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Principal component analysis of body measurements of Zobawng bulls: A local hill cattle of Mizoram, India

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Abstract
The different body measurements, which represent the size of the animal is important criteria for selection of animal. Principal component analysis (PCA) transform an original group of variables into another group, principal components, which are a linear combination of original variables. The objective of current study was to provide the information about morphological structures of local bulls "Zobawng" of Mizoram for the purpose of breed characterization using PCA. Twenty different biometric traits (body length, height at wither, heart girth, paunch girth, forehead width, arm length, elbow length, fore-shank length, thigh length, hind shank length, pes length, tail length, switch length, ear length, head length, eye to eye space, circumference of neck, neck length, circumference of horn and space between horns) in 50 bulls of Mizoram local cattle 'Zobawng' were recorded from native tract (*viz.* Champhai and Saiha districts) of Mizoram, India and analyzed by Principal component analysis to explain body conformation. The average of these various traits indicates that local cattle of Mizoram is of smaller type of cattle breed. Factor analysis with promax rotation revealed five factors which explained about 78.37% of the total variation. Factor 1 described the general body conformation and explained 45.56% of total variation. It was represented by significant positive high loading of body length, height at wither, Paunch girth, forehead width, circumference of neck, neck length, arm length, elbow length, fore shank length, thigh length and hind shank length. The communality ranged from 0.633 (high at weather) to 0.963 (elbow length) and unique factors ranged from 0.367 to 0.037 for all the 20 different biometric traits.

Keywords: principal component analysis, Zobawng, local cattle of Mizoram, biometric traits

1. Introduction
The characterization of a breed of livestock is the first approach to a sustainable use of its animal genetic resources. Body dimensions have been used to indicate breed, origin and relationship or shape and size of an individual as they give an idea of body conformation. However, principal component analysis (PCA) is a refinement and can explain relationships between biometric traits in a better way when the recorded traits are correlated. It provides information about the relative importance of each variable in characterizing the individuals. This analysis transforms an original group of variables into another group, principal components, which are linear combination of original variables. A small number of these new variables are usually sufficient to describe the individual without losing too much information. Previous studies reported PCA of body measurement can be used to explain the body conformation of ruminants such as cattle [1-7], buffalo [8, 9], goat [10, 11] and sheep [12]. The indigenous cattle of Mizoram are still considered as non-descript cattle in the country. Therefore, the present study was undertaken to study the different body measurements, relationships among different body measurements and to develop unobservable factors (latent) to define which of these measures best represent body conformation in bulls of local cattle of Manipur. Thus, the study will help in stabilizing these cattle as a breed and to indulge in the conservation strategies.

2. Materials and Methods
2.1 Source of Data
Data consisted of 20 different body measurements on 50 local bulls of Mizoram were collected from their native tract *i.e.* Champhai and Saiha districts of Mizoram, India. All measurements were recorded twice by the same recorder to minimize the error and to avoid

between-recorder effects. The circumference measurements were taken by a measuring tape while the other measures were taken by a mapping stick. The recorded body measurements were body length, height at wither, heart girth, paunch girth, forehead width, arm length, elbow length, fore-shank length, thigh length, hind shank length, pes length, tail length, switch length, ear length, head length, eye to eye space, circumference of neck, neck length, circumference of horn and space between horns.

2.2 Statistical analysis
Mean, standard error and coefficient of variation of body measurements were calculated using SPSS 16.0 software. Data collected were analysed using fixed effect model, by considering the districts effect as fixed so as to adjust the data for significant effect of village if any for further analysis.

2.3 Principal component analyses
The objective of principal component analysis is to account for the maximum portion of the variance present in the original set of variables with a minimum number of composite variables. Promax rotation was used for rotation of principal factors through the transformation of the factors to approximate a simple structure. The Kaiser rule criterion [13] was used to determine the number of factors *i.e.* retaining only the factors that have eigen value greater than one. Kaiser's measure of sampling adequacy (MSA) was used to determine whether the common factor model was appropriate. All the analysis was carried out using the SPSS (2001) statistical package for social science [14].

3. Results and Discussion
3.1 Morphometric traits
The basic descriptive statistical parameters for all the 20 body measurements in Zobawng bulls are presented in Table 1. There was low to moderate coefficient of variation for all the biometrical traits under study. The moderate coefficient of variation were also reported in Pasundan cows and Jabres cow [7, 15]. The morphometric characteristics observed in the present study suggested that indigenous bull of Mizoram are small size cattle, with short and horizontally placed ears, long tail almost similar to local bulls of Manipur [2] and Siri cattle of Sikkim [16].

The average body length, height at withers and chest girth of adult males of local cattle of Tripura were similar to that in adult males of Bachaur cattle [17] and Manipur cattle [2]. They reported the respective average of these body measurements as 117.40±0.40, 118.39±0.51 and 148.58±0.71 cm and 120.36±0.84, 112.55±0.78 and 142.94±1.16 cm, respectively. In Ponwar cattle almost similar heart girth (140.6±0.50 cm), but shorter body length (102.5±0.5 cm) in adult males were reported [18]. Higher estimate of height at wither (134.36=2.03 cm) in male Deoni cattle was reported [19].

Table 1: Mean with standard error of various biometric traits of local bulls of Mizoram

Traits	Measurement	Mean±SE (cm)	Coefficient of variation (%)
Body length	Length between the point of shoulder up to the point of pin bone was measured for both sides and the average was recorded	119.05±1.47	8.73
Height at withers	Distance from the highest point of wither to the ground after allowing the animal to stand	112.49±1.03	6.47
Heart girth	It was measured as circumference of the heart	142.28±1.23	6.11
Paunch girth	Circumference at the pouch region just anterior to the hip joint	149.24±1.36	6.44
Forehead width	Distance between front of both eyes	18.71±0.11	4.16
Arm length	Length between the point of shoulder up to the point of elbow	33.15±0.22	4.69
Elbow length	Length between the knee joint up to the point of elbow	32.78±1.02	22.00
Fore-shank length	Length between the pastern joint up to the knee joint	32.49±0.56	12.19
Thigh length	Length between the hip joint up to the stifle joint	32.79±0.10	2.16
Hind shank length	Length between the pastern joint up to the hock joint	34.69±0.11	2.24
Pes Length	Length between the tarsal joint / hock joint up to the end of distal phalange	33.70±0.43	9.02
Tail length	Length between the root of the tail up to the tip excluding switch at the tip	72.21±0.60	5.88
Switch Length	Length between the tip of the tail up to the end of the switch	27.78±0.37	9.42
Ear length	Distance from the point of attachment of ear to the tip of the ear	17.78±0.11	4.37
Head length	Length from the poll up to the tip of the nostril (Excluding the muzzle) along the nasal bone	41.50±0.10	1.70
Eye to eye space	Distance between the inner canthuses	24.12±0.56	16.42
Neck circumference	Circumference at the middle of the neck	74.93±0.82	7.74
Neck length	Distance from neck attachment to breast	32.75±0.66	14.25
Circumference of horn	Circumference of the horn were recorded at three places viz., at base, middle and tip for two horn separately and the average will be taken	14.09±0.07	3.51
Space between the horns	Space between two horns were measured at three places viz., space between two horns at base, middle and tip	6.33±0.05	5.59

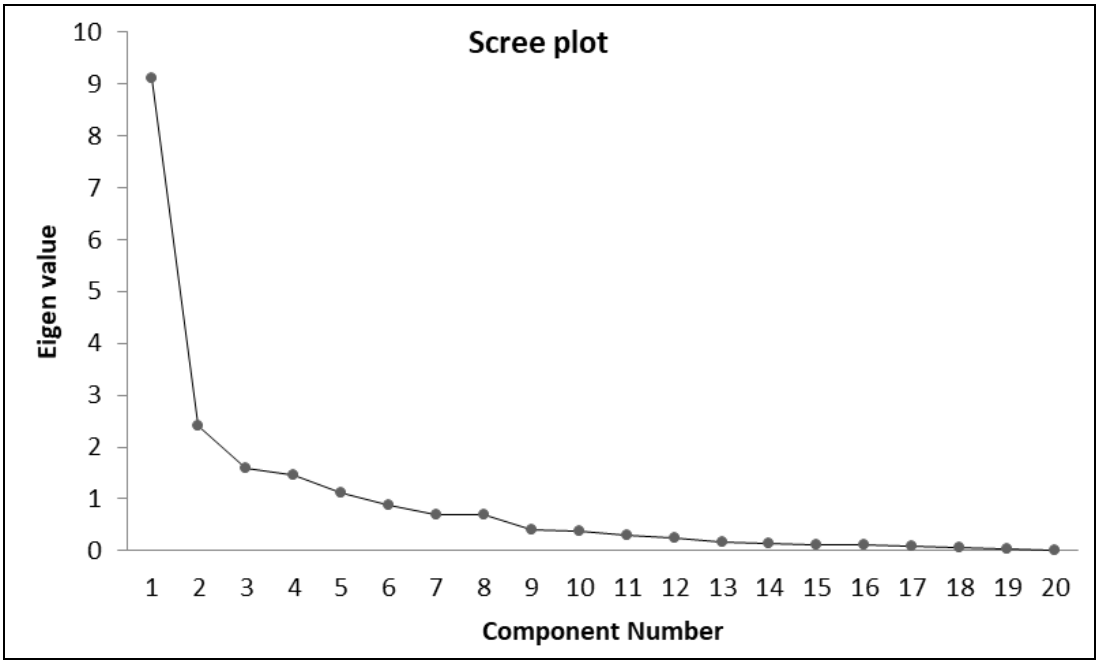

Fig 1: Scree plot showing component number with eigen values

3.2 Factor analysis

The Anti-image correlations computed showed that the partial correlations were low, indicating that true factors existed in the data. This was supported by Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy which was 0.731. However, Manipur bulls exhibited higher estimates of sampling adequacy as 0.609 [2]. The estimate of sampling adequacy Kaiser-Meyer-Olkin (KMO) revealed the proportion of the variance in different biometric traits caused by the underlying factors. The overall significance of the correlations tested with Bertlett's test of Sphericity for the biometric traits (chi-square was 6811, P<0.01) was significant and provided enough support for the validity of the factor analysis of data. Smaller estimate of Bertlett's test of Sphericity (5,182.01) as compared to the present study was reported in Kankrej cows [20].

Table 2: Total variance explained by different factors in bulls of local cattle of Mizoram

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	9.11	45.56	45.56	9.11	45.56	45.56	5.24
2	2.40	11.91	57.54	2.40	11.98	57.55	4.64
3	1.58	7.92	65.47	1.58	7.92	65.47	2.68
4	1.46	7.28	72.75	1.46	7.28	72.75	1.69
5	1.13	5.62	78.37	1.12	5.62	78.37	1.43
6	0.88	4.40	82.77				
7	0.70	3.51	86.28				
8	0.69	3.43	89.71				
9	0.41	2.07	91.78				
10	0.38	1.92	93.71				
11	0.31	1.56	95.26				
12	0.24	1.20	96.46				
13	0.16	0.82	97.29				
14	0.15	0.77	98.06				
15	0.11	0.54	98.60				
16	0.11	0.53	99.14				
17	0.08	0.42	99.56				
18	0.05	0.24	99.80				
19	0.03	0.13	99.93				
20	0.01	0.07	100.00				

The estimated factors loading extracted by factor analysis, eigen values and variation explained by each factor are presented in Table 2. The scree plot is presented in Fig. 1. There were five factors extracted with eigen values greater than 1 and accounted for 78.37% of total variance. In previous study, in bulls of local cattle of Manipur, six factors were extracted with eigen values greater than 1 [2]. However, two factors each explaining 86.47% and 73.36% of the total variation were extracted in White Fulani bulls [21] and Pasundan cows [7], respectively. In Taro cattle, higher value of 91.08% of the total variation with 2 principal components were extracted [6]. In the present study, the first factor accounted for 45.56% of the variation out of the total of 20 original measurements. It was represented by significant positive high loading of body length, height at wither, Paunch girth, forehead width, circumference of neck, neck length,

arm length, elbow length, fore shank length, thigh length and hind shank length (Table 3). This factor seemed to be explaining the body of the bull, *i.e.* general size of the bull.

Table 3: Component matrix of different factors for biometric traits in bulls of local cattle of Mizoram

Traits	Component				
	1	2	3	4	5
Body length	0.83	-0.04	-0.28	0.19	0.01
Height at withers	0.68	0.14	-0.35	0.12	0.11
Heart girth	0.79	0.01	-0.24	0.39	-0.10
Paunch girth	0.79	-0.06	-0.24	0.35	-0.04
Forehead width	0.76	0.13	-0.04	0.11	0.35
Ear length	0.67	-0.06	-0.04	0.27	0.39
Tail length	0.03	0.06	0.63	0.47	0.25
Switch Length	0.09	0.17	0.58	-0.19	0.48
Neck circumference	0.78	-0.06	-0.06	0.35	0.10
Neck length	0.74	-0.12	0.39	-0.01	0.03
Arm length	0.91	-0.18	0.19	-0.19	-0.11
Elbow length	0.88	-0.24	0.21	-0.24	-0.15
Fore-shank length	0.85	-0.20	0.13	-0.29	-0.14
Thigh length	0.83	-0.27	0.17	-0.11	-0.17
Hind shank length	0.81	-0.34	0.14	-0.22	-0.21
Pes Length	0.61	0.43	-0.22	-0.35	0.08
Eye to eye space	0.50	0.66	-0.12	-0.35	0.19
Head length	0.37	0.76	-0.02	-0.24	0.02
Circumference of horn	0.29	0.68	0.20	0.21	-0.36
Space between the horns	0.03	0.60	0.34	0.35	-0.47

In Manipuri bulls, lower first factor accounting for 21.93% of the variation out of the total of 15 original measurements was extracted [2]. It was represented by height at wither, body length, heart girth, paunch girth and ear length. In Kankrej cows, that the first factor explained 38.89% of total variation [20].

The second factor accounted for 11.91% of total variability in bulls. It had comparatively higher loading for eye to eye space, head length, circumference of horn and space between horns. Similarly, in bulls of local cattle of Manipur, the second factor accounted for 12.36% of total variability with comparatively higher loading for horn characteristics [2]. The third factor accounted for 7.92% of total variation with high loading for tail length and switch length. The fourth and fifth factors accounted for 7.28% and 5.62% respectively of total variation with no significant high loading for any trait.

In bulls of local cattle of Manipur, third factor accounted for 10.49% of total variation, containing high loading for neck length and hind leg length. The fourth factor accounted for 9.07% of total variation with high loading of fore leg length and tail length. The fifth factor accounted for 8.24% and of total variation containing high loading for switch length and six factors, 7.67% with no particular variable having high loading [2].

The communality ranged from 0.633 (high at weather) to 0.963 (elbow length) and unique factors ranged from 0.367 to 0.037 for all the 20 different biometric traits. In earlier reports, the communality were ranged from 0.597 (body length) to 0.857 (hind girth) in local bulls of Manipur [2], 0.79 to 0.93) in White Fulani cattle [21] and 0.57 to 0.90 in Pasundan cows [7].

The inter- factor correlations between different factors ranged from -0.004 to 0.658 in bulls. The first factor showed positive correlation with factors 2 (high), 3 (medium) and 5 (low) and negative with 4. In bulls of local cattle of Manipur, narrower range of inter-factor correlations *i.e.* -0.07 to 0.17 was reported [2]. The first factor showed positive correlation with all other factors except the sixth factor.

4. Conclusion

The five extracted factors determine the source of shared variability to explain body conformation in local bulls of Mizoram. The first factor contributes effectively to explain general body conformation in local bulls of Mizoram. The results suggests that principal component analysis (PCA) could be used in breeding programs with a drastic reduction in the number of biometric traits to be recorded to explain the body conformation.

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