Tissue and Cell 41 (2009) 222–229

Contents lists available at ScienceDirect

Tissue and Cell

journal homepage: www.elsevier.com/locate/tice

Distributions of the endocrine cells in the gastrointestinal tract of nectarivorous and sanguivorous bats: A comparative immunocytochemical study

Clarice Machado-Santos[a,b,*], Aparecida Alves do Nascimento[b], Adriano Lúcio Peracchi[c], Jefferson Simanas Mikalauskas[a,c], Patrício Adriano Rocha[c], Armando Sales[b]

[a] Postgraduate Program in Animal Biology, Rio de Janeiro Federal Rural University (UFRRJ), Seropédica, RJ, Brazil
[b] Animal Biology Department, Histology and Embryology Area, UFRRJ, Seropédica, RJ, Brazil
[c] Laboratory of Mastozoology, UFRRJ, Seropédica, RJ, Brazil

ARTICLE INFO

Article history:
Received 18 September 2008
Received in revised form 6 November 2008
Accepted 12 November 2008
Available online 8 January 2009

Keywords:
Bats
Endocrine cells
Immunohistochemical
Dietary habits

ABSTRACT

The present study was conducted to clarify the influence of feeding habits on regional distribution and relative frequency of endocrine cells secreting cholecystokinin (CCK), gastrin (GAS), serotonin (5-HT) and enteroglucagon (GLUC) in the nectarivorous *Anoura geoffroyi* and *Glossophaga soricina* and the sanguivorous *Desmodus rotundus* bats of the Phyllostomidae family, by specific immunohistochemical methods. The regional distribution and frequency of the different types of endocrine cells varied according to their location in the GIT. 5-HT immunoreactive cells (IR), detected throughout the GIT of three bats, were the most predominant gastrointestinal endocrine cells. GAS-IR cells in *A. geoffroyi* were found at the base of the pyloric gland, while in *G. soricina* they could also be observed in the middle to basal portions of the gland. GLUC-IR cells were located in the fundic region of *A. geoffroyi*, *G. soricina* and *D. rotundus*. These endocrine cells were more abundant in the sanguivorous bat. In nectarivorous bats were compared to sanguivorous bat, which differ in dietary habits, difference in the distribution and relative frequency of gut endocrine cells would be predicted. The absence of some, and decrease in frequency of other, gastrointestinal endocrine cells may reflect, in part, its interspecies differences or dietary habits.

1. Introduction

The Chiroptera order is surpassed in number of species only by rodents. In Brazil, there are 138 known species to date, representing 74% of the total for South America (Koopman, 1993). Since bats show greatly divergent diets in a single order, the morphological adaptation of their digestive system to different modes of feeding has received a great deal of attention (Komori et al., 2000). The gastrointestinal tract (GIT) of these diverse mammals is a very attractive model not only for understanding the evolution of the digestive tract in general, but also for investigating the relationships between the distribution and frequency of gut endocrine cells and feeding habits (Yamada et al., 1987).

Today more than 30 gastrointestinal hormone genes and a multitude of GI hormones have been recognized, thus making the GIT the largest endocrine organs in the body (Ahlman and Nilsson, 2001). The gastrointestinal endocrine cells are dispersed along the epithelium, gastric and intestinal glands of the digestive tube and synthesize various types of biologically active polypeptides and amines (Sundler et al., 1980). The physiological functions mediated in the gut by these peptides include the control of motility, the secretion of fluid, electrolytes and digestive enzymes, cell proliferation and survival, vascular and immune functions, visceral pain and inflammation (Brown et al., 1973). Some GI dysfunctions are related to these hormones (Nyhlin et al., 1999). Some GI hormones have synergistic expression in gastric carcinoma and take part in the occurrence of gastric carcinoma (Milutinovic et al., 2003).

It is generally accepted that GI endocrine cells are remarkably different in regional distribution, relative frequency and cells types in the gastrointestinal tract (Huang and Wu, 2005). Some studies have elucidated the regional distribution and relative frequency of different endocrine cells in chiropteran's gastrointestinal tracts and 15 different kinds of these cells have been described using the immunohistochemical method. These studies have revealed some inter-species differences and suggest a certain correlation between endocrine cell distribution and feeding habits (Yamada et al., 1984, 1988; Ashihara et al., 1999; Komori et al., 2000).

The present study was conducted to clarify the influence of feeding habits on regional distribution and relative frequency of endocrine cells secreting cholecystokinin (CCK), gastrin (GAS), serotonin (5-HT) and enteroglucagon (GLUC) in the nectarivorous *Anoura geoffroyi* and *Glossophaga sorina* and the sanguivorous

* Corresponding author at: Laboratório de Histologia e Embriologia, Instituto de Veterinária, sala 85. Universidade Federal Rural do Rio de Janeiro, Rod. BR 465, Km 07, CEP 23, 890-000 Seropédica, Brazil. Fax: +55 21 2682 1711.
E-mail address: claricemachado@yahoo.com.br (C. Machado-Santos).

0040-8166/$ – see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.tice.2008.11.004

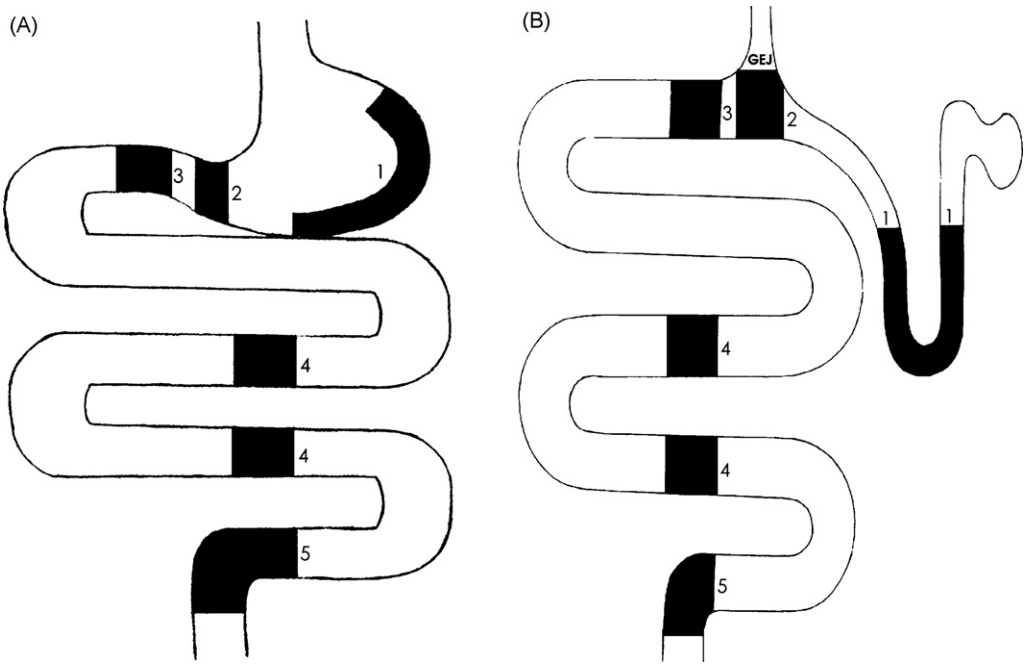

Fig. 1. (A and B) Representation of the digestive tract illustrating regions sampled from (A) nectarivorous and (B) sanguivorous. (1) Stomach, fundic region. (2) Stomach, pyloric region. (3) Intestine I, duodenum. (4) Intestine II, jejunum/ileum. (5) Intestine III, large intestine and rectum. (GEJ) Gastroesophageal junction (modified from Komori et al., 2000).

Desmodus rotundus bats of the Phyllostomidae family, by specific immunohistochemical methods, contributing to the knowledge of the cellular composition of the bat gastrointestinal tract.

2. Materials and methods

2.1. Animals and tissue preparations

Nine animals were used; three of them were *A. geoffroyi* (two males and one female), three *G. soricina* (three males) and three *D. rotundus* (two females and one male) collected according to Brazilian law. The specimens were collected during the night with mist nets and hand nets, in Casa de Pedra cave in the state of Sergipe, Brazil. The bats were sacrificed with sodium thiopentone at a dose of 100 mg/kg and the two regions of the stomach and three regions of the intestine were removed (Fig. 1A and B) and fixed with Bouin's fluid for 6 h. The tissues were dehydrated through a graded series of ethanol solutions and embedded in Histosec (Merk, Darmstadt, Germany) using routine protocols. 5-μm thick sections were cut by microtome and mounted on glass slides pre-coated with 0.1% poly-L-lysine (Sigma Chemical Co., Saint Quentin Fallavier, France).

2.2. Immunohistochemistry

The primary antisera were used for both the specificity controls and immunolocalization of cells immunoreactive to regulatory peptides and biogenic amine. They were: rabbit polyclonal anti-5-HT (S 5545—Sigma–Aldrich, Inc.), rabbit polyclonal anti-GAS (G 0785—Sigma–Aldrich, Inc.), rabbit polyclonal anti-CCK (C

Table 1
Distribution and relative frequency of endocrine cells of (A) the nectarivorous bats *A. geoffroyi** and *G. soricina* and (B) sanguivorous bat *D. rotundus* (cells/0.25mm^2, mean ± S.D.).

Portion of alimentary tract	Serotonin	Gastrin	CCK	Enteroglucagon
(A)				
Stomach	11.2 ± 2.6*/24.3 ± 4.9	f/0	0/0	2.2 ± 1.0/1.6 ± 1.0
Fundic				
Stomach	29.7 ± 12.9/36.3 ± 8.1	48.2 ± 15.7/47.7 ± 4.3	0/0	0/0
Pylorus				
Intestine I	15.4 ± 3.7/27.1 ± 14.3	0/0	9.6 ± 1.5/12.3 ± 2.0	2.8 ± 0.7/3.4 ± 1.0
Intestine II	10.3 ± 2.0/28.6 ± 9.0	0/0	11.9 ± 4.8/11.4 ± 1.4	2.0 ± 0.6/2.0 ± 0.5
Intestine III	16.9 ± 1.1/19.5 ± 6.5	0/0	11.5 ± 5.1/12.7 ± 6.7	2.4 ± 0.5/3.6 ± 1.9
(B)				
Stomach	58.5 ± 7.2	0	0	4.0 ± 1.2
Fundic				
Stomach	45 ± 5.0	26.7 ± 6.0	0	0
Pylorus				
Intestine I	18.8 ± 6.4	0	10 ± 2.2	3.0 ± 1.7
Intestine II	10.9 ± 3.0	0	14.7 ± 5.2	1.8 ± 0.8
Intestine III	13.5 ± 3.0	0	7.1 ± 2.8	2.2 ± 0.8

f: few—not detected in every animal.