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Phenotypic characterization of the goat population of Santa Elena province (Ecuador)

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SUMMARY

It was proposed to typify phenotypically the goats of the Santa Elena province, Ecuador, and to test if there were different phenotypes. 344 animals were sampled in different types of production systems. The following variables were observed: a) morphological: coat color pattern and coat color (CCP, CC); fur and fur characteristics (FUR, CHF); pigmentation of skin, mucous membranes and hooves (SP, PMM, HP); size and arrangement of ears (ES, EO); facial profile (FP); mamellas (M); beard (B); type and orientation of horns (HT, HO); shape of rump (SR); b) morpho-structural: length and width head (HL, HW); face length (FL); ear length (EL); shoulder width (SW); depth and girth chest (CHD, CHG); cannon perimeter (CP); body length (BL); height at withers (HAW); length and width of rump (RL, RW). The multivariate analyzes performed showed 3 groups: 1) small animals; CC: red (35%), pied (33%); PMM: pigmented (43%); B: presence (44%); FP: straight (83%); ES: small (89%); EO: horizontal (47%), erect (42%); HT: arched (68%); SR: slight slope (89%). 2) wider and longer animals; medium height; CC: black (38%), red (35%); FP: straight (55%), slight convex (34%); ES: small (37%), medium (38%); EO: horizontal, erect and pendolous (84%); HT: arched (58%), curved (38%); SR: slight slope (71%). 3) taller animals; greater RL and BW; PMM: pigmented (24%); B: presence (19%); CC: red (41%), black (36%); FP: slight convex (58%), straight (39%); ES: long (51%), pendolous (64%); HT: arched (45%), straight (43%); SR: slight slope (75%). Group 1 corresponded to the oldest biotype of Santa Elena that would represent the Creole phenotype, the other two would be the result of crossings due to introductions of other races coming mainly from Loja (southern Ecuador) and Peru.

Caracterización fenotípica de la población caprina de la provincia de Santa Elena, Ecuador

Palabras clave adicionales

Morfología.
Morfoestructura.
Zoometría.
Biotipos caprinos.
Criollo.

RESUMEN

Se propuso tipificar fenotípicamente a las cabras de la provincia de Santa Elena, Ecuador, y probar si existían diferentes fenotipos. Se muestrearon 344 animales en distintos tipos de sistemas productivos y se observaron las siguientes variables: a) morfológicas: patrón y color de capa (PCA, CCA); pelaje y características del pelaje (PEL, CPEL); pigmentación de piel, mucosas y pezuñas (PPI, PMU, PPE); tamaño y disposición de orejas (TOR, DOR); perfil craneal (PCR); mamelas (MAM); barba (BAR); tipo y orientación de cuernos (TCU, OCU); grupa (GRU); b) morfo-estructurales: longitud y ancho de cabeza (LCB, ACB); largo de cara (LCA); longitud de oreja (LOR); ancho de hombros (AHO); profundidad y perímetro del tórax (PRT, PET); perímetro de caña (PC); longitud del cuerpo (LCR); altura a la cruz (ACR); longitud y ancho de grupa (LGR, AGR). Los análisis multivariados mostraron 3 grupos: 1) animales pequeños; CCA: colorada (35%), variada (33%); PMU (43%); BAR (44%); PCR recto (83%); TOR pequeñas (89%); DOR: horizontal (47%), hacia adelante (42%); TCU arqueados (68%); GRU semiplana (89%). 2) animales más anchos y largos; altura mediana; CCA: negra (38%), colorada (35%); PCR: recto (55%), subconvexo (34%); TOR: pequeñas (37%), medianas (38%); DOR: horizontal, hacia adelante y caídas (84%); TCU: arqueados (58%), curvos (38%); GRU semiplana (71%). 3) animales más altos; mayor LGR y PC; PMU (25%); BAR (19%); CCA: colorada (42%), negra (36%); PCR: subconvexo (58%), recto (39%); TOR: largas (51%), caídas (64%); TCU: arqueados (45%), rectos (43%); GRU semiplana (75%). El Grupo 1 correspondió al biotipo más antiguo de Santa Elena que representaría el fenotipo Criollo, los otros dos, serían el resultado de cruzamientos debidos a introducciones de otras razas procedentes principalmente de Loja (sur de Ecuador) y Perú.

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INTRODUCTION

The implementation of a plan for animal genetic resource (AnGR) conservation and/or genetic improvement requires to have population inventories and phenotypic and genotypic characterizations in advance. The Guide of Phenotypic Characterization of Animal Genetic Resources (FAO, 2012), conducted by experts in the subject of different countries, gives the guidelines for the phenotypic characterization of animals of economic interest. It is defined as the process of identifying populations of different breeds and describing their external characteristics and production in a given environment. The phenotypic expression includes the observable characters in an individual or group of individuals, classified in three categories: morphological, morphostructural and phaneroptic.

Morphological and phaneroptic characters comprise those traits that express the shape, color and external appearance of animals, determined in general by a small number of genes. Morphostructural observations, such as body measurements, may be modified by the environment. However, proportions and indexes obtained from zoometric variables would show independence with respect to the environment, constituting an advantage for the study of the variability within and between groups (Lanari, 2004).

In several goat populations of different countries, the recommendations of the above mentioned Guide for phenotypic characterization were applied, identifying differences among populations from different places (Vargas, 2003, Bedotti et al. 2004, Chacón, 2009, Gómez et al. 2013).

In Ecuador, no phenotypic characterization was carried out on goats, at least until the last report on animal genetic resources was sent to FAO in 2015 (FAO, 2015). At the beginning of this investigation, there was no documented information on the morphological and morpho-structural characteristics of the goat population of the Santa Elena province (SEP), which would allow to recognize possible biotypes for the implementation of conservation and/or improvement plans. Therefore, it was proposed as objective of the present work to phenotypically characterize the goat population of the SEP, by means of the study of phaneroptic, morphological and morpho-structural characters, and to evaluate whether there were different goat phenotypes.

MATERIALS AND METHODS

Santa Elena is a province of the Ecuador Republic, it is located in the Southwest of the Ecuadorian coast. Politically it is divided into three cantons: La Libertad (25.3 km^2), Salinas (68.7 km^2) and Santa Elena (3668.9 km^2). The provincial goat population is concentrated in the Santa Elena canton. This canton has a high rural population and 67 communes registered in the Provincial Agricultural Direction of Santa Elena (MAGAP). The province has three climatic zones: semi-arid tropical mega-thermal zone, dry tropical mega-thermal zone and semi-humid tropical mega-thermal zone (Memoria Técnica IEE y MAG/CGSIN, 2012); the first two are the most representative of the province.

Seven groups of productive systems were identified in the SEP (Solís et al. 2016) and the 50% of the establishments of each group were sampled at random. Eighty-six systems were visited, 48 of them belonging to the semi-arid zone and 38 to the dry zone. In all of them, the adult animals (4 teeth or more) were observed.

The variables measured in each animal were based on the Guide of Phenotypic Characterization of Animal Genetic Resources (FAO, 2012). The following characters were included: a) morpho-structural characters: head length (HL), head width (HW), face length (FL), ear length (EL), shoulder width (SW), chest depth (CHD), chest girth (CHG), cannon perimeter (CP), body length (BL), height at withers (HAW), rump length (RL), rump width (RW); b) morphological characters: coat color pattern (CCP), coat color (CC), facial profile (FP), ear size (ES), ear orientation (EO), horn type (HT), horn orientation (HO), fur (F), characteristic of fur (CHF), mamellas (M), beard (B), skin pigmentation (SP), pigmentation of mucous membranes (PMM), hoof pigmentation (HP), shape of rump (SR), nipple number (NN); c) zoometric indexes (I): body: BI=(BL/CHG)*100, cephalic: CEI=(HW/HL)*100, pelvic: PEI=(RW/RL)*100, proportion: PROI=(BL/HAW)*100, relative chest depth: RCHDI=(CHD/HAW)*100, transverse pelvic: TRPI=(RW/HAW)*100, longitudinal pelvic: LPI=(RL/HAW)*100, metacarpus thoracic: MTI=(CP/CHG)*100, cannon relative thickness: CRI=(CP/HAW)*100, compactness: COI=(BW/HAW)*100.

Significant differences between climatic zones (semi-arid and dry), between sexes and zone*sex interactions were tested by applying: a) MANOVA and ANOVA for morpho-structural variables and zoometric indexes ($p < 0.05$); b) Pearson's χ^2 tests for morphological variables ($p < 0.05$).

With the objective of identifying possible biotypes: a) the number of quantitative variables was reduced through a principal components analysis (PCA), by sex; the number of components was determined by the percentage criterion (Cuadras, 2014), taking into account the value of the cofenetic correlation coefficient. b) With the main components chosen, a cluster analysis (CA) was performed, using the Euclidean distance and the Ward method (Ward, 1963). The number of groups was obtained by cutting to 50% of the maximum distance (Balzarini et al. 2008). c) We tested for which variables there were significant differences between groups, by means of Tukey-Kramer mean comparison tests ($p < 0.05$) for quantitative variables and $\chi 2$ tests ($p < 0.05$) for qualitative ones. d) With those variables that showed differences between the groups, a multiple correspondence analysis (MCA) was carried out with the purpose of visualizing the possible associations of the categories of the variables with the groups.

The statistical analyses were carried out with the professional Infostat program developed by the Faculty of Agricultural Sciences of the National University of Córdoba, Argentina (Di Rienzo et al. 2008).

RESULTS

Sexual dimorphism

The morpho-structural variable averages and the zoometric indexes, with the exception of rump widht, cephalic index, proportion index, relative chest depth index and longitudinal pelvic index, differed between sexes ($p < 0.01$). The estimated frequencies of the morphological variables also differed between sexes ($p < 0.05$), except for coat color pattern, coat color, presence of horns and mamellas, and skin pigmentation. These results showed that the males are heavier, larger, longer and taller, with a longer head and longer ears; presenting convex (28%), straight (33%) and slight-convex (31%) facial profiles; long (54%) and pendolous (59%) ears; with erect orientation (73%); presence of fur (72%), predominantly the raspil (61%); high presence of beard (90%); low pigmentation of mucous membranes (15%) and hooves (28%). In females the predominant facial profile was straight (63%); small (55%), horizontal (34%) and erect ears (29%); horn arched (60%) and upward (48%), twisted (53%); low fur presence (18%); presence of beard (37%); mucous membrane pigmentation (66%) and hooves (55%). In both sexes, predominance of slight slope rump, uniform with stripes coat color pattern, presence of horns, absence of mamellas and skin pigmentation was observed.

Phenotypic differences between climatic zones

Given the differences found between sexes, the averages of the morpho-structural variables and the zoometric indexes of the semi-arid and dry zones were estimated and compared within each sex. The averages of the morpho-structural variables were lower for the semi-arid zone with respect to the dry zone. The averages differed significantly in both sexes ($p < 0.05$) for variables related to the width and height of the animal: head width, chest depth, chest girth, cannon perimeter, height at withers and rump width. The females differed ($p < 0.05$) for coat color pattern, presence of beard, skin pigmentation and mucous membrane pigmentation. In summary, it was observed that in the semi-arid zone the females were smaller, mostly with uniform with stripes coat color pattern (58%), absence of beard (71%) and pigmentation of the skin (79%) and of the mucous membranes (74%). The males were smaller, with slight-convex (41%), straight (29%) and slight-concave (18%) facial profiles, and slight slope rump (82%). And in the dry zone, the females were of bigger size, with uniform (26%), irregular (24%) and uniform with stripes (33%) coat color pattern in similar percentages, with greater presence of beard (45%), pigmentation of the skin (35%) and mucous membranes (42%). The males in this area were larger, with a convex (41%) and straight (36%) facial profile, not finding animals with a slight-concave profile; with little presence of pigmentation in the hooves (86%). Significant areas*sexes interactions for morpho-structural variables and indexes ($p < 0.05$) were mainly explained by the greater expression of sexual dimorphism in the dry zone for the variables: head width, chest depth, chest girth, cannon perimeter and compactness index, and in the body weight, attributable exclusively to the highest averages of the males; while the females were less variable in their morpho-structural, morphological and phaneroptic characteristics with respect to the zones.

Differentiation of biotypes

The PCA performed with the 12 morpho-structural variables showed that the first two main components explained more than 69% and 74% of the variability in females and males, respectively, with the highest values of the cofenetic correlation. In the first component, all the variables presented similar and positive coefficients, that is to say that a greater value of the component corresponded to a larger size of the animal. In the second one, the length of the ears weighed more. With these first two components a CA was performed within sex. Three groups of females and two groups of males were observed, from the cut at the distance of 52.8 and 8.91, respectively. Tables I, II and III show the general averages and the averages per group for which

Table I. Means of the morpho-structural characters per groups for females (Medias de los caracteres morfoestructurales por grupos para hembras).

Groups	n	BW	CC	HL	HW	FL	EL	SW	CHD	CHG	CP	BL	HAW	RL	RW
1	131	40.7^{b}	2.2^{a}	20.1^{b}	11.4^{b}	13.8^{b}	16.1^{b}	13.7^{b}	31.2^{a}	81.3^{a}	9.1^{b}	74.6^{b}	66.2^{b}	19.7^{b}	15.2^{a}
2	104	30.1^{c}	1.9^{b}	18.7^{c}	10.7^{c}	12.9^{c}	14.9^{c}	12.4^{c}	28.2^{b}	73.0^{b}	8.1^{c}	68.4^{c}	62.1^{c}	18.2^{c}	13.5^{b}
3	70	43.5^{a}	2.3^{a}	21.3^{a}	11.7^{a}	15.1^{a}	21.7^{a}	14.0^{a}	31.2^{a}	82.1^{a}	9.4^{a}	76.9^{a}	70.2^{a}	20.8^{a}	15.2^{a}
Means		38.1	2.2	20.5	11.3	13.9	17.6	13.4	30.2	78.8	8.9	73.3	66.2	19.6	14.6

BW: body weight, CC: corporal condition, HL: head lenght, HW: head width, FL: face lenght, EL: ear lenght, SW: shoulder width, CHD: chest depth, CHG: chest girth, CP: cannon perimeter, BL: body lenght, HAW: height at withers, RL: rump lenght, RW: rump width. Within a columnn, different letters indicate significative differences ($p<0.05$).

Table II. Means of the zoometric indexes per groups for females (Medias de los índices zoométricos por grupos de hembras).

Groups	n	BI	CEI	PEI	PROI	RCHDI	TRPI	MTI	LPI	CRI	COI
1	131	91.9^{b}	56.9^{a}	77.2^{a}	112.9^{a}	47.2^{a}	23.0^{a}	11.2^{a}	29.8^{a}	13.7^{a}	61.5^{a}
2	104	93.8^{a}	57.2^{a}	74.4^{b}	110.4^{b}	45.5^{b}	21.8^{b}	11.2^{a}	29.4^{a}	13.4^{ab}	48.5^{b}
3	70	93.7^{a}	55.4^{b}	73.3^{b}	109.5^{b}	44.4^{c}	21.7^{b}	11.2^{a}	29.7^{a}	13.2^{b}	61.7^{a}
Means		93.1	56.5	74.9	110.9	45.7	22.2	11.3	29.6	24.2	57.2

BI: body index, CEI: cephalic index, PEI: pelvic index, PROI: proportion index, RCHDI: relative chest depth index, TRPI: transverse pelvic index, MTI: metacarpus thoracic index, LPI: longitudinal pelvic index, CRI: cannon relative thicknees index, COI: compactness index. Within a columnn, different letters indicate significative differences ($p<0.05$).

Table III. Means of the morpho-structural characters and zoometric indexes per groups for males (Medias para los caracteres morfo estructurales e índices zoométricos por grupos para los machos).

Groups	n	BW	FL	EL	CHD	CP	BL	HAW	RL	BI	COI
1	17	46.6	14.5	16.2	32.9	10.4	75.4	70.7	21.3	87.7	65.8
2	22	59.5	15.9	23.6	35.2	11.3	84.3	75.6	22.7	93.6	78.3
Means		53.1	15.3	19.9	34.1	10.8	79.9	73.2	21.9	90.6	72.1

BW: body weight, FL: face lenght, EL: ear length, CHD: chest depth, CP: cannon perimeter, BL: body lenght, HAW: height at withers, RL: rump lenght, BI: body index, COI: compactness index.

significant differences were found between groups. In females, Group 2 is the one with the least weight and size, and small ears; Group 1 is intermediate and Group 3 is the largest. In males, Group 1 included the animals of smaller weight and size, with shorter ears. Only with those morphological and phaneroptic variables that showed significant differences between groups for each sex ($p < 0.05$), two MCA was performed, which allowed to visualize the location of the variables, groups and zones in the plane of the first two dimensions (**Figures 1 and 2**). The separation of two biotypes can be observed in both sex. In females, a) Biotype 1: composed of the animals of Groups 1 and 2, whose most frequent characteristics are: red coat color, straight facial profile, small ears with horizontal and erect orientation, arched horns, absence of beard and pigmentation in mucous membranes and slight slope rump. The animals of this biotype may be subdivided into two others according to size: small (Group 2) and medium (Group 1) animals. b) Biotype 2: consisting of animals of Group 3, taller, with longer rump, wider cannon perimeter, black coat color, convex and slight-convex facial profile, long ears with pendolous arrangement, curved and arched horns, absence of beard and pigmentation in mucous membranes, fall and slight slope rump. In males, Biotype 1: constituted by the animals of Group 1, smaller, of smaller weight, with straight, slight convex and slight concave facial profile, small and medium ears, with mostly horizontal and erect orientation, and with presence of pigmentation in the mucous membranes. The Biotype 2, included the animals of Group 2, higher and larger, of greater weight, is associated with the dry zone and the convex facial profile, long and pendolous ears, with greater absence of mucous membrane pigmentation, twisted horn type and it is the group with the highest presence of pigmented mucosa. They are animals with greater milk capacity (>BI).

94% of the females of Biotype 1 matched with the "Creole" visual phenotype, and 82% of those of Biotype 2 did it with the "other" phenotype (animals of

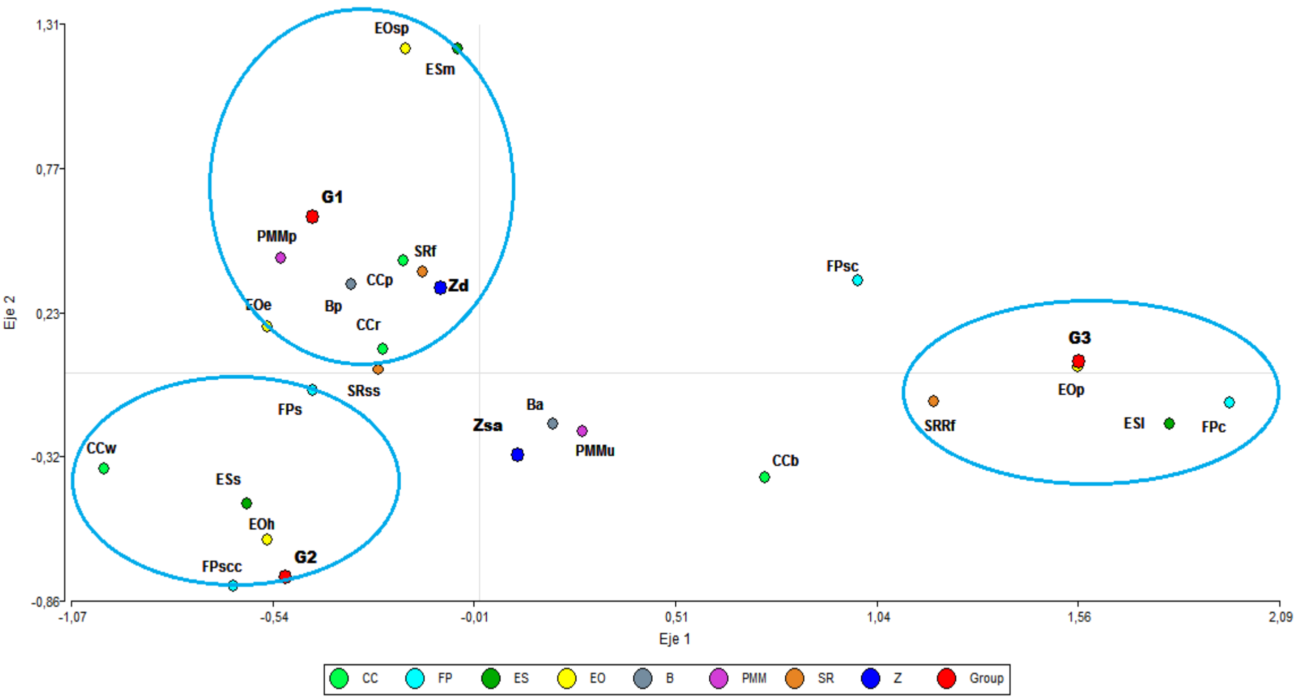

Figure 1. Multiple Correspondence Analysis for females (Análisis de correspondencias múltiples para las hembras) G1: group 1, G2: group 2, G3: group 3, Zd: dry zone, Zsa: semi-arid zone, CCva: varied coat color, CCb: black coat color, CCr: red coat color, CCw: white coat color, FPsc: slight convex facial profile, FP: straight facial profile, FPscc: slight concave facial profile, FPc: convex facial profile, ESm: medium ear size, ESs: small ear size, ESl: long ear size, EOsp: slight pendolous ear orientation, EOh: horizontal ear orientation, EOe: erect ear orientation, EOp: pendolous ear orientation, Bp: presence of beard, Ba: absence of beard, PMMp: pigmented mucous membranes, PMMu: unpigmented mucous membranes, SRss: slight slope rump, SRRf: fall rump, SRf: flat rump.

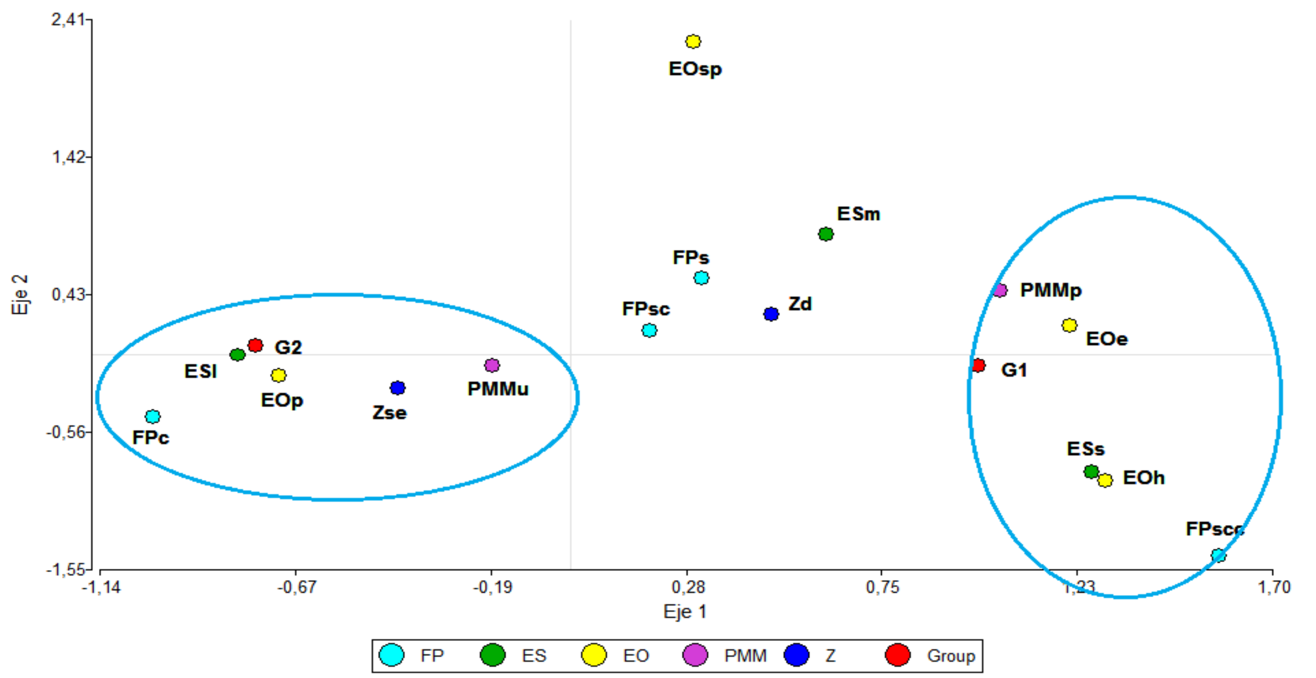

Figure 2. Multiple Correspondence Analysis for males (Análisis de correspondencias múltiples para los machos) G1: group 1, G2: group 2, Zd: dry zone, Zsa: semi-arid zone, FPscc: slight concave facial profile, FP: straight facial profile, FPsc: slight convex facial profile, FPc: convex facial profile, ESs: small ear size, ESm: medium ear size, ESl: long ear size, EOh: horizontal ear orientation, EOp: pendolous ear orientation, EOe: erect ear orientation, EOsp: slight pendolous ear orientation, PMMu: unpigmented mucous membranes, PMMp: pigmented mucous membranes.

other breeds and crossbreeds). Similarly, in the association between visual phenotype and biotypes found for females, 82% of the males characterized with the "Creole" phenotype belonged to Biotype 1, while 86% with the "other" phenotype was included in the Biotype 2. Therefore, in both sexes, there is a correspondence between the visual phenotypes and the groups defined by the multivariate analysis.

Female Biotypes 1 and 2 were equally distributed in both agro-ecological zones. It was noted that 50% of the goats of Biotype 1 and 53% of those of Biotype 2 were located in the semi-arid zone, this agrees with the mentioned fact that the females were less variable with respect to the zones for their morpho-structural, morphological and phaneroptic characters with respect to the zones. A greater presence of animals of Biotype 1 (Creole) was detected in the semi-arid zone (59%) and Biotype 2 (others) in the dry zone (64%), without reaching statistical significance.

DISCUSSION

The SEP goats showed marked sexual dimorphism. Regarding the dimorphism for size, it is known that goats belong to the group of mammals that would show a greater sexual dimorphism for this character (Weckerly, 1998, Polák and Frynta, 2009). According to Rensch's rule (SSD: sexual size dimorphism), the larger species have proportionally a larger body size in males (Polák and Frynta, 2009). Dimorphism at the morphostructural level would allow a better knowledge of the ethnology of the breeds (Hevia and Quiles, 1993).

Since SSD tends to correlate positively with body size, it could be said that smaller species that live in warmer regions, with a shortage of food, could not develop fully and achieve lower SSD (Polák, 2014). In this way, the type of habitat would explain the differences of the SSD. However, the dimorphism found in the SEP goats was evidenced in eleven of the twelve morphostructural variables, such as the Argentine Pampas goats (Bedotti et al. 2004). In Marota breed goats in Brazil, sex differences were found only for height at withers, chest girth and rump length (Almeida, 2007).

At the level of morphological and phaneroptic characters, a high sexual dimorphism was observed in the facial profile, size and orientation of the ears, presence of raspil and short fur, presence of beard, presence of horns, arched type upwards in the females and of the twisted type with lateral orientation in the males. In these last characters a high degree of dimorphism is usually present (Polák and Frynta, 2009).

Facial profile, horns (length and type) and ears (length and orientation) characters allow to differentiate possible breeds or subpopulations (Mason, 1981). Together with the length and orientation of the ears, goats can be classified according to three trunks of origin: European, Asian and African. Thus, a trunk of European origin corresponds to a concave facial profile, ears of small size, thin, erect and moving; those of Asian origin, correspond to a straight profile, ears of medium length and projected horizontally almost perpendicular to the temples, and they turn in their opening down and forward; and the African trunk, show convex profile and wide, long, hanging ears (Alía, 1996).

According to the characteristics mentioned above, the "Creole" goats of Santa Elena would come from the Asian and European trunks, and the "other" biotype has characteristics of the African trunk, possibly due to the introduction of Anglo Nubian animals in the last three decades (Solís et al. 2016).In the Santa Elena goats, the straight facial profile and the arched and twisted horns are features that coincide with the populations of Creole goats from other countries such as Mexico, Argentina, Spain, Ethiopia, Peru (Hernández et al. 2002, Lanari et al. 2003, Bedotti. et al. 2004, Deza 2007, Carné et al. 2007, Luque 2011, Hassen et al. 2012, Gómez et al. 2012). The small, horizontal and forward ears are similar to those found for goats from Ethiopia and Brazil (Hassen et al. 2012, Madella and Quirino, 2012) and different from those found in the Creole goats of Puebla, La Pampa, Córdoba and Apurímac , with medium size and with differences in the orientation of them (Hernández et al. 2002, Bedotti et al. 2004, Deza, 2007, Gómez, 2013). In general, SEP goats have short hair, similar to goats from Peru and Ethiopia (Gómez et al. 2012, Hassen et al. 2012) but with certain fur characteristics such as raspil and short, with a percentage of beard presence equal to those in Spain and Ethiopia (Carné et al. 2007, Hassen et al. 2012), with little pigmentation of skin, mucous membranes and hooves. This differs from what was found for goats from Neuquen, La Pampa and Apurimac goats that mostly have long hair and a high pigmentation in the skin, mucous membranes and hooves (Lanari et al. 2003, Bedotti et al. 2004, Gómez et al. 2012).

When comparing the females of SEP with regard to the morpho-structural variables with those of other countries, the averages for length and width head are similar to those found in the Creole goats of Mexico, Paraíba, Cuba, Formosa, Northwestern Argentina (Hernández et al. al 2002, Hernández et al 2007, Almeida 2007, Chacón et al. 2011, Revidatti et al. 2013, Fernández et al. 2014), they are above those found in Puebla goats (Vargas et al. 2005), but with values lower than the averages found in Creole goats in Argentina, Spain and Peru (Bedotti et al. 2004, Lanari et al. , 2003, Deza, 2007, Carné et al. 2007, Luque, 2011, Gómez, 2013). The body length is within the values observed in the goats of Apurímac, Cuba, Argentine (La Pampa, Neuquén and Formosa), Puebla and Spain (Gómez, 2013, Chacón et al. 2011, Bedotti et al. 2004, Lanari, 2004, Deza, 2007, Vargas et al 2005, Carné et al. 2007, Luque, 2011), with values higher than those found in Creole goats from Mexico, Brazil and Ethiopia (Hernández et al. 2002, Hernández et al. 2007, Almeida, 2007, Okpeku et al. 2011, Hassen et al. 2012, Gatew, 2014, Gebreselassie, 2015) and lower than those found in the goats from Puebla and Northwestern Argentina (Vargas et al. 2005, Fernández et al. 2014). The values for the chest depth are similar to those reported for goats from Mexico, Cuba, Argentina, Peru and Spain (Hernández et al. 2002, Vargas et al. 2005, Hernández et al. 2007, Hernández et al. 2013, Chacón et al. 2011, Deza, 2007, Lanari, 2004, Revidatti et al. 2013, Gómez, 2013, Fernández et al. 2014, Carné et al. 2007, Luque, 2011). The height at the withers and the perimeter of the chest are within the values reported for Argentinian, Cuban and Mexican goats, below those found for Spanish goats, and with values higher than those found in Brazilian , Ethiopian and Nigerian goats (Almeida, 2007; Okpeku et al. 2011; Gebreselassie, 2015).

The head length (HL) of the SEP goats is larger compared to the body, given that the HL is three times the height at the withers, similar to that found in the red Pampas goats (Bedotti et al. 2004). According to the value of the cephalic index (CEI), with values above 50 (Fuentes et al. 2013), SPE goats would be classified as mediocefalas, with predominance of the head length over its width. This differs from what was found in Blanca de Raquera goats in Spain and Northwestern Argentina (Carné et al. 2007, Fernández et al. 2014). For the characters related to the rump (RL and RW), values similar to those reported for the goats of the places mentioned above were found in the SPE (Bedotti et al. 2004, Fernández et al. 2014, Chacón et al. 2011).

The pelvic index value observed allows to classify the SPE goat as convex-line (PEI<100), where the length of the rump predominates over its width, similar to that found in Mexican goats (Fuentes et al. 2013).

The body index (BI) showed that the Creole females according to the Baronian classification are dolicomorphic or longilinear (BI>90) and the Creole males, unlike the females, are classified as mesolinse (BI<88), of greater meatiness (Parés, 2009). It is similar to what was found for the goats of Argentinean Northwest (Fernández et al. 2014). The values of BI<85 (Bedotti et al. 2004, Gómez et al. 2012) were reported in the Apurimeña and the Red Pampeana goats. The "other" biotype, for both females and males, would be classified as longilinear (BI>90).

The index of the relative chest depth (RCHDI) expresses an indirect measure of the length of the limbs (Aparicio, 1974). The values found in the Creole goats of the SEP are greater than those of the "other" biotype. This would suggest that the Creole are animals more detached from the soil, which have acquired a greater adaptation to the search for food, as a result of long walks, which allows them to withstand the heat radiation coming from the ground when the weather is too hot. Similar values were found in the goat from Oaxaca (Mexico) and Cuba (Fuentes et al. 2013, Chacón et al. 2011).

The proportionality index (PROI) of the SCE goats (PROI>95) is lower than that reported for other goat populations such as those of Argentinian Northwest (Fernández et al. 2014). It is a more intuitive measure, which would mark a disposition of the SEP animals towards a double aptitude, with a greater tendency towards meat.

The thoracic metacarpal index (MTI) allows to have an idea of the thinness of the skeleton of the animals and it is related to the productive aptitude of the animal (meat or milk). A lower value would indicate an animal with higher legs and light weight, and an agile and fast animal. A higher index corresponds to animals with resistance and strength adapted to a difficult environment (Sañudo, 2009, Fuentes et al. 2013). The MTI of SEP goats, both for the "creoles" and for the "others" (MTI>11) suggests that they are animals with greater resistance and strength, robust, with outstanding bone supports, adapted to the forages of the environment where they are found (Carné et al. 2007); this is a feature of animals in extensive systems of meatiness (Luque, 2011). However, it could be said that they show a certain tendency to milk production, since the CP is included in the CHG 9 times, very similar to the goats of Northwestern Argentina (Fernández et al. 2014). This is in accordance with the cannon relative thickness index that relates the strength of the extremities with respect to the body mass they hold (Fuentes et al. 2013). It could be said that the SEP goats have robust limbs, which would be the result of long walks in the search for food and that would allow them to support the weight of their body mass. This feature would be very useful if it were to increase their weight in order to increase meat production. It can be classified according to this index as a eumétrica population.

The phenotypic characterization of the SEP goats allowed to differentiate subpopulations or different biotypes, information that is indispensable for any conservation and/or genetic improvement plan that one wishes to undertake. This characterization also makes it possible to compare Santa Elena goats with goat populations from other countries where the phenotypes have been described based on the same FAO recommendations.

CONCLUSION

For the first time the local goats of the SEP have been phenotypically characterized, finding a "Creole" phenotype and a phenotype called "others". It has been shown that there is a "Creole" population with signs of adaptation to the environment given that it has characteristics of rusticity at the morphological, morphostructural and zoometric levels, for which it would be recommended to carry out a conservation process.

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BIBLIOGRAPHY

Alía, R 1996, ´La base animal en el ganado caprino´, En Buxadé Carbó (Coord.) Producción caprina Tomo IX, Ediciones Mundi Prensa, Madrid, pp. 64-84.

Almeida, M 2007, `Caracterização de Caprinos da raça Marota no Brasil`, Areia: Centro de Ciências Agrárias, Universidade Federal da Paraíba.

Aparicio, S 1974, `Exterior de los animales domésticos` Imprenta Moderna, 4ª, Ed. Córdoba, España. pp. 323.

Balzarini, M, Gonzalez, L, Tablada, M, Casanoves, F, Di Rienzo, J & Robledo, C 2008, `Manual del Usuario` Editorial Brujas, Córdoba, Argentina.

Bedotti, D, Castro, A, Rodríguez, M & Peinado, J 2004, `Caracterización morfológica y faneróptica de la cabra colorada pampeana`, Archivos de zootecnia vol. 53, no. 203, pp. 261-271.

Carné, S, Roig, N & Jordana, J 2007, `La cabra Blanca de Rasquera: Caracterización estructural de las explotaciones`, Arch. Zootec. vol. 56 no. 215, pp. 43-54.

Chacón, E, Macedo, F, Velázquez, F, Paiva, S, Pineda, E & McManus, C 2011, `Morphological measurements and body indices for Cuban Creole goats and their crossbreds`, Revista Brasileira de Zootecnia vol. 40, no. 8, pp. 1671-1679.

Cuadras, C 2014, `Nuevos métodos de análisis multivariante` CMC, Editions, Barcelona, España

Deza, M 2007, `Caracterización del caprino criollo del noroeste de Córdoba mediante el uso de caracteres morfoestructurales y polimórficos proteínicos. Su relación con aptitud productiva`, Tesis Magister. Facultad de Ciencias Agropecuarias Universidad de Córdoba, Argentina

Di Rienzo, J, Casanoves F, Balzarini M, González, L, Tablada M & Robledo C 2008, `InfoStat, versión 2008`, Grupo InfoStat, FCA, Universidad Nacional de Córdoba, Argentina.

Organización de las Naciones Unidas para la Alimentación y la Agricultura, FAO, 2007, `Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration`, Rome.

FAO 2011, `Status and trends of animal genetic resources - 2010`. Commission on Genetic Resources for Food and Agriculture, Thirteenth Regular Session. CGRFA-13/11/Inf.17. Rome.

FAO 2012, `Phenotypic characterization of animal genetic resources`, Animal Production and Health Guidelines'. no. 11. Rome.

FAO 2015,`The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture`, Editado por B.D. Scherf y D. Pilling. FAO Commission on Genetic Resources for Food and Agriculture Assessments. Rome.

FAO 2012, Phenotypic characterization of animal genetic resources. FAO Animal Production and Health Guidelaines No. 11 Rome.

FAO 2015, `The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture`, edited by B.D. Scherf & D. Pilling. FAO Commission on Genetic Resources for Food and Agriculture Assessments, Rome (available at http://www.fao.org/3/a-i4787e/index.html).

Fernández, J, Holgado, F, Hernández, M, Solaligue, P, & Salinas, C 2014, `Caracterización morfológica del caprino Criollo del NOA` I: Medidas morfométricas e índices corporales. Trabajo presentado en la Octava Reunión de Producción Vegetal y Sexta de Producción Animal del NOA. San Miguel de Tucumán, pp. 4-6

Fuentes, M, Martínez, J, Alejandre, O, Chirinos, Z & Ricardi C 2013, `Zoometría y distribución de partos de la cabra criolla de los valles centrales de Oaxaca`, Actas Iberoamericanas de Conservación Animal (AICA), vol 3, pp. 150-154.

Gatew, H 2014, `On-farm phenotypic characterization and performance evaluation of Bati, Borena and short eared Somali goat populations of Ethiopia`, Doctoral dissertation, Haramaya University.

Gebreselassie, T & Kebede, K 2015, `Phenotypic characterization of goat type and their husbandry practices in nuer zone of gambella people regional state, South Western Ethiopia`, Doctoral dissertation, Haramaya University.

Gómez, N, Bustinza, R, Revidatti, M, Ferrando, A & Jordana, J 2012, `Caracterización morfológica y faneróptica de la cabra Apurimeña Peruana`, Actas Iberoamericanas de conservación animal vol. 2 pp. 57-60.

Gómez, N 2013, `Caracterización estructural, morfológica y genética de la población de cabras autóctonas de la región Apurímac del Perú`, Tesis doctoral, Universidad Autónoma de Barcelona (UAB), Facultad de Veterinaria, Departamento de Ciencia Animal.

Hassen, H, Baum, M, Rischkowsky, B & Tibbo, M 2012, `Phenotypic characterization of Ethiopian indigenous goat populations`, African Journal of Biotechnology vol. 11n. 73, pp. 13838-13846. doi.org/10.5897/AJB12.2092

Hernández J, Franco F, Herrera M, Rodero E, Sierra A, Bañuelos A & Delgado J 2002, `Estudio de los recursos genéticos de México: características morfológicas y morfoestructurales de los caprinos nativos de Puebla`, Archivos de Zootecnia, vol. 51, pp. 193-194.

Hernández J, Reséndiz R, Vargas S & Robson, J 2007, `Valoración del uso de puntos anatómicos para la agrupación de caprinos ubicados en dos regiones geográficas distintas, en el Estado de Puebla, México. Sitio Argentino de Producción Animal.

Hevia, M & Quiles, A 1993, `Determinación del Dimorfismo Sexual en el Pura Sangre Inglés mediante Medidas Corporales`, Arch. Zootec. vol. 42 pp. 451-456.

IBM Corp. Released 2011, `IBM SPSS Statistics for Windows, Version 20.0` Armonk, NY: IBM Corp.

Lanari, M 2004, `Variación y diferenciación genética y fenotípica de la cabra criolla Neuquina en relación con su sistema rural campesino`, Tesis Doctoral. Facultad de Ciencias Biológicas, Centro Regional Universitario Bariloche. Universidad Nacional del Comahue.

Lanari, M, Taddeo, H, Domingo, E, Pérez, M, & Gallo, L 2003, `Phenotypic differentiation of exterieur traits in local Criollo Goat Population in Patagonia (Argentina)`, Archiv fur Tierzucht vol. 46 no. 4, pp. 347-356

Luque, M 2011, `Caracterización y evaluación de las razas caprinas autóctonas españolas de orientación cárnica`, Tesis Doctoral, Universidad de Córdoba, Departamento de Producción Animal España.

Madella-Oliveira, A & Quirino, C 2012, `Caracterização do rebanho de cabras semisselvagens das montanhas do sul do Espirito Santo, Brasil`, Actas Iberoamericanas de Conservación Animal, vol. 2, pp. 319-322.

Martínez, R, Torres, H & Martínez, H 2013, `Caracterización fenotípica, productiva y reproductiva de la cabra blanca Criolla del "Filo Mayor" de la Sierra Madre del Sur en el estado de Guerrero`, Nova Sscientia vol. 6 no. 11, pp. 25-44.

Mason, I 1981, `Razas Indígenas de ovinos y caprinos de América Latina`, Estudio FAO Producción y Sanidad Animal vol. 22, pp. 132-140.

Okpeku, M, Yakubu, A, Peters, S, Ozoje, M, Ikeobi, C, Adebambo, O & Imumorin, I 2011, `Application of multivariate principal component analysis to morphological characterization of indigenous goats in Southern Nigeria`, Acta Agriculturae Slovenica vol. 98, no. 2, pp. 101.

Parés i Cassanova, P 2009, `Zoometría`, En: Sañudo C., Valoración morfológica de los animales domésticos. Madrid: Ministerio de Medio Ambiente y Medio Rural y Marino, Madrid pp. 167-198.

Polak, J 2014, `Pohlavní dvojtvárnost velikosti a související jevy u kopytníků Sexual size dimorphism and related phenomena in ungulates`. Univerzita Karlova v Praze, Přírodovědecká fakulta Katedra zoologie Charles University in Prague, Faculty of Science Department of Zoology. Summary of the Ph.D. Thesis. Praha

Polak, J & Frynta, D 2009, `Sexual size dimorphism in domestic goats, sheep, and their wild relatives`, Biological Journal of the Linnean Society vol. 98 no. 4, pp. 872-883.

Revidatti, M, De la Rosa, S, JS, C, Orga, A & Tejerina, E 2013, `Propuesta de estándar racial de la cabra criolla del oeste formoseño, Argentina`. AICA vol. 3, pp. 111-122.

Sañudo, C 2009, `Valoración morfológica en el ganado ovino. En: Valoración morfológica de los animales domésticos`, Madrid: Ministerio de Medio Ambiente y Medio Rural y Marino, Madrid pp. 369-385.

Solís, A, Lanari, MR & Oyarzabal, MI 2016, ´Sistemas de producción caprina de la provincia de Santa Elena, Ecuador´ Libro de resúmenes de la I Reunión Transdisciplinaria en Ciencias Agropecuarias. XVII Jornada de Divulgación Técnico-Científicas de la Facultad de Ciencias Veterinarias, UNR. II Jornadas de Ciencia y Tecnología / Néstor Di Leo; Hugo Labria; Ada Seghesso. - 1a ed.- Rosario: Foja Cero, 2016. Libro digital, PDF. pp. 527-528, https://fveter.unr.edu.ar/jornadas/

Solís, A, Lanari, MR & Oyarzabal, MI 2016, `Resultados preliminares de la caracterización fenotípica de la población caprina de la provincia de Santa Elena, Ecuador´, Memorias del XVII Simposio iberoamericano sobre conservación y utilización de recursos zoogenéticos Red CONBIAND – Facultad de Ciencias Veterinarias de la UNNE, Argentina. Pp. 60. Https://conbiand2016argentina.files.wordpress.com/2016/12/memorias-del-xvii-simposio-conbiand.pdf

Vargas, S, Sánchez, M, Rodríguez, J, Hernández, J & Casiano, M 2005, ´La cabra para carne y su respuesta a la mejora del manejo`, Arch. Zootec. vol. 54, pp. 529-534

Vargas, S 2005, Análisis y desarrollo del sistema de Producción agrosilvopastoril caprino para carne en condiciones de subsistencia de puebla, México. Tesis doctoral. Universidad de Córdoba. Facultad de Veterinaria. Córdoba, España.

Ward, J 1963, `Hierarchical Grouping to Optimize an Objective Function`, Journal of the American Statistical Association, vol. 58, pp. 236-244

Weckerly, F 1998, `Sexual-size dimorphism: influence of mass and mating systems in the most dimorphic mammals`. Journal of Mammalogy vol. 79 no. 1, pp. 33-52.