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An assessment of biodiversity in morphological traits of Muscovy ducks in Nigeria using discriminant analysis

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Abstract—Biodiversity, which includes the diversity of the living organisms, their genes and genomes, is a fascinating product of evolution, which is increasingly challenged by intrinsic natural causes and human interference. The present investigation therefore, examined morphological diversity in Muscovy ducks from the guinea savannah and rainforest zones of Nigeria using multivariate discriminant analysis. Data comprised eight morphometric traits measured in a total of 435 adult ducks randomly selected in the two agro-ecological zones. Common descriptive statistics showed that ducks from the rainforest zone had higher (P<0.05) body weight, foot length and thigh circumference, while their guinea savannah counterparts were longer (P<0.05) in the neck. Stepwise discriminant analysis indicated that foot length, neck length, thigh circumference and body length were more effective in discriminating between the duck populations. The low Mahalanobis distance of 3.39, as revealed by the canonical discriminant analysis, is an indication of high gene flow between ducks from the two agro-ecological zones. The cluster analysis also revealed the homogeneity of the genetic identity of the duck populations. The present information will be the basis for further characterization, conservation and sustainable genetic improvement strategies for indigenous ducks.

Keywords- muscovy duck; morphological traits; discriminant analysis; agroecological areas; Nigeria.

I. INTRODUCTION

Poultry has long been recognized as a major contributor to long lasting solution to insufficient protein intake in Nigeria. Ducks represent the second largest poultry population in Africa after chicken. They are hardy, less exigent for feed quality, less susceptible to diseases than chicken, and quite promising among indigenous poultry species because of their rapid growth rate and dressed weight of drakes. Characterization, conservation and use of indigenous animal resources under low levels of input in the tropics are usually more productive than is the case with exotic breeds [1]. The locally adapted animals are also more readily available to resource-poor farmers and they can be productive without high disease-control inputs. Yet, paucity of information on the genetic resources present in the indigenous farm animals in developing countries has led to their underutilization, replacement and dilution through crossbreeding. This, therefore, underscores the paramount significance of the characterization, management and conservation of the indigenous ducks.

Phenotypic comparison based on morphological characters can provide to some extent a reasonable representation of genetic difference among populations. This genetic variation in the duck populations is essential for the development of appropriate breeding goals and programmes for each agro-ecological zone of the country. However, earlier work on the body conformation characteristics of ducks in Nigeria and elsewhere in Africa (Teguia *et al*., 2008) had been centred on univariate statistical techniques, which is highly limited (it analyzes each variable separately) in assessing variation within and between livestock populations. The current trend involves the use of multifactorial discriminant analysis of morphological characters, which explains how populations under investigation differ when all measured variables are considered jointly.

The present investigation therefore, aimed at examining the morphological variation between Muscovy ducks of two agro-ecological zones of Nigeria using multifactorial discriminant analysis. This could aid their proper management, conservation and improvement in breeding programmes.

II. MATERIALS AND METHODS

Data were obtained from four hundred and thirty five randomly selected adult Muscovy ducks of both sexes from three states (Nasarawa, Lagos and Cross River) within two agro-ecological zones of Nigeria. This comprised two hundred and twenty one (221) ducks from the guinea-savannah and two hundred and fourteen ducks from the tropical rainforest zones, respectively. They were managed through the traditional scavenging system.

The body parts measured were, Body weight (BWT), body length (BDL), breast circumference (BTC), thigh circumference (THC), bill length (BLL), neck length (NKL) foot length (FTL) and wing length (WNL). Measurements were restricted to apparently healthy birds that conformed to the species' classification descriptors.

MEAN procedure of SAS statistical package was used to study morphological variation in the duck populations of the two agro-ecological zones, with means separation done using t-test. Stepwise discriminant procedure was applied using PROC STEPDISC to determine which morphological traits have more discriminant power than others for eventual use in the cluster analysis. The relative importance of the morphometric variables in discriminating the two duck

populations was assessed using the level of significance, partial R^2 and F-statistic. The CANDISC procedure was used to perform univariate and multivariate one-way analysis that calculated the Mahalanobis distance between ducks from the two agro-ecological zones. The degree of morphological similarity or divergence between the ducks was determined using PROC CLUSTER procedure. It involved the use of Ward's option where MACRO SHOW was employed to display cluster results. This invoked the FREQ procedure to cross tabulate cluster of the two duck populations.

III. RESULTS AND DISCUSSION

The results of the descriptive statistics of the morphometric traits of the ducks showed that body weight (2.18±0.05 versus 2.04±0.05), foot length (5.49±0.09 versus 4.32±0.05) and thigh circumference (8.60±0.18 versus 7.47±0.15) were higher significantly (P<0.05) in rainforest ducks compared to their guinea savannah counterparts (Table 1). However, the latter had longer neck (P<0.05) compared to the former. There were no marked differences (P>0.05) in body length, bill length, wing length and breast circumference of ducks from the two zones. The body weights of muscovy ducks in this study are higher than the range of 1.515kg and 1.710kg reported for extensively reared Deshi and Deshi X Khaki Campbell cross in India [3]. The high coefficients of variation especially of body weight and thigh circumference of birds from both agro-ecological zones in the present study could be attributed to the sensitivity of these traits to environmental changes such as temperature and nutrition. The practical implication of this is that there is room for their genetic improvement based on the observed variations.

TABLE I. MEANS (CM), STANDARD ERRORS (SE), STANDARD DEVIATIONS (SD) AND COEFFICIENTS OF VARIATION (CV) FOR THE ZOOMETRICAL CHARACTERS OF GUINEA SAVANNAH DUCKS AND RAINFOREST DUCKS

	Guinea savannah ducks			Rainforest ducks		
Traits	Mean±SE	SD	CV	Mean±SE	SD	CV
Body weight	2.04±0.05[b]	0.7	38.2	2.18±0.05[a]	0.6	30.2
Body length	42.44±0.51	8	4	41.57±0.38	6	8
Neck length	[a]	7.6	17.9	[a]	5.5	13.3
Bill length	16.01±0.18	1	3	14.13±0.24	3	0
Foot length	[a] 4.28±0.06[a] 4.32±0.05[b]	2.71 0.88 0.72	27.07 20.56 16.67	[b] 4.36±0.09[a] 5.49±0.09[a]	3.52 1.34 1.25	24.91 30.73 22.77
Wing length	20.41±0.39 [a]	5.75	28.17	20.05±0.37 [a]	5.40	26.93
Breast circumference	34.52±0.37 [a]	5.56	16.11	34.18±0.35 [a]	5.07	14.83
Thigh circumference	7.47±0.15[b]	2.16	28.92	8.60±0.18[a]	2.68	31.16

[ab] means in the same row with different superscripts are significantly different (p<0.05)

Phenotypes are an expression of genetic characteristics, modified by environmental condition; and variance in both genetics and environment may affect phenotypic variance. Geographic and adaptive variation in different populations of waterbirds is closely associated with the environmental conditions in different regions. The birds from the rainforest zones in the present study were larger in size than their guinea savannah counterparts probably as a result of their closeness to the coastal areas, which is favourable to the growth of ducks. This trend could be explained by the thermoregulatory advantages of being larger in colder environments; larger animals face smaller heat losses in cold climates because of their proportionally smaller surface areas However, [4] argued that the patterns underlying geographic variation are complex and highly context-dependent, reducing the predictive power of ecogeographical rules.

The stepwise discriminant analysis indicated that foot length, neck length, thigh circumference and body length have more discriminating power in assessing morphological variation between the two duck populations (Table 2). The most important of these variables was however, foot length (partial R^2 = 0.2477, F-value = 142.60 at P< 0.0001). These four variables were used to obtain an estimate (3.39) of the Mahalanobis distance between the two duck populations. This distance appeared low.

TABLE II. SUMMARY OF STEPWISE SELECTION OF TRAITS

Step	Traits entered	Partial R^2	F-value	P> F	Wilk's Lambda	P< lambda	Average squared canonical correlation	P> ASCC
1	FTL	0.2477	142.60	<0.0001	0.752260	<0.0001	0.248	<0.0001
2	NKL	0.2132	117.08	<0.0001	0.591860	<0.0001	0.408	<0.0001
3	THC	0.0536	24.35	<0.0001	0.540359	<0.0001	0.460	<0.0001
4	BDL	0.0353	15.78	<0.0001	0.570959	<0.0001	0.429	<0.0001

FTL: foot length, NKL: neck length, THC: thigh circumference, BDL: body length

Only variables that were significant in the stepwise discriminant function procedure and that had partial R^2 values ≥0.01 were retained in the final model. These four variables generated the mahalanobis distance of 3.39 between the guinea savannah and rainforest ducks.

The low morphological differentiation between ducks from the two agro-ecological zones as revealed by the Mahalanobis distance did not give enough evidence to separate the populations into different genetically distinct groups or breeds. This could be an indication of high intermingling and absence of selection among the indigenous stock. There is free movement of birds from one area to another within the country as a result of human activities, which overtime, leads to random mating among birds (introgression). The small distance also implies that ducks from the two agro-ecological zones could have descended from a common ancestral population during the process of domestication. This was consolidated by the result of the cluster analysis (Table 3), where ducks from the guinea savannah zone and their counterparts from the rainforest zone were well represented in the three clusters obtained. In a related study, [5] used multivariate analysis to evaluate morphological differences between two subspecies of Crested Duck to gain a better understanding of the forces that have acted to shape geographical variation in morphology of highland and lowland populations.

TABLE III. SUMMARY OF CLUSTER BY AGRO-ECOLOGICAL ZONE OF DUCKS

Cluster	Guinea savannah ducks		Rainforest ducks	
	Frequency	Percentage	Frequency	Percentage
1	123	28.28	162	37.24
2	58	13.33	29	6.67
3	40	9.20	23	5.29
Total	221	50.80	214	49.20

This study showed that ducks from the rainforest agroecological zone were larger in size than those from the guinea savannah zone. However, foot length, neck length, thigh circumference and body length were more discriminating in explaining morphological variability between ducks from the two zones. Maintaining this variation is important if the goal is to continue to improve the performance of the birds and respond to change in climate, disease or consumers' preference while improving the livelihood of livestock keepers and food security of the populace. The low mahalanobis distance was an indication of the extent of genetic exchange between the two duck populations. The present information could aid their management, conservation and future selection and breeding programmes.

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