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تشريح الحافر فى الحمـار

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ANATOMY OF THE HOOF IN DONKEYS (With 12 Figures)

By

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SUMMARY

A detailed anatomical structure of wall, sole and frog of the hoof and corium of the foot was described. This study revealed that the hoof of the donkeys differs from that of the horse as regards to the dimensions of the hoof, the slope of the wall, size and density of horny tubes and the number of the horny lamellae.

INTRODUCTION

Many Surgical affections of the hoof usually encountered in donkeys and are responsible for severe lameness. To facilitate the study of the pathogenesis and to recommend the suitable surgical correction of these conditions, the detailed anatomical structure of the hoof is needed.

The anatomy of the hoof was studied fully by many authors in horses (BRADLEY, 1946; WEBER, 1961; STUMP, 1966; and 1967; and GETTY, 1975). However, the available literatures lack any data on donkeys.

The present investigation is carried out to get a detailed description of the anatomical features of the hoof in donkeys and its differences from that of horse.

MATERIAL and METHODS

50 hoofs of the thoracic and pelvic limbs of donkeys are collected and subjected to a full anatomical description. The Wild Heerbrugg Microscope was used to clarify the detailed structure of the hoof.

RESULTS

For description, the hoof of donkeys is divided into 3 parts, wall, sole and frog (Fig. 1).

The wall covers the front and sides of the foot and is reflected palmarly at an acute angle to form the bars. The slope of the wall varies considerably in normal hoof. The average measurements of the angle of 30 thoracic and 20 pelvic feet give the following (Fig. 2):

	Thoracic limb	Pelvic limb
Toe	55.5°	62.5°
Medial angle	91.0°	95.0°
Lateral angle	88.5°	86.0°

In donkeys the average length of the wall in the thoracic limb, at the toe is 6.6 cm, at the quarter 4.6 cm and at the heels 3 cm in a ratio of about 3 : 2 : 1/2. In the pelvic limb, the length of the wall at the toe is 6.5 cm, at the quarter 5 cm and at the heels 3.5 in a ratio of about 2 : 1/2 : 1.

The wall consists of three layers : (Fig. 3).

- 1- Stratum externum: It consists of periople and Stratum tectorium. The periople is a ring of soft nonpigmented tubular horn. It is continuous with the epidermis of the skin above and extends downward to a variable distance (2-3 cm). Usually it forms a distinct band except at the heels, where it is much wider and caps the angle of inflection of the wall to form the so-called bulb of the heel. The Stratum tectorium is a thin layer of compact horny scales which gives the external surface of the wall its smooth and glossy appearance. This protective layer reduces loss of moisture from the wall.
- 2- Stratum medium: It forms the bulk of the wall and forms the most dense part of the hoof. It consists of

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tubular and intertubular hard horn. It is produced by *Stratum germinativum* which lies in the coronary groove adjacent to the coronary corium by which it is nourished. In donkeys the horn tubes of the *Stratum medium*, in cross section, appear in two forms and are distributed in two layers. The inner layer contains horn tubes which have a narrow lumen surrounded by a wide inner light and narrow outer dark zones (Fig. 4). The lumen of these horn tubes increases in diameter near the coronary groove to receive the papillae of the coronary corium (Fig. 5 & 6). The intertubular horn is light in colour and relatively poor in amount. The outer layer of the horn tubes is oval in shape with a narrow lumen surrounded by a light zone (Fig. 4). These horn tubes become more flattened toward the *Stratum tectorium*. The intertubular horn is larger in amount and darker in colour in comparison with that of inner layer.

3- *Stratum internum (S. lamellatum)*: It is constructed of series of non-pigmented horny lamellae attached to the inner surface of the *Stratum medium* (Fig. 7). The number of these lamellae is about 350 in donkeys.

The coronary border of the wall consists of two grooves. The proximal and narrow one is the perioplic groove. In donkeys, it is about 0.3 cm in width at the toe, 0.2 cm at the quarter and greatly widened at the heels where it is fused with the frog (Fig. 1). The distal wide groove is the coronary groove. In donkeys, it is about 1.3 cm in width at the toe, 1.1 cm at the quarter and 1.4 cm at the heels. It is perforated by innumerable openings which are relatively large and take honey-comb appearance. At the heels, the openings are arranged in rows parallel with the horny lamellae of the bars. The basal or ground border comes in contact with the ground. Its thickness at the toe is the greatest and decreased considerably at the quarter and there is a slight increase at the angles.

The junction of the wall and sole is formed by the interdigitation of the wall lamellae with the sole epidermis. The germinal epithelium covering the papillae of the terminal ends of the corial laminae produces pigmented horn in a form of tubes which fill the spaces between the non-pigmented horny lamellae (Fig. 9). This combination forms the white line.

The sole constitutes the greater part of the ground surface of the face of the foot. Its internal surface is convex, and slopes with a varying degree of obliquity downward to the convex border. It presents numerous small funnel-like openings of different diameters and increased in size towards the apex of the frog and white line (Fig. 10). The tubular horn of the sole is directed downward and forward parallel with that of the wall. The thickness of the sole varies according to the degree of the wear. In donkeys, its average thickness near the white line is 1.3 cm and near the apex of the frog 0.6 cm.

The frog occupies the angle bounded by the bars and sole and extends below these on the ground surface of the foot. The internal surface bears the spine of the frog. On either side of this spine, there is a deep depression which is bounded outward by the rounded ridge formed by the junction of the frog with the bar palmarly or plantarly and with the sole dorsally. The internal surface of the frog presents fine openings which are larger at the depression than at the spine and sides of the frog (Fig. 11). The horn tubes of the frog are smaller in size than that of the wall and of the same diameter with that of the sole. These tubes are soft, darker in colour and slightly flexuous. The intertubular horn is less than that of the sole. The horn of the sole is less rigid than that of the wall and the frog is composed of the softest and most pliable horn of the whole digit.

The corium of the foot is a direct continuation of the dermis of the skin. It is divided into 5 parts which nourish corresponding parts of the hoof.

The perioplic corium is a narrow band which lies in the perioplic groove. It is continuous with the dermis of the skin above and the coronary corium below. Palmarly or plantarly it widens over the heels and merges with the frog corium.

The coronary corium is a thick raised band that fills the coronary groove of the wall. The convex superficial surface is covered with filiform papillae which are received into the openings of the coronary groove.

The laminar corium bears lamellae which are interleaved with the horny lamellae of the wall and bars. The laminae are small at their origin above, become wider below, and end in several papillae.

ANATOMY OF THE HOOF IN DONKEYS

The sole and frog coria line the inner surface of the sole and frog. These coria form long papillae that extend into the epidermis of the sole and frog. These papillae have a broad base and pointed apex and vary in length (Fig. 12). The papillae of the corium of the sole increase in size towards the apex of the frog and white line.

DISCUSSION

The slope of the wall in horse given by BARADLY (1966) and GETTY (1975) was as follows:

	Thoracic limb	Pelvic limb
Toe	47.26°	54.1°
Medial angle	101.57°	96.5°
Lateral angle	101.37°	96.1°

Also STUMP (1967) mentioned the slope of the wall at the toe in the thoracic limb from 45 - 50° and at the pelvic limb 50 - 55°. From the above mentioned measurements, it is clear that the slope of the hoof of donkey is more upright than that of horse.

In the present work the length of the wall at the toe, quarters, and heels is in the ratio of about 3:3:1½ in the fore foot and about 2:1½:1 in the hind foot. GETTY (1975) mentioned the same ratio in horses for the pelvic limb while that of the thoracic limb is 3:2:1:

In donkey the number of the horny lamellae is about 350. In horse many authors mentioned that the number of these horny lamellae was about 600 (BRADLEY, 1946; STUMP, 1967 and GETTY, 1975). These lamellae are parallel, to each other and extend from the deep edge of the coronary groove to the junction with the sole.

The perioplic groove in the donkey greatly widenes at the heels where it is fused with the frog. While in the horse is merged with the coronary groove (GETTY 1975).

In donkey, the average length of the thickness of the sole near the white line is 1.3 cm and near the apex of the frog 0.6 cm. However BRADLEY (1946) mentioned that the thickness of the sole in the horse varies between 0.7 to 1.0 cm.

The horn of the sole is less rigid than that of the wall, and the frog is composed of the softest and most pliable horn of the whole digit. These results are in agreement with that given on the horse by ADAMS (1966) who stated that the water content of the wall is 25%, sole 33% and frog 50%.

The present work shows that the perioplic groove in donkeys is continuous with the frog, therefore the perioplic corium is continuous with the frog corium. On the contrary ROONEY, *et al.* (1967) as well as SISSON and GROSSMAN (1953) stated that the perioplic groove in horse is continuous with the coronary groove. They added that the perioplic corium is continuous with the frog corium.

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DESCRIPTION OF FIGURES

- Fig. 1: Internal view of the hoof shows
A- Periopic groove.
B- Coronary groove.
C- Sole.
D- Angle of the wall (bar).
E- Wall.
F- Frog.
- Fig. 2: Shows the hoof of the thoracic limb (A) and pelvic limb (B). Note that the wall of the hoof of the pelvic limb is more upright than that of the thoracic limb.
- Fig. 3: Cross section at the wall just below the coronary groove (X6).
A- Stratum externum
B- Stratum medium
C- Stratum internum
- Fig. 4: Cross section of the wall at a mid-way between the coronary groove and ground border of the wall (X12). Note the types of horny tubes at the stratum medium.
A- Oval and elongated horny tubes with abundant intertubular horny material.
B- Rounded horny tubes with scanty intertubular horny material.
- Fig. 5: Cross section at a level below the coronary groove (X18) shows the horny tubes of the stratum internum with large lumen.
- Fig. 6: The same as figure 5 (X50).
- Fig. 7: Stratum internum (X19) Note that the horny lamellae are parallel to each other.
- Fig. 8: Shows the honey-comb appearance of the funnel-shaped openings of the coronary groove. (X18).
- Fig. 9: Cross section at the white line (X12) shows the horny tubes between the horny lamellae of the wall.
- Fig. 10: The internal surface of the sole (X12) shows the small funnel-like openings of different sizes.
- Fig. 11: The internal surface of the frog (X18) shows the funnel-like openings of different diameter.
- Fig. 12: Shows the papillae of the sole (X50) Note the broad base and tapered apex of the papilla.

Fig. (1)

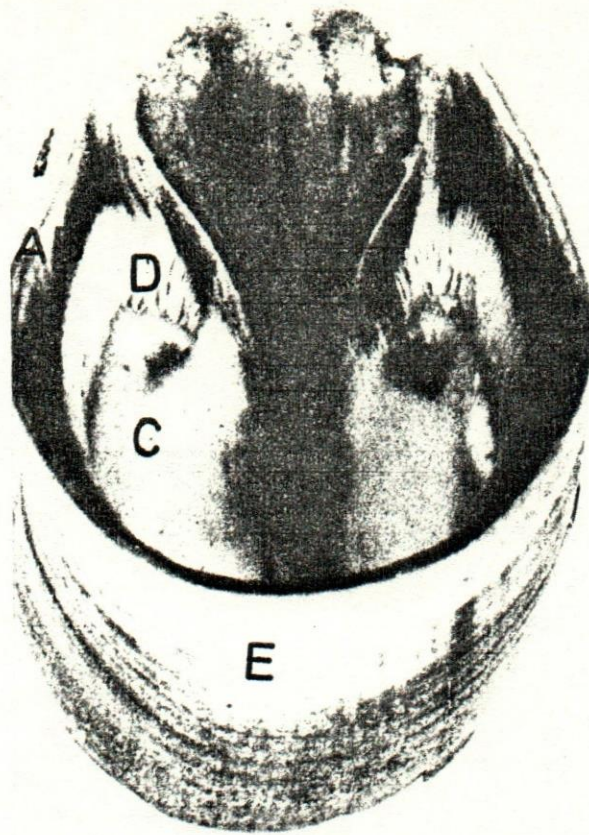


Fig. (2)

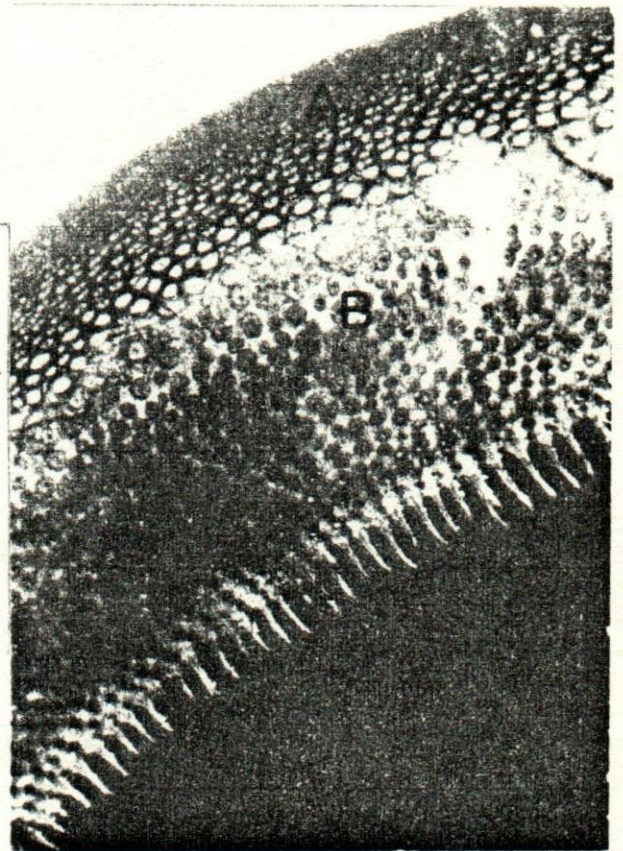
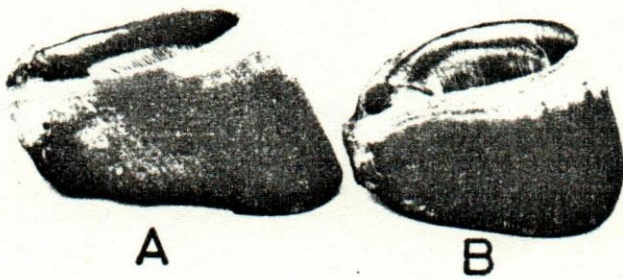


Fig. (3)

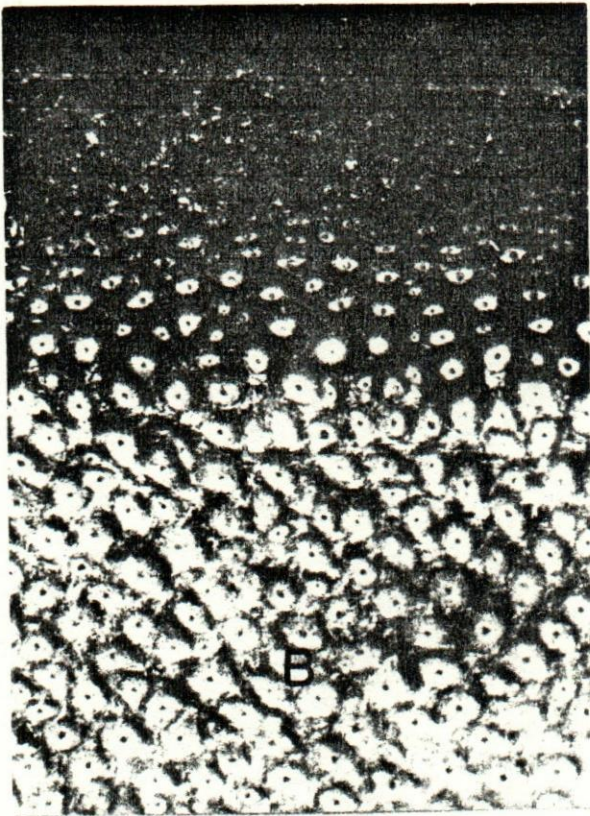


Fig. (4)

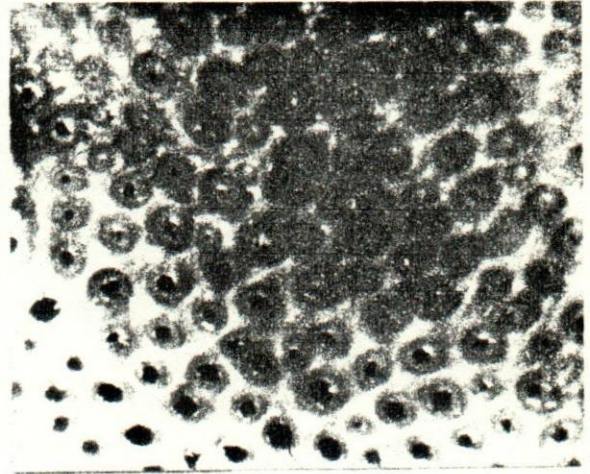


Fig. (5)

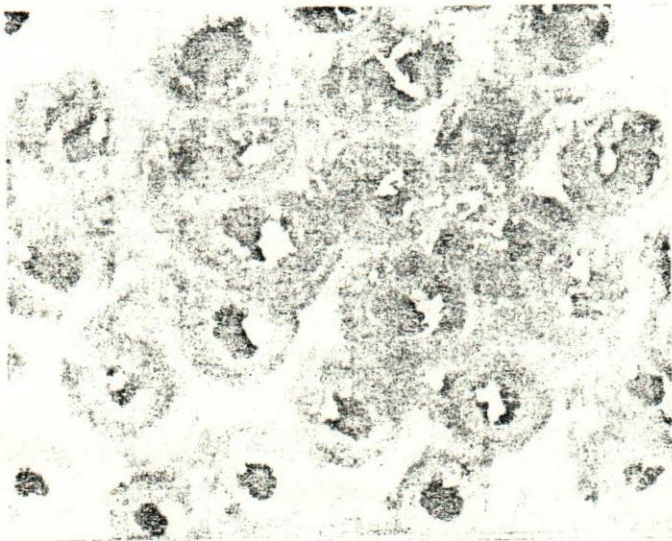


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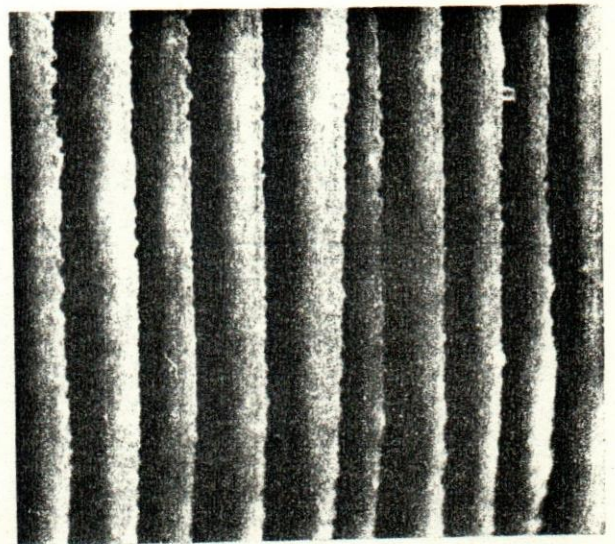


Fig. (7)

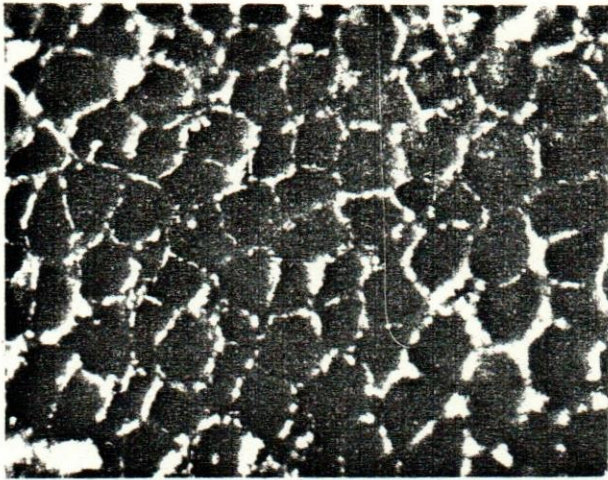


Fig. (8)

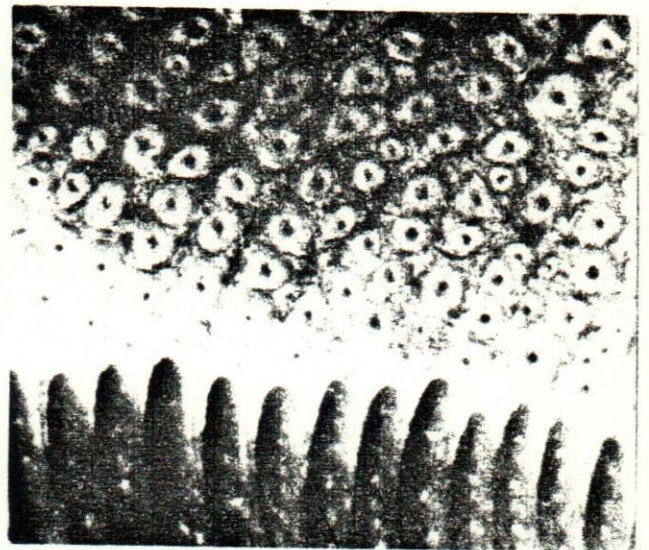


Fig. (9)

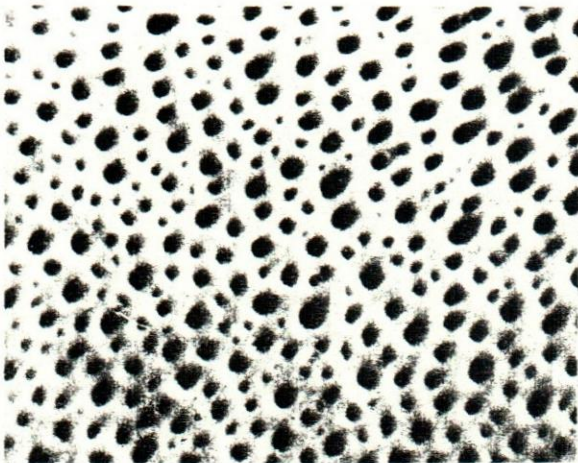


Fig. (10)

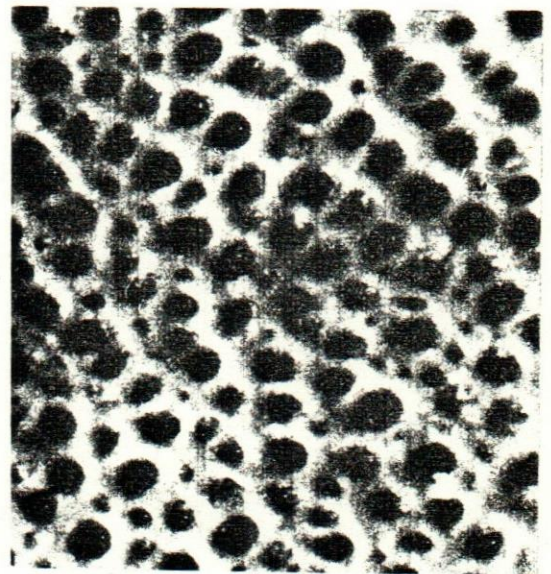


Fig. (11)



Fig. (12)

