florence, Italy for his kindness to send reference through email. Finally many thanks are given to Rob Stuebing for his valuable comments on the manuscript.

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APPENDIX I. Specimen Examined

Huia sumatrana. MZB Amp. 427 (female), Deli, North Sumatra; MZB Amp. 3216 (male), Gunung leuser National Park, North Sumatra; MZB Amp. 3488 (male), Bukit Barisan Selatan National Park, Lampung, South Sumatra; MZB Amp. 3914 (female), Wai Ratai, Pantai Cermin, Lampung, South Sumatra; MZB Amp.3893 (4 specimen; 2 females, 2 males), Sumatra; MZB Amp. 10345 (male), 10346 (male), 10349 (male), 10352 (male), 10356 (male), 10357 (male), 10361 (male), Lembah Anai, West Sumatra; MZB Amp. 13182 (male), 13186 (female), Payakumbuh, West Sumatra; MZB Amp. 14858 (male), 14859 (male), 14860 (male), Kerinci Seblat National Park, Jambi, Central Sumatra; MZB Amp. 2477 (male), Bukit Lawang, North Sumatra.

Huia* cf *sumatrana. MZB Amp. 3461 (female), Kubu Perahu, Bukit Barisan Selatan, Lampung, South Sumatra; MZB Amp. 13190 (male), 13200 (female), Payakumbuh, West Sumatra; MZB Amp. 3630 (male), Lahat, South Sumatra; MZB Amp. 10358 (male), 10361 (male), 10362 (male), Lembah Anai, West Sumatra.