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MORPHOLOGICAL VARIATION OF THE THREE SPECIES FRUIT BAT GENUS *MEGAEROPS* FROM INDONESIA WITH ITS NEW DISTRIBUTION RECORD

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Abstract

Morphological variation in the fruit bat Megaerops *spp. from five islands in Indonesia were examined. Univariate and multivariate statistical analyses based on 19 skull characters and 12 external body characters from 32 adult specimens were conducted to examine morphological variation.*

Multiple regression analysis on the three species examined indicated that there were not sexually dimorphic in both skull and external body characters. Between these species examined showed a marked distinction, as detected by using discriminant function analysis. Specimens of Megaerops *from Bali and Lombok were not morphologically distinct from* M. kusnotoi, *while our additional Sumatran* Megaerops *were morphologically similar to* M. w. albicollis.

This is the first report of M. kusnotoi *from Bali and Lombok, and* for M. w. albicollis *from Sumatra.*

Keywords: Taxonomic, morphology, distribution, Indonesia.

Introduction

The member of the bat genus *Megaerops* is small to medium size (Forearm 46 - 60.5 mm), upper parts body fur varies from mid-brown to gray-brown with unspotted wing, invisible or short tail, short tubular facial nostril, interfemoral membrane is much reduced with scarcely hair and one pair of lower incisors. Exception is for *M. wetmorei*, which have white fur around the centre neck through both sides of neck, but not joint at the dorsal neck (Medway 1977, Hill and Smith 1984, Payne *et al.* 1985). It is distributed widely from India through Indochina, Thailand, Malaya, Philippines, Sumatra, Jawa and Borneo.

Currently, based on this paper we consider the genus *Megaerops* comprises the following species and subspecies (van Strein 1986, Francis 1989, Corbet and Hill, 1992, Koopman 1993, Suyanto *et al*, 1998):

M. niphanae Yenbutra and Felten, 1983.
N. E. India, Thailand and Vietnam.
M. ecaudatus (Temminck, 1837).
C. S. Thailand, Vietnam (?), Malaya, Sumatra and Borneo
M. kusnotoi Hill and Boeadi, 1978.
Jawa, Bali* and Lombok*.
M. wetmorei Taylor, 1934.
M. w. wetmorei Taylor, 1934.
Philippines.
M. w. albicollis Francis, 1989.
Malaya, Borneo and Sumatra*.
*) New distribution record

Vertebrae surveys in the Lesser Sunda Islands carried out by Dr. D. J. Kitchener and his colleagues from Western Australian Museum and Balitbang Zoologi LIPI, in which we participated, collected for the first time *M. kusnotoi* from Bali and Lombok. Also, one of us (IM) recently netted *M. ecaudatus* from Sumatra, as well as *wetmorei* from Borneo and Sumatra.

This study was principally to diagnose the first Bali and Lombok *Megaerops* against species of *kusnotoi* from Jawa. We determined if morphological differentiation among the island populations of *Megaerops* from Jawa, Bali and Lombok using univariate and multivariate analyses. We re-examined representative of the *M. wetmorei* regarding our additional specimens since it has been described from only a few specimens. This paper also reported the first distributional record of *wetmorei* in Sumatra.

Materials and Methods

A total of 32 adult specimens from five islands in Indonesia were available for this study. Locations of sample collected are given in Figure 1 and Appendix 1. Specimens examined were from Museum Zoologicum Bogoriense (MZB) - LIPI, Bogor. Adult specimens were recognized by basioccipital and sphenoid bones completely fused and no epiphyseal swellings on the phalangeal joints of wing bones.

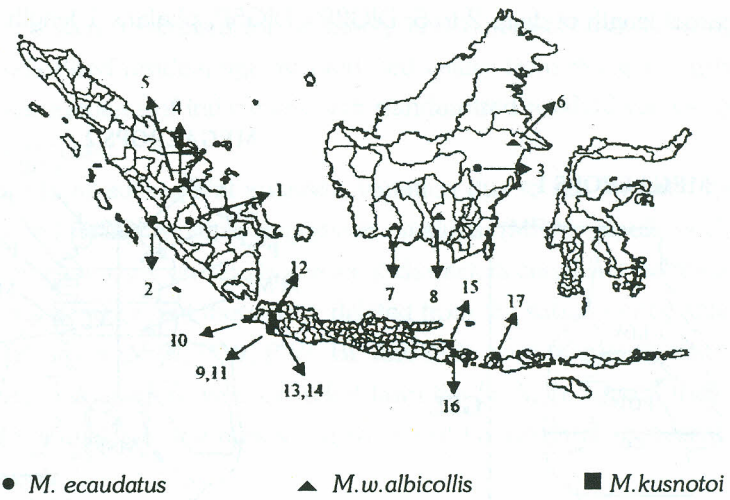


Figure 1. Map showing localities of *Megaerops* spp. examined in this study. Locality codes and details information see Appendix 1.

Bats were captured by mist net. The specimens were fixed in 10% formalin. Specimens were mainly preserved in 70% ethanol and a few were prepared as scientific 'cabinet skin'. Skull was separated from the body.

Nineteen measurements of skull, dentary and dental (hereafter referred to as skull characters) and 12 external body characters were recorded from adult specimens listed in Appendix 1. Measurement points for skull and external body characters are shown in Figure 2.

Measurements of skull characters were as follows: GSL, greatest skull length; ZB, zygomatic breadth; LIW, least interorbital width; POW, postorbital width; BW, braincase width; MSF, mesopterygoid fossa width; PL, palatal length; RAP, ramus angular process; DL, dentary length; C_1M_2, lower canine to second lower molar length; BL, bullae length; C^1W, first upper canine width; C^1C^1, width between outside upper canine; M^1M^1, width between outside first upper molar; P^3P^3, width between outside third upper premolar; P^4P^4, width between outside fourth upper premolar; P^3W, third upper premolar width; P^4W, fourth upper premolar width; and M^1W, first upper molar width.

Measurements of external characters were as follows: FA, forearm length; TIB, tibia length; SV, snot–vent length; Ear, ear length; DIG2 - DIG5,

metacarpal length of digits 2 to 5; DIG2P - DIG5P, phalanx 1 length of digits 2 to 5.

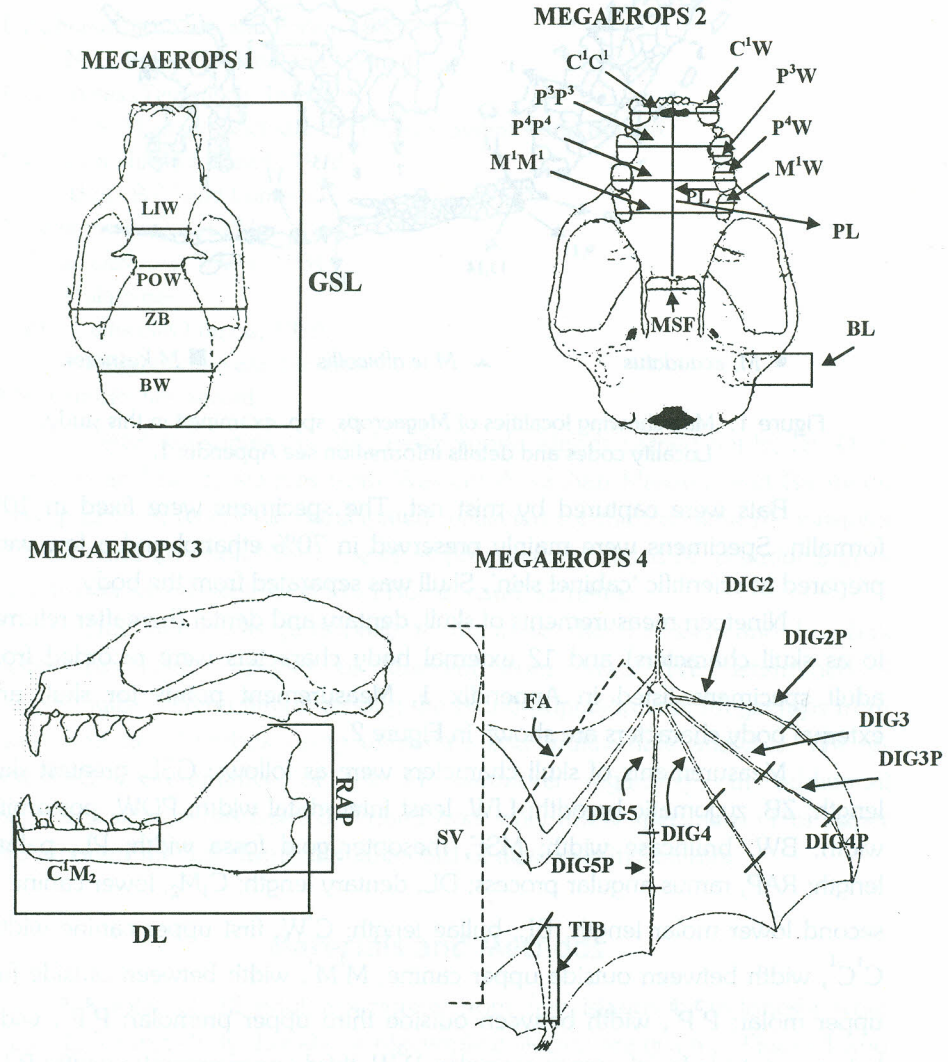


Figure 2. Measurement points of skull and external body characters *Megaerops* spp. The Measurement points are labelled with codes, corresponding to the description in the text.

The data were examined for normality and heteroscedasticity using the plots of standardized residual against predicted values from multiple regression analysis. Measurements of individuals with standardized residual values greater than 3 were checked.

Prior to all subsequent analyses, variation due to sex for each species were examined using multiple regression analysis (MRA) of all skull and external body characters on sex. Some skull characters could not be measured because of the damage and these were deleted from the subsequence analyses. Five skull characters (M^1W, P^3W, P^4W, BL and MB) were frequently damaged. These damaged characters were excluded from the DFA; because if they were included in the analyses, the number of cases will be too small to satisfactorily analyse the data.

Canonical variate (discriminant function) analysis (DFA) using both sexes combined was carried out on most skull characters and all external body characters separately using the species as *a priori* groupings. The association between these species in discriminant function space was very similar for both skull and external body characters. The analysis was run for combined skull and external body characters and again for a reduced set of characters. These two analyses also produced very similar pattern of association between these species in discriminant function space.

Given a particular set of characters, discriminant function analysis identifies characters that are important in separating the species/group. Thus, it is possible to drop those characters which do not significantly contribute in the separating power. Also, using too many characters can give misleading results due to what is known as "overfitting". Thus, instead of using all characters, a sub set of characters were selected on the basis that they minimised the values of Wilk's lambda. Consequently, the DFA presented and discussed below is that for skull and external body characters combined using the reduced set of characters.

Computations for all analyses were made through the SPSS (Green *et al.* 1997).

Results and Discusion

1. Univariate statistics

The sample size, mean, standard deviation, maximum and minimum values for some measurements (in mm) for skull and external body characters of *Megaerops* spp. a presented in Table 1. This descripttive statistics show that the largest species of the genus is *ecaudatus*. It differs from the other two species *Megaerops* in having larger all characters. For example on its average of FA 55.02, TIB 21.67, GSL 26.95, PL 13.28, DL 19.88 and ZB 17.94 mm. *M. wetmorei* is the smallest species by having the shortest for most characters, except POW which is slightly larger than *kusnotoi* (*wetmorei* 6.61 v. *kusnotoi* 6.28 mm). The intermediate species is *kusnotoi*; *ie.* larger than *wetmorei* but smaller than *ecaudatus* on average for all characters except for POW as stated earlier.

Table 1. Descriptive statistics of skull (a) and external body (b) measurements (in mm) for of *Megaerops* spp. examined in this study. N: sample size, x: mean, SD: standard deviation, Min: minimum and Max: maximum. For explanation of characters codes, please see the text.

1a. Skull characters

Species		BL	C^1W	C^1C^1	DL	GSL	LIW	M^1M^1	M^1W	MB	MSF	P^3W	P^3P^3
M. ecaudatus	N	6	8	8	9	8	8	8	8	8	8	8	8
	Min	2.68	1.53	5.46	18.77	26.23	5.24	8.07	1.23	11.23	3.65	1.45	7.51
	Max	3.05	1.69	6.22	20.92	28.31	6.20	9.05	1.46	12.30	4.41	1.65	8.83
	x	2.91	1.59	5.76	19.88	26.95	5.65	8.38	1.34	11.73	3.94	1.57	7.96
	SD	0.14	0.05	0.24	0.73	0.74	0.33	0.35	0.08	0.37	0.26	0.08	0.42

Species		BL	C^1W	C^1C^1	DL	GSL	LIW	M^1M^1	M^1W	MB	MSF	P^3W	P^3P^3
M. kusnotoi	N	9	9	10	11	10	11	11	9	11	11	9	11
	Min	2.73	1.45	5.34	18.04	24.50	4.76	7.36	1.13	10.89	3.19	1.39	6.87
	Max	3.09	1.72	6.03	19.77	26.19	5.33	8.15	1.30	11.66	3.55	1.54	7.60
	x	2.98	1.57	5.71	18.77	25.33	5.09	7.76	1.19	11.34	3.37	1.48	7.23
	SD	0.13	0.10	0.23	0.57	0.69	0.16	0.25	0.05	0.24	0.11	0.05	0.27

Species		BL	C^1W	C^1C^1	DL	GSL	LIW	M^1M^1	M^1W	MB	MSF	P^3W	P^3P^3
M. wetmorei	N	8	8	8	8	7	8	8	6	6	8	8	8
albicollis	Min	2.54	1.14	4.56	15.03	21.19	4.08	6.57	.890	10.14	3.23	1.24	6.37
	Max	3.03	1.35	5.03	16.61	23.15	4.69	7.14	1.06	11.35	3.62	1.42	7.23
	x	2.79	1.25	4.88	16.06	22.31	4.39	6.84	0.99	10.71	3.36	1.34	6.75
	x	2.79	1.25	4.88	16.06	22.31	4.39	6.84	0.99	10.71	3.36	1.34	6.75
	SD	0.18	0.07	0.17	0.60	0.67	0.22	0.18	0.06	0.44	0.13	0.06	0.28

Table 1. Continued.

Species		P^4W	P^4P^4	PL	POW	RAP	C_1M_2	ZB
M. ecaudatus	N	8	8	8	8	8	8	8
	Min	1.37	8.01	12.44	6.07	8.97	8.97	17.07
	Max	1.61	9.28	14.55	7.10	10.10	10.31	18.99
	x	1.51	8.42	13.28	6.57	9.67	9.69	17.94
	SD	0.09	0.45	0.77	0.44	0.37	0.43	0.64

Species		P^4W	P^4P^4	PL	POW	RAP	C_1M_2	ZB
M. kusnotoi	N	9	11	11	11	11	11	11
	Min	1.25	7.26	11.87	5.88	7.76	8.86	16.13
	Max	1.53	8.21	13.24	6.86	10.39	9.57	17.39
	x	1.41	7.63	12.57	6.28	9.19	9.31	16.53
	SD	0.09	0.29	0.39	0.30	0.81	0.20	0.40

Species		P^4W	P^4P^4	PL	POW	RAP	C_1M_2	ZB
M. wetmorei	N	8	8	8	8	8	6	8
albicollis	Min	1.15	6.65	9.85	6.34	6.88	7.30	14.64
	Max	1.32	7.56	11.28	6.85	8.64	7.84	15.86
	x	1.25	7.08	10.47	6.61	7.76	7.68	15.40
	x	1.25	7.08	10.47	6.61	7.76	7.68	15.40
	SD	0.07	0.33	0.44	0.19	0.65	0.20	0.40

1b. External body characters

Species		DIG2	DIG2P	DIG3	DIG3P	DIG4	DIG4P	DIG5	DIG5P	EAR	FA	SV	TIB
M. ecaudatus	N	9	9	9	9	9	9	9	9	9	9	9	9
	Min	24.39	6.75	36.43	26.36	33.82	19.25	34.36	17.08	11.94	51.33	61.94	20.42
	Max	31.46	8.43	41.69	29.93	40.75	23.44	41.23	19.71	15.94	60.09	79.12	24.39
	x	27.30	7.48	38.81	27.61	37.25	20.87	37.83	18.57	14.13	55.02	69.00	21.67
	SD	1.94	0.54	1.65	1.25	2.21	1.24	1.93	0.79	1.40	2.63	5.88	1.24

Species		DIG2	DIG2P	DIG3	DIG3P	DIG4	DIG4P	DIG5	DIG5P	EAR	FA	SV	TIB
M. kusnotoi	N	11	11	11	11	11	11	11	11	11	11	11	11
	Min	21.79	5.97	33.04	23.72	31.58	17.89	33.23	15.74	11.08	48.36	58.19	18.15
	Max	26.81	8.53	39.30	27.15	37.39	20.96	38.51	18.33	15.16	55.92	75.51	22.68
	x	24.96	7.59	36.24	25.57	34.18	19.65	34.76	17.20	13.05	51.51	66.23	20.63
	SD	1.48	0.78	1.82	1.07	1.64	0.96	1.59	0.89	1.56	2.32	6.08	1.40

Species		DIG2	DIG2P	DIG3	DIG3P	DIG4	DIG4P	DIG5	DIG5P	EAR	FA	SV	TIB
M. wetmorei	N	10	10	10	10	10	10	10	10	10	10	10	10
albicollis	Min	19.98	5.41	31.06	20.45	28.94	14.81	29.08	14.06	8.93	45.95	54.08	16.84
	Max	23.44	7.42	34.12	24.48	32.38	17.84	33.49	16.17	13.25	51.52	72.53	19.96
	x	21.52	6.48	32.42	22.54	30.57	16.86	30.98	15.37	10.71	47.58	62.90	18.61
	SD	1.13	0.55	0.95	1.31	1.12	0.93	1.30	0.70	1.18	1.77	6.23	0.94
	SD	1.13	0.55	0.95	1.31	1.12	0.93	1.30	0.70	1.18	1.77	6.23	0.94

2. *Multiple regression analysis (MRA)*

The MRA of main effects of sex for each species are presented in Table 2. Because of the large number of interactions being tested, weak significance ($0.01<P<0.05$) may result from chance association. Thus, the level of significance is considered at $P<0.01$. Variables that were statistically significant ($P<0.01$) for sex were excluded from the following analyses.

All skull and external body characters showed a non significant ($P<0.01$) correlation with sex indicated there is no sexual dimorphism within the three species bats of *Megaerops* (Table 2). With all of these, however, there was weak interaction with sex at $P<0.05$ for *ecaudatus* for the character of DIG3 and DIG5P.

Table 2. Simple regression of skull and external body characters on sex of *Megaerops* spp. examined in this study. Significance of F values are as follows: * = $p<0.05$, ** = $p<0.01$ and *** = $p<0.001$

Character	*M. ecaudatus*	*M. kusnotoi*	*M. wetmorei albicollis*
a. Skull			
BL	0.11	1.47	0.05
C^1W	0.69	0.75	0.27
C^1C^1	0.04	0.01	0.36
C^1M^2	0.04	0.01	0.07
DL	0.05	0.00	0.36
GSL	0.12	0.96	1.56
LIW	0.12	2.42	5.98
M^1M^1	0.00	0.68	1.64
M^1W	0.72	0.09	1.05
MB	0.34	0.25	0.62
MSF	0.06	0.09	0.09
P^3W	0.39	0.03	0.08
P^3P^3	0.20	0.07	0.29
P^4W	0.34	0.80	0.02
P^4P^4	0.05	0.70	0.30
PL	0.05	0.76	1.67
POW	0.01	0.02	1.72
RAP	0.44	0.30	0.91
ZB	0.36	1.22	1.44

b. External body			
DIG2	4.54	1.20	0.24
DIG2P	0.54	0.03	1.03
DIG3	5.98*	0.63	1.99
DIG3P	2.25	0.78	1.14
DIG4	4.80	0.96	4.06
DIG4P	5.97	0.16	0.81
DIG5	3.13	2.05	2.37
DIG5P	6.20*	0.06	0.74
EAR	0.13	0.34	3.85
FA	0.75	0.24	1.09
SV	0.92	1.26	0.03
TIB	0.62	0.00	0.02

3. Canonical variate (discriminant function) analysis (DFA)

The analysis was run for complete skull and external body characters combined using the species as *a priori* groupings, and again for a reduced set of selected characters. The reduced characters gave very similar pattern of clustering between these three species in discriminant function space as those provided by the complete set of characters. As a consequence, the subsequent DFA was run using reduced characters selected on the basis that they minimised values of Wilk's lambda, are presented.

Morphological Variation between *Megaerops* spp.

Discriminant function analysis was run for complete skull and external body characters combined using the species as *a priori* groupings, and again for a reduced set of 6 characters (GSL, MSF, C^1C^1, ZB, LIW and FA) that were selected on the basis minimising Wilk's lambda values. The reduced set of five characters gave very similar pattern of association between these species in discriminant function space to the complete characters. This secondary DFA produced a plot of Functions 1 and 2 showing considerable morphological separation between the groups indicating they belong to distinct biological species (Figure 3). All individuals were correctly classified in to their species group. The ranges of members of each species of *Megaerops* examined in this study were not overlapping with the others.

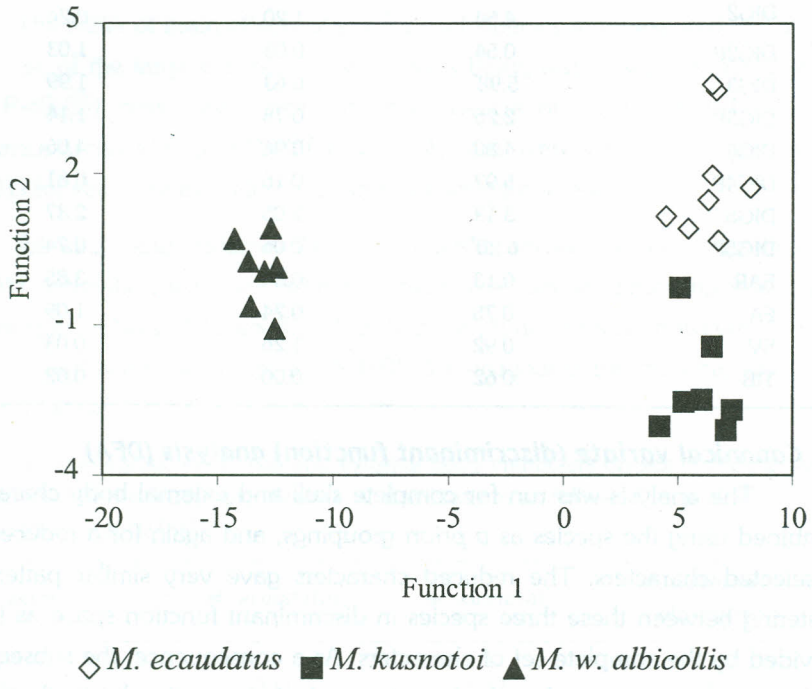


Figure 3. Plot of canonical variate (discriminant) functions 1 and 2 for *Megaerops* spp. based on six selected characters (GSL, MSF, C^1C^1, ZB, LIW and FA).

Two significant functions were extracted from this DFA; Function 1 explaining 96.55% of the variation; and Function 2, 3.45%. Function 1 separated *wetmorei* from both *ecaudatus* and *kusnotoi*. The characters loading most heavily (>0.5) on Function 1 were GSL, ZB, C^1C^1, MSF, FA and LIW (Table 3). Function 2 completely separated *kusnotoi* from *ecaudatus*. It partially separated *wetmorei* from both *ecaudatus* and *kusnotoi* (see Figure 3). The characters that loaded heavily (>0.5) on Function 2 were again MSF, ZB, C^1C^1, GSL, LIW and FA (see Table 3). These indicated that a wide range of morphological divergence involving overall skull size and forearm length was an important characters in separating *Megaerops* spp. examined.

Table 3. Standardised and unstandardised (in brackets) Discriminant Function Coefficient for the three species of *Megaerops* examined in this study

Character	Function 1	Function 2
GSL	3.73 (5.35)	-0.33 (-0.47)
ZB	-2.31 (-4.50)	0.73 (1.41)
C^1C^1	1.93 (10.21)	-0.70 (-3.67)
MSF	-1.38 (-7.33)	0.96 (5.06)
FA	-1.34 (-0.57)	-0.26 (-0.11)
LIW	1.18 (4.47)	0.29 (1.08)
Eigen value	94.12	3.36
Constant	-80.91	-9.59
Variance explained (%)	96.55	3.45

Taxonomic Arrangement

Megaerops wetmorei albicollis Francis, 1989.

Megaerops wetmorei albicollis, Francis, C. M. 1989. Notes on fruit bat (Chiroptera, Pteropodidae) from Malaysia and Brunei, with the description of a new subspecies of *Megaerops wetmorei* Taylor, 1934. *Can. J. Zool* 67: 2878-2882.

Holotype

British Museum (Natural History) BM(NH) 1988.45, subadult male, skull extracted, carcase fixed in ethanol.

Type locality

Pasoh Forest Reserve, Peninsular Malaysia (2°58' N, 102°17' E), collected on August 1987.

Distribution

Malaya, Borneo and Sumatra.

Specimens examined

Listed in Appendix 1.

Taxonomic Remarks

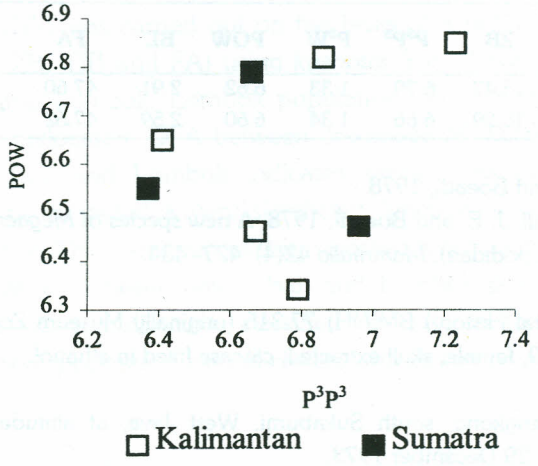
Some morphological variation has already been noted to occur within *M. wetmorei*. Francis (1989) importantly observed some morphological variation within *M. wetmorei* over its range from Philippines, Peninsular Malaysia and Borneo (Brunei). He stated that the Bornean *wetmorei* has pelage with broader area and more contrast of white colour around the neck;

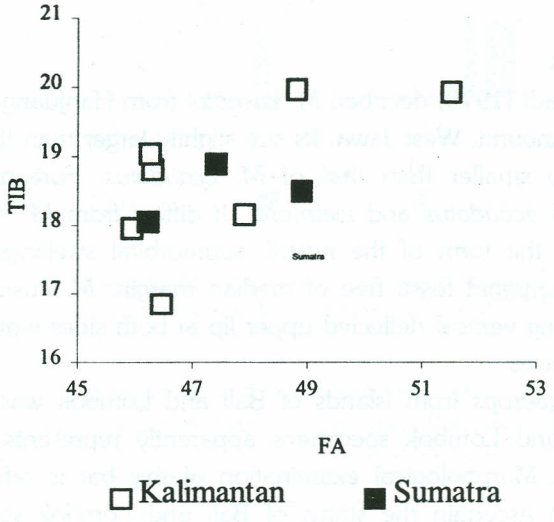
and slightly different skull shape *ie.* relatively wider skull and more protrude but shorter of nasal. Skull measurements and external body generally similar to the nominate species. Francis (1989) named the Bornean form as *M. w. albicollis.*

Megaerops wetmorei albicollis previously was known occur in Borneo and Peninsular Malaysia (Francis 1989, Mickleburgh *et al,* 1992). We have three additional adult specimens of *Megaerops* from Sumatra. These were two from Jambi District (MZB. 14798 and MZB. 15435) and one from Riau District (MZB 15123). All *M. wetmorei* from Sumatra collected from peat forest. These bats are similar in size, shape and pelage colour, to those *M. wetmorei* from Borneo. Since there appears to be no previous published record of individuals *wetmorei* from Sumatra, these specimens were examined and compared to the known form of Bornean *wetmorei.*

We could not run DFA for these two *wetmorei* island populations since our specimens only constitute a small data base (Borneo, 7; Sumatra, 3) and may greatly influence the results. Small sample sizes can appear significantly different when being compared and may in fact represent extremes in a range of variation within a species when more specimens are examined. However, univariate statistics showed an evidence that Sumatran *wetmorei* have measurements that overlap with those *M. w. albicollis* from Borneo which suggests that these two islands populations were similar morphologically. This is confirmed by Figures 4a and 4b indicating there was to be concordance measurements in P^3P^3, POW, FA and TIB. Further, average measurements (in mm) for both the Bornean and Sumatran *wetmorei* for selected characters presented in Table 4 indicated that measurements of the three Sumatran *wetmorei* incorporated with seven specimens *albicollis* from Borneo.

Measurements and shape of skull, external body and pelage colouration of Sumatran *wetmorei* indicated that these bats were morphologically close to those *M. wetmorei* from Borneo. It was decided then, a new record of distribution of *wetmorei* from Sumatra appeared representative of *M. w. albicollis*; and it is not allocated to different subspecies.





Figures 4ab. Scatter plot of P^3P^3 against POW (a) and FA against TIB (b) of *M. wetmorei albicollis* from Kalimantan and Sumatra.

Table 4. Measurements (average, in mm) for some selected skull and external body characters of *M. w. albicollis* from Kalimantan and Sumatra.

M. w. albicollis	GSL	ZB	P^3P^3	P^3W	POW	BL	FA	TIB
Kalimantan	22.38	15.47	6.79	1.33	6.62	2.91	47.60	18.67
Sumatra	22.15	15.29	6.66	1.34	6.60	2.59	47.52	18.48

Megaerops kusnotoi Hill and Boeadi, 1978.

Megaerops kusnotoi Hill, J. E. and Boeadi, 1978. A new species of *Megaerops* from Java (Chiroptera: Pteropodidae). *Mammalia* 42(4): 427- 434.

Holotype

British Museum (Natural History) BM(NH) 77.316 (originally Museum Zoologicum Bogoriense MZB 10669, female, skull extracted, carcase fixed in ethanol.

Type locality

Hanjuang, Ciletuh, Lengkong, south Sukabumi, West Java, at altitude 700 m, collected by Boeadi on 29 December 1973.

Distribution

Malaya, Borneo and Sumatra.

Specimens examined

Listed in Appendix 1.

Taxonomic Remarks

Hill and Boeadi (1978) decribed *M. kusnotoi* from Hanjuang, Ciletuh, Lengkong, South Sukabumi, West Jawa. Its size slightly larger than that of *M. wetmorei* but slightly smaller than that of *M. ecaudatus*. Forearm length intermediate between *ecaudatus* and *wetmorei*. It differs from *M. ecaudatus* and *M. wetmorei* in the form of the nostril, supraorbital swellings, muzzle structure and mesopterygoid fossa free of median margin. *M. kusnotoi* also characterised by having vertical deflected upper lip at both sides which is not found at the other species.

A series of *Megaerops* from islands of Bali and Lombok was recently collected. The Bali and Lombok specimens apparently represents the first record of this genus. Morphological examination of this bat is referable to *kusnotoi*. In order to ascertain the status of Bali and Lombok specimens, morphometric variation between island populations of *kusnotoi* were examined. An analysis of discriminant function using *Megaerops kusnotoi*, against Bali and Lombok specimens was assigned. In this section,

measurements and morphological variation analysis of *M. kusnotoi* are presented.

DFA was carried out on the basis of a reduced set characters (PL, P^4P^4, C^1W, ZB, TIB and FA) using *kusnotoi* from Jawa; and *Megaerops* from both Bali and Lombok. Lombok population which represented by two specimens was unallocated. DFA between Jawanese *M. kusnotoi*, and *Megaerops* from both Bali and Lombok indicates strong possibility of single species. This analysis extracted a very significant function, which explained 100% of the variance. The histogram of this extracted function indicated there were no clear separation between Jawa, Bali and Lombok populations (Figure 5). Of the cases, all of individuals classified correctly to their appropriate island. The Lombok specimen clustered closely with Jawanese *kusnotoi*.

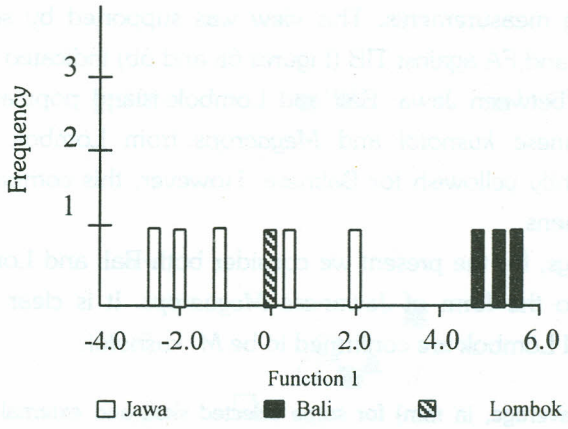


Figure 5. Frequency histogram of *M. kusnotoi* examined with Lombok unallocated based on six selected characters (PL, P^4P^4,C^1W,ZB,TIB and FA).

Table 5. Standardised and unstandardised (in brackets) Discriminant Function Coefficient for *Megaerops kusnotoi* from Jawa, Bali and Lombok.

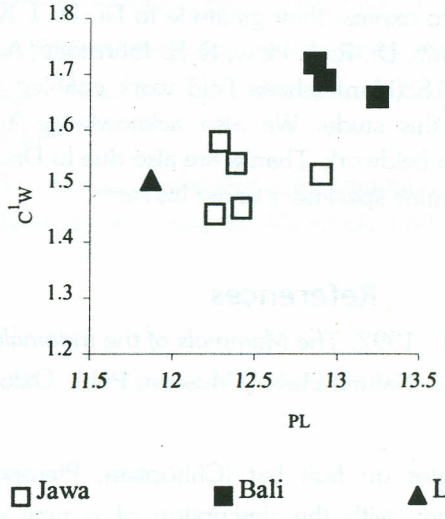
Character	Function 1
PL	0.75 (3.61)
C^1W	0.83 (15.87)
Eigen value	10.87
Constant	69.84
Variance explained (%)	100

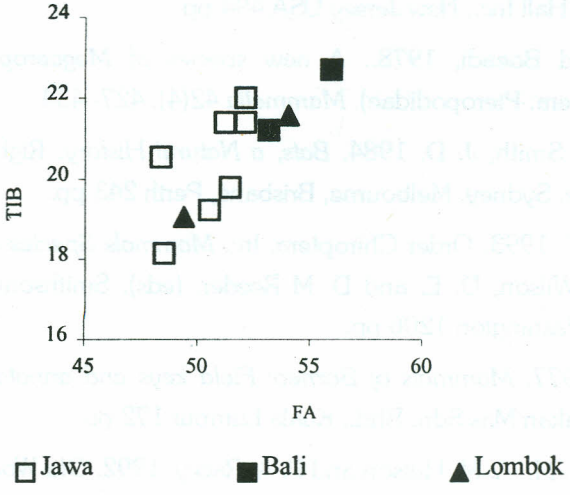
The characters loading most heavily on the extracted function were: PL and C^1W (Table 5). This indicated that shape differences detected between Jawa, Bali and Lombok populations principally relate to palatal length and width of upper canine. However, the differences in three islands populations of *kusnotoi* was interpreted as response to the environmental gradients. Specimens from Bali were somewhat differentiated morphologically from those from the Jawa and Lombok, but this differences was not considered to warrant taxonomic distinction suggests they belong to single species. Measurements of adult *Megaerops* from Bali and Lombok fell within the range of its nominate species from Jawa (see Table 6). Although these characters were the most important in separating between Jawa, Bali and Lombok populations; but there was still an overlapping measurements. This view was supported by scatter plots of PL against C^1W and FA against TIB (Figures 6a and 6b) indicated there was no discrete cluster between Jawa, Bali and Lombok island populations. Pelage colour of Jawanese *kusnotoi* and *Megaerops* from Lombok were broadly similar, but slightly yellowish for Balinese. However, this comparison based on alcohol specimens.

Based these findings, for the present we consider both Bali and Lombok specimens are similar to the form of Jawanese *Megaerops*. It is clear then, specimens from Bali and Lombok are confirmed to be *M. kusnotoi*.

Table 6. Measurements (average, in mm) for some selected skull and external body characters of *Megaerops kusnotoi* from Jawa, Bali and Lombok.

Megaerops kusnotoi	**GSL**	**DL**	**P^4P^4**	**PL**	**C^1W**	**ZB**	**FA**	**TIB**
Jawa	25.15	18.51	7.49	12.41	1.50	16.50	50.59	20.35
Bali	25.97	19.34	7.78	13.01	1.69	16.44	54.53	21.94
Lombok	24.50	18.90	8.21	12.39	1.54	17.03	51.71	20.30





Figures 6ab. Scatter plot of PL against C^1W (a) and FA against TIB (b) of *M. kusnotoi* from Jawa, Bali and and Lombok.

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Appendix 1. Specimens examined of *Megaerops* spp for this study.

Megaerops ecaudatus
Sumatra
Muara Siaw (2°18'00"S; 102°06'00"E).
♂: MZB 16683, 16712,16718 ♀: MZB 16704,16707.
Barumun Tengah (2°30'00"N;100°09'00"E).
♂: MZB 13561 ♀: MZB 13560.
Kalimantan
Oatalibaq (0°00'12"S; 115°37'00"E).
♀: MZB 13509.
Kalimantan. Barat (Locality unknown).
Sex unknown: MZB 15849.

Megaerops kusnotoi
Jawa
Sukawayana.
♂: MZB 10680.
Cidaun.
♀: MZB 10929.
Cikepuh (7°14'00"S; 106°21''00"E).
♀: MZB 9872.
Cibodas.
Y: MZB 9219.
Citadahan.
♀: MZB 12702.
Buligir Putih (6°39'56"S; 106°26'57'IE).
♂: MZB 16853.
Pasir Cangkuang (6°40'43 "S; 106°28'11"E).
♂: MZB 16906.
Baluran (7°51'00"S; 114°22'00"E).
♂: MZB 14634. Bali
Gunung Kelatakan (8°13'00"S; 114°30'00"E).
♂: MZB 16936 ♀: MZB 16937-8.
Lombok Locality unknown
♂: MZB 35955, 17709.

M. wretmorei albicollis.
Sumatra.
Sarulangan.
♂: MZB 14798.
Pangkalan Kasai (0°43'00"S; 102°30'00"E).
♂: MZB 15123.

Bungo Tebu.
♀: MZB 15435. Kalimantan.
Muara Maau (0°59'00"N; 117°15'00"E).
♂: MZB 13562.
Camp Leakey (2°46'17""S; 111°57'00"E).
♀: MZB 22156-7.
Pahandut (2°19'15"S; 113°54'00"E)
♂: MZB 22295-6, Field # 15, 64.