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Morphometric and Phaneroptic Characteristics of Goat Livestock Guardian Dogs in Southern Ecuador

Lenin Aguirre [1], *, Karen Conde [1], Galo Perez [1], Melania Uchuari [1], Darwin Armijos [1] and Manuel Quezada [1]

[1]   Veterinary Medicine and Zootechnics School, National University of Loja, 110110, Loja, Ecuador.
*   Correspondence: edgar.aguirre@unl.edu.ec

Abstract: In southern Ecuador, 73% of the country's goats are raised under extensive production systems, which exposes them to various threats, particularly attacks by predators such as pumas and feral dogs. As a result, farmers have adopted strategies to protect their livestock, including the use of a specific type of guardian dog of creole origin, locally known as the "Ganacho dog." The objective of this study was to determine the morphometric and phaneroptic characteristics of these livestock guardian dogs. A sample of 60 adult males and females was obtained through field visits across the entire ecosystem. Data were collected on 23 morphometric measurements and 10 phaneroptic traits. The results indicate that the Ganacho dog is a medium-sized breed (47.7 ± 5.2 cm in height and 57.1 ± 5.9 cm in body length), ellipometric in body structure, with an average live weight of 18.6 ± 5.1 kg. The breed exhibits excellent thoracic development (thoracic depth: 21.7 ± 2.6 cm; thoracic circumference: 61.7 ± 5.5 cm; chest width: 13.4 ± 2.4 cm) and a dolichocephalic head type. Sexual dimorphism was observed in favor of males ($p < 0.05$) in terms of thoracic circumference and posterior wrist width. Phaneroptically, these dogs possess short, straight hair lying close to the body. Coat color varied: light brown (32%), black (8%), mixed patterns such as wolfish, tabby, or roan (42%), and spotted (15%). Most animals displayed a calm temperament (70%), a curvilinear fronto-nasal profile with a prominent stop, and pigmented labial mucosa (95%) and nose (truffle) (93%). The majority had brown eyes and exhibited polydactyly (60%), particularly in the forelimbs. Nails were predominantly mixed and pigmented (57%). The ears were typically semi-erect to drooping (92%), and dentition included a pincer bite (57%) and a scissor bite (43%). This study provides a preliminary standard for the Ganacho dog, offering a basis for selection and genetic improvement efforts.

Keywords: Livestock guardian dogs; zoometric characterization; local genetic resource; creole dog; Ganacho dog; dog breed standard

1. Introduction

The domestic dog (Canis lupus familiaris), as known today, was the first mammal to be domesticated by humans, approximately 15,000 years ago in Southeast Asia [1, 2]. Over time, dogs have been selectively bred to support humans in various roles, including livestock herding, livestock guarding, hunting, and companionship. As a result, they are present in virtually every human-inhabited environment and even in remote areas as feral populations.

Temple et al. [3] emphasized that livestock guardian dogs should not be confused with herding dogs. Although both are classified as working dogs, their functions differ significantly. Herding dogs are trained to move livestock from one location to another, typically in response to specific and well-learned commands. In contrast, livestock guardian dogs do not necessarily respond to human commands; instead, they possess an inherent instinct to protect their flock. According to Rigg [4], livestock guardian dogs have been used for at least 6,000 years, originating in Europe and Asia and now employed globally as a non-lethal method to prevent livestock losses due to predation by carnivores and

bears [5]. Livestock guardian dogs play a crucial role in the management of extensive small ruminant production systems. However, to the best of our knowledge, their use in this context is gradually declining, despite their continued importance. The dogs employed for this purpose are typically selected from local breeds, as these animals demonstrate appropriate protective behaviors and are raised in close association with the livestock flock to foster a strong bond [6, 7]. According to Novaro et al. [8], approximately 40 dog breeds are currently used worldwide for livestock guarding.

Goat farming is one of the most important economic activities in the seasonal dry forest ecosystem of southern Ecuador. This system is characterized by open grazing, whereby goats are released from their pens in the morning to forage freely in the forest and return to their shelters in the afternoon. The dog known locally as the "Ganacho" is a creole breed that accompanies and guards the goats during this daily routine. It is noteworthy that, according to Dunner and Cañon [1], the canine species exhibits some of the greatest morphological, physiological, and behavioral diversity among mammals.

The objective of the study was to obtain morpho-phenotypic and ethological information on the Ganacho dog population in order to identify similarities and differences with other dog breeds. Such knowledge can guide livestock keepers in making informed decisions regarding the management of their canine companions within livestock production systems. Moreover, this information will contribute to distinguishing the Ganacho dog from other guardian breeds and support the establishment of a breed standard. This, in turn, will aid in the development of programs for the selection, conservation, and multiplication of this valuable genetic resource, thereby contributing to the maintenance of ecological balance and genetic biodiversity in the region.

2. Materials and Methods

2.1. Study Area

This research was conducted across the seasonal dry forest ecosystem in the southern region of Ecuador, specifically in the province of Loja (4°3′ S, 79°39′ W). According to Aguirre et al. [9], Loja covers a range of altitudinal zones, from 100 meters above sea level (m.a.s.l.) in Zapotillo to 1,200 m.a.s.l. in the areas of Gonzanamá, Calvas, and Paltas. The region is characterized by a warm and dry climate, with an average temperature of 24.9 °C and annual precipitation ranging between 400 and 600 mm. Rainfall typically occurs over a period of three to four months, from January to April (Figure 1).
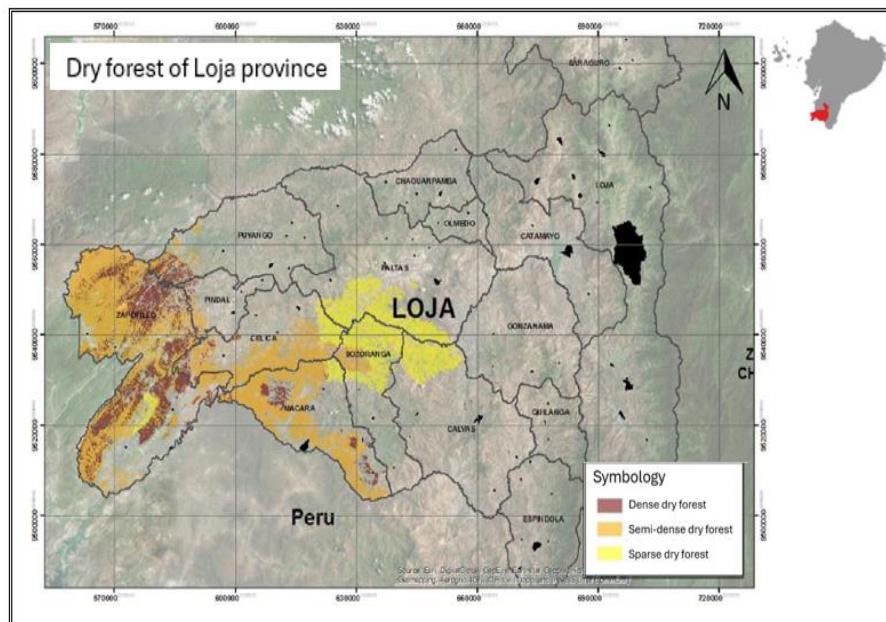

Figure 1. Location of the study area in the province of Loja, southern Ecuador. Source: Research project 015-DI-FARNR-UNL-2023

2.2. Sample Size and Analyzed Variables

The study included a sample of 60 adult dogs (22 females and 38 males). A total of 23 morphometric measurements were recorded: withers height (WH), hip height (HH), dorsal-sternal height (DSH), head length (HL), skull length (SL), face length (FL), jaw length (JL), ear length (EL), hip length (HiL), tail length (TL), body length (BL), head width (HW), face width (FW), snout width (SW), ear width (EW), chest width (CW), anterior hip width (AHW), posterior hip width (PHW), anterior wrist perimeter (AWP), posterior wrist perimeter (PWP), thoracic perimeter (TP), abdominal perimeter (AP), and testicular perimeter (TeP). Body weight (BW) was also recorded.

In addition, 12 phenotypic traits were assessed: coat color, skin color, eye color, nail pigmentation, nose pigmentation, lip and gum pigmentation, presence of polydactyly, ear shape, temperament, bite type, and coat texture. All variables were recorded for both sexes.

2.3. Data Collection

Once the locations and owners of the dogs were identified, and with their consent and assistance, the animals were restrained and muzzled to ensure safety. A harness was then placed on each dog, and body weight was measured using a hanging scale (CAMRY®, 100 kg capacity, 0.3 kg precision). Morphometric data were collected using a measuring tape, caliper, and vernier caliper, with all measurements taken by the same person to maintain consistency. Each of the phaneroptic traits was observed and documented, and this was further reinforced by taking photographs to support the identification of each individual in the technical data sheet.

2.5. Statistical Analysis

The analysis of each morphometric and phenotypic characteristic was performed using the SPSS statistical software, version 26. Descriptive statistics were first applied, followed by an analysis of variance (ANOVA). To further evaluate statistically significant differences based on sex, the Kruskal–Wallis test for independent samples was employed.

3. Results

3.1. Morphometric Characteristics

The morphometric characteristics of the Ganacho dog, specifically its longitudinal and width dimensions, are presented in Tables 1 and 2. The findings indicate that this breed exhibits a body structure where length predominates over width. The Ganacho dog possesses a dolichocephalic head, with a head length (HL) of 21 cm and a head width (HW) of 9.6 cm. The snout width (SW) measures 5 cm, emphasizing its long and robust jaw, which averages 15.7 cm in length. The ears are moderately long, measuring 11.1 cm in length and 6.9 cm in width, and are predominantly semi-erect and drooping in 92% of the individuals assessed.

Table 1. Longitudinal morphometric characteristics of the Ganacho dog (cm).

Items	Body characteristics [1]							
	HL	**SL**	**FL**	**JL**	**EL**	**HpL**	**TL**	**BL**
Sex								
Male	21.4	11.6	9.8	15.8	11.1	14,3	32.6	56.8
Female	20.6	11	9.5	15.6	11	14,4	33.6	57.4
General	21	11.4	9.7	15.7	11.1	14,3	33	57.1
SD [2]	3.2	2.3	1.4	3.1	1.8	2,4	10	5.9
CV [3]	0.15	0.20	0.14	0.2	0.16	0,16	0.3	0.1

[1] HL – Head length; SL – Skull length; FL – Face length; JL – Jaw length; EL – Ear length; HpL – Hip length; TL – Tail length; BL – Body length. [2] Standard deviation. [3] Coefficient of variation.

The Ganacho dog exhibits a relatively short hip length (HpL: 14.3 cm), with the anterior part being narrower (9.6 cm) than the posterior part (11.8 cm), resulting in a body shape resembling a parallelepiped. The breed has a long tail (TL: 33 cm); however, approximately 7% of the population is born with a naturally short tail (anuro characteristic), not exceeding 15 cm in length and locally referred to as "jotos." The chest width (CW) averages 13.4 cm, with females showing slightly greater chest width than males (13.7 cm and 13.2 cm, respectively). In terms of body length (BL: 57.1 cm), the Ganacho dog is classified as mesoline, with females being marginally longer (57.4 cm) than males (56.8 cm), potentially attributable to their broader hips.

Table 2. Width-related morphometric characteristics of the Ganacho dog (cm).

Items	Body characteristics [1]						
	HW	FW	SW	CW	EW	aHW	pHW
Sex							
Male	10	7.9	5	13.2	6.9	9.8	11.7
Female	9.2	7.9	5.1	13.7	6.8	9.5	11.8
General	9.6	7.9	5	13.4	6.9	9.6	11.8
SD [2]	1.6	1.9	0.95	2.4	1.1	1.7	2
CV [3]	0.17	0.24	0.19	0.18	0.16	0.18	0.17

[1] HW – Head width; FW – Face width; SW – Snout width; CW – Chest width; EW – Ear width; aHW – Anterior hip width; pHW – Posterior hip width. [2] Standard deviation. [3] Coefficient of variation.

The morphometric data related to height and body perimeters are presented in Table 3. The Ganacho dog can be classified as a medium-sized breed, characterized by a straight dorsal line and good limb conformation (aplombs). This is supported by the measurements of withers height (WH: 47.7 cm) and hip height (HH: 47.6 cm), indicating balanced proportions. The breed also demonstrates considerable thoracic depth, with a dorsal-sternal length (DSL) of 21.7 cm, accounting for 45.5% of the withers height. The thoracic perimeter (TP) averages 61.7 cm, with a statistically significant difference ($p = 0.02$) observed in favor of males.

As livestock herding dogs, Ganacho dogs are highly physically active, which contributes to their lightweight build and relatively low body weight (BW: 18.6 kg). Males tend to be slightly heavier (19.3 kg) than females (17.4 kg). They exhibit reduced abdominal capacity (AP: 52.4 cm) and possess slender limbs, as indicated in the anterior (aWP: 10.6 cm) and posterior wrist perimeters (pWP: 9.1 cm). A statistically significant sexual dimorphism was observed in the posterior wrist perimeter ($p = 0.013$), favoring males. Additionally, adult males have a testicular perimeter (TeP) averaging 14 cm.

Table 3. Morphometric characteristics related to height, body perimeters (cm), and body weight (kg) of the Ganacho dog.

Items	Body characteristics [1]								
	WH	HH	DSL	TP	AP	aWP	pWP	TeP	BW
Sex									
Male	48.3	48.1	21.9	62.9[a]	53.1	10.3	9.4[a]	14	19.3
Female	46.8	46.9	21.4	59.5[b]	51.3	11.1	8.7[b]	--	17.4
General	47.7	47.6	21.7	61.7	52.4	10.6	9.1	14	18.6
SD [2]	5.2	6.1	2.6	5.5	6.5	3.9	0.9	1.6	5.1
CV [3]	0.11	0.13	0.12	0.09	0.12	0.37	0.11	0.11	0.27

[a-b] Different superscripts in the same column indicate a significant difference ($p < 0.05$).
[1] WH – Withers height; HH – Hip height; DSL – Dorsal-sternal length; TP – Thoracic perimeter; AP – Abdominal perimeter; aWP – Anterior wrist perimeter; pWP – Posterior wrist perimeter; TeP – Testicular perimeter; BW – Body weight. [2] Standard deviation. [3] Coefficient of variation.

An analysis of the coefficient of variation (CV) for body weight (BW) and the 23 morphometric traits assessed in this study revealed that all values remained below 0.37, indicating a relatively uniform breed pattern within the population (Figure 2). This uniformity was consistent across both sexes.Notably, significant sexual dimorphism was observed in the thoracic perimeter (TP) and posterior wrist perimeter (pWP), with males exhibiting higher values in both traits.


HL: 21 cm
JL: 15,7
EL: 11,1
HpL: 14,3
BL: 57,1
TL: 33
WH: 47,7
HH: 47,6
DSL: 21,7
aWP:10,6
pWP: 9,1
TP: 61,7
CW: 13,4
HW:9,6
aHW: 9,6
AP: 52,4
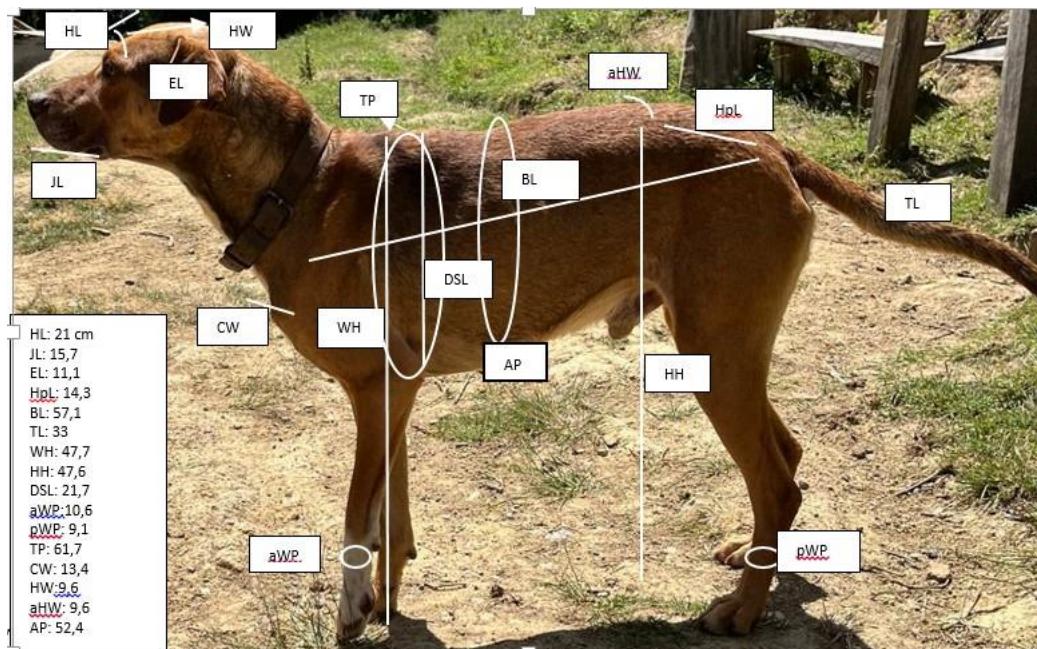
Figure 2. Breed standard of the Ganacho dog.

3.2. Phaneroptic Traits

Regarding the phaneroptic traits of the Ganacho dog, as illustrated in Figure 3, the breed exhibits a concave facial profile with a well-defined naso-frontal groove (stop). The coat is short, straight, and closely adherent to the body. Coat color varies, with light brown being the most common (32%), followed by black (8%), intermingled patterns (42%) such as wolf-like, brindled, or grayish, and spotted coats (15%). Approximately 70% of the dogs display a calm temperament. The iris is typically brown, and the majority of individuals show pigmentation of the lip mucosa (95%) and nose (93%). Pigmentation of the gums (67%) and nails (57%) ranges from mixed to fully pigmented. In terms of dentition, 57% of the dogs present a scissor bite, while the remaining 43% exhibit a pincer bite.

(a)   (b)

<div align="center">(c)   (d)</div>
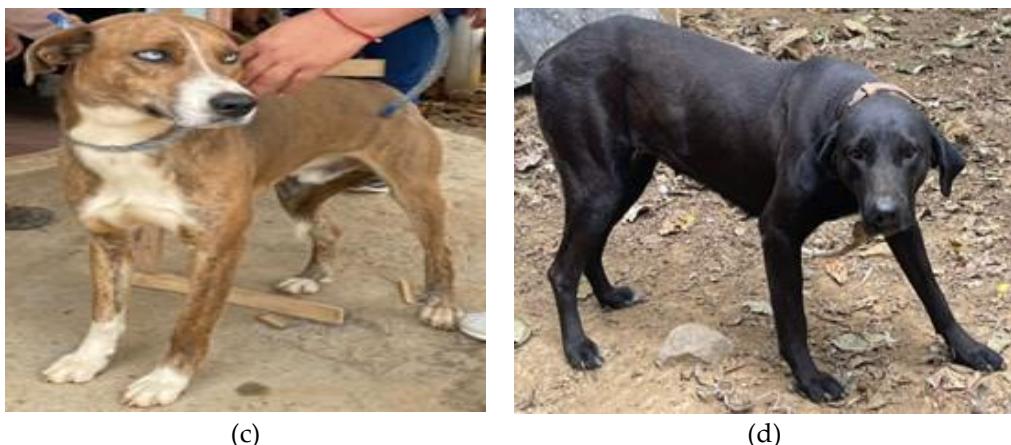
Figure 3. Coat characteristics and predominant color patterns of Ganacho dogs: (a) intermingled coat, (b) light brown, (c) spotted coat, and (d) black mantle.

4. Discussion

According to Méndez and Castellví [10], dogs that work with livestock become a "productive and economic species." In this context, the Ganacho dog, based on its racial characterization, should be included in this category. Similar to the "cabrero" dog of the Argentine Gran Chaco region [11], the Ganacho dog fulfills a dual role: herding and guarding livestock. It not only guides goats during grazing but also provides protection during the night by guarding the animals in the corral against intruders and predators.

The Ganacho dog is a medium-sized breed, a characteristic that, according to Novaro et al. [8] and Márquez et al. [11], offers a practical advantage for livestock keepers with limited economic resources, as the cost of acquiring and maintaining large dogs can be prohibitive. Additionally, Medrano [12] highlights that, under the ecological conditions of the dry forest, medium-sized dogs are better suited for fieldwork, as they can move more efficiently without being hindered by the dense and thorny vegetation typical of this ecosystem. In a similar context, indigenous Navajo communities in the United States have successfully employed mixed-breed, intermediate-sized dogs for herding and guarding functions [13]. This contrasts with observations by Coppinger and Coppinger [14] and Welker et al. [15] in the Adriatic region of Croatia, where large-sized guardian dogs are preferred. In that region, the demands of transhumance—such as endurance during cold weather, long distances, and periods of fasting—favor larger breeds adapted to those specific challenges.

Costa et al. [16] note that the breeds introduced to the American continent by the Spanish conquerors in the 15th century included the Spanish Galgo and the Spanish Mastiff. The Spanish Galgo of that era was described as a dolichomorphic dog, characterized by a medium-sized skull, a fine and elongated muzzle, upright or semi-folded ears, strong yet lean limbs, a nearly horizontal dorsal line, and a medium-length tail that was more slender than thick. It was known for its agility and quick prey response, had a short coat, and exhibited varied coat colors such as bay, reddish brindled, grayish, or black. This historical description closely aligns with the morpho-phaneroptic traits observed in the Ganacho dog, which features a dolichocephalic head, a concave frontonasal profile, an elongated body, strong and slender limbs, a dorsolumbar line parallel to the ground (with withers and hips at similar height), and a short coat predominantly bay brown mixed with black. In this context, the morphometric characterization of the Cimarrón dog of Uruguay by Fernández and Barba [17], and Fernández and Mernies [18], describes the breed as more closely resembling the Spanish Mastiff.

The Ganacho dog generally exhibits a calm temperament but displays territorial aggression, a trait similar to that reported by Damián et al. [19] in the Cimarrón dog of Uruguay, where females were found to be more aggressive than males. This behavior typically manifests through growling, barking, showing of teeth, piloerection along the back, and erect ear posture.

Within the Ganacho dog population, two heritable traits are particularly notable: polydactyly (presence of dewclaws), observed in 60% of individuals, and the anuran trait (absence of tail), present in 7% of the population. Both characteristics are considered desirable by local dog fanciers, who believe they enhance the dog's aggressiveness and obedience—although such claims lack scientific validation.

5. Conclusions

In conclusion, The Ganacho dog represents a productive and functional breed, characterized as elipometric, lightweight, and of medium height, with a notably large thoracic capacity, a dolichocephalic head, and a strong bite. It exhibits a well-defined and homogeneous racial pattern, with minimal sexual dimorphism. The breed is further distinguished by its calm and obedient temperament, short and straight coat that lies close to the body, and a predominant coat color that is either solid brown or mixed with black. These findings contribute valuable information to the morphological and functional characterization of the Ganacho dog and may support future initiatives aimed at its recognition, sustainable use, and promotion as a local genetic resource.

References

1.   Dunner, S.; Cañón, J. Cani Feli Origen y diversidad de la especie canina. *Canis et Felis* **2014**, *130*, 18–26. [Google Scholar]
2.   Global Invasive Species Database (GISD). *Canis lupus*; IUCN: **2024**. [Online link] (accessed 2024).
3.   Temple, D.; Lampreave, G.; Mauriès, M.; Amat, M.; Manteca, X. El perro de protección de rebaños: el mejor amigo de la ganadería de montaña; *Farm Animal Welfare Education Centre*: **2020**. [Online link]
4.   Rigg, R. *Livestock Guarding Dogs: Their Current Use World Wide*; IUCN/SSC Canid Specialist Group Occasional Paper No. 1; IUCN: **2001**. [Online link]
5.   Rigg, R.; Finďo, S.; Wechselberger, M.; Gorman, M.; Sillero-Zubiri, C.; Macdonald, D. Mitigating carnivore-livestock conflict in Europe: lessons from Slovakia. *Oryx* **2011**, *45* (2), 272-280. [Google Scholar] [CrossRef]
6.   Coppinger, R.; Coppinger, L. Livestock guarding dogs: from the transhumance to pre-zygotic selection. *Carnivore Damage Prevention News* **2005**, *9*, 2-8. [Google Scholar]
7.   Gehring, T.; VerCauteren, K.; Landry, J. Livestock protection dogs in the 21st century: is an ancient tool relevant to modern conservation challenges? *BioScience* **2010**, *60* (4), 299-308. [Google Scholar]
8.   Novaro, A.; González, A.; Pailacura, O.; Bolgeri, M. J.; Hertel, M. F.; Funes, M. C.; Walker, R. S. Manejo del conflicto entre carnívoros y ganadería en Patagonia utilizando perros mestizos protectores de ganado. *Mastozoología Neotropical* **2017**, *24* (1), 47-58. [Google Scholar]
9.   Aguirre, E.; Ullaguari, V.; Alvarado, V.; Aguirre, M.; Viñan, H. Shrubby and arboreal species diet preferences of creole goat in extensive husbandry during dry season at different altitude levels of dry forest in southern Ecuador. *Livest. Res. Rural Dev.* **2024**, *36*, 30. [Online link]
10. Méndez, M.; Castellví, J. L. Análisis normativo del bienestar animal en España y Latinoamérica: especial referencia a la labor de los perros en la construcción de paz. *Rev. Latinoam. Estud. Paz Conflicto* **2020**, *1* (1), 39-58. [Google Scholar]

11.   Marquez, V.; Wajner, N.; Zamudio, F. "El cabrero" guardián de las cabras en el Chaco árido. *Mundo Antes* **2023**, *17* (1), 279-293. [Google Scholar]

12.   Medrano, C. Hacer un perro. Relaciones entre los qom del Gran Chaco argentino y sus compañeros animales de caza. *Anthropos* **2016**, 113-125. [Google Scholar]

13.   Black, H.; Green, J. S. Navajo use of mixed-breed dogs for management of predators. *J. Range Manage.* **1984**, *38*, 11-15. [Google Scholar]

14.   Coppinger, R.; Coppinger, L. *Dogs: A Startling New Understanding of Canine Origin, Behavior, and Evolution*; Scribner: New York, 2001.

15.   Welker, M.; Zavodny, E.; Podrug, E.; Jović, J.; Triozzi, N.; Kennett, D.; McClure, S. B. A wolf in sheep's clothing: The development of livestock guarding dogs in the Adriatic region of Croatia. *J. Archaeol. Sci.* **2022**, *42*, 103380. [Google Scholar] [CrossRef]

16.   Costa, G.; Estévez, J.; Gorozurreta, A. *Estudios genéticos en la raza canina cimarrón uruguaya*; Tesis de grado DMV, Universidad de la República: Uruguay, 2007.

17.   Fernández, G.; Barba, C. Primeros datos de la caracterización etnológica del perro Cimarrón. *Arch. Zootec.* **2002**, *51* (194), 223-228. [Google Scholar]

18.   Fernández, G.; Mernies, B. Capítulo 3: Caracterización racial del perro Cimarrón. In *Conociendo al perro Cimarrón uruguayo*, 1st ed.; Biblioteca Plural, CSIC-Universidad de la República: Montevideo, Uruguay, 2013.

19.   Damián, J. P.; Belino, M.; Rijo, R. Etología clínica y agresividad canina en Montevideo: implicancia de las razas y el sexo. *Rev. Argent. Cienc. Comport.* **2011**, *3* (2), 19-28. [Google Scholar]