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Criollo cattle: Heritage Genetics for Arid Landscapes

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On the Ground

- Precipitation variability within and across years remains a major challenge for livestock producers in arid and semiarid ecosystems.
- Cattle adapted to harsh desert ecosystems may offer exciting genetic opportunities for optimizing beef production from arid ecosystems.
- A type of Criollo cattle, introduced from the Chinipas region of Chihuahua, Mexico, may provide opportunities to use cattle adapted to arid and semiarid environments that require minimal management yet provide quality beef.

Keywords: livestock, dry lands, foraging, Mexican cattle.

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In this article we assemble published information about Criollo cattle and their present genetic contribution to the US beef industry. It is not known when the term ***Criollo*** (a noun) was first used (Encarta Dictionary—13th century; Merriam-Webster—1604; Oxford Dictionary—late 19th century) and although its origin appears to be Spanish, there are possible French and Portuguese derivations. Since colonial times, Criollo has been used in Latin America to describe people and animals born in a newly discovered land from imported parents.[1] Criollo cattle refer to bovines introduced to the New World from the Andalusia region of southern Spain[2] by Christopher Columbus during his second voyage (1493–1496). These cattle have had a significant influence on present-day North American cattle.[3] The first cattle specifically used for breeding purposes are reported to have been brought to Mexico by Gregorio Villalobos and Hernán Cortés,[4] yet Criollo cattle have largely been ignored by historians and scientists due to the lack of detail in their history.[5] In 1572, Mexican Criollo cattle were introduced to the state of Chihuahua at Santa Barbara and Valle de Allende, and in 1627, Jesuit missionaries introduced them to the Sierra Tarahumara Indians.[6] Today, many Tarahumara remain in isolated family units influenced by a mix of traditional and 21st-century trappings with the cow as their most valuable possession.[7]

Lowery Woodbury, as quoted in Bowling,[3] wrote that cattle from Mexico were moved into the present boundaries of the United States as early as 1539. Rouse[5] indicates that Coronado had about 500 head of cattle with him when he traveled through New Mexico between 1540 and 1542; however, the actual fate of these animals is not known. The best estimate of when Criollo genetics were introduced into New Mexico is 1598, when Don Juan de Oñate introduced between 2,500 and 7,000 head.[5] DNA markers are being used to fill in missing pieces of the Criollo story with recent research showing the possibility of some African influence on the development of the Iberian breeds.[8]

Although research on Criollo is limited, certain Mexican cattle have remained isolated in specific areas without the influence of crossbreeding.[9] Because of the unique genetics of various isolated groups, it is not accurate to refer to Criollo cattle as a breed.[10] Reference to Criollo cattle as a type (Briggs[11]) or biotype[12] is more appropriate. It is important that the genetics of these cattle be studied and preserved for maintaining or improving the quality of current domestic breeds for future generations.

Criollo cattle can be found throughout the Western Hemisphere (see Rouse[5]) and some Criollo have been developed into unique breeds, e.g., the tropically adapted Romosinuano of Colombia, one of the few polled Criollo cattle (see Rouse[5]). Other Criollo cattle were responsible for the genetics that led to the Longhorn.[13] The resurgence of sport rodeo rekindled interest in Mexican cattle frequently referred to as Corriente or Corrientie (a less preferred spelling). Although Corriente has been used interchangeably with Criollo,[14] this terminology is incorrect. Corriente cattle have been selected and raised primarily as sports cattle, primarily for team roping and bulldogging according to the North American Corriente Association headquartered in Monument, Colorado, whereas Criollo cattle are more frequently associated with beef production.

Although crossbreeding may be the goal for owners of Criollo cattle, the US Department of Agriculture-Agricultural

Research Service's Jornada Experimental Range (JER) is interested in studying the attributes of Criollo and their ability to adapt to harsh arid landscapes with minimal human intervention (e.g., supplemental feed, vaccination for disease, treatment for internal and external parasites, etc.) while producing a high-quality grass-fed beef that is in demand from healthy environment–conscious consumers.

Although uncommon, some Criollo cattle in the state of Chihuahua, Mexico have not been crossbred. Frequently, such cattle are found in small, relatively isolated populations where they survive on woody plants, cacti, and native herbaceous vegetation largely limited in abundance due to low and erratic rainfall.[15] Criollo cattle within the Copper Canyon in Chihuahua can be found in villages geographically isolated due to poor or no road infrastructure; hence, the genetics of these Criollo cattle have evolved to become strikingly different from one location to another as a result of many years of adaptation and survival under stressful nutritional conditions with minimal prophylactic sanitary husbandry practices.[9] These small isolated cattle groupings are not part of Mexico's commercial market due in large part to their short stature and nonuniform conformation, yet they provide milk from which cheese is made and serve as draft animals and a source of cash for individuals who own these cattle.[14] When members of our team traveled to Mexico to select our Criollo cattle they reported numerous cases in which the owners considered their animals as members of the family and actually allowed them to enter their homes. Geographic isolation of these Criollo cattle has provided animals with substantial genetic diversity. McTavish et al.[16] suggested Criollo cattle found in Mexico may represent 80 to 200 generations of unmanaged breeding (natural selection).

Body size, conformation, milking ability, and horn shape of Criollo differ markedly among the different regions of the Western Hemisphere, yet hair color patterns have remained remarkably consistent.[5] Isolation, time, natural selection, and husbandry have shaped the development of Criollo within the ***Bos taurus*** line into animals quite different from those originally imported.[1] Genetically, Criollo cattle in the state of Chihuahua appear to be more closely related to Charolais than to Angus cattle based on microsatellite markers.[17] The genetic diversity within the Criollo is remarkable considering that probably fewer than 300 cattle were originally introduced to the new World by the Spanish.[18] However, purebred Spanish Criollo cattle appear to be losing ground as crossbreeding with Brahman, Santa Gertrudis, and other breeds increases.[19]

A Unique Group of Criollo Cattle

Criollo cattle can appear quite different depending upon their origin; therefore, inspectors charged with registering these cattle have been provided written guidelines on which to judge phenotypic characteristics.[20] The Criollo cattle introduced onto the JER came from between Chinipas and Temeris, Chihuahua between the Barranca de Chinipas and the Barranca de Septentrion region in the remote area of the Rio Oteros of the Sierra Tarahumara (Copper Canyon) of Mexico, home to the Tarahumara Indians. This area is between 200 m to 400 m above sea level and is characterized by hot summer ambient air temperatures. The most accurate description of this particular Criollo cattle type (Figs. 1 and 2) is Raramuri Criollo (RC) cattle (J. De Alba, personal communication, September 2007). Raramuri is the name the Tarahumara give themselves, which means "fleet foot" or "the light-footed ones" or "footrunners."[21] For a complete overview of the great geographic diversity of Criollo cattle in North America, the reader is referred to Martinez.[22]

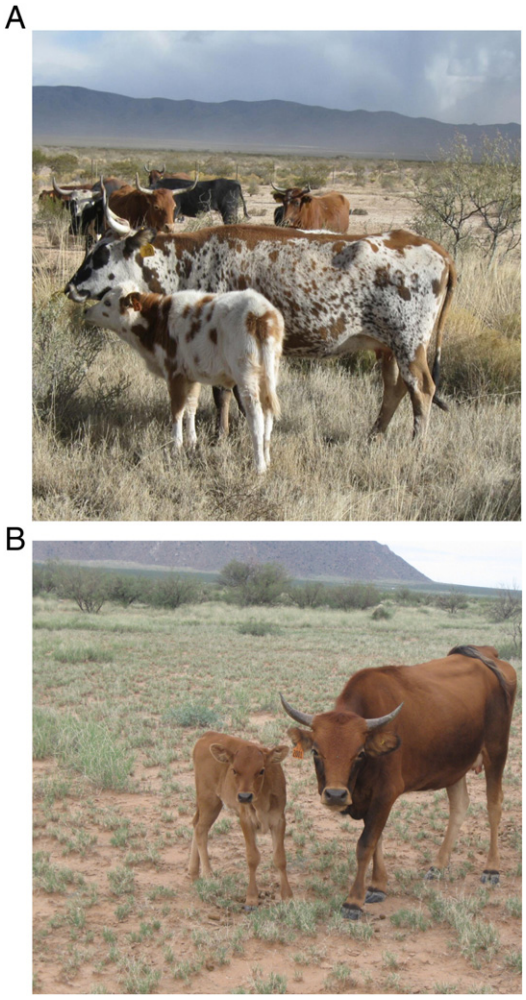

Fig. 1. A, Raramuri Criollo cows on the Jornada Experimental Range. **B,** Raramuri Criollo first calf heifer with calf.

The original introduction of Criollo cattle to the JER consisted of 30 cows and 3 bulls that were hand selected and purchased from individual families in 2005 within an area no greater than 10 km surrounding Chinipas Mexico. The goal of the JER is to establish a base herd of approximately 200 purebred RC cows on which to conduct foraging behavior and economic research that will be compared with traditional crossbred cattle of the area. As of May 2014, the JER had several bull calves and 8 bulls older than 2 years of age (Fig. 2), 139 cows between ages 2 and 22 years, 67 replacement heifers 18 months or younger, 32

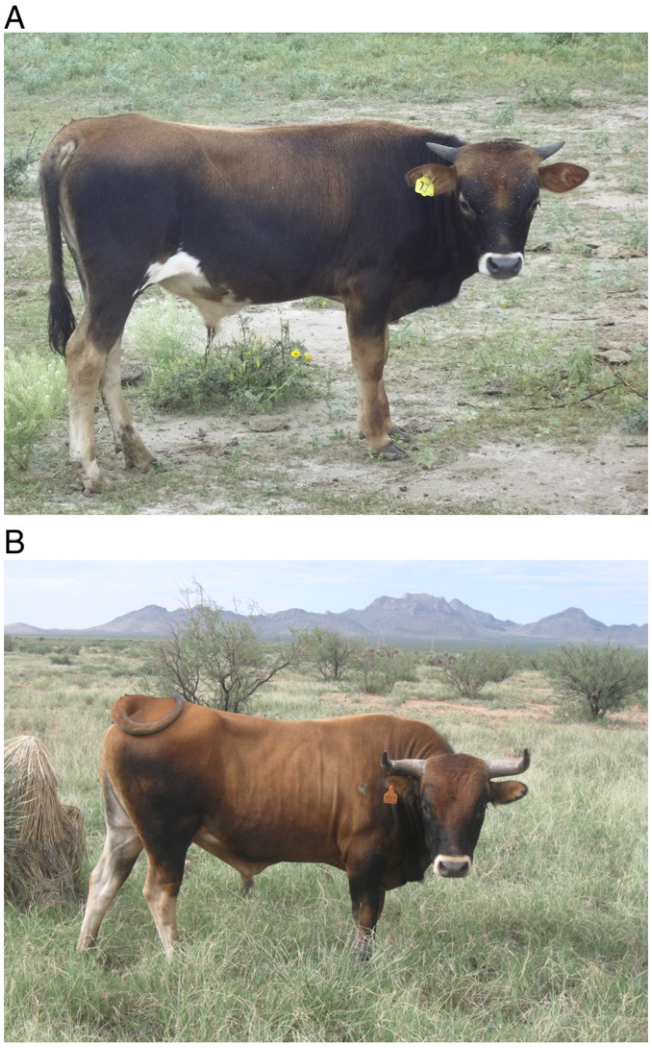

Fig. 2. Raramuri Criollo bulls raised on the Jornada Experimental Range; **A,** bull calf younger than 1 year of age, **B,** 3-year-old bull.

steers at least 2 years of age, and 50 steers 18 months or younger. The JER steers are finished as grass-fed beef at 30 months of age as a result of their slower growth rate. Preliminary enterprise budgets prepared using production and marketing experiences from the JER[23] indicate a similar to improved level of net return with RC cattle. The advantageous fertility, longevity, and low-cost production noted for these cattle meant net economic returns were equal to what could be made from typical British breeds of the area. Net returns were increased with RC production when it was assumed that added forage could be harvested because of their favorable foraging behavior. The enterprise budget analysis recognized the extended foraging time for grass-finished production, a sale price discount for RC animals, and differences in forage demands with the small-framed animals. Future research is being proposed in collaboration with New Mexico State University Department of Animal and Range Science to further investigate calving frequency, diets, behavior, and the economics and marketing of RC cattle.

What We Know to Date

Research to date on foraging behavior of pure Criollo cattle is limited[24]; however, some reproductive/genetic studies are available.[25] Mexican and Argentinian studies have focused on production and performance. Montaño Bermúdez[26] reported that "Coreño" Criollo mother cows from the region of Nayarit (Jalisco, Mexico) had higher pregnancy, calving, and weaning rates than their Guzerat (a ***Bos indicus*** breed from the region of Bombay, India) counterparts, whereas birth weights and weaning weights of calves from Criollo mothers were lower than those of Guzerat cows. A 4-year study comparing Argentine Criollo (AC) with Angus cows raised in the hot semidesert environment of the La Rioja Province (northwest Argentina) showed Criollo cattle had higher pregnancy rates (93.5 vs. 87.5%), higher calving rates (91.3 vs. 81.9%), and higher weaning rates (90.6 vs. 81%) than their Angus counterparts.[27] A second 4-year study conducted at a drier location in the province of La Rioja showed similar pregnancy rates (85.7 vs 89.5%), calving rates (84.1 vs. 87.3%), and weaning rates (82.3 vs. 81.8%) in Criollo versus Angus cows.[28] Mean daily weight gains of cull cows fattened for 122 days on buffelgrass (***Cenchrus ciliaris***) pastures at a site in La Rioja in a 2-year study did not differ ($P \geq 0.05$) between AC cows (0.649 kg/day) and Angus cows (0.721 kg/day).[29] Namur et al.[30] selected single-color coat biotypes (doradillo de capa entera) to improve the Argentine Criollo's acceptability in local livestock sale barns. Eight years of reproductive records from a rangeland-based trial indicated that cows with a single-color coat performed no differently ($P \geq 0.05$) than Criollo having a hair coat of multiple colors.

Garriz[31] examined beef quality of AC and crossbred cattle having Nelore and Hereford genetics raised on semiarid rangeland in the province of Tucumán. The study concluded that AC beef was leaner, more tender, and had better flavor than that of crossbred steers. Vranic et al.[32] compared tenderness of the 11th rib section of the ***longissimus dorsi*** muscle of AC, Angus, Hereford, Shorthorn, and crosses raised together and slaughtered at 26 months or 32 months of age. They found no differences ($P \geq 0.05$) in tenderness among breeds. Garriz et al.[33] compared dressing percentage and carcass yield of AC, Hereford, and crossbred (Hereford × AC) steers raised in the province of La Pampa on rangeland and slaughtered at similar ages and weight. Dressing percentage was significantly ($P \leq 0.05$) higher in Hereford (59.1%) than in AC (57.2%) or Hereford × AC (56.9%). However, the AC carcasses yielded more muscle (58.3%) and less fat (16.7%) than Hereford (53.8% muscle; 22.2% fat) and Hereford × AC (56.9% muscle; 19.1% fat) carcasses ($P \leq 0.05$). The AC carcasses yielded a similar ($P \geq 0.05$) percentage of bone (16.3%) compared with Hereford or Hereford × AC crosses (15.6% and 15.7%, respectively). Although data on meat quality have been obtained on RC steers from the JER, these data are yet to be published. Preliminary data from Arizona taken in 2013 on eight RC steers and four crossbred steers representing nine different breeds gave similar Warner-Bratzler data (mean 2.70 kg/cm^2 and 2.53 kg/cm^2 for the two cattle groups, respectively) that reflected very tender meat based on samples taken between the 12th and 13th ribs.

The RC steers weighed between 800 pounds and 1,000 pounds, whereas the crossbred steers weighed between 1,000 and 1,200 pounds.

Although there is much consistency in what is written about Criollo cattle, especially in the popular press, many of the characteristics and traits attributed to them have yet to be verified scientifically. In general, Criollo cattle have a very docile temperament and under extensive management are reported to graze and browse considerable distances from peers; thus, demonstrating a weaker herd instinct than zebu cattle.[10] Koppa[34] compared travel of RC cattle with Angus (A) × Hereford crossbred cattle (12 of each fitted with GPS collars). On 9 of 15 days, RC cows traveled slightly farther than the A × Hereford (16.9 vs. 16.1 km/day). Other minor differences were detected between the crossbred and RC cows but it was their separation into distinctly different groups beginning on day 4 that proved most interesting. Although both groups used similar areas initially (not at the same time), during the last 2 days of the study, the crossbreds and RC cows used entirely different areas of the 2,425 ha study area. Peinetti et al.[24] examined spatial distribution patterns of RC and A cows in spring and fall 2005. They reported no differences between breeds during the spring when forage availability was high and more uniformly distributed; however, RC and A cows exhibited very different spatial distribution patterns during the fall when forage availability was low and nonuniformly distributed. Under these harsher environmental conditions, RC animals foraged across a much larger area and traveled twice the distance from water compared to the A cows. These data suggest the Jornada RC cattle distribute themselves over more of the JER landscape compared with the purebred Angus.[24] However, these data have not been replicated in time or among seasons so must be considered preliminary.

Late in 2013, research was begun on Criollo cattle managed by the Universidad Autónoma de Chihuahua Facultad de Zootecnia y Ecología. This research was designed to examine the diets and distribution of free-ranging Criollo cattle as well as their fatty acid profiles and shelf life of meat compared to cattle of both pure and crossbred European genetics (I. Garcia-Galicia and G. Bezanilla, personal communication, August 2013).

Criollo cattle appear to have an exceptionally long reproductive life. RC cattle up to 22 years of age have remained reproductive on the JER. Furthermore, preliminary JER research suggests RC cattle reach puberty earlier than British breeds.[35] Furthermore, the agility and exceptional mothering ability of RC have been reported by De Alba.[22]

For additional material pertinent to Criollo cattle behavior, genetics, history, marketing, and reproduction the reader is directed to the online supplemental material at http://dx.doi.org/10.1016/j.rala.2015.01.006.

Implications

Criollo cattle originally introduced from Spain via the Caribbean Islands into Mexico that have not been subjected to crossbreeding appear to possess a remarkable gene pool that may have potential for arid rangeland management. Although the effect of breed on biodiversity has been minimal in France, Germany, Italy, Spain, and the United Kingdom,[36] traditional (heritage) beef breeds may be slightly less selective in their diet than current-day commercial breeds.[37] Such research with RC cattle is not yet available; however, preliminary data suggest RC may prefer areas with low shrub density yet in the fall may be much less dependent on water than Angus cattle.[24] Keeping the genetics "pure" may provide new opportunities for managing arid landscapes. An awareness of the diversity of Criollo cattle is critical; therefore, adding regional specificity[38] to the term ***Criollo*** when referring to these cattle may be useful to identify unique genetic pools of various biotypes.[15] Criollo genetics may offer exciting new possibilities in crossbreeding programs, especially if the resulting animals prefer diets with a high percentage of shrubs[39] or are more adept at distributing themselves over a larger area of the landscape.[40]

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.rala.2015.01.006.

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