Records of the Western Australian Museum **17**: 147–152 (1995).

Small *Pteropus* (Chiroptera: Pteropodidae) from Timor and surrounding islands, Indonesia

D.J. Kitchener[1] and I. Maryanto[2]

[1] Western Australian Museum, Francis Street, Perth, Western Australia 6000

[2] Museum Zoologicum Bogoriense, LIPI, Jalan Ir. H. Juanda 9, Bogor, Indonesia, 16122

Abstract – A series of 10 adult *Pteropus* specimens collected in West Timor in 1929 are described as a new subspecies, *Pteropus lombocensis salottii* Kitchener. These specimens are compared using univariate and multivariate statistical analysis, principally of skull and dentary characters, with other subspecies of *P. lombocensis* and with both *P. griseus* and *P. temmincki*. This is the first report of *P. lombocensis* from Timor and Komodo.

INTRODUCTION

Three species of *Pteropus* have been reported from Timor Island, Nusa Tenggara Timur, Indonesia. These are *P. vampyrus edulis* Geoffroy, 1810; *P. alecto* ? *gouldi* Peters, 1867 and *P. g. griseus* Geoffroy, 1810 (Andersen 1912, Goodwin 1979, Hill 1992 and Kitchener *et al.* 1995a). Timor is the type locality for *P. g. griseus*.

Goodwin (1979: 88) stated that the many reports of *P. temmincki* Peters, 1867 from Timor and Semau (e.g., Dobson 1878, Andersen 1912, Schwarz 1914) are with one exception "traceable to misidentifications of specimens of *P. griseus*". The exception is the British Museum specimen BMNH 58.11.18.2, initially cited by Dobson (1878). Goodwin (1979) confirmed that this specimen was indeed *P. temmincki*. However, he stated that because it was purchased from a dealer in Holland, its provenance may be doubtful. His reason for doubt was that its occurrence on Timor would represent a "rather anomalous distribution pattern" because elsewhere it is restricted to Ambon, Buru and Seram.

Goodwin (1979) also doubted the report by Seabra (1897) of *P. pselaphon* Lay, 1829 from Timor. His examination of this Timor specimen in the Museu Bocage, Lisbon (MB296) suggested that it was in fact an immature *P. griseus*.

The Museum Zoologicum Bogoriense has a series of 10 adult *Pteropus* skulls and skins (MZB 2182, 2184, 2189–96) collected by Mrs Walsh, on 3 February 1929 from Soe, West Timor, at an altitude of 880 m and one (MZB 9208) from Komodo Island. These specimens appeared to have been overlooked by previous workers. The Timor specimens are of particular interest because they are a small bat (forearm 109–115 mm) but with pelage and skull and body dimensions allied to, but differing, from both *P. griseus* and *P. temmincki*; they clearly do not represent the much larger *P. pselaphon*. This paper reports on an examination of the taxonomic status of these MZB specimens and compares their morphology to *P. lombocensis*, *P. griseus* and *P. temmincki*.

MATERIALS AND METHODS

Ten adult skulls and 'cabinet skins' (1♂, 9♀♀) in the MZB series of *Pteropus* from Timor Island (2182–97) were measured and compared with the following specimens (all currently lodged in the Western Australian Museum). *P. griseus griseus*, Panite, W. Timor Island (9°50'S, 124°29'E), 1♂, (WAM M34858); Uiasa, Semau Island (10°10'S, 123°28'E), 2♂♂ (WAM 35592–3); Baa, Roti Island (10°46'S, 123°16'E), 4♂♂ 1♀, (WAM M35400, M35405–57, M35420); Ipokil, Wetar Island (7°50'S, 126°16'E), 1♂ (WAM M44679). *P. griseus pallidus* Temminck, 1825, Banda Neira Island (4°31'S, 129°50'E), 3♂♂ 3♀♀ 1 ? sex (WAM M42004–7, M42377, M42381, M42393). *P. temmincki temmincki*, Amboinea, Ambon Island (3°41'S, 128°10'E), 2♂♂ 1♀, (WAM M43130–31, M43900); Solea, Gunung Manusela, Seram Island (2°53'S, 129°32'E), 3♂♂, (WAM M34520–22) and *P. lombocensis lombocensis* and *P. l. heudei* listed in Kitchener *et al.* (1995a).

The measurements were recorded only from adults. These measurements were the same as those reported in Kitchener *et. al* (1995a), with two additional measurements. These were maximum diameter of the orbit and dentary coronoid height. Only forearm length was measured from the external body. This was because this was the only measurement from the skins of the MZB specimens that was comparable to the external preserved specimens. Only skull, dentary and dental measurements were used in the statistical comparison of the MZB specimens with the others.

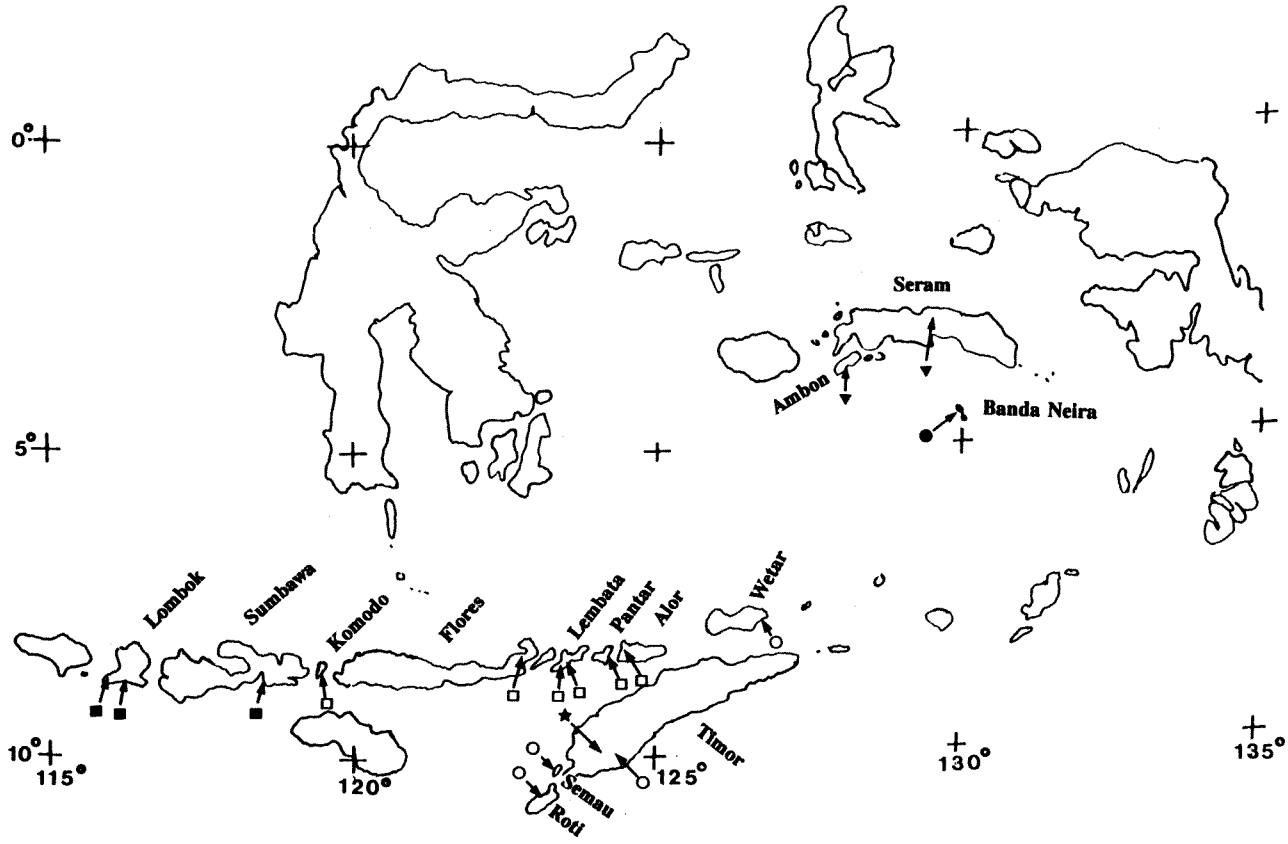

Figure 1 Locality of specimens used in this study. *Pteropus g. griseus* (O); *P. g. pallidus* (●); *P. t. temmincki* (▼); *P. l. lombocensis* (■); *P. l. heudei* (□) and *P. l. salottii* (★).

Adult condition was judged to be when both the basioccipital/basisphenoid and basisphenoid/presphenoid sutures were fused.

The statistical procedures were as described in Kitchener *et al.* (1995a). Both sexes were combined. The stepwise canonical variate (discriminant function) analysis was initially run for all 20 skull characters for islands separately and islands grouped. The DFA was then run for a subset of 5 of these characters on the grouped populations. This subset was selected to minimise Wilk's lambda. This was because the full set of characters exceeded the sample size of the smallest island group examined. Because the DFA plots using the subset of characters were very similar to those when all characters were employed in the DFA, only the analysis carried out with the reduced set of characters are presented below.

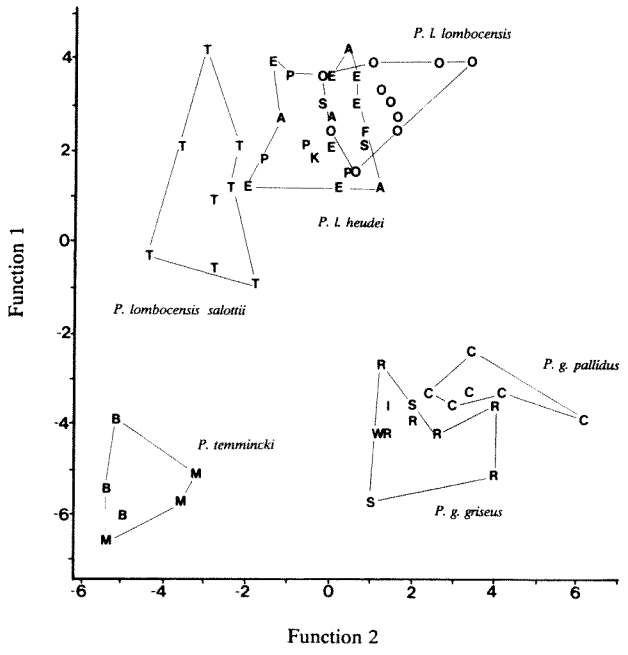

Figure 2 Plot of Functions 1 and 2 from DFA based on six taxa [*Pteropus l. salottii* (Timor, T); *P. l. lombocensis* (Lombok, O); *P. l. heudei* (Flores, F; Lembata, E; Pantar, P; Alor, A; and Komodo, K); *P. g. griseus* (Wetar, W; Timor, I; Semau, S; and Roti, R); *P. g. pallidus* (Banda Neira, C); and *P. t. temmincki* (Ambon, B; Seram, S)] and five selected skull characters.

RESULTS

Discriminant Function Analysis

The preliminary analysis using all 20 characters clearly placed the single Komodo Island specimen with *Pteropus l. heudei*.

All groups/taxa

A DFA was run based on 6 taxon/groups (the

Table 1 Canonical Variate Function Coefficients from DFA between six taxon (*Pteropus lombocensis* – Timor; *P. l. lombocensis; P. l. heudei; P. g. griseus; P. griseus pallidus* and *P. t. temmincki*) and based on five cranial characters (see text). Standardised values followed by (in brackets) unstandardised values.

Character	Function 1	Function 2
P^3 breadth	–0.6906 (–1.2756)	0.5497 (1.0153)
Rostrum length	0.7794 (6.6908)	0.3124 (2.6814)
Greatest skull length	0.7440 (0.6660)	0.3350 (0.2998)
C_1M_3 length	–0.5234 (–0.8375)	0.1362 (0.2180)
Mesopterygoid fossa breadth	0.3390 (1.1297)	0.3364 (1.1209)
Constant	–23.8467	–50.7967
Variance explained (%)	60.7	33.0

unidentified MZB Timor group; *P. l. lombocensis; P. l. heudei; P. t. temmincki; P. griseus griseus;* and *P. g. pallidus*) and five selected characters (rostrum length; P^3 breadth; greatest skull length; C_1M_3 length; and mesopterygoid fossa breadth). This DFA extracted four significant functions, which combined explained 99.9% of the variation. The separation between these six taxon/groups was clearly apparent from the plot of Function 1 and 2 (Figure 2). The unidentified Timor group clearly clustered close to *P. l. lombocensis* and *P. l. heudei* and was a form of *P. lombocensis*. Function 1, which explained 60.7% of the variance, clearly separated the *P. lombocensis* from both *P. temmincki* and *P. griseus*. The characters loading most heavily (>0.5) were P^3 breadth, greatest skull length, rostrum length and C_1M_3 length (Table 1). Function 2, which explained 33.0% of the variance, clearly separated *P. temmincki* and *P. griseus*. The character loading most heavily (>0.5) on Function 2 was rostrum length (Table 1). A total of 93.6% of individuals were classified to their correct group/taxon. Two of 20 *P. l. heudei* misclassified to the Timor form of *P. lombocensis* and two of the 10 *P. g. griseus* misclassified to *P. g. pallidus*.

The *Pteropus lombocensis* Group

The sample of one male and nine female *P. lombocensis* specimens from Timor preclude an analysis of sexual dimorphism in this sample. However, males and females were combined in this sample following the absence of observed sexual dimorphism in *P. l. lombocensis* and *P. l. heudei* by Kitchener *et al.* (1995a).

A DFA based on the three forms of *P. lombocensis* (the Timor form, *P. l. lombocensis* and *P. l. heudei* – including Komodo) and five selected skull and dentary measurements (C_1M_3 length; M^1 length; mesopterygoid fossa breadth; braincase breadth; and rostrum length) extracted two very significant Functions. Function 1, which explained 84.9% of

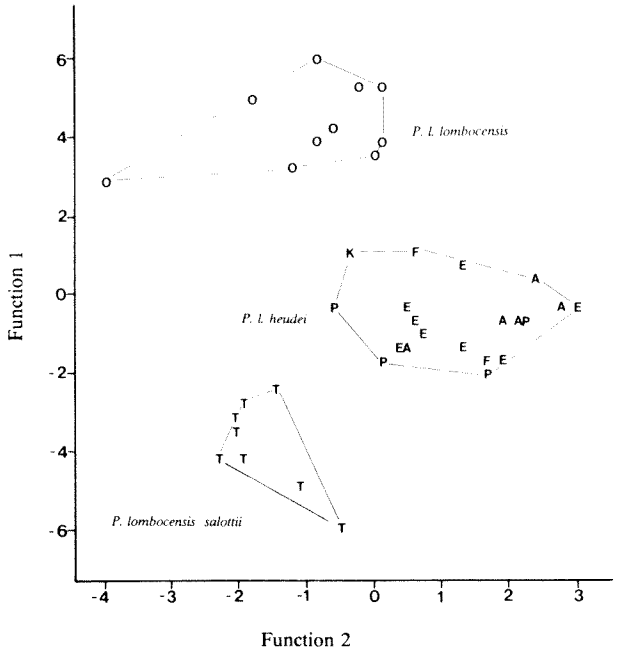

Figure 3 Plot of Functions 1 and 2 from DFA based on the three *P. lombocensis* subspecies (*P. l. lombocensis, P. l. heudei* and *P. l. sallottii*) and five selected skull characters (see text). Island codes as for Figure 2.

the variance, separated each of these forms (Figure 3). The characters loading most heavily (>0.5) on Function 1 were C_1M_3 length and braincase breadth (Table 2). Function 2, which explained 15.1% of the variance, partially separated *P. l. heudei* from the other two forms (Figure 3). The characters loading most heavily (>0.5) on Function 2 were mesopterygoid fossa breadth, M^1 length and C_1M_3 length (Table 2). The DFA allocated all specimens to their correct group.

Summary of the multivariate analysis

The above analyses indicated that the MZB Timor specimens clustered closely in discriminant function space with *Pteropus lombocensis* but were

Table 2 Canonical Variate Function Coefficients from DFA between three groups of *P. lombocensis* [(i) Timor; (ii) Lombok; and (iii) Komodo, Flores, Lembata, Pantar, Alor] and based on five cranial characters (see text). Standardised values followed by (in brackets) unstandardised values.

Character	Function 1	Function 2
C_1M_3 length	1.0847 (3.1533)	–0.6713 (–1.9513)
Braincase breadth	0.7276 (1.6337)	0.2222 (0.4990)
Mesopterygoid fossa breadth	–0.0025 (0.0080)	0.8745 (2.8395)
M^1 length	0.1323 (0.3851)	0.8612 (2.5064)
Rostrum length	–0.1786 (–0.3192)	0.4564 (0.8157)
Constant	–98.8921	–11.6914
Variation explained (%)	84.9	15.1

Table 3 Measurements, in mm, for skull, dentary, dental and radius length of adult *Pteropus lombocensis* [*P. l. lombocensis* (Lombok), *P. l. heudei* (Komodo, Flores, Lembata, Pantar and Alor), and *P. l. salottii* (Timor)]; *P. g. griseus* (Timor, Semau, Roti, Wetar); *P. g. pallidus* (Banda Neira); and *P. t. temmincki* (Ambon, Seram).The character codes are as follows: GSL, greatest skull length; CBL, condylobasal length; PL, palatal length; MFW, mesopterygoid fossa breadth; RL, rostrum length; IOB, minimum interorbital breadth; ZB, zygomatic width; BB, braincase breadth; DL, dentary length; C^1C^1, outside width across C^1C^1 (alveoli); P^4P^4 inside width between P^4P^4; M^1M^1, outside width across M^1M^1 (alveoli); C^1M^2, maxillary tooth row length; C_1M_3, lower C_1 to M_3 length (alveoli); P^3L, P^3 crown length; P^3B, P^3 crown breadth; M^1L, M^1 crown length; M^1B, M^1 crown breadth; HTC, height of dentary coronoid; ORBD, maximum orbit diameter; FA, forearm length.

		GSL	CBL	PL	MFW	RL	IOB	ZB	BB	DL	C^1C^1	P^4P^4	M^1M^1	C^1M^2	C_1M_3	P^3L	P^3B	M^1L	M^1B	HTC	ORBD	FA
P. l. salottii	$\bar{X}$	52.22	50.15	27.84	6.51	13.42	7.55	29.08	20.04	39.37	9.71	9.72	14.18	18.39	20.58	3.61	2.56	4.27	2.22	20.85	11.58	110.6
	SD	0.79	0.55	0.70	0.29	0.62	0.42	0.59	0.25	0.72	0.31	0.29	0.41	0.35	0.34	0.21	0.13	0.31	0.27	0.47	0.17	2.5
	MIN	51.38	49.45	26.55	6.16	12.51	7.11	28.09	19.68	38.47	9.37	9.20	13.51	17.80	19.84	3.21	2.41	3.82	1.83	20.22	11.34	108.5
	MAX	53.57	51.11	29.19	7.04	14.70	8.25	30.30	20.45	40.59	10.27	9.98	14.74	19.10	20.95	3.89	2.80	4.64	2.68	21.68	11.93	114.9
	N	10	9	10	10	10	10	10	10	10	10	10	10	10	9	10	10	10	10	10	10	10
P. l. lombocensis	$\bar{X}$	55.03	53.11	29.73	6.98	14.58	8.08	30.24	21.12	41.91	10.63	9.54	15.61	20.06	22.69	3.88	2.97	5.13	2.80	21.98	11.83	117.4
	SD	0.99	0.89	0.73	0.23	0.51	0.38	0.59	0.49	0.75	0.33	0.36	0.67	0.40	0.29	0.15	0.11	0.28	0.13	0.63	0.25	2.6
	MIN	53.18	51.23	28.22	6.60	13.72	7.36	29.43	20.30	40.28	10.13	8.82	14.26	19.16	22.19	3.61	2.77	4.68	2.67	21.05	11.54	113.6
	MAX	56.90	54.22	31.06	7.29	15.38	8.79	31.02	21.82	43.09	11.07	10.01	16.89	20.58	23.20	4.08	3.17	5.51	3.09	22.96	12.20	121.1
	N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
P. l. heudei	$\bar{X}$	54.14	52.10	29.17	7.09	14.29	7.90	29.86	20.94	40.61	10.40	9.52	15.02	19.30	21.17	3.82	2.73	4.79	2.54	21.86	11.68	114.6
	SD	1.01	1.10	0.67	0.34	0.54	0.25	0.74	0.49	0.81	0.31	0.33	0.30	0.32	0.37	0.16	0.11	0.38	0.10	0.77	0.20	4.3
	MIN	52.35	50.06	29.97	6.65	13.34	7.47	28.21	19.97	38.93	9.89	8.91	14.45	18.82	20.54	3.53	2.51	3.95	2.29	20.26	11.35	107.4
	MAX	55.83	53.69	30.36	7.88	15.25	8.45	31.09	21.98	41.85	10.95	10.20	15.57	19.88	21.94	4.14	2.92	5.36	2.72	23.12	11.98	122.0
	N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	19	20	20	19
P. g. griseus	$\bar{X}$	56.26	54.85	31.14	6.37	16.91	7.91	32.45	21.43	44.06	10.52	9.42	15.07	20.56	23.45	3.62	2.45	4.09	2.51	20.48	11.91	119.3
	SD	1.29	1.56	1.17	0.34	0.44	0.36	1.77	0.45	1.44	0.38	0.34	0.53	0.86	1.21	0.17	0.16	0.26	0.18	0.97	0.35	4.3
	MIN	54.69	52.78	29.43	5.59	16.56	7.44	29.05	20.95	41.83	10.05	8.94	14.32	19.41	21.33	3.34	2.17	3.63	2.24	19.10	11.24	113.8
	MAX	59.19	57.83	33.43	6.80	17.84	8.65	34.07	22.25	46.48	11.22	9.90	15.99	22.43	25.29	3.83	2.68	4.45	2.82	22.49	12.42	128.1
	N	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
P. g. pallidus	$\bar{X}$	56.39	54.97	31.60	6.78	17.60	7.51	30.70	21.41	43.86	10.23	9.59	15.21	20.46	23.59	3.67	2.63	4.60	2.60	19.96	11.61	126.6
	SD	1.66	2.06	0.90	0.18	0.58	0.46	1.74	0.50	2.06	0.51	0.22	0.31	0.89	0.89	0.23	0.04	0.40	0.09	2.04	0.15	2.9
	MIN	54.80	52.90	30.55	6.54	17.07	7.10	28.43	20.77	41.87	9.61	9.26	14.85	19.47	22.73	3.26	2.59	3.81	2.52	16.87	11.39	121.4
	MAX	59.44	58.77	33.12	7.06	18.70	8.38	33.65	22.15	47.51	10.90	9.80	15.77	22.02	25.25	3.95	2.69	4.89	2.74	22.43	11.79	129.9
	N	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
P. t. temmincki	$\bar{X}$	49.43	47.90	27.21	5.85	14.30	7.07	28.74	20.06	37.82	9.31	8.49	13.72	18.08	20.63	3.28	2.15	4.06	2.11	17.87	12.33	119.3
	SD	1.10	1.27	1.17	0.26	0.53	0.52	1.23	0.54	1.42	0.62	0.58	0.58	0.61	0.65	0.14	0.09	0.28	0.17	1.13	0.28	4.3
	MIN	47.86	46.53	26.36	5.58	13.40	6.07	26.65	19.48	36.19	8.57	7.91	13.06	17.31	19.93	3.08	1.99	3.71	1.90	16.18	12.07	113.8
	MAX	50.98	50.02	29.05	6.24	4.83	7.50	29.73	20.66	39.99	9.93	9.52	14.73	19.11	21.50	3.44	2.27	4.49	2.38	19.06	12.71	128.1
	N	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	10

phenetically not close to either *P. temmincki* or *P. griseus*. They were phenetically closer to *P. l. heudei*, the eastern subspecies, than to *P. l. lombocensis*. The Komodo specimen was allocated to *P. l. heudei* by DFA. The Banda Neira form of *P. griseus (pallidus)* clustered close to the nominate form on Timor, Semau, Roti and Wetar but is recognised by us as a subspecies.

The Timor form of *P. lombocensis* is described below as a new subspecies by D.J. Kitchener.

SYSTEMATICS

Pteropus lombocensis salottii subsp. nov. Kitchener

Holotype

Museum Zoologicum Bogoriense No. MZB 2195 adult male; skull and dentaries separate; skin prepared as 'cabinet' skin; collected on 3 February 1929 by Mrs Walsh.

Type locality

Soe, W. Timor, Nusa Tenggara Timur, Indonesia (9°51'S, 124°16'E); from an altitude of 880 m.

Paratypes

(All adult females from the type locality and collected on the same date as the holotype). MZB 2182, 2184, 2189–94, 2196.

Diagnosis

Similar in pelage colouration to *Pteropus lombocensis lombocensis* and *P. l. heudei* but differing from both these subspecies in averaging smaller in all skull, dentary and dental characters, except P^4P^4 width (Table 3) and by having C_1M_3 shorter relative to braincase breadth (Figure 4).

It also differs from *P. l. lombocensis* by being absolutely smaller in condylobasal length, C^1M^2 length, C_1M_3 length and M^1 length (Table 3).

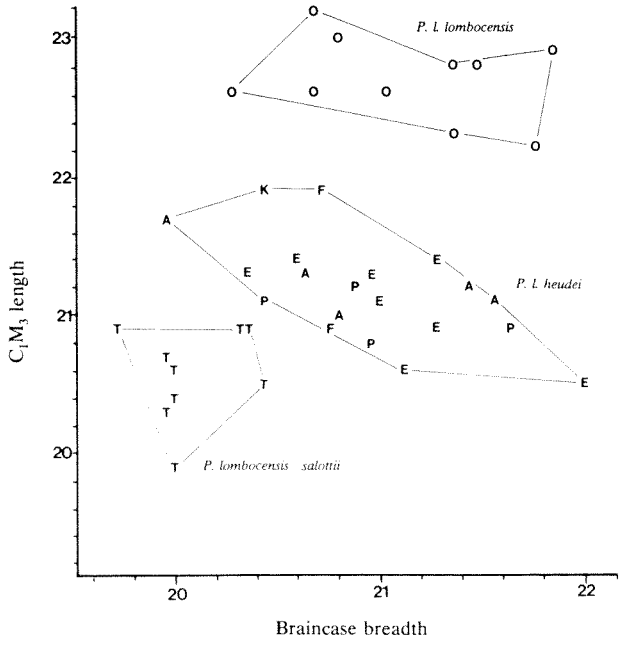

Figure 4 Plot of C_1M_3 length *versus* braincase breadth for the three subspecies of *Pteropus lombocensis*. Island codes as for Figure 2.

Distribution

Known only from Soe, West Timor.

Etymology

Named after Mr Mark Salotti in recognition of his work in contributing towards the curation of the mammal collections from Indonesia made between 1987 and 1993.

Remarks

Pteropus lombocensis is readily distinguished from both *P. temmincki* and *P. griseus* on overall body size and pelage colouration and on skull and dental measurements as described in Andersen (1912). Our measurements confirm that *P. lombocensis* differs from *P. temmincki* in having a number of skull and dentary measurements that are different, particularly a larger P^3 breadth, coronoid height and greatest skull length and a smaller orbit diameter (see Table 3). It also differs from *P. griseus* in a number of measurements, particularly in having a shorter rostrum length and forearm length (Table 3).

Discussion

Previously *Pteropus lombocensis* was thought to be restricted to the volcanic islands of the inner Banda Arc from Lombok Island in the west to Alor Island in the east (Kitchener *et al.* 1995a). Its discovery on Timor Island in the Gondwanic outer Banda Arc, where it has differentiated morphologically into a distinct subspecies, follows a pattern that is commonly repeated for bats in this region. There is a trend for Nusa Tenggara bats to so differentiate in the eastern parts of the inner Banda Arc and between the inner and outer Banda Arcs (e.g., Kitchener *et al.* 1995a,b,c; Kitchener and Maharadatunkamsi (in prep.).

Goodwin (1979) recorded the distribution of *P. g. griseus* as Timor, Semau, Bonerate, Djampea and possibly Saleyer islands. Its occurrence also on Roti and Wetar Islands suggests that it will probably also be found on other islands in the inner Banda Arc.

ACKNOWLEDGEMENTS

We gratefully acknowledge the support of Mr A. Reeves, Director, Western Australian Museum; Drs M. Amir, Director, Balitbang Zoologi (LIPI): and

the then Directors of the Department responsible for the conservation of wildlife in Nusa Tenggara Barat, Ir P. Supriadi and Nusa Tenggara Timor, Ir J. Mochtar. To our colleagues Dr R. How and Mr R. Johnstone, Western Australian Museum; Mr A. Gunnell, Curtin University of Technology and Drs A. Suyanto, Ir Maharadatunkamsi, and Bapak Boeadi, Museum Zoologicum Bogoriense, who participated in the field work, we extend our thanks for both their effort and companionship.

We thank Dr Soetikno, Kepala, Puslitbang Biologi, LIPI, for the loan of the MZB specimens.

Expedition costs were defrayed by grants to the senior author from: National Geographic Society, Washington, Australian National Parks and Wildlife Service and the Scott Trust, Sydney. Garuda Indonesia kindly defrayed freight costs of the expeditions. Additional skulls were prepared by Mr M. Salotti, Western Australian Museum. All measurements were recorded by Dr W.C. Packer, Western Australian Museum. Mrs N. Cooper assisted with statistical analyses. Mrs A. Nevin, Western Australian Museum kindly typed the manuscript.

REFERENCES

Andersen, K. (1912). *Catalogue of the Chiroptera in the Collection of the British Museum Vol. 1: Megachiroptera.* British Museum Natural History, London.

Dobson, G.E. (1878). *Catalogue of the Chiroptera in the Collection of the British Museum.* British Museum Natural History, London.

Goodwin, R.D. (1979). The bats of Timor: systematics and ecology. *Bulletin of the American Museum of Natural History* **163**: 74–122.

Hill, J.E. (1992). *In* G.B. Corbet and J.E. Hill, *The Mammals of the Indomalayan Region: a Systematic Review.* Natural History Museum Publications, Oxford University Press.

Kitchener, D.J., Packer, W.C. and Maharadatunkamsi (1995a). Morphological variation in *Pteropus lombocensis* (Chiroptera: Pteropodidae) in Nusa Tenggara, Indonesia. *Records of the Western Australian Museum* **17**: 61–67.

Kitchener, D.J., Schmitt, L.H., Strano, P., Wheeler, A. and Suyanto, A. (1995b). Taxonomy of *Rhinolophus simplex* Andersen, 1905 (Chiroptera: Rhinolophidae) in Nusa Tenggara and Maluku, Indonesia. *Records of the Western Australian Museum* **17**: 1–28.

Kitchener, D.J., Cooper, N. and Maryanto, I. (1995c). The *Myotis adversus* (Chiroptera: Vespertilionidae) species complex in eastern Indonesia, Australia, Papua New Guinea and the Solomon Islands. *Records of the Western Australian Museum* **17**: 191–212.

Kitchener, D.J. and Maharadatunkamsi (in prep.). Geographic variation in morphology of *Cynopterus nusatenggara* (Chiroptera, Pteropodidae) in southeastern Indonesia and description of two new subspecies.

Schwarz, E. (1914). Saugetiere von Timor. *In* C.B. Haniel, *Zoologie von Timor.* II. Leiferung: 113–161. Stuttgart.

Seabra, A.F. de (1897). Noticia sobre algumas especies do genero "Pteropus" provenientes da ilha de Timor. *Journal de Sciencias Mathematicas, Physicas, e naturaes (Academia das Scienceas de Lisbôa)* **5**: 117–125.

Manuscript received 27 September 1994; accepted 28 October 1994.