Anatomical, Histological and Histochemical Adaptations of the Reptilian Alimentary Canal to Their Food Habits: I. *Uromastyx aegyptiaca*

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Abstract: A series of studies was carried out to elucidate the relationship between the microscopic anatomy of the alimentary canal and the food habits in reptiles. Three reptiles were chosen according to different feeding habits, *Uromastyx is* a herbivouous, *Chameleon* is an insectivorous, while *Crocodilys* is a carnivorous reptile. So, it is obvious that the anatomy as well as the histology of the alimentary tract of reptiles demonstrate certain specific characteristics of functional adaptations as a reflection of the herbivorous, carnivorous and insectivorous mode of feeding. The anatomical and histological study of the alimentary canal of *Uromastyx aegyptiaca* was carried out. A comparison between the different histological structures found and those known in other reptiles was done. The straight oesophagus is lined with ciliated epithelium and goblet cells, leading to the stomach which consists of two portions, fundic or oxyntic and pyloric or mucous. The small intestine is comparatively short although the animal is purely herbivorous. It consists of the duodenum and ileum. The duodenual mucosa is in the form of leaf-like villi provided with shallow branched Lieberkühn crypts at their bases. The ileum is devoid of found glands. The large intestine is formed of a well developed large caecum, colon and rectum. At the posterior edge of the caecum there is a small blind sac which is considered as the appendix. The caecum which is devoid of glands is lined with simple columnar cells of a special type. While the ileo -caecal valve is in the form of a characteristic well developed protrusion, the caeco-colic valve is formed of a flap arising from one side. The mucosa of the colon is folded and lined with goblet and columnar cells, while that of the rectum is, more or less, straight and is rich in goblet cells and lymph spaces. The distribution and localization of different carbohydrate categories (PAS-positive material, mucopolysaccharides) were studied in the mucosal epithelium of the alimentary canal of *Uromastyx aegeptiaca*. The goblet cells of the oesophagus are rich in acid mucpolysacharides, those of the small and large intestine contained smaller amounts. Neutral mucpolysacharides were found in small to moderate amounts, being most obvious in the gastric mucosa. Mode of feeding as well as habitat, show, more or less a close similarity in the histochemical pattern of their gut mucosa as regards to the distribution and localization of proteins and nucleic acids.
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1. Introduction

The present study deals with the morphological adaptations in the reptilian digestive system in relation to their food nature .In general , most reptiles feed chiefly on animals and insects , but land tortoises some turtles and few lizards eat vegetations. Lizards and small snakes eat insects and other small invertebrates. Small turtles feed on aquatic invertebrates. Large lizards, turtles, snakes and crocodiles eat various vertebrates from fishes to mammals (**Saber, 1989; Sadek, 1992 and Saleh, 1993**). Reptiles include as many as 7500 different species, most known are: alligators, turtles, tortoises, lizards and snakes (**Elliott, 2007**). The total intake of food is small in amount if compared with that necessary for birds and mammals. Reptiles eat more, and digestion is faster at higher temperatures (**Boolootian, 1979 and Karasov *et al*., 1986**). In general, the digestive system of reptiles consists of the buccal cavity with its associated structures, the oesophagus, the stomach, the small and large intestine in addition to the accessory digestive glands represented by the liver and the pancreas (**Ibrahim, 1991**). The anatomical and histological structure of the alimentary tract of the agamid *Uromastyx aegeptiaca* and its relation to the herbivorous type of feeding will be discussed in detail.

Reptiles have been suggested to be useful models for the study of the regulatory mechanism of the gastrointestinal system for several reasons (**Secor and Diamond, 1998**). First, their regulatory responses are easier to examine experimentally than those of the typical mammalian models because they have extreme responses to feeding. Many reptiles consume huge meals (up to 160% of their own body mass) at infrequent intervals (sometimes fasting for 18 months). By contrast, most the mammalian model species (i.e. rats, mice, rabbits, pigs, etc.) that eat small meals have correspondingly larger regulatory responses to feeding than do mammals. Second, studying the

digestive responses of reptiles improves our understanding of the evolution of the regulatory mechanisms of the gastrointestinal tract. Although previous research on the digestive responses of reptiles has examined regulatory phenomena such as hormone release, the growth and atrophy of organs, and acid –base homeostasis (**Secor and Diamond , 1995&1998; Starck, 1999; Busk et al., 2000; Secor et al., 2001; Starck aond Beese, 2001, 2002; Pennisi, 2003; Andrade et al., 2004; Starck et al., 2004**).

Reptiles have been suggested to be a future useful model for studying the physiological regulation of the digestive process as they have well responses to feeding even more than other commonly used experimental mammals such as mice, rats, rabbit and pigs (**Secor and Diamond, 1998**).

The digestive system of the reptiles contains all the structures present in other higher vertebrates, from the oral cavity to the cloaca. The oral cavity is lined by mucous membrane made of non-keratinized stratified squamous epithelium with salivary glands distributed in the submucosa (**Putterill and Soley, 2003**).

The alimentary tract of reptiles is similar to higher vertebrates with some exceptions. The oesophagus shows adaptive modifications from group to group. In turtles, the oesophagus has heavily keratinized papillae that protect the mucosa from abrasive diet such as speculated sponges and jellyfish, and also may act as filtering devices. In lizards, it is formed of folds lined by ciliated columnar epithelium with goblet cells. Some snakes have mucous glands along their submucosa (**Elliott, 2007**). The muscularis mucosa of the oesophagus is absent in many species of reptiles but may be found in some species of turtles (**Elliott, 2007**).

Oppel (1896, 1897& 1900) described the alimentary canal of reptiles; **Greschik (1917)** studied the anatomy and histology of the alimentary canal of both *Ableparus pannonicus* and *Anguis fragilis*. **Langley (1881)** gave an account on the histology and physiology of pepsin-forming glands in some reptiles. **Beguin (1904 a & b)** studied the oesophageal glands of reptiles. **Staley (1925)** gave a brief account on the structure of gastric glands of *Alligator mississippiensis*. **Beattie (1926)** described the ileo-caecal region of *Tupinambis teguexin*.

Compared with mammals, reptiles possess a number of peculiarities that could be of specific advantages for some histological aspects in general and histochemical ones in particular. A considerable bulk of literature analyzing histochemically the lacertilian gastrointestinal tract has come to light (**Chou,1977; Odebode et al., 1979; El- Taib and Jarra, 1983;Taib,1984; Dehlawi et al., 1987c and 1988 a & b ; Zaher et al.,1987 a & b**).

The macroscopic structure of the reptilian alimentary tract has been subjected to extensive studies since the work of **Beguin (1904 a &b), Kahlie (1913) and Krause (1922)**. Reports on this subject were presented by Abo-**Taira et al. (1988a & 1988c)** on *Acanthodactylus boskianus* and *Tarentola annularis*, respectively. **Zaher et al. (1989b, 1990a & 1991a)** studied the anatomy of the alimentary tract in *Stenodactylus slevini*, *Mabuya quinquetaeniata* and *Echis carinatus*, respectively .

Efforts have been exerted in the study of the microscopic structure of the reptilian alimentary tract organs. Of these, the histological studies of the alimentary tract of some lizards were carried-out by several authors including the work of **El-Toubi and Bishai (1958)** on *Uromastyx aegyptiaca*; **Bishai (1959)** on *Varanus griseus*; **Anwar & Mahmoud (1975)** on two egyptian lizards *Mabuya quinquetaeniata* and *Chalcides ocellatus*; **Amer and Ismail (1976)** on *Agama stellio*; **Farag (1982)** and **Dehlawi et al. (1988a)** on *Uromastyx philbyi*, **Dehlawi and Zaher (1985a)** on *Acanthodactylus boskianus*; **Zaher et al. (1989a & 1990b)** on *Mabuya brevicollis* and *Chalcides sepoides*, respectively.

The histology of the tract organs of the gecko *Gekko japonicus* was studied by **Oidumi & Ishihara (1964). Chou (1977) and Dehlawi and Zaher (1985b)** studied the histology of the alimentary tract organs in the geckos *Ghyra mutilata* and *Pristurus rupestris*, respectively.

The microscopic structure of the tract organs of some snakes was also investigated by **Heyder (1974)** on *Typhlops vermicularis* and **Abdeen et al. (1994)** on *Malpolon monspessulanus*, *Coluber florulentus* and *Tarpophis obtusus*. **Ballmer (1949)** studied the histology of the digestive tract organs of some american turtles; **Thiruvathukal and Kuriakosa (1965)** studied the digestive tract of the fresh water turtle *Chrysemys picta.*

Extensive histochemical studies have been carried-out on the alimentary tract organs of reptiles. **Dehlawi and Zaher (1985b &1987a)** studied the histochemical distribution and localization of carbohydrates in the alimentary tract of the gecko *Pristurus rupestris* and the lizard *Agama adramitana*, respectively.

A comparative histochemical study on the distribution of carbohydrates in the gut mucosa of the lizard *Uromastyx philbyi* and the snake *Naja nigricolis* was carried-out by **Badr El-Din (1991)**.

The histochemical distribution of lipids and mucopolysaccharides in the alimentary tract mucosa of the gecko *Tarentola annularis* was studied by **Amer et al. (1987a)**. The mucopolysaccharides, lipids and proteins in the tract mucosa of the lizard *Acanthodactylus scutellatus* was subjected to such study by **Amer et al. (1988).**

The localization of lipids, proteins and nucleic acids in the mucosal epithelium of the alimentary tract was investigated in the gecko *Pristurus rupestris* by **Zaher *et al*. (1987a)**, the lizard *Uromaxtyx philbyi* and the snake *Naja nigricolis* by **El-Dawoody *et al*.(1992).**

The localization and distribution of carbohydrates, proteins, lipids, and nucleic acids in the mucosal coat of the reptilian gut has been extensively described (**El-Taib and Jarrar 1983; Dehlawi and Zaher, 1985 a & b; Amer *et al*., 1987b ; Abo Taira *et al*., 1988 a & b; Zaher *et al*., 1989 a & b; Abdeen, *et al*., 1990 a ; El-Dawoody, 1992 and Zaher *et al*, 1995).** Also, **Berrin (2005**) made an immunohisochemical study on the endocrine cells in the gastrointestinal tract of the freshwater turtle *Mauremys caspica caspica*, while **Giovanni *et al* .(2008)** worked on the histochemical and the immunohistochemical characterization of exocrine cells in the foregut of the red eared slider turtle, *Trachemys scripa*. **Banan Khojasteh *et al*. (2009)** showed that the intestinal goblet cells of *Oncorhynchus mykiss* have both acidic and neutral mucosubstances. **Perez-Tomas *et al*. (1990)** suggested that mucins can play different roles among regions of the digestive tract of the Greek tortoise, *Testudo graeca.*

The distribution of carbohydrates, proteins, nucleic acids, and lipids in the alimentary tract was studied by **Amer *et al*. (1987b)** in the snake *Echis carinatus*. Reports on this subject was presented by **Abdeen *et al*. (1990 a & b)** on the skink *Eumeces schneideri* and the snake *Cerastes vipera*, **Amer *et al*. (1990)** on the gecko *Pristurus flavipunctatus*, and **Zaher *et al*. (1990b)** on the lizard *Chalcides sepoides*.

Uriona *et al*. (2005) studied the structure and function of the oesophagus of *Alligator mississippiensis*; **Strarck *et al*. (2007)** studied the physiological and morphological responses to feeding in *Caiman latirostis*; **Ahmed *et al*. (2009)** studied the histological and histochemical of the gut of *Varanus niloticus*; **Biomy (2010)** studied the ultrastructural and histochemical characterization of the alimentary tract of the insectivorous reptile, *Scincus scincus.* **Khamas and Reeves (2011)** studied the morphology of the oesophagus and stomach of the gopher snake *Pituophis catenifer*.

In this respect, the present work is designed to add a new speculation about the anatomical, histological and histochemical variations of the alimentary canal in the herbivorous species *Uromastyx aegyptiaca*. The main goal of the present study is to cast light on the relationship between the anatomical, histological and histochemical adaptations of the alimentary canal of the investigated species to its herbivorous mode of feeding.

2. Material and Methods

Uromastyx aegyptiaca (family: Agamidae) which lives in the desert, is purely herbivorous. It is one of the very few forms among lizards having this feeding habit. Ten animals caught from Gabal Al-Maghara, south of El-Arish city, northern Sinai, Egypt were used as a model of herbivorous reptiles (Fig.1).

The specimens were anaesthized by chloroform and then dissected carefully by making a longitudinal incision at the midventral surface.

For gross anatomy, photographs were taken for the digestive system within the body of the animal and also for the alimentary canal taken out of the body. In addition, in two specimens, the alimentary canal was cut longitudinally to describe the structure of the internal surface as the folds, the villi and valves.

For the general histological studies, the contents of the gastrointestinal tract were drained by saline solution, small pieces of the various segments were fixed in aqueous Bouin solution , after fixation, parts of the gastrointestinal tract were dehydrated, embedded in paraffin wax and then transversely sectioned 6μ thick .Sections were stained with differential double stained Mayer's haemotoxylin and eosin (**Castro and Camargo, 1951**).

For the histotochemical studies, the following techiques were implemented:

1- General carbohydrates were illustrated using the periodic acid −Schiff (PAS) technique (Pearse, 1968). In this procedure, sections were placed in 0.5%periodic acid for the liberation of aldehydes, and then treated with Schiff's reagent for 2 minutes. A positive reaction is indicated by the appearance of magenta colouration resulting from the reaction between aldehydes and the decolourized solution (leucofuchsin) of Schiff's reagent.

2- Acid and neutral mucopolysaccharides were demonstrated by the Alcian blue-PAS method (**Mowry, 1956**). By this method, acid mucins exhibit blue stainabilities whereas neutral mucins take a reddish colouration, and the mixtures of both mucins acquire a purple stainability.

3- For displaying the total proteins, the mercuric bromophenol blue method (**Mazia *et al*., 1953**) was employed. The existence of a dark blue stainability denotes the occurrence of total proteins.

4- Nucleic acids (DNA and RNA) were demonstrated by the methyl green pyronin method (**Kurnick, 1955**), while the application of Feulgen reaction was used for demonstration of DNA only (**Stowel, 1945**).

Photomicrographs were taken to illustrate the histological structures of the various organs of the alimentary canal.

3. Results

Gross anatomy

The buccal cavity leads to the funnel-shaped pharynx which opens into the oesophagus. The latter

structure is a long tube with its anterior end wide, then it becomes narrow till the stomach region. Its narrow cavity is lined by numerous high longitudinal folds. The oesophagus leads to the stomach, the transition between the two is not clear.

The stomach is a wide curved tube with lesser and greater curvatures. It is   placed at the left side of the body cavity. It is a long tube which ends in the pylorus near which it becomes gradually narrow. The pylorus is guarded by a strong sphincter muscle which partly protrudes into the duodenum.

The intestine is differentiated into small, and large intestines.

The small intestine begins from the pylorus till the caecum. The large intestine includes the well-developed caecum, colon and rectum.

The small intestine is a coiled tube which is wide near the pylorus, and gradually narrows towards the caecum. There is no external or internal indication of the transition between the duodenum and the ileum as they pass indistinguishably in one another.

The small intestine is comparatively short, although this animal is purely herbivorous. Its length is about 3/4 the length of the large intestine. The ileum protrudes into the caecum for about 6-10mm. This protruding part is covered internally and externally by mucous membranes, which are thrown into longitudinal folds parallel to its longitudinal axis. The mucous membrane around the ileo-caecal opening is thrown into radiating folds, which are continuous with both the external and internal longitudinal folds of the protruding part. This protruding part of the ileum is well-developed and provided with a strong sphincter muscle; its cavity is distinctly narrow. Thus this part can be considered as a valve, and is called the ileo-caecal valve.

The caecum is extremely large possessing a thin wall. Its mucosa has no folds, but it possesses numerous shallow pits, which are only seen when examined with low power of the microscope and they are evenly distributed on its inner surface. The caecum occupies a great part of the body. It lies on the right side opposite to the stomach. The caecum possesses at its posterior surface, near the colon, a small flattened blind sac (the appendix). This sac is found in all animals dissected but it differs in size and shape. It is strongly attached to the wall of the caecum by connective tissue. The caecum leads to a wide colon. The two being separated by a narrow curved part, which is provided by a strong muscle arising from one side. The colon is a wide, short tube provided internally with well-developed longitudinal folds. It leads to the rectum which is also short, but provided with less distinct longitudinal folds. The outer wall of both the colon and the rectum is provided with longitudinal striations. The rectum opens into the cloaca which is of small diameter. Its opening to the

exterior is guarded by a sphincter muscle.   A membranous, bask-shaped urinary bladder is connected to the ventral wall of the cloaca.

The liver is a large triangular gland and it is composed of two lobes. They are completely fused together anteriorly. These fused parts are connected to the dorsal body wall by a strong falciform ligament. Posteriorly, the two lobes of the liver diverge from each other. Each lobe is more or less triangular, and is notched anteriorly. (Figs. 2,3)

There are two long bile ducts, which run parallel to each other, and open posteriorly in the duodenum close to the pylorus.

The gall-bladder is a large, membranous sac which lies in the notch present on the inner surface of the right elongated lobe of the liver.

The pancreas is a large, yellowish organ. It is formed of a thin layer spread out in the mesentery between the duodenum and stomach. A single short pancreatic duct arises from the edge and opens in the duodenum near the openings of the bile ducts.

The Histological studies of the Alimentary Canal
The oesophagus

The serosa is in the form of a thin, folded membrane covering the musculosa, which is narrow, and formed of smooth muscles. Two layers can be seen, an outer longitudinal muscle layer and an inner circular one. The former is narrow and folded externally. Its muscles are in the form of patches separated by little connective tissue. It is not uniform in thickness, but is more developed than the inner circular muscle layer. The latter layer is also not uniform in thickness, and it is not well developed. It contains more connective tissue. It is not in the form of a continuous layer. Some of its fibers lie in an oblique manner. The two layers of musculosa are separated by intermusculosal connective tissue layer.

The submucosa is narrow and contains mainly collagenous fibers, and some reticular fibers.

The muscularis mucosa appears as scattered patches of longitudinal muscle fibers entering in the formation of the oesophageal folds. Near the posterior end of those, the muscularis mucosa is in the form of a continuous layer of longitudinal muscles, and there are no circular muscles.

The oesophageal mucosa is in the form of longitudinal folds, which are highly extending in the lumen of the oesophagus. It is in the form of simple epithelium. Two types of cells that can be observed which are, the ciliated cells, and the mucous secreting cells or goblet cells. (Fig .4A)

The goblet cells are cylindrical cells composed of two portions, an upper large hyaline portion, and a lower small protoplasmic one.The upper part is stained by the specific mucous stains. These cells have wide openings. (Fig .4B)

The ciliated cells are scattered irregularly between the goblet cells. Their bodies are elongated and thin. The nucleus is elongated, rod –shaped and located in the middle of the cells. (Fig .4B)

The stomach:

In a transverse section through the stomach, the serosa appears as a thin membranous layer.

The outer longitudinal layer of the musculosa is narrow and composed of fine fibres. It is in the form of elongated patches separated by plenty of connective tissue. The inner layer is thicker than the outer one and is formed of compact circular muscles. The two layers of the musculosa are separated by a thin intermusculosal connective tissue layer.

The submucosa is more developed than that of the oesophagus (Fig.5A).

The muscularis mucosa is represented by a continuous layer composed of an outer longitudinal muscle layer and inner circular muscle layer, both being well developed. In the anterior portion of the stomach, the two layers are more or less equal in thickness. Towards the middle region, the inner circular muscle layer is more developed. Near the pylorus, the inner circular muscle layer of the muscularis mucosa begins to disappear and it is in the form of few fibers which lie beneath a more developed outer longitudinal muscle layer. The two layers, however, are less developed in the pyloric region but they form a continuous layer (Fig.5A).

The mucosa is thick and contains gastric glands which open into gastric pits. The latter are continuous with the surface epithelium. The surface epithelial cells, as well as those of the gland pits and necks, have the same structure. There is no sharp line of demarcation between the neck cells and the surface epithelium. These cells (cells lining gland necks, pits and gastric mucosa) secrete a substance related to mucin (Fig.5B).

The gastric glands in *Uromastyx aegyptiaca* are of two types, fundic and pyloric glands.

The fundic glands are tubular with narrow cavities. A gland may open by a separate neck, but two or more glands may have one common neck. The body of the fundic gland is formed of polyhedral granular cells with central rounded nuclei. Their granules react in the same way as do oxyntic cells. This shows that the glands are oxyntic, and comparable to oxyntic glands described in the stomach of other reptiles.

The pyloric glands extend from the middle region of the stomach to the pylorus where they disappear. Near the middle region of the stomach, the pyloric glands are simple tubular or branched tubular with long necks; while near the pylorus they are alveolar with longer necks. The pyloric glands are numerous near the middle region, where near the pylorus they are few with much connective tissue in between them. The body of these glands is formed only of one type of

cells. The cytoplasm of these cells is pale and appears clear, as it contains indistinct granules.

The Small intestine:

The small intestine extends from the pylorus to the caecum as a narrow tube. Near the pylorus it is in the form of a wide tube which narrows gradually towards the caecum. The first loop after the pylorus, receiving the pancreatic and bile ducts, is considered as the duodenum, the rest is the ileum. There is no external indication to differentiate between the duodenum and the ileum. Examining the mucosa, it is noticed that the duodenal mucosa is much folded, the folds are high and numerous. Low folds occur between the high ones. Thus the intestine in the duodenal region has a wide cavity full of folds. On the other hand, the ileal region has a narrow cavity lined with few longitudinal folds. The folds of the small intestine run in a "zigzag" manner parallel to each other.

The serosa is a very thin membrane continuous with the mesenteries.

The musculosa is formed of two layers, an outer longitudinal and an inner circular. They are much less developed than those of the musculosa of both the oesophagus and the stomach. The outer longitudinal muscle layer, in the region after the pylorus, is weakly developed and formed of fine scattered fibres; while the inner circular muscle layer is formed of scattered oblique muscles, with much connective tissue in between. Towards the middle region of the intestine the two layers of the musculosa are well developed and separated by a well developed intermusculosal layer of connective tissue. The outer longitudinal muscle layer is in the form of patches covered with the folded serosa.

The submucosa is narrow near the pylorus and wider towards the posterior region near the caecum where it is well developed.

The muscularis mucosa appears only near the pylorus, as a continuation of the muscularis mucosa of the stomach. Here, it is in the form of scattered longitudinal muscle fibres which enter in the formation of the folds (Fig.6A). A short distance from the pylorus the muscularis mucosa disappears and the greater part of the small intestine is devoid of muscularis mucosa. It makes its appearance again at the posterior region of the intestine, near the caecum. In this region the muscularis mucosa is in the form of patches of longitudinal fibres which are, more or less, in the form of a layer. These muscle fibres enter in the formation of the folds, where they are more developed at the top (near the lumen). Also it enters in the formation of the ileo-caecal valve.

The mucosa shows a marked difference in the nature and shape of the folds according to the region. Thus in the region near the pylorus, the mucosa is in the form of numerous long villi, between the bases of which the intestinal glands or Lieberkühn crypts are

found, while near the caecum, the mucosa is in the form of few thick folds (Fig.6B).

The epithelial lining of both regions is formed of the same elements, *i.e.* columnar and goblet cells. Thus, histologically, one can differentiate between the duodenum and the ileum, by the presence of Lieberkühn crypts in the former.

The Large intestine:

It is composed of a very conspicuous caecum, colon and rectum.

The caecum

In *Uromastyx aegyptiaca*, the caecum is an exceedingly large sac which is attached to the ileum from one side and to the colon from the opposite side, *i.e*. lying between the ileum and the colon. The ileum protrudes into the caecum forming a well developed ileo-caeeal protrusion which acts as a valve, as it is provided with strong-muscles. On the other hand, the opening between the caecum and the colon is guarded by a caeco-colic valve.

The ileo-caecal protrusion in *Uromastyx aegyptiaca* is well developed. It extends inside the caecum and is provided with a narrow cavity, while its wall is provided with strong muscles continuous with the circular muscle layer of the musculosa of both the ileum and caecum. It is covered by caecal mucosa and lined by ileal mucosa.

The caecum is a thin-walled sac. Its mucosa is in the form of concentric shallow pits, which are small and uniformly arranged. In a transverse section through the caecal wall, it is composed of the following layers (Fig. 7A).

The serosa is a thin membrane followed by a thin layer of connective tissue.

The outer longitudinal layer of the musculosa is narrow and composed of fine fibres. It is in the form of elongated patches separated by plenty of connective tissue. The inner layer is thicker than the outer one and is formed of compact circular muscles. The two layers of the musculosa are separated by a thin intermusculosal connective tissue layer.

The submucosa is comparatively narrow and well supplied by blood vessels.

The muscularis mucosa is a continuous layer directly in contact with the mucosa. It is formed of two layers, an outer longitudinal and an inner circular. Both layers are well developed and formed of fine fibres.

The mucosa is formed of one type of simple columnar epithelial cells. These cells are very much elongated. The nuclei are small, oval, and located in the center.

The mucosal cells may contain pigment granules which, when present, are numerous near the lumen. It is noticed also that in some regions, goblet cells exist between the tall epithelial cells; however, they are very rare. The mucosa of the caecum is invaded by a large number of lymphocytes which are numerous near the

basement membrane. The great number of lymphocytes is noticed only to exist in both the mucosa and the lamina propria of the caecum (Fig.7B). They exist in small amounts in the mucosa of the colon and rectum. The lymphocytes, which are present in the caecum, are small and provided with small darkly stained rounded nuclei. Their cytoplasm is clear and scanty.

A blind sac with narrow lumen arises from the posterior surface of the caecum near the colon. This sac is considered to be the appendix it is small, flattened and connected by compact connective tissue to the caecal wall. It widely opens into the caecum. Its wall is covered by the thin-walled serosa which is continuous with that of the caecum. The serosa is followed by a wide well developed subserosa.

The opening between the caecum and the colon is guarded by a caeco-colic valve, which is provided with a strong muscle arising from one side.

The longitudinal muscle layer of the caecum is continuous with that of the colon. It does not enter in the formation of the caeco-colic valve. The inner circular muscle layer of the caecum and that of the colon form at their junction the strong, well developed muscle of the caeco-colic valve. This caeco-colic muscle may contain few longitudinal fibres at its periphery.

The muscularis mucosa of the caecum in this region is continuous with that of the colon. This caeco-colic muscle is covered at the caecal side with caecal epithelium, and at the colonic side with colonic epithelium. When the valve is relaxed, a constriction is seen between the caecum and the colon.

The Colon

The colon is widely attached to the caecum. At the junction of the two there is the caeco-colic valve. The large intestine, after the caecum, is in the form of a wide short tube. Its anterior portion is the colon, and the posterior portion is the rectum. There is neither an internal nor an external morphological difference between the colon and the rectum, as the two are widely connected to each other. But, histologically, they are different in the nature of their mucosal folds and blood supply.

In a transverse section through the colon the following layers are observed.

The serosa is formed of flattened cells with flat nuclei. The serosa as well as the outer longitudinal muscle layer of musculosa are in the form of low longitudinal folds. Thus these folds appear externally as white longitudinal striations on the wall of the colon. The serosa is followed by a very thin layer of connective tissue which extends between the patches of the longitudinal muscle layer of the musculosa .

The musculosa is composed of two layers. The outer longitudinal muscle layer is thin, formed of wavy bundles of fine muscle fibres. The inner circular

muscle layer is thick formed of compact fibres. The two layers of the musulosa are separated by a layer of connective tissue containing small lymph spaces (Fig. 8A).

The submucosa is well developed and well supplied with blood vessels. The muscularis mucosa is a well developed continuous layer. It is composed of an outer longitudinal and an inner circular muscle layer . The two layers are, more or less, equal. The muscularis mucosa enters in the formation of the large folds of the mucosa, where it is well developed at the top of these folds.

The mucosa is in the form of shallow concentric depressions, it is thick, and composed of two types of cells; columnar, and goblet cells. Below the epithelial layer there is one or more layers of cells, which do not reach the surface; these are considered as replacing cells. Thus the mucosa appears, more or less, stratified.

The columnar cells are few especially at the base of the shallow folds. Their nuclei are oval and lie near the base.

Between the columnar cells, the goblet cells exist and they are abundant in such a way that they predominate in between the columnar cells. The mucosa lies on a basement membrane, which is formed as a condensation of the reticular fibers of the lamina propria. It is invaded by numerous leucocytes, which are usually near the basement membrane(Fig. 8A).

The lamina propria is not well developed, especially at the bases of the shallow folds, where the muscularis mucosa lies in close contact with the mucosa. At the top of the folds, the lamina propria is more developed. It is provided with numerous blood capillaries directly underneath the mucosa, but still fewer than those in the caecum.

The Rectum

The serosa is thin with shallow longitudinal folds continuous with those of the colon. Underneath the serosa, there is a thin layer of subserosa. It extends between the patches of the longitudinal muscle layer of the musculosa.

The musculosa is more developed than that of the colon. The outer longitudinal muscle layer is in the form of folded bundles. The inner circular muscle layer is well developed, and penetrated by large blood vessels. The two layers of the musculosa are separated by intermus-culosal connective tissue, which is wider than that of the colon. It is noticed that this layer is richly supplied with large blood vessels; also it contains numerous lymph spaces. The last two characters of the intermusculosal connective tissue layer are not noticed in the corresponding narrow layer of the colon. The submucosa is well supplied with blood vessels, and small lymph spaces.

The muscularis mucosa is more developed than that of the colon. The outer longitudinal muscle layer is thicker than the inner circular layer. The muscularis

mucosa enters in the formation of the folds where it is well developed at the top of these folds (Fig.9A).

The mucosa is thicker than that of the colon. There are few large folds which project in the lumen. But the mucous membrane is straight, and not in the form of shallow pits, as in the case of the colon. The shallow pits of the mucosa are only found at the bases of the large folds. The mucosa is formed of two types of epithelial cells, columnar and goblet cells. These columnar cells are few and become fewer near the cloacal region, where the mucosa is formed of goblet cells (Fig.9B).

The goblet cells are provided with an upper goblet part, which is larger than that of the goblet cells of the colon. It occupies the greater part of the cells and widely opens in the lumen. Underneath the epithelial cells there is another layer of replacing cells which do not reach the surface, and are wedged between the epithelial cells. The mucosa lies on a well developed basement membrane. It is invaded by numerous leucocytes, which are usually present near the basement membrane. These leucocytes are similar to those present in the mucosa of the colon, as previously described.

The lamina propria is more developed than that of the colon. It is formed of reticular fibres. The lamina propria is richly supplied with blood vessels and contains numerous large lymph spaces, compared to that of the colon.

The histochemical studies of the alimentary canal
1-Carbohydrates (PAS-positive material) :
Oesophagus:

Application of the PAS-technique indicated that the goblet cells were loaded with positively stained material (Fig.10), indicating that it is rich in carbohydrates.

Stomach:

The mucosal cells lining the gastric lumen appeared strongly PAS-positive (Fig .11). The PAS-positive material was generally found in the luminal portions of the epithelial cells, the rest of the cell (middle and basal parts) displayed very weak reactivity.

Small intestine:

In the small intestine, the positive reaction was moderate in the goblet cells and at the luminal surface lining the intestinal villi. The reaction was very weak in the cytoplasm of the columnar epithelial cells (Fig.12).

Large intestine:

As in the small intestine, the goblet cells as well as the luminal surface of the columnar epithelial cells displayed a moderate PAS- positive reactivity (Fig .13). The cytoplasm of the columnar mucosal cells was very lightly stained, which indicates the presence of only traces of carbohydrates.

2-Mucopolysaccharides:
Oesophagus:

The Alcian blue–PAS method showed that most of the carbohydrates present in the mucosal epithelium of *Uromastyx aegyptiaca*, oesophagus are in the form of acid mucopolysaccharides (Fig .14, the blue colour). The figure indicates that most cells contain only acid mucosubstances , a few contain a mixture of both, acid and neutral mucopolysubstances .

Stomach:

Neutral mucopolysaccharides were abundantly found in the luminal poles of the mucosal epithethelium (Fig .15).

A positive stained border lining the luminal surface of the stomach was clearly observed.

Small intestine:

As shown in figure 16, a mixture of acid and neutral mucopolysaccharides appears in the goblet cells of the small intestine. The PAS reaction is much less than that at the oesophageal goblet cells. The acid mucin was found towards the lumen (in the upper parts of the goblet cells).

In some cells, the neutral mucopolysaccharides were predominating. The reaction at the luminal surfaces of the cells was also in the form of a mixture of both types of mucopolysaccharides. The cytoplasm of the columnar epithelial cells contained very few neutral mucopolysaccharides.

Large intestine:

Moderate amounts of acid mucopolysaccharides were detected in the luminal poles of mucosal epithelial cells making a continuous positive sheet along the luminal border of the colon. The rest of the cells displayed a weak neutral mucopolysaccharides reactivity. In the rectum (Fig.17) a mixture of moderate amounts of both polysaccharides was found in the goblet cells and along the luminal surface of the columnar epithelial cells .

3-Total proteins:
Oesophagus :

Application of mercuric bromophenol blue method on the oesophagus of *Uromastyx aegyptiaca* proved an exaggerated amount of proteonic elements situated in the cytoplasm of the columnar epithelial cells. On the other hand their goblet cells showed a weak response to the above mentioned method (Fig. 18). This means that a small amount of proteins was only present in these cells.

Stomach:

In the stomach of *Uromastyx aegyptiaca*, the cytoplasm of its superficial columnar cells contains a moderate amount of proteins. However low proteonic content was detected in the cytoplasm of the cells constituting the bodies and the necks of the gastric glands. On the other hand, the cells of the gastric glands showed a strong response to the bromophenol blue method. This proves the presence of a large amount of proteonic elements. (Fig.19)

Small and large intestines:

In the small and large intestines of the *Uromastyx aegyptiaca*, comparatively less amounts of proteins was scored in the cytoplasm of the columnar cells, while a weak reaction was noticed in the cytoplasm of the goblet cells. (Fig .20).

4-Nucleic acids:

Histochemical demonstration of DNA revealed the appearance of a dense product in the nuclei of the oesophageal, gastric and intestinal mucosal columnar cells. Such a positive staining product is present in the place of the chromatin substances containing DNA, (Figs. 21&22). Application of methyl green pyronin method proved the existence of a considerable amount of RNA inside the cytoplasm of the columnar epithelial cells in the different gut regions of *Uromastyx aegyptiaca*. (Figs. 23- 25).

4. Discussion

The anatomical observations of the alimentary canal of *Uromastyx aegyptiaca* detect the absence of a constriction between the oesophagus and the stomach. The absence of such a constriction seems to be a common feature for the lacertilian species, since it characterizes also all the described lacertilian insectivorous members (**Bishai, 1960; Al-Nassar, 1976; Chou, 1977; Zaher *et al*., 1987c and 1990 a &b and Abo- Taira *et al*., 1988a**). Such a character was also detected in the carnivorous ophidian species (**Luppa, 1977, Abo-Taira *et al*., 1988b; Afifi *et al*., 1990 and Zaher *et al*., 1990 c**). On the contrary, the presence of a constriction between the oesophagus and the stomach was referred in turtles (**Luppa, 1977**). Obviously, the absence of a constriction between the oesphagus and stomach is, thus, closely related to the type of food, where it permits easier passage of food to the stomach. The alimentary canal mucosa of the examined species as indicated from the present study, confirms to a great extent the basic reptilian pattern. The oesophagus is represented by a well developed muscular wall which may help in performing the function of mechanical conveyance of ingested food and in food swallowing.

In the present investigation, the mucosal epithelium of the oesophagus is represented by simple ciliated columnar epithelial cells and goblet cells. Such structural observation of the oesophageal mucosa was reported in other reptiles studied by **El-Toubi and Bishai (1958), Andrew and Hickman (1974), Amer and Ismail (1976), Pryzystalski (1980), Farag and Al-Robai (1986) and Mohallal and Rahmy (1992).** However, in *Ablephorus pannonicus* (**Greschik, 1917**), *Chamaeleon vulgaris* (**Bishai, 1960**) and *Uromastyx philibyi* (**Farag, 1982**), the mucosal membrane of only the anterior region of the oesophagus consists of simple epithelial cells, while that of the posterior region is formed of a stratified one.
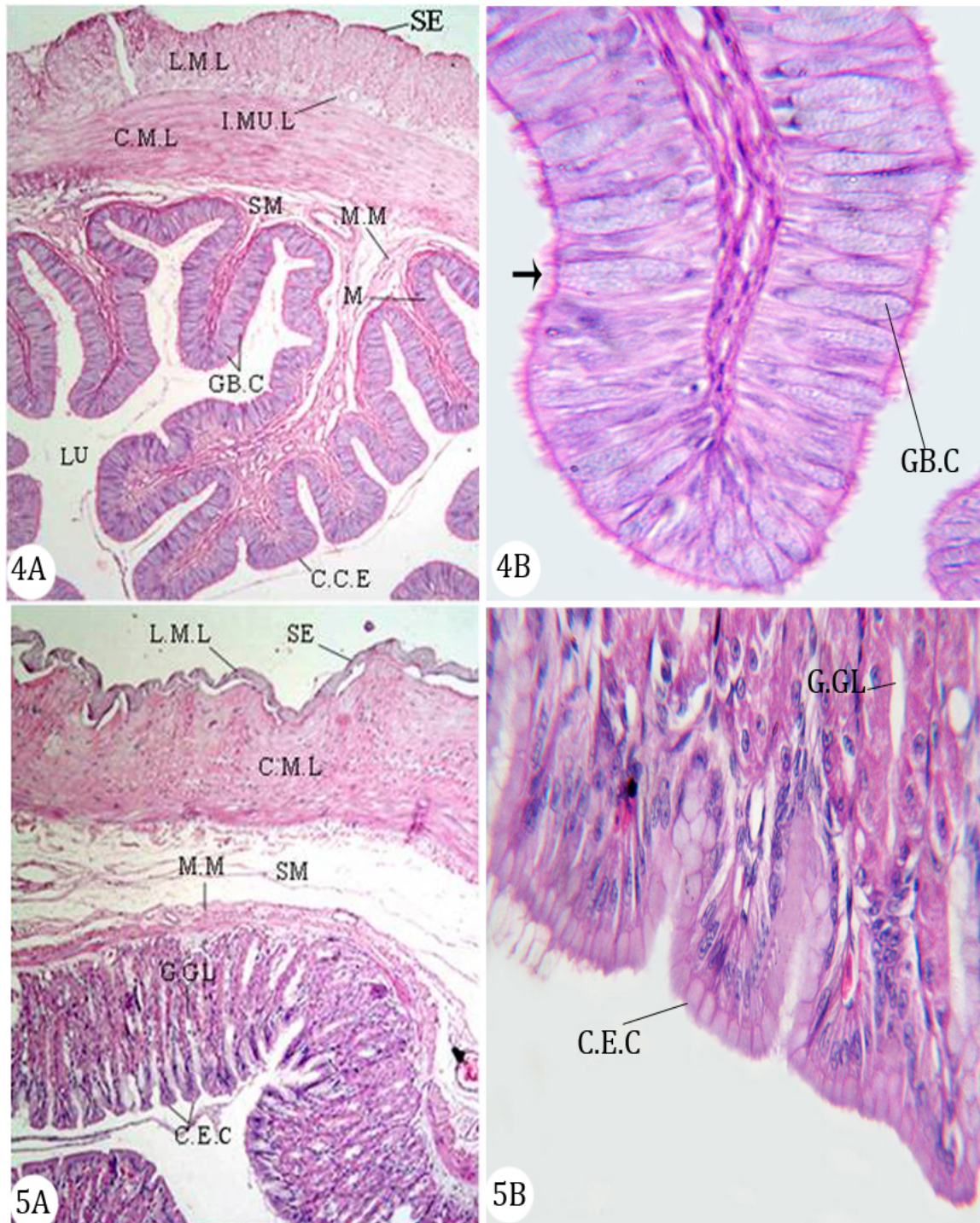
Fig. (1): Photograph of *Uromastyx aegyptiaca*.
Fig. (2): Photograph of the dissection of the alimentary canal of *Uromastyx aegyptiaca***.**
Fig. (3): Photograph of a fresh isolated alimentary canal of *Uromastyx aegyptiaca* showing (the oseophagus, stomach, small and large intestine). The liver is shifted to the left.
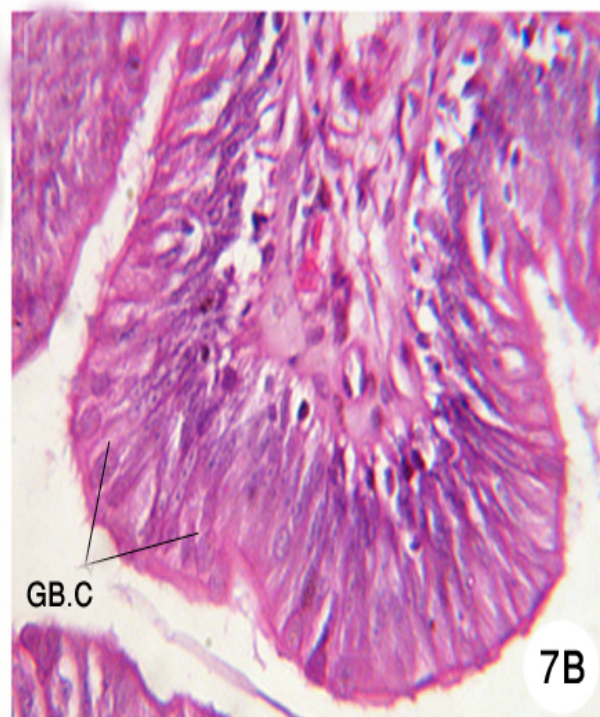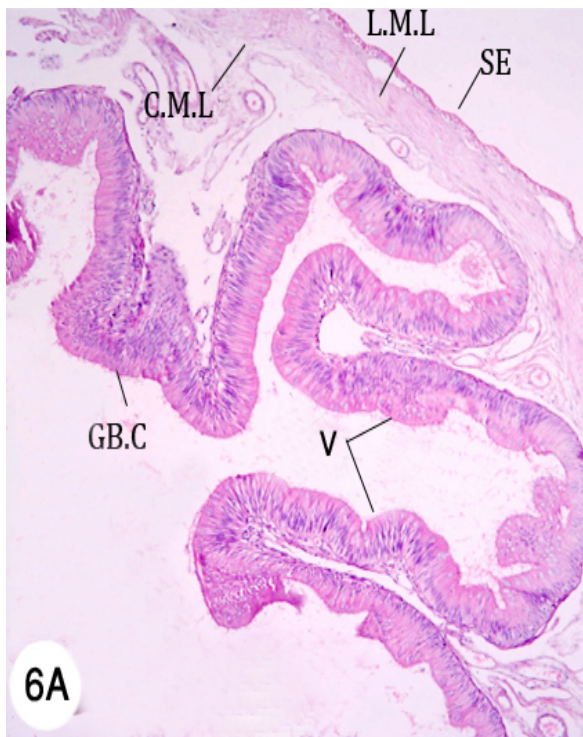
Fig. (4A): Photomicrograph of a transverse section of the oesophagus of *Uromastyx aegyptiaca* showing the mucosa(M), submucosa (SM), muscularis mucosa(M.M), muscularis (circular and longitudinal layers C.M.L&L.M.L) and serosa (SE). H&E stain, X100.

Fig. (4B): Photomicrograph of enlarged portion of the oesophagus of *Uromastyx aegyptiaca* showing the mucosa(M). H&E stain, X600.

Fig. (5A): Photomicrograph of a transverse section of the stomach of *Uromastyx aegyptiaca* showing the mucosa(M), submucosa(SM), muscularis mucosa (M.M), muscularis (circular and longitudinal layers C.M.L&L.M.L) and serosa(SE). H&E stain, X100.
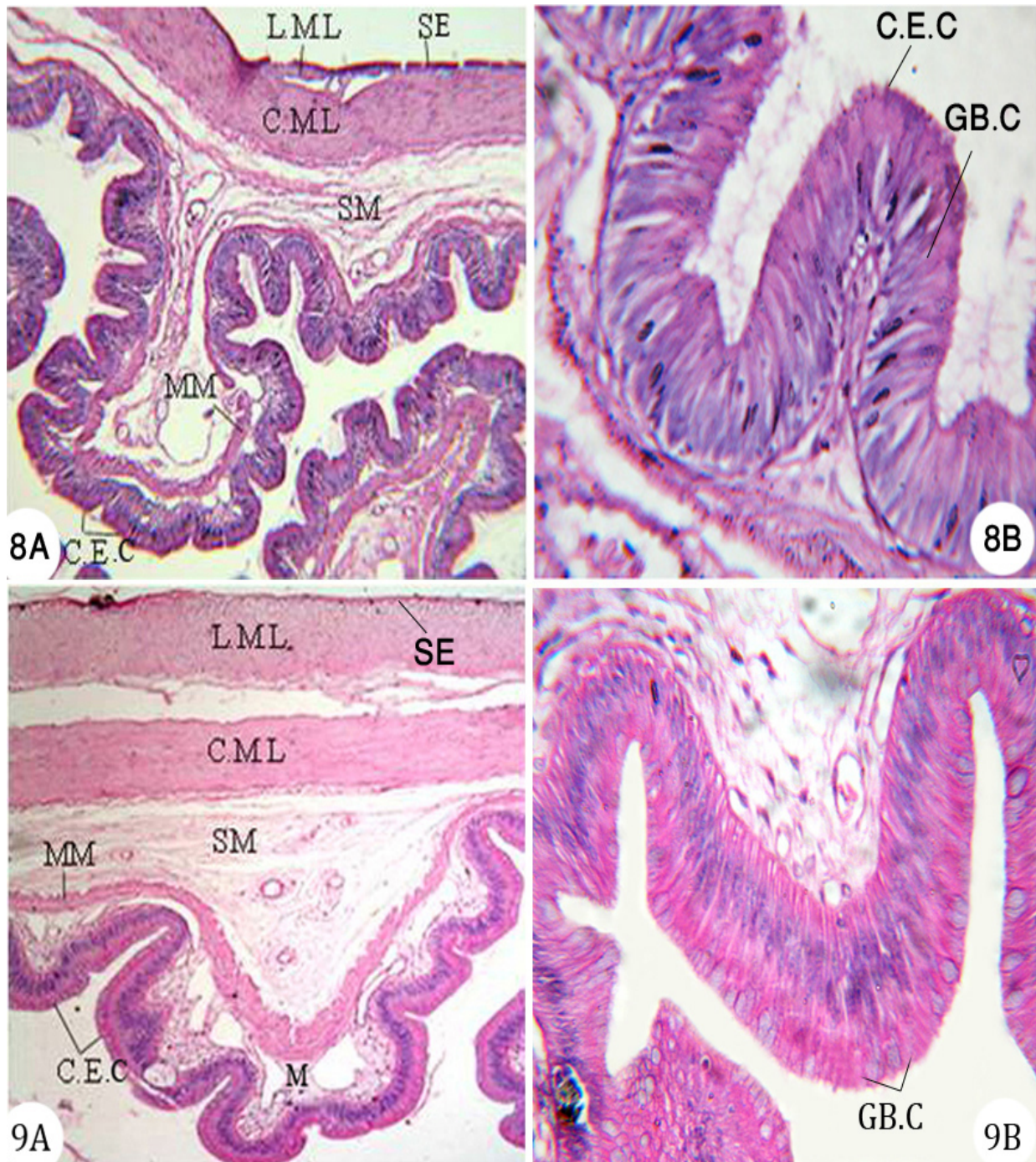
Fig. (5B): Photomicrograph of enlarged portion of the stomach of *Uromastyx aegyptiaca* showing the mucosa(M). H&E stain, X600.

Fig. (6A): Photomicrograph of a transverse section of the small intestine of *Uromastyx aegeptiaca* showing the mucosa(M), muscularis mucosa((M.M), muscularis (circular and longitudinal layers C.M.L&L.M.L) and serosa(SE). H&E stain, X100.

Fig. (6B): Photomicrograph of enlarged portion of the small intestine of *Uromastyx aegyptiaca* showing the mucosa(M). H&E stain, X600.

Fig. (7A): Photomicrograph of a transverse section of the large intestine   (Caecum) of *Uromastyx aegeptiaca* showing the mucosa(M), submucosa(SM), muscularis mucosa(M.M) ,muscularis (circular and longitudinal layers C.M.L&L.M.L) and serosa(SE), H&E stain, X60.

Fig. (7B): Photomicrograph of enlarged portion of the large intestine (Caecum) of *Uromastyx aegyptiaca* showing the mucosa(M). H&E stain, X600.
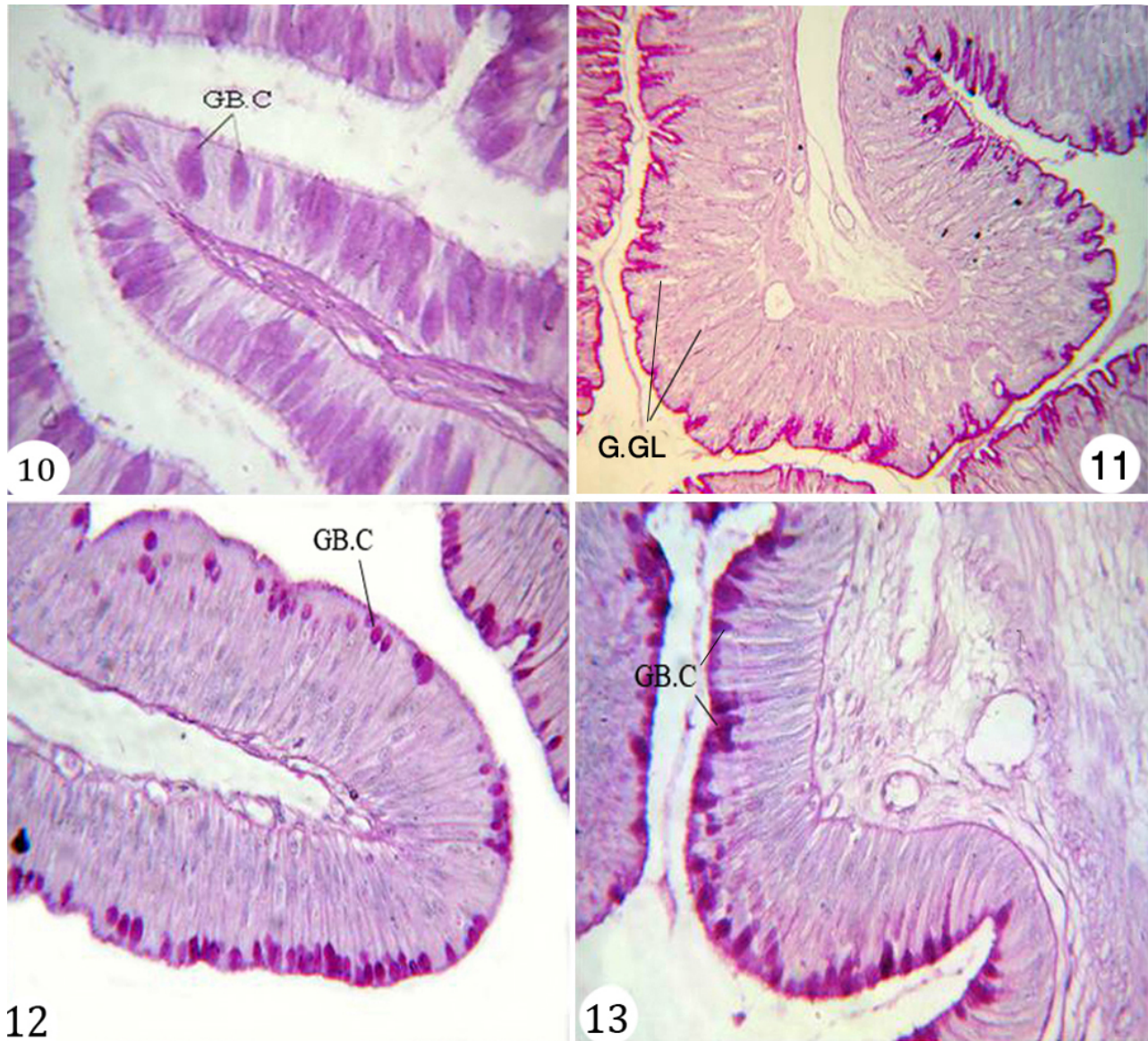
Fig. (8A): Photomicrograph of a transverse section of the large intestine   (Colon) of *Uromastyx aegeptiaca* showing the mucosa(M), submucosa(SM), muscularis mucosa(M.M) ,muscularis   (circular and longitudinal layers C.M.L&L.M.L) and serosa(SE), H&E stain, X100.

Fig. (8B): Photomicrograph of enlarged portion of the large intestine   (Colon)   of *Uromastyx aegyptiaca* showing the mucosa(M). H&E stain, X600.

Fig. (9A): Photomicrograph of a transverse section of the large intestine (Reuctum) of *Uromastyx aegeptiaca* showing the mucosa(M), submucosa(SM), muscularis mucosa(M.M) ,muscularis (circular and longitudinal layers C.M.L&L.ML) and serosa(SE), H&E stain, X100.

Fig. (9B): Photomicrograph of enlarged portion of the large intestine(Reuctum) of *Uromastyx aegyptiaca* showing the mucosa(M). H&E stain, X600.
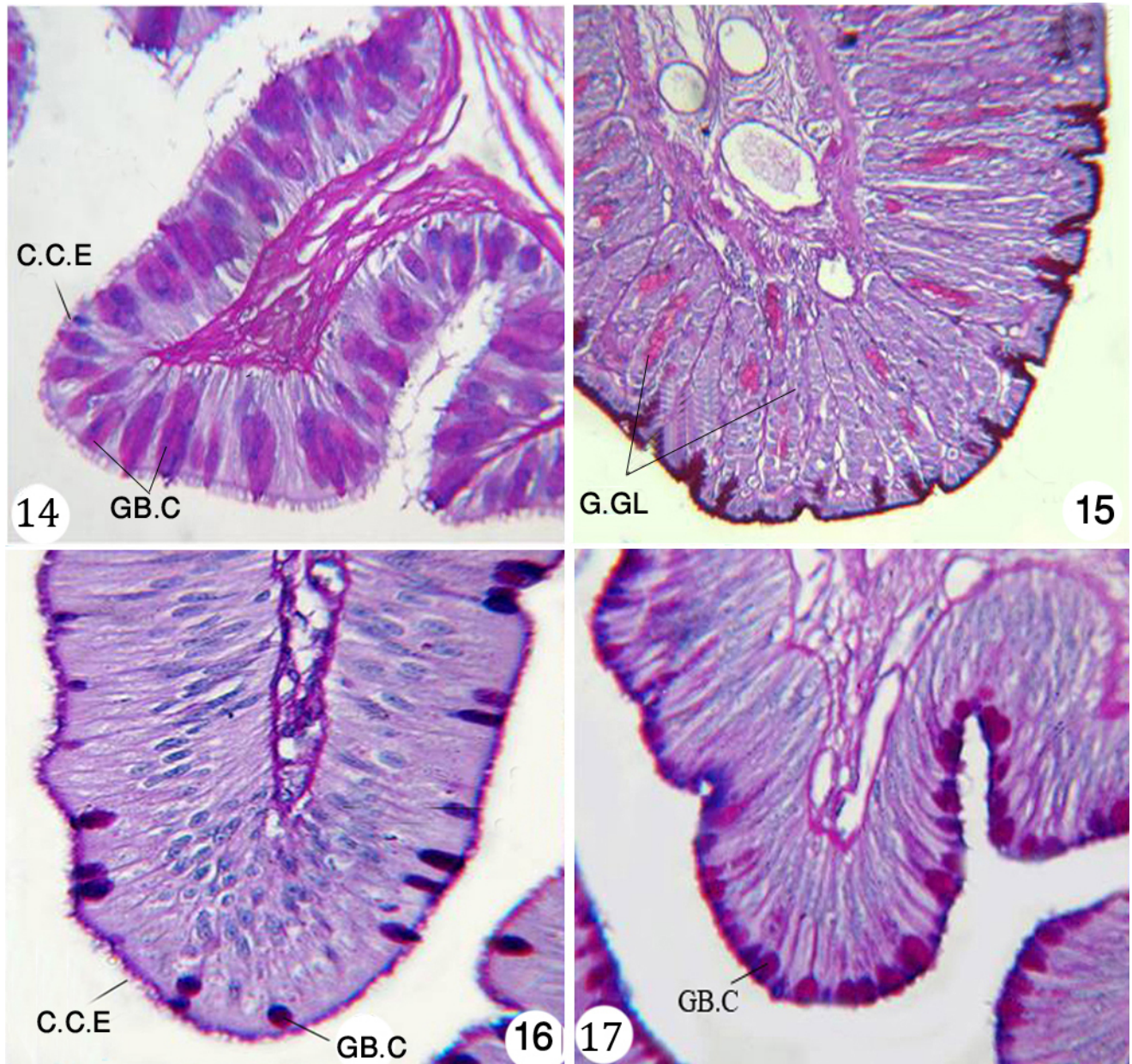
Fig. (10): Photomicrograph of a transverse section of the oesophagus of *Uromastyx aegeptiaca* showing the carbohydrate content: (PAS positive stain) X 560.

Fig. (11): Photomicrograph of a transverse section of the stomach of *Uromastyx aegeptiaca* showing the carbohydrate content: (PAS positive stain) X 560.

Fig. (12): Photomicrograph of a transverse section of the small intestine of *Uromastyx aegeptiaca* showing the carbohydrate content: (PAS positive stain) X 656.
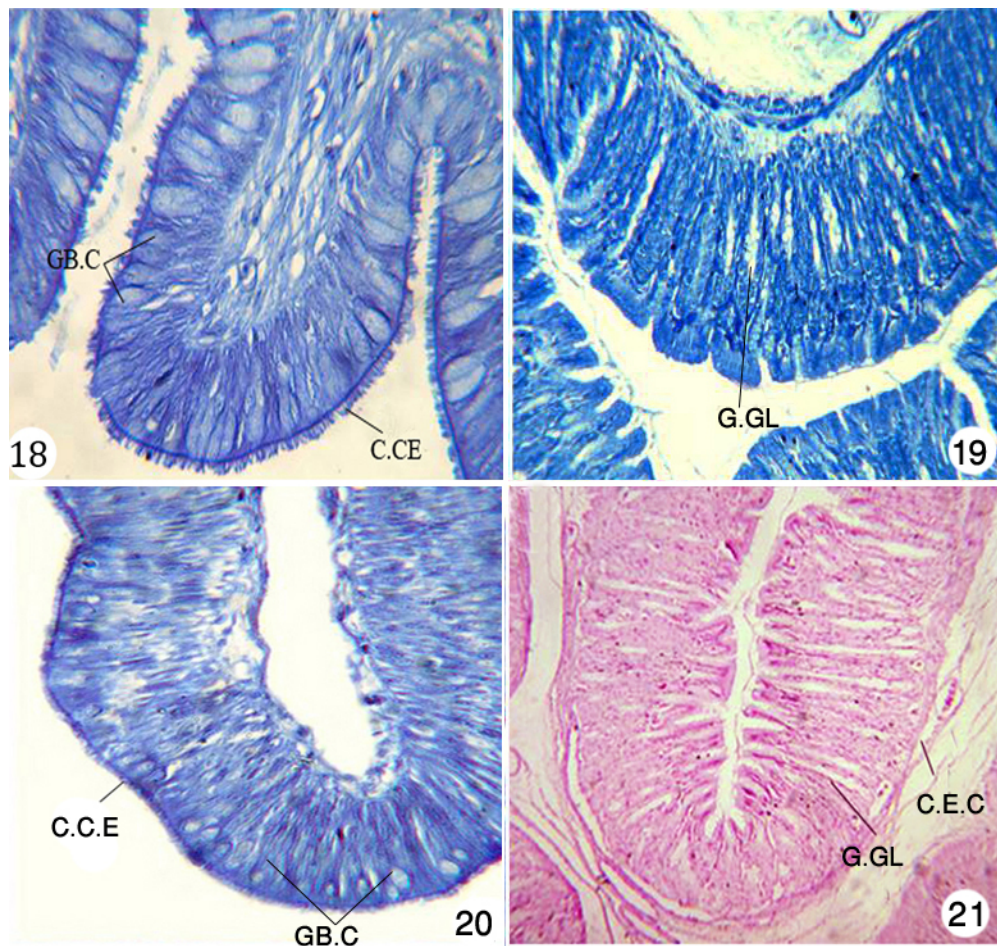
Fig. (13): Photomicrograph of a transverse section of the   large intestine (Rectum) of *Uromastyx aegeptiaca* showing the carbohydrate content: (PAS positive stain) X400.

Fig. (14): Photomicrograph of a transverse section of the oesophagus of *Uromastyx aegeptiaca* showing the mucopolysaccharide content. (Alcian blue stain) X656.

Fig. (15): Photomicrograph of a transverse section of the stomach of *Uromastyx aegeptiaca*   showing   the mucopolysaccharide content. (Alcian blue stain) X164.

Fig. (16): Photomicrograph of a transverse section of the small intestine of *Uromastyx aegeptiaca* showing the mucopolysaccharide content. (Alcian blue stain) X 656.

Fig. (17): Photomicrograph of a transverse section of the large intestine   (Rectum) of *Uromastyx aegeptiaca* showing the mucopolysaccharide content: (Alcian blue stain) X600.
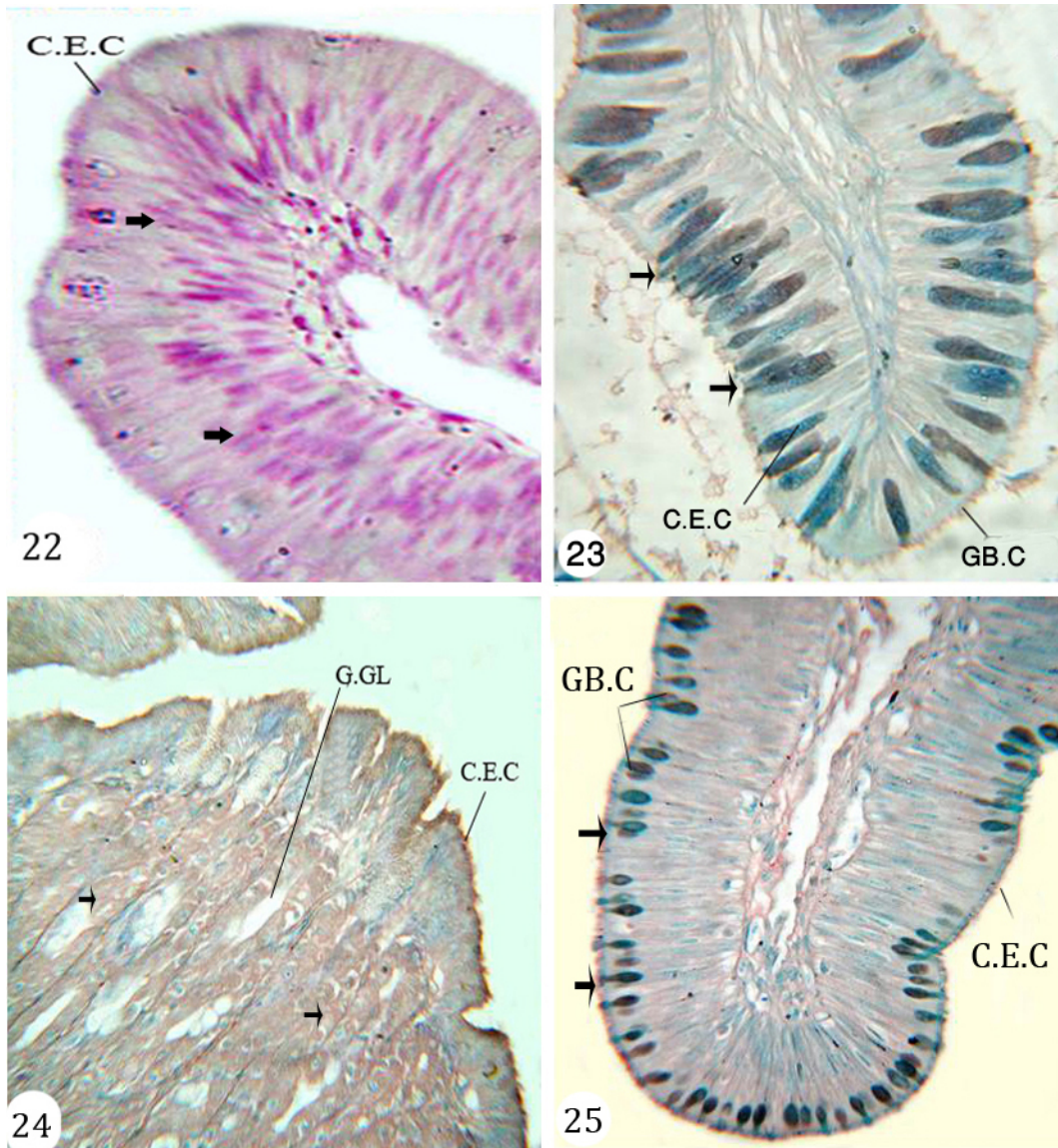
Fig. (18): Photomicrograph of a transverse section of the oesophagus of *Uromastyx aegeptiaca* showing the protein content (Bromophenol blue stain) X 600.

Fig. (19): Photomicrograph of a transverse section of the stomach of *Uromastyx aegeptiaca* showing the protein content (Bromophenol blue stain) X 164.

Fig. (20): Photomicrograph of a transverse section of the small intestine   of *Uromastyx aegeptiaca*   showing the protein content (Bromophenol blue stain) X 600.

Fig. (21): Photomicrograph of a transverse section of the stomach   of *Uromastyx aegeptiaca* showing the DNA content (small arrow). (Feulgen technique;) X 140.

Fig. (22) : Photomicrograph of a transverse section of the small intestine of *Uromastyx aegeptiaca* showing the DNA content (small arrow). (Feulgen technique;) X 560.

Fig. (23): Photomicrograph of a transverse section of the oesophagus of *Uromastyx aegeptiaca indicating* the DNA(small arrow) and RNA (large narrow) contents (Methyl green-pyronine stain) X560.

Fig. (24): Photomicrograph of a transverse section of the stomach of *Uromastyx aegeptiaca indicating* the DNA (small arrow) and RNA (large narrow) contents (Methyl green-pyronine stain) X 560.

Fig. (25): Photomicrograph of a transverse section of the small intestine of *Uromastyx aegeptiaca* indicating the DNA (small arrow) and RNA (large narrow) contents (Methyl green-pyronine stain) X400.

In the gecko *Ghyra mutilata* (**Chou, 1977**) this membrane is free from goblet cells, while in the gecko *Pristurus rupestris* (**Dehlawi and Zaher, 1985b**) it is evident, that the oesophageal mucosal membrane does not show a constant histological configuration among the so far investigated reptilian species related to different families. This membrane assumes different histological patterns in *Ablephorus pannonicus* (**Greschik, 1917**), *Chamaeleon vulgaris* (**Bishai, 1960**), *Uromastyx philbyi* (**Farag, 1982**), *Chalcides*

levitoni (**El-Taib *et al*., 1982**), *Mauremyes caspica* (**El-Taib and Jarrar, 1983**) and *Acanthodactylus boskianus* (**Dehlawi and Zaher, 1985a**) where the mucosal membrane of the anterior region of the oesophagus declares the present configuration, while it is composed of non-ciliated simple columnar and goblet cells in its posterior region.

The oesophageal mucosa of the studied species is characterized by the absence of glands. This finding confirms that found in *Agama stellio* (**Amer and**

Ismail, 1976), *Lacerta agilis*, *Natrix matrix* and *Vipera berus* (**Pryzystalski, 1980**), *Agama adramitana* (**Farag and El-Robai, 1986**), *Natrix tessellata* (**Abo-Taira et al., 1988b**), *Coluber florlentus* (**Dehlawi and Zaher, 1989; Afifi et al., 1990**).

However, Jeksajewa and **Koloss, (1964) and Dilmuhamidov(1975)** confirmed the presence of tubuloalveolar mucous glands in the oesophagus of *Testudo graecea* and *Testudo horsfieldii*, respectively. Moreover, **Farag and El-Robai (1986)** revealed the presence of two types of glands in the oesophagus of *Scincus hemprichi,* one is probably mucous secreting and the other has cells with acidophilic granules. This may confirm that the presence or absence of oesophageal glands is independent of the mode of feeding. Additionally, there is no link between the animal's systematic position and the presence or absence of such glands.

The present study reveals that the oesophageal mucosa is thrown into several longitudinal folds. This feature is common for all the described reptiles e.g. *Uromastyx philibyi* (**Farag, 1982**) and *Pristurus rupestris* (**Dehlawi and Zaher, 1985b**).

The stomach of *Uromastyx aegyptiaca* is differentiated into two clearly visible portions, the fundic and pyloric portions. This result agrees with that of **Abo- Taira et al. (1988a)** in *Acanthodactylus boskianus,* **Zaher et al. (1989a)** in *Mabuya brevicollis,* and **Liquori et al. (2000)** in *Podarcis sicula campestris.*

The muscularis layer is composed of a thin outer longitudinal layer and a well-developed inner circular one. This observation agrees with that of **Zaher et al. (1989a)** in *Mabuya brevicollis.*

The stomach of the examined species is characterized by the presence of a relatively thick gastric muscularis layer which is obviously a good adaptation for breaking up food to small pieces through strong muscular contractions.

The gastric mucosa of the fundic and pyloric portions of *Uromastyx aegyptiaca* is thrown into prominent folds, which are lined by simple columnar epithelial cells. These columnar cells possess a homogeneous faintly stained cytoplasm and oval basally located nuclei. These findings are in accordance with those of **Giraud et al. (1979)** in *Tiliqua scincoides,* and **Dehlawi and Zaher (1985b)** in *Pristurus rupestris.* However, these findings disagree with those of **Chou (1977)** who stated that the gastric mucosa of *Ghyra mutilate* contains goblet cells. Moreover, the apical cytoplasm of these cells contains condensed secretory granules which have a positive PAS reaction. This result is in agreement with that of **Abdeen et al. (1990b)** in *Cerastes vipera,* and **Zaher et al. (1990c)** in *Eryx colubrinus.*

The gastric mucosa of *Uromastyx aegyptiaca* is characterized by the presence of fundic and pyloric glands. This observation is in accordance with that of **Amer and Ismail (1976)** in *Agama stellio,* **Farag (1982)** in *Uromastyx philbi* and **Dehlawi and Zaher (1985b)** in *Pristurus rupestris*. These glands are extensively coiled in the fundic portion, while they are simple and straight in the pyloric portion. This result agrees with that of **Giraud et al. (1979)** in *Tiliqua scincoides* and **Zaher et al. (1989a)** in *Mabuya brevicollis.*

The simple columnar cells and the glandular cells of the fundic portions of the stomach show moderate amounts of protein content , while their nuclei are deeply stained .This finding is in accordance with that with that of **Abdeen et al.(1990b)** in *Cerastes vipera*, and **Zaher et al. (1990c)** in *Eryx colubrinus*.

The pyloric glands of *Uromastyx aegyptiaca* are lined by the glandular cells which possess a positive PAS reaction. These results indicate that the pyloric glands may be involved in the mucous secretion to facilitate the passage of food material, as previously reported by Abo-**Taira et al. (1988a and 1988c)** in *Acanthodactylus boskianus* and *Tarentola annularis annularis, respectively,* and **Zaher et al. (1989a)** in *Mabuya brevicollis.*

Examination of the mucosal epithelium of the small intestine, (duodenum and ileum) of the studied species revealed the absence of the intestinal glands. Such a condition was recorded in the intestinal mucosa of *Mabuya quinquetaeniata*, *Chalcides ocellatus* (**Anwar and Mahmoud, 1975**), *Agama stellio* (**Amer and Ismail, 1976**), and *Pristurus rupestris* (**Dehlawi and Zaher, 1985b**). On the contrary, the presence of the intestinal glands was recorded in the intestinal mucosa by **Toro (1930) and Farag (1982)** in crocodilians, and *Uromastyx philipyi*, respectively.

Microscopic examination of the intestinal mucosa indicated the presence of extremely long and coiled villi to compensate the shortness of the small intestine. Such a histological feature may allow efficient absorption of the digested food.

The Lieberkühn crypts are described in reptiles by many authors. In *Uromastyx aegyptiaca*, these crypts are found at the bases of the duodenal villi. They are branched and composed of columnar cells with thin outer borders. Goblet cells are also present. The columnar cells are provided with oval central nuclei, and their protoplasm is granular and darkly stained.

Similar structures were described in several reptiles and birds, as **Jacobshagen (1915)** gives a similar diagram in *Lotta lota*.

The villi of the duodenum, which are numerous, wavy and leaflike, contain central lymph spaces (i.e. lacteals). Fine fibres of the muscularis mucosa enter in the formation of these villi. The present investigation detects the absence of dudeno-ileac constriction which

is considered as a significant squamatic merit (**Afifi *et al*., 1990**).

The present study revealed the complete absence of glandular crypts in the mucosa of the large intestine of the studied species. Such a condition is concordant to what were recorded by **Farag (1982)** and **Dehlawi and Zaher, (1985b)** in *Uromastyx philipyi* and *Pristurus rupestris, respectively.*

In *Uromastyx aegyptiaca*, the large intestine is composed of a large caecum, colon and rectum. The caecum is a large thin walled sac with a blind end. It is attached to the ileum from one side and to the colon form the opposite side. The caecal mucosa is thrown up into a limited number of longitudinal shallow pits. The simple tall columnar epithelium lining the mucosal surface is composed of absorptive cells which are provided with finely granular cytoplasm with elongated darkly stained nuclei situated at the middle or near the base. In between these cells, there are few goblet cells which are mucus-secreting in nature. The striated border is completely absent (**Naguib, 1988 and 1991**).

The mucosa of the colon is in the form of few large folds. It is thick and composed of two types of cells; tall columnar and few goblet cells. The columnar cells have finely granular cytoplasm and oval basally located nuclei. Below the epithelial layer there are one or more layers of cells that do not reach the surface. These are considered as replacing cells. Thus, the mucosa appears more or less stratified (**El-Toubi and Bishai, 1958 ; Naguib, 1988**).

The rectal mucosa has a series of small longitudinal folds, which increase gradually in length towards the posterior direction. These folds are large and broad. The mucous membrane is lined with simple columnar epithelium which contains numerous goblet cells. The relative length of the small and large intestine is obviously greater in herbivorous than in carnivorous and insectivorous reptiles, since the plant-origin food is more resistant to digestion than the animallized diet (**Groombridge 1982; Hamlyn, 1989**).

The present study revealed that a strong PAS-positive reaction was given by the mucosal epithelium of both the oesophagus and the stomach of *Uromastyx aegyptiaca*, and the mucosa of the small and large intestine showed a moderate reaction. These observations are similar to those of **Mousa *et al*. (1985)** on the lizard and **Dehlawi *et al*. (1987c)**, on the gecko *Pristurus rupestris* .

The present findings are similar to those in mammals (**Amer, 1983 and El-Beih *et al*., 1987**), in that the goblet cells are the source of acid mucopolysaccharides, and that gastric mucosa is devoid of these substances, containing only neutral mucopolysaccharides. Similarly, **Anwar and Mahmoud (1975)** found that the goblet cell in the alimentary tract of the Egyptian lizards contains mucoid secretions of an acid mucoprotein nature.

These being more abundant in the rectum than in the ileum.

The present study reveals that the goblet cells show a strong acid mucopolysaccharide reactivity in the oesophagus and moderate reactivity in the small and large intestines. **Mousa *et al*. (1985)** also reported that the goblet cells of small and large intestine of the lizard gave a strong reaction for acid mucopolysaccharides. However, in contrast with the present results, Mousa and his co-workers claimed that the gastric glands of the lizard stomach showed a strong acid mucopolysaccharide reactivity.

The present data showed that in *Uromastyx aegyptiaca,* the distribution of proteins in the cytoplasm of their gut mucosal cells is more or less identical. It is of interest to mention that the histochemical pattern of the proteins in the gut mucosa of the described animals is closely similar to the previously investigated reptiles (**Anwar and Mahmoud, 1975; El-Taib and Jarrar, 1983; Zaher *et al*., 1987 a, b and 1991 a, b; Zaher and Abdeen, 1991**).

The present work showed also a proportional correlation between the RNA content and the proteonic amount of the cytoplasm of the mucosal epithelial cells in the different gut regions. This feature confirms the findings of **Amer *et al*. (1987b), Zaher *et al*. (1987a), Zaher *et al*. (1990c, 1991a, b) and Zaher and Abdeen (1991).**

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