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GEOGRAPHIC DIFFERENTIATION IN THE BROWNED THROATED SUNBIRDS, *ANTHREPTES MALACENSIS* (AVES: NECTARINIIDAE)

ASEP S ADHIKERANA & ALWIN MARAKARMAH*)

ABSTRAK

Penelitian terhadap keragaman geografis bentuk morfologi delapan unit taksonomi dari jenis *Anthreptes malacensis* telah dilakukan. Empat karakter morfologi yang diukur dalam penelitian ini adalah ukuran panjang paruh (*culmen*), sayap, ekor dan jari kaki (tarsus), dan pengukuran dilakukan terhadap 248 spesimen burung yang terdapat di Museum Zoologicum Bogoriense. Hasil analisis menunjukkan bahwa keragaman karakter tersebar merata di antara unit taksonomi yang dipelajari. Hal ini menunjukkan tidak adanya perubahan keragaman intraspesifik dari satu lokasi lainnya, sehingga dapat diduga bahwa keragaman karakter morfologi anak jenis merupakan hasil seleksi terarah. Dugaan ini didukung oleh hasil analisis yang menggambarkan pengelompokan anak jenis sesuai dengan tingkat kesamaan morfologinya.

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INTRODUCTION

Natural selection is assumed to be the dominant process in the mechanism that maintains patterns of phenotypic geographic variation in birds. Adaptation to environmental conditions is presumed to result in an optimal phenotype for each geographical magnitude. It is predicted that selection can change the average values of traits in predictable directions (James *et al.* 1990). Gradual changes of characters across large geographic areas can also result from genetic drift among local populations and gene flow between them, but natural selection is likely to be the only cause of parallel variation among species (James *et al.* 1990). Such parallelism is widespread in the plumage variation of birds (Zink & Remsen 1986), but disagreement about the existence of parallelism among species in size variation has not been solved. James *et al.* (1990) briefly reviewed this phenomenon, and concluded that the congruence in size variation among passerines is most likely caused by both natural selection and gene flows.

Supports for the current view of the predictions of how microevolution works may come from studies on differentiation in phenotypic characters between populations, from which the result may provide clearer understanding about directional selection leading to character variation in populations. Lande (1979) has proposed a model for the estimation of such a directional selection based on two assumptions: (1) there is no correlation between genetic and environmentally induced variation, (2) intraspecific phenotypic variances and covariances within population do not change across localities or through time. The first assumption can be evaluated using reciprocal transplant experiments. Such experiments can discover the magnitude and directions of environmental effects. The second assumption can be evaluated using phenotypic characters from different populations. This requires another assumption that phenotypic variation reflect genotypic one. The assumption is valid for Lande's model when the phenotypic variances, covariances, and correlations among characters are stable in closely related populations. This paper reports geographicals variation in the body size of the browned-throated sunbird, *Anthreptes malacensis,* and the possibility of natural selection working on such variation.

MATERIALS AND METHODS

The analysis was based on measurements of 248 individuals, made on museum specimens measured by AM, collected from Sumatera, Jawa, Kangean, Panaitan, Kalimantan, Sulawesi and Komodo. Other specimens from satellite islands as well as those from Bali island were excluded, mainly due to small numbers of specimens available. Subspecies examined in this study were: (1) *Anthreptes malacensis*

malacensis from Sumatera (abbreviated as AmmS); (2) *A.m.malacensis* from Jawa (AmmJ); (3) *A.m.malacensis* from Kalimantan (AmmB); (4) *A.m.malacensis* from Kangean (AmmK); (5) *A.m.malacensis* from Panaitan (AmmP); (6) *A.m.citrinus* from Sulawesi (AmCi); (7) *A.m.celebensis* (AmCe); and (8) *A.m.convergens* from Komodo (AmmF).

Four measurement reported here are the lengths of culmen (chord), wing (flattened), tail, and tarsometatarsus. These are measurements that can be made on skin collections in the Museum Zoologicum Bogoriense, Bogor with minimal error. Sexual dimorphism was preliminary examined for each of those eight taxonomic units, and there was not any significant difference in the morphological measurements between sexes. Examination on the plumage patterns of those taxonomic studies failed to find any conspicuous intraspecific difference. This puts morphological measurements as a major consideration in this study.

Univariate analysis was done on all characters to examine differences between taxonomic units, using Student's t-test which was computed with Minitab version 7.1. This would show both variation and differentiation in characters between taxonomic units examined in the study. Chisquare test was performed to examine the distribution of coefficient variabilities of each character among taxonomic units. Principal component analysis was done on the correlation matrix calculated from the average values of each character for all taxonomic units; and the average values for each character were computed from raw data which were normalized with their mean values and standard deviation (see Mathematical Taxonomy). Cluster analysis was also carried out on the Normalized Euclidean distances between taxonomic units calculated from the same set of average values. This would emphasize the degrees of association between taxonomic units. Principal component and cluster analyses were performed using a Multivariate Statistical Package produced by W.L.Kovach (Bloomington University),whose procedures followed those in Orloci (1975).

RESULTS AND DISCUSSIONS

It was shown that the character variability was distributed evenly within taxonomic units examined in this study. Along with that, Lande's hypothesis acquires a stable distribution of character variability when intraspecific phenotypic characters within populations do not change across localities. The results might indicate that intraspecific variation within the populations of these sunbirds would not change across localities or through time. In other words, stable phenotypic characters within populations of taxonomic units examined in this study might be the results of a directional selection. The variation of morphological characters can be described as follows.

The culmen length of *A.m.malacensis* from Sumatra, Jawa, and Kalimantan was not significantly different from one another. The culmen of birds from Kangean was of the same length as that of birds from Sumatra and Kalimantan, but significantly smaller than that of birds from Jawa. On the other hand, the culmen of Panaitan's birds was longer than that of Sumatran's, Kalimantan's and Kangean's, but it was not different from that of birds from Jawa. The culmen of *A.m.citrinus* was not different from that of *A.m.malacensis* from Sumatra, Jawa, Kalimantan, Kangean, and Panaitan, and so was that of *A.m.celebensis* except that this subspecies had longer culmen than Kangean's birds. Meanwhile, both subspecies of *A.m.malacensis* from Sulawesi did not show any significant different in the culmen length; and subspecies from Komodo island had significantly shorter culmen than the other subspecies.

The wing of *A.m.malacensis* from Sumatra, Jawa, and Kalimantan was significantly of the same length, while the birds from Jawa and Kalimantan had shorter wing than the birds from Kangean, Panaitan, Sulawesi, and Komodo. On the other hand, the wing of birds from Kangen, Panaitan, Sulawesi, and Komodo was not different from one another; either, there was not any significant difference in the wing length of the two subspecies of *A.m.malacensis* from Sulawesi. Both subspecies from Sulawesi had significantly longer wing than did the birds from Sumatra, Jawa, and Kalimantan.

The tail of Kalimantan birds was shorter than that of birds from Sumatra, Jawa, and Panaitan. The birds from Kangean and Komodo did not show any difference in tail length from the other subspecies, but they had shorter tail than Panaitan birds. *A.m.citrinus* significantly had shorter tail than *A.m.malacensis* from Sumatra, Jawa, Panaitan, and Komodo; and the birds from Komodo was significantly of the same tail length as the other subspecies, but longer than *A.m.citrinus.* Significant difference in tail length between the two subspecies from Sulawesi was not found.

The birds from Sumatra, Jawa, and Kalimantan did not differ from one another in tarsus length, but the birds from Panaitan had longer tarsus than the other *A.m.malacensis* subspecies, except Komodo's subspecies. Komodo's birds did not have different tarsus length from the other subspecies, and so did the birds from Sulawesi. The tarsus of Sulawesi's birds was, however, shorter than that of Panaitan's, but the two subspecies from Sulawesi did not have different tarsus length.

The dendrogram (Figure 1) reflects such morphological variations, and shows that the taxonomic units examined in this study were classified into two separate groups, i.e. subspecies from Sumatra, Jawa, Panaitan, and Komodo which were clustered into one group, and the other group consisted of subspecies from Kalimantan, Kangean, and the two Sulawesi's subspecies. Subspecies from Sumatra and Jawa had the highest similarity for they were clustered into a separate group, and so did the subspecies from Panaitan and Komodo which were separately clustered before they had the closest similarity with the Sumatra and Jawa group. The figure also showed that Kalimantan subspecies did not have closed similarity with those from Sumatra and Jawa, but was closely related to that from Kangean. Both subspecies from Sulawesi were clearly grouped into one cluster prior to joining the group of Kalimantan and Kangean subspecies. Geometrical space shown in Figure 2 seems to confirm a such pattern of taxonomic clustering. Each group of clusters was located at its specific quadran, and the two major groups were placed on opposite spaces.

The grouping patterns of those subspecies examined in this study, as depicted in Figures 1 and 2, might have been the results of adaptation to environments encountered by individuals within the clusters of islands. Sumatra, Jawa, and Kalimantan have to some extent similar ecosystem characteristics (Whitten *et al.* 1987), and adaptive pressures in these islands may act in a similar way so that their conspecific birds, or even congeneric birds, show similarities in size. The results did, however, not fully support this idea, since the subspecific birds of Kalimantan did not show high similarities with those from Sumatra and Jawa.

On the other hand, the results showed that *A.malacensis* subspecies from Sulawesi had also similar morphological characteristics to the subspecies of the other islands except the wing length. Despite Sulawesi has unique ecosystems in itself which differ from the other islands, it was demonstrated that such uniqueness may not necessarily facilitate adaptation unique to the respective islands. The wing of Sulawesi's birds was longer than that of the other subspecies. This seems to correspond with Tiainen's (1982) findings, in that the wing length difference in *Phylloscopus* warblers was correlated with the differences of characteristic between ecosystems. The Warblers lived in the spruce-dominated areas had shorter wings than those in the deciduous-dominated ones. The results cannot necessarily support the idea that differences in habitat characteristics may lead to differences in body sizes.

In general, *A.m.malacensis* subspecies from similar islands such as Kangean, Panaitan, and Komodo showed different figures of morphological characters, and there was not any pattern showing their differences from one another or from the other islands. The birds from Panaitan showed consistently longer culmen, tail, and tarsus than the birds from other islands; while Komodo's subspecies consistently showed the same lengths of tail and tarsus as the birds from the other islands, but shorter culmen and longer wing than the other subspecies. These findings were not consistent with those of Ebenham & Nilsson (1981) who found that male willow warblers (*Phylloscopus trochilus*) had larger body sizes on the mainland than those on small lake islands in Southern Sweden. They suggested that such differences were due to habitat differences between the study sites. The results in this study did not seem to approve their hypothesis, and such a prediction remains open for investigation.

It is interesting to note that the two subspecies of *A.malacensis* from Sulawesi did not show any differences in the four morphological characters examined in this study, and their plumage patterns did not clearly show any difference. These subspecies were categorized into two separate subspecies based on their distribution (Stresemann 1940); *A.m.citrinus* is distributed in the southeastern peninsula of Sulawesi which intergrades with *A.m.celebensis* over considerable areas in central and nothern Sulawesi, while *A.m.celebensis* is dispersed in the southern peninsula. However, the status of *A.m.celebensis* from central and northern Sulawesi is still uncertain (Paynter 1968).

If both recognized subspecies were parapatric allopatry and genetically compatible with each other, they could surely be categorized as distinctive subspecies (Amadon & Short 1992). Clancey (1992) suggests that variation in characters between subpopulations leading to subspeciation is generally the results of their adaptation to surrounding environments. If these hypothese were true, both *A.malacensis* subspecies from Sulawesi should show their allopatric distribution where different types of environments could be found. This remains open for further investigation.

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Figure 1. Dendrogram showing the grouping of *A.malacensis* subspecies from various islands examined in this study (Cophenetic correlation = r^2=0.76; t_{26}=9.01; $p < 0.01$).

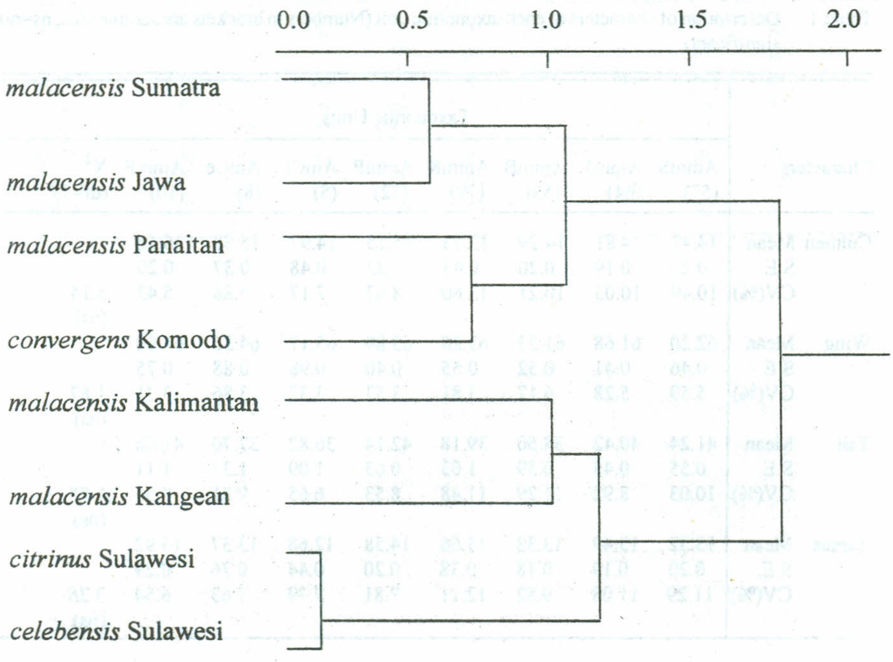
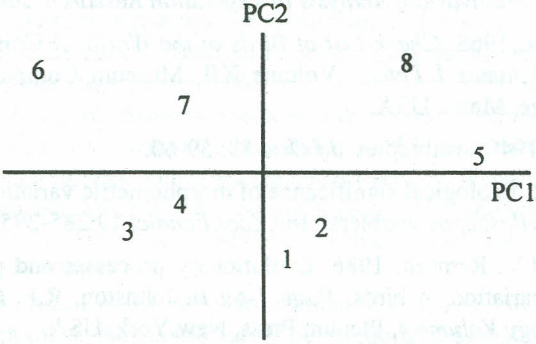


Figure 2. Geometrical space of each *A.malacensis* subspecies based on their first and second principal component scores.



Notes :
1. *malacensis* (Sumatra)
2. *malacensis* (Jawa)
3. *malacensis* (Kalimantan)
4. *malacensis* (Kangean)
5. *malacensis* (Panaitan)
6. *citrinus* (Sulawesi)
7. *celebensis* (Sulawesi)
8. *Convergens* (Komodo)

Table 1. Description of characters of each taxonomic unit (Numbers in brackets are sample size; ns=not significant).

Characters		Taxonomic Units								
		AmmS (57)	AmmJ (64)	AmmB (53)	AmmK (19)	AmmP (32)	AmCi (5)	AmCe (8)	AmmF (10)	X^2 (df=7)
Culmen	Mean	14.42	14.81	14.29	13.73	15.15	14.97	15.08	16.66	
	S.E.	0.20	0.19	0.20	0.43	0.23	0.48	0.37	0.29	
	CV(%)	10.49	10.03	10.21	13.60	8.67	7.17	6.88	5.43	5.14 (ns)
Wing	Mean	62.20	61.68	61.23	63.28	63.89	65.17	64.36	64.00	
	S.E.	0.46	0.41	0.52	0.55	0.40	0.98	0.88	0.75	
	CV(%)	5.59	5.28	6.17	3.81	3.53	3.37	3.86	3.71	1.87 (ns)
Tail	Mean	41.24	40.42	38.50	39.18	42.14	36.82	37.70	41.06	
	S.E.	0.55	0.45	0.59	1.03	0.63	1.09	1.31	1.11	
	CV(%)	10.03	8.92	11.29	11.48	8.53	6.65	9.81	8.55	1.88 (ns)
Tarsus	Mean	13.32	13.49	13.33	13.66	14.58	12.68	13.37	13.92	
	S.E.	0.20	0.19	0.18	0.38	0.20	0.44	0.36	0.29	
	CV(%)	11.29	11.08	9.82	12.11	7.81	7.79	7.63	6.54	3.26 (ns)

Table 2. Probabilities of differences between *A.malacensis* subspecies in culmen length (upper half) and in wing length (lower half) (ns=not significant, *=p<0.05, **=p<0.01).

Taxonomic Units	(N)	AmmS	AmmJ	AmmB	AmmK	AmmP	AmCi	AmCe	AmmF
AmmS	(57)		ns	ns	ns	*	ns	ns	**
AmmJ	(64)	ns		ns	*	ns	ns	ns	**
AmmB	(53)	ns	ns		ns	**	ns	ns	**
AmmK	(19)	ns	*	**		**	ns	*	**
AmmP	(32)	**	**	**	ns		ns	ns	**
AmCi	(5)	*	*	*	ns	ns		ns	*
AmCe	(8)	*	*	**	ns	ns	ns		**
AmmF	(10)	*	**	**	ns	ns	ns	ns	

Table 3. Probabilities of differences between *A.malacensis* subspecies in tail length (upper half) and in tarsus length (lower half) (ns=not significant, *=p<0.05, **=p<0.01).

Taxonomic Units	(N)	AmmS	AmmJ	AmmB	AmmK	AmmP	AmCi	AmCe	AmmF
AmmS	(57)		ns	**	ns	ns	**	*	ns
AmmJ	(64)	ns		**	ns	*	*	ns	ns
AmmB	(53)	ns	ns		ns	**	ns	ns	ns
AmmK	(19)	ns	ns	ns		*	ns	ns	ns
AmmP	(32)	**	**	**	*		**	**	ns
AmCi	(5)	ns	ns	ns	ns	**		ns	*
AmCe	(8)	ns	ns	ns	ns	**	ns		ns
AmmF	(10)	ns	ns	ns	ns	ns	*	ns	

NOTES ON THE NEST AND EGGS OF THE CHESTNUT-BACKED SCIMITAR BABBLER *Pomathorinus montanus* (Timaliidae)

During an excursion to Situgunung forest, a part of Gn.Gede Pangrango National Park (106°54'79"-106°55'79" E, 6°39'40"-6°41'12" S; 1000 m asl) between 7-9 October 1993, observations on bird were carried out. Along the pathway from the basecamp to Curug Sawer waterfall, we observed a chestnut-backed scimitar babbler flushing from a nest. The nest was located in a ground hole of the hill embankment alongside the pathway, about 1.4 m above the pathway surface. It was a large sphere composed of branches (interior) and dry leaves (exterior). Its cavity faced sideward. Its exterior diameter was between 13- 15 cm with the depth of 15 cm, while its interior diameter was about 8-10 cm with 13 cm depth.

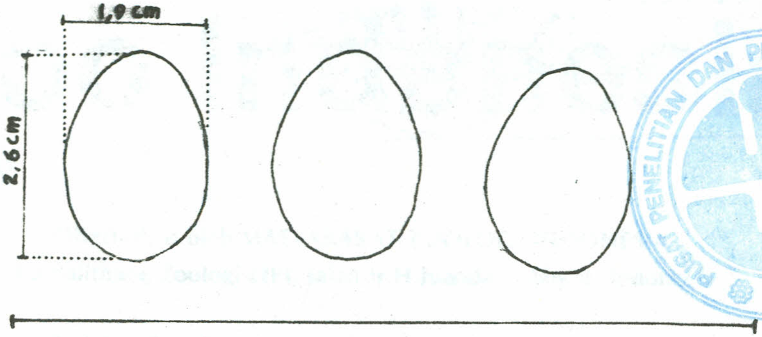
Three eggs were found in the nest. Their size were 26.94x19.32 mm, 26.50x19.04 mm and 26.34x19.26 mm. The ground colour of the eggs was clear white, and the average weight of the whole eggs was 5.0 g. The eggs were not different from these of *Pomathorinus montanus* disposed in the Museum Zoologicum Bogoriense (see Table 1).

Table 1. The egg collections of *Pomathorinus montanus* in the Museum Zoologicum Bogoriense

No.MZB	Clutch	Date	Collector	Size(mm)	Locality
305	3 eggs	-	H.C. Siebers	26.90x18.80 26.70x18.60 27.10x18.70	Cibodas
306	3 eggs	-	H.C. Siebers	26.20x18.60 26.90x18.60 27.30x19.00	Kamojan
821	3 eggs	19XI1935	V. Bartels	24.99x18.65 25.82x19.00 25.82x19.00	-
+	3 eggs	09XI1993	the authors	26.34x19.26 26.50x19.04 26.94x19.32	Situgunung

+ this study
- not recorded

Further, the content of the eggs was taken out, but they had developed embryos, which were ready to hatch. Hence, the analysis on egg contents could not be done. Mackinnon (Birds of Java & Bali, 1990) states that this species breeds in Java throughout the year, and May and June being the peak periods. W. WIDODO & ASEP S. ADHIKERANA, Balitbang Zoologi Puslitbang Biologi - LIPI Bogor.


1,9 cm
2,6 cm


0
7,5 cm.