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Body Weight is an Important Trait for Comparisons of Goat Breeds

Short Communicaion

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ABSTRACT

Eleven goat breeds of different origin (10 Spanish and 1 African) were considered for this study: Zambian Dwarf, Azpi-Gorri, Blanca-Andaluza, Blanca-Celtibérica, Blanca de Rasquera, Catalana, Malagueña, Moncaína, Murciano-Granadina, Negra Serrana and Pyrenean. Nine linear body measurements for females, as well as the body weight ratio between gender and body weight, were obtained from literature and compared. Our results showed that the two principal components (PC) accounted for near 94% of total variation. The PC1 included the ratio between sexes, body weight and thoracic perimeter while the PC2 included body weight and ratio of body weight between sexes. Interestingly, all these high discriminating traits - body weight, body weight ratio between gender and thoracic perimeter- are related with body weight. The clustering of breeds according to those three traits offered a good picture of breeds according to their origin, with a cophenetic correlation, a measure of how faithfully a dendrogram preserved pairwise distances between the original unmodeled data points, high.

KEY WORDS body trait, dendrogram, morphological trait, zoometry.

INTRODUCTION

Domestic goats are important domestic animals because of their adaptability to extreme environmental conditions (Abdul-Aziz, 2010) and they provide a full range of products for humans including meat, milk, skin and hair (Okpeku *et al.* 2011). Morphological differences exist among differentt breeds and goat populations worldwide and detailed characterization and breed inventories are important in the conservation of caprine genetic resources. Breed characterization has traditionally been recognized as the first approach to the sustainable use of animal genetic resources. There are several reports on characterization efforts from different perspectives and detailed characterization data are available for many breeds (see References). Several authors have used principal component analysis (PCA) for body morphological data analysis and compression in many animal studies. The biological relationships among the morphological traits may differ if these body measurements are treated as bivariate rather than multivariate values. The PCA is a multivariate technique which could be used with success when morphological variables are interdependent. The principal component (PC) is a weighted linear combination of correlated variables, explaining maximum variance for variables, therefore, aids in data reduction and breaks multi colinearity which may lead to incorrect inferences. The independent factor scores derived from the multivariate technique of the PCA to estimate body weight (Yakubu and Ayoade, 2009), functional traits (Karacaoren and Kardamideen, 2008), and as a selection criterion for the improvement of body size (Pinto *et al.* 2006).

The PCA was used to reduce the number of independent variables in the prediction of genomic breeding values (Macciotta and Gaspa, 2009). For African breeds, only Yakubu *et al.* (2010) and Okpeku *et al.* (2011) have applied these techniquesand there are no reports on the PCA for body measurements in composite goat comparisons. So, this study was aimed at providing objective breed comparison of goat conformation using principal components. The purpose is also to know if body conformation allows a clustering of breeds according to their origin.

MATERIALS AND METHODS

Eleven goat breeds were evaluated in this study including Zambian Dwarf, Azpi-Gorri, Blanca-Andaluza, Blanca-Celtibérica, Blanca de Rasquera, Catalana, Malagueña, Moncaína, Murciano-Granadina, Negra Serrana and Pyrenean. Zambian Dwarf was the only breed of African origin. The Azpi-Gorri, Malagueña, Moncaína, Murciano-Granadina, Negra Serrana and Pyrenean goats belong to the "Aegagrus" group, while Blanca-Andaluza, Blanca-Celtibérica, Blanca de Rasquera and Catalana belong to the "Prisca" group, according to Aparicio (1960). The following average values were obtained from literature (except for the Zambian Dwarf goat, which was studied by the author in August 2011): head length, thoracic perimeter, cannon perimeter, withers height, thorax depth, bicoastal width, length and width of croup, body length, and weight (Table 1). Only measurements for adult females were been taken into account, but a ratio between body weight for both sexes was considered in order the express the degree of sexual dimorphism ([male body weight / female body weight] × 100), where low values indicated low sexual dimorphism. The data first tested for normality and as the distribution of some traits departed significantly from normality, correlation was analysed with the non-parametric Spearman test. The cluster analysis, another of the primary methods of modern multivariate analysis, was then used. To take into account the covariance structure of the data for the cluster analysis, the Mahalanobis distance was chosen as the distance measure for the most discriminating traits. Clusters were joined based on the average distance between all members in the two groups (unweighted pair-group average).

Similarities between breeds were measured by the correlation of dimension scores (cophenetic correlation). For all analysis, data were analyzied using the multivariate procedure components of PAST® software v. 2.17c (Hammer *et al.* 2001). The PCA was used to identify variables that could adequately describe the morphological characteristics and the number of the PC to be retained was determined using the elbow plot (Johnson and Wichem, 2001).

RESULTS AND DISCUSSION

Linear body measurements are shown in Table 1 and Spearman's correlation coefficients among the various traits are shown in Table 2. The significant ($P<0.01$) correlation among body measurements were all positive, which indicated that an increased body measurement would result in a corresponding increase in the other, thus a global body harmony can be deduced. The association may also be interesting since positive correlations suggest that the traits may be under the same genetic influences.

Table 1 Head length (cm), withers height (cm), body length (cm), thoracic perimeter (cm), thorax depth (cm), bicoastal width (cm), croup width (cm), croup length (cm), cannon perimeter (cm), body weight ratio male to female body (%) and weight (kg). Except for the Zambian Dwarf breed, data was obtained from published literature

Breeds	Head length	Withers height	Body length	Thoracic perimeter	Thorax depth	Bicoastal width	Croup width	Croup length	Cannon perimeter	Body weight	Ratio male / female body weight
Zambian Dwarf	18.9	50.7	56.2	60.0	24.6	11.5	11.4	16.9	7.4	22.0	83.3
Murciano-Granadina	18.6	70.0	68.0	80.0	30.0	18.0	16.1	18.0	8.0	50.0	135.0
Azpi Gorri	24.3	74.5	78.4	85.4	34.2	20.1	16.1	23.2	9.4	50.0	150.0
Blanca Celtibérica	23.4	71.5	75.5	85.4	32.6	19.3	13.8	21.6	8.8	62.5	124.0
Blanca de Rasquera	23.3	71.9	71.0	87.4	33.3	18.3	15.8	20.5	9.4	57.5	117.4
Catalana	28.5	79.9	76.5	88.2	40.2	17.7	15.8	19.6	9.2	56.7	119.8
Malagueña	17.9	65.0	74.0	84.0	32.0	20.0	18.0	20.0	8.0	60.0	116.7
Moncaína	20.0	69.7	69.6	82.1	30.9	18.0	15.0	16.3	8.2	42.5	141.2
Blanca Andaluza	22.7	76.7	81.1	94.7	33.9	19.3	14.9	23.4	9.6	65.0	138.5
Negra Serrana	25.3	76.2	82.4	97.4	34.5	19.8	14.3	22.9	10.3	55.0	154.5
Pyrenean	21.8	70.0	76.0	84.0	32.0	24.0	18.0	23.0	6.0	70.0	121.4

Body weight only correlated with length of croup, and weak relationship existing between body weight and the rest of the body measurements suggested that either or the combination of these morphological traits, could be used to estimate live weight in goats (rather than the use of individual traits). The results of the PCA showed that 10 principal components (PCs**)** explained the total variance in the body conformations (Table 2). The Joliffe cut-off point of 56.57 showed that the first two PCs explained more than 90% of the total variance (Table 3). Each of the eigenvalues for PCs 1 to 5 presented values that were above 5%. Figure 1 shows the scree (“elbow”) plot indicating the cut-off point for the PC2 at the point which the curve flattens out. The traits with heaviest loadings of total variance in the PC1 (75.3%) were the ratio between sexes, body weight and thoracic perimeter, 0.740, 0.368 and 0.362, respectively (Figure 2).

The two highest loadings in the PC2 (Figure 3) were 0.737 and -0.594 for body weight and ratio between sexes, respectively, which accounted for about 18.5% of total variance.

The clustering obtained for the most discriminating traits (ratio between sexes, body weight and thoracic perimeter; Figure 4. Polymorphism between breeds could be phenotypically expressed (mainly) as differences in body weight. The cophenetic correlation coefficient was 0.857.

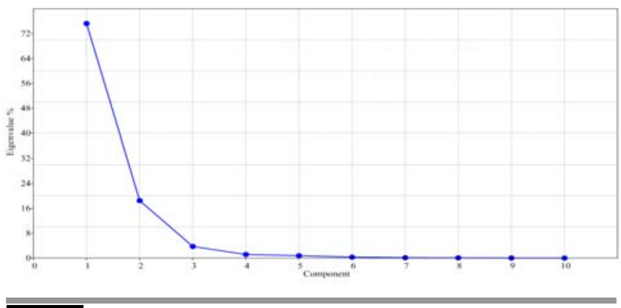

Figure 1 Scree plot for morphological variables of adult’s female goats. Each of the eigenvalues of PCs 1 to 5 had values that were above 5%

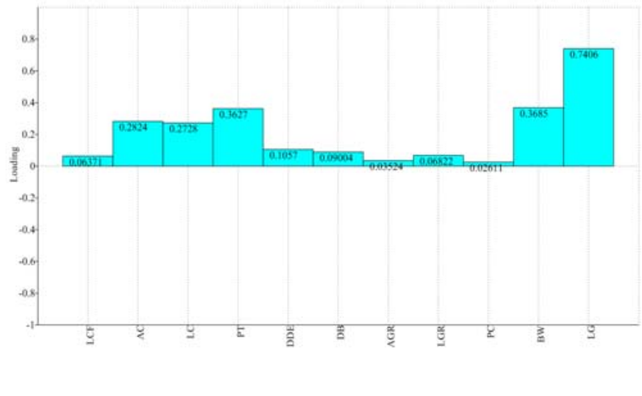

Figure 2 Eigenvectors (factor loadings) of principal component 1. The traits with heaviest loadings (75.3%) in PC1 of total variance are: ratio between sexes (0.740), body weight (0.368) and thoracic perimeter (0.362)

Table 2 Phenotypic correlations among body weight and linear body measurements

	HD	WH	BL	PT	TD	BiW	WC	LC	CP	BW	LGr
HD	-	0.001	0.015	0.005	0.000	0.789	0.422	0.180	0.017	0.719	0.212
WH	0.843	-	0.003	0.000	0.000	0.753	0.799	0.065	0.003	0.349	0.159
BL	0.709	0.797	-	0.001	0.001	0.067	0.947	0.003	0.018	0.145	0.071
PT	0.781	0.890	0.863	-	0.000	0.401	0.651	0.033	0.001	0.159	0.238
TD	0.884	0.916	0.866	0.924	-	0.406	0.979	0.060	0.003	0.353	0.239
BiW	0.091	0.108	0.571	0.282	0.279	-	0.107	0.007	0.752	0.065	0.324
WC	-0.270	-0.087	0.023	-0.154	-0.009	0.513	-	0.677	0.349	0.389	0.799
LC	0.436	0.574	0.809	0.644	0.583	0.758	0.142	-	0.123	0.030	0.235
CP	0.699	0.803	0.694	0.867	0.799	0.108	-0.313	0.493	-	0.841	0.064
BW	0.123	0.313	0.469	0.455	0.311	0.574	0.289	0.651	0.069	-	0.739
LGr	0.409	0.456	0.564	0.388	0.387	0.329	-0.087	0.391	0.575	-0.114	-

HD: head length; WD: withers height; BL: body length; PT: thoracic perimeter; TD: thorax depth; BiW: bicostal width; WC: width of croup; LC: length of croup; CP: cannon perimeter; BW: body weight and LGr: [male body weight / female body weight] × 100.

Table 3 Eigenvalues and the proportion of the total variance for derived components in the adult population of different goat breeds. Cophenetic correlation= 0.857

CP	Eigenvalue	% Variance	% Cumulative variance
1	607.915	75.265	75.265
2	149.368	18.493	93.758
3	30.261	3.747	97.505
4	9.347	1.157	98.662
5	6.303	0.780	99.442
6	2.552	0.316	99.758
7	1.015	0.126	99.884
8	0.703	0.087	99.971
9	0.221	0.027	99.998
10	0.014	0.002	100

Joliffe cut off= 56.57.

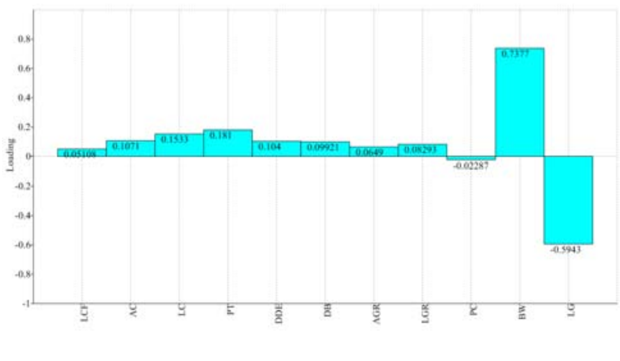

Figure 3 Eigenvectors (factor loadings) of principal component 2. Two highest loadings in PC2 were 0.737 and -0.594 for body weight and ratio between sexes, respectively, and accounted for about 18.5%

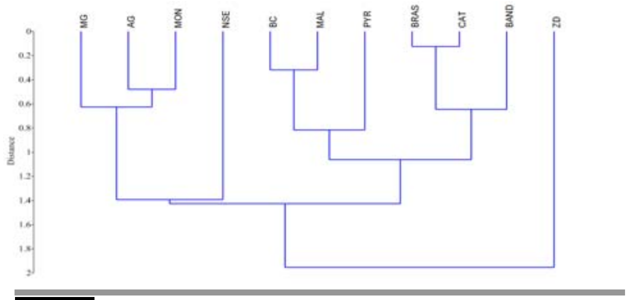

Figure 4 Dendrogram using only the most discriminating characteristics (thoracic perimeter, body weight and [male body weight / female body weight] × 100). Clusters were joined based on the average distance between all members in the two groups (unweighted pair-group average). The MG, AG, MON, NSE, MAL and PYR goats belong to the "Aegagrus" group, while BC, BRAS, CAT and BAND belong to the "Prisca" group. Zambian Dwarf is an African breed

CONCLUSION

This study showed that two first PC accounted for nearly 94 % of the total variation in morphological traits. The PC1 included ratio between sexes, body weight and thoracic perimeter while PC2 included body weight and ratio between sexes. Interestingly, the most discriminating traits were those related to body weight, although in this study, the thoracic perimeter did not appear related to body weight, although both measurements are usually clearly correlated (Mason, 1951; Robinet, 1967; Ngere *et al.* 1979; Moruppa and Ngere, 1986; Ibiwoye and Oyatogun, 1987; Osinowo *et al.* 1989; Islam *et al.* 1991; Slippers *et al.* 2000; Singh and Mishra, 2008). Clustering breeds according to these three traits offered a good picture of the origins of the breeds as cophenetic correlation, a measure of how faithfully a dendrogram preserves the pairwise distances between the original unmodeled data points, was high. So, as data related to mass appear as highly informative even though obtaining body weight could be difficult for goats (as well as for other domestic species), especially when comparing breeds.

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