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Research Article

Morphological Studies on the Anal Canal of Adult Male Cat (*Felis domestica*)

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Abstract

The study was carried out on six male adult domestic cats of local breed. The anal canal examined macroscopically through different incisions to locate and illustrate the zones of the canal as well as the site of the anal sacs on each side of the canal and their openings. For microscopical studies, samples were immediately fixed in 10% neutral buffered formalin, dehydrated and embedded in paraffin blocks. Paraffin sections (5-6 µm) were prepared and stained with haematoxylin and eosine and periodic acid Schiff (PAS). The anal canalwas a short passage joined the bowel to the exterior. The lumen was constricted at the rectoanal junction where the mucosa was thrown into longitudinal folds, normally pressed together to occlude the orifice. Many glands were present in the anal region, both in the mucosa and in the surrounding skin. The cat also possessed two so-called anal sacs (*Sinus paranales*). Each was roughly the size of a hazelnut and was located ventrolateral to the anus between the internal and external sphincters. The fundus of the sac secretes an evil-smelling fluid that drained through a single duct to an opening near the anocutaneous junction. The sac was compressed at defecation, expelling the secretion, which probably served as a territorial marker. In cat, the anal canal possessed 3 distinct zones: (1) narrow columnar zone; (2) intermediate zone and (3) cutaneous zone. The columnar zone was contained anal columns between which were the anal sinuses. Modified tubulo-alveolar sweet glands and modified sebaceous glands were present in the lamina propriasubmucosa of the anal canal. They opened in anal canal by ducts and were not associated with hair follicles. Also numerous striated muscle fibers, vascular elements, the paired circumanal glands and nerve endings were met.

Keywords: Morphology, Anal canal, Cat.

Introduction

The terminal part of the rectum was called the anal canal and was borded at its external opening or anus by internal and external sphincter muscles (Jordan and Verma, 1983andWingerd, 1985). Getty(1975), Dyce et al. (2002), Sebastiani and Fishbeck (2005) and MacPhial(2008) in carnivores, recorded a pair of paranal glands, anal sacs that opened into the rectum near the anus. Dyce et al. (2002) also cited that each anal sac drained its secretion into a single duct to an opening near the ano-cutanous junction. On the other hand, Huston (2010) recorded that the excretory duct of the anal sac opened in the lateral margin of the anus in the dog, while in the cat it opened in a ventrolateral position. They added that these glands were compressed at defication, expelling an evil secretion which probably served as a territorial marker.

The mucosa of the canine anal canal can be divided into three zones; the proximal columnar zone, the middle intermediate zone and the distal cutaneous zone(Ogunkoya[2] et al.,2007). Hashimoto et al. (1963)mentioned that in the cat, sweat glands and well-developed sebaceous glands were found in the

wall of the anal sac. In the dog, sweat glands were found in the same location, but sebaceous glands lie only around the excretory duct. However, Shoieb and Hanshaw (2009)cited that in the cat, the anal sacs were surrounded by tubular apocrine glands and sebaceous glands, whereas only apocrine glands were found in dogs. Banks (1986)added that in dogs, the anal sac glands were apocrine tubular; in cats, they were apocrine tubular and sebaceous glands. Carnivore anal glands secrete lipids; those of pigs secrete mucoid substances. Dellmann (1992)mentioned that the circumanal glands of the dog were lobulated, modified sebaceous glands located around the anus in the cutaneous zone. Montagna andParks (1948) mentioned that the sebaceous glands in dogs were found in the dermis of the excretory duct of each anal sac. These glands, like the apocrine tubules of the anal sacs, excrete their product into the main duct.Marjorie et al. (1966)mentioned that the anal sac duct of cat was lined by stratified squamous epithelium similar to that observed in the sac lining, but with more cell layers and a thicker area of keratinization. Each anal sac duct opened at the anocutaneous line. Stefanov (2012) in dogscited that the malodorous paranal sinus fluid was composed of the secretory products of the apocrine paranal sinus glands and the sebaceous glands. Trautmann and Fiebiger (1957)recorded that the wall of the anal sac of carnivores bears a cutaneous mucosa. Sokolov and Shabadash (1979) mentioned that the apocrine glands of the anal sacs in cats were substantially rich in glycogen.

Studies on the anal canal of the local breeds of cat were lacking, therefore the present work aimed to spot light on the anatomy and histology of the anal canal of local breed of the cat (*Felis domestica*).

Materials and Methods

This study was carried out on six male adult healthy domestic cats of a local breed and weighing from 2.5 to 3.5 kg. After chloroform anesthesia, the cats were killed by exsanguination through the common carotid artery.

For obtaining the anal canal, a median and transverse incision of the abdominal wall was made to eviscerate all abdominal organs aside then follow the course of colon and rectum to reach the anal canal. The anal canal examined macroscopically through different incisions to locate and illustrate the zones of the canal as well as the site of the anal sacs on each side of the canal and their openings. For microscopical studies, samples were immediately fixed in 10% neutral buffered formalin, dehydrated and embedded in paraffin. Paraffin sections (5-6 µm) were prepared and stained with haematoxylin and eosine and periodic acid Schiff (PAS) (Drury and Wallington, 1980).

The findings for macroscopical investigations were documented with a digital photocamera (Nikon COOLPIX L310 "14.1" Megapixel).

Results and Discussion

Two paranal sacs (fig.1/3) were well observed in the cat as cutaneous pouches between the internal smooth and the outer striated anal sphincters, one on either side of the anus. On dissecting the anorectal junction by a dorsal midline incision, we noticed the mucosal folds of rectum (fig.2/2), the anorectal demarcation (fig.2/4) and the raised small openings of the paranal sac (fig.2/B/8) one on each side which were located at a ventrolateral position.

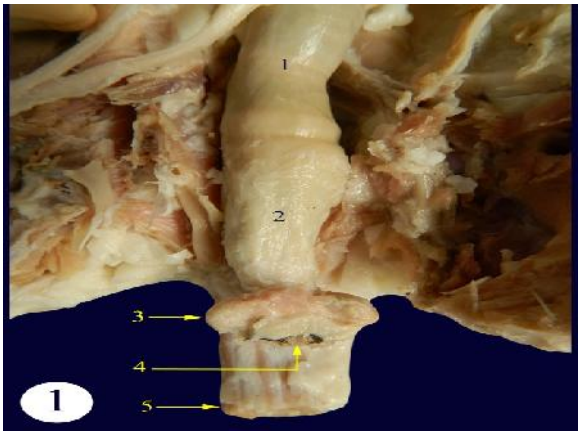

Figure 1: Topography of the terminal part of gastrointestinal tractof cat showing the location of the "paranal sacs" "ventral view"; 1.Descending colon, 2.Rectum, 3.Right paranal sac, 4.Anus, and 5.Tail.

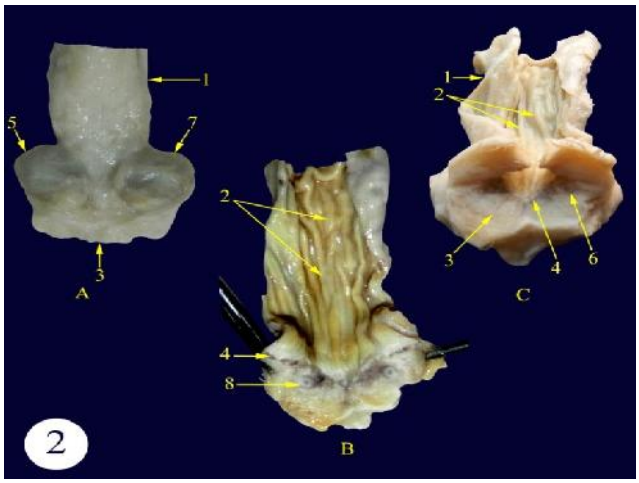

Figure 2: A photograph showing the paranal sacs of cat & their openings at the ventrolateral position of anorectal region; A.Ventral view, B.Dorsal view, C.Caudodorsal view, 1.Rectum, 2.Rectal folds, 3.Anus, 4.Mucocutaneous junction, 5.Right anal sac, 6.Opening of right anal sac, 7.Left anal sac, and 8.Opening of left anal sac.

The present investigation was in accordance with that reported by Getty, (1975); Dyce et al., (2002) and Sebastiani&Fishbeck, (2005), in the cat. They described two paranal sacs that appeared as pouches located between the internal smooth and the external striated sphincter muscles of the cat`s anus. Each paranal gland opened by a single duct ventrolaterally in the anal canal. However, MacPhail (2008) and Huston (2010) added that the paranal sacs contained a more even distribution of sebaceous and apocrine glands and this might explain the low occurrence of anal sac disease in cat compared with dog.

The anal canal in cat differentiated into three distinct zones; columnar zone, narrow intermediate zone and large caudal cutaneous zone which in agreement with that recorded by Ellenport (1975), Schummer and Nickel (1979), Evans (1993), Hudson and Hamilton (1993) in cat; Banks (1993) in dog and cat, Anderson and Anderson (1994), Evans and de Lahunta (1996) in dog; Dellmann and Eurell (1998) in carnivore and pigs and Abd El-Gawad (2002) in foxes.

The anal sacs in the present investigation were bilateral hazelnut diverticula of the anal mucosa as stated by MontagnaandParks (1948) in dogs, Marjorie et al. (1966), Schwarz (1987), Banks (1993) in most carnivores and rodents and Godynicki et al. (1995) in cats.

Each anal sac in our work was opened by a single opening on the lateral angle of the anocutaneous line like that of the cat (Marjorie et al., 1966) and dog (Dellmann and Eurell, 1998).

The wall of the anal canal of the cat in the present study was lined by non-keratinized stratified squamous epithelium in columnar and intermediate zones however, the cutaneous zone was lined by keratinized stratified squamous epithelium(fig.3) which in a similarity with that recorded by Dellmann and Eurell (1998) in pigs and carnivores. The latter authors mentioned that there was abruptly change of the columnar epithelium of the rectum into stratified squamous epithelium at the anorectal junction and the lamina muscularis of the rectum terminated which in a line with our obtained results. The lamina propriasubmucosa of the wall of anal canal of the cat contained sweat glands and sebaceous glands(fig.4) in addition to what is called the circumanal glands which simulate that mentioned by Trautmann and Fiebiger (1957), Atoji et al. (1998), Abd El-Gawad (2002) in foxesandShabadash and Zelikina (2002) in dogs. Budsberg et al. (1985) in dog.Banks (1993) andDellmann and Eurell (1998) in dog, pig and cat reported the presence of only modified sweat glands in the propriasubmucosa in addition to the circumanal glands in the cutaneous zone.

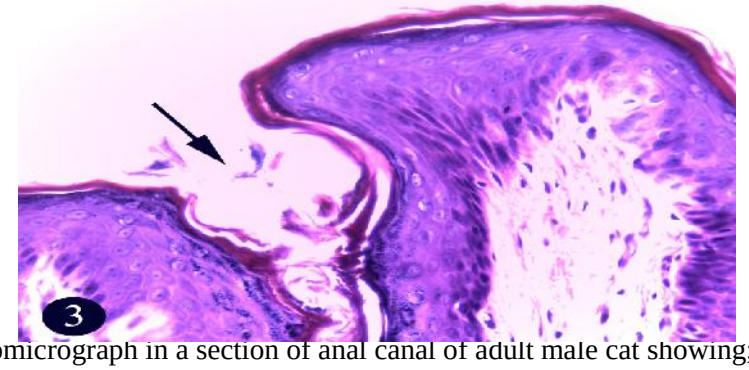

Figure 3: A photomicrograph in a section of anal canal of adult male cat showing; the keratinized Stratified epithelium and the common duct of sebaceous & apocrine sweat glands (arrow) (H & E, X 1000).

The anal sac and duct of cat were lined by keratinized stratified squamous epithelium and the lamina propriasubmucosa was filled by apocrine sweat glands(fig.4). This was in agreement with that mentioned by Marjorie et al. (1966) in cat, Dellmann and Eurell (1998) in carnivores. Banks (1993) in cat mentioned that the wall of the anal sac presented both apocrine sweat glands and sebaceous glands.

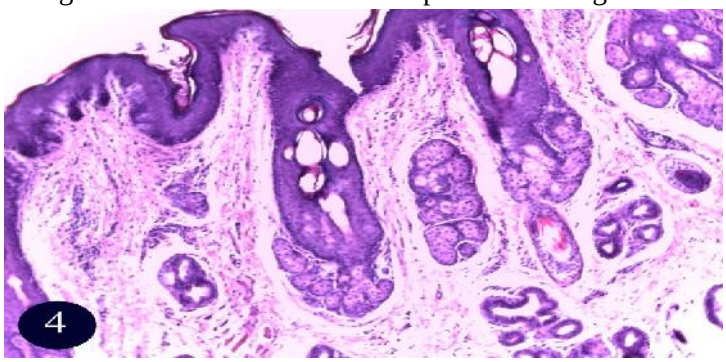

Figure 4: A photomicrograph in a section of anal canal of adult male cat showing; the epithelium lining the anal sac region formed of keratinized stratified squamous epithelium, L.propria-submucosa contains sebaceous gland complex & apocrine sweat gland; all of them open in a common duct (H & E, X100).

Similar to our results in cats, Ogunkoya[2] et al. (2007) in caninesmentioned that the location and the morphology of both the sebaceous and sweat glands in dog do not differ from what has been described by earlier workers, but numerous skeletal muscle fibers were observed at the zones of these three glands(fig.5). Baker (1967) andIsitor (1978) observed striated muscle fibers at the zone of the hepatoidcircumanal glands. The importance of the striated muscle fibers was not discussed by these authors but we think that the striated muscle fibers to be part of external anal sphincter muscle. The observation of smooth muscle fibers in this study.

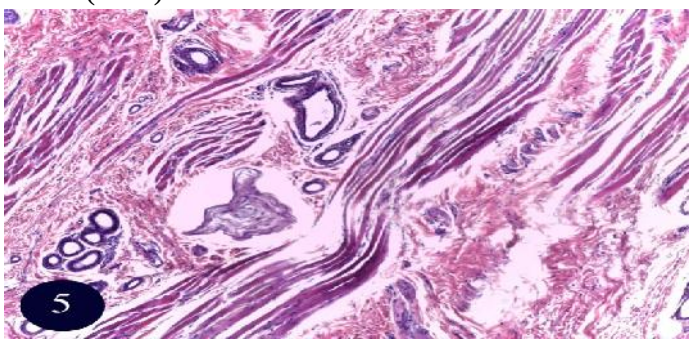

Figure 5: A photomicrograph in a section of anal canal of adult male cat showing;pacinian corpuscle, striated muscles and apocrine sweat glands (H & E, X 100).

agreed with the report of Baker (1967) whereas Isitor (1978) reported to the contrary the absence of smooth muscle fibers.The muscular layer in the present work might serve as a compressor for the excretory movement. Nerve fibers were found to supply between the muscular and the submucous connective tissues. In the latter tissue, a pacinian corpuscle (nerve ending) was observed(fig.5). It was probable that this nerve supply possessed an intimate association with the excretory mechanism of anal sac. This simulates the results of Hashimoto et al. (1963) in tiger.

In agreement with Marjorie et al. (1966)the present work in cats revealed that the sebaceous gland complexes in cats were dispersed in the connective tissue of the wall of the anal sac at fairly regular intervals(fig.4). The connective tissue surrounding a complex was similar to and continuous with that surrounding the epithelial lining of the anal sac and that in which the apocrine glands were embedded. Several of the sebaceous complexes appeared to be composed of indistinct lobules of sebaceous gland units(fig.6). Blood vessels and occasional apocrine gland ducts were embedded in the connective tissue of the sebaceous complexes. Krölling (1926) stated that the sebaceous excretory ducts were tubules consisting of 1 to 2 layers of epithelium. The present investigation indicated that the beginning of an excretory duct was formed by degeneration of sebaceous cells located in the center of an alveolus. The lumens formed by these areas of disintegration led into epithelial-lined ducts similar to those described by Krölling (1926). The duct scattered throughout the sebaceous gland complex, converged and joined to form larger ducts. The final union of the ducts formed a large cistern which emptied into the lumen of the anal canal (fig.3).

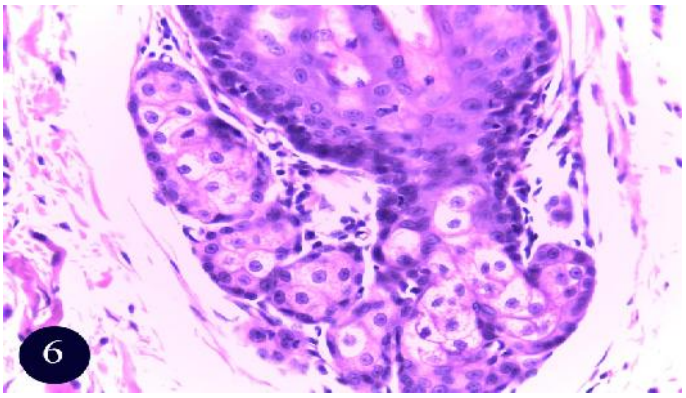

Figure 6: A photomicrograph in a section of anal canal of adult male cat showing; sebaceous gland complexes appeared to be composed of lobules of sebaceous gland units, the individual sebaceous gland alveoli were composed of central polygonal or spherical vacuolated sebaceous cells enclosed by smaller flatten cells that rested on a well-developed basement membrane (H & E,X 1000).

Regarding the apocrine sweat glands, our findings in cats were recorded also by Marjorie et al. (1966). The apocrine glands were embedded in the connective tissue of the anal wall between and surrounding the sebaceous gland complexes(fig.7), the tubules of the glands appeared tortuous and coiled as evidenced by the large numbers of cross sections of tubules seen in small, circumscribed areas. In places, the tubules branched or formed diverticuli(fig.8) similar to the apocrine glands of the human skin described by Montagna (1956). The tubules were lined by simple columnar or cuboidal epithelial cells varying in height and structure. Many of the luminal borders of the cells appeared to form cytoplasmic extensions into the lumens(fig.9), whereas some were smooth. The tubules were surrounded by a thick-appearing basement membrane and myoepithelial cells. The excretory ducts were lined by 1 or 2 layers of cuboidal epithelium. Most apocrine gland ducts opened directly into the sebaceous gland complex(fig.10).

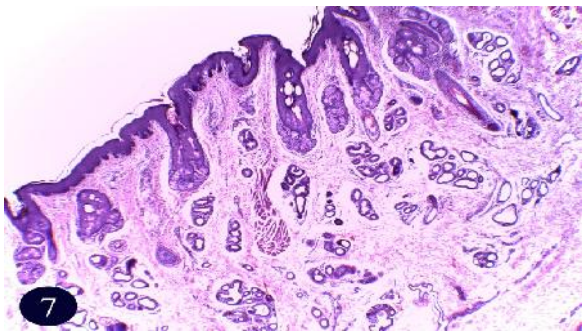

Figure 7: A photomicrograph in a section of anal canal of adult male cat showing; the epithelium lining the anal sac region formed of keratinized stratified squamous epithelium, L.propria-submucosa contains sebaceous gland complex & apocrine sweat gland; all of them open in a common duct (H & E, X 40).

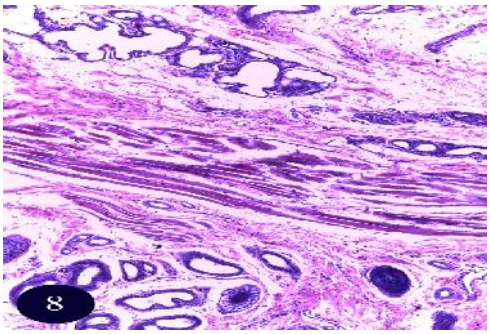

Figure 8: A photomicrograph in a section of anal canal of adult male cat showing; skeletal muscle fibers inbetween modified apocrine sweat glands, notice that apocrine sweat gland tubule possessed many diverticuli, inbetween highly coiled tubules of sweat gland, strands of skeletal muscles (H & E,X100).

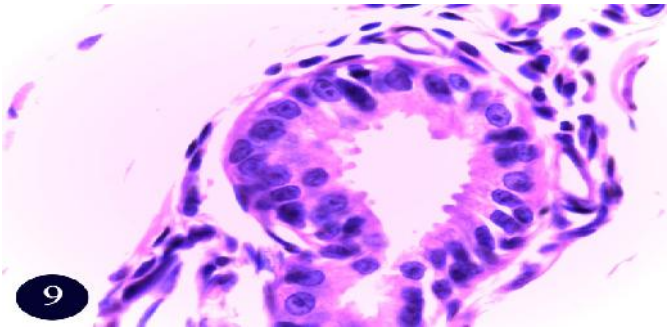

Figure 9: A photomicrograph in a section of anal canal of adult male cat showing; apocrine sweat glands, most of the luminal borders of the cells appeared to form bleb-like protrusions (H & E, X 1000).

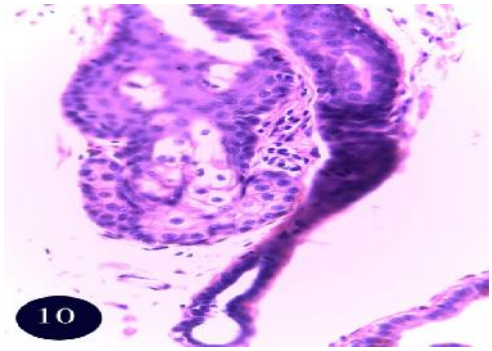

Figure 10:A photomicrograph in a section of anal canal of adult male cat showing; duct of apocrine sweat glands, open into sebaceous gland Complex (H & E,X1000).

Stoeckelhuber et al. (2000) mentioned that in the anal pouch of the aardwolf, bundles of cross-striated muscle tissue invaded the glandular zone and can be found regularly among the apocrine glands and apparently help to extrude the secretory product, which simulates our results in cats.

In agreement with our findings in cat, Atoji et al. (1998) in dog stated that, the apocrine secretion from the apocrine sweat glands was characterized morphologically by the pinching off of smoothsurfaced apocrine projections into the lumens of apocrine tubules (Kurosumi et al., 1984). To date, apocrine secretion from apocrine sweat glands had been detected in the antebrachial organ of the ring-tailed lemur(Kneeland, 1966), the ceruminous gland and axillary gland of the human (Kurosumi and Kawabata, 1976; Testa-Riva and Puxeddu, 1980; Kurosumi and Kurosumi, 1982), the anal scent gland of the woodchuck (Smith and Hearn, 1979), the jugulo-sternal scent gland of the tree shrew (Zellerand Richter, 1990), the skin of the pig (Gargiulo et al., 1990), the anal sac of the cat (Flachsbarth et al., 1992), and the infraorbital gland of the Japanese serow(Atoji et al., 1993).

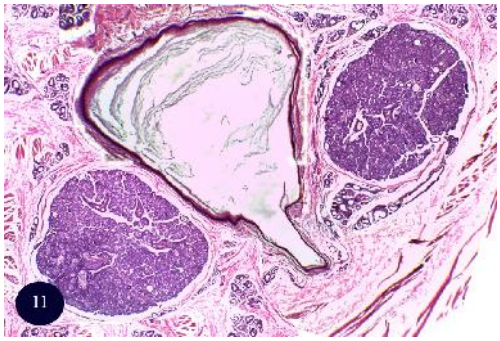

Figure 11: A photomicrograph in a section of anal canal of adult male cat showing; paired circumanal glands & their common duct, duct lined with stratified squamous epithelium; the glands and duct surrounded with apocrine sweat glands and strands of skeletal muscle (H & E, X10).

Our results in cats revealed that the anal canal at the cutaneous zone contained two large cellular masses on either side with a single duct (Fig.12). Each cellular mass was formed of lobules of cells. The lobules of each cellular mass could be divided into two types according to the presence or absence of cyst. In the lobules with cyst (fig.13), many layers were identified. The outermost formed of flattened cells, followed by a layer of polyhedral cells, then layer of flattened cells. The innermost layer consisted of eosinophilic keratin. Lobules without cyst (fig.14) formed of peripheral flattened cells and central polyhedral cells. All cells and keratin possessed positive reaction to PAS (fig.15). No blood capillaries were noticed in lobules either with cyst or without. Apocrine sweat glands were dispersed through the connective tissue of these cellular masses (fig.16). They were not connected to these cellular masses.

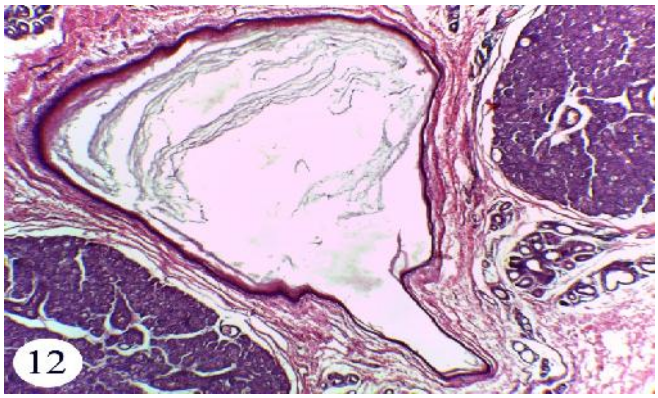

Figure 12: A photomicrograph in a section of anal canal of adult male cat showing; paired circumanal glands a single common duct, the duct lined with stratified squamous epithelium (H & E, X 40).

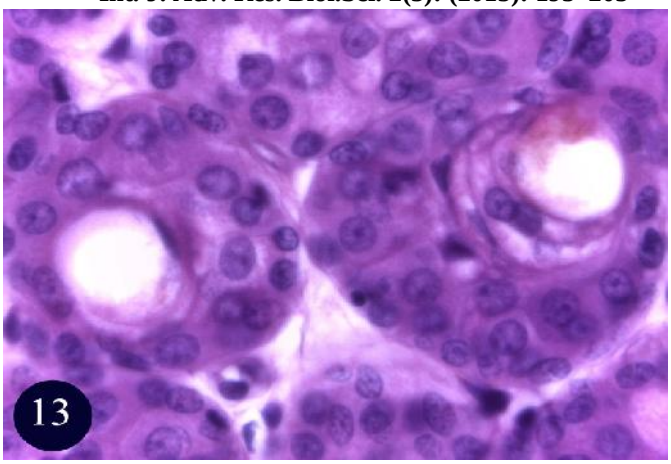

Figure 13: A photomicrograph in a section of anal canal of adult male cat showing; lobules of circumanal glands with cyst formed of polyhedral cells, then layer of flattened cells. The innermost layer consisted of keratin (H & E, X1000).

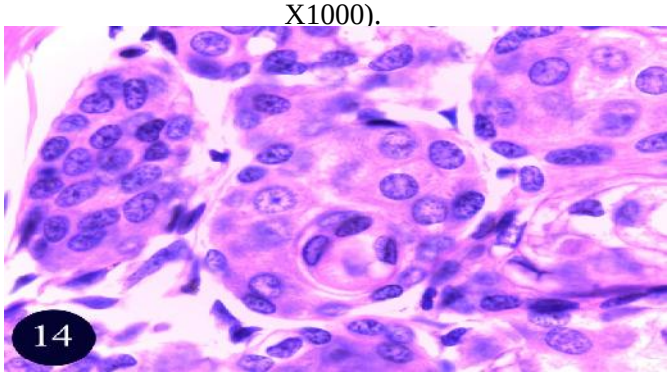

Figure 14: A photomicrograph in a section of anal canal of adult male cat showing; lobules of circumanal glands without cyst formed of peripheral flattened cells & central polyhedral cells(H & E, X1000).

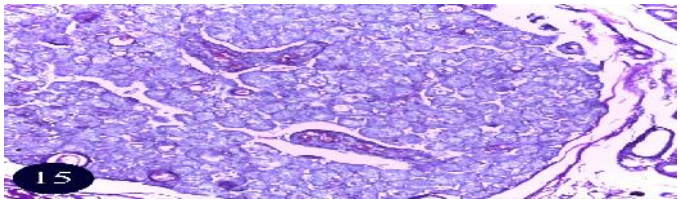

Figure 15: A photomicrograph in a section of anal canal of adult male cat showing; one of the circumanal glands.Notice that some lobules with central cysts others without cyst(PAS,X400).

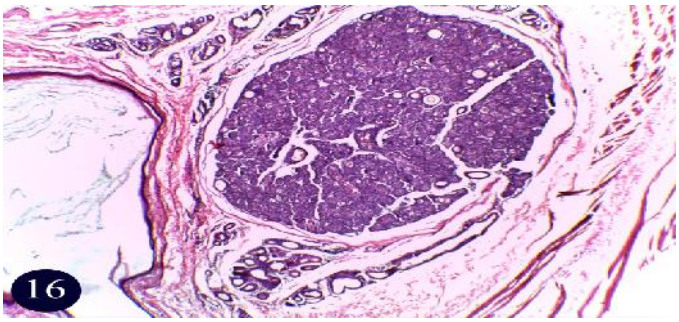

Figure 16:A photomicrograph in a section of anal canal of adult male cat showing; the circumanal gl. surrounded by apocrine sweat gl. & strands of skeletal muscles (H & E, X100).

Abd El-Gawad (2002) in foxes showed that the anal canal and anal sacs of the wall of the cutaneous zone was filled with two large cellular masses.These masses were described in the most literatures as circumanal glands. Dellmann and Eurell (1998) described those glands in the dog as lobulated modified sebaceous glands formed from superficially typical sebaceous gland layer, and deep solid compact masses of hepatocyte-like cells with intercellular canaliculi termed hepatoid glands. Banks (1993) in canines described typical sebaceous glands and nonpatent masses of polyhydral parenchymal hepatocyte-like cells (circumanal glands). Shabadash and Zelikina (1991, 1995, and 2002) in dog and foxes described the circumanal glands as hepatoid glands and mentioned that these glands presented a network of intercellular tubules, lysis of some secretory cells and cyst formation. From the obtained results in cats were the cellular masses which described previously as the circumanal glands characterized by presence of crowded peripheral cells like that of stratum basale of stratified squamous epithelium and absence of the blood vessels. So, it was suggested that these masses were early down growth from the stratified squamous epithelium. Atoji et al. (1998) in the dog mentioned that the lobules of the circumanal glands had many characteristics of epidermis and they should not be classified as glandular tissue. Moreover, Banks (1993) was reported that these glands were predisposed to neoplasia. These masses might have a supportive function to the cutaneous area of the anus. Ogunkoya[1] et al.(2007) mentioned that the hepatoidcircumanal glands of dog were located in the deep layer of the dermis and the hypodermis. The cells of these glands appeared like cords of liver cells. There was no evidence of ducts in or around these glands and could not be regarded as an exocrine gland.

Our opinion regarding the circumanal glands of cat, simulate the opinion of Atoji et al. (1998) in dogs. They stated that the lobules of the circumanal glands had many characteristics of epidermis (a basal layer, a polyhedral, a granular layer, and a horny layer) and they should not be classified as glandular tissue.

Sokolov and Shabadash (1979) showed that the neutral and acid mucopolysaccharides in anal sacs of the cats were present in the mature secretion in the form of complexes with one another in approximately equal proportions; neutral polysaccharides consisted chiefly of glycogen. Besides polysaccharides, the apocrine glands produced large quantities of protein. These observations were similar to our results in cats.

Stoeckelhuber et al. (2000) stated that the aardwolf was a nocturnal animal with an exquisite diet consisting largely of termites (Kruuk and Sands, 1972). Extensive studies on the scent marking behavior of the aardwolf had been conducted in South Africa (Richardson, 1991; Sliwa, 1996; Sliwaand Richardson, 1998). Two principal scent marking organs were observed, the penile pad and the anal pouch, the latter producing a creamy product which had a brown coloration in the male. Furthermore, ethological observations suggested the existence of scent glands in the forefeet. The territorial marking of male animals played an important role in the defense of their access to females and to food resources, whereas females were defending feeding territories only. Scent-marking played also an important role in the mating-season in both sexes (Sliwa and Richardson, 1998).Atoji et al. (1998) showed that the apocrine sweat glands in the circumanal glands of the dog appeared to be more active than those on the general body surface. Shed secretory cells containing large granules, as well as degenerated polyhedral cells from the circumanal glands, might contribute, to some extent to the subtle composition of sweat from these apocrine sweat glands and formation of scent marking.

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