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THE FEATURES OF SHEEP ADAPTATION TO THEIR KEEPING IN MOUNTAINOUS CONDITIONS

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Abstract:

A significant amount of precipitation is the main obstacle to the promotion of cultivated sheep breeds in mountainous conditions. In scientific literature, there are individual authors' statements that such sheep in the mountains feel oppressed. As a result of heavy rains their fleece quickly gets wet, and than gets dry for a long time. That is why sheep become heavy and often die of colds. On mountain pastures it is often observed that sheep with thin and semi-thin wool stand motionless and helpless in the rain, and sheep with half-rough and coarse wool continue to graze even in the rain. These observations served as the basis for experiments on the adaptability of sheep in mountainous conditions. The scientific-production experiments were conducted in distant-mountain maintenance of the Republic of North Ossetia-Alania. Under the experience were fine-Tushino hybrids with different types of wool and fleece structure. The first group was formed from the ewes with fine wool and staple fleece structure; the second group consisted of the sheep with semi-thin wool and staple-braid structure of fleece; the third group consisted of the sheep with semi-rough wool and staple-braid structure of fleece; the fourth group consisted of the sheep with the braid structure of fleece. The skin and the wool were taken of all the experimental ewes before the start of the experiments. The studies on the morphology of the skin were carried out according to the method of Diomidova N. A. Panfilova, E. P. and Suslina E.S. It is found that the different fleece structures in sheep are due to the differences in the structure of the skin, location of the follicles in the skin, their size and density. There is the highest density of hair follicles in the group of animals, having staple fleece structure, they have a less depth and length of hair follicles and thinner skin compared to the sheep, which have braid and staple-braid fleece structure. The nature and the duration of water runoff, as well as the drying time of the sheep's wool with various fleece structure are different. In sheep with braid and staple-braid fleece structure water does not penetrate deep into the fleece during precipitation, it flows intensively, a small amount of it stays in the wool cover and evaporates quickly. Water penetrates deep into the fleece and the skin of the sheep with a staple structure, and a significant amount of it stays in their fleece.

Key words: fleece, staple structure, braid structure, staple-braid structure, skin thickness, skin layers, follicles.

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INTRODUCTION:

More than 600 breeds and genetically distinct groups of sheep of different productivity are bred in the world, depending on the natural and economic conditions, as well as ethnic and other characteristics. The cultivated sheep breeds predominate in economically developed countries, thin or semi-thin wool and high-quality lamb are their main products. Rough-woolen sheep breeds predominate in other countries.

In modern conditions, rough-woolen sheep breeding is important [1,2], especially for the regions of the North Caucasus, with vast areas of mountain hayfields and pastures with wide variety of high nutrient content of vegetation [3-9]. However, these mining mountain resources are not effectively used. Nowadays, the load per one hectare is less than 2 heads of sheep, while the yield and nutritional value of mountain pastures can provide at least 5-6 heads of sheep per hectare for 4-4.5 months [10-16].

One of the reasons for inefficient use of mountain forage resources is associated with a reduction in the number of coarse-haired sheep breeds, well adapted to extreme conditions of mountain keeping [17-20]. Solving the problem of the local coarse-wooled breeds' wool productivity improvement, the breeders crossed them with the various fine-wooled rams. Poor survival, weakened constitution and, consequently, low productivity were showed in the process of such a long-term crossing between a hybrid with a high proportion of blood of fine-wool and the sheep with thin and semi-thin wool in high-mountain pastures [21,22].

Professor Avsadzhanov G.S. and his students suggest that frequent changes in the weather during the day and a large amount of rainfall, depressing animals with thick wool, as a consequence of the strong moisture content of fine-wool and semi-fine-wool sheep are the obstacle to breeding sheep with thin and semi-thin wool in mountainous areas. The wool of such sheep gets dry for a long time, so it becomes heavy, and at night the temperature is greatly reduced and the sheep get colds in the mountains [23-35].

The experimental studies were carried out to confirm this hypothesis and obtain objective indicators of the water-protective properties of sheep's fleece, so to determine the desired type of sheep, adapted to the extreme conditions of mountain keeping.

THE MATERIALS AND METHODS OF THE RESEARCH:

Scientific-production experiments were conducted in distant-mountain maintenance of the North Ossetia-Alania in 2018. Fine fleece-Tushino hybrids with a different type of coat and fleece structure were under the experience. The first group was formed from the ewes with fine wool and staple fleece structure; the second group consisted of the sheep with semi-thin wool and staple-braid structure of fleece; the third group consisted of the sheep with semi-rough wool and staple-braid structure of fleece; the fourth group consisted of the sheep with rough wool and the braid structure of fleece.

The skin and the wool were taken of all the experimental ewes before the start of the experiments. The studies on the morphology of the skin were carried out according to the method of Diomidova N. A. Panfilova, E. P. and E. S. Suslina. 1960. [36]

All the samples of the skin and the wool were taken from the right side in a supine position, before feeding the animal. The samples were enclosed between pieces of the labeled thick paper. Fixation was made in 10% formalin during a day, after that they were transferred to 5% formalin, for longer-term of preservation. After the 12-hour washing in running water, the skin pieces were placed in 18% gelatin solution for a day, then they were transferred to a stronger 25% gelatin solution for 2-3 hours and compacted in formalin vapor for 12 hours. Before preparation of products the blocks were stored in 4% formalin solution. Before preparing the skin sections, gelatin blocks were being washed for 15-20 minutes in running water, the sample was released from gelatin and transferred to the table of the freezing microtome.

The horizontal sections were cut at the level of sebaceous glands 10-15microns thick, parallel to the surface of the skin.

The Vertical sections were made with a thickness of 20-30 microns. The skin slices were put into distilled water for 5 minutes, and then into 50-s % alcohol for 2 minutes and after that in a solution of Sudan III for fat inclusions staining in the sebaceous glands of the skin for (15-20 minutes). From Sudan III, the sections were placed into the 50-s ' % alcohol for 2 minutes, then in distilled water, and after that in hematoxylin Karracci for 10-20 minutes (for staining the connective tissue of the skin to stiff fully), then sections were transferred to running water where they were kept to complete deposition of nuclear substances in the cells of the hair follicles. For a short time sections were placed in distilled water after hematoxilin Karracci, and then they were caught with a glass hook on the slide. A mixture of gelatin and glycerin was carefully dripped onto the straightened sections, then the sections were covered with a covering glass. The product dried and was ready to use for several hours.

The thickness of the epidermis, pilar and reticular layers, the depth of primary (PF) and secondary hair follicles (VF), the width of the primary follicles and secondary hair follicle depth, the width of the sweat glands, the length and the width of the sebaceous glands, the cross-sectional diameter of the collagen fibers were determined on vertical sections. The number of primary and secondary fibers was calculated on the horizontal sections of the skin, and at a younger age of lambs – and rudimentary secondary fibers both in the hair group and on 1 mm2 of the skin.

In addition to these indicators, the following values were also determined by calculations: the ratio of the sawn layer thickness to the reticular; the ratio of the secondary follicles number to the primary ones in the hair group and per a unit area of the skin; the ratio of the primary fibers to the secondary fibers; the ratio of the depth of the primary hair follicles to the depth of the secondary follicles.

The wool thinness was determined with an accuracy - 0.5 of an ocular ruler division under a microscope (at the magnification of 10x40), equipped with an ocular micrometer. The wool samples were pre-washed. All materials were processed biometrically with the definition of criteria in necessary cases.

THE RESEARCH RESULTS AND THEIR DISCUSSION:

Studies have shown that animals with different fleece structure have different skin thickness (table.1).

The ewes of the fourth group with a braid fleece structure had the greatest thickness of the skin, the smallest thickness of the skin belonged to the fine-coarse-wool ewes of the first group, having a staple fleece structure. If the thickness of the IV-th group ewes' skin is taken for 100%, then this indicator in the ewes of the I-st, the II-nd and the III-rd groups will respectively be 92,5; 96,8; 94,9%. The differences in the thickness of the individual skin layers cause the differences in its total thickness, as it can be seen from the data, given in table 1, from which it follows that different experimental groups of sheep have their own characteristics in the development of individual layers of the skin. So, the thickness of the ewes with a staple fleece structure epidermis is by 5,7% greater than in ewes with a staple-braid fleece structure, at the same time the animals of the third and the fourth groups had almost the same indicators.

Table 1 - The Thickness of the Skin and the Individual Layers of the Experimented Ewes

Group	n	The Total Thickness of the Skin	The Thickness of the…					
			Epidermis		Pilar Layer		The Reticular Layer	
			mkm	%	mkm	%	mkm	%
I	9	2529,0 ± 51,67	22,7	0,90	1710	67,6	796	31,5
II	6	2648,0 ± 71,95	24,0	0,91	1771	66,9	853	32,2
III	13	2594,0 ± 51,58	24,0	0,93	1720	66,3	851	32,8
IV	9	2734,0 ± 40,10	23,7	0,87	1830	66,9	880	32,2

A more noticeable difference was observed between the I-st and the II-nd groups, in the thickness of the pilar (7,4%) and reticular (6,4%) skin layers. In animals of the III-rd and the IV-th groups, the difference in these indicators was from 3,4 – 3,6%.

The experimental groups of animals also differed in the depth of the hair follicles, as well as in the width of the hair follicles. From table 2 it is seen that with the transition from staple fleece structure, the depth of primary hair follicles increases. For example, the depth of primary hair follicles was the lowest in ewes, having a staple fleece structure, and that of the animals with the staple-braid fleece structure was the greatest. The ewes with a staple-braid fleece structure (the II-nd and the III-rd group), took an intermediate position.

The depth of the secondary hair follicles has the opposite pattern. The secondary hair follicles of the I-st ewes'group, having a staple fleece structure lie much deeper, than the ewes from the IV-th group, having a braid fleece structure.

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Table 2 – The Indicators of the Skin and Wool of the Experimental Sheep

Indicator	Group			
	I	II	III	IV
The Depth of the hair Follicles, mkm: - primary - secondary	 1709,0 ± 40,90 1295,0 ± 23,23	 1775,0 ± 56,64 1135,0 ± 19,18	 1722,0 ± 40,21 1098,0 ± 28,43	 1815,0 ± 49,93 1105,0 ± 32,94
The Width of the Hair Follicles, mkm: - primary - secondary	 130,0 ± 2,76 108,0 ± 1,83	 139,0 ± 1,59 111,0 ± 3,42	 136,6 ± 2,86 110,0 ± 2,51	 142,0 ± 1,83 111,0 ± 2,17
The Depth of the Sweat Glands	1740,5 ± 42,00	1795,0 ± 31,00	1712,0 ± 38,00	1815,0 ± 51,63
The Width of the Secretory Part of the Sweat Glands	100,0 ± 1,22	102,0 ± 2,61	108,0 ± 1,90	110,2 ± 2,50
The Length of the Sebaceous Glands	295,0 ± 3,60	317,0 ± 5,10	312,0 ± 8,61	316,0 ± 7,11
The Width of the Sebaceous Glands	99,9 ± 0,89	104,0 ± 1,98	106,0 ± 2,52	114,0 ± 1,63
The Diameter of the Collagen Fiber Bundles	14,4 ± 0,39	15,2 ± 0,49	15,8 ± 0,39	17,3 ± 0,35
The Length of the Hair	8,4 ± 0,33	12,8 ± 0,07	12,1 ± 0,45	16,3 ± 0,55
The Thickness of the Wool Fibers: - primary - secondary	 32,3 ± 0,71 24,9 ± 0,54	 34,9 ± 0,97 23,6 ± 0,45	 33,9 ± 0,62 27,0 ± 0,33	 36,0 ± 0,71 26,4 ± 0,46
The Number of the Hair Follicles in the Hair Group (Complex),pcs	12,5 ± 0,36	11,1 ± 0,47	11,2 ± 0,45	10,3 ± 0,09
The Number of the Hair Follicles in 1 mm2 skin, pcs	38,5 ± 1,45	35,0 ± 2,10	34,5 ± 2,46	32,2 ± 1,14

As a result of differences in the depth of the uterine follicles, the experimental groups had different indicators of the primary follicles and the secondary follicles depth ratio. These figures were, respectively, equal for these groups: the I-st – 1,32; the II-nd – 1,56; the III-rd – 1,57; the IV-th – 1,64. Therefore, the greatest indicator of the secondary follicles' depth ratio to the primary ones was that of the ewes from the IV-th group, the smallest secondary follicles' depth ratio belonged to the ewes from the I-st group.

The experimental ewes' groups differed also in the size of hair bulbs. The experimental groups of ewes had almost no difference with each other in the size of the secondary hair follicle bulbs, although the ewes with a staple-braid fleece structure have some natural advantage.

A different pattern is observed in the analysis of the primary follicle bulbs' width. The largest primary hair follicles' width belonged to the ewes from the IV-th group, the smallest primary hair follicles' width belonged to ewes from the I-st group with a difference of 9.2%. The ewes from the II-nd and the III-rd groups occupied an intermediate position between these extreme indicators, but the animals of II-nd group had larger bulbs than the animals from the III-rd group.

The experimental groups of ewes had not much difference in the size of the skin glands, although the animals with staple-braid fleece structure had some natural advantages (table 2). The experimental groups of ewes had corresponding differences in the thickness of collagen fiber bundles. The thickest bundles of collagen fibers belonged to the ewes from the IV-th group and were superior to those of the ewes from other groups. The thinnest bundles belonged to the ewes from the I-st group, the ewes from the II-nd and the III-rd groups occupied an intermediate position and had approximately the same indicators.

The analysis showed that the experimental groups of ewes differed in the length of the hair with the same sequence as in the thickness of the skin, i.e. the thicker the skin, the longer is the hair growing on it (table. 2).

The greatest length of wool belonged to the animals from the IV-th group, the smallest belonged to the I-st group. The ewes from the II-nd group had a longer wool comparing with the animals of the I-st group by 4,4 cm or 52,4%, the ewes from the IV-th group had a longer wool comparing with the animals of the III-rd group by 4,2 cm or 34,9% (P> 0,99). The finesse of the wool in experimental groups of animals has changed in accordance with the length of the hair. The longer the hair, the rougher it is, conversely, with a decrease in the length of wool the average cross-sectional diameter of the fibers also decreases.

Higher rates of cross-sectional diameter of primary fibers belonged to the ewes from the IV-th group, having the braid structure of the fleece, the smallest belonged to the I-st group, having the spun struc-

ture of the fleece. The thickness of the primary fibers in animals of the II-nd and the III-rd groups was approximately the same and occupied an intermediate position between the indicators of the I-st and the IV-th groups. A slightly different picture is shown by the thickness of the secondary fibers. The largest cross-sectional diameter of secondary fibers belonged to the animals of the III-rd group. The second place was occupied by the ewes from the IV-th group, the third place was to the I-st group, the fourth place was taken by the ewes from the III-rd group.

The data, showing the fineness PV/VV had a noticeable difference. For example, in the ewes with a staple-braid fleece structure, this indicator was, on average, more than that of ewes with a staple fleece structure.

The data on the number of hair follicles in the group and per unit skin area are presented in table 2. From the table it follows that the ewes from the I-st group have a larger amount of hair follicles than other animals' groups. The least amount of the hair follicles was in the animals of the IV-th group. The rest groups occupied a middle position. A similar pattern is obtained in the analysis of data, showing the ratio of the number of secondary follicles to primary follicles.

The distribution of the ewes' experimental groups by the number of hair follicles in the group (complex) is in good agreement with their distribution by the number of hair follicles per 1mm2 skin area.

The crossbred ewes, with a staple fleece structure, had the highest density of hair follicles, the sheep with braid fleece structure had the lowest density of hair follicles and, accordingly, lower density of wool.

It was found that the sheep with different fleece structure differed from each other, both in the structure of the skin and the physical properties of wool fibers. From the obtained data, it follows that the structure of the skin, such indicators as the number of hair follicles, their depth and width, the size of the hair follicle bulbs determine the physical properties of wool fibers, which is the main factor in the structure of sheep fleece, as can be seen from the picture.

The indicators of the thickness of the skin and its layers show that the thicker the skin, the longer and relatively coarser the wool is, and the thinner the skin – the thinner is the wool. The same pattern is observed along the length of the wool fibers, that is, the thicker the skin, the longer and relatively coarser the wool is in comparison with the thinner skin, which produces a shorter and thinner wool.

It is obvious that the sheep with different fleece structure have different reactivity to unfavorable climatic conditions of mountain keeping. Therefore, a special technique was developed to conduct the appropriate research about the waterproof properties of runes with different structures.

The skin area of each experimental animal was determined to obtain more accurate data, as the rate of the runoff and the amount of water remaining in the fleece depends on the total amount of water. That is, the area of the skin makes it possible to correctly calculate the amount of water necessary for irrigation of sheep with a hand shower. It is established that at the same rate of water outflow from the watering plant 2 liters of water at the rate of every 10 dm2 of body area should be poured for each sheep.

It is stated that the time and the duration of water runoff, elapsed from the beginning of irrigation and till the beginning of runoff, depend on the length of wool and fleece structure. In sheep with a staple fleece structure, the water flow from the body after the irrigation was almost by 2,5 times slower than in sheep from other groups. More rapid runoff occurred in sheep with the braid fleece structure. On this indicator they surpassed the animals from other groups on average by 7,4 times.

Table 3 – The Water-resistant Properties of Fleece

Group	n	The Duration of the Water Runoff, (in minutes)	The Time from the Start of the Irrigation to The Water Runoff, (in seconds)	The Amount of Water Remaining in the Wool of the Sheep with Different Fleece Structure, (in liters)	The Amount of Water, Left from the Beginning of Irrigation to the Beginning of the Runoff in Sheep with Different Fleece Structure, (in liters)	The Rate of the Desiccation of Sheep with a Different Fleece Structure (in hours)
I	9	16,2 ± 0,741	66,7 ±3,333	4,2 ± 0,204	3,3 ± 0,145	12,5 ±0,377
II	6	7,5 ± 0,108	38,3± 5,731	2,3 ± 0,248	1,9 ± 0,269	5,2 ± 0,575
III	13	7,4 ± 0,537	36,1± 2,759	2,1 ± 0,245	1,9 ± 0,186	5,4 ± 0,349
IV	9	5,3 ± 0,408	21,6 ±0,525	1,8 ± 0,252	1,2 ± 0,880	2,5 ± 0,132

This pattern is observed not only when comparing the average performance of each of the experimental groups, but also in the individual data of each group. For example, the correlation coefficients between the length of wool and the duration of water runoff from the body of sheep were negative: for the I-st group 0,98± 0,083; for the III-rd group – 0,78 ± 0.19. In this category, the reliability was high (11,8; 4,1).

It should be noted that the water began to flow from the body of the sheep from the IV-th group, which had a braid fleece structure in about 22 seconds after the start of the irrigation. It took 3 times more period in the I-st group of ewes with a staple structure of the fleece, i.e. more than 66 seconds, the sheep of the II-nd and the III-rd groups, which had the staple-braid fleece structure, spent, respectively, by 1,8-1,7 more time than the ewes of the IV-th group.

Within each group, the animals also showed a very high negative correlation between long hair and the time, elapsed from the beginning of irrigation to the beginning of water runoff from the body of the sheep. The correlation coefficients in all cases were significant, equal to: I group - 0,82 ± 0,218 (td=3,76), the second - 0,85 ± 0,264 (td=3,22) in the III-rd group - 0,80 ± 0,182 (P > 0,99), the IV-th group - 0,62 ± 0,298 (P > 0,95).

It should be noted that the nature of water runoff and penetration into the depths of the wool from the sheep with a different fleece structure was different. In the ewes of the I-st group the water penetrates deep into the fleece and flows down the legs and belly. The water flowed in the form of a set of streams from the top of the braids and the lower part of the trunk of the sheep of the II-nd, the III-rd and the IV-th groups. After the runoff cessation, the part of it remained in the wool, and in the sheep with braid and staple-braid fleece structures only the top of the braids was wet (about 50-60% of the length of the braids).

The amount of water remaining after the termination of runoff has also changed in connection with the structure of the fleece and the length of the wool. The analysis of the data showed a certain relationship between the fleece structure and the amount of water that remains in sheep after the termination of its runoff.

The presence of mathematically significant differences between the indicators of the amount of water remaining in the coat when comparing the ewes of the I-st group with animals of the II-nd, III-rd and the IV-th groups is also established, as well as when comparing the animals of the IV-th group with those of the I-st and the II-nd groups.

In animals with the staple fleece structure, the amount of water remaining in the wool, was by 2 times more than in the sheep with staple-braid fleece structure and by 2,3 times more than in the sheep with braid fleece structure.

Corresponding calculations showed that there is also a definite link between the length of hair and the amount of water that remains in the fleece after the cessation of the water runoff from the body of the sheep. The correlation coefficient of these characteristics in animals of the first group was positive, very high and reliable (0,99 ± 0,17; P > 0.99). In other groups of animals they were negative, but also very high (for example, for the III-rd group = 0.91 ± 0.13; P > 0.99). This is of great practical importance in terms of mountain sheep keeping. The more water remains in the fleece of sheep after the rain, the more time it takes to dry them, the more likely the disease of these sheep from hypothermia at night, from the cold air flowing down from the glaciers.

The data of table 3 also show the great water-absorbing capacity of the staple fleece structure. There were significant individual differences within each group, especially in the III-rd and the IV-th groups, called individual variations in the length and density of wool. The staple fleece structures, i.e., are moredense, absorb a much greater amount of water compared to the staple-braid and especially braid fleece structure.

As a result of the penetration of water into the fleece and abnormal conditions for its evaporation, the drying process of the staple fleece structured sheep was much slower than that of the sheep with staple-braid and braid fleece structure. Drying of sheep with a staple fleece structure was 5 times slower than that of the sheep with a braid structure and more than 2 times slower than that of the sheep with a staple-braid structure.

It was discovered that the length of the wool and the time for desiccation of sheep has a certain relationship. Thus, for example, the animals of the first group, having a staple fleece structure, the length of wool and the drying rate of sheep had a high positive relationship (r=0.84 ± 0.204; tr=4.13). The other groups of animals had negative correlation coefficients equal to: the II-nd group – 0,67 ± 0,371; the III-rd – 0,93 ± 0,350; the IV-th – 0,76 ± 0,246.

The time of the sheep's drying process after the rain is of great importance in the conditions of mountain sheep keeping, where a significant amount of precipitation falls. In summer months, the ambient temperature drops significantly at night and sometimes there are frosts as a result of the movement of cold air from the overlying glaciers.

The sheep with a staple fleece structure, being wet in the afternoon, do not have enough time to dry out till night. Wool cover at night remains wet, resulting in hypothermia. These sheep often have colds, as the time goes, their productivity falls, and eventually they die.

It should be noted that within each experimental group of ewes the duration of water runoff depended on the length of the wool of individual animals. In other words, the longer the wool, the faster is the runoff of water, poured on the sheep.

There was the same relationship between the amount of remaining water, the drying time of sheep and the length of the wool of the sheep with a braid fleece structure and staple-braid fleece structure. There was a reverse picture, in sheep, which had a staple fleece structure, i.e. the longer the wool, the more water remained in their woolen cover and the longer it took to dry the sheep. This situation should be obviously explained by more density and hygroscopicity of the wool of the sheep with staple fleece structure.

CONCLUSIONS:

- Different structures of the sheep fleece are due to differences in the skin structure, the location of the follicles, their size and density;
- in animals with the staple fleece structure, there is the greatest density of hair follicles in the group, a wider ratio of the number of VF/PF, they are of less depth and length of hair follicles and thinner skin compared with the sheep, having a braid and staple-braid fleece structure;
- the nature and the duration of the water runoff, as well as the drying time of the wool cover of the sheep with various fleece structures are different. Water does not penetrate deep into the fleece during precipitation, it flows intensively in sheep with braid and staple-braid fleece structure. In the wool cover there is a small amount of water and it evaporates quickly. Water penetrates deep into the fleece and in a significant amount of it remains in the fleece of the sheep with a staple fleece structure. The wool cover of such sheep dries several times longer;
- there are significant individual differences in the water-protective properties of the fleece, due to the length and the density of the wool cover of the sheep with different fleece structure. The longer and the less the wool is, the quicker is the drying process of the wool of the sheep with braid and staple-braid fleece structure. For the staple fleece structured ewes, it is characterized by an inverse relationship: the longer the wool, the more water it holds, the longer it takes to evaporate it;
- in the conditions of high humidity of mountainous and foothill areas of North Caucasus it is necessary to conduct the sheep selection not only on wool and meat productivity, but also on the structure of the fleece.

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