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Comparative histological studies on the intestinal wall between the prenatal, the postnatal and the adult of the two species of Egyptian bats. Frugivorous *Rousettus aegyptiacus* and insectivorous *Taphozous nudiventris*

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Abstract The present study was planned to find the effect of different feeding habits on the structure of the duodenum and small intestine of adult, prenatal and postnatal of both fructivorous *Rousettus aegyptiacus* and the insectivorous *Taphozous nudiventris* using the histological and the histochemical techniques. Histologically, the duodenal wall of *R. aegyptiacus* and *T. nudiventris* is composed of the typical layers: mucosa, submucosa, muscularis and serosa, we observed that the mucosa with finger like villi and very sharp apices in prenatal and adult of *R. aegyptiacus* but compact finger like villi in *T. nudiventris*. Scattered among the columnar epithelium goblet cells which less numerous in *R. aegyptiacus* than in *T. nudiventris*. Brunner's glands are less numerous also in *R. aegyptiacus* than in *T. nudiventris*. In postnatal the mucosa with pyramidal like villi in *R. aegyptiacus* and finger like villi in *T. nudiventris*. In ileum the intestinal glands are less numerous in *R. aegyptiacus* than in *T. nudiventris*. In prenatal the goblet cells are less developed in *R. aegyptiacus* and *T. nudiventris*. The intestinal glands are less developed also in *R. aegyptiacus* and *T. nudiventris* but in the postnatal the goblet cells and the intestinal gland are few in number in both *R. aegyptiacus* and *T. nudiventris*.

Introduction

The studies on bats in the world have attracted the attention of many authors. Since studies in the Egyptian bats may be few, my research focus was on the Egyptian bats. Many authors have studies on the histological and some general histochemical characteristics of gastric mucosa, small intestine, and gut associated lymphoid tissue in many different species of bats (Schultz, 1965; Rouck and Glass, 1970; Forman, 1971, 1972, 1973, 1974). Brunner's gland formed from acini and contained (PAS) positive droplets Cochrane et al. (1954).

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Forman (1974) noticed that frugivorous bats have more Payer's patches than nectarivorous, carnivorous or insectivorous ones, and that they can occur anywhere along the tract.

Physiological studies made by Keegan (1975) indicated that long intestines would not hamper the flight of frugivorous bats, since food transmit and absorption time are quite rapid. The disposition of Kerckring's folds, absent in the upper region of the duodenum and in the distal portion as it approaches the colon, is similar to that generally found in mammals.

Madkour (1977) and Madkour et al. (1982) made a comparative study of certain features of the alimentary canal and deposition of viscera in different bats from Egypt, they stated that the different parts of the alimentary tract showed a marked difference in size, shape, and length. The longest intestinal canal is found in *Rousettus*, *Nycteris*, *Rhinolophus*, and *Asellia tridens* forming a definite group as regards the length of this canal.

The Light and the Scanning electron microscopy have been used to distinguish the different portions of bat intestines (Okon, 1977; Ishikawa et al., 1985; Tedman and Hall, 1985; Makanya and Maina, 1994; Makanya, 1997; Makanya et al. 2001).

External morphology does not allow a clear distinction between the small and the large intestines in all bat species, Tedman and Hall (1985) stated that the intestine of *Pteropus alecto* and *P. poliocephalus* is a continuous tube without separation between the small and large intestines.

The gastrointestinal secretions in vertebrates contain number of muco substances that can differ according to cell type, anatomical region, functional status, pathological condition, age, sex and species (Sheahan and Jervis, 1976; Filipe, 1979; Sato and Spicer, 1980; Allen, 1981; Suganuma et al., 1981; Pedini et al., 2001; Liquori et al., 2002; Choi et al., 2003; Schumacher et al., 2004).

The intestine of *Rhinolophus ferrumequinum* is divided into three main areas: duodenum, jejuno-ileum and rectum, while the intestine of the cogeneric *Rhinolophus hildebrandti* from Africa is similar to that of *R. ferrumequinum* in having a long small intestine and a short rectum, but differs in that it lacks a distinct duodenum (Makanya and Maina, 1994).

The ileum is the final section of the small intestine, it is about 2–4 m long in man, follows the duodenum and jejunum, and is separated from the ceacum by the ileoceacal valve (Coico, 2003). The mucosa of the pangolin was noticed to be characterized by horizontal folds called plicae circulares, in contrast to abnormal finger-like projection (villi) found projecting into the lumen in rats and bats. The plicae circulares with villi increases the surface area. Further examination revealed that the muscularis externa is thicker in pangolin with rat and bat (Ofusori et al., 2008).

In *C. perspicillata*, *P. hastatus*, and *G. soricina* Peyer's patches were found in the distal portion near the large intestine, whereas in *D. rotundus* and *S. lilium* aggregations of lymphoid nodulous tissue were distributed along the tube. In *Sturnira lilium*, *Phyllostomus hastatus*, *Carollia perspicillata*, *Glossophaga soricina* and *Desmodus rotundus*, Paneth cells at the base of the crypts of Lieberkühn (Gadelha et al., 2008).

Materials and methods

Bats

The specimens of *Rousettus aegyptiacus* (Megachiroptera) and *Taphozous nudiventris* (Microchiroptera) used in this study were procured alive from Abu-Rawash, Giza Governorate through the years 2010 and 2011.

Measurements

The mean of 20 measured adult specimens in millimetre was as follows:

R. aegyptiacus: total length: 93 (88.5–95), tail: 40.5 (39.2–41.5), fore-arm: 80 (79.4–82.5), hind foot: 35.5 (34.2–36), ear: 25 (24.3–26.5).
T. nudiventris: total length: 73 (69.3–74.5), tail: 24.5 (21.1–25.6), fore-arm: 62 (60.4–63.8), hind foot: 25.5 (25.0–26.1), ear: 18 (17.5–18.5) and targus: 6 (5.8–6.3).

Collected the animals

The specimens of *Rousettus aegyptiacus* and *T. nudiventris* were collected and classified as follows:

(a) Adult group.
(b) Pre-natal group; (embryos).
(c) Post-natal group; (lactating bats) (Fig. 1).

Histological examination

Organs of adult, pre-natal, and post-natal bats (frugivores and insectivores) were collected. Parts of the duodenum, ileum, tongue, pituitary, and thyroid glands were immediately fixed in Bouin's fluid and 10% neutral buffered formalin for 24 h. The tissue samples were dehydrated in ascending grades of ethyl alcohol, cleared by xylene and embedded in paraffin. Sections of 5 μm thickness were mounted and stained with Haematoxylin and Eosin method (Bancroft and Stevens, 1990). All preparations were microscopically examined for the histological examination.

Histochemical examination

Periodic Acid Schiff procedure (PAS)

Sections were treated by Periodic Acid Schiff procedure (PAS). This comprised placing the sections in 0.5% periodic acid for 5–10 min, washing for 5 min in running tap water, then rinsed in distilled water and treated with Schiff's reagent for 20–35 min. Sections were passed through 3 changes of freshly prepared M/20 sodium acid sulphite solution, 2 min in each. They were washed in tap water for 5 min, and then rinsed in distilled water. Dehydration was carried out in ascending series of ethyl alcohols, cleared in xylene and mounted in canada balsam.

The PAS reaction is based on the oxidation of the glycol linkages in polysaccharides by periodic acid, thus producing aldehydes. These librated aldehydes react with the leuco fuchsin of Schiff's reagent producing a compound of a magenta