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MORPHOLOGICAL VARIATION IN *CHIRONAX MELANOCEPHALUS* (CHIROPTERA: PTEROPODIDAE) FROM INDONESIA AND DESCRIPTION OF NEW SUBSPECIES

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ABSTRACT

The taxonomy of small fruit bat members of the genus *Chironax* was examined. Morphological character, as well as statistical analyses of skull and external characters revealed that the Kalimantan population is sub-specifically different from Sulawesi and Sumatra-Jawa populations. The Kalimantan population is desribed herein as *Chironax melanocephalus dyasae* subsp. nov.

Key words: *Chironax melanocephalus*, taxonomy, variation, morphology

INTRODUCTION

Chironax melanocephalus is a small tailless fruit bat with head black, back gray or brown, chin yellowish, ventral pale buff and without spot on the wings. The forearm length is 39-47 mm, weight between 12-19 gram and two pairs of lower incisors. It is found in lowland forest to montane forest at elevation above 600 m (Lekagul & McNeely 1977, Nowak 1999) but more abundant at higher altitude (Kingston *et al*. 2009). It is recorded from about 300 m asl at Bogani Nani National Park, Sulawesi (Maharadatunkamsi 2006). It flies in forests at all level height below the canopy (Hodgkison *et al*. 2004). It feeds mainly on figs (Lekagul & McNeely 1977). It roosts in small colony consists of 2-8 individuals in tree ferns and in shallow cave (Payne *et al*. 2000), but can also roost in gregarious colony in rock crevices and caves in forest (Kingston *et al*. 2009). Some reports indicate that breeding is restricted to the beginning of the year (Bergmans & Rozendaal 1988, Kingston *et al*. 2009). It is distributed in South-East Asia region throughout Thailand, Malaysia, Sumatra, Kalimantan, Sulawesi and Jawa (Hill 1983, Bergmans & Rozendaal 1988).

There appear to be limited publications of *C. melanocephalus* since its first description by Temminck in 1825. Examination by Hill (1974)

using small samples from Malaysia, Jawa and Sulawesi could find no appreciable differences between them. While waiting additional samples, he tentatively referred the Sulawesi form to nominated species which was described from Bantam, West Jawa (Andersen 1912, Corbet & Hill 1992). With two other additional specimens from Sulawesi for comparison, Hill (1983) found that there were differences between the Sulawesi and Jawa forms. Subsequent study of *C. melanocephalus* from Jawa and Sulawesi by Bergmans & Rozendaal (1988) showed morphological differentiation in subspecific level of these two island populations. They named the Sulawesi form as *C. melanocephalus tumulus*. However, due to lack of material from Kalimantan, the status of this population remains uncertain.

The collection of *C. melanocephalus* in Museum Zoologicum Bogoriense-LIPI from Sumatra, Kalimantan, Sulawesi and Jawa is much more extensive than was hitherto available for previous studies. This paper reports the morphological variation *C. melanocephalus* from some Indonesian islands in the context of their subspecific taxonomic ranking. On this basis, the Kalimantan population is thus considered sub-specifically distinct and herein described as a new subspecies.

MATERIALS AND METHODS

A total of 81 adult specimens from the collections of Museum Zoologicum Bogoriense-LIPI were examined. These were from Kalimantan (12 ♀), Sumatra (4 ♂, 16 ♀), Jawa (11 ♂, 21 ♀, 2 unknown) and Sulawesi (10 ♂, 4 ♀, 1 unknown) (Appendix 1). Adults specimens were diagnosed as those with the basisphenoid-presphenoid suture completely fused.

Eighteen measurements of skull, dentary and dental characters (hereafter referred to skull characters) and of 15 external body characters from all specimens were recorded to an accuracy of 0.01 mm. Measurements points for skull and external characters followed Kitchener *et al*. (1993) and Maharadatunkamsi & Kitchener (1997). Measurements were taken using vernier caliper. Pelage descriptions follow the color terminology of Kornerup & Wanscher (1984).

The measurements recorded for skull are as follows: GSL, greatest skull length; ZB, zygomatic breadth; LIW, least interorbital width; POW, postorbital width; BW, braincase width; ONL, orbit to nasal length; CPL, dentary condyle to tip of dentary; C^1M^1, upper canine to first upper molar length; C^1C^1, width between outside upper canine; M^1M^1, width between outside first upper molar breadth; P^3L, third upper premolar length; P^3W, third upper premolar width; P^4L, fourth upper premolar length; P^4W, fourth upper premolar width; M^1L, first upper molar length; M^1W, first

upper molar width; C_1M_2, lower canine to second lower molar length; and M_1M_1, width between outside first lower molar.

The external body measurements are as follows: FA, forearm length; TIB, tibia length; D1, digit 1 length; D2M - D5M, metacarpal length of digits 2 to 5; D2P1 - D5P1, phalanx 1 length of digits 2 to 5; and D2P2 - D5P2, phalanx 2 length of digits 2 to 5.

Computations for all analyses were undertaken using the SPSS 14.0 statistical package. Sexual dimorphism of 18 skull characters and 15 external body characters were investigated by analysis of variance on sex effect. A discriminant function analysis was run for all skull and body combined using all sex-free effect characters. For subsequent analyses, reduced set of characters were selected on the basis of minimizing the Wilk's Lambda value.

RESULTS AND DISCUSSION

Descriptive statistics

Summary statistics of the data including mean, standard deviation, minimum and maximum values and sample size for all characters examined for each subspecies are presented in Table 1.

Analysis of Variance (Anova)

To determine the influence of sex effect on characters measured, Anova was run for the main effects sex. Five skull characters (LIW, P^3L, P^3W, P^4L and POW) and two external characters (D1 and D3M) were significantly influenced by sex. These results indicated that most characters were not sexually dimorphic in both skull and external body characters (see Table 2).

Canonical variate (discriminant function) analysis (DFA)

The DFA was run using the following island groupings representative of putative taxa as follows: *C. m. dyasae* subsp.nov (Kalimantan), *C. m. melanocephalus* (Sumatra-Jawa) and *C. m. tumulus* (Sulawesi). All DFA were initially run with the full set of 26 skull and external body characters that had no significant sex interaction. To avoid what is known as "overfitting", instead of using all characters, a sub set of ten characters (C^1C^1, C^1M^1, C^1M^2, M_1M_1, M^1M^1, ONL, D2P2, D3P1, D4M and D4P1) were selected on the basis that they minimised the values of Wilk's lambda. The DFA on the three island groups using this reduced set of characters produced similar DFA plots to those based using complete characters. Consequently, only results based on reduced characters are detailed below.

Table 1. Skull and external body measurements (mm) sex-free effect for *Chironax melanocephalus* examined in this study. N, sample size; Min, minimum; Max, maximum; Mean; and SD, standard deviation

Taxon		GSL	BW	C^1C^1	C_1M_2	C^1M^1	M^1L	M^1M^1	M_1M_1	M^1W	CPL	ONL	P^4W	ZB
C.m. dyasae	N	10	10	10	10	10	10	10	9	10	10	10	10	10
	Min	21.80	9.94	4.41	8.01	6.96	1.29	6.36	6.00	1.05	16.15	5.40	1.33	13.49
	Max	23.63	10.31	5.07	8.38	7.50	1.43	7.10	6.87	1.16	17.19	6.32	1.51	15.70
	Mean	23.08	10.12	4.73	8.17	7.19	1.38	6.73	6.53	1.11	16.71	5.95	1.40	14.56
	SD	0.55	0.11	0.18	0.14	0.18	0.05	0.26	0.31	0.03	0.33	0.27	0.05	0.68
C.m. melanocephalus	N	53	53	53	53	53	53	52	53	53	53	53	53	53
	Min	20.23	9.38	4.18	6.88	6.62	1.02	6.29	5.78	0.88	14.93	4.80	1.18	13.30
	Max	24.30	10.63	4.97	8.42	7.51	1.51	7.15	6.84	1.24	17.41	6.40	1.46	15.46
	Mean	22.58	10.09	4.57	7.72	7.01	1.25	6.68	6.29	1.02	16.36	5.65	1.28	14.51
	SD	0.76	0.24	0.19	0.32	0.23	0.10	0.20	0.22	0.07	0.53	0.43	0.07	0.45
C.m. tumulus	N	15	15	15	15	15	15	15	14	15	15	15	15	13
	Min	21.03	9.52	3.74	6.73	6.58	0.99	5.95	5.58	0.77	15.27	5.12	1.09	13.23
	Max	23.52	10.37	4.41	8.05	7.40	1.39	6.93	6.55	1.15	17.32	6.45	1.27	14.70
	Mean	22.57	9.98	4.24	7.47	7.04	1.24	6.49	6.12	0.95	16.44	5.91	1.17	14.11
	SD	0.62	0.19	0.17	0.43	0.30	0.12	0.26	0.25	0.11	0.49	0.47	0.05	0.42

Taxon		FA	TIB	D2M	D2P1	D2P2	D3P1	D3P2	D4M	D4P1	D4P2
C.m. dyasae	N	12	12	12	12	12	12	12	12	12	12
	Min	41.98	13.50	19.00	4.62	3.05	20.48	20.53	26.80	15.23	15.69
	Max	46.32	16.86	22.92	5.81	3.90	23.39	25.84	30.59	18.43	17.38
	Mean	44.20	15.67	20.62	5.31	3.40	22.07	23.64	28.40	16.79	16.67
	SD	1.37	1.02	1.28	0.37	0.27	0.82	1.49	1.14	0.93	0.55
C.m. melanocephalus	N	54	54	54	54	54	54	54	54	54	54
	Min	39.39	13.92	18.03	4.07	2.18	19.26	22.43	24.68	14.34	14.97
	Max	47.02	17.90	22.25	5.92	3.69	23.18	28.63	29.08	18.42	19.19
	Mean	43.41	15.96	20.38	4.82	2.88	21.43	25.98	27.11	16.83	17.36
	SD	1.65	0.81	0.92	0.38	0.31	0.91	1.61	0.95	0.89	1.09
C.m. tumulus	N	13	13	13	13	13	13	13	13	13	13
	Min	43.35	15.03	19.56	3.83	3.00	22.05	22.10	27.86	15.23	14.71
	Max	47.85	17.70	23.31	6.47	3.92	24.77	27.17	31.08	19.61	17.07
	Mean	45.88	16.54	21.60	5.26	3.47	23.22	24.46	29.76	17.31	15.75
	SD	1.39	0.68	1.09	0.56	0.24	1.01	1.41	1.09	1.19	0.62

Table 1. Continued

Taxon		D5M	D5P1	D5P2
C.m. dyasae	N	12	12	12
	Min	26.81	13.67	13.54
	Max	30.97	16.05	17.29
	Mean	28.86	14.94	15.16
	SD	1.57	0.78	1.09
C.m. melanocephalus	N	54	54	54
	Min	26.07	12.86	13.00
	Max	30.30	16.64	17.46
	Mean	28.33	14.64	15.19
	SD	1.04	0.82	1.04
C.m. tumulus	N	13	13	13
	Min	28.58	14.24	13.78
	Max	33.43	16.40	16.02
	Mean	31.42	15.59	14.83
	SD	1.48	0.66	0.66

Table 2. Anova of skull and external characters of *Chironax melanocephalus* by sex. Significance of F values are as follows: $p<0.05$*, $p<0.01$** and $p<0.001$***

Skull characters								
BW	C^1C^1	C^1M^1	C_1M_2	CPL	GSL	LIW	M^1L	M^1W
2.82	1.42	3.28	1.21	0.39	0.30	4.97*	1.23	0.30

Skull characters								
M^1M^1	M_1M_1	ONL	P^3L	P^3W	P^4L	P^4W	POW	ZB
0.42	0.05	0.83	14.22***	10.10**	6.02**	2.22	5.51*	0.65

External characters								
FA	TIB	D1	D2M	D2P1	D2P2	D3M	D3P1	D3P2
0.83	0.32	8.01**	0.10	0.89	0.92	2.72*	1.13	0.01

External characters					
D4M	D4P1	D4P2	D5M	D5P1	D5P2
0.99	0.01	2.17	0.40	0.01	1.40

DFA based on reduced set characters extracted 2 significant functions that explained all the variance (Fig. 1). Function 1 explained a total of 87.2% of the variance ($p<0.001$, df = 60) and Function 2, 12.8 % ($p<0.001$, df = 9). Plots of Functions 1 and 2 clearly separated the above three sub species of *Chironax melanocephalus* (Fig. 1). A total of 98.6% of individuals was correctly classified to their appropriate subspecies. Misclassification occurred on *C. m. melanocephalus* with 1 of 51 individuals were classified to *C. m. dyasae*.

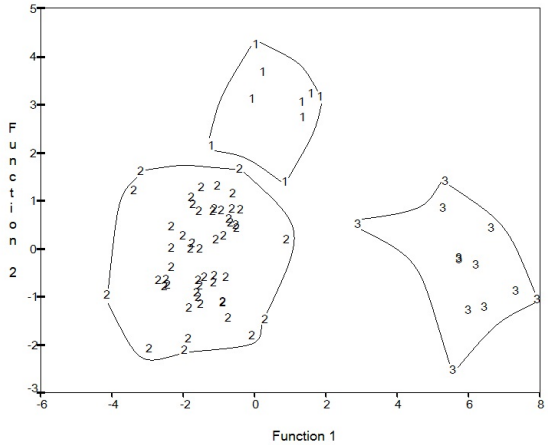


Figure 1. Plot of canonical variate (discriminant) functions 1 and 2 based on ten selected characters of *Chironax melanocephalus*
(1) *C. m. dyasae* Kalimantan, (2) *C. m. melanocephalus* Sumatra-Jawa and (3) *C. m. tumulus* Sulawesi

The characters with the canonical discriminant function coefficient that most loaded heavily on Function 1 were C^1C^1, C^1M^1, C^1M^2, D2P2 and D4M. The characters that most loaded heavily on Function 2 were M^1M^1, C^1M^2, C^1C^1, M_1M_1 and D2P2. All of these suggested that some dental characters and wing characters were important discriminant between *C. m. dyasae* (Kalimantan), *C. m. tumulus* (Sulawesi) and *C. m. melanocephalus* (Sumatra-Jawa) (Table 3).

Table 3. Standardized and unstandardized (in brackets) canonical variate function coefficients for the three subspecies of *Chironax melanocephalus*

Character	Function 1	Function 2
C^1C^1	-1.0450 (-5.6070)	0.5850 (3.1400)
C^1M^1	0.9840 (4.0750)	-0.0530 (-0.2180)
C^1M^2	-0.6960 (-2.4560)	0.8620 (3.0410)
D2P2	0.8020 (2.9420)	0.3950 (1.4490)
D4M	0.5150 (0.6100)	0.1200 (0.1420)
M^1M^1	-0.4380 (-5.0360)	-1.1540 (2.4337)
M_1M_1	0.4040 (1.7190)	0.5720 (2.4340)
Constant	-17.573	-18.596
Variation explained (%)	87.2	12.8

DFA indicated that three broad morphological forms occurred among *C. melanocephalus* in Indonesia. These morphological groups were considered subspecifically distinct. The analyses indicated clearly that Sumatra and Jawa had similar skull and external body characters.

Kalimantan and Sulawesi, differed greatly in both skull and external body characters, as well as from Sumatra-Jawa group. It is clear that Kalimantan form is not representative of *C. m. melanocephalus* (Sumatra-Jawa) and *C. m. tumulus* (Sulawesi). Kalimantan is an undescribed subspecies of *C. melanocephalus* and formally here described as a new subspecies in the following systematics section.

SYSTEMATICS

Chironax melanocephalus dyasae subsp. nov.

Holotype

MZB 14777, adult female, skull and mandible separate, teats enlarged but not lactating, fixed in 10% formalin, skin prepared as a cabinet specimen.

Type locality

Muara Rekut, Busang River, Barito Ulu, Central Kalimantan, collected using mist net on 22 April 1989 by M.H. Sinaga.

Paratypes

Eleven adult females from Kalimantan as follows: MZB 14772 collected by Boeadi on 12 March 1989 from Muara Rekut, Busang River, Barito Ulu, Central Kalimantan; MZB 12686.1 and 12686.2 collected by Sugardjito on 24 December 1979 from Wanariset Semboja, East Kalimantan; MZB 17983 collected by Boeadi on 25 June 1996 from Menjahan, Sibau Hulu, West Kalimantan; MZB 17984 collected by Boeadi on 6 June 1996 from Sei Aso, Nanga Bungan, Kapuas Hulu, West Kalimantan; MZB 22612, 22630 collected by A. Suyanto, K. Sato and Yusup on 5 February 2001 and MZB 24429 collected by by A. Suyanto, K. Sato and A. Saim on 19 February 2002 from Taman Hutan Wisata Bukit Bangkirai, Samboja, Regency of Kutai, East Kalimantan; MZB 23884 collected by Ibnu Maryanto and Pandam on 13 March 2006 from Maruwei Km 72, East Kalimantan; MZB 23885 collected by Ibnu Maryanto and Pandam on 22 March 2006 from Babao, Maruwei, East Kalimantan; and MZB 31010 collected by Ibnu Maryanto on 27 May 2008 from Lematang, Village of Tugup, Puruk Cahu, Central Kalimantan.

Distribution

Kalimantan.

Specimens examined

Specimens other than types are listed in Appendix 1.

Etymology

Named after the author's daughter, Retno Sri Widyastuti (Dyas),

in recognition of her understanding my frequent absence from home to do fieldwork.

Diagnosis

Externally *Chironax melanocephalus dyasae* subsp. nov. differs from two other known subspecies in having linoleum brown dorsal pelage, while in *C. m. melanocephalus* the dorsal fur is brown to dark brown and grey to greyish brown in *C. m. tumulus*. Ventral fur yellowish brown compare to greyish brown in *C. m. melanocephalus*, and brownish grey to white in *C. m. tumulus*. Tip of the ears tend to be oval rather than rounded as at the other two subspecies.

Lateral cranial view of *C. m. dyasae* has longer rostrum among the three subspecies. Its rostrum gently concave away to dorsocranial region. The dorsalateral cranium is moderately inflated compared to *C. m. tumulus*. *C. m. dyasae* differs from *C. m. melanocephalus* and *C. m. tumulus* in shape of its teeth which is more robust, heavier and squarer. Its palatal is moderately wider compared to *C. m. melanocephalus* and *C. m. tumulus*. Dorsal view of cranial of *C. m. dyasae* shows a wider braincase width than the other two subspecies.

It differs from *C. m. melanocephalus* by being larger in most skull measurements for example greatest skull length 23.08 (21.80-23.63) versus 22.57 (20.23-24.30), least interorbital width 4.95 (4.52-5.37) versus 4.49 (4.02-5.13), lower canine to second lower molar length 8.17 (8.01-8.38) versus 7.72 (6.88-8.42) and orbit to nasal length 5.95 (5.40-6.32) versus 5.65 (4.80-6.40).

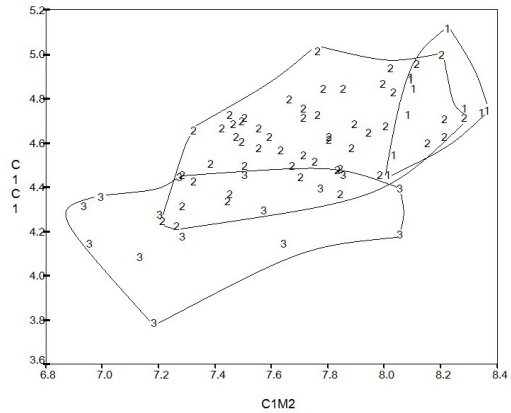
It differs from *C. m. melanocephalus* by being longer in most external body character for example forearm length 44.20 (41.98-46.32) versus 43.41 (39.39-47.02), phalanx 1 length of digit two 5.31 (4.62-5.81) versus 4.82 (4.07-5.92), phalanx 1 length of digit five 14.94 (13.67-16.05) versus 14.64 (12.86-16.64) and phalanx 2 length of digit two 3.40 (3.05-3.90) versus 2.88 (2.18-3.69). It has shorter in phalanx 2 length of digit three 23.64 (20.53-25.84) versus 25.98 (22.43-28.63).

It differs from *C. m. tumulus* by being in most skull characters for example greatest skull length 23.08 (21.80-23.63) versus 22.57 (21.03-23.52), lower canine to second lower molar length 8.17 (8.01-8.38) versus 7.47 (6.73-8.05), width between outside upper canine 4.73 (4.41-5.07) versus 4.24 (3.74-4.41), width between outside first lower molar 6.53 (6.00-6.87) versus 6.12 (5.58-6.55) and zigomatic breadth 14.56 (13.49-15.70) versus 14.11 (13.23-14.70).

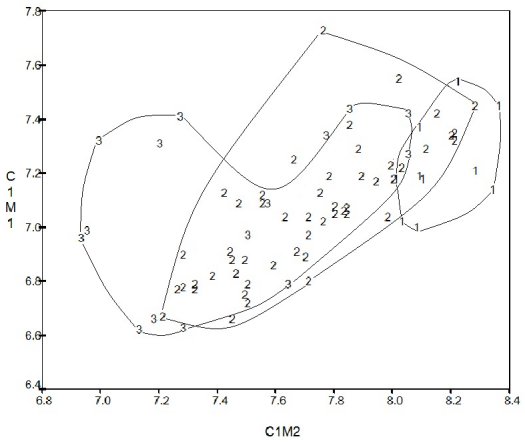
It differs from *C. m. tumulus* in having the following external body characters much shorter, *i.e.*, forearm length 44.20 (41.98-46.32) versus 45.88 (43.35-47.85), tibia length 15.67 (13.50-16.86) versus 16.54 (15.03-17.70), phalanx 1 length of digit three 22.08 (20.48-23.39) versus 23.22

(22.05-24.77), metacarpal length of digit five 28.86 (26.81-30.97) versus 31.42 (28.58-33.43) and phalanx 1 length of digit five 14.94 (13.67-16.05) versus 15.59 (14.24-16.40).

The morphological differences demonstrated amongst *C. m. dyasae*, *C. m. melanocephalus* and *C. m. tumulus* were also apparent in the univariate statistics. For example in skull characters, *C. m. dyasae* generally has longer distance between lower canine to second lower molar (C_1M_2) relative to both width between outside upper canine (C^1C^1) (Fig. 2) and length between upper canine to first upper molar length (C^1M^1) (Fig. 3) than those in the *C. m. melanocephalus* and *C. m. tumulus*. *C. m. dyasae* differs from *C. m. tumulus* in having generally shorter metacarpal length of digits 4 (D4M) and from *C. m. melanocephalus* in having generally longer D4M (Fig. 4).



Figures 2. Bivariate plots of C^1C^1 over C_1M_2 for *Chironax melanocephalus*
(1) *C. m. dyasae* Kalimantan (2) *C. m. melanocephalus* Sumatra-Jawa and (3) *C. m. tumulus* Sulawesi



Figures 3. Bivariate plots of C^1M^1 over C_1M_2 for *Chironax melanocephalus*
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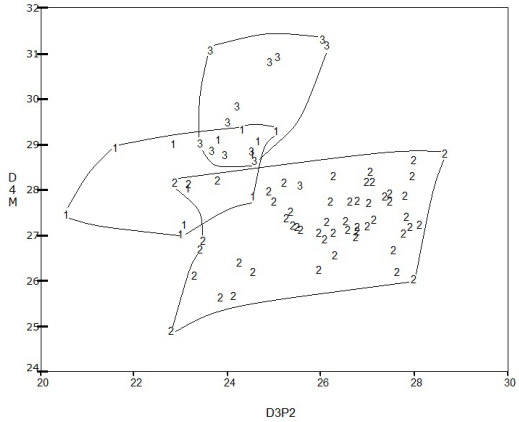

Figure 4. Bivariate plot of D4M over D3P2 for *Chironax melanocephalus*
(1). *C. m. dyasae* Kalimantan (2) *C. m. melanocephalus* Sumatra-Jawa and (3) *C. m. tumulus* Sulawesi

Description

C. m. dyasae subsp. nov. is small with greatest skull length of 23.08 mm (21.80-23.63), braincase width moderate 10.12 mm (9.94-10.31) and nasal length 5.95 mm (5.40-6.32). The overall cranium shape of *C. m. dyasae* is similar to *C. m. melanocephalus*. The skull is small, lightly built, with moderate width of braincase to a relatively short rostrum. In lateral view, the braincase is convex descending at the posterior part. Its rostrum is gently concave dorsally to a moderately inflated dorsocranial region. In ventral view, the palate is wide. It has massive canines and molars that in occlusal view tend to be more square in outline than the other two subspecies of *C. melanocephalus*. Anterior premolar (P^1) is minute. Mandible is slender, ramus of mandible high, angular process stout and thin.

It has small body-size with forearm length 44.20 mm (41.98-46.32) and tibia length 15.67 mm (13.50-16.86). The dorsum is linoleum brown, slightly darker on head. Basal part of hairs is pale orange, tipped with linoleum brown. The hairs around shoulder, throat and extending to chin, side of neck to behind ears are lighter in colour.Ventral surface paler, yellowish brown, lighter on throat. Fur are more sparse on the chin and throat. Patagia is brownish grey to greyish brown. Ears brown with the tip tend to be oval and slightly thickened at the edges.

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Appendix 1. List specimens of *Chironax melanocephalus* examined in this study (all adults)

Sumatra:

Wai Kambas, Lampung.
♀ MZB 10670.2

Gunung Bungkuk, North Bengkulu.
♀ MZB 15424, 15434.6, 15434.7

Bukit Jarum Kapahiang, North Bengkulu.
♀ MZB 15441, 15442, 15444
♂ MZB 15443

Air Putih, Muara Aman, North Bengkulu.
♀ MZB 15107

Sawah Melintang, Lebong Selatan, Bengkulu.
♀ MZB 13284

Sungai Sengak, Muara Siaw, Regency of Sarolangun Bangko, Jambi.
♀ MZB 16720

Aek Nambaru, Bandar Pasir Mandago, Regency of Asahan, North Sumatra.
♀ MZB 13622

Tapanuli Utara, North Sumatra.
♂ MZB 10546

Martabe, Batang Toru, Regency of Tapanuli Selatan, North Sumatra.
♀ MZB 24952, 25994, 25997
♂ MZB 25995, 25996

Ketambe, Kutacane, Gunung Leuser, Aceh Tenggara.
♀ MZB 12986, 12988

Jawa:

Linggarjati, Gunung Ciremai National Park, West Jawa.
♀ MZB 30201, 30202, 30204
♂ MZB 30205

Awibengkok, Jayanegara, Gunung Salak, West Jawa.
♀ MZB 14713

Gunung Salak, Sukabumi, West Jawa.
♀ MZB 14203
♂ MZB 22448
Sex unknown MZB 14337

Kelapa Nunggal, Sukabumi, West Jawa.
♀ MZB 14087

Gunung Masigit, West Jawa.
♀ MZB 14653
Situgunung, Cisaat, Sukabumi, West Jawa.
♀ MZB 15492
Kebun Raya Cibodas, West Jawa.
♂ MZB 22534
Gunung Bengbreng, Gunung Halimun National Park, West Jawa.
Sex unknown MZB 22408.05
Gunung Kendeng, Gunung Halimun National Park, West Jawa.
♂ MZB 22381
Pasir Cangkuang, Gunung Halimun National Park, West Jawa.
♀ MZB 16888
Cikaniki, Gunung Halimun National Park, West Jawa.
♀ MZB 17004, 17017, 17020
♂ MZB 17008
Citorek, Gunung Halimun National Park, West Jawa.
♀ MZB 18128
Ciwalen, Gunung Halimun National Park, West Jawa.
♂ MZB 18434
Purwabakti, Cibumbulan, Gunung Halimun National Park, West Jawa.
♀ MZB 18440
Bodogol, Cicurug, Gunung Gede Pangrango National Park, West Jawa.
♀ MZB 22514, 22515
♂ MZB 22513
Cibodas, Gunung Gede, West Jawa.
♀ MZB 10545.10, 10545.20
♂ MZB 10544
Linggoasri, Gunung Dieng, Regency of Wonosobo, Central Jawa.
♀ MZB 27562
♂ MZB 27563
Gunung Slamet, Central Jawa.
♀ MZB 12953
♂ MZB 11958
Curug Cipendok, Regency of Banyumas, Central Jawa.
♀ MZB 33742, 33743

Sulawesi:
Toraut, Bogani Nani Wartabone National Park, North Sulawesi.
♀ MZB 24861, 24863,
♂ MZB 24862, 24864, 24865

Matayangan, Dumoga, Regency of Bolaang Mangandow, North Sulawesi.
♂ MZB 16943
Telawi, Nokilalaki, Lore Lindu National Park.
♀ MZB 23455
♂ MZB 23450, 23456, 23461, 23462
Wuasa, Lore Lindu National Park.
♀ MZB 23703
♂ MZB 23465
Pedreh, Kanawe, Southeast Sulawesi
Sex unknown MZB 23708
Village of Makarti Jaya, Taluditi, Gorontalo.
♂ MZB 32385

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