

A new species of fruit bat (Megachiroptera: Pteropodidae: *Thoopterus*) from Sulawesi and adjacent islands, Indonesia

Ibnu Maryanto¹, Mohamad Yani², Siti Nuramaliati Prijono¹ and Sigit Wiantoro¹

¹ Museum Zoologicum Bogoriense, Research Center for Biology-LIPI, Jl. Jakarta-Bogor Km 46, Cibinong 16911, Indonesia. Email: ibnu_mar@yahoo.com

² Jl. Gotong Royong, Gang Jeruk 6/2, Komplek Kebon Jeruk, Pejjeruk, Ampenan, Mataram Lombok, Indonesia.

ABSTRACT – A new species of fruit bat in the genus *Thoopterus*, *T. suhaniahae*, is described from Sulawesi, Talaud and Wowoni Islands in Indonesia. The new species differs from *T. nigrescens* in having larger cranial, dental, mandibular, external measurements, and a wider calcar. In addition, the tail of the new species is absent or reduced to a rudiment, a quarter to a half of the under face of the uropatagium is sparsely furred and the urethral aperture of the glans penis lacks a conspicuous scale-like projection. The new species is sympatric with *T. nigrescens* and is known from elevations of 60–2,100 m above sea level.

KEYWORDS: taxonomy, morphology, *Thoopterus suhaniahae* sp. nov.

INTRODUCTION

The fruit bat genus *Thoopterus* was proposed by Matschie (1899) as a subgenus of *Cynopterus*. Gray (1870) recognized *nigrescens* as a variety of *Cynopterus marginatus* (Geoffroy, 1810). Andersen (1912) recognized *Thoopterus* as a valid monotypic genus, based on the absence of a postorbital foramina, incisors complete, upper canine grooved, cheek teeth 4/5, P₄ and M₁ broad, quadrate with large surface, tail reduced to a rudiment, membranes attached on the second toe, fur much longer compared to *Cynopterus*, and grooved upper canines without cingulum cusps.

Thoopterus nigrescens has been recorded from Morotai in the North Moluccas (the type locality) and Sulawesi. Bergmans and Rozendaal (1988) and Suyanto *et al.* (1998) reported it occurring on the Sangihe Talaud Islands. Boeadi and Saim collected this species from Sula and Kabaena, Buton in 1991 and 2002, and from Wowoni Islands in 2005 which were then deposited in the Museum Zoologicum Bogoriense (MZB). Bergmans and Rozendaal (1988) reported that specimens from South-West Sulawesi (Bantimurung and Malino) were larger than that from northern Sulawesi and may represent a new taxon. *Thoopterus nigrescens* has previously been reported from sea level up to 1,780 m (Bergmans and Rozendaal 1988). During a 2000–2001 survey, however, we found *T. nigrescens* to be most common at even higher altitudes of Nokilalaki and Rorekatimbu-Lore Lindu National Park: 2,100 m and 2,200 m, respectively

(Maryanto and Yani 2001). To clarify the taxonomic status of these populations, this paper provides a morphological description of these high elevation populations of *Thoopterus* from Sulawesi and adjacent islands. We found compelling evidence to describe these populations as a new species of *Thoopterus*, here named *T. suhaniahae* sp. nov.

MATERIALS AND METHODS

A total of 102 adult specimens of *Thoopterus* from Sulawesi, Buton, Sula, Talaud and Wowoni Islands were included in our morphometric analyses (see specimens examined and Figure 1). All cranial, dental, mandibular and external measurements are given in mm. Measurements used in this paper follow Kitchener *et al.* (1995) and Kitchener and Maharadatunkamsi (1991) and are as follows:

Skull and dentition: greatest skull length (GSL), interorbital breadth (IO), zygomatic breadth (ZB), rostrum length (RL), mastoid breadth (MB), braincase height (HB), mesopterygoid fossa width (MSF), palatal length (LOP), bulla length (BL), postorbital width (POW), braincase width (BW), dentary length (DL), height of ramus at angular process (RAP), C¹-C¹ breadth (outside), M¹-M¹, M²-M², P³-P³, P⁴-P⁴ (alveoli, inside), C¹-M² (crown length), C₁-M₂ (crown length), M¹ crown length (M¹L), M¹ crown width (M¹W), M² crown length (M²L), M² crown width (M²W), P³ crown length (P³L), P³ crown width (P³W), P⁴ crown length (P⁴L), P⁴

crown width (P^4W).

External: forearm length (FA), head and body length (HBL), tail length (TAIL), ear length (EAR), tibia length (TIBIA), metacarpal 2 length (P2), metacarpal 2 phalanx 1 length (P2_1), metacarpal 3 length (P3), metacarpal 3 phalanx 1 length (P3_1), digit 4 phalanx 1 length (P4_1), metacarpal 5 length (P5), metacarpal 5 phalanx 1 length (P5_1). Adults were identified as those specimens with basioccipital and basisphenoid bones completely fused and epiphyseal swelling of metacarpal joints absent. Sexual dimorphism in skull and external characters was analyzed by a 2-way ANOVA. We tested for sexual dimorphism and morphological characters using canonical discriminant function analyses (DFA) of *Thoopterus* groups. Multiple analysis of variance (MANOVA) was run separately for craniodental and external characters. Colour terminology follows Kornerup and Wanscher (1984). Specimens discussed here are deposited in the Natural History Museum, London (BMNH) and the Museum Zoologicum Bogoriense, Cibinong Bogor (MZB).

RESULTS

UNIVARIATE STATISTICS

Skull, dentary, dentition

Thoopterus suhaniahae sp. nov. males are larger in most dimensions than females; respective measurements for males and females are as follows:

GSL 38.85 (37.21–40.55) v. 37.10 (35.82–38.28); ZB 25.12 (23.76–26.35) v. 23.93 (22.10–25.23); HB 12.77 (10.41–14.60) v. 12.78 (11.34–14.19); RL 9.54 (8.95–10.75) v. 9.20 (8.54–10.01); IO 8.71 (7.89–9.34) v. 8.24 (7.51–8.58); C^1-C^1 8.06 (7.57–8.58) v. 7.68 (7.23–7.83); POW 7.62 (7.17–8.26) v. 7.51 (7.20–7.91); LOP 19.60 (18.37–20.92) v. 18.84 (18.10–20.03); MSF 4.59 (4.16–5.03) v. 4.64 (4.23–5.42); BL 3.03 (2.20–3.68) v. 3.00 (2.42–3.53); RAP 15.32 (13.63–17.01) v. 14.11 (13.12–14.95); DL 29.33 (28.03–31.06) v. 27.67 (25.58–28.91) (Table 1).

Cranial, dental, mandibular and external dimensions in *T. suhaniahae* sp. nov. are mostly larger than *T. nigrescens*. For example, measurements of female *T. suhaniahae* sp. nov. and *T. nigrescens* are respectively (mean, range in mm): GSL 37.10 (35.82–38.28) v. 34.29 (33.06–35.62), RL 9.20 (8.54–10.01) v. 8.39 (7.57–9.14), ZB relatively wide 23.93 (22.1–25.23) v. 21.67 (20.02–23.31), HB 12.78 (11.34–14.19) v. 11.65 (11.14–12.04); for males, the equivalent comparisons are GSL 38.85 (37.21–40.55) v. 35.33 (32.55–37.67), RL 9.54 (8.95–10.75) v. 8.65 (7.22–9.61), ZB 25.12 (23.76–26.35) v. 22.125 (19.39–23.71), HB 12.77 (10.41–14.60) v. 11.81 (10.88–12.50) (Table 1).

External features

In *T. suhaniahae* sp. nov., external measurements are larger in males than females, for example, HBL (in mm) 98.47 (89.35–109.67) v. 94.91 (86.02–101.11); ear length 17.79 (16.62–19.06) v. 17.64 (16.62–19.50); FA 78.36 (74.42–81.77) v. 76.44 (73.03–78.47); Tibia 32.26

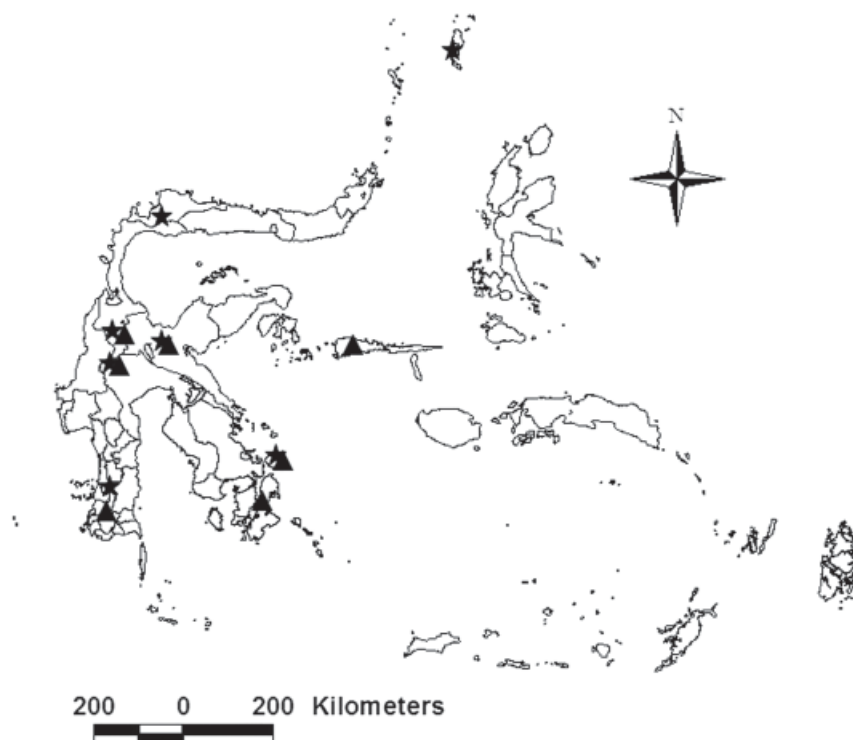


FIGURE 1 Collection localities of *Thoopterus* spp. used in this study, *T. nigrescens* (▲) and *T. suhaniahae* sp. nov. (★).

TABLE 1 Measurements (mm) for skull includes dentary, dental and external characters (see Material and Methods section for explanation of character codes) of adult *Thoopterus* spp.

♀ <i>Thoopterus nigrescens</i>	Mean	Standard deviation	Minimum	Maximum	N
GSL	34.29	0.69	33.06	35.62	31
ZB	21.67	0.73	20.02	23.31	31
HB	11.66	0.26	11.14	12.04	31
RL	8.39	0.37	7.57	9.14	31
IO	7.37	0.31	6.58	7.99	31
C ¹ -C ¹	6.76	0.22	6.3	7.17	31
POW	6.83	0.28	6.13	7.33	31
LOP	7.23	0.5	16.19	18.05	31
MSF	4.48	0.18	4.11	4.87	31
BL	2.77	0.25	2.3	3.2	31
RAP	12.77	0.61	11.63	4.2	31
DL	25.62	0.78	24.04	27.64	31
M ¹ W	1.92	0.09	1.74	2.12	31
M ¹ L	2.29	0.12	2.09	2.59	31
P ³ W	1.83	0.17	1.17	2.13	31
P ³ L	2.32	0.14	1.9	2.52	31
P ⁴ W	2.16	0.1	1.96	2.38	31
P ⁴ L	2.4	0.13	1.99	2.66	31
CBL	33.2	0.79	31.71	35.19	31
M ¹ -M ¹	7.34	0.52	5.13	7.96	31
P ³ -P ³	5.2	0.51	4.43	6.81	31
P ⁴ -P ⁴	6.33	0.55	4.89	7.6	31
BS	13.86	0.55	12.72	14.81	31
POZ	14.54	0.44	13.68	15.42	31
C_M ¹	11.56	0.35	10.56	12.16	31
C_M ²	12.67	0.46	11.29	13.68	31
HBL	88.91	4.65	78.98	97.76	31
EAR	17.19	1.07	4.26	19.24	31
FA	72.85	1.99	67.88	77.32	31
TIBIA	30.06	1.18	27.47	32.52	31
P2	34.48	1.6	30.58	37.31	31
P2_1	9.05	0.66	7.96	10.49	31
P3	50.43	1.47	47.17	53.33	31
P3_1	38.01	1.29	35.37	40.08	31
P4	48.08	1.79	44.25	51.92	31
P4_1	29.63	1.18	26.82	31.46	31
P5	50.5	1.96	46.92	55.22	31
P5_1	24.34	0.83	22.47	25.61	31

♀ <i>Thoopterus suhaniahae</i> sp. nov.	Mean	Standard deviation	Minimum	Maximum	N
GSL	37.1	0.81	35.82	38.28	14
ZB	23.93	0.83	22.1	25.23	14
HB	12.78	0.93	11.34	14.19	14
RL	9.2	0.48	8.54	10.01	14
IO	8.24	0.28	7.51	8.58	14
C ¹ -C ¹	7.68	0.5	7.23	7.83	14
POW	7.51	0.19	7.2	7.91	14
LOP	18.84	0.57	18.1	20.03	14
MSF	4.64	0.29	4.23	5.42	14
BL	3	0.34	2.42	3.53	14
RAP	14.11	0.59	13.12	14.95	14
DL	27.67	0.82	25.58	28.91	14
M ¹ W	2.16	0.11	1.93	2.37	14
M ¹ L	2.52	0.13	2.23	2.75	14
P ³ W	1.95	0.24	.9	2.13	14
P ³ L	2.48	0.2	1.99	2.84	14
P ⁴ W	2.37	0.1	2.22	2.61	14
P ⁴ L	2.64	0.11	2.48	2.87	14
CBL	35.57	0.71	34.74	36.86	14
M ¹ -M ¹	8.21	0.3	7.78	8.73	14
P ³ -P ³	5.61	0.25	5.21	6.07	14
P ⁴ -P ⁴	7.18	0.31	6.5	7.53	14
BS	15.19	0.62	14.05	16.04	14
POZ	5.58	0.38	4.95	6.03	14
C_M ¹	12.76	0.29	12.1	13.17	14
C_M ²	14.01	0.59	12.52	14.82	14
HBL	94.91	3.9	86.02	101.11	14
EAR	17.64	0.89	16.62	19.5	14
FA	76.44	1.64	73.03	78.47	14
TIBIA	31.47	1.17	29.85	33	14
P2	37.22	1.42	34.5	39.54	14
P2_1	10.08	0.38	9.58	10.66	14
P3	54.24	1.43	51.07	56.63	14
P3_1	39.45	1.47	36.64	41.2	14
P4	50.35	1.2	47.39	51.94	14
P4_1	30.34	1	28.7	32.18	14
P5	52.22	1.79	48.66	55.17	14
P5_1	25.51	0.83	23.96	27.2	14

<i>♂ Thoopterus nigrescens</i>	Mean	Standard deviation	Minimum	Maximum	N
GSL	35.33	1.2	32.55	37.67	32
ZB	22.13	1.06	19.39	23.71	32
HB	1.81	0.44	10.88	12.5	32
RL	8.65	0.57	7.22	9.61	32
IO	7.5	0.31	6.4	7.94	32
C ¹ -C ¹	7.05	0.41	6.18	7.76	32
POW	6.98	0.38	6.43	7.8	32
LOP	17.76	0.64	16.57	18.76	32
MSF	4.47	0.2	4.19	4.92	32
BL	2.78	0.22	2.26	3.31	32
RAP	3.29	1	10.43	15	32
DL	26.33	1.31	2.78	28.05	32
M ¹ W	1.98	0.11	1.79	2.15	32
M ¹ L	2.28	0.5	1.84	2.53	32
P ³ W	1.93	0.23	1.35	2.53	32
P ³ L	2.34	0.25	1.41	2.75	32
P ⁴ W	2.22	0.7	1.91	2.62	32
P ⁴ L	2.47	0.4	2.27	2.75	32
CBL	33.97	1.11	31.53	35.89	32
M ¹ -M ¹	7.32	0.66	5.15	7.98	32
P ³ -P ³	5.12	0.45	4.21	6.4	32
P ⁴ -P ⁴	6.45	0.41	5.46	7.1	32
BS	14.15	0.49	13.21	15.03	32
POZ	14.75	0.37	14.08	15.67	32
C_M ¹	1.92	0.53	10.89	13.27	32
C_M ²	13.02	0.54	11.9	13.79	32
HBL	92.12	6.94	78.55	105.12	32
EAR	17.74	0.98	16.17	19.97	32
FA	74.25	3.47	66.65	79.36	32
TIBIA	31.02	1.99	25.84	35.52	32
P2	35.73	.83	32.26	38.26	32
P2_1	9.44	0.91	7.93	11.72	32
P3	51.35	2.16	47.89	55.49	32
P3_1	38.7	.52	35.35	41.31	32
P4	48.94	1.88	44.24	52.77	32
P4_1	30.33	1.23	27.05	32.57	32
P5	51.75	1.88	46.02	55.51	32
P5_1	24.84	1.01	22.59	26.62	32

<i>♂ Thoopterus suhaniahae</i> sp. nov.	Mean	Standard deviation	Minimum	Maximum	N
GSL	38.85	0.81	37.21	40.55	22
ZB	25.12	0.77	23.76	26.35	22
HB	12.77	0.98	10.41	4.6	22
RL	9.54	0.46	8.95	10.75	22
IO	8.71	0.4	7.89	9.34	22
C ¹ -C ¹	8.06	0.29	7.57	8.58	22
POW	7.62	0.31	7.17	8.26	22
LOP	19.6	0.57	18.37	20.92	22
MSF	4.59	0.26	4.16	5.03	22
BL	3.03	0.38	2.2	3.68	22
RAP	15.32	0.93	13.63	17.01	22
DL	29.33	0.77	28.03	31.06	22
M ¹ W	2.24	0.07	2.08	2.33	22
M ¹ L	2.57	0.17	2.3	2.92	22
P ³ W	2.15	0.16	1.96	2.55	22
P ³ L	2.65	0.2	2.02	2.85	22
P ⁴ W	2.48	0.18	2.19	2.9	22
P ⁴ L	2.68	0.1	2.44	2.8	22
CBL	37.25	0.88	35.51	39.28	22
M ¹ -M ¹	8.37	0.34	7.68	8.85	22
P ³ -P ³	5.77	0.37	5.13	6.36	22
P ⁴ -P ⁴	7.34	0.4	6.61	7.85	22
BS	16.04	0.59	15.18	17.24	22
POZ	16.19	0.51	15.6	17.77	22
C_M ¹	13.27	0.29	12.71	13.73	22
C_M ²	14.88	0.27	14.26	15.3	22
HBL	98.47	4.05	89.35	109.67	22
EAR	17.79	0.69	16.62	19.06	22
FA	78.36	1.87	74.42	81.77	22
TIBIA	32.26	1.03	30.49	34.11	22
P2	38.03	0.95	36.13	39.87	22
P2_1	10.45	0.65	9.5	11.57	22
P3	55.23	1.74	52.37	57.73	22
P3_1	41.19	1.16	37.85	42.83	22
P4	51.97	1.62	48.72	54.43	22
P4_1	31.98	0.97	30.46	33.59	22
P5	53.51	1.53	50.27	55.65	22
P5_1	26.27	0.91	24.73	27.52	22

TABLE 2 Measurements (mm) for skull includes dentary, dental and external characters (see Material and Methods section for explanation of character codes) of adult *Thoopterus* spp.

Dependent Variable	Sex		Species		Sex vs. species	
	F	P	F	P	F	P
GSL	43.11	0.001	205.49	0.001	3.04	0.08
ZB	14.97	0.001	163.72	0.001	2.93	0.09
HB	0.18	0.67	53.48	0.001	0.56	0.46
RL	8.86	0.001	56.08	0.001	0.53	0.47
IO	18.98	0.001	208.67	0.001	6.51	0.01
C1-C1	21.99	0.001	181.59	0.001	0.42	0.52
POW	3.74	0.06	81.26	0.001	0.03	0.86
LOP	27.33	0.001	167.29	0.001	1.01	0.32
MSF	0.15	0.7	5.98	0.02	0.27	0.61
BL	0.01	0.94	14.87	0.001	0.01	0.95
RAP	0.35	0.55	12.95	0.001	1.42	0.24
DL	28.22	0.001	115.03	0.001	5.41	0.02
M1W	10.03	0.001	120.9	0.001	0.4	0.53
M1L	0.51	0.48	60.17	0.001	0.7	0.41
P3W	10.2	0.001	12.53	0.001	1.36	0.25
P3L	4.42	0.04	23.79	0.001	2.58	0.11
P4W	5.25	0.02	47.04	0.001	0.18	0.67
P4L	4.95	0.03	59.66	0.001	0.31	0.58
CBL	35.47	0.001	182.37	0.001	3.96	0.05
M1-M1	0.48	0.49	60.7	0.001	0.51	0.48
P3-P3	0.78	0.38	31.23	0.001	0.81	0.37
P4-P4	2.35	0.13	68.92	0.001	0.08	0.78
MB	20.2	0.001	153.91	0.001	6.11	0.02
BW	19.8	0.001	157.82	0.001	5.51	0.02
C_M1	23.97	0.001	178.64	0.001	0.98	0.33
C1-M2	33.59	0.001	201.61	0.001	6.66	0.01
TL	2.27	0.135	10.9	0.001	0.27	0.6
EAR	1.57	0.213	1.967	0.164	0.34	0.56
FA	9.77	0.002	47.91	0.001	0.29	0.59
TIBIA	8.37	0.005	16.1	0.001	0.16	0.69
P2	9.2	0.003	56.19	0.001	0.36	0.55
P2_1	4.72	0.033	36.17	0.001	0.01	0.94
P3	4.7	0.033	70.19	0.001	0.01	0.98
P3_1	5.51	0.021	15.37	0.001	1.543	0.22
P4	11.7	0.001	47.16	0.001	0.73	0.4
P4_1	7.45	0.008	23.17	0.001	1.48	0.23
P5	7.49	0.008	17.57	0.001	0.05	0.82
P5_1	10.5	0.002	40.74	0.001	0.32	0.57

(30.49–34.11) Vs 31.47 (29.55–33.00); P2 38.03 (36.13–39.87) v. 37.22 (34.50–38.54); P2_1 10.45 (9.50–11.57) v. 10.08 (9.58–10.66) (Table 1).

External measurements of *T. suhaniahae* sp. nov. are larger than *T. nigrescens* as follows: the female head and body length 94.91 (86.02–101.11) v. 89.69 (78.98–107.66), ear length 17.63 (16.62–19.50) v. 17.19 (14.26–19.24), forearm length 76.43 (73.03–78.47) v. 72.84 (67.88–77.32); the male head and body length 98.47 (89.35–109.67) v. 92.12 (78.55–105.12), ear length 17.79 (16.62–19.06) v. 17.74 (16.17–19.97), FA 78.36 (74.42–81.77) v. 74.25 (66.65–79.36).

Mean, standard deviation, minimum, maximum values and samples size for each species and different sexes are presented in Table 1 for cranial, dental, mandibular and external characters. MANOVA results (see Table 2 for details) indicate that nearly all characters differed significantly between the sexes. Characters that not were significantly influenced by sex ($P > 0.05$) were: braincase height (HB), bulla length (BL), ramus angular process (RAP), upper first molar length (M^1L), distance between upper first molars (M^1-M^1), upper third premolars (P^3-P^3), and upper fourth premolar (P^4-P^4), ear length (EAR) and head and body length (HBL) (Table 2). All characters showed significant differences between *T. nigrescens* and *T. suhaniahae* sp. nov. at $P < 0.001$; exceptions are MSF and ear length.

For most characters there were no significant interactions between sex and species (Table 2). Weak interactions between sex and species were found for interorbital width (IO), lower canine to second molar distance ($C-M_2$) ($P < 0.01$) and for condylobasal length (CBL), dentary length (DL), braincase width (BW) and mastoid breadth (MB) ($P < 0.05$).

MULTIVARIATE ANALYSES

DFA for 26 skull dental and dentary characters and 12 external characters were run separately. The DFA was run using a reduced set of five selected characters to reduce the effect of over fitting data. Five variables were selected to minimize Wilk's lambda. These subsets provided similar cluster values in discriminant function space as had been observed in the full set of 26 skull, dental and dentary characters. The DFA for males and females extracted a highly significant function that did not misclassify any individuals of *T. nigrescens* and *T. suhaniahae* sp. nov.

The DFA of male specimens contrasted *T. suhaniahae* sp. nov. from Sulawesi, Wowoni and Talaud Islands with *T. nigrescens* collected from Sulawesi, Sula, Wowoni and Buton Island. The five skull and external character for male selected to minimize Wilk's lambda (Kitchener *et al.* 1995) are M^1W , IO, POW, POZ, M^1-M^1 and P3, P2_1, P5, P3_1, HBL. The analyses of female specimens contrasted *T. suhaniahae* sp. nov. from Sulawesi and second, *T. nigrescens* collected from Sulawesi, Buton, Sula,

Wowoni Islands. The five skull and external characters selected to minimize Wilk's lambda female are C^1-C^1 , GSL, HB, MSF, M^1L and P3, P5, P2_1, FA, HBL.

The separate DFA for males and females extracted the highly significant function (Function 1) and classified 100% individuals correctly to species. Variables loading most heavy (> 0.5) on these functions were POW, P3, P5, P3_1, P2_1 (males) and C^1-C^1 , P3, P5, HBL (females).

SYSTEMATICS

Family Pteropodidae

Genus *Thoopterus* Matschie, 1899

TYPE SPECIES

Cynopterus marginatus var. *nigrescens* Gray, 1870.

DIAGNOSIS

Postorbital foramina absent; incisors complete, upper canine grooved, cheek teeth 4/5, P_4 and M_1 broad, quadrate with large surface and grooved upper canines without cingulum cusps; tail reduced to a rudiment, membranes from second toe with longer fur.

Thoopterus nigrescens (Gray, 1870)

Figures 2, 3

MATERIAL EXAMINED

Holotype

Indonesia: North Moluccas: ♀ skin and skull, Morotai, A.R. Wallace (BMNH 62.10.21.6).

DIAGNOSIS

No postorbital foramina, incisors 2/2-2/2, upper canine grooved, cheek teeth 4/5, P_4 and M_2 extremely broad, quadrate, with large surface cusps, and the inner ridge quite obsolete. Tail rudimentary, membranes from second toe' (Andersen 1912).

DESCRIPTION

Description follows Andersen (1912): fur much longer than in *Cynopterus*, back warm prout's brown, under fur pale drab grey, head similar but slightly darker, nape neck paler, under parts from chin to interfemoral, hair brown, slightly shaded with a warmer brown on flanks and sides of breast and belly, the metacarpal and phalanges dark brown. Rostrum unmodified; premaxillae slender, tapering above in simple contact interiorly; row of upper incisors in sharp profile of rostrum (one canine covering the other) partly hidden between canines. Front of orbits above back of P^4 , maxillary tooth row not extending beyond ventral margin of orbit. Sagittal crest fully developed, but low.

DISTRIBUTION

Sulawesi, Talaud, Sula, Buton, Wowoni, Morotai

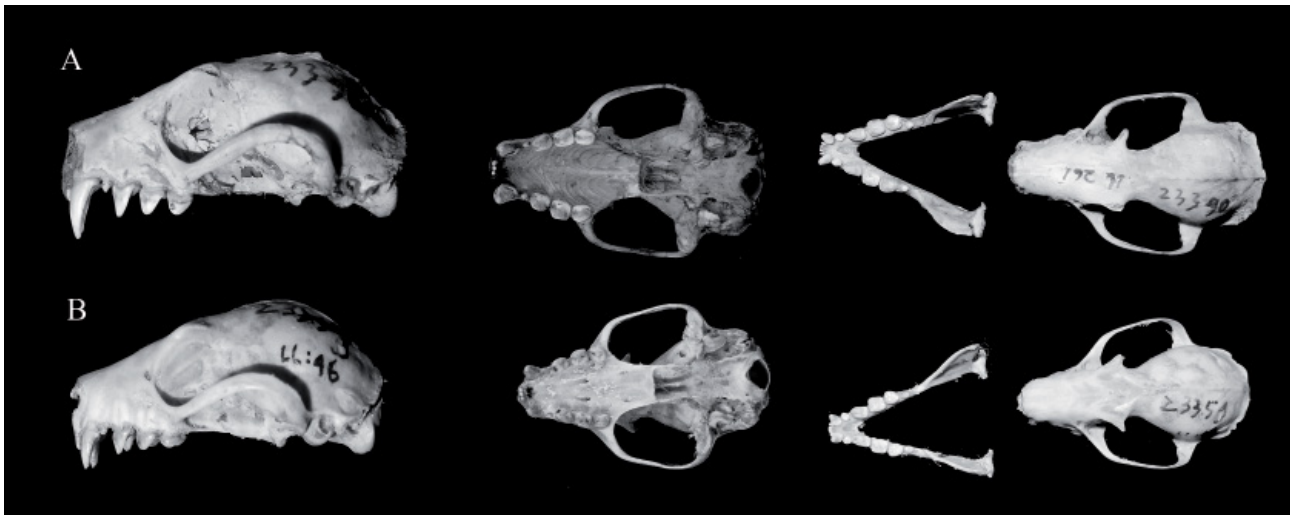


FIGURE 2 Photograph of the skulls of *Thoopterus suhaniahiae* (a) and *T. nigrescens* (b), showing the lower mandible and cranium in dorsal, ventral and lateral views.

Island.

***Thoopterus suhaniahiae* sp. nov.**

Figures 2, 3, 6

MATERIAL EXAMINED

Holotype

Indonesia: Central Sulawesi: MZB 23390: ♀, LL 261, Lore Lindu National Park, Watumeta (1°23'57"S, 120°18'07"E, 1125 m), collected on 26 July 2000 by I. Maryanto and M. Yani.

Paratypes

Indonesia: 12 ♀: MZB 23360, MZB 23363, MZB 23365, MZB 23369, MZB 23372, MZB 23374, MZB 23383, MZB 23384, MZB 23386, MZB 23387, MZB 23376, MZB 23478 (see Appendix 1); 24 ♂: MZB 13378, MZB 15326, MZB 15329, MZB 17812, MZB 23361, MZB 23364, MZB 23367, MZB 23368, MZB 23370, MZB 23371, MZB 23373, MZB 23377, MZB 23378, MZB 23379, MZB 23380, MZB 23381, MZB 23382, MZB 23385, MZB 23389, MZB 23391, MZB 23392, MZB 23393, MZB 27725, MZB 27726 (localities details see Appendix 1).

DIAGNOSIS

Thoopterus suhaniahiae sp. nov. is diagnosed by cranial, dental, and external characters and by combinations of these (see discriminant function analysis and univariate plots, Figures 4, 5). Compared to *T. nigrescens*, metacarpal 3 of *T. suhaniahiae* sp. nov. is longer relative to metacarpal 4 phalanx 1; ZB is wider relative to skull length in *T. suhaniahiae* sp. nov. and palatal length is longer relative to postorbital width than *T. nigrescens* (Figure 5).

DESCRIPTION

Skull, dentary, dentition. Compared with *T. nigrescens* cranium of *T. suhaniahiae* sp. nov., is broader and has a shorter rostrum. There are no postorbital foramina in either taxon. The mandible is more robust underneath the mandibular tooth row. In *T. suhaniahiae* sp. nov. the second upper incisors are slightly shorter than first upper incisors. There is a broad and deep vertical groove on the antero-medial surface of the upper canine. The canine and second incisors are separated by auricle diastema. P_1 is more massive than P^1 ; M_2 nearly the same size as P_1 ; M^1 smaller than M_1 ; P_4 heavier than M_1 ; and P^4 smaller than P_4 .

External characters. Tail absent or reduced to a rudiment but usually more conspicuous than in *T. nigrescens*. Other external characters are as described for *T. nigrescens* by Andersen (1912), except for the interfemoral membranes which differ in having a quarter to half of the under face of the uropatagium sparsely furred and the calcar wider in *T. suhaniahiae* sp. nov. is 10–11 mm (measured from tibia) v. 7–8 mm in *T. nigrescens*.

Pelage. The dorsum of *T. suhaniahiae* sp. nov. is brown, under fur grayish brown, and head, forehead, forearm and rump darker brown. The under parts from chest to abdomen are brownish gray, from chin to interfemoral brown, and the flanks and sides of breast and belly are slightly shaded with a warmer brown. The ear and membranes are unmarked; the metacarpals and phalanges are dark brown. The dorsal fur of both *T. suhaniahiae* sp. nov. and *T. nigrescens* is 10–13 mm long.

Glans penis. Seen under a scanning electron microscope, the urethral aperture of the glans penis of *T. suhaniahiae* sp. nov. lacks the conspicuous scale-like projection seen in *T. nigrescens* (Figure 3).

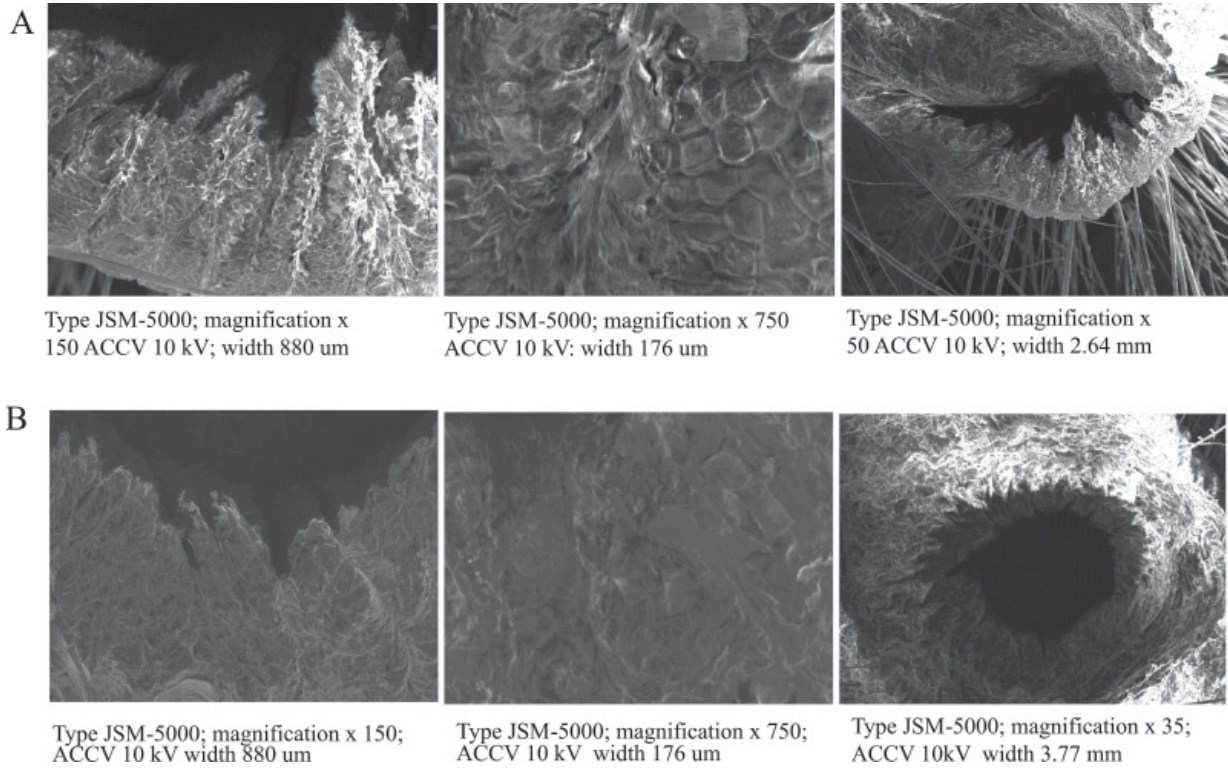


FIGURE 3 Scanning electron microscope photograph of glans penis morphology of *Thoopterus nigrescens* (a) and *T. suhaniahae* sp. nov. (b).

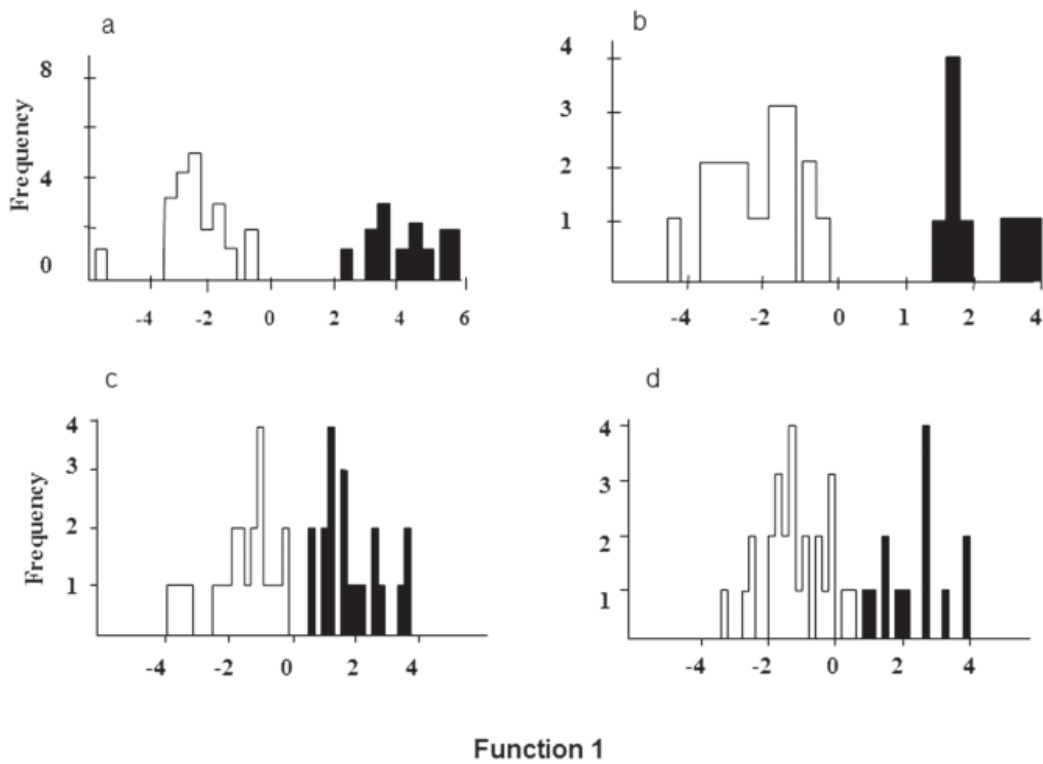


FIGURE 4 Dendrograms of discriminant function values for male and female between *Thoopterus nigrescens* (white) and *T. suhaniahae* sp. nov. (black) (a), male skull characters; (b), female skull characters; (c), male external characters; and (d) female external characters.

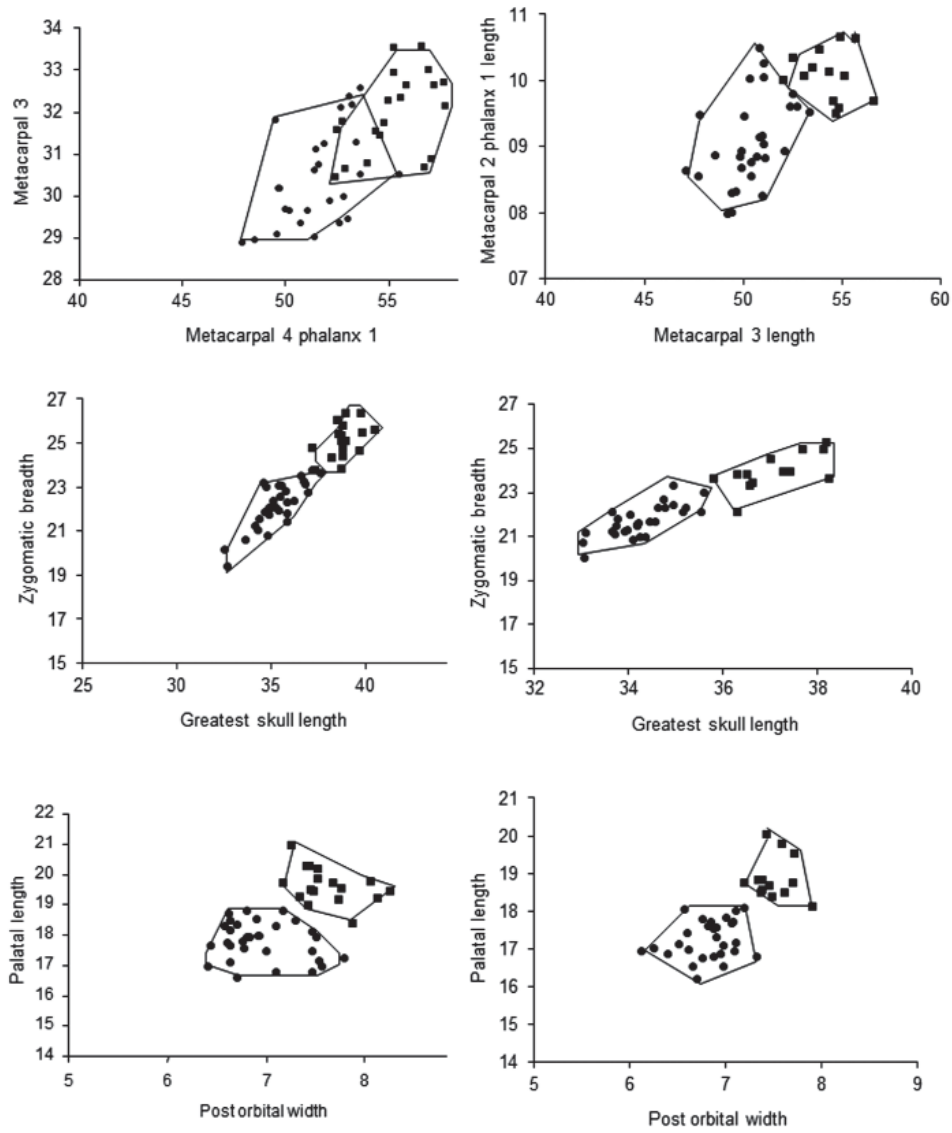


FIGURE 5 Univariate plots of palatal length and postorbital width, and greatest skull length and zygomatic breadth, metacarpal 3 and metacarpal 4 phalanx1 (in mm) of male and female *Thoopterus nigrescens* (●) and *T. suhaniahae* sp. nov. (■).

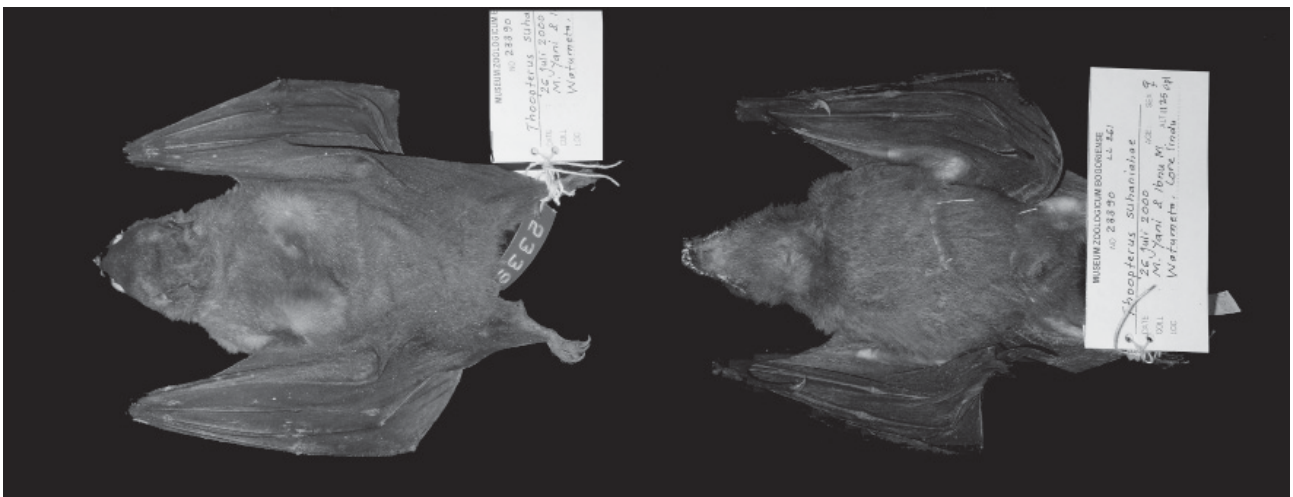


FIGURE 6 Dorsal and ventral views of the holotype (MZB 23390) of *Thoopterus suhaniahae* sp. nov.

TABLE 3 Standardised and unstandardised values of the canonical variate function for the two species group of the genera of *Thoopterus*. a) cranium, dental and b) external characters.

a) Skull, dental, and dentary characters

♂	Function 1		♀	Function 1	
	Standardised	Unstandardised		Standardised	Unstandardised
C1-M2	0.44	0.9508127	C1-C1	0.58	2.84
IO	0.41	1.2561244	GSL	0.465	0.64
POW	0.55	1.526736	HB	0.34	0.61
POZ	0.46	1.0838556	POW	0.29	1.14
P4W	0.34	1.9432024	MIL	0.3	2.4
(Constant)		-55.07			-63.42

b) External characters

♂	Function 1		♀	Function 1	
	Standardised	Unstandardised		Standardised	Unstandardised
P3	0.955	0.567	P3	0.819	0.584
P2_1	0.521	0.638	P5	-1.023	-0.584
P5	-0.829	-0.468	P2_1	0.452	0.973
P3_1	0.553	0.421	FA	0.452	0.261
HBL	0.231	0.393	HBL	0.568	0.126
(Constant)		-32.271			-38.22

HABITAT

Thoopterus suhaniahae sp. nov. is common in Central Sulawesi at elevations of 600–1,000 m. Specimens were also captured at 1,930 m at Rorekatimbu, Lore Lindu National Park, Central Sulawesi, and at 60 m asl at Wowoni Island. *Thoopterus suhaniahae* sp. nov. has been collected sympatrically with *T. nigrescens*, *Rousettus celebensis*, *Cynopterus luzoniensis*, *Cynopterus minutus* (a new record for Sulawesi), *Chironax melanocephalus* and *Macroglossus minimus*. The species was collected from Maros, South Sulawesi; Bakiriang-Batu, South-West Sulawesi; Dako Mountain-Toli-Toli, Central Sulawesi; Talaud Island, North Sulawesi, and Wowoni Island, South-East Sulawesi and South-West Sulawesi.

DISTRIBUTION

Known from Sulawesi, Talaud and Wowoni Islands, Indonesia.

ETYMOLOGY

For Suhaniah (wife of Mohamad Yani), who passed away on 31 March 2000 while her husband studied in Lore Lindu National Park.

REMARKS

The new species of *Thoopterus* is a medium-sized fruit bat in Sulawesi and small adjacent island groups. From our observations, it is one of the most abundant bats which widely distributed on Sulawesi from 60–2,100 m asl.

Geographically sympatric to *T. suhaniahae* sp. nov., *T. nigrescens* is found in primary, secondary, cacao and coffee plantation forest, whereas *T. suhaniahae* sp. nov. is more common in primary forest at middle and low land altitudes.

The discovery of a second species of *Thoopterus* endemic to Sulawesi and adjacent islands provides further evidence that Sulawesi is a ‘hot spot’ of pteropodid evolution (Maryanto and Yani 2003). The majority of distribution of the new species such as *Rousettus linduensis* and *R. bidens* were known from Central Sulawesi which appears to emphasize once more the complex geological history of the island as a composition of parts with different origins (Maryanto and Yani 2003).

Unfortunately, ongoing large scale hunting and trapping of fruit bats in the north and parts of Central Sulawesi and elsewhere, seriously endangers the survival of this species as well as other fruit bats on these islands.

ACKNOWLEDGMENTS

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APPENDIX 1 *Thoopterus* spp. specimen examination (Remarks D= preserved in dry specimens and A= preserved in alcohol 70%)

Species and MZB No.	Field No	Preserved	Sex	Collector	Date	Locality at LLNP	Alt (m)	Weight (gr)	Longitude	Latitude
<i>Thoopterus nigrescens</i>										
15232		D	Female	T. M. Flannery and Boeadi	12/11/91	Mangole-Sula		60	125° 50' 0"	1° 53' 0" S
15327		D	Female	Yusuf and Cholik	15/10/92	Maros			119° 45' 0"	5° 0' 0" S
23301	F204	A	Female	M. Yani and M. Annas	06/02/01	Lempe	1900	54	120° 12' 42"	1° 46' 28" S
23302	F206	A	Male	M. Yani and M. Annas	05/02/01	Lempe	1870	64	120° 12' 37"	1° 46' 22" S
23303	F209	A	Female	M. Yani and M. Annas	08/02/01	Lempe	1860	51	120° 12' 37"	1° 46' 22" S
23304	F223	A	Female	M. Yani and M. Annas	17/02/01	Hanggira	2030	57	120° 8' 26"	1° 42' 55" S
23305	F228	A	Male	M. Yani and M. Annas	18/02/01	Hanggira	2020	74	120° 8' 33"	1° 43' 1" S
23306	F238	A	Male	M. Yani and M. Annas	18/02/01	Hanggira	1920	61	120° 8' 19"	1° 42' 58" S
23307	F244	A	Male	M. Yani and M. Annas	23/02/01	Hanggira	1920	69	120° 8' 20"	1° 42' 58" S
23308	F88	A	Female	M. Yani and M. Annas	18/09/00	Dodolo	1485	58	120° 17' 41"	1° 29' 7" S
23309	F90	A	Male	M. Yani and M. Annas	14/09/00	Dodolo	1485	59	120° 17' 41"	1° 29' 7" S
23310	F91	A	Male	M. Yani and M. Annas	17/09/00	Dodolo	1485	66	120° 17' 41"	1° 29' 7" S
23311	F93	A	Male	M. Yani and M. Annas	18/09/00	Dodolo	1485	66	120° 17' 41"	1° 29' 7" S
23312	LL20	A	Female	M. Yani and M. Annas	27/03/00	Nokilalaki	2020	52	120° 9' 27"	1° 14' 47" S
23313	LL23	A	Female	M. Yani and M. Annas	24/03/00	Nokilalaki	1810	50	120° 9' 12"	1° 14' 41" S
23316	LL34	A	Male	M. Yani and M. Annas	29/03/00	Nokilalaki	1785	53	120° 9' 8"	1° 14' 31" S
23317	LL368	A	Female	M. Yani and M. Annas	27/01/01	Doda-Pointoa	1885	57	120° 16' 12"	1° 47' 9" S
23318	LL369	A	Female	M. Yani and M. Annas	27/01/01	Doda-Pointoa	1840	52	120° 16' 13"	1° 47' 0" S
23319	LL370	A	Female	M. Yani and M. Annas	27/01/01	Doda-Pointoa	1715	52	120° 16' 38"	1° 46' 17" S
23320	LL372	A	Female	M. Yani and M. Annas	27/01/01	Doda-Pointoa	1715	56	120° 16' 38"	1° 46' 17" S
23321	LL375	A	Female	M. Yani and M. Annas	28/01/01	Doda-Pointoa	1815	68	120° 16' 12"	1° 46' 52" S
23322	LL376	A	Male	M. Yani and M. Annas	28/01/01	Doda-Pointoa	1885	65	120° 16' 12"	1° 47' 9" S
23323	LL380	A	Male	M. Yani and M. Annas	29/01/01	Doda-Pointoa	1815	76	120° 16' 12"	1° 47' 6" S
23324	LL383	A	Female	M. Yani and M. Annas	29/01/01	Doda-Pointoa	1815	63	120° 16' 23"	1° 46' 43" S
23325	LL387	A	Male	M. Yani and M. Annas	23/03/01	Kenawu Atas	1330	68	120° 10' 13"	1° 21' 7" S

Species and MZB No.	Field No	Preserved	Sex	Collector	Date	Locality at LLNP	Alt (m)	Weight (gr)	Longitude	Latitude
23326	LL397	A	Male	M. Yani and M. Annas	28/03/01	Kenawu Atas	1720	59	120° 11' 28"	1° 19' 56" S
23327	LL42	A	Male	I. Maryanto and M. Yani	06/03/00	Noki	2165	66	120° 9' 44"	1° 15' 4" S
23328	LL44	A	Female	M. Yani and M. Annas	26/03/00	Nokilalaki	2165	57	120° 9' 44"	1° 15' 4" S
23329	F219	A	Male	M. Yani and M. Annas	12/02/01	Lempe	1870	58	120° 12' 37"	1° 46' 22" S
23330	F220	A	Male	M. Yani and M. Annas	12/02/01	Lempe	1870	79	120° 12' 42"	1° 46' 28" S
23331	F222	A	Female	M. Yani and M. Annas	17/02/01	Hanggira	2020	58	120° 8' 33"	1° 43' 1" S
23332	F232	A	Male	M. Yani and M. Annas	18/02/01	Hanggira	1920	63	120° 8' 19"	1° 42' 58" S
23333	F86	A	Female	M. Yani and M. Annas	18/09/00	Dodolo	1485	52	120° 17' 41"	1° 29' 7" S
23334	F87	A	Male	M. Yani and M. Annas	18/09/00	Dodolo	1485	75	120° 17' 41"	1° 29' 7" S
23335	F92	A	Female	M. Yani and M. Annas	11/09/00	Dodolo	1470	70	120° 17' 41"	1° 29' 7" S
23336	LL19	A	Female	M. Yani and M. Annas	24/03/00	Nokilalaki	1785	51	120° 18' 34"	1° 16' 57" S
23337	LL28	A	Female	M. Yani and M. Annas	24/03/00	Nokilalaki	2020	56	120° 9' 27"	1° 14' 47" S
23338	LL283	A	Female	M. Yani and M. Annas	08/09/00	Wuasa	1290	69	120° 17' 0"	1° 24' 55" S
23340	LL378	A	Male	M. Yani and M. Annas	28/01/01	Doda-Pointoa	1815	78	120° 16' 12"	1° 47' 6" S
23341	LL382	A	Male	M. Yani and M. Annas	29/01/01	Doda-Pointoa	1715	64	120° 16' 38"	1° 46' 17" S
23342	LL384	A	Male	M. Yani and M. Annas	29/01/01	Doda-Pointoa	1815	48	120° 16' 12"	1° 47' 6" S
23343	LL392	A	Female	M. Yani and M. Annas	26/03/01	Kenawu Atas	1720	54	120° 11' 28"	1° 19' 56" S
23344	LL396	A	Male	M. Yani and M. Annas	28/03/01	Kenawu Atas	1720	68	120° 11' 28"	1° 19' 56" S
23345	LL398	A	Female	M. Yani and M. Annas	29/03/01	Kenawu Atas	1720	55	120° 11' 50"	1° 19' 44" S
23346	LL6	A	Male	I. Maryanto and M. Yani	06/03/00	Kamarora	665		120° 9' 1"	1° 14' 25" S
23347	F225	A	Male	M. Yani and M. Annas	17/02/01	Hanggira	1920	62	120° 8' 20"	1° 42' 58" S
23348	F233	A	Female	M. Yani and M. Annas	18/02/01	Hanggira	2020	59	120° 8' 18"	1° 43' 2" S
23349	LL24	A	Male	M. Yani and Thius	24/03/00	Nokilalaki	1785	42	120° 9' 8"	1° 14' 31" S
23350	LL312	A	Female	M. Yani and M. Annas	10/11/00	Rompo	1200	50	120° 17' 9"	1° 34' 33" S
23351	LL315	A	Female	M. Yani and M. Annas	17/11/00	Doda	1320	50	120° 18' 6"	1° 42' 35" S
23352	LL32	A	Male	M. Yani and M. Annas	28/03/00	Nokilalaki	2060	67	120° 9' 40"	1° 14' 56" S
23353	LL330	A	Female	M. Yani and M. Annas	29/11/00	Taba-Doda		59	120° 17' 55"	1° 46' 19" S
23354	LL36	A	Male	M. Yani and M. Annas	28/03/00	Nokilalaki	1785	50,5	120° 9' 8"	1° 14' 31" S
23355	LL377	A	Male	M. Yani and M. Annas	28/01/01	Doda-Pointoa	1815	65	120° 16' 12"	1° 47' 6" S

Species and MZB No.	Field No	Preserved	Sex	Collector	Date	Locality at LLNP	Alt (m)	Weight (gr)	Longitude	Latitude
23356	LL394	A	Male	M. Yani and M. Annas	26/03/01	Kenawu Atas	1720	73	120° 11'	1° 19' 56" S
23357	LL395	A	Female	M. Yani and M. Annas	26/03/01	Kenawu atas	1800	60	120° 11'	1° 19' 44" S
23358	LL43	A	Female	M. Yani and M. Annas	28/03/00	Nokilalaki	2165	56	120° 9'	1° 15' 4" S
23359	LL46	A	Female	M. Yani and M. Annas	28/03/00	Nokilalaki	2165	59	120° 9'	1° 15' 4" S
24220		D	Female	T. Kinstone	9/09/02	Buton		57	122° 55' 0"	5° 0' 0" S
27775		D	Female	A. Saim	29/03/05	Wowoni	60	58	123° 6' 0"	4° 8' 0" S
24218		D	Male	T. Kinstone	09/09/02	Buton		61	122° 55' 0"	5° 0' 0" S
24219		D	Male	T. Kinstone	09/09/02	Buton		67	122° 55' 0"	5° 0' 0" S
27776		D	Male	A. Saim	29/08/05	Wowoni	60	52	123° 6' 0"	4° 8' 0" S
27777		D	Male	A. Saim	29/08/05	Wowoni	60	48	123° 6' 0"	4° 8' 0" S
27778		D	Male	A. Saim	29/08/05	Wowoni	60	45	123° 6' 0"	4° 8' 0" S
<i>Thoopterus suhaniahae</i> sp.nov										
13378		D	Male	A. Suyanto	08/10/82	Poso		80	121° 15' 0"	1° 30' 0" S
15326		D	Male	Yusuf and Cholik	13/10/92	Maros Bantimurung			119° 45' 0"	5° 0' 0" S
15329		D	Male	Yusuf and Cholik	12/10/92	Maros Bantimurung			119° 45' 0"	5° 0' 0" S
17812		D	Male	J. Riley	19/03/97	Talaud		87	126° 50' 0"	4° 20' 0" N
23360	F107	A	Female	I. Maryanto and M. Yani	10/10/00	Kadidia	700	100	120° 6' 44"	1° 12' 39" S
23361	F109	A	Male	I. Maryanto and M. Annas	10/10/00	Kadidia	780	69	120° 6' 44"	1° 12' 39" S
23363	F126	A	Female	I. Maryanto and M. Yani	10/10/00	Kadidia	680	72	120° 6' 45"	1° 11' 59" S
23364	F181	A	Male	I. Maryanto and M. Annas	18/10/00	Watubuse	830	79	120° 4'	1° 11' 50" S
23365	F184	A	Female	I. Maryanto and M. Annas	18/10/00	Watubuse	810	80	120° 4' 50"	1° 12' 1" S
23367	LL231	A	Male	M. Yani and Thius	17/08/00	Sibalaga	640	80	119° 56' 7"	1° 9' 8" S
23368	LL232	A	Male	M. Yani and Thius	17/08/00	Sibalaga	640	85	119° 56' 7"	1° 9' 8" S
23369	LL265	A	Female	M. Yani and M. Annas	03/09/00	Watumeta	1125	62	120° 17' 48"	1° 24' 2" S
23370	LL316	A	Male	M. Yani and M. Annas	17/11/00	Uwebiro-Doda	1320	77	120° 18' 6"	1° 42' 35" S
23371	M47042	A	Male	M. Yani and M. Annas	13/03/01	Kenawu	930	86	120° 9' 21"	1° 21' 33" S
23372	M47048	A	Female	M. Yani and M. Annas	13/03/01	Kenawu	930	70	120° 9' 21"	1° 21' 33" S
23373	F180	A	Male	I. Maryanto and M. Annas	15/10/00	Watubuse	860	90	120° 4' 45"	1° 11' 54" S

Species and MZB No.	Field No	Preserved	Sex	Collector	Date	Locality at LLNP	Alt (m)	Weight (gr)	Longitude	Latitude
23374	F182	A	Female	I. Maryanto and M. Annas	18/10/00	Watubuse	840	68	120° 4'	1° 11' 50" S
23376	LL157	A	Female	I. Maryanto and M. Yani	31/07/00	Nokilalaki	605	52	120° 7'	1° 11' 42" S
23377	LL287	A	Male	M. Yani and M. Annas	09/09/00	Wuasa	1200	86	120° 17'	1° 25' 2" S
23378	LL318	A	Male	M.Yani and M. annas	17/11/00	Uwebiro-Doda	1320	80	120° 18'	1° 42' 35" S
23379	M47023	A	Male	M. Yani and M. Annas	19/03/01	Kenawu	1035	91	120° 10'	1° 21' 21" S
23380	M47027	A	Male	M. Yani and M. Annas	18/03/01	Kenawu	1030	76	120° 9'	1° 21' 8" S
23381	M47035	A	Male	M. Yani and M. Annas	14/03/01	Kenawu	1030	98	120° 9'	1° 22' 0" S
23382	M47036	A	Male	M. Yani and M. Annas	14/03/01	Kenawu	1030	87	120° 9'	1° 22' 0" S
23383	M47041	A	Female	M. Yani and M. Annas	13/03/01	Kenawu	930	82	120° 9'	1° 22' 0" S
23384	M47045	A	Female	M. Yani and M. Annas	13/03/01	Kenawu	930	76	120° 9'	1° 21' 33" S
23385	M47046	A	Male	M. Yani and M. Annas	13/03/01	Kenawu	930	76	120° 9'	1° 21' 33" S
23386	M47049	A	Female	M. Yani and M. Annas	13/03/01	Kenawu	930	72	120° 9'	1° 21' 33" S
23387	F129	A	Female	I. Maryanto and M. Yani	10/10/00	Kadidia	680	71	120° 6'	1° 12' 4" S
23389	LL174	A	Male	I. Maryanto and M. Yani	26/07/00	Shelter I Nokilalaki	910	79	120° 9'	1° 12' 31" S
23390	LL261	A	Female	M. Yani and M. Annas	03/09/00	Watumeta	1125	71	120° 18'	1° 23' 57" S
23391	LL386	A	Male	M. Yanni and M. Annas	22/03/01	Kenawu Atas	1100	83	120° 10'	1° 21' 7" S
23392	M47034	A	Male	M. Yani and M. Annas	14/03/01	Kenawu	1030	90	120° 9'	1° 22' 0" S
23393	M47040	A	Male	M. Yani and M. Annas	14/03/01	Kenawu	925	83	120° 9'	1° 21' 33" S
27725		D	Male	A. Saim	29/08/05	Wowoni	60	73	123° 6'	4° 8' 0" S
27726		D	Male	A. Saim	29/08/05	Wowoni	60	75	123° 6'	4° 8' 0" S
23478	LL99	A	Female	M. Yani and M. Annas	18/06/01	Rorekatimbu	1930	58	120° 18'	1° 18' 58" S