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A comparative histomorphology of tongue and dentition in rats, bats and hedgehogs

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ABSTRACT: This study was designed to compare the macro-and micro-anatomical features of the tongue and dentition of the Hedgehogs (insectivorous), bats (frugivorous) and rats (omnivorous), to see if there are observable differences. This study was carried out using eight rats, eight bats and five Hedgehogs of both sexes. Animals were sacrificed the tongue tissues were excised and fixed in 10% formol saline and followed by histological processes, using Haematoxylin and Eosin (H&E) method. Using the Students't-test; body weight, tongue weight, relative tongue weight, tongue length, relative tongue length and dentition were significantly different ($P< 0.05$) between the three mammals. It is therefore concluded that the differences in the morphological assessment, dentition and histological analysis are due to the different feeding (diet) pattern and habitation in the three mammals.
Keywords: Dentition, morphology, mammals, tongue, Hedgehog, bat, rat.

Introduction

The three mammals were chosen out of the numerous mammals because of the accessibility and dearth of documented data on their relation, which correlate their tongue and dentition. Hedgehog, bat and rat are mammals (Hildebran and Goslow, 2001; Wells, 1964; Stevens and Lowe, 2005) while bat is an arboreal (Ogunbiyi and Okon, 1976), Hedgehog and rat are terrestrial (Hildeband and Goslow, 2001; Well, 1964). However, great work has been done on the comparative anatomy of tongue of bat and rat (Oke, 2005). The tongue is a highly muscular organ covered in squamous epithelium, of deglutition, taste and speech (Stevens and Lowe, 2005). Its is partly oral and partly pharyngeal in position, and is attached by its muscles to the hyoid bone, mandible, styloid processes, soft plate and the pharyngeal wall (Standring *et al*., 2005; Stevens and Lowe, 2005) while the teeth also form part of the structures that are found in the oral cavity, their shape, size and arrangement depend on the dietary intake (Taylor *et al*., 1998). There are three basic tooth forms in the dentition: incisiform, caniniform, and molariform. The incisiform teeth (incisors) are cutting teeth, caniniform teeth (canines) are piercing or tearing teeth, and molariform teeth (molars and premolars) are grinding teeth and possess a number of cusps on an otherwise flattened biting surface (Standring *et al*., 2005; Wells, 1964; Stevens and Lowe, 2005).

To the best of our knowledge no precise work has been done to relate all these differences with the micro-and macro-anatomical adaptation, which the tongue and teeth of these three mammals have adopted. The soft internal parts of invertebrate along with their flesh do contain protein and fat which provide the nutrient for Hedgehog and other ant-eaters (Redford and Dorea, 1984). The sand and ditrus adsorbed together with the termite has been reported to add bulk to the digestive load of insectivorous and thus, reduced the caloric proportion of their digestive content (Redford, 1983).

The tongue of bat which has sharp and backward pointing rasps or papillae on the upper surface is moved forwards and backward and sometimes sideways, rasping away the fruit rich in fibers contents

in the a kind of grating action. Unlike bat and hedgehog, the permanently growing incisor, two on top and two below are used for the manipulation of food (plant & animal materials) in rats (Ofusori *et al*., 2008).

In this study, we comparatively elucidate the macro-and micro-structural organization of tongue and dentition of the three mammals to successfully manipulate their different diets and cope with the morphological differences.

Materials and Methods

CARE OF THE ANIMALS: Eight rats weighing 132g in average, five hedgehogs weighing 210g in average and eight bats weighing 257g in average of both sexes were used. The rats were obtained and maintained in the Animal Holding of the Department of Anatomy, University of Ilorin, Ilorin Nigeria. They were fed with rat pellets and given water *ad libitum.* The hedgehogs were cured from local sellers in Ilorin, Nigeria following ethical clearance and maintained in the animal holding of the same Department. They were fed with insects and allowed to have asses to water. The bats were curled from their roosting colony on the Family garden, Ilorin, Nigeria. They were fed with ripe bananas and water. The animals were carefully conditioned. Handling and care of the animals conform to the animal right committee of the University of Ilorin, Nigeria and the rule guiding Good Laboratory Practice was also adhered to.

EXCISION OF THE TONGUES: After sacrifice by cervical dislocation, the tongues were excised from the animals and were blotted using filter paper and their wet weight was recorded, using Gallenkomp electric weighing balance (Model FA2104A). The anterioposterior length (APL) and Diameter (D) of the tongues were also taken using transparent meter ruler. The tissues were quickly transferred into bottle containing 10% formol saline for 48 hours.

HISTOLOGICAL PROCEDURES: The tongues were carefully excised and processed routinely for paraffin embedding. Serial sections (transverse and longitudinal) were obtained at 5µ thickness from a rotary microtome and subjected to the Haematoxylin and Eosin (H&E) stains (Bancroft and Stevens, 1999). The sections were mounted and examine with the light microscope and the photomicrograph of each slide was taken for further analysis.

Results

MORPHOLOGICAL ANALYSIS

TONGUE WEIGHT: Using the students' test ($P<0.05$) there was significant difference in the tongue weight between the three mammals. The bat has their highest tongue weight (**4.16±0.41g)** followed by the hedgehog (**1.32±0.09g**) and this is correlate with their body weight (Table A1).

RELATIVE TONGUE WEIGHT (RTW): Using the Students' test ($P<0.05$), there was significant different in the RTW between the three mammals. RBW of the bat (16.18×10^{-2}) is significant higher than that of hedgehog (6.27×10^{-2}) and rat (6.26×10^{-2}). However, there is no stable significant different between RTW of rats & Hedgehog (Table A1).

RELATIVE TONGUE LENGTH (RTL): The RTL of bat (36.0406×10^{-2}) is higher than other two, mammals while that of the rat (10.553×10^{-2}) is the lowest of all and this difference is statistically significant ($p>0.05$) (see the table A1).

HISTOLOGICAL OBSERVATIONS

Following the histological preparations with Haematoxylin (H) and Eosin (E), microscopic observations were carried out with binocular light microscope and the photomicrograph of each slide was taken using photographic set. The following observations were made.

Epithelia lining: the epithelia lining in the rat tongue is thicker than those of other two mammals, followed by those of the hedgehogs.

Muscle: The patterns of arrangement of the circular and longitudinal muscles in the three mammals are histologically the same.

Lamina propia: LP is more distinctly outline in hedgehog unlike those in bat which is thinnest of all.
Papilla: the fungiform and filiform papillae are well outline in hedgehog and bat unlike those in rat.

Glands: the serous glands are more prominent in rat and hedgehog tongue unlike bat.

TABLE A1: BODY WEIGHT (GRAM) OF THE THREE MAMMALS.

Animals	No of Animals	Body weight (g) Mean± S.E	Body length (cm) Mean± S.E	Tongue weight (g) Mean± S.E	Tongue APL (cm) Mean± S.E	Tongue Diameter Mean± S.E	RTW (X10-2)	RTL (X10-2)
Hedgehog	**5**	**210.00 ±11.03**	**15.80±0.09**	**1.32±0.09**	**3.10±0.51**	**0.90±0.01**	**6.27**	**21.62**
Bat	**8**	**257.15 ± 15.30**	**18.70±1.00**	**4.16±0.41**	**6.20±0.90**	**1.20±0.09**	**16.18**	**36.04**
Rat	**8**	**131.73 ±16.67**	**22.30±1.01**	**0.83±0.12**	**2.30±0.16**	**0.60±0.00**	**6.26**	**10.55**

S.E: Standard Error; APL: Anterioposterior length; RTW: Relative Tongue Weight; RTL: Relative Tongue Length

TABLE A2: DENTITION OF THE THREE MAMMALS.

Animals	Dental formula	Total teeth
Hedgehog	**$2[I^3_2\ C^1_1\ PM^3_2\ M^3_3]$**	**36**
Rat	**$2[I^1_1\ C^0_0\ PM^0_0\ M^3_3]$**	**16**
Bat	**$2[I^2_2\ C^1_1\ PM\ 33M^2_3]$**	**34**

NB: I: incisors; C: Canine; PM: premolar; M: molar

Discussion

In the present study, the mean tongue weight and length of hedgehog, bat, and rat were found to be 1.3164±0.09g, 3.10±0.51cm, 4.1594±0.41g, 6.20±0.90cm and 0.8264±0.12g, 2.30±0.16cm, respectively; With those of bat being highest with a high significant difference ($p<0.05$).
A comparative study of the relative thickness of the epithelia lining of the tongue of the three mammalian species was significantly different microscopically while that of muscular pattern was not significantly different and this observation may reflect similar and consistent role-played in maintaining the structural integrity throughout the tongue.

The serous glands in the rats are more prominent than those of other mammals, this may reflect the fact that the rats feed more on dry materials, such as grains, which required more salivary secretion for easy lubrication and swallowing processes unlike other two mammals that feed majorly on soft tissue diets, insects (hedgehog) and fruits (bats).

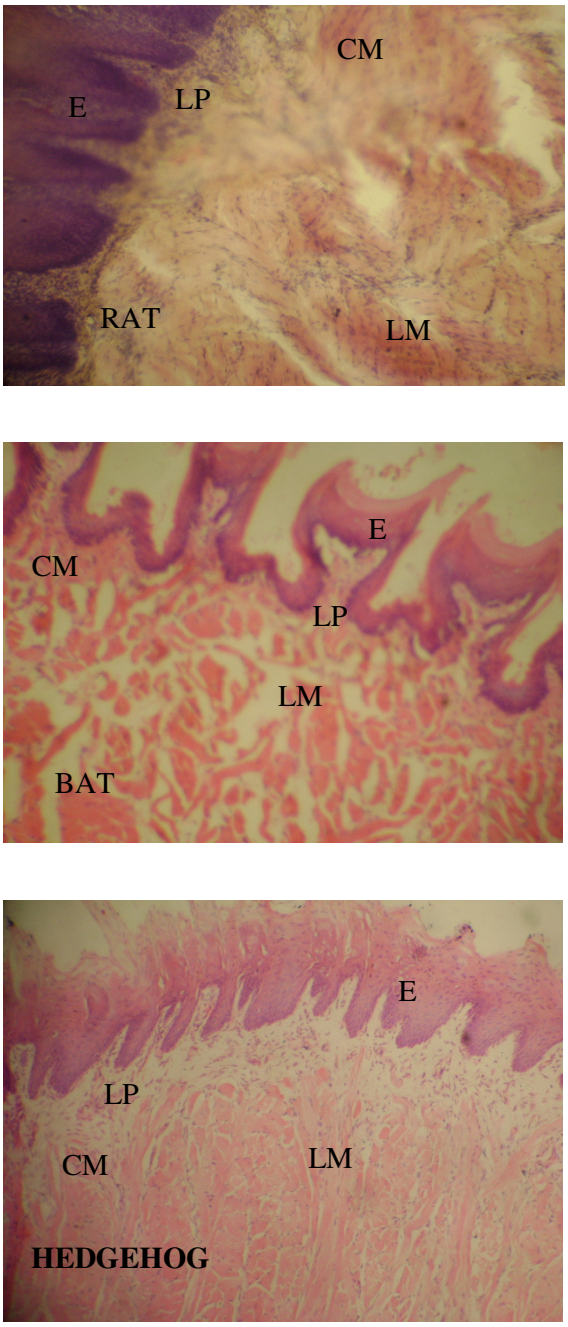

Fig A1: **Photomicrograph of The Tongue In The Three Mammalian Species (X 576)**
All sections are longitudinal; E: epithelium, CM: Circular muscle; LM: Longitudinal muscle, LP: lamina propia

For dentition pattern, the three mammals show a similar number of molar (M^3_3) on each side while bat and hedgehog have equals number and arrangement of their canine (C^1_1) which is similar to those of carnivores. But the rat has a typical teeth pattern of herbivores; it lack canines and premolar which is similar to the space called *diastema* in herbivores (Well, 1964; Taylor *et al*., 1998; Stevens and Lowe, 2005). However, the total number of teeth is significantly different ($p<0.05$), with that of hedgehog highest (36) followed with bat (34) and rat the lowest (16). These findings correlate with the reports of Well (1964), Standring, *et al*., (2005) and Taylor, *et al*., (1998) that the shape, size and arrangement of teeth depend on the dietary intake of a spices. It is worthy to say at this junction that our findings

indicate equal number of teeth (36) in hedgehog and that in adult Man. pattern is quiet little different in the number of incisors (I) and premolar (PM).

It is therefore worthy to conclude that the histomorphological assessment of the tongue and dentition in the three mammalian species has a functional implication in respect to their respective diets

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