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Principal Component Factor Analysis of the Morphostructural Traits of Muscovy Duck

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Abstract: Eleven body measurements were taken on 320 adult Muscovy duck (124 male and 196 females) within the guinea savanna zone of central Nigeria. The body measurements included Body Length (BDL), Body Width (BDD), Bill Length (BLL), Bill Width (BLD) Bill Height (BLH), Shank Length (SHL), Body Height (BH), Head Length (HL) Neck Length (NL), Head Width (HD) and Wing Length (WL). Sex had significant influence on all traits with higher means recorded for male traits. The correlation coefficient of the body measurements range from negative to moderately high for both sexes. In factor solution of the principal component analysis with VARIMAX rotation of the transformation matrix, four factors with ratio variances of 71.85% were identified for male, the first factor accounted for 36.66% and had its loading for body width, bill width, shank length and body height. In female 2 factors with ratio variances of 53.04% were extracted, the first and the second factors explain 36.76 and 16.27% of the generalized variances with the first had its loading on body length, bill width, body height, neck length and wing length respectively. From the result factor loading in Muscovy duck is sex dependent and can be exploited in improvement programme for the bird.

Key words: Body measurement, factor analysis, muscovy duck, variance

INTRODUCTION

Morphological traits and weight are important to assess the potentials in a bird, this traits indicates the usefulness of a poultry bird for commercial production purpose. Therefore an attempt to measure these parameter in away other than conventional weighing and grading seems appropriate. A number of multivariate techniques have been greatly applied in animal breeding research. The concept of principal component has received limited attention (Carpenter *et al.*, 1971). It has been used to assess body shape and size mostly in large animals (Brown *et al.*, 1973; Hammock and Shrode, 1986; Fumio *et al.*, 1982 and Yakubu *et al.*, 2009) in cattle, Riva *et al.* (2004) and Salako (2006) in Sheep and goats) whereas there are only a few report about the use of principal component analysis in poultry (Ibe, 1989 and Debut *et al.*, 2003).

Analysis of variance and correlations are widely used to characterize phenotypic and genetic relationships among body measurements of animals (Shahin *et al.*, 1993). However, principal component analysis is a valuable refinement. According to Morrison (1976), the principal component analysis is a multivariate methodology that can be use with success when characteristics are correlated. This analysis transforms an original group variable into another group. Principal Component (PC) which are linear combinations of the original variables. The main advantage is the independence of these components. From the view point of animal genetics and improvement. Principal component simultaneously consider a group of attribute which may be interesting for selection purpose. Another important aspect is that each of the PCS explain a percentage of the total variance, with the first PC explaining the highest percentage of this variance.

The present study was embarked upon to evaluate the relationship among body dimensions in adult male and female Muscovy ducks in order to obtain fewer measurement for genetic and breeding purposes using principal component analysis.

MATERIALS AND METHODS

The data used for this study was collected from Lafia, Nasarawa State. The area falls within the guinea savanna zone of north central Nigeria and is located within latitude 08°35'N and longitude 08°33'E.

Three hundred and twenty adult Muscovy duck of both sexes reared under extensive system of management were randomly measured. Only birds that have laid eggs or are mounting females were used for data generation Eleven morphometric traits were measured on each bird using the method described

They include Body length BDL, body width BDD, bill length BLL, bill width BLD, bill height BLH, shank length

SHL, body height BH, head length HL neck length NL, head width HD and wing length WL. The length and height measurements were done using a flexible tape and calibrated wooden caliper was used for the width measurements. Measurements were done by the same person to avoid between-individual variations.

Statistical analysis: Means, standard errors minimum and maximum of the body measurements were calculated. General Linear Model (GLM) was used to analyze sex effects. Pearson's coefficients of correlation (r) among the various morphometric traits were estimated. From the correlation matrix, data were generated for the principal component factor analysis. Anti-image correlations, Kaiser-Meyer-Olkin measures of sampling adequacy and Bartlett's Test of Sphericity were computed to test the validity of the factor analysis of the data sets. Principal component analysis according to Everitt *et al.*(2001), is a method for transforming the variables in a multivariate data set, X_1, X_2, ..., X_P, into new variables, y_1, y_2..., y_p, which are uncorrelated with each other and account for decreasing proportions of the total variance of the original variables defined as:

$$y_1 = a_{11} x_1 + a_{12} x_2 + --- + a_{1p}x_p$$

$$y_2 = a_{21} x_1 + a_{22} x_2 + --- + a_{2p}x_p$$

$$y_p = a_{p1} x_1 + a_{p2} x_2 + --- + a_{pp}x_p$$

With the coefficients being closed so that y_1, y_2 ---, y_p account for decreasing proportions of the total variance of the original variables, x_1, x_2, ---, x_p. The factor programme of SPSS (2004) 14 statistical package was used for the principal component analysis.

RESULTS AND DISCUSSION

Table 1 shows the descriptive statistics for each of the morphometric traits of the two sexes investigated. The male Muscovy ducks had significant $p<0.05$ higher mean values in all body measurements than the female as indicated in the previous study (Ogah *et al.*, 2009). This explain the concept of sexual dimorphism which is said to be a pronounced phenomenon in Muscovy duck (Baeza *et al.*, 2001; Badyaev *et al.*, 2001).

Pearson's coefficient of correlation among the various traits are shown in Table 2, the coefficient were from negative to moderately high. In male the highest correlation was found between head length and body width .710 whereas in female its between bill width and neck length .788 ($p<0.01$). The negative coefficient indicate an inverse response between the traits concerned.

Anti-image correlations computed for the two sexes showed that partial correlations were low, indicating that true factors existed in the data. This was buttressed by Kaiser-Meyer-Olkin measure of sampling adequacy studied from the diagonal of partial correlation, revealing the proportion of the variance in the body measurements caused by the underlying factor. .755 for male and .785 for female. While The overall significance of the correlation matrices tested with Bartlett's Test of Sphericity for the body dimensions of both sexes were significant at ($p<0.01$). Communalities which is the explained variance together with the determinant obtained from the correlation matrix for male were all above .527 except for head width, thus permitting all other measurements into reasonable factor analysis with the exception of head width. In female the communalities for bill height, shank length, head length and head width were low suggesting there removal from principal component analysis. The reason for this might be due to the size of the data.

After VARIMAX rotation of the component matrix in male four Principal Component (PC) explaining 71.8% were yielded by the factor solution as presented in the Table 3, the first principal component comprises 6 measurement body width, bill width, shank length, body height and head length and neck length explaining 36.66% of the generalized variance in the body measurement (.638-.892). The second , third and fourth factors comprises 2, 2 and 1 measurements explaining 14.76, 10.68 and 9.755 variances respectively. In female 2 PC were yielded explaining 53.021% by the factor solution. The first PC comprises 5 measurement body length, bill width, body height and wing length (0.716-0.909) explaining 36.76% of the generalized variance in the body measurement. The second factor comprises only 2 measurement body width and bill

Table 1: Descriptive statistics of morphological traits by sex

Parameter	Sex	Mean±SE	Minimum	Maximum
BDL	Male	27.49±0.29	20.00	32.00
	Female	23.95±0.09	21.00	25.80
BDD	Male	15.97±0.21	11.40	19.30
	Female	11.66±0.09	8.40	11.66
BLL	Male	6.18±0.63	3.80	10.20
	Female	4.63±0.02	4.00	5.10
BLD	Male	2.96±0.64	2.00	5.10
	Female	2.82±0.03	1.80	3.70
BLH	Male	1.75±0.14	0.30	6.00
	Female	1.48±0.18	1.20	5.30
SHL	Male	6.27±0.06	1.80	26.70
	Female	5.52±0.42	3.50	8.50
BH	Male	21.12±046	10.80	26.70
	Female	17.43±0.16	12.00	19.50
HL	Male	5.42±0.09	2.90	6.70
	Female	4.74±0.65	5.50	6.20
NL	Male	15.39±0.14	11.50	18.0
	Female	14.28±0.14	10.30	16.40
HD	Male	2.83±0.09	1.80	3.00
	Female	2.53±0.09	2.10	5.00
WL	Male	29.72±0.18	22.10	32.30
	Female	23.62±0.20	17.00	28.20

Body Length (BDL), Body Width (BDD), Bill Length (BLL), Bill Width (BLD) Bill Height (BLH), Shank Length (Shl), Body Height (Bh), Head Length (HL) Neck Length (NL), Head Width (HD) Wing Length (WL)

Table 2: Coefficient of correlation of the body measurements of Muscovy duck, below diagonal male traits and above diagonal female traits

	BDL	BDD	BLL	BLD	BLH	SHL	BH	HL	NL	HD	WL
BDL	1.00	0.066	0.076	0.523	0.032	0.200	0.708	-0.171	0.568	-0.197	0.631
BDD	0.303	1.00	0.548	0.034	0.127	0.037	-0.030	0.236	0.104	-0.006	-0.153
BLL	0.037	0.120	1.00	0.185	0.223	0.118	0.001	0.132	0.215	0.015	-0.049
BLD	0.101	0.501	0.414	1.00	0.029	0.126	0.668	-0.360	0.788	-0.284	0.647
BLH	0.090	0.305	0.045	0.291	1.00	0.002	0.022	0.066	0.019	0.020	-0.005
SHL	0.158	0.635	0.606	0.640	0.252	1.00	0.215	-0.052	0.233	-0.054	0.194
BH	-0.055	0.368	0.004	0.289	-0.052	0.549	1.00	-0.178	0.717	-0.234	0.732
HL	0.325	0.710	0.059	0.599	0.400	0.576	0.151	1.00	-0.430	0.097	-0.355
NL	0.198	0.619	0.057	0.627	0.388	0.569	0.143	0.770	1.00	-0.327	0.751
HD	0.085	0.218	0.027	0.112	0.139	0.082	-0.062	0.226	0.204	100	-0.246
WL	0.293	0.150	-0.066	-0.284	-0.073	-0.300	-0.212	-0.004	-0.160	0.023	1.00

Table 3: Eigenvalues and share of total variance along with factor loadings after rotation and communalities of the body measurements of Muscovy duck

	Female			Male				
Traits (cm)	Factor 1	Factor 2	Communality	Factor 1	Factor 2	Factor 3	Factor 4	Communality
BDL	0.766	0.073	0.592	0.200	0.102	0.744	0.079	0.610
BDD	-0.005	0.829	0.687	0.750	0.301	0.361	0.065	0.788
BLL	0.109	0.841	0.719	0.020	-0.044	0.016	0.964	0.932
BLD	0.846	0.072	0.720	0.650	0.283	-0.134	0.530	0.812
BLH	0.022	0.414	0.172	0.185	0.698	-0.062	0.032	0.527
SHL	0.289	0.148	0.102	0.892	0.108	-0.101	-0.055	0.820
BH	0.861	-0.020	0.742	0.743	-0.433	-0.168	0.105	0.737
HL	-0.430	0.391	0.338	0.661	0.549	0.240	0.083	0.802
NL	0.909	0.104	0.837	0.638	0.574	0.032	0.096	0.747
HD	0.381	0.033	0.146	0.012	0.575	0.059	-0.027	0.335
WL	0.865	-0.169	0.777	0.224	-0.061	0.830	-0.107	0.754
Eigenvalues	4.04	1.79		4.03	1.63	1.17	1.07	
% variance	36.76	16.27		36.66	14.76	10.68	9.75	
% total variance	36.76	8		36.66	51.42	62.10	71.85	

length explaining 16.27% variance. Report of Salako (2006) and Yakubu *et al.* (2009) also explained that the first factors explaining the highest variation. Clearly two major underlying factors are responsible for the observed clusters. There may be related to the different association of each measurement with bone, environmental component or time taken to reach maturity which is normally time dependent (Salako, 2006). Traits in clusters are probably having same genetic control.

Conclusion: Principal component analysis was used to consolidate interdependence among the traits in this bird, the aggregation of the morphometric traits into factor was sex dependent, four factor for male and two factors for female. This can be used in breeding and selection programme for improvement of performance in Muscovy duck.

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