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ORIGINAL RESEARCH PAPER

RESEARCH ON THE MANAGEMENT OF QUANTITATIVE AND QUALITATIVE PRODUCTION PERFORMANCE IN TWO ROMANIAN CATTLE BREEDS IN THE EASTERN REGION OF ROMANIA

Alin A. Afloroaei*, Gabriel I. Bărbuţă, Vasile Maciuc

University of Life Sciences „Ion Ionescu de la Brad", 3rd Mihail Sadoveanu Alley, 700490, Iasi, Romania

*Corresponding author: alin.afloarei@iuls.ro

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Abstract: The objective of this study was to conduct a detailed comparative analysis of the principal milk quality parameters in the Romanian Black-Spotted (RBS, *Bălţată cu Negru Românească*) and Maramureș Brown (MB, *Brună de Maramureș*) cattle breeds, reared under a semi-intensive production system. Statistical analysis of the primary data was performed using the SPSS 16.0 for Windows software package, ensuring a high level of accuracy and reliability of the results. In the RBS breed, milk yield reached an average of 7,530.25 kg, representing an increase of 20.3 % compared to the production recorded in the MB breed. From a qualitative perspective, however, milk produced by the MB breed demonstrated superior characteristics, with a fat content of 3.99 % and a protein content of 3.49 %, highlighting the breed's notable genetic potential for milk quality. These findings underscore the importance of maintaining genetic selection for milk quality as a central objective of animal improvement programs, through the implementation of breed-specific selection strategies.

Keywords: *fat, milk components, protein percentage, somatic cells*

INTRODUCTION

Romanian Black-Spotted (RBS, *Bălţată cu Negru Românească*) breed is one of the native cattle breeds, accounting for approximately 20 - 25 % of the national cattle population, and is recognized for its good productive performance and adaptability to the diverse farming conditions of Romania. Its distribution is predominantly concentrated in the lowland regions of the southern and south-eastern parts of the country, as well as in the hilly areas of Moldova and in the vicinity of major urban centers. The breed was officially homologated in 1987, following long-term crossbreeding programs involving rustic local breeds, such as Red of Dobrogea and Brown cattle, crossed with Frisian bulls over four to five generations. Its recognition as a distinct breed confirms the establishment of a stable and unique genetic pool, which, in conjunction with trends toward reproductive isolation and continuous genetic improvement, led to the formation of this new breed. Phenotypically and productively, the RBS exhibits characteristics similar to those of Frisian-type breeds and demonstrates considerable variability in productive traits. It is well suited to specialized dairy systems. Under current national farming conditions, average milk yields generally do not exceed 4,000 - 4,500 kg per lactation, with a fat content ranging between 3.8 and 3.9 %. Research indicates that, under optimal management conditions, this breed is capable of achieving production levels comparable to its parental breeds, with first-lactation yields exceeding 70 % of maximum lactation production and a specific feed consumption of 1 - 1.2 U.N. per liter of milk. Breeding programs for the RBS aim to improve milk production by 90 % and 10 % for fitness traits, while also enhancing feed efficiency by reducing specific consumption to below 1 U.N. [1].

Maramureș Brown (MB, *Brună de Maramureș*) breed was developed through absorption crossbreeding between local cattle populations, namely Mocănița and Grey Steppe, and Schwyz bulls imported into the Maramureș region beginning in 1881 from countries such as Hungary, Austria, and Germany. Owing to its strong adaptive capacity and resistance to the pedoclimatic conditions of Romania, this breed experienced substantial expansion during the communist period, at which time it represented over 40 % of the national cattle population. In recent decades, however, its area of distribution has narrowed significantly, accompanied by a marked decline in herd size. Currently, the only preserved original nucleus of the breed is maintained at the Research and Development Station (RDS) Secuieni-Neamț, while crossbred animals are still found in the Maramureș region among small-scale breeders and on farms with limited herd sizes. Although the MB breed is suitable for various production systems, cows maintained at RDS Secuieni are exploited under a semi-intensive system, under management conditions that allow for the expression of their genetic potential. The milk obtained under these conditions is characterized by very good quality, making it particularly suitable for processing [2, 3]. Under appropriate feeding and management conditions, the MB breed achieves average milk yields of approximately 3,000 - 3,500 kg per lactation, with production levels exceeding 5,000 kg in some cases, and with fat contents ranging from 3.9 to 4.0 % and protein contents between 3.3 and 3.6 %. The objectives of the RDS Secuieni and associated breeding programs focus on increasing the population size of this breed, improving body mass and milk production, and reducing specific feed consumption. These goals are pursued through purebred breeding strategies and the controlled introduction of genetic material from imported Schwyz breeds [2, 3].

MATERIALS AND METHODS

The objective of this study was to compare the main quantitative and qualitative parameters of milk production in Romanian Black-Spotted (RBS) and Maramureș Brown (MB) cattle maintained under semi-intensive production systems on two different farms. The analysis of milk quality indicators was conducted on a herd of 70 RBS cows reared for milk production on the Polena Farm, Iași County, and on a herd of 48 MB dairy cows exploited at the Research and Development Station (RDS) Secuieni, Neamț County.

Polena Farm is a family-owned operation in which a semi-intensive production technology is applied, adapted by the farmer according to local conditions and available resources. Cattle feeding is carried out three to four times daily and is seasonally differentiated. During the winter period, cows receive a total mixed ration composed of succulent feed (maize silage), concentrated feed (soybean meal, maize grain, and ground cereals), and fibrous feed (alfalfa hay and straw). In the summer season, feeding is based primarily on pasture utilization, supplemented with maize silage at a level of approximately 10 - 15 kg per adult cow per day. Milking is performed twice daily, at 05:00 and 18:00, in a "coulter"-type milking parlor. The milking procedure is standardized and includes transferring animals to the milking room, thorough udder hygiene, removal of the first milk jets, and massage of the mammary gland during milking to ensure rapid and complete milk let-down. Following milking, teat disinfection is applied by immersion in a disinfectant solution to prevent conditions that may adversely affect milk quality. The milk is immediately transferred to the farm's cooling tank, where it is stored at a constant temperature of 3 - 5 °C. Collection by a local processor occurs every two to three days, depending on production volume and storage capacity.

At the RDS Secuieni farm, animals are housed in tied stalls, and feeding is based exclusively on stored feed throughout the year. Cows receive a uniform ration formulated to meet physiological requirements for health and productive performance, with differentiation according to age and physiological status. The ration consists of concentrated feeds (maize grain, wheat bran, soybean meal, sunflower meal), succulent feeds (brewers' grains, beet pulp, maize silage), and high-quality hay. Milking is carried out twice daily, at 05:00 and 18:00, following established milking procedures; however, the process is less technologically advanced, being performed into milk cans using a milking installation. After milking, the milk is transferred to the processing unit of the station, where it is either stored or processed into dairy products such as curd, telemea cheese and yogurt.

Data on quantitative and qualitative milk production parameters were obtained from farm records and from official analysis reports generated during the Official Production Control (OPC). Information regarding pedigree, first lactation performance, lactation duration, and milk yield and composition for both breeds was included in the analysis. Statistical processing of the primary data was performed using SPSS 16.00 for Windows software. The calculated statistical indicators included the arithmetic mean ($\bar{X}$), standard error of the mean ($\pm s\bar{X}$), standard deviation (s), and coefficient of variation (V %). Regression line graphs were also generated to illustrate relationships among the analyzed parameters.

RESULTS AND DISCUSSION

Table 1 shows the average values for the most important parameters of milk production in MB and RBS breeds regarding the ancestry of the studied herds. The results highlight clear differences between the two breeds, reflecting their genetic particularities and productive orientation.

Table 1. *Statistics of the main milk quality indicators in case of ascending to the two MB and RBS breeds*

Character	MB	±SD	RBS	±SD
Number of samples [n]	34	-	77	-
Milk production [kg]	6,258.38	122.933	7,530.25	133.44
Fat [%]	3.99	0.046	4.07	0.014
Fat [kg]	250	5.679	305	5.213
Protein [%]	3.49	0.026	3.40	0.016
Protein [kg]	218.74	4.558	259.97	5.369
Duration of lactation [days]	473.55	18.989	354.15	10.066
SCC [thousand·mL^{-1}]	117.02	19.625	118.04	26.845
Lactose [%]	4.81	0.106	4.64	0.04
Urea [%]	23.55	1.296	26.44	23.55

±SD - standard deviation; RBS - Romanian Black-Spotted; MB - Maramureș Brown; SCC - somatic cell counts.

Table 1 presents the mean values and standard deviations of the main milk production and composition parameters recorded for the ascendant populations of Maramureș Brown (MB) cows from the SCDA Secuieni farm and Romanian Black-Spotted (RBS) cows from the Polena farm. Average milk yield was higher in RBS cows (7,530.25 kg) compared to MB cows (6,258.38 kg), indicating a superior productive potential of the RBS breed under the analyzed management conditions. The relatively low standard deviation values observed for both breeds indicate a good degree of production homogeneity within each group.

Milk fat percentage was slightly higher in RBS cows (4.07 %) than in MB cows (3.99 %). More pronounced differences were observed for total fat yield, with RBS cows producing an average of 305 kg of fat compared to 250 kg in MB cows, a difference primarily attributable to the higher overall milk yield of the RBS breed. In contrast, milk protein percentage was marginally higher in MB cows (3.49 %) than in RBS cows (3.40 %), suggesting a greater protein concentration in MB milk. Nevertheless, the total protein yield was higher in RBS cows (259.97 kg) than in MB cows (218.74 kg), again reflecting the influence of higher milk production levels [4, 5].

Lactation length was considerably longer in MB cows (473.55 days) compared to RBS cows (354.15 days), which may be associated with differences in management practices or breed-specific physiological characteristics, with direct implications for total milk yield and lactation persistence. Somatic cell counts (SCC) were comparable between the two breeds, with values of 117.02 thousand cells/mL in MB cows and 118.04 thousand cells/ml in RBS cows, indicating a similar udder health status in both herds. Lactose content was higher in MB milk (4.81 %) compared to RBS milk (4.64 %), potentially reflecting differences in metabolic efficiency or energy balance. Milk urea concentration

was higher in RBS cows (26.44 mg·dL^{-1}) than in MB cows (23.55 mg·dL^{-1}), suggesting possible differences in the protein-energy balance of the rations.
Overall, the table provides a detailed comparative overview of the two breeds with respect to their main production and milk quality traits, including mean values, standard deviations (±SD), coefficients of variation (V %), and minimum and maximum values. This comparative analysis highlights breed-related differences in both quantitative traits (milk yield) and qualitative parameters (fat, protein, and somatic cell count), offering a comprehensive assessment of the dairy performance of the two cattle populations.
The comparative analysis of the descendances belonging to the RBS and MB breeds highlights significant differences in both milk production parameters and milk quality traits (Table 2). Average daily milk yield was higher in the MB breed (20.03 kg·day^{-1}) compared to the RBS breed (15.66 kg·day^{-1}); however, greater inter-individual variability was observed in the MB population (V % = 30.32 %) relative to RBS (V % = 19.28 %). Milk fat content showed similar mean values between the two breeds, reaching 4.13 % in MB cows and 4.09 % in RBS cows. Protein content was slightly higher in MB milk (3.59 %) compared to RBS milk (3.54 %), although protein variability was also more pronounced in the MB breed. Somatic cell count values were higher in MB cows (157.65 × 10^3 cells·mL^{-1}) than in RBS cows (118.04 × 10^3 cells·mL^{-1}). Conversely, the coefficient of variation for this parameter was considerably higher in the RBS population, indicating the presence of individuals with extreme somatic cell count values. Overall, the MB breed demonstrated superior milk production performance, whereas the RBS breed was characterized by greater stability of qualitative milk parameters, despite notable variability in certain milk quality traits [6, 7].

Table 2. *Statistics of quantitative and qualitative indicators of milk production*

Characters	RBS		$\overline{X}$	±SD	V [%]	MB		$\overline{X}$	±SD	V%
	Min	Max				Min	Max			
Milk production [kg·day^{-1}]	9.8	22.5	15.66	0.344	19.277	14	36.06	20.03	0.877	30.323
Fat [%]	2.32	6.24	4.09	0.101	21.652	2.93	5.77	4.13	0.142	23.852
Protein [%]	2.9	4.43	3.54	0.045	11.171	2.33	4.66	3.59	0.094	18.156
SCC [thousand·mL^{-1}]	2	1222	118.04	26.845	199.562	27	521	157.65	16.925	73.606

$\overline{X}$ - Average; ±SD - standard deviation; V % - coefficient of variation; RBS - Romanian Black-Spotted; MB - Maramureș Brown; SCC - somatic cell counts.

The regression line illustrated in Figure 1 describes the linear relationship between total milk production and fat yield (kg). The positive slope of the regression line indicates that increases in fat yield are associated with corresponding increases in total milk production, thereby confirming a direct and positive relationship between these two productive parameters [8, 9].

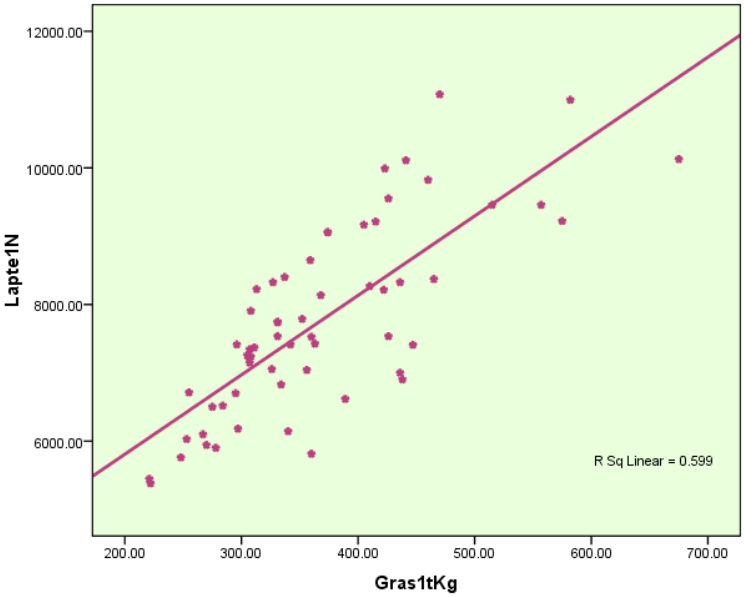

Figure 1. *Right regression for quantity of milk [kg] and fat [kg] in RBS breed*

The coefficient of determination ($R^2 = 0.599$) indicates that approximately 59.9 % of the variability in milk production can be explained by variation in fat yield. This result suggests that fat production is a relevant indicator of overall milk yield; however, it also highlights the contribution of additional biological, genetic, and management-related factors to the remaining unexplained variability.

Table 3 presents the mean productive performance of the MB and RBS breeds, emphasizing both the absolute and relative differences observed between the two populations.

Table 3. *Average productive performance per breed of ascendancy /absolute and relative (+/-)*

Indicator	MB	RBS	Absolute difference (RBS – MB)	Relative difference [%]
Average milk production/lactation [kg]	6,258.38	7,530.25	+1,271,87	+20.3%
Fat [%]	3.99	4.07	+0.08	+2.0%
Protein [%]	3.49	3.40	−0.09	−2.6%
Total fat [kg]	250.00	305.00	+55.00	+22.0%
Total protein [kg]	218.74	259.97	+41.23	+18.9%
Fat + Protein [kg]	467.75	564.97	+97.22	+20.8%
Milk /day [kg]	20.03	15.66	−4.37	−21.8%
Duration of lactation [days]	473.55	354.15	−119.40	−25.2%

MB- Maramureș Brown; RBS- Romanian Black-Spotted

Ascendant cows of the RBS breed achieved a significantly higher average milk yield per lactation, exceeding that of the MB breed by 1,271.87 kg, which corresponds to a relative increase of 20.3 %. This difference confirms the superior capacity of the RBS breed to

produce higher milk volumes during a standard lactation. At the same time, milk fat content (%) was slightly higher in the RBS breed, by 0.08 percentage points (+2.0 %), indicating a modest but consistent advantage in terms of milk quality [10, 11].
With respect to protein content (%), the MB breed recorded marginally higher values, with a difference of 0.09 percentage points in its favor (corresponding to a decrease of 2.6 % for the RBS breed). Nevertheless, owing to its higher milk yield, the RBS breed produced substantially greater total quantities of milk components. Total fat yield was higher by 55.00 kg (+22.0 %), while total protein yield exceeded that of the MB breed by 41.23 kg (+18.9 %). The combined fat and protein yield (F+P), a key indicator for evaluating the economic value of milk production, was also superior in the RBS breed by 97.22 kg, representing a relative increase of 20.8 %.
In contrast, average daily milk yield was higher in the MB breed, which exceeded the RBS breed by 4.37 kg/day, corresponding to an increase of 21.8 %. This difference is closely associated with the longer lactation duration observed in MB cows, whose lactation period exceeded that of the RBS breed by 119.40 days (+25.2 %) [11, 12].
The regression line shown in Figure 2 describes the relationship between the amount of fat produced (kg) and the total milk production, expressed in a strongly correlated linear form.

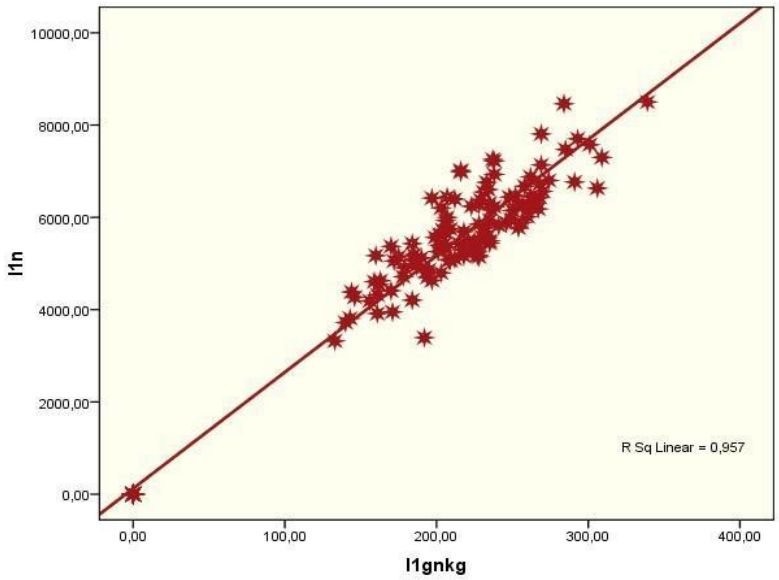

Figure 2. *Right regression for milk [kg] and fat [kg] at MB*

The distribution of the points around the regression line indicates a strong correlated linear relationship between the two characters, confirmed by the high value of the coefficient of variation ($R^2 = 0.957$).
Table 4 presents the main statistical values for milk quality in order to carry out a comparative analysis between the two breeds, based on the data obtained both from the evaluation of maternal ascendancy and from the performances recorded in a normal lactation. Includes mean values, character variability in herd, variation ranges and levels of statistical significance of race differences determined by *t*-test. This approach allows highlighting the genetic and productive differences between the two breeds, as well as

assessing their potential for milk production and the quality of its components under similar exploitation conditions [13, 14].

Table 4. *Comparison of quantitative and qualitative characteristics of milk production at the ascendancy of MB and RBS breeds*

Analytical character	Breed	n	Mean±SD	Minimum	Maximum	Statistical significance (*t*-test)
Milk production [kg]	MB	34	6,258.38 ±716.82	5308	8286	$p < 0.001$
	RBS	77	7,530.25 ±1,170.94	4239	10017	
G [%]	MB	34	3.99±0.27	3.56	4.63	$p > 0.05$
	RBS	77	4.07±0.12	3.74	4.34	
G [kg]	MB	34	250.00 ± 33.11	204	308	$p < 0.001$
	RBS	77	305.00 ± 45.74	167	404	
P [%]	MB	33	3.49± 0.15	3.21	3.91	$p < 0.01$
	RBS	77	3.40± 0.14	3.11	3.73	
P [kg]	MB	34	218.74± 26.58	170	270	$p < 0.001$
	RBS	77	259.97 ± 47.11	134	409	
(G+P) [kg]	MB	32	467.75 ± 58.80	386	578	$p < 0.001$
	RBS	77	564.97 ± 89.32	301	745	
Milk production LN1 [kg]	MB	38	5,683.26 ±556.30	4797	6722	$p < 0.001$
	RBS	60	7,746.67±1,377.07	5380	11076	
G [%] NL1	MB	38	4.04± 0.30	3.21	4.44	$p < 0.05$
	RBS	60	4.12±01	3.8	4.53	
P [%] NL1	MB	38	3.47± 0.14	3.28	3.77	$p < 0.05$
	RBS	60	3.43±01	3.03	3.71	
SCC [thousand·mL^{-1}]	MB	47	157.64 ±116.03	27	521	$p < 0.05$
	RBS	77	118.04 ±235.56	2	1222	
Milk production [kg·day^{-1}]	MB	48	20.03± 6.07	14	36.06	$p < 0.01$
	RBS	77	15.6±3.0	9.8	22.5	

G - fat; P - protein; NL1 - normal lactation 1; SCC - somatic cell counts.

The comparative analysis of milk production and quality traits between the Maramureș Brown (MB) and Romanian Black-Spotted (RBS) breeds revealed statistically significant differences for most of the evaluated parameters. Average milk yield in the maternal ascendancy was significantly higher in the RBS breed compared to the MB breed (7,530.25 ± 1,170.94 kg *vs.* 6,258.38 ± 716.82 kg), with the difference being highly significant ($p < 0.001$). This pattern was also maintained during the first normal lactation, in which RBS females achieved significantly higher milk yields than their MB counterparts ($p < 0.001$).

Total fat and protein yields, expressed in kilograms, were significantly greater in the RBS breed in both the maternal ascendancy and the first lactation, resulting in higher combined fat and protein production in milk ($p < 0.001$). Regarding milk composition, fat percentage in the maternal ascendancy did not differ significantly between the two breeds ($p > 0.05$); however, during the first normal lactation, the RBS breed exhibited slightly but significantly higher fat content values ($p < 0.05$).

In contrast, milk protein percentage was significantly higher in the MB breed, both in the maternal ascendancy and in the first normal lactation ($p < 0.05$), indicating a qualitative advantage of this breed with respect to protein concentration.

Somatic cell counts were significantly lower in the RBS breed ($p < 0.05$), reflecting superior hygienic quality of the milk. Conversely, average daily milk yield was significantly higher in the MB breed ($p < 0.01$), suggesting a stronger daily production capacity despite lower total lactation yield.
Overall, these results highlight the superiority of the RBS breed in terms of total milk production, while the MB breed is distinguished by higher milk protein content and greater daily milk yield.

CONCLUSIONS

The findings of the present study highlight clear and consistent differences between the Maramureș Brown (MB) and Romanian Black-Spotted (RBS) breeds with respect to milk production and quality traits under semi-intensive management conditions. The RBS breed was characterized by significantly higher average milk yields at both the maternal ascendancy level and during the first normal lactation, confirming its predominantly quantitative genetic orientation. This superiority in milk volume was directly reflected in higher total yields of fat and protein, expressed in kilograms, as well as in a greater overall economic value of milk production.
In contrast, the MB breed exhibited a marked qualitative advantage, expressed through a higher milk protein percentage and comparable or slightly higher fat content, traits that are particularly important for milk processing and the production of value-added dairy products. In addition, the MB breed showed higher daily milk yield and a significantly longer lactation duration, indicating good lactation persistence and a favorable adaptation to production systems with lower technological intensity.
Somatic cell counts were lower in the RBS breed, suggesting superior hygienic quality of milk, whereas the higher lactose content observed in MB milk indicates improved metabolic balance and appropriate mammary gland functionality. The differences identified between the two breeds reflect both their specific genetic characteristics and the influence of farm-level management and feeding strategies applied under the studied conditions.
The statistically significant differences associated with maternal ascendancy, daily milk yield, and somatic cell count emphasize the importance of incorporating maternal performance into selection programs, alongside the implementation of breed-specific management practices. Continued genetic improvement aimed at increasing milk yield while maintaining milk quality and ensuring continuous monitoring of mammary health may contribute to enhanced genetic efficiency, stability of productive performance, and long-term sustainability of dairy production systems, while also supporting the conservation of indigenous genetic resources.
Overall, the results indicate that the RBS breed is better suited to production systems focused on maximizing milk quantity, whereas the MB breed demonstrates valuable potential for higher-quality milk production and is particularly recommended for farms oriented toward milk processing and the preservation of local genetic resources. These conclusions support the need for differentiated breeding strategies tailored to the specific characteristics of each breed, with an emphasis on balancing productive performance, milk quality, and the sustainability of animal production systems.

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