International Journal of Bio-resource and Stress Management https://ojs.pphouse.org/index.php/IJBSM

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IJBSM January 2025, 16(1): 01-06

Article AR5839a

Research Article

Natural Resource Management

DOI: HTTPS://DOI.ORG/10.23910/1.2025.5839a

Anatomical Studies on the Reticular Groove of Adult Non-descript Sheep of Jammu Region

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ABSTRACT

The study was conducted at the Division of Veterinary Anatomy from 2021–2022 to understand the functional aspect of reticular groove and scarcity of literature in sheep. Reticular groove was characterized by floor and two muscular lips extending from the cardia to the level of reticulo-omasal opening. Both the lips were prominent and more developed in the aboral part than in the oral part. The left lip was cranial whereas the right lip was more caudal in position. The width was maximum in middle. Papillae resembling the claws of a small bird.were seen towards reticulo-omasal opening. Histologically, reticular groove was lined by stratified squamous keratinized epithelium. Incomplete lamina muscularis mucosae was seen mainly in the lips. Lamina propria blended with tunica submucosa. In the floor of groove, mainly transverse smooth muscle fibers were seen whereas lips contained thick longitudinal smooth muscle fibers. The epithelium and keratin layer were thicker at lips. Lamina propria submucosa was thicker at floor. Histochemically, strong positive PAS reaction was seen in the stratum corneum whereas basement membrane showed moderate PAS reaction. Cells of stratum granulosum showed strong reaction for Alcian Blue (pH 2.5) whereas other layers showed moderate reaction for Acid mucopolysaccharides with Alcian Blue (pH 2.5). Glycogen was moderately observed in the lamina epithelialis except stratum corneum. Layers of lamina epithelialis and tunica muscularis showed strong reaction for basic proteins. Stratum corneum showed strong reaction for lipids whereas other layers were weak to moderately positive.

KEYWORDS: Anatomy, epithelium, histochemistry, reticular groove, sheep

Citation* (VANCOUVER)*: Sasan et al., Anatomical Studies on the Reticular Groove of Adult Non-descript Sheep of Jammu Region. *International Journal of Bio-resource and Stress Management,* 2025; 16(1), 01-06. HTTPS://DOI.ORG/10.23910/1.2025.5839a.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

RECEIVED on 02nd October 2024 RECEIVED in revised form on 24th December 2024 ACCEPTED in final form on 14th January 2025 PUBLISHED on 30th January 2025

1. INTRODUCTION

On the basis of foraging behaviour, ruminants can be classed as grazers, browsers, or intermediate grazers (Gordon, 2003). Sheep prefer to graze (Mosavat and Chamani, 2013). Grazers eat lower-quality grasses. The sheep of Jammu are known as "migratory type animals" because they migrate to the plains in the last week of September or the first week of October, and then return to the hills in the last week of March or the first week of April. The feeding habits of ruminants, according to Hofmann and Stewart (1972), can induce physical changes in their digestive systems.

A better nutrient supply, adequate digestion, and absorption are all necessary for an animal's optimal health. Ruminants have a digestive mechanism that permits them to use energy from fibrous plant material more efficiently than other herbivores. Ruminants have a digestive tract that is designed to ferment feedstuffs and create energy precursors for the animal.

The compound stomach of true ruminants, such as cattle, sheep, goats, deer, and antelope, is divided into four compartments: the rumen, reticulum, omasum, and abomasum. Forestomach or pro-ventriculus is the combination of rumen, reticulum, and omasum (Teixeira et al., 2009). The ruminant stomach takes up approximately 75% of the abdominal cavity, filling nearly the whole left side and spreading into the right side. Forestomach ensures that big ingesta particles must be regurgitated and remasticated, improving digestive efficiency (Fritz et al., 2009 and Clauss et al., 2009). Because most fermentation occurs in the rumen and reticulum, the ruminant forestoamch is viewed as a fermentation chamber/vat (Van Soest, 1994). Each compartment of the forestomach has its own anatomical characteristics that play an important role in the rumination mechanism (Scala et al., 2011).

In stomach of ruminants, gastric groove starts at the orifice of cardia passing through the lesser curvature of reticulum, omasum and abomasum and extends up to pylorus. It is divided into three segments, namely reticular groove (Sulcus reticuli), omasal groove (Sulcus omasi) and abomasal groove (Sulcus abomasi) (Sandovall, 1988). Reticular groove which begins at the cardiac ostium and passes ventrally on the medial wall of reticulum and end at reticulo-omasal ostium (Eurell and Frappier, 2006). It might be closed into a channel conducting liquid foodstuffs to pass the fermentation chamber and enter directly into the regions where digestion takes place (Scala and Maruccio, 2012). When stimulated, muscular tissue contracts to form a duct which connects the esophagus (cardia) with the reticulo-omasal orifice (Titchen and Newhook, 1975). The reticulo-omasal orifice remains open to allow the flow of milk (Reid et al., 1988), which is of great interest particularly in new born animals, as it allows the colostrum and milk to pass directly to the abomasum, without falling into the rumen and reticulum, thereby preventing abnormal fermentation. The activity of the reticular groove decreases after weaning and as the age of the animal advances, but can be triggered under certain conditions in the adult animal (Arruebo, 1996).

Literature is available on the gross morphology, biometry, histomorphology of reticular groove of non-descript goats (Sasan et al., 2022) and Bakerwali goat of Jammu region (Sasan et al., 2023). However, meager information is available on the anatomy of reticular groove of non-descript sheep of Jammu region. Hence, the present study was planned and executed to understand the functional aspect of reticular groove and scarcity of literature in sheep.

2. MATERIALS AND METHODS

Present research was conducted at the Division of Veterinary Anatomy, F.V.Sc & A.H., SKUAST-Jammu from 2021–2022. For the study, six stomach samples from adult apparently healthy adult non-descript sheep were collected from slaughter houses in and around Jammu region. Immediately after collection, the stomach was cleaned with running water and brought to the laboratory for recording the gross morphological and biometrical studies. The parameters recorded were total length (cm) of reticular groove and width (cm) of reticular groove at three sites, namely towards cardia, in middle and towards reticulum.

After recording the gross and biometrical parameters, tissue samples were collected from two sites, i.e. lips and floor of reticular groove and preserved in 10% Neutral Buffered Formalin (NBF) solution (Luna, 1968). The tissue samples were processed and tissue sections of 5 μ thickness were obtained. The sections were stained with Haematoxylin & Eosin for routine histomorphology, Von Gieson & Verhoeff's and Gomori stains for connective tissue fibers, Ayoub-Shklar method for keratin (Luna, 1968). For histochemistry, Best Carmine, Bromophenol Blue, PAS-AB and Sudan Black B methods were used for demonstration of glycogen, basic proteins, neutral & acidic mucopolysaccharides and lipids, respectively. The micrometrical observations were taken i.e. thickness (μ) of lamina epithelia, keratin layer and lamina-propria submucosa. All the data was subjected to standard statistical analysis (Snedecor and Cochran, 1994).

3. RESULTS AND DISCUSSION

3.1. Gross morphology and biometry

In non-descript sheep, the reticular groove was characterized by two muscular ridges/lips which extended from the cardia to the level of reticulo-omasal opening (Figure 1). Both the lips were less developed towards the cardia but well developed towards the reticulo-omasal orifice with separate termination (Figure 1). The left lip was cranial whereas the right lip was more caudal in position. Agungpriyono et al. (1992) reported that in Lesser Mouse deer, the lips were prominent and more developed in the aboral part than in the oral part. Similar observations were made in non-descript goats (Sasan et al., 2022) and Bakerwali goat of Jammu region (Sasan et al., 2022). In present study, the length of reticular groove was 9.63±0.15 cm which was higher as compared to non-descript goats (8.70±0.07 cm) (Sasan et al., 2022) and Bakerwali goat (8.04±0.33 cm) (Sasan et al. 2023). The difference in the length of reticular groove might be related to different feeding habits of these species The width was maximum in middle (2.46±0.02 cm) followed by width towards reticulum (2.15±0.05 cm) and least towards cardia (1.94±0.02 cm). Similar pattern was observed by Sasan et al. (2023) in Bakerwali goat (2.81±0.27 cm in middle, 2.66±0.14 cm towards reticulum and 2.03±0.05 cm towards cardia). Close to the reticulo-omasal opening, the floor of the groove presented papillae resembling the claws of a small bird (Figure 1). Similar observations were made earlier by Sasan et al. (2022) in non-descript goats

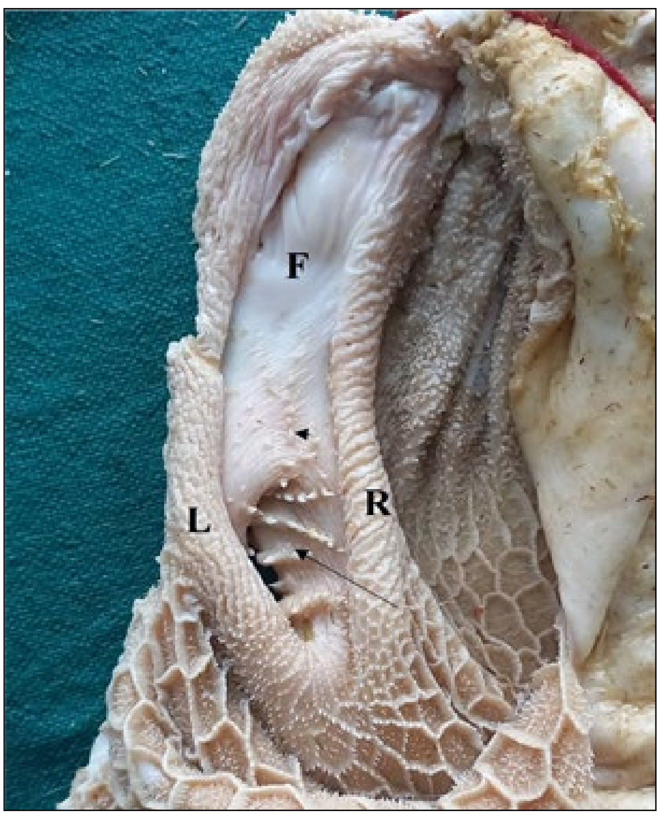

Figure 1: Photograph showing right (R) and left (L) lip and floor (F) of reticular groove with presence of papillae unguiculiformes (arrow) towards reticulo-omasal opening. Floor presented longitudinal folds (arrow head)

and Sasan et al. (2023) in Bakerwali goat of Jammu region. Such papillae were absent at reticulo-omasal orifice in deer (Perez et al., 2015). Teixeira et al. (2009) suggested that these papillae act as filter barrier and check the passage of those particles which were of inappropriate size and not suitable to be forwarded into the omasum and abomasum. The floor of the reticular groove was pale and marked by longitudinal folds (Figure 1) as also observed in non-descript goats (Sasan et al., 2022) and Bakerwali goat (Sasan et al., 2023).

3.2. Histomorphology and micrometry

The entire reticular groove and its lips were lined by stratified squamous keratinized epithelium (Figure 2, 3, 4). Similar observation was made by Eurell and Frappier

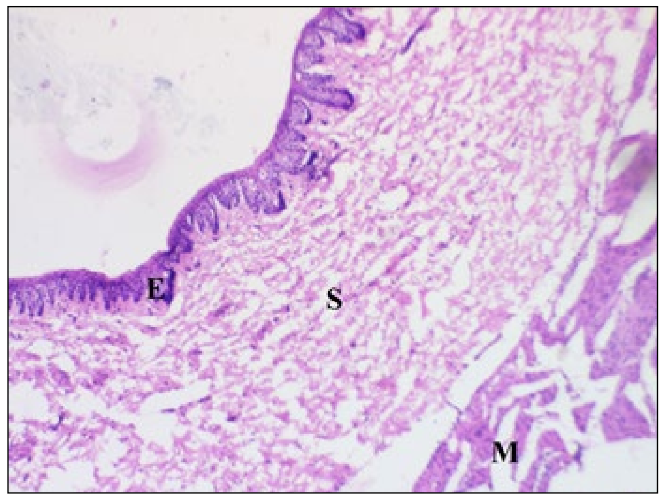

Figure 2: Photomicrograph of floor of reticular groove showing keratinized stratified squamous epithelium (E), lamina propria submucosa (S) and smooth muscle fibers (M). x100, H and E stain

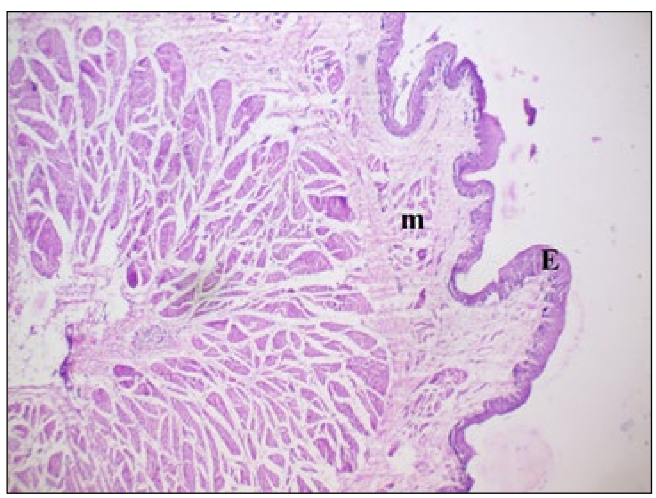

Figure 3: Photomicrograph of lip of reticular groove showing keratinized stratified squamous epithelium (E), presence of lamina muscularis (m) in lamina propria submucosa. x40, H and E stain

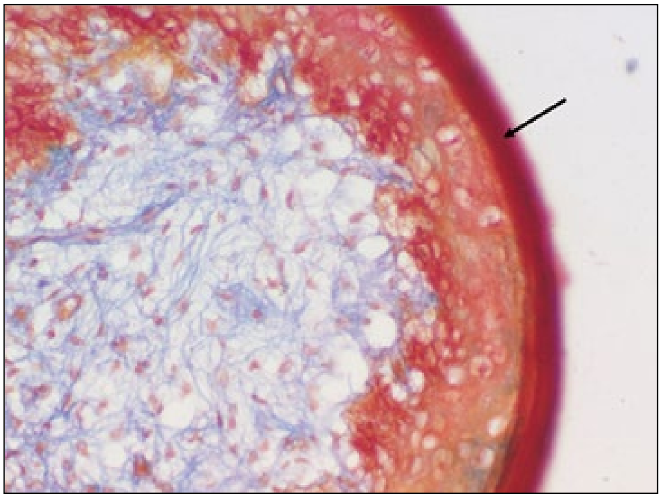

Figure 4: Photomicrograph of floor of reticular groove showing keratinized stratified squamous epithelium (arrow). x400, Ayoub-Shklar method

(2006) in ruminants. Well developed reticular layer was present between epithelium and lamina propria submucosa (Figure 5). Lamina muscularis mucosae was incomplete and seen mainly in the lips of reticular groove (Figure 3). Lamina propria blended with tunica submucosa which mainly consisted of collagen and elastic fibers (Figure 6). Glands were not observed in lamina propria. Eurell and Frappier (2006) in ruminants also reported that lamina-propria submucosa consisted predominantly collagen and elastic fibers. In the floor of groove, mainly transverse smooth muscle fibers were seen whereas lips contained thick longitudinal smooth muscle fibers whereas Pochon (2002) observed that the muscle fibers present in the lips of groove were arranged longitudinally and the floor of the groove presented outer longitudinal muscle fibers and inner layer of fibers arranged perpendicular to the long axis of the groove.

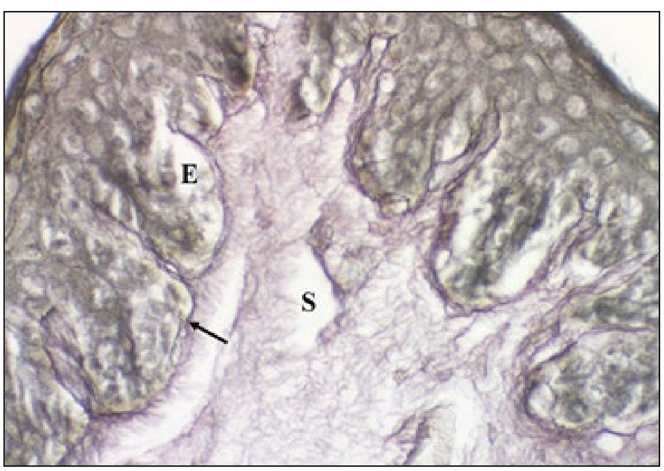

Figure 5: Photomicrograph showing presence of prominent reticular layer (arrow) between epithelium (E) and lamina propria submucosa (S). x400 Gomori's stain

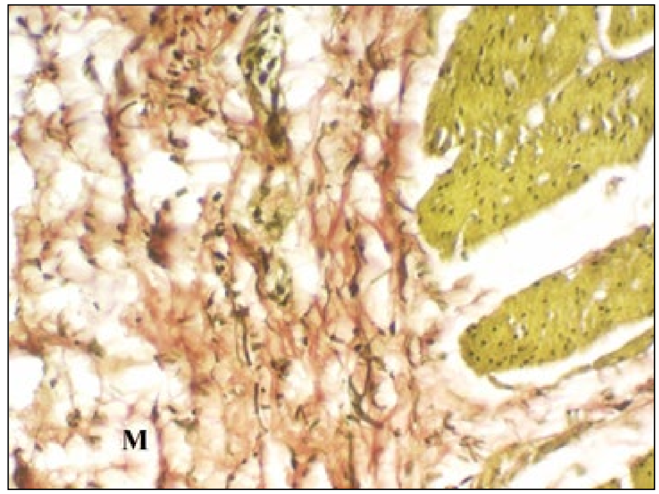

Figure 6: Photomicrograph of reticular groove showing collagen fibers (pink colour) and elastic fibers (black colour) in Lamina propria submucosa (M). x400 Von Geison Verhoeff's stain

In non-descript sheep of Jammu region, the thickness of epithelium was 114.14±7.50 μ at lips and 98.24±6.09 μ at floor. Sasan et al. (2022) in non-descript goats also reported thicker epithelium (121.04±9.16 μ) at lips as compare to the floor (71.69±6.18 μ). Keratin layer was thicker at lips (14.92±1.00 μ) as compared to the floor (11.46±0.27 μ). Lamina propria submucosa was thicker at floor (587.22±51.40 μ) than at lips (384.25±34.07 μ). However, in non-descript goats, lamina propria submucosa was thicker at lips (421.32±20.04 μ) as compared to floor (333.55±15.83 μ) (Sasan et al. 2022).

3.3. Histochemistry

The histochemical distribution of neutral and acid mucopolysaccharides, basic proteins, glycogen and lipids was studied in reticular groove of non-descript sheep of Jammu region. A PAS positive reaction indicated the presence of neutral mucopolysaccharides and acid mucopolysaccharide reactivity was observed with Alcian Blue stain at pH 2.5. Presence of basic proteins was demonstrated by Bromophenol Blue method. A positive reaction for Best carmine method indicated presence of glycogen whereas positive reaction for Sudan Black B method indicated presence of lipids.

Strong PAS positive reaction was seen in the stratum corneum whereas basement membrane showed moderate PAS reaction. Muscle fibers showed moderate PAS reaction (Figure 7).

The layers of lamina epithelialis showed gradation in intensity of mucopolysaccharide reaction. Cells of stratum granulosum showed strong reaction for Acid mucopolysaccharides with Alcian Blue (pH 2.5) whereas other layers showed moderate reaction for acid

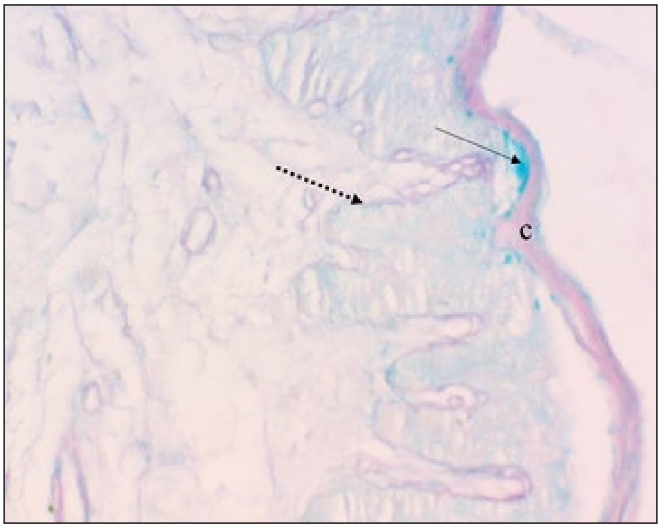

Figure 7: Photomicrograph of lip of reticular groove. Stratum corneum (c) showed strong reaction for neutral mucopolysaccharides whereas stratum granulosum (arrow) showed strong reaction for Alcian Blue. Basement membrane (dotted arrow) showed moderate to strong reaction for PAS. x400 PAS-AB stain

mucopolysaccharides. Mucopolysaccharide reaction was also evident in connective tissue (Figure 7).

Glycogen was moderately observed in the lamina epithelialis except stratum corneum, weekly in tunica muscularis and no reaction in lamina propria-submucosa (Figure 8).

Layers of lamina epithelialis and tunica muscularis showed strong reaction for basic proteins (Figure 9).

Stratum corneum showed strong reaction for lipids whereas other layers were weak to moderately positive (Figure 10).

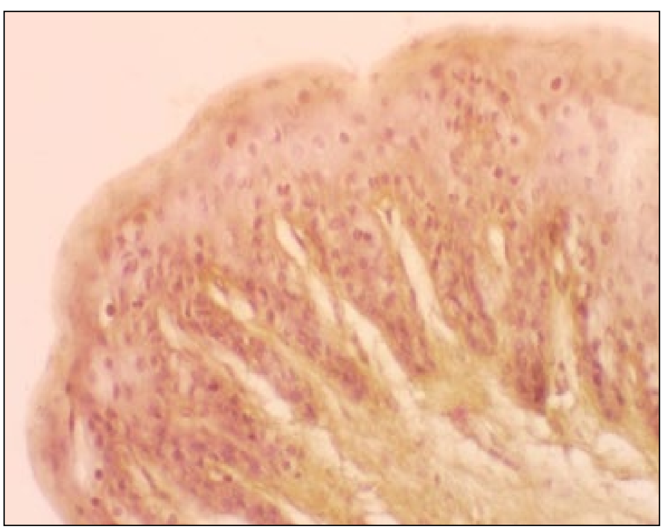

Figure 8: Photomicrograph of lip of reticular groove. Stratum corneum showed negative reaction whereas other epithelial layers showed moderate reaction for glycogen. x400 Best Carmine stain

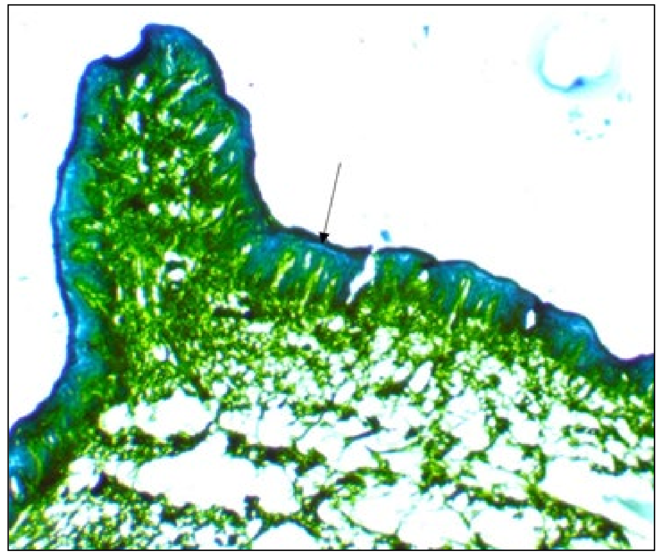

Figure 9: Photomicrograph of floor of reticular groove. Tunica mucosa (arrow) showed strong reaction. x100 Bromophenol Blue stain

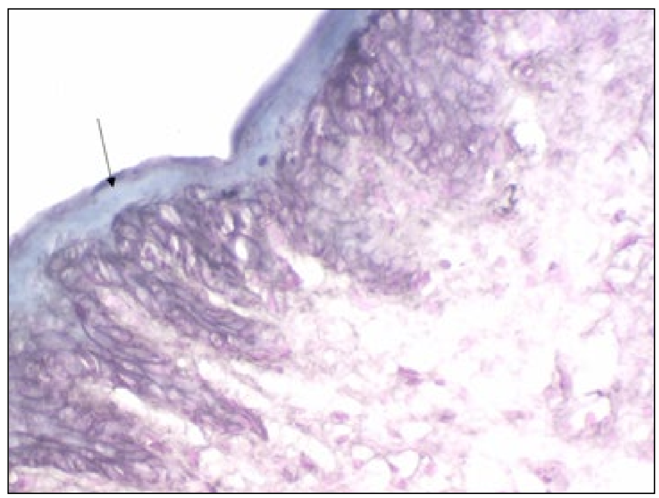

Figure 10: Photomicrograph of lip of reticular groove. Stratum corneum (arrow) showed strong reaction. x400 Sudan Black B stain

4. CONCLUSION

The reticular groove of non-descript sheep was characterized by two muscular lips. Width was maximum in middle. Close to the reticulo-omasal opening, the floor of the groove presented papillae resembling the claws of a small bird. Reticular groove was lined by stratified squamous keratinized epithelium. Incomplete lamina muscularis mucosae was seen in the lips. Strong PAS positive reaction was seen in the stratum corneum. Cells of stratum granulosum showed strong reaction for Acid mucopolysaccharides.

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