IDENTIFYING THE SOCIAL DOMINANCE ORDER IN A MIXED BREED HERD: A PRACTICAL METHODOLOGY

Identificando el orden de dominancia social en un rebaño racialmente mixto. Una metodología práctica

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RESUMEN

Con el objetivo de identificar un método simple y confiable para evaluar diferencias en el status social, se compararon 3 métodos para estimar el valor de dominancia (DV) en vacas de tres razas cárnicas: Angus (A; n=10), Brahman (B; n=10) y Senepol (S; n=10). Las vacas fueron distribuidas en dos grupos de 15 animales, en potreros separados y conteniendo cada grupo la misma cantidad de animales de cada raza. Las interacciones agonistas ocurridas durante cada período de suplementación fueron recopiladas durante 45 d, en sesiones de 1 h y dos veces al día, usando el método del orden competitivo ganador/perdedor. Los métodos para estimar DV incluyeron: I) Proporción entre individuos dominados y total de enfrentados, II) proporción entre encuentros ganados y total de encuentros, III) proporción de individuos dominados y total de individuos en el rebaño. Debido a los diferentes niveles de interactividad evidenciados entre animales, así como entre y dentro de categorías sociales, el método III con subsiguiente transformación Arc-sin fue considerado el más práctico y preciso, tanto para la estimación de DV como para la posterior organización de un orden de dominancia social. Adicionalmente, se halló que la dominancia social fue influenciada por la raza. Las vacas Senepol (1.24 ± 0.08) obtuvieron mayores valores de dominancia que las Angus (0.97 ± 0.08; P<0.03) y Brahman (0.76 ± 0.08; P<0.005).

Palabras clave: Ganado vacuno, conducta, organización social.

ABSTRACT

The major objective of this study was to identify a simple and accurate method of assessing differences in female social status. Three methods of estimating dominance value (DV) were compared in beef cows of three breed-types; Angus (A; n=10), Brahman (B; n=10), and Senepol (S; n=10). Cows were equitably assigned to two groups of fifteen each, allocated into separate pastures and containing equal number of animals by breed. Agonistic interactions were recorded for 45 d of study, in two 1 h periods during concentrate feeding using the method of competitive orders winner/loser. Methods of estimating DV included: I) Ratio between individuals dominated and total encountered, II) Ratio between encounters won to total encounters, III) Proportion of individuals dominated to total herdmates. Due to the different level of interactivity evidenced among animals as well as between and within social orders, method III with subsequent arc-sin transformation was considered as the most practical and accurate method for estimating DV and subsequent allocation of cows into a social dominance order. In addition, a breed effect was found on social dominance. Senepol cows obtained greater DV´s (1.24 ± 0.08) than Angus (0.97 ± 0.08; P<0.03) and Brahman cows (0.76 ± 0.08; P<0.005).

Key words: Cattle, behavior, social organization

INTRODUCTION

Due to the need of increasing production efficiency in the management of large herds and flocks, there is a growing interest in understanding the behavioral patterns of domestic animals, [25]. Social organization within herds can influence many

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aspects of animal production such as grazing activity and weight gain [2,26], feed intake [1,9], milk yield [9], estrus expression [16, 21], composition of sexually active groups [12] and performance under confinement conditions [18]. Therefore, designing optimal management systems for animal production requires a good understanding of the basis for social organization [25].

On the other hand, given the demonstrated spectrum of parameters influenced by the social organization, the research field is also affected by its repercussions. Thus, when designing an experiment, there is always a possibility for overlapping and confounding anytime the role of social organization as a variable is ignored. Confusion with respect to definitions [3] and lack of a practical and accurate methodology for social categorization have probably limited a widespread use of current knowledge on cattle social behavior. Thus, application of such knowledge on management and even research activities is limited. Therefore, the major objective in this study was to develop a practical methodology to estimate dominance values and subsequent social categorization of cattle. A secondary objective was to determine the effect of breed on social dominance.

MATERIALS AND METHODS

Thirty (30) non-pregnant, cycling, non-suckling purebred cows representing three beef breed-types (Angus; n=10, Brahman; n=10, and Senepol; n=10) were transported from the USDA Subtropical Agricultural Research Station (STARS) near Brooksville, Florida, USA to University of Florida Beef Research Unit (BRU) near Gainesville, Florida. At Brooksville, cattle were normally managed in separate herds by breed-type. Therefore, when introduced at the BRU, these cows underwent a social re-organization. In order to facilitate collection of data with uniform groups, after a 7-d period of acclimatization, cows were allocated by breed, parity and size into two groups (A and B) of 15 cows each (Angus; n=5, Brahman; n=5, and Senepol; n=5).

Body weight and body condition score [15] were recorded at the time of arrival at BRU. Means ± SD for age, body weight, and body condition score were as follows: Angus 6.3 ± 0.8 (range 5 to 7 years), 528 ± 28 (range 475 to 568 k), and 5.9 ± 0.3 (range 5 to 6), respectively; in Brahman 7.08 ± 1.6 (range 5 to 9 years), 532 ± 40 (range 471 to 609 k), and 5.4 ± 0.8 (range 3 to 6), respectively; in Senepol 5.1 ± 1.4 (range 3 to 7 years), 535 ± 33 (range 484 to 565 k), and 5.3 ± 0.5 (range 5 to 6), respectively. One Brahman cow had one horn while the remaining cows were polled.

Each group was allocated to individual, non-adjoining pastures of approximately 1½ hectares containing Bahia grass (*Paspalum notatum*). Thus, although confined, by providing such pasture dimensions to the cows we guaranteed that space was never an inhibitory factor to the display of normal social behavior. In addition to the available grass on pastures, cows were provided with free choice Bermuda grass hay (*Cynodon dactilon*) and water. Competition was induced by dispensing one kilogram (2 lb) of concentrate (92% corn meal + 7% soybean meal + 0.5% trace minerals) twice a day per cow.

Observations of agonistic interactions were made daily over 2 one hour periods (8:00 to 9:00 am and 5:00 to 6:00 pm) for 45 d using the method of competitive orders [6]. In order to facilitate observations from a distance, easily discernable numbers were painted on the sides of each cow. Approximately 1.2 mt/cow of bunk space were provided using three portable feeders with double entry, each 3 mts length. Competition for bunk feed or space was promoted by dispensing a small portion of palatable concentrate twice a day. Agonistic interactions occurring within a cow body length were recorded. These interactions included forced displacements from the feeder, threats, butting, charges, and avoidances. Each interaction was recorded having a designated cow as winner and another as loser (e.g., 16W / 7L). No doubtful interactions were recorded.

Three methods were tested for the calculation of dominance values. Method I consisted of the calculation of ratio between dominated and encountered individuals [3, 5, 20]. Method II used the ratio between encounters won to total encounters [1]. Method III used a modification of previously proposed methodologies [9, 26] whereby the proportion of individuals defeated was assessed relative to total herdmates.

In order to obtain normally distributed data, an arc-sin conversion was applied to the dominance values (DV) obtained from each method [3, 5, 6, 12]. Subsequently, using PROC CORR of SAS [23], a Pearson correlation analysis was performed to compare arc-sin values obtained from each method. In addition, in order to visualize the level of interactivity between cows, matrix tables containing all observed interactions were assembled.

Values obtained by applying the arc-sin conversion with method III were used to arrange animals into a simple linear social dominance order represented by three social categories as follows: Dominants, represented by cows which dominated all herdmates and concomitantly obtained the highest DV (DV=1.57); Intermediates, represented by cows which defeated most herdmates and obtained DV in between 0.93 and 1.57 (DV=1.0 - 1.3); Subordinates, were represented by cows which were mostly defeated and obtained a DV less than 1 (DV=0.38 - 0.93). These DV´s, arc-sin conversions and social categories are shown in TABLE I. It may be important to notice that depending upon objectives, if animals are arranged in separate categories according their obtained DV´s, social hierarchies or more complexes (intransitive) arrangements can be constructed.

In this methodological study, we considered inappropriate to use the term “aggressive order”. Instead, we used the term “dominance order” because aggressiveness only occurred to a limited extent. After a relatively short time of agonistic interactions involving physical contact, some cows started to display seniority and conversely others showed avoidance toward these dominant cows. Thus, cows displaying

TABLE I

DOMINANCE VALUE AND SOCIAL CATEGORY IN A HERD OF ANGUS (A), BRAHMAN (B), AND SENEPOL (S) COWS

VALOR DE DOMINANCIA Y CATEGORÍA SOCIAL EN UN REBAÑO DE VACAS ANGUS, BRAHMAN Y SENEPOL

Cow ID	Breed	Group	DV [a]	Arcsin	[b]Category [c]
16	A	A	100	1.57	D
11	A	A	71.4	1.00	I
26	A	B	78.6	1.08	I
7	A	A	64.3	0.93	S
1	A	A	50.0	0.78	S
14	A	A	64.3	0.93	S
19	A	B	57.1	0.85	S
17	A	B	57.1	0.85	S
29	A	B	64.3	0.93	S
20	A	B	50.0	0.78	S
5	B	A	100	1.57	D
3	B	A	14.3	0.38	S
6	B	A	28.6	0.56	S
9	B	A	35.7	0.64	S
8	B	A	64.3	0.93	S
15	B	B	50.0	0.78	S
30	B	B	28.6	0.56	S
28	B	B	42.9	0.71	S
25	B	B	28.6	0.56	S
27	B	B	64.3	0.93	S
4	S	A	100	1.57	D
23	S	B	100	1.57	D
24	S	B	100	1.57	D
10	S	A	78.6	1.08	I
22	S	B	71.4	1.0	I
13	S	A	78.6	1.08	I
12	S	A	78.6	1.08	I
2	S	A	92.9	1.3	I
18	S	B	71.4	1.0	I
21	S	B	85.7	1.18	I

Legend: a= DV (dominance value)= $\frac{\text{N° herdmates dominated x 100}}{\text{Total herdmateses}}$

b= Arc-sin transformed dominance value. c= Social category: D= dominant, I=intermediate, S= subordinate.

seniority started to have free and undisturbed access to feed. After calculation of DV´s and categorization, these cows were later designated as dominants.

An ANOVA using PROC GLM of SAS [23] indicated that group did not exerted an influence on either DV or social dominance order. Therefore, data from groups A and B were pooled and the effect of breed on social dominance order was statistically analyzed. In order to analyze interactivity of social categories, total agonistic interactions, agonistic interactions between social categories (IBSC) and within social categories (IWSC) were analyzed using Chi-square procedure. A similar procedure was used to perform a statistical comparison between IBSC and IWSC as well as individual analyses of IBSC and IWSC. To apply this Chi-square, the probability of random interaction between pairs was estimated. With the assumption that interactions occurred at random, the expected number of interactions for comparing IBSC and IWSC was obtained by calculating the number of within rank pairs (166) and the number of between rank pairs (269) as follows:

Within rank pairs (5/2) = 10 (9/2) = 36 (16/2) = 120 = 166 ÷ 435 = 0.3816

Total pairs (30/2) = 435

Between rank pairs = 435 – 166 = 269 ÷ 435 = 0.6184

Subsequently, the total number of interactions (1124) was proportionally allocated to the previously calculated pair counts, i.e., I-within = (1124) (166) / 435 and I-between = (1124) (269) / 435 as follows:

Expected IWSC = 166 ÷ 0.38 = 435

Expected IBSC = 1124 – 435 = 689

Once the expected values were obtained, Chi square analysis was applied.

RESULTS AND DISCUSSION

A "goal standard" to compare accuracy of procedures to estimate dominance values is not available in the scientific literature concerning social behavior of domestic animals. Therefore, all the recorded agonistic interactions were arranged in matrix tables and analysis of intra and between rank interactions were performed. Observations from matrix tables and analysis of intra and between rank interactions were used as approaches to compare the accuracy of outcomes from the compared methodologies.

Method III (proportion of individuals dominated to total herdmates) was considered the most appropriate and accurate because of gaps and inconsistencies revealed when the entire data set of agonistic interactions (TABLES II and III) and the type of interactions (e.g., intra and between rank interactions) were analyzed. In addition, Method III considered data from all herdmates while keeping a high correlation with the other methods (TABLE IV).

TABLES II and III showed that the level of interactivity between all cows was not similar. Instead, lack of interactivity between some cows occurred, and not all of the dominant cows needed the same number of interactions to attain their social category. The lack of behavioral interactivity between some individuals may be due to a number of reasons. Either, animals might avoid confrontation due to learning or tacit recognition of their subordinate status. Alternatively, some animals may have not established social relationships with each other [25] or the observation periods may have been inadequate to detect a sufficient amount of interactions.

The learning process involved in the establishment of dominance relationships in lactating Holstein cows was described by Kondo and Hurnick (1990) [14]. In that experiment, approximately 48 h after group formation, most agonistic interactions were represented by avoidance [14]. In agreement with the Kondo and Hurnick findings, in our study, most agonistic interactions involving physical contact occurred at the beginning of the experiment (first 2 weeks). After that conflictive period,

TABLE II

TOTAL AGONISTIC INTERACTIONS RECORDED AMONG ANGUS, BRAHMAN AND SENEPOL COWS FROM GROUP A.

TOTAL DE INTERACCIONES AGONISTAS COLECTADAS ENTRE VACAS ANGUS, BRAHMAN Y SENEPOL DEL GRUPO A

L(W	1A	2S	3B	4S	5B	6B	7A	8B	9B	10S	11A	12S	13S	14A	16A
1A				10	5		1			3	1			1	3
2S				14	1		2	2			6	4	3	4	1
3B		1		9	8		1		1			5	10	1	1
4S		6			5			2		3	2	6	5		1
5B	1	8		21			8	1		2	5	9	7		3
6B		7		12	16			5	1	1	4	9	18	2	1
7A	1	1		8	1			2	1	1			1		2
8B		6	2	10	11	2	1		3		4	2	8	3	3
9B	1	1	13	8	11	2		2		1	2	1	11	1	1
10S	4	6		10	2	1	2				3	1	2		6
11A	2	10		9	1		2	2		3		2	1		5
12S	1	4		12	3	2	1	1		6	5		7	3	2
13S		2		12	1		1	2		1	3	4		1	3
14A		2		8	3				3	4					3
16A	1	2		7	1					2		1		2	

Legend: W= wins represented in columns. L= losses represented in rows. Breeds: A= Angus, S= Senepol, and B=Brahman and ID Number.

TABLE III

TOTAL AGONISTIC INTERACTIONS RECORDED AMONG ANGUS, BRAHMAN AND SENEPOL COWS FROM GROUP B.

TOTAL DE INTERACCIONES AGONISTAS COLECTADAS ENTRE VACAS ANGUS, BRAHMAN Y SENEPOL DEL GRUPO B

L(W	15B	17A	18S	19A	20A	21S	22S	23S	24S	25B	26A	27B	28B	29A	30B
15B						1	5	10	1		2	21	1		2
17A			4	6		1	4	5	2		10		1	7	
18S				2	1	5		6	3	1	9			5	
19A		2	2		4	1		7	3		7	1		6	
20A		3	6	3		1	3	5	3		6	1		1	
21S							1	7	5		2	1		1	
22S	1	4	3	2	2	2		3	2			3			
23S	2	6		6	6	6	1		9	1	10		1	6	
24S	2	3	6		3	1		6		2	9	1	1	3	
25B			1	2	3	2	4	12	1		2	16	1		1
26A		3	1	6		1		4	2					2	
27B	1		1			1	10	6	5		6		3	1	1
28B	4	1	1				5	7	3		21				
29A	1	2	4	6	4		1	10	4		5	2			
30B	1					1	6	10	1	6		16			

Legend: W= wins represented in columns. L= losses represented in rows. Breeds: A= Angus, S= Senepol, and B=Brahman and ID Number.

agonistic interactions involving physical contact progresively decreased. By the last 3 weeks, most agonistic interactions were represented by avoidance. Likely reasons for the differences between our finding and the Kondo and Hurnick finding are due to breed (e.g., lactating Holstein cows vs Angus, Senepol and Brahman cows) and management factors (e.g., confined dairy cows vs pasture handled beef cows).

Some degree of balance probably occurs between dominant and subordinate animals after a certain stage of social organization is reached, whereby dominant animals may become tolerant of subordinates [1, 26], even allowing them access to feed. Similarly, a lack of social interactivity between some individuals within a herd may also become evident once social organization has been established [12].

When agonistic interactions displayed between and within each social category were quantified (TABLE V), it was evident that the level of interactivity between social categories differed. Here, interactions between social categories (IBSC) occurred more frequently (814 vs 310; P< 0.05) than interactions within social categories (IWSC). Likewise, individual analyses of IBSC and IWSC revealed that, although dominant cows were a smaller group (n=5) than intermediate (n=9) and subordinate (n=16) cows, they were involved in more agonistic interactions with the other social categories than either group (dominants vs intermediates= 96, dominants vs subordinates= 140, intermediates vs subordinates= 170; P<0.0005). Meanwhile, within social categories, it was found that subordinate and intermediate cows generated more (157 vs 100, respectively; P< 0.0005) agonistic interactions within their own social order than dominants cows did (53).

TABLE IV

CORRELATION ANALYSIS BETWEEN THREE METHODS TO DETERMINE DOMINANCE VALUES IN A HERD OF ANGUS, BRAHMAN AND SENEPOL COWS

CORRELACIONES ENTRE TRES MÉTODOS PARA DETERMINAR EL VALOR DE DOMINANCIA EN UN REBAÑO DE VACAS ANGUS, BRAHMAN Y SENEPOL

Method*	I	II	III
I	1.0000	0.7694 (P<0.0001)	0.9890 (P<0.0001)
II		1.0000 (P<0.0001)	0.7468 (P<0.0001)
III			1.0000

*Legend: I = ratio between dominated and encountered individuals.
II = ratio between encounters won to total encounters.
III = ratio between individuals beaten to total herdmates.

Differences in the level of social interactivity between cows and in the level of activity displayed by dominant cows are indicative of individual differences between animals in sociability and leadership [24]. Individual variations in social interactivity have been associated with factors such as breed, temperament, hormone treatments, organic condition (e.g., advanced pregnancy, early lactation, illness), territoriality, and social stability of the herd [3, 4, 13, 19, 22, 25].

TABLE V
FREQUENCY DISTRIBUTION OF AGONISTIC INTERACTIONS IN ANGUS, BRAHMAN AND SENEPOL COWS.
DISTRIBUCIÓN DE FRECUENCIAS DE INTERACCIONES AGONISTAS EN VACAS ANGUS, BRAHMAN Y SENEPOL

		Type of agonistic interactions				
Rank	n	Intra-rank	Between rank			Total
			D	M	S	
Dominant	5	53	–	193	281	527
Intermediate	9	100	193	–	340	633
Subordinate	16	157	281	340	–	778
		Total 310[a] (28%)			814[b] (72%)	

(a,b) within a row lacking common supercript differ (P<0.005).

Procedures to determine social organization such as methods I and II may be insensitive to all these social phenomena described when analyzing matrix tables (e.g., lack of interactivity between some animals, number of interactions required to achieve a social category may differ between animals) as well as interactions intra and between social ranks (e.g., different level of interactivity within and between social ranks). Hence, assessment of dominance values and the establishment of social categories using either method I (ratio between dominated and encountered individuals) or II (ratio between encounters won to total encounters) would have probably resulted in either overestimation or underestimation of the social status of individuals, respectively.

In agreement with previous reports [17, 26], and as a marginal finding of this study, breed exerted a significant influence on the obtained dominance value (Senepol= 1.24 ± 0.08; Angus= 0.97 ± 0.08 and Brahman= 0.76 ± 0.08) and consequently on the obtained social category. Thus, Senepol cows exerted greater social dominance above Angus (P<0.03) and Brahman cows (P<0.005). Nevertheless, the absence of reports on social organization using herds composed by *Bos taurus* and *Bos indicus* breeds makes difficult to compare findings. Senepol is a composed breed derived from crossbreeding N'Dama and Red Poll cattle [10]. N'Dama is an African type of cattle which display a remarkable competitiveness for resources and social dominance [11, 12]. The extensive and sometimes feral conditions under which the N´Dama cattle are raised may promote such social behavior. At a less degree, similar conditions are present in Senepol because its origin and development have involved open ranch conditions also. Therefore, we speculate that the observed social dominance exerted by Senepol cows above Angus and Brahman cows may have genetic [for review 7,8] and environmental components.

CONCLUSIONS

Method III (proportion of individuals dominated to total herdmates) was found to be a practical and most accurate approach compared to methods I and II. Using methods I and II, there is a certain risk of either overestimation or underestimation of the social status of some animals. In addition, method III permits a great versatility because it allows the user to build either linear (transitive) or complex arrangements (intransitive) according objectives and needs.

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