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Morphometric Characterization of American Brown Swiss Cows in a Tropical Region of Chiapas, Mexico

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Abstract: In order to characterize morphometrically the breed, under tropical conditions, a study was done in the Frailesca region of Chiapas, Mexico. Five herds of 272 lactating cows, four were selected from the Mexican Association of Brown Swiss Breeders. Each cow was measured for 29 type traits, milk production and body weight. Milk production per lactation was estimated through monthly sampling with a fixed date and adjusted to 305 day. The information was analyzed using a fixed effects model with covariance in the SAS software and Least Square Means (LSM) were estimated. A multivariate Analysis of Principals Components (ACP) was then done to reduce the dimensional spaces of the variables. A Cluster analysis was calculated with the selected subset defining four well-defined morphotypes. A Pearson correlation analysis was done and type traits were related with milk production and body weight. Six type traits accounted for 70% of the total variation. The estimated LSM were: body weight (PC) 519.23±4.0 kg, Heart Girth (HG) 187.3±0.6 cm Withers Height (WH) 137.4±0.3, Abdominal Perimeter (AP) 203.4±0.8 cm, Body Depth (BD) 231.8±0.9 cm and Front Legs Perimeter (FLP) 19.5±0.1. The Pearson correlations coefficient among type traits and milk production were low ($r<0.23$) and significant ($p>0.05$) but the relationship between type traits with body weight were high (0.70, $p<0.01$). The Cluster analysis grouped the cows in three morphotypes with little variation among them. It is concluded that the 6 traits selected though the ACP can be used to define type groups of Brown Swiss cows under Mexican tropical environment.

Key words: Morphometric, Brown Swiss cows, Mexican tropics, multivariate analysis, morphotyze, Mexico

INTRODUCTION

The Mexican Brown Swiss Associations base their genetic programs on the monthly evaluation of milk production and evaluation of type, they propose artificial insemination sires (I.A) as candidates to mate with certain cows to increase milk production and improve type traits in the daughters. Moreover, the evaluation of morphometric traits in a cow population allows to establish a similarity or discrepancy with the ideal breed type (Van Vleck *et al*., 1969) and associates certain traits with the productive life and commercial value of an animal. Premises not easily provable are generally established which indicate that some traits are directly related with a greater milk production, conformation that is more adequate for reproduction or that propitiate a longer productive life (Specht *et al*., 1967) and which are used for selection purposes. During this process of selecting the best females based on phenotypic traits, a positive correlation is often assumed between the external appearance of the animal and the response variable. However, most studies show little correlation between type traits and the productive life in the herd (Norman and van Vleck, 1972b; Specht *et al*.,1967), thus evidencing that milk production is the most important factor in the longevity of a cow (Miller *et al*., 1967).

However, Berger *et al*. (1973) reported that the phenotypic type score was 0.35-2.94 times as important as the production phenotype in determining the length of herd life. The morphometric techniques used to evaluate an animal allow to know the functional state of reproductive organs and so indirectly valuate its physiological state. Nevertheless, the external morphology of the animal can change with age or its

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natural environment, where it grows and produces (Norman and van Vleck, 1972b). This makes it necessary to take them into consideration when doing regional studies and establishing morphotypes.

Erb and Ashworth (1961) found a positive association between size and body weight with a greater milk production also pointing out that bigger cows produce more milk than do smaller cows and that a lower heart girth is associated with a greater production (Sieber *et al*., 1988). However, research by Wilk *et al*. (1963) evidenced the scarce value that an animal's body measurements have on predicting milk production. Age and the lactation stage influence a cow's body structure whose udder development and body size shows minor changes in the first two months of lactation. This too has to be taken into account in type trait evaluations (Norman and van Vleck, 1972b).

When judging dairy cattle, the Purebred Dairy Cattle Association in the U.S.A. classifies the characteristics into 5 categories: frame, dairy character, body capacity, udder, legs and hooves (Stamscchror, 2000). In these are included the following traits: stature, strength, body depth, dairy type, angle and width of rump, rear legs rear and side view, hoof angle, front insert, height, rear width, suspensory ligament and udder depth, teat placement and length. To characterize the structure of a population (Kobrich *et al*., 2003) know their productivity (Caballero, 2001) or estimate technical-economic indicators (Milan *et al*., 2003), it is common to use exploratory multivariate statistical methods which also allow the group into morphotypes. These are essential to define the appropriate genetic management of pure breeds, racial identification and to improve some type traits that can influence their productive life.

The objectives of the present study were: to carry out a morphometric description of the American Brown Swiss breed in the Mexican tropic using a sample of cows in production; to determine the type traits that explain the greater variation percentage in the population of cows and their correlations among themselves and with milk production and body weight and to use the principal components and Cluster analysis to define morphotypes of American Brown Swiss cows in the Mexican tropical region of La Frailesca, Chiapas, Mexico.

MATERIALS AND METHODS

The research took place at the Frailesca region of the state of Chiapas, Mexico, located between 15°33' and 16°32' North latitude and 92°21' and 93°40' West longitude, average annual precipitation and temperature of 1,100 mm and 25°C, rains during summer from May to October, minimum temperature of 18°C and maximum of 27°C. The data collection milk production, body weight and 29 type traits were obtained from 272 cows whose body condition varied from 3.0-3.5, located in five farms registered in the Mexican Association of Brown Swiss Breeders. The type trait measurements were done between 30 and 60 days after calving using a metric tape, zoometrics cane, caliper (vernier) and scale following the judging association's criteria for dairy milk cattle (Hansen and Mudge, 1983; Sieber *et al*., 1988; Vij *et al*., 1990). Milk production was evaluated through monthly sampling with a fixed date and adjusted to 305 days.

The morphometric variables were measured in centimeters and PV and PL in kilograms. The evaluated variables were classified according to frame, dairy character, body capacity legs and hooves udder (Purebred Dairy Cattle Association, 1994) which are shown in Table 1.

Statistical analysis: To evaluate the components of morphometric traits and their relationship with milk production and body weight, the GLM, ACP and CLUSTER procedures of the SAS (2003) were used. A variance analysis of the 29 evaluated morphometric traits was done using a one way fixed effects model with Parity Number (PN) as class variable and PC as covariable. Least square means were estimated and compared using the adjusted Tukey test. A multivariate exploratory analysis of principal components was then done, based on the set of morphometric variables and a subset of six variables was obtained. These variables accounted for 70% of the variation in the type traits evaluated; also estimating the Pearson correlation coefficients among

Table 1: Type traits classification of Brown Swiss cows (Purebred Dairy Cattle Association, 1994)

Variables	Traits
Frame	Stature: Wither Height (WH), Rump Height (RH), Chest Height (CHH)
	Rump: Pelvic Angle (PA), Pelvic Width (PW), Rump Width (RW), Rump Length (RL)
Dairy character	Ribs: Ribs Left Space (RLS)
	Neck. Neck Length (NL), Head Length (HL), Head Width (HW), Ear Length (EL) and Tail Length (TL)
Body capacity	Barrel. Body Depth (BD), Body Length (BL), Heart Girth (HG), Abdominal Perimeter (AP).
	Chest. Chest Width (CHW)
Foot and legs	Legs. Hock Height (HH), Knee Height (KH), Front Legs Length (FLL), Rear Legs Perimeter (RLP), Front Legs Perimeter (FLP)
	Hooves: Hoof Angle (HA)
Udder	Dimension: Udder Depth (UD), Rear Udder Height (RUH), Rear Udder Width (RUW)
	Support: Suspensory Ligament (SL)
	Teats: Teat Length (TL)

the selected traits and these with milk production and body weight. Based on the subset of variables defined by the ACP, a Cluster analysis was done using a k-measurement non-hierarchical grouping method based on the euclidean distance. This gave off three conglomerates which were related with the Brown Swiss cattle typology (Kobrich *et al*., 2003) in the Mexican tropical region of Chiapas.

RESULTS AND DISCUSSION

Morphometric description of the American Brown Swiss breed: The sampling morphometric characterization of 272 American Brown Swiss cows in the tropic is shown in general and by lactation, besides the least square means and standard errors of 29 type traits, live body weight and milk production in the region of Frailesca, Chiapas, Mexico (Table 2). These type traits measurements are important to establish a basis of comparison of this breed in the Mexican tropic against the same breed in different latitudes and knowing the similarities or discrepancies with the breed ideal type and to evidence type traits that could affect their productive life.

In general, the results showed that the studied type traits are very homogeneous among lactations (p>0.05) which allows to assume that the Brown Swiss breed shows well-defined type traits and that environmental conditions affect all herds similarly regardless of handling. Only Milk Production (MP), Body Weight (BW) and 6 morphpometric traits: WH, TL, RH, CHH, HL and NL showed significant differences (p<0.05) among lactations; being those in their first lactation the ones that showed the lowest values. The general type traits represent the standard morphotypes of the breed in this region of the Mexican tropic. The classification by number of lactation proves to be more appropriate given that there was only a single breed, this would not be so if dealing with total herds or characteristics.

Table 2: Least square means±standard errors of milk production, body weight and morphometric traits of American Brown Swiss by lactation

	Mean±EEM	Lactation number (mean±EEM)				
Variables	n = 272	1 n = 45	2 n = 43	3 n = 74	4 n = 110	p>F
Milk Production (MP)	3118.0±53	2857.0±62	3150.0±51	3179.0±56	3300.0±85	0.05
Body Weight (BW)	519.2±40	484.0±11	527.9±11	516.7±70	527.9±60	0.05
Frame						
Wither Height (WH)	137.4±0.3	137.8±0.7	139.2±0.6	137.3±0.5	136.4±0.4	0.05
Rump Height (RH)	138.5±0.3	140.0±0.8	140.0±0.6	137.9±0.5	137.6±0.4	0.05
Chest Height (CHH)	59.8±0.3	60.8±0.7	60.6±0.6	58.8±0.5	59.7±0.4	0.05
Pelvic Angle (PA)	7.6±0.2	7.6±0.6	7.6±0.5	7.4±0.4	7.7±0.3	NS
Pelvic Width(PW)	44.1±0.3	43.1±0.9	43.4±0.7	43.4±0.6	45.1±0.5	NS
Rump Width (RW)	11.4±0.1	11.1±0.3	11.3±0.2	11.4±0.2	11.5±0.1	NS
Rump Length (RL)	50.1±0.2	49.9±0.4	50.1±0.4	50.1±0.3	50.1±0.2	NS
Dairy character						
Ribs Left Space (RLS)	4.1±0.1	4.3±0.2	4.2±0.1	4.2±0.1	3.9±0.1	NS
Neck Length (NL)	43.1±0.3	41.4±0.7	44.1±0.6	43.5±0.5	43.0±0.4	0.001
Head Length (HL)	52.8±0.1	51.6±0.4	53.1±0.3	52.7±0.3	53.0±0.2	0.001
Head Width (HW)	23.7±0.1	23.2±0.4	24.0±0.3	23.5±0.3	23.8±0.2	NS
Ear Length (EL)	23.5±0.1	22.7±0.3	23.7±0.3	23.4±0.2	23.8±0.2	NS
Tail Length (TL)	98.5±0.5	99.9±1.3	98.4±1.1	97.9±0.9	98.6±0.7	NS
Body capacity						
Body Depth (BD)	231.8±0.9	228.9±1.3	231.4±1.0	232.1±0.9	232.8±0.7	NS
Body Length (BL)	214.6±0.7	211.4±1.7	214.2±1.4	214.5±1.2	215.8±0.1	NS
Heart Girth (HG)	187.3±0.6	186.8±0.9	188.1±0.7	187.8±0.6	186.7±0.5	NS
Abdominal Perimeter (AP)	203.4±0.8	199.7±1.4	202.9±1.1	204.4±0.9	204.0±0.8	NS
Chest Width (CHW)	25.0±0.2	24.9±0.6	25.6±0.5	25.3±0.4	24.5±0.4	NS
Feet and legs						
Hock Height (HH)	54.4±0.2	55.1±0.4	54.9±0.3	54.5±0.3	53.9±0.2	NS
Knee Height (KH)	39.9±0.1	40.4±0.4	40.3±0.3	39.6±0.3	39.7±0.2	NS
Front Legs Length (FLL)	76.8±0.2	78.1±0.6	77.4±0.5	76.4±0.4	76.3±0.3	NS
Rear Legs Perimeter (RLP)	22.7±0.1	22.6±0.2	22.7±0.1	22.9±0.1	22.6±0.1	NS
Front Legs Perimeter (FLP)	19.5±0.1	19.7±0.1	19.7±0.1	19.6±0.1	19.3±0.1	NS
Hoof Angle (HA)	42.9±0.2	43.6±0.7	42.8±0.5	43.1±0.4	42.5±0.4	NS
Udder						
Udder Depth (UD)	40.5±0.3	38.7±0.8	40.5±0.7	41.1±0.6	40.6±0.5	NS
Rear Udder Height (RUH)	27.1±0.3	27.5±0.7	27.5±0.6	27.6±0.5	26.5±0.4	NS
Rear Udder Widht (RUW)	10.3±0.1	9.6±0.4	10.3±0.3	10.1±0.2	10.7±0.2	NS
Suspensory Ligament (SL)	27.1±0.3	25.1±0.9	27.9±0.7	27.3±0.6	27.1±0.5	NS
Teat Length (TL)	7.9±0.1	6.7±0.3	8.1±0.2	7.8±0.2	8.3±0.2	0.001*

p>0.05, ** p<0.01, NS: p>0.05. measurement units: BW in kg, HA en degrees and other measurements in cm. Means comparison: Adjusted tukey test. Body weight was used as covariable in the model

Table 3: Least square means and standard errors of morphometric traits from ACP analysis in American Brown Swiss cows in Chiapas, Mexico

Variables	Mean	EEM
Heart Girth (HG)	187.7	0.6
Body Weight (WB)	519.2	4.0
Wither Height (WH)	137.4	0.3
Abdominal Perimeter (AP)	203.6	0.8
Body Depth (AP)	231.8	0.9
Front Legs Perimeter (FLP)	19.5	0.1

Main type variables: Using ACP, an exploratory analysis of the total type traits was done which reduced the group of variables and allowed to select a subset of traits that explained the greater variation proportion (Table 3). Thus, the variables HG, BW, WH, AP, BD and FLP were taken into account given that they explained >70% of the total variation in the type of breed in the study region.

Milk production was adjusted to 305 day, 2x and EM and showed that it did not influence the morphometric measurements, however for judging, this trait could influence the animal type scoring because the animal is growing and has not reached its maximum body development.

The results showed (Table 4) that milk production (PL) presented a low positive correlation with PC ($p<0.003$), HG, AP and BD ($p<0.04$) whose correlation coefficient (r) ranged from 0.16-0.35. Likewise, there were high correlations ($r>0.60$) among BW and WH, HG, AP and BD ($p<0.001$) and among the other morphometric variables.

As a result of the ACP (Table 5), the first three components were selected (M1-M3) that explained >90% of the total variation. Each component included: M1:HG, BW, WH, AP, BD and FLP; M2:KH, SL and HH; M3:PN, RUW and RUH.

It can be seen that M1 contains traits related with the body condition of the cow; M2 with legs and udder and M3 with rear udder. Using this criteria, three homogeneous clusters were obtained (Fig. 1). Here can be seen that in the first cluster, the animals share four variables, adding another variable for the second cluster and in the third cluster all the variables selected in the ACP are used.

In the first principal component, two variables showed differences ($p<0.05$) which suggests a different environmental influence on the size of the animals. Components 2 and 3 show informative variables that indicate homogeneity in the animals' traits.

Graphic distribution of the animals in the factorial plane: Figure 2 shows the relative position of each animal in the factorial plane being the animals that share similar measurements in the center of the plane and outside the circle are those considered outliers or animals that present morphometric parameters that do not correspond to the

Table 4: Pearson correlation coefficients among morphometric traits, milk production and body weight

	MP	BW	WH	HG	AP	BD	FLP
MP	1.00	0.23	0.07	0.16	0.35	0.31	0.06
		(0.003)	(0.385)	(0.040)	(0.001)	(0.001)	(0.4353)
BW		1.00	0.16	0.84	0.80	0.84	0.58
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
WH			1.00	0.70	0.47	0.48	0.48
				(0.001)	(0.001)	(0.001)	(0.001)
HG				1.00	0.79	0.78	0.57
					(0.001)	(0.001)	(0.001)
AP					1.00	0.87	0.40
						(0.001)	(0.001)
BD						1.00	0.38
							(0.001)
FLP							1.00

p>F: Value in parentheses; MP: Milk Production, BW: Body Weight, AP: Abdominal Perimeter, BD: Body Depth, HG: Heart Girth, WH: Wither Height, FLP: Front Legs Perimeter

Table 5: Analysis of principals components of Brown Swiss cows in Chiapas, Mexico

Principal component 1	Cows in lactation	p<F
Heart Girth (HG)	187.3±0.6	NS
Body Weight (BW)	519.2±4	0.05
Wither Height (WH)	137.4±0.3	0.05
Abdominal Perimeter (AP)	203.4±0.8	NS
Body Depth (BD)	231.8±0.9	NS
Front Legs Perimeter (FLP)	19.5±0.1	NS
Explained variation (%)	70%	
Principal component 2		
Knee Height (KH)	39.9±0.1	NS
Suspensory Ligament (SL)	27.1±0.3	NS
Hock Height (HH)	54.4±0.2	NS
Explained variation	10%	
Principal component 3		
Lactation Number (LN)	3.17±0.1	NS
Rear Udder Height (RUH)	10.3±0.1	NS
Udder Depth (UD)	40.5±0.3	NS
Explained variation	10%	NS
Total explained variation (%)	90%	

mean found in the study region. This could probably be because the animals preserve genes from other related breeds with which they are linked or they are animals that show a greater degree of adaptation than the rest of the animals and they reach greater sizes. On the other hand, they could be very small animals, unadapted to the tropical environment or that have suffered pathological problems stunting their development.

Some Mexican Swiss breeders consider type traits as selection purposes, however in this study, the type traits showed low correlations with of milk production suggesting that type traits have only a limited value in selection for important economics traits. Likewise, Rodriguez stated that the measurements of type traits are not enough to determine the animal productivity, however Vij *et al*. (1990) reported high correlations between milk production and some type traits in the same way, Sieber *et al.* (1988) mentioned that bigger cows produce more milk than smaller cows. Aitchison *et al.* (1972) reported correlation coefficient of -0.10 to -0.6 between cow basic form and milk production.

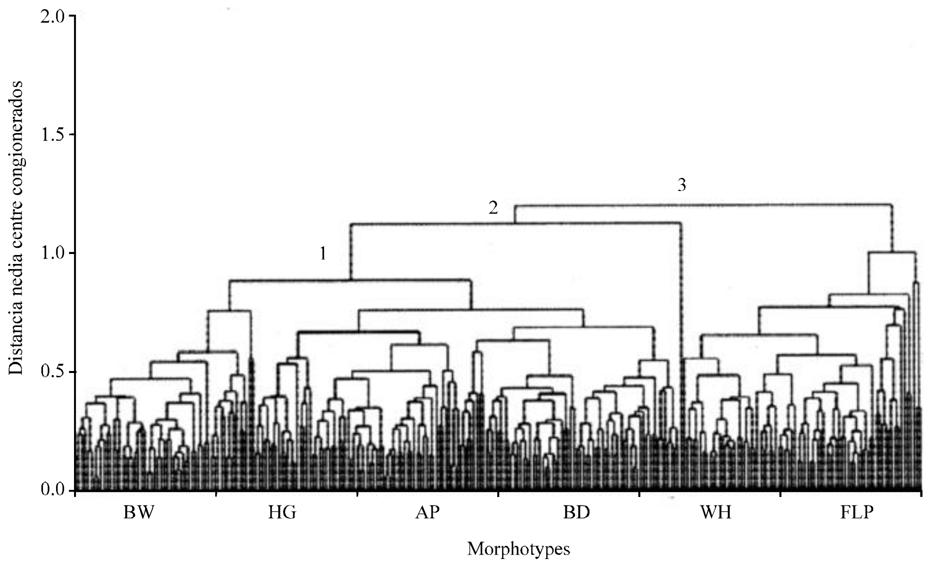

Fig. 1: Population of Brown Swiss Cows dendogram in Chiapas, Mexico

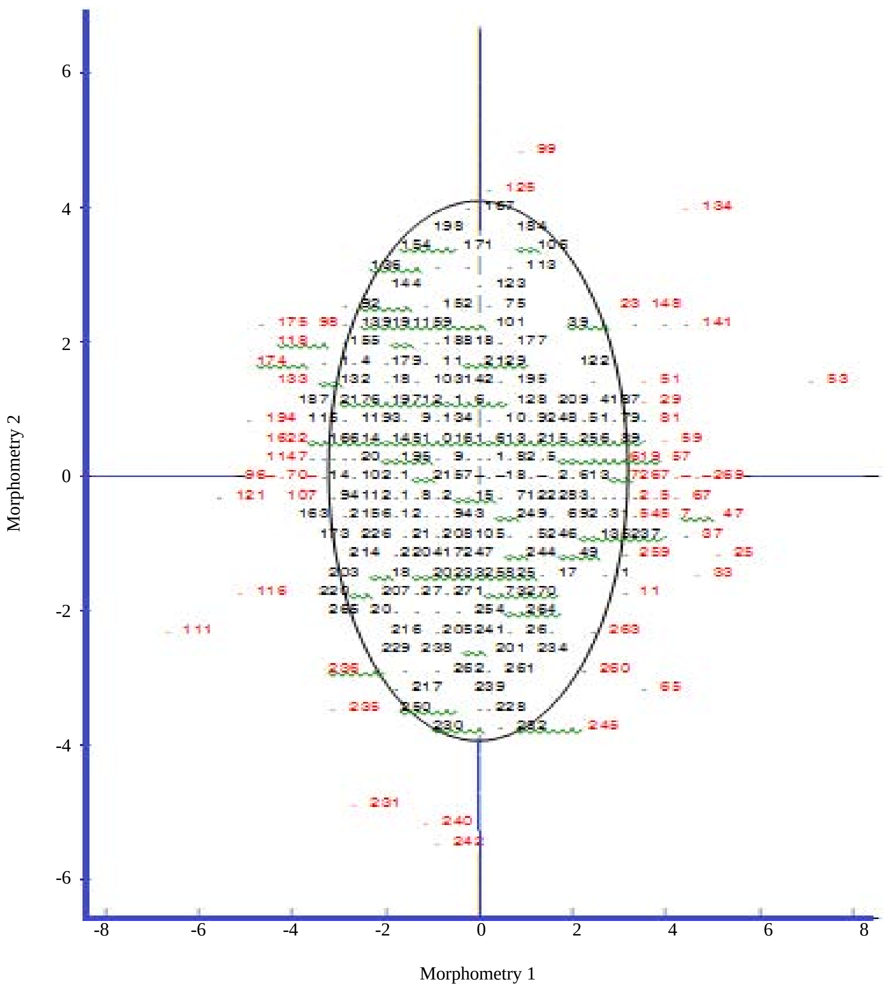

Fig. 2: Representation of the cloud of point individuals

Henao and Mejia found high correlations among live body weight, heart girth, abdominal perimeter and wither height in Brown Swiss cows in Colombia which are similar to the results found in this study. In the same way, Lopez and Alvarado, Fry, Mahecha and Ramirez estimated live body weight from HG measurements, thus showing a high correlation between both traits.

The correlation between HG and WH has also been reported by other researchers in other breeds such as Native Argentinean cattle. This indicates that the morphometry is an ecological indicator that measures the degree of adaptation of the species to its environment.

The traits differences among stage of lactations are related to the different management practices, environmental effects and growing phase, mainly between young and mature cows and requires be considered for judging to prevent overscoring young animals (Norman and van Vleck, 1972a). The multivariate statistical methods were an adequate tool for exploratory analysis and to define morphotypes based in many type traits and the ACP and cluster criteria reduced the overall set from 29-6 traits based on total variation percentage (Kobrich *et al*., 2003).

CONCLUSION

The results showed that the type traits are high correlated but has low correlation with milk production. The cluster analyses showed three clusters or morphotypes with a low degree of variability in their characteristics and can be used to represent the populations of Brown Swiss cow in the Frailesca, Chiapas, likewise these classification criteria can be used as reference to evaluate the Brown Swiss breed under Mexican tropical environmental conditions and considered as a selection approach in a breeding program.

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