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Changes in Some Blood Haematochemical Parameters of Maltese Goats During Lactation

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Abstract: The course of some haematochemical parameters sensitive to variations due to lactation in Maltese goats during the 2nd and the 4th lactation has been investigated. Total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, β-hydroxybutyrate, total protein, urea, calcium, phosphorus values were determined in Maltese goats during lactation in 2 different groups. The purpose was to determine if there are sustained modifications in the levels of these parameters due to lactation between two groups and within groups. Twelve goats were divided into two groups, each consisting of 6 subjects: Group A aged 14 months at the second lactation and group B aged 22 months at the fourth lactation. Through a simultaneous monitoring equipment and a blood collection by means of a jugular venipuncture, some parameters were assessed for each subject on the following experimental conditions: at 30th, 60th, 90th, 120th and 150th day after parturition. The Bonferroni's test was applied to determine statistical significances within each group and between groups, respectively. With regards to lactation stage, statistically significant differences were observed for all the studied parameters within each group whereas no statistically significant differences were observed between group A and B. These results suggest that lactation curve is responsible for the changes in concentration of the parameters under investigation.

Key words: Haematochemical parameters, lactation, goats, collection, modification

INTRODUCTION

The determination of the main blood serum biochemical parameters of sheep or goats is very helpful for the veterinarian so as to confirm the clinical diagnosis, to estimate the severity of the cases, to apply the appropriate treatment and to evaluate the outcome (Roubiens *et al*., 2006). To interpret biochemical data correctly, the results obtained in the laboratory must be compared with values corresponding to reference values (Yokus *et al*., 2006). But it is unequivocal that a large number of factors such as status species, breed, sex, age, nutrition, illness and seasonal variations, can affect the pattern of serum chemistry values (Swanson *et al*., 2004; Nazifi *et al*., 2003; Pernthaner *et al*., 1993). Several investigators have studied the variations in the concentration of clinical chemical parameters in goats in relation to physiological conditions (Mbasa and Poulsen, 1991; Okorie and Anugwa, 1986; Mbassa *et al*., 1989) such as in pregnancy and lactation. It was observed that during pregnancy and lactation maternal metabolic activities are strained due to foetal and off-spring growth requirements which pose extra demands for water and nutrients (Maltz and Shkolnik, 1984).

In literature little information is available about metabolic modifications during lactation. The effects of first gestation and lactation on bone metabolism in dairy goats and milk sheep (Liesegang *et al*., 2005) were studied. Results suggest that the calcium requirements for milk production have a significant effect on maternal mineral and skeletal homeostasis during lactation.

The adjustments and effects of pregnancy and lactation on plasma and serum biochemical parameters in cows and sheep have been described (Manstorn *et al*., 1975; Siggurdson, 1988). Findings suggest the influence of dietary protein on same biochemical blood constituents in late pregnancy and during lactation.

Pregnancy and lactation are considered as the most critical periods in small ruminants; but the influence of lactation on clinical chemical parameters in relation to age in goats has not, however, been adequately investigated.

As far as we know, some studies have been carried out on effect of lactation on theblood serum biochemical parameters in ewes (Alonso *et al*., 1997; Durak and Altiner, 2005) while in goats, only few investigations were performed (Min *et al*., 2005; Salama *et al*., 2005).

On such basis this study was undertaken to determine the course of some haematochemical

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parameters subject to alterations due to lactation in goats, during the 2nd and 4th lactation.

MATERIALS AND METHODS

Twelve female well-fed were used in the experiment. All animals were clinically healthy and free from internal and external parasites. They were treated for endoparasites control twice a year and their health status was monitored by veterinarians regularly.

Goats differed for the number of lactations; hence animals were divided in 2 groups: Six goats aged 14 months with a body weight of 45±2 kg at the 2nd lactation (group A) and 6 goats aged 22 months with a body weight of 50±2 kg at the 4th lactation (group B).

Feeding was based on mixed pasture, integrated with 1 kg per animal/day of a special diet for lactating goats (DM 87.2%, CP 15.5%, CF 26.3%, NSC 35.7%, FUM 0.84kg; composition was calculated on dry matter basis) and administered after the milking. Blood samples, 10 mL each, were collected through jugular venipuncture, using vacutainer tubes (Terumo Corporation, Japan) with no additive. Recordings and collections were done every 30 days for 5 months at the time 08:00 am. Blood samples were clotted at room temperature for 1 h and centrifuged at 3000 rpm for 10 min sera were separated and until analyses stored at -20°C. Sera were analysed with commercially available kits by means of a UV spectrophotometer (model Slim SEAC, Firenze, Italy). Serum concentrations of the following hematochemical parameters were analyzed: total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, β-hydroxybutyrate, total protein, urea, calcium and phosphorus.

To compare overall parameters studied, two-way repeated measures Analysis of Variance (ANOVA) was used followed by posthoc analysis using the Bonferroni test with significance set at $p = 0.05$. All results were expressed as mean±Standard Deviation of the means (SD). Data were analyzed using STATISTICA 5.5 (Stat Soft Inc.) software package.

RESULTS

Table 1 and 2 show average values of the parameters considered, expressed conventional units of measurement

Table 1: Average values of the parameters considered, expressed in their conventional units of measurement with the related standard deviations and statistical significance observed in different experimental conditions in 6 Maltese goats, aged 14 months, at second lactation

	Experimental conditions				
	Group A				
Parameters (mmol L^{-1})	30th day	60th day	90th day	120th day	150th day
Total cholesterol	90.83±7.08●	74.67±8.89	74.67±12.63	70.50±7.12	86.50±5.79●
HDL-Cholesterol	50.00±7.10■	41.00±2.76	39.50±3.21	35.17±5.19	40.00±5.48
LDL-Cholesterol	38.83±5.56	31.00±6.90	32.67±10.63	33.00±6.03	43.00±8.00●
Triglycerides	10.50±0.84	12.33±2.80	13.17±1.94	12.00±1.41	17.50±5.17●
β-hydroxybutyrate (mg dL^{-1})	5.58±1.22■	4.15±0.71†	2.40±0.41	2.38±0.55	2.28±0.48
Total protein (g L^{-1})	7.28±0.15	7.25±0.44	7.27±0.22	6.92±0.32○	7.10±0.17
Urea	7.10±0.73	6.08±1.17	8.52±0.97♦◊	8.02±1.24*	6.94±0.73
Calcium	1.95±0.14	1.96±0.24	2.02±0.11	2.10±0.12♦	2.17±0.09○
Phosphorus	2.30±0.86	2.29±0.29	2.31±0.71	1.96±0.55	1.97±0.90

Significance: ♦ vs 30th day $p<0.05$; ◊ vs 60th day $p<0.05$; * vs 90th day $p<0.05$; † vs 90th, 120th and 150th day $p<0.05$; ○ vs 30th, 60th and 90th day $p<0.05$; ● vs 60th, 90th and 120th day $p<0.05$ and ■ vs 60th, 90th, 120th and 150th day $p<0.05$

Table 2: Average values of the parameters considered, expressed in their conventional units of measurement with the related standard deviations and statistical significance observed in different experimental conditions in 6 Maltese goats, aged 22 months, at fourth lactation

	Experimental conditions				
	Group A				
Parameters (mmol L^{-1})	30th day	60th day	90th day	120th day	150th day
Total cholesterol	100.17±21.55●	78.67±11.66	79.33±12.55	75.67±10.52	96.83±9.72●
HDL-Cholesterol	54.50±7.23■	43.33±4.76	41.67±6.28	38.00±8.34	43.33±6.50
LDL-Cholesterol	43.50±14.04	33.17±7.14♦	35.17±7.31	36.00±6.87	49.67±6.44●
Triglycerides	11.00±0.89	10.67±2.07	13.17±1.17	10.00±0.89*	19.00±2.37●
β-hydroxybutyrate (mg dL^{-1})	5.23±1.43†	4.72±1.04†	2.57±0.33	2.24±0.45	2.75±1.44
Total protein (g L^{-1})	7.25±0.14	7.13±0.30	7.13±0.14	6.87±0.21♦	7.03±0.16
Urea	6.64±1.27	5.72±0.67	7.69±0.64◊	6.77±0.78	6.06±1.25*
Calcium	1.95±0.12	1.91±0.09	1.89±0.07	2.09±0.08○	2.1±0.15○
Phosphorus	2.50±0.39	2.29±0.50	2.41±0.56	2.04±0.24	1.67±0.19*♦

Significance: ♦ vs 30th day $p<0.05$; ◊ vs 60th day $p<0.05$; * vs 90th day $p<0.05$; † vs 90th, 120th and 150th day $p<0.05$; ○ vs 30th, 60th and 90th day $p<0.05$; ● vs 60th, 90th and 120th day $p<0.05$ and ■ vs 60th, 90th, 120th and 150th day $p<0.05$

with standard deviations and statistical significance observed in different experimental conditions in group A and B.

By applying a two-way repeated measures analysis of variance, the following results were obtained: total cholesterol (lactation: $F_{(1,40)} = 5.16$, $p = 0.04$; time: $F_{(4,40)} = 27.79$, $p<0.0001$; interaction: $F_{(4,40)} = 0.56$, $p = 0.69$), HDL-cholesterol (lactation: $F_{(1,40)} = 1.33$, $p = 0.27$; time: $F_{(4,40)} = 17.06$, $p<0.0001$; interaction: $F_{(4,40)} = 0.30$, $p = 0.87$), LDL-cholesterol (lactation: $F_{(1,40)} = 1.33$, $p = 0.27$; time: $F_{(4,40)} = 9.63$, $p<0.0001$; interaction: $F_{(4,40)} = 0.24$, $p = 0.91$), triglycerides (lactation: $F_{(1,40)} = 0.24$, $p = 0.63$; time: $F_{(4,40)} =$

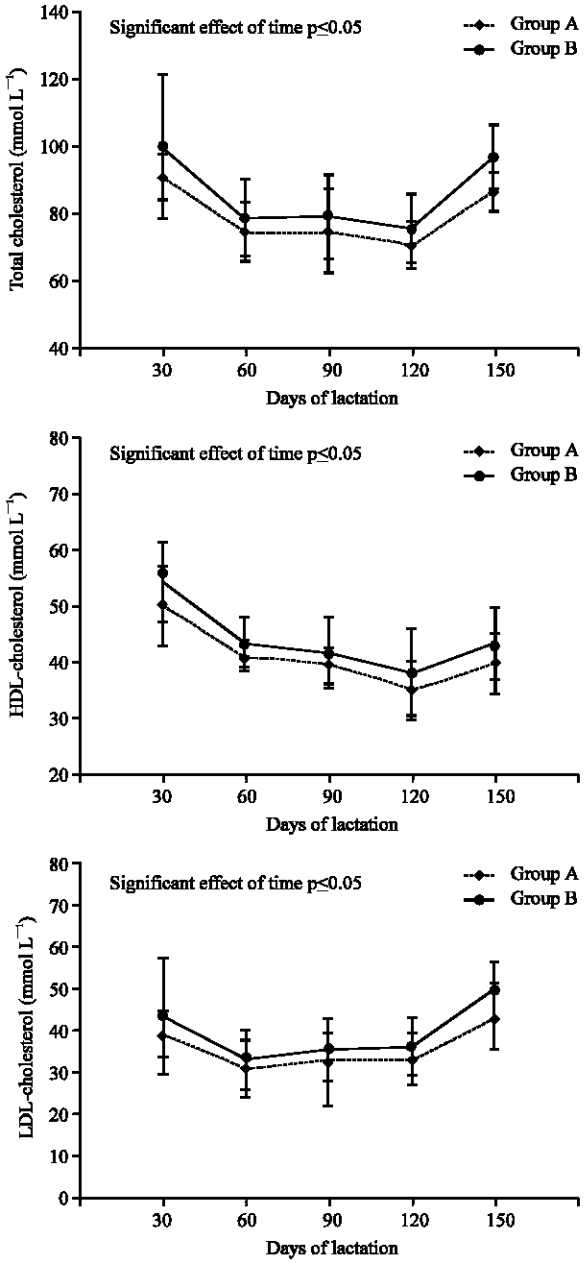

Fig. 1: Total cholesterol, HDL-cholesterol and LDL-cholesterol (mmol L^{-1}) mean value trend, with SD obtained on the different experimental conditions in goats of Group A and B

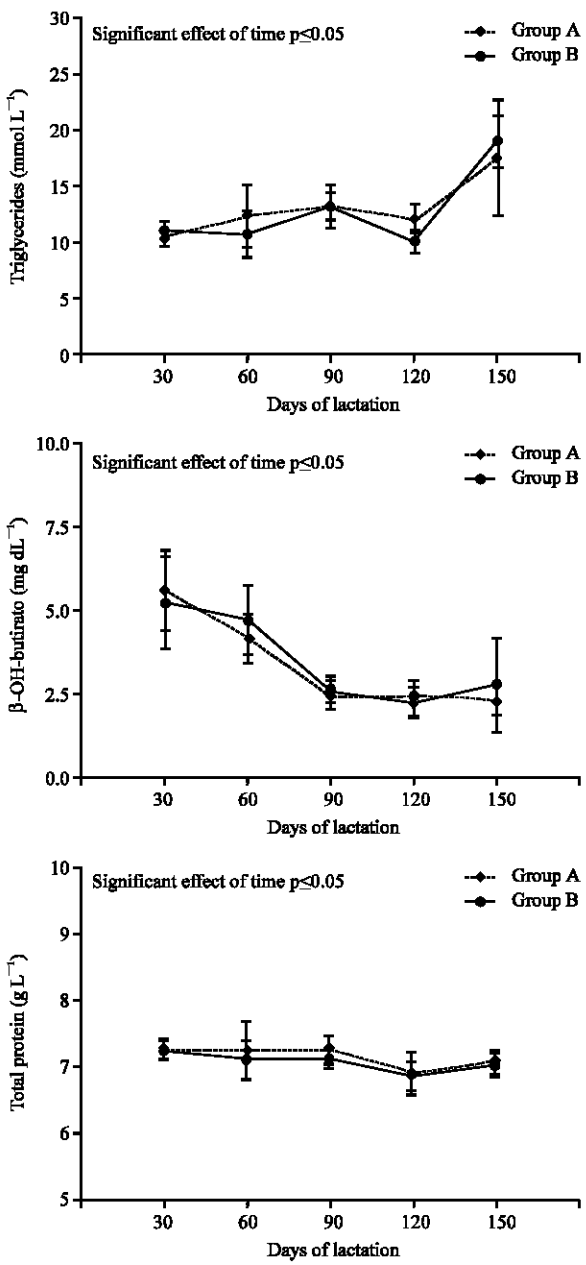

Fig. 2: Triglycerides (mmol L^{-1}), β-hydroxybutyrate (mg dL^{-1}) and total protein (g L^{-1}) mean value trend, with SD obtained on the different experimental conditions in goats of group A and B

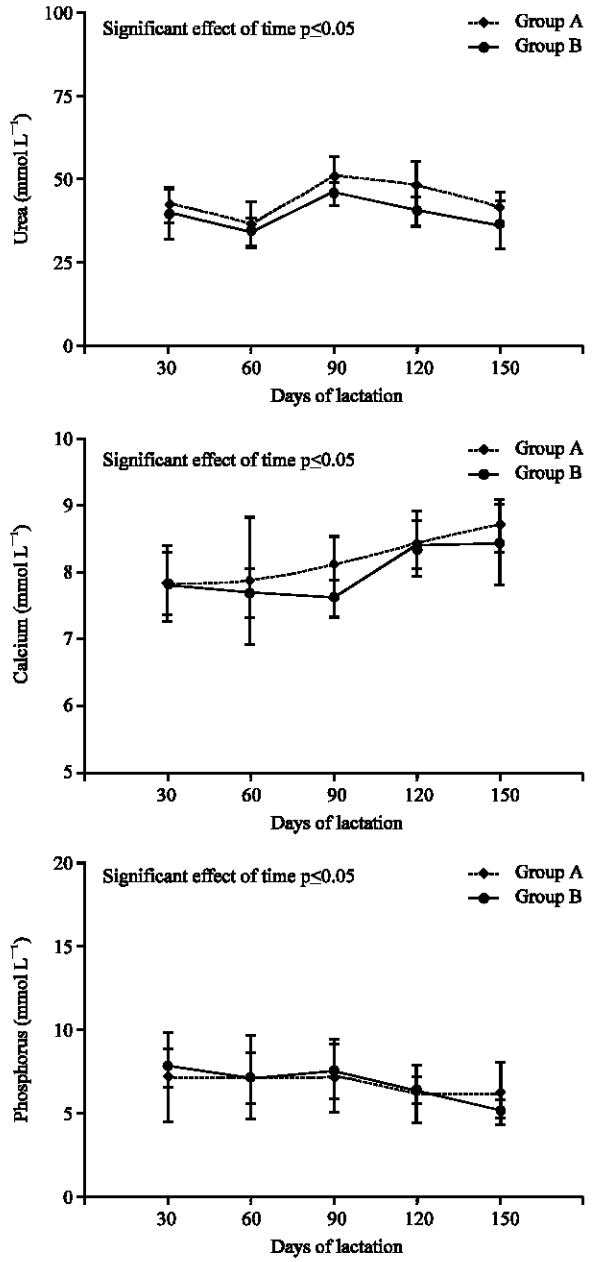

Fig. 3: Urea, calcium and phosphorus (mmol L^{-1}) mean value trend, with SD obtained on the different experimental conditions in goats of group A and B

23.37, p<0.0001; interaction: $F_{(4,40)}$ = 1.31, p = 0.28), β-hydroxybutyrate (lactation: $F_{(1,40)}$ = 0.29, p = 0.59; time: $F_{(4,40)}$ = 30.62, p<0.0001; interaction: $F_{(4,40)}$ = 0.60 p = 0.66), total protein (lactation: $F_{(1,40)}$ = 1.06, p = 0.32; time: $F_{(4,40)}$ = 5.20, p = 0.0018; interaction: $F_{(4,40)}$ = 0.11, p = 0.97), urea (lactation: $F_{(1,40)}$ = 3.47; p = 0.09; time: $F_{(4,40)}$ = 9.76, p<0.0001; interaction: $F(4,40)=0.20, P=0.93)$, calcium (lactation: $F_{(1,40)}$ = 0.88, p = 0.37; time: $F_{(4,40)}$ = 9.52, p<0.0001; interaction: $F_{(4,40)}$ 0.66, p = 0.62), phosphorus (lactation: $F_{(1,40)}$ = 0.00, p = 0.95; time: $F_{(4,40)}$ = 3.44, p = 0.0165; interaction: $F_{(4,40)}$ = 0.49, p = 0.74) (Fig. 1-3).

These results do not show statistically significant changes due to lactation number between the two groups; indeed the curves of all examined parameters do overlap. No interaction between studied parameters could be detected but a significant effect of lactation stage for all parameters considered was found in both groups.

In present study total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, βhydroxybutyrate, total protein, urea, calcium and phosphorus values were within the physiological range for goats (Kaneko, 1989).

DISCUSSION

The analysis of obtained data outline statistically significant differences due to lactation stage either within group A and B.

Total cholesterol shows a significant decrease (p<0.001) at day 60, 90, 120 compared to day 30 and a significant increase (p<0.01) at day 150 compared to day 60, 90, 120 in both groups.

As previously observed by Nazifi *et al.* (2000) there is a significant positive correlations between the time of sampling and serum cholesterol. It was noted that cholesterol concentrations were the highest at day 30 and 150 probably because during the midlactation period, there is a strong reduction in lipogenesis and esterification and an increase in norepinephrine and epinephrine-stimulated free fatty acid release. The lipoprotein lipase activity in adipose tissue decreases while it increases in the mammary gland. This metabolic shift precedes the energy demand for lactation and is stimulated by prolactin, the triggering factor for the onset of lactation.

HDL-cholesterol shows a significant decrease (p<0.01) at day 60, 90, 120 and 150 compared to day 30 in both groups.

LDL-cholesterol shows a significant decrease (p<0.05) at day 60 compared to day 30 in group B only. LDL-cholesterol shows a significant increase (p<0.05) at day 150 compared to day 60, 90 and 120 in both groups.

During lactation and lactation-pregnancy, very low-density lipoprotein lipids concentration is significantly lower than during the dry period. The low VLDL lipids during lactation and lactation-pregnancy are associated with increased Low-Density Lipoprotein (LDL) and High-Density Lipoprotein (HDL) lipids at a time when milk production is at a peak (Nazifi *et al.*, 2003).

Triglycerides show a significant decrease (p<0.05) at day 120 compared to day 90 in group B and a significant increase (p<0.01) at day 150 compared to day 30, 60, 90, 120 in group A and B.

Watson *et al.* (1993) reported that after foaling, the concentrations of triglycerides and VLDL decreased significantly because of increased lipoprotein lipase activity consistent with the induction of the enzyme in mammary tissue to provide for milk fat synthesis. Watson *et al.* (1995) reported that during lactation in cats, the concentrations of triglycerides decreased owing to reductions in VLDL-cholesterol and LDL-cholesterol concentrations. These changes, as resulted by our data, are associated with alterations in activities of lipoprotein lipase which increases after parturition and hepatic lipase that increases during pregnancy and lactation. In our study triglyceride concentrations increase during late lactation according with Gradinski-Vrbanac *et al.* (1986) that reported that during pregnancy the serum triglyceride content was high than during lactation.

β-hydroxybutyrate shows a significant decrease ($p<0.05$) at day 60, 90, 120 and 150 compared to day 30 in group A and a significant decrease ($p<0.05$) at day 90, 120 and 150 compared to day 30 in group B. Another β-hydroxybutyrate shows a significant decrease ($p<0.01$) at day 90, 120 and 150 compared to day 60 in group A and B.

In contrast to Sakha *et al.* (2002) that reported an increase of the concentration of blood β-hydroxybutyrate during lactation compared to the dry period in Iranian Holstein cow, the results of this study show a decrease of this parameter in the same phase in goats of Maltese breed. In fact, lactation and pregnancy, too, are physiological stages considered to induce metabolic stress and in does, there is great variation in the haematological and biochemical parameters during different physiological stages and between breeds and animals (Iriadam, 2006).

Total protein show a significant decrease ($p<0.05$) at day 120 compared to day 30, 60, 90 in group A and a significant decrease ($p<0.05$) at day 120 compared to day 30 in group B.

In sheep a decrease in total protein was observed at parturition (Vihan and Rai, 1983) these changes in plasma protein might represent an adaptive response to the higher need of water mobilization by blood to mammary glands for milk production. For this reason, in the period of lactation the values of total protein do not change.

Urea shows a significant increase ($p<0.05$) at day 90 compared to day 30 and 60 in group A; it shows a significant decrease ($p<0.05$) at day 120 and 150 compared to day 90 in group A and only at day 150 compared to day 90 in group B.

According to Mbassa and Poulsen (1991) urea concentration decreases in early and mid-lactation and increases in late-lactation in cows, while in our study in Maltese goats urea concentration decreases in early and late-lactation and increases in mid-lactation; these differences are probably due to the changing level of dietary protein intake in the course of lactation.

Calcium shows a significant increase ($p<0.05$) at day 120 and 150 compared to day 30 in both groups, at day 120 compared to day 60 and 90 in group B and at day 150 compared to day 60 and 90 in group A and B.

Unlike urea concentration, calcium modifications are not related to nutrition but they are probably related to seasonal factors rather than physiological status. Nevertheless the effect of these seasonal factors is not always uniform, therefore further investigations are needed on this topic (Biagi *et al.*, 1987). Indeed increased bone remodeling during lactation may represent physiological mechanisms to help replace the maternal skeleton lost as the animal adapted to enormously increased Ca losses to the foetus and milk in late gestation and early lactation (Liesegang *et al.*, 2005).

Phosphorus shows a significant decrease ($p<0.01$) at day 150 compared to day 30 in group B and a significant decrease ($p<0.05$) at day 150 compared to day 90 in group B. As showed in literature, serum concentration of calcium and phosphorus are correlated; so, the adsorption of phosphorus is influenced by calcium (Arienti, 1996). More specifically, phosphorus modifications decrease in late-lactation and not in early-lactation, are due to the opposite effect of calcium in the same period of lactation.

CONCLUSION

The results of the present research confirm that lactation represents a very important metabolic moment. In Maltese goats as in other small ruminants changes observed for individual haematochemical parameter are mostly related to physiological status. Therefore, our results further support previously confirm further the date demonstrated previously.

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