SOME HISTOLOGICAL CHANGES IN THE HAIR AND SKIN FOLLICLES OF DROMEDARY CAMELS AT DEFERENT AGES

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ABSTRACT

The present study aimed at investigating some histological parameters that could be related to hair production and the developmental process of different types of camel hair fibres and follicles. Eight camels, two at each age, (6,12,18 and 24 months) raised at Maryout Research Station, 32°N latitude of the Desert Research Center, were used in the study.

Skin samples were collected from two regions (shoulder and midside) of each animal and prepared for the histological investigations. Results showed that camel skin has mainly two follicle types (primary and secondary). The primaries (P) were usually the largest, while the secondaries (S) are more numerous and lie to one side of the primaries. Each primary follicle with its associated secondary follicles constitutes the follicle group, which is considered the common unit of fibre production. In camels there were different types of follicle groups, which contained one, two, four and five primary follicles, in addition to the usual type, three primaries. Values of S/P Ratio significantly ($p<0.05$) varied in the different regions and tended to increase with advanced ages especially between 18 and 24 months.

Primary follicles had the largest external and internal diameters and wall thickness than those of the secondaries at different regions in addition to an increase of the follicle dimensions with advaneing age. The primary follicles were found to produce the hairs containing medulla. Medulla of hairs tended to increase between 6 and 18 months of age, while the reverse was true from the mid-line of the animal towards the front parts.

Keywords: *Skin follicles; Hair; Camels; Histology.*

INTRODUCTION

Camels have special adaptation to environments and developed special physiological mechanisms to face stress of dehydration and shortage of nutrients (Guerouli *et al*, 1994). Skin and coat cover act together as an external barrier against environmental extremes.

The separate components of the skin become more clearly differentiated and increased in size as the animals grew older (Sholohov, 1954). The quantitative relations within a follicle may be fundamentally connected with the type of hair coat produced. The histological observations indicated that the guard hairs are usually produced by the large follicles.

In sheep, Dry (1934) had previously stated that formation of the late fibres decreased relatively the growth of the earlier ones. Moreover, Fraser (1953) demonstrated competition between the early developing hair follicles and the late ones.

The aim of this study was to investigate some histological traits in camel skin that affects the hair follicle dimensions, which could be related to hair characteristics produced in the post-natal life. The hair fibre diameter was also assessed to throw light on the developmental process of the different fibre types present in camel fleeces.

MATERIALS AND METHODS

The present study was carried out on the skin of eight *dromedary* camels, raised at Maryout Research Station of the desert Research Center, 32°N latitude, at the North Western costal desert of Egypt. The skin samples were collected from both shoulder and midside regions, representing different regions of fibre density of each animal at six, twelve, eighteen and twenty four months of age.

Skin samples were processed (Clarke, 1960) (one block from each sample), sectioned at 6-8 microns at the sebaceous gland level and stained with haematoxylin and eosin (Drury & Wallington, 1980). A section from each block was microscopically examined and follicle types were identified, counted, for ten follicle groups (each section). S/P ratio (number of secondaries per each primary follicle) was calculated.

In each section, internal and external diameters of 40 primary and 90 secondary follicles were measured using an image analyzer (LEICA-Q 500 MC) with lens 40/0.65. Follicle wall thickness was also calculated.

Data were statistically analyzed according to SAS (1995) using general linear models (GLM) classification, followed by Duncan's multiple range test to examine the significance between means.

RESULTS AND DISCUSSION

Camel skin has two follicle types, primary and secondary follicles. The primaries are usually the largest, arranged in the skin often three, while the secondaries are the smallest in size, more numerous and lie on one side of the primaries (Fig.1). Histologically all follicle types have the same basic structure. The wall of the hair follicle is divided into two distinct layers, the outer and inner root sheaths. The main difference between the primary and secondary follicles was the presence of both sweat and sebaceous glands and erector muscle accompanying the primary follicles while the secondaries have only the sebaceous glands (Fig. 1).

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The primary follicles with their associated secondary follicles constitutes the hair follicle group which is considered the unit of hair production. In camel skin there were variable numbers of primary follicles in the hair production unit. Figure(2) shows a different type of hair follicle group which contains two, three and four primary follicles, while (Fig.3) showed a follicle group with five primaries. The follicle group which contained one primary follicle was illustrated in (Fig.1). It seems that the hair follicle groups of camel skin are mainly of the trio type, as described by Carter (1943) in his study on the development of wool follicles in Merino sheep. However, differential growth over different body regions with the advancement of age may account for the change in the types of follicle groups. Possibly, a trio group could separate into two groups one has two primaries and the other has one primary. Also, a part of a trio group could join a neighboring trio group to form groups with four or five primaries.

While thick connective tissue separated follicle groups from each side, it was observed that within each group, a fine connective tissue further divided the follicle group into smaller groups, each group having one primary with a number of associated secondaries (Fig. 4).This may account for the claim of Kamel *et al.*(1986) that all follicle groups in camel skin are of the type having one primary follicle. On the other hand, Lee & Schmidt- Nielsen (1962) described only two follicle group types, having two or three primaries in camel skin.

Table (1) illustrates that most of follicle groups are composed of trio groups, which contains three primary follicles and a variable number of secondaries. It constitutes about 70% and 59.8% of follicle groups in both shoulder and midside regions, respectively.

Higher number of primary follicles to more than three per group means higher sweat gland numbers, which might be suitable to hot climate for heat dissipation and better thermoregulation.

The results obtained showed that average values of the secondary to primary follicle ratio (S/P) varied significantly between shoulder and midside regions ($p<0.05$) but no significant differences were observed throughout different ages studied as well as the interaction of age and region had no significant effect (Table 2). Figure (5) shows a sign of branching in secondary follicles growing more than one hair from the same follicle pore.

Table (3) shows that mean values of S/P ratio calculated from different regions revealed that the shoulder possessed a mean value (6.17±0.672) at six months of age which was significantly larger than that of the midside (3.46±0.608); a slight decrease was observed at 12 months of age for the midside region (3.96±0.582) followed by an increase at 18 months (4.67±0.762) then at 24 months (4.45±0.713) with no significant differences. S/P ratio values of the shoulder showed a trend of increase from 12 months to 18 months (4.73±0.902) to reach (5.23±0.638) at 24 months.

An increase in the pooled S/P ratios with advancing age was observed between 18 and 24 months of age which might be attributed to the development of the secondary follicles which occurred as a result of the later secondaries derived by branching from the original ones (Hardy & Lyne, 1956). This result might occur by the fusion of the external root sheath that surrounded more than one hair that protruded from the same pore (Fig.5).

The follicle density is largely determined by genes that control the extent to which secondary follicles would develop (Carter, 1955). Variations in the fibre density followed the general biological principle in which the densest regions of the fleece tend to be of those where fibres developed first in the embryo. Thus, the anterior parts of the body (i.e. shoulder) showed the highest density, which tended to decrease towards the posterior parts (i.e. midside).

The primary follicles had generally thicker internal and external diameters than those of secondaries at different ages and body regions of camel skin. Fraser (1952) attributed these differences to the time of follicle initiation, which is correlated with the depth at which each type of follicle extends into the skin.

The external and internal diameters of both primary and secondary follicles at the shoulder region surpassed those of the midside (Tables 4 and 5) which could be explained on the basis that the gradient in the amount of hair grown on various body regions might be attributed to the differences in blood supply (Henderson, 1953). Ryder (1955) failed to find evidence that the patterns of blood vessels could account for that gradient in sheep skin. Cockrem & Wickham (1960) postulated that measurements of skin temperature could act as indirect factor for estimating blood supply to various body regions. Accordingly, they had partly attributed the gradient of fibre growth over the body to differences in the blood supply. On the other hand, Cockrem (1962) proposed that an inherent factor associated with the skin follicle population might be involved in determination of the amount of fibre grown on a particular region.

As animals grow older, the external and internal diameters as well as wall thickness of both follicle types in both shoulder and midside regions increases significantly ($p<0.05$) (Table 1).

The overall mean of the external diameter ranged from 78.55 to 93.34 μm and from 46.56 to 52.97 μm for both primary and secondary follicles, respectively, from 6 to 18 months of age followed by a decrease at 24 months in the two follicle types (Table 3).

Overall means of the internal diameter of primary and secondary follicles ranged from 22.65 to 39.25 μm and between 16.37 to 20.89 μm throughout the different ages studied, respectively, (Table 5). The

shoulder exhibited a wider range than that of the midside and there was a slight decrease in both values of follicle types at the age of 24 month.

The overall means of primary follicle wall thickness ranged between 43.75 and 54.15 μm, while those of secondary follicles lied between 26.04 and 32.47 μm. A trend of decrease from 6 to 12 months was followed by an increase at 18 months and then decreased thereafter, was observed in both the two follicle types (Table 6). The fluctuated trend of wall thickness throughout different ages might be partly due to the hair growth cycle in addition to changes in the environmental elements.

The decrease in all hair follicle dimensions at the age of 12 months might be also due to a reduction in the amount of the available substrate, that might be explained by nutritional retardation. A significant decrease in all follicle dimensions was also observed at the age of 24 month (Tables 4, 5, 6). Burns & Clarkson (1949) illustrated that the outer root sheath thickness changed during shedding process and fibre replacement, did not appear on a visual inspection, to bear a constant relation to the size of other parts of the follicle. It should be noted that it is possible to find follicles have the same total cross-sectional area, but contain fibres with widely different diameters. In these instances, the follicle contained small fibres (less coarse) and had thickened outer root sheath compared with those that contained coarser fibres.

At young ages, a relative decease in the bulb size with increasing follicle volume was observed, probably a true indication to the changes in relative dimensions which occurred during the development and differentiation of the young follicles, since in such follicles the outer root sheath is thin and therefore contributes less to the total volume than it does in the mature follicles.

Age had an effect on fibre diameter. The results are shown (Table 7) in which fibre diameter increased from 22.65 to 39.25 μm and from 18.95 to 20.89 μm between 6 to 18 months of both primary and secondary fibers, respectively, then a slight decrease was observed at 24 months, where values were 35.97 and 19.69 μm in primary and secondary fibres, respectively.

The medullated fibres were found to be produced only by primary follicles in all samples studied. Medulla thickness showed a trend of increase from 12.09 to 25.79 μm, between 6 to 18 months of age and decreased to 24.37 μm at 24 months (Table 8). The distribution of medulla differed between body regions and at different ages. The highly medullated fibres were generally highest in the mid-line and appeared to decrease towards the front parts. A constant relationship between rate of skin expansion and rate of fibre increase in all body regions was suggested by Henderson (1953). He argued that both variables are largely governed by heredity and there might be a common control of some strongly inherited physiological characteristics. The higher degree of medullation in the fibres at advanced ages would help in reduction of external heat load and would help animals to be more heat tolerant.

Generally, the early-developed follicles tended to be larger, and that only primary follicles were found to have medulla which appeared to increase with increased follicle volume.

Hair growth cycle appeared to be affected by various environmental elements; skin follicle itself have an ability to exert some measures of controlling fibre growth. The relative lengths of the anagen and telogen phases of growth, and the proportions of follicles in each phase at different times, will influence total fibre output and might alter composition and other properties of the fibre (Mitchell *et al.*, 1991). Accordingly, fibre production development would result from the ability to sustain the higher level of fibre growth attained for long periods.

It seems probable that the regular dimensional relations are characteristic of follicles during optimal or near-optimal fibre production, but they become disturbed when follicle activity is not optimal.

It is of interest to note what changes in relative dimensions take place during the process of fibre shedding and replacement as encountered at the age of 24 month (Tables 4, 5, 6). The relative dimensions obviously change with the degeneration of the papilla. It might be anticipated, by analogy with immature follicles, that the papilla and bulb would be relatively larger during the early stages of fibre replacement than at other times.

Finally, it is also thought that different rates of mitotic activity, including time of initiation, might be responsible for differences in the growth of fibres at different ages. Hence, skin samples examined might give more details on the follicle ability to produce fibres throughout different periods of age than would be possible if obtained from the coat observations alone.

Table (1): Frequency of primary follicle groups in camel skin.

Age in month	Number of primaries									
	Shoulder					Midside				
	1	2	3	4	5	1	2	3	4	5
6	2	3	15	5	1	9	7	28	2	1
12	11	6	49	10	2	-	2	7	4	1
18	4	3	15	2	2	2	3	15	3	1
24	-	1	7	3	-	5	4	26	5	2

Table (2): Analysis of variance of the effect of different factors on primary and secondary follicle dimensions, S/P ratio, fibre diameter and medulla thickness.

Source of variation	Primary follicle						Secondary follicle					S/P ratio	
	DF	Mean square					DF	Mean square				DF	Mean square
		Ext. Diameter	Int. Diameter.	Wall thick.	Fibre Diameter	Medulla		Ext. Diameter	Int. Diameter	Wall thick.	Fibre Diameter		
Age(A)	3	2736.18*	2361.06**	1045.62^{NS}	2361.06**	324.10^{NS}	3	3274.42**	564.87^{NS}	1316.29**	564.87^{NS}	3	3.70^{NS}
Position(P)	1	1049.37^{NS}	197.11^{NS}	134.74^{NS}	197.11^{NS}	1043.67**	1	103.66^{NS}	851.76^{NS}	47.19^{NS}	851.76^{NS}	1	9.86^{NS}
AxP	3	4132.57**	855.77*	1526.24*	855.77*	377.94*	3	966.61**	1129.35^{NS}	1014.41**	1129.35^{NS}	3	7.76^{NS}
Error	187	935.50	238.99	441.85	238.99	107.37	843	57.01	1916.99	43.32	1916.99	59	4.07

*Significant at($p<0.05$)

**Highly significant at($p<0.01$)

NS. not significant

Table (3): Average values ±SE of secondary to primary follicle ratio (s/p) in camel skin at different ages and positions.

position	Age months				Overall means
	6	12	18	24	
shoulder	6.17±0.672	3.63±0.902	4.73±0.902	5.23±0.638	5.16[a]
midside	3.46±0.608	3.96±0.582	4.67±0.762	4.45±0.713	4.05[b]
Overall mean	4.68[a]	3.86[a]	4.69[a]	4.88[a]	

Overall means followed by the different letters differ significantly ($p<0.05$).

Table (4): Average values of the external diameter (µm ± SE) of follicle types in camel skin at different ages and positions.

Follicle type	position	Age months				Overall mean
		6	12	18	24	
Primary Follicle	Shoulder	79.85±4.962	60.41±5.493	90.77±6.674	91.25±6.839	84.08[a]
	Midside	76.30±6.521	90.70±7.017	96.51±7.418	77.94±5.886	78.53[a]
Overall mean		78.55[b]	71.92[a]	93.34[a]	83.601[ab]	
Secondary Follicle	Shoulder	48.65±0.673	40.48±0.634	52.12±0.844	50.73±0.720	47.22[b]
	Midside	44.32±0.695	46.43±0.909	53.79±0.834	50.32±0.678	48.56[a]
Overall mean		46.56[c]	42.42[d]	52.97[a]	50.51[b]	

Overall means followed by the different letters differ significantly ($p<0.05$).

Table (5): Average values of the internal diameter (µm ±SE)of follicle types in camel skin at different ages and positions.

Follicle type	Position	Age months				Overall mean
		6	12	18	24	
Primary Follicle	Shoulder	21.66±2.508	24.18±2.777	41.99±3.373	37.34±3.457	33.14[a]
	Midside	24.36±3.296	38.31±3.547	35.87±3.749	34.95±2.975	29.10[a]
Overall mean		22.65[c]	29.55[b]	39.25[a]	35.96[a]	
Secondary Follicle	Shoulder	23.05±3.900	15.74±3.674	21.47±4.895	19.97±4.174	19.77[a]
	Midside	14.56±4.031	17.65±5.271	20.33±4.835	19.44±3.932	17.85[a]
Overall mean		18.95[a]	16.37[a]	20.89[a]	19.69[a]	

Overall means followed by the different letters differ significantly ($p<0.05$).

Table (6): Average values of the wall thickness (µm ±SE) of follicle types in camel skin at different ages and positions.

Follicle type	Position	Age months				Overall mean
		6	12	18	24	
Primary Follicle	Shoulder	57.01±3.410	39.46±3.775	48.78±4.587	53.90±4.700	50.48[a]
	Midside	51.93±4.481	50.74±4.822	60.64±5.098	42.71±4.045	49.93[a]
Overall mean		55.15[a]	43.75[b]	54.08[a]	47.47[ab]	
Secondary Follicle	Shoulder	35.12±0.586	24.73±0.552	30.44±0.736	30.67±0.627	30.69[a]
	Midside	29.64±0.606	28.73±0.792	33.86±0.727	30.67±0.591	30.01[a]
Overall mean		32.47[a]	26.04[c]	32.17[a]	30.67[b]	

Overall means followed by the different letters differ significantly ($p<0.05$).

Table (7): Average diameters (µm ±SE) of the fibre types in camel skin at different ages and positions.

Fibre type	Position	Age months				Overall mean
		6	12	18	24	
Primary fibres	Shoulder	21.66±2.508	24.18±2.777	41.99±3.373	37.34±3.457	33.14[a]
	Midside	24.36±3.296	38.31±3.547	35.87±3.749	34.95±2.975	29.10[a]
Overall mean		22.65[c]	29.55[b]	39.25[a]	35.96[a]	
Secondary fibres	Shoulder	23.05±3.900	15.74±3.674	21.47±4.895	19.97±4.174	19.77[a]
	Midside	14.56±4.031	17.65±5.271	20.33±4.835	19.44±3.932	17.85[a]
Overall mean		18.95[a]	16.37[a]	20.89[a]	19.69[a]	

Overall means followed by the different letters differ significantly ($p<0.05$).

Table (8): Average values of medulla thickness (µm ±SE) in the primary fibres of camel skin at different ages and positions.

Position	Age months				Overall mean
	6	12	18	24	
Shoulder	0	22.87±5.983	26.47±4.634	17.55±5.181	19.37[a]
Midside	24.18±7.327	23.88±5.983	25.36±3.663	51.63±10.362	26.75[a]
Overall mean	12.09[a]	23.38[a]	25.79[a]	24.37[a]	

Overall means followed by the different letters differ significantly ($p<0.05$).

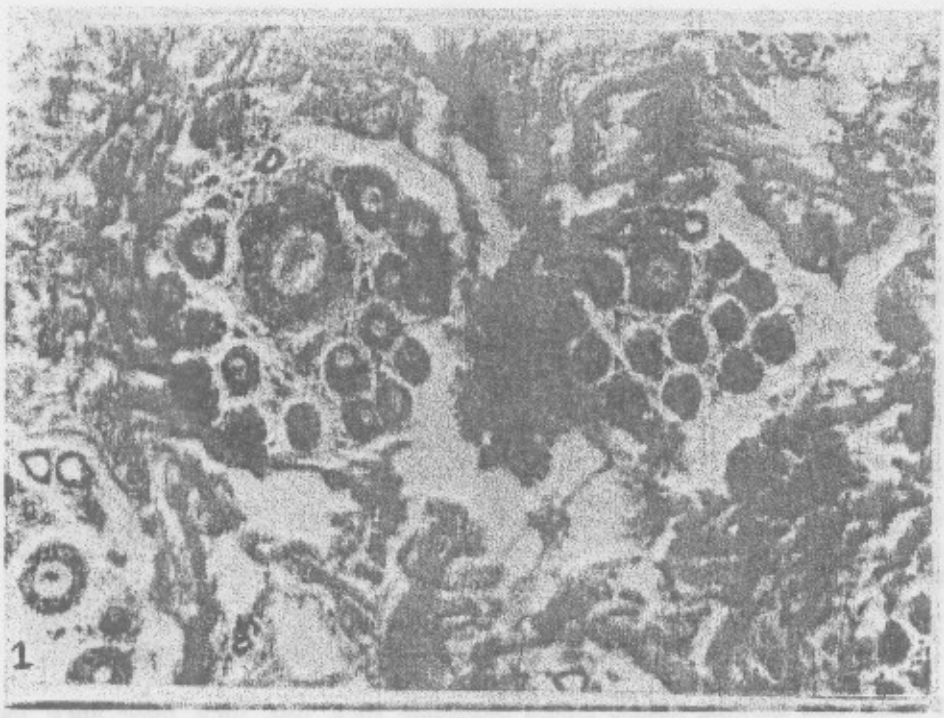

Fig.1: T.S. of camel skin showing follicle groups containing one,1 pr.g; three 3pr.g, primary follicles; o, outer root sheath; I, inner root sheath. (Hx.E.,X100).

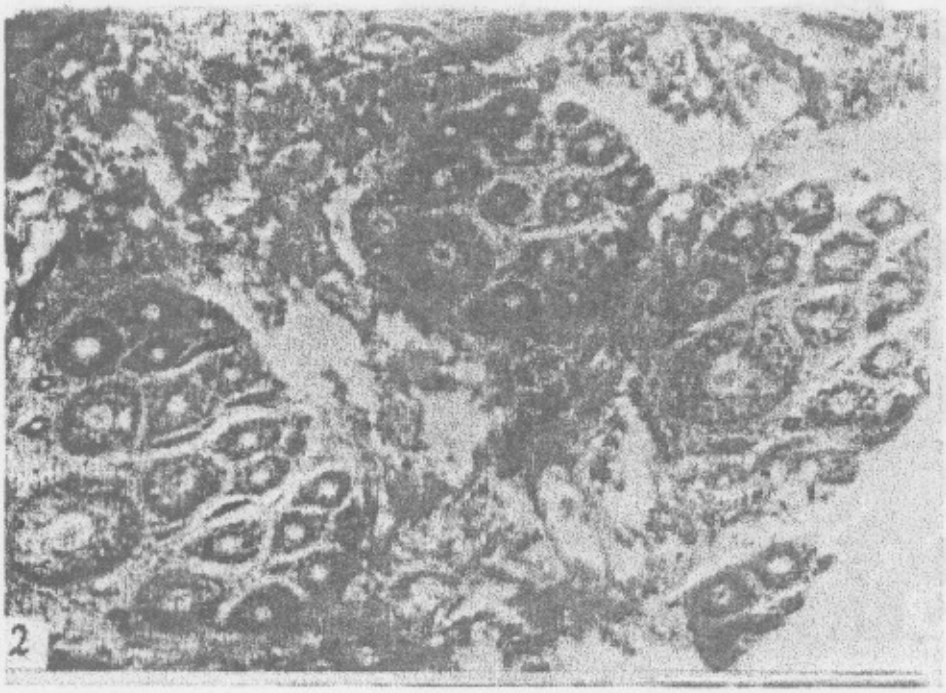

Fig.2: T.S. of camel skin showing fine connective tissue trabeculae dividing the follicle group into smaller groups, arrow; pr, primary follicle; sec, secondary follicle; sw, sweat gland; sb, sebaceous gland; e, erector muscle. (Hx.E.,X100).

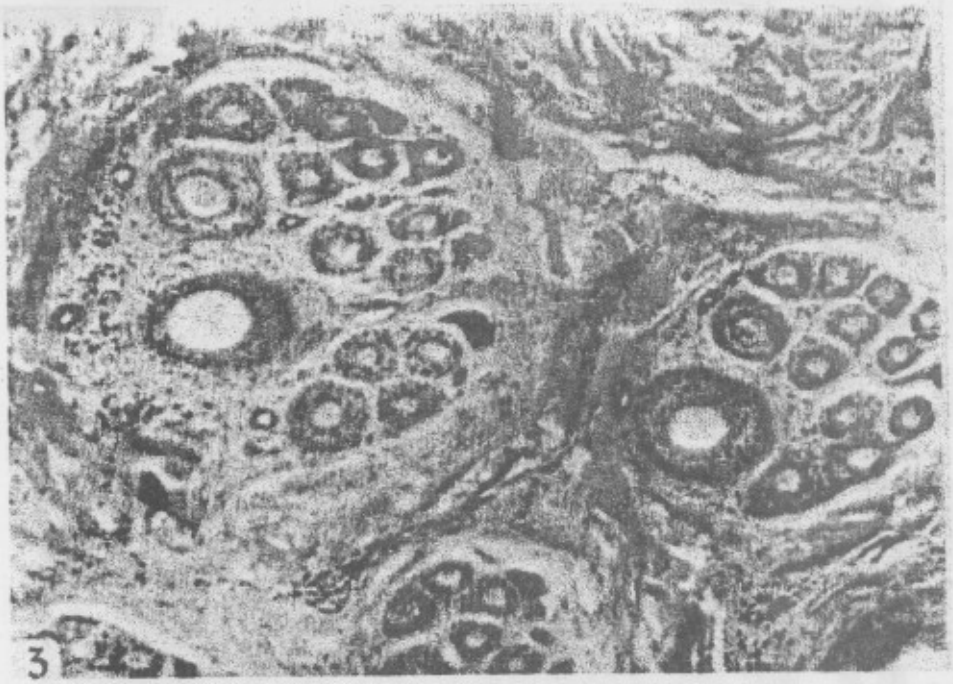

Fig.3: T.S. of camel skin showing follicle groups containing 2pr.g, two; 3pr.g, three; 4pr.g, four primary follicles. (Hx.E.,X100).

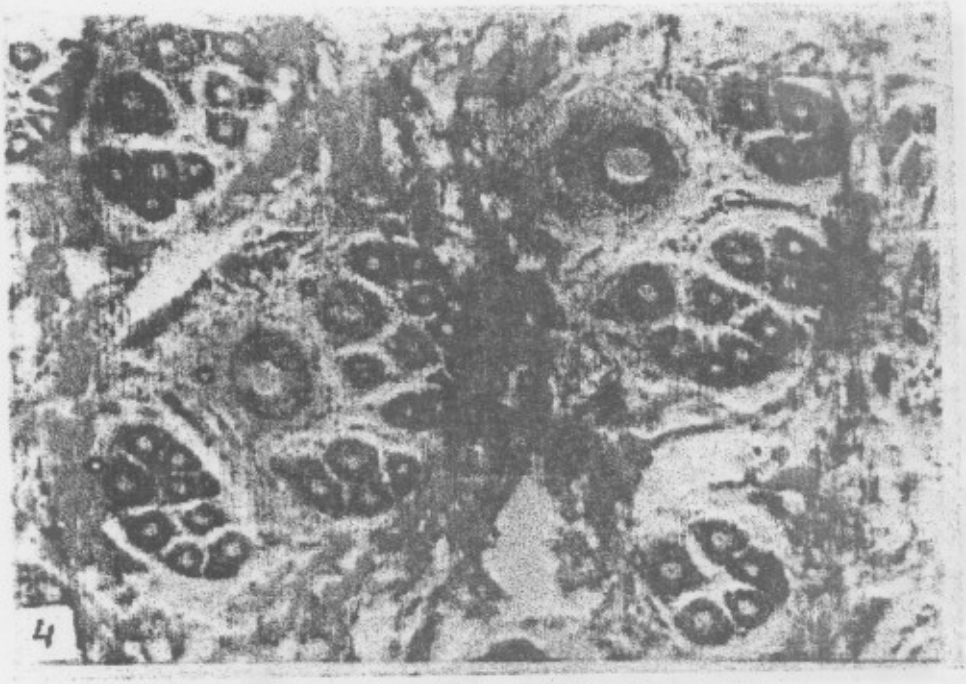

Fig.4: T.S. of camel skin showing follicle group containing 5pr.g, five primary follicles. (Hx.E.,X100).

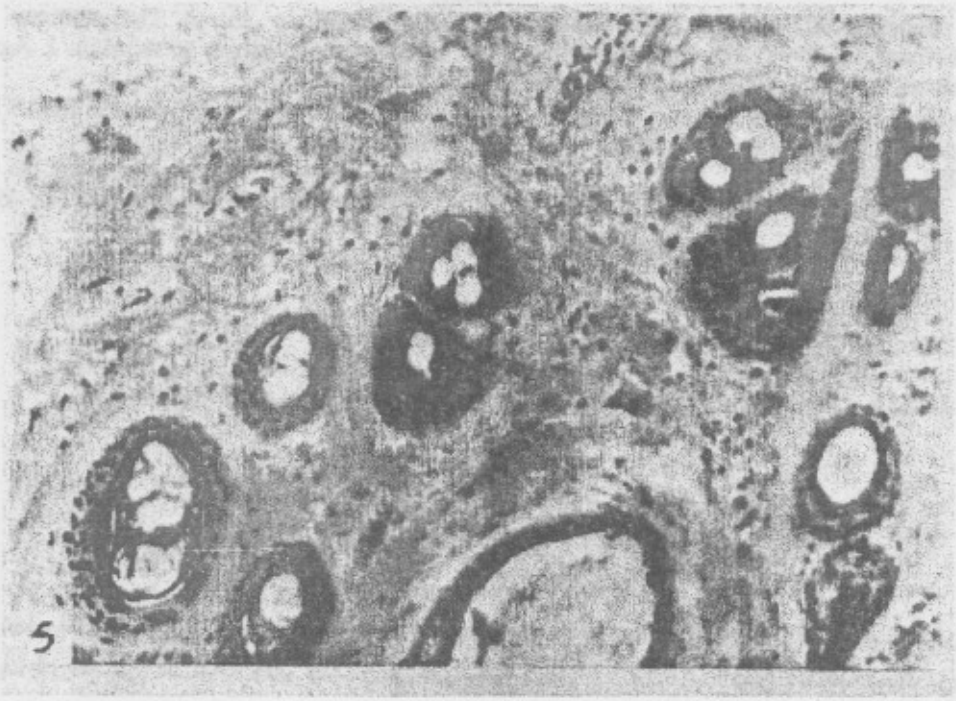

Fig.5: T.S.in camel skin showing more than one hair protruding from the same pore (arrows). (Hx.E.X400).

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الملخص العربى

بعض التغيرات الهستولوجية فى بصيلات جلد ووبر الجمال وحيدة السنام فى الأعمار المختلفة

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تهدف الدراسة إلي توضيح إرتباط بعض الصفات الهستولوجية بإنتاج الوبر وكذلك تطور الأنواع المختلفة من ألياف وبصيلات الوبر. أجريت الدراسة علي عدد ثمانية جمال اثنان من كل عمر ممثلة لأعمار (٢٤،١٨،١٢،٦ شهر) بمحطة بحوث مربوط التابعة لمركز بحوث الصحراء علي بعد ٣٥ كيلو متر جنوب غرب الإسكندرية.

تم تجميع عينات الجلد من منطقتي الكتف ومنتصف الجانب لكل حيوان وتحضيرها للفحص الهستولوجي. وقد أظهرت النتائج أن جلد الجمال يحتوي بصفة أساسية علي نوعين من بصيلات الألياف (أولية وثانوية) وكانت البصيلات الأولية عادة كبيرة في الحجم بينما كانت البصيلات الثانوية متعددة وتوجد علي ناحية واحدة من البصيلات الأولية. كما لوحظ أن كل ثلاث بصيلات أولية متكاملة مع بعض البصيلات الثانوية تكون مجموعة البصيلات والتي تعتبر الوحدة المنتجة للألياف. ويحتوي جلد الجمال علي عدة أنواع من مجموعات الألياف حيث تحتوي كل مجموعة علي ١ – ٥ بصيلات أولية بالإضافة إلي النوع الشائع والمحتوي علي ثلاثة بصيلات أولية.

كما إختلفت نسبة البصيلات الثانوية إلي الأولية معنويا طبقا لاختلاف المنطقة علي جسم الحيوان كما أظهرت ميلا للارتفاع مع تقدم العمر ولاسيما في الأعمار بين ١٨و٢٤ شهر.

كما أوضحت القياسات الهستولوجية أن قيم الأقطار الخارجية والداخلية وكذلك سمك الجدار في البصيلات أنها كانت أعلي في البصيلات الأولية عنها في البصيلات الثانوية بالإضافة إلي زيادة في أبعاد البصيلات بإتجاه تقدم العمر. كما أنتجت البصيلات الأولية ألياف ذات نخاع حيث إزداد سمك نخاع الألياف في الأعمار من ٦ إلي ١٨ شهر بينما نقص من منطقة منتصف الجانب باتجاة الأجزاء المتقدمة من الجسم. كما تأثرت أقطار الألياف بتقدم العمر حيث ازدادت أقطار الألياف المنتجة من كل من البصيلات الأولية والثانوية في أعمار ٦ و ١٨ شهر وكانت متبوعة بنقص عند عمر ٢٤ شهر.