Gross and microscopic anatomy of thyroid gland of the wild African grasscutter (*Thryonomys swinderianus*, Temminck) in Southeast Nigeria

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SUMMARY

The thyroid gland of the wild African grasscutter (*Thryonomys swinderianus)* was studied morphometrically and histologically by gross dissection. The organ was a symmetrical bilobed organ located on the lateral aspect of the trachea, between the first and the third tracheal rings, without an isthmus connecting the lobes. The mean weight of the two lobes was 0.23 ± 0.02 g and the relative thyroid-body weight was 0.03 ± 0.01 g/kg. The mean length (long axis), width (short axis) and thickness (height) were 1.50 ± 0.06 cm, 0.61 ± 0.05 cm and 0.42 ± 0.02 cm, respectively. The mean diameter of the small round follicles was 96.001 ± 0.03 µm, and that of the medium round follicles measured 180.18 ± 0.07 µm, while that of the large round follicles was 240.01 ± 0.08 µm. The epithelial cell heights of the small, medium and large-sized follicles were 7.52 ± 0.05 µm, 7.31 ± 0.01 µm and 7.12 ± 0.06 µm respectively. The general histologically appearance did not vary greatly from that described for most mammals. The small follicles were remarkably located centrally and the large ones were located peripherally. Peripheral vacuoles were present in the follicular lumen. The features and sizes of the follicular epithelial cells and the presence of parafollicular cells suggest activity in the thyroid gland of the wild African grasscutter.

Key words: *Gross anatomy – Histology – Thyroid gland – Grasscutter – Nigeria*

INTRODUCTION

The Grasscutter (*Thryonomys swinderianus*) is a wild herbivorous rodent regarded by some people as a large version of the rat (Asibey and Addo, 2000).The genus, *Thryonomys*, also known as ‘cane rat’ in Southern Africa or ‘grasscutter’ in West Africa is a genus of rodent and the only member of the family *Thryonomidae* and the suborder *Hystricomorpha*. Although many varieties have been described, there are probably only two species. The greater can rate (*Thryonomys swinderianus*) weights 9 kg or more and has a head-and-body length of up to 60 cm. The lesser can rat (*Thryonomys gregorianus*) weights about 3.5-5 kg and may occasionally reach 8 kg and a body length of 50 cm). The Grasscutter is the second largest African rodent after the Porcupine (National Research Council, 1991).

It is currently being hunted aggressively in the wild because of its meat, leading to destruction of the environment through the

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setting of bushfires by hunters in these areas (Yeboah and Adamu, 1995). Although attempts to domesticate this rodent have continued (Eben, 2004), these efforts have not been successful in the recent past (Opara et al., 2006). Being the most preferred (Martin, 1985) and most expensive meat in West Africa, including Nigeria, Togo, Benin, Ghana and Coted'voire (Baptist and Mensah, 1986; Asibey and Addo, 2000), it contributes to both the local and export earnings of most West African countries (National Research Council, 1991; Ntiamoa-Baidu, 1998).

Some studies have shown that the grasscutter can be tamed and even used for laboratory research. Certain aspects of the biology of the grasscutter have been studied, including its reproductive characteristics (Addo, 2002; Olukole et al., 2009), gastrointestinal tract morphology (van Zyl et al., 2005; Byanet et al., 2008a), brain morphometry (Byanet et al., 2008b; Byanet et al., 2009), haematology and plasma biochemistry (Byanet et al., 2008c). However, is no information about the anatomy and histology of the thyroid gland. The thyroid gland secretes hormones that regulate growth and metabolism and plays a critical role in tissue development and differentiation (Choksi et al., 2003). Weighing and histological evaluations of the thyroid are classically required for the evaluation of thyroid function. Additional evaluations include biomarkers that demonstrate the effects of thyroid hormones on metabolism, thyroid function, and blood levels (Christian and Trenton, 2003). Thyroid hormones are produced by the follicular cells that compose the bulk of the parenchyma. They are stored in the follicular fluid and later broken down to yield the final products, which are then released into the blood stream (Dyce et al., 2002).

Research studies on the endocrine organs of the African grasscutter are rare. The purpose of this study is to provide baseline data on the gross anatomy and histology of the thyroid gland of the grasscutter that could complement other information available about the grasscutter. The findings could be useful to farmers, breeders, and researchers.

Materials and Methods

Eight wild grasscutters (5 males and 3 females) weighing between 7.2-8.5 kg purchased alive at intervals from farmers engaged in kill-trapping in the farmlands around Nsukka area of Southeastern, Nigeria, were used for this study. The animals were fed with feed supplement and elephant grass, and water was given *ad-libitum*. The animals were acclimatized for 7 days before the experiments. All animals were weighed using manual a weighing balance, recording in kilograms. They were euthanized using pentobarbital sodium and the jugular veins were severed. The thyroids glands were dissected out following exposure by two ventral incisions between the first to the fourth tracheal rings. The gross anatomical features of the thyroid, including weight (cm), length (cm) and width (cm), were recorded before fixation. The tissues were fixed in Bouin's fluid, dehydrated in a graded series of ethanol, cleared in xylene, and embedded in paraffin wax. The blocks were sectioned at 6 µm thickness using a rotary microtome. Paraffin sections were stained with haematoxylin and eosin and studied with a Hund Wetzlar 600H light microscope with a Moticam 1000 digital camera attachment and the images were captured on a computer.

An ocular micrometer, calibrated with a stage micrometer, was used to measure the diameter of the small round follicles (µm), the diameter of medium-sized round follicles (µm) and the diameter of large-sized round follicles (µm). Also, the heights of the epithelial cell (µm) were determined for the small-, medium- and large-sized follicles. All measurements are expressed as means and standard errors of the means (mean ± SEM).

Results

Gross observations: Gross studies of the thyroid gland of the grasscutter showed that it was a bi-lobed organ located on the lateral surface of the trachea between the first and third tracheal rings. The two lobes were totally separated, without an isthmus. The left lobe was slightly more cranial. It was an oval-shaped, compact mass with a smooth surface and was reddish brown in colour (Fig. 1). The mean weight of the two lobes was 0.23 ± 0.02 g and the relative thyroid-body weight was 0.03 ± 0.01 g/kg. The mean length (long axis or crown-tail length), width (short axis) and thickness (height) were 1.50 ± 0.06 cm, 0.61 ± 0.05 cm and 0.42 ± 0.02 cm respectively for each lobe.

Figure 1. Gross photograph showing the left (*L*) and right thyroid (*R*) lobes.

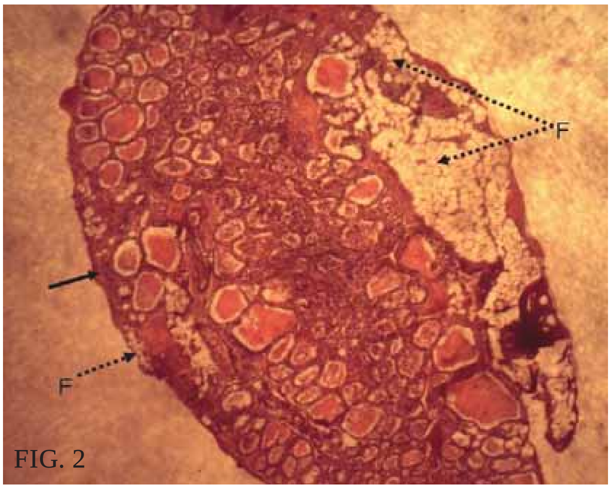

Figure 2. Histological section showing the general features of the thyroid gland at low magnification: capsule (*arrow*), adipose tissue (*broken arrows*, F). Note the arrangement of the large-, medium- and small-sized follicles. x 100. H & E.

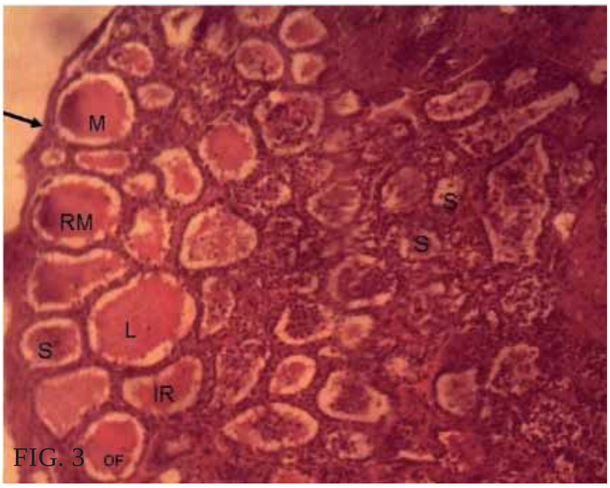

Figure 3. Histological section showing the arrangement of follicles from the periphery to the central parenchyma of the organ. Large round follicle (L), irregular follicle (IR), oval follicles (OF), small follicle (S), medium round follicles (RM), medium follicles (M), capsule (*arrow)*. x 200. H & E.

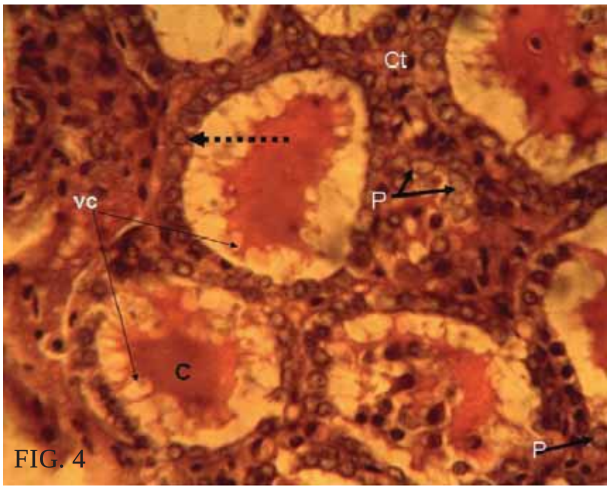

Figure 4. Small-sized follicles showing: follicular epithelium, high cuboidal epithelium (dotted arrow), interfollicular connective stroma (Ct), colloid vacuoles (vc), parafollicular cells (P), colloid (C). x 400. H & E.

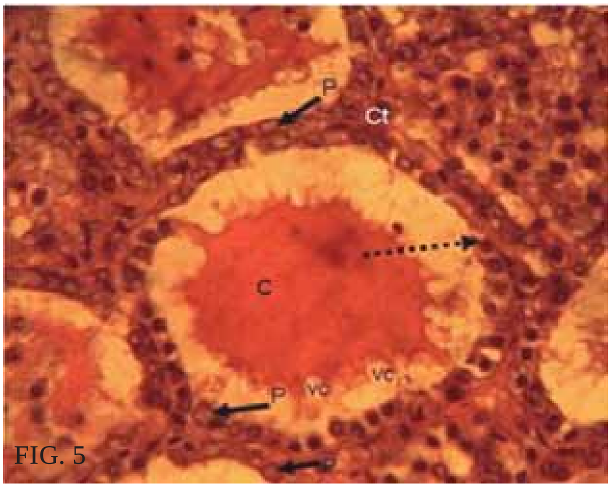

Figure 5. Medium-sized follicles (round and irregular), showing parafollicular cells (P), colloid (C), peripheral vacuoles (vc), interfollicular stroma (Ct). Note the retraction of the colloid away from the lumen due to histological preparation. x 400. H & E.

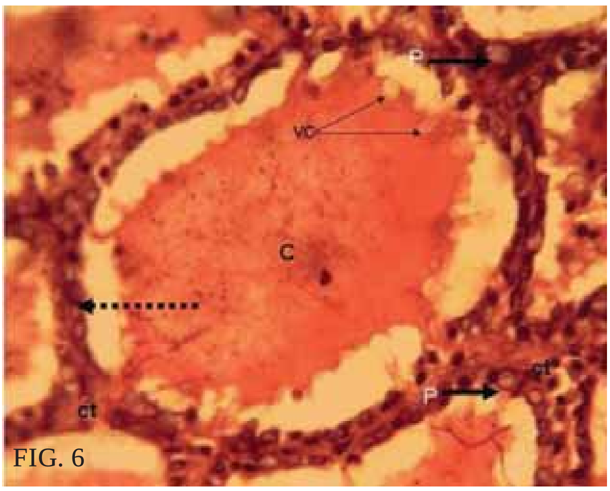

Figure 6. Large-sized follicles showing low cuboidal epithelium and even flattened squamous cells in some follicles (*dotted arrow)*, colloid vacuoles (vc), parafollicular cells (*black arrows)*, colloid (C), interfollicular stroma (ct). x 400. H & E.

Histological features: The thyroid gland consisted of a thin connective tissue capsule composed of coarse and fine collagenous fibres. Some layers of adipose tissue were observed in association with the capsule in sites around it. Small blood vessels and fibroblasts were also present in the capsule. Thin strands of trabeculae extended from the capsule into the glandular substance, dividing it into indistinct lobules (Fig. 2). Each lobule consisted of an aggregation of follicles, each follicle being surrounded by a basement membrane. The shapes of follicles were round, oval and irregular (tubular). However, the round and oval shapes predominated in the sections of the thyroid glands examined here. Three types of follicles were apparent; the large-, medium and small-sized follicles. Large follicles interspersed with medium-sized follicles were seen near the capsule and adipose tissue, while with few exceptions small-sized follicles were located towards the centre of the gland (Fig. 3). The small-sized follicles were lined by high, simple cuboidal epithelium (even low columnar in some follicles) (Fig. 4); the medium-sized follicles were equally lined by very low, simple cuboidal epithelium with flattened nuclei (Fig. 5), while the large-sized follicles had low, simple cuboidal, and even squamous, epithelium in some very large follicles (Fig. 6). Some of the follicles displayed a retraction of the colloid from the follicular wall or distortion due to the preparation for histology. The thyroid gland also consisted of a thin network of interfollicular connective tissue made of reticular fibres and blood capillaries and surrounding each follicle. Equally present in all the sizes of follicles were parafollicular cells (C cells), which were larger, oval and exhibited a cytoplasm that was more lightly stained than that of the follicular cells. These cells were located in the interfollicular stroma and few in the follicular epithelium. Follicles of all sizes and shapes contained variable quantities of eosinophilic colloid in the intrafollicular spaces. Some follicles were filled up with colloid; some contained only small amount, and a few were completely devoid of the substance. The large- and medium-sized follicles showed a small number of inconspicuous peripheral vacuoles, while the small follicles were filled with many peripheral colloid vacuoles that were highly visible in the colloid material.

The small-sized follicles predominated in all the tissue sections examined. The mean diameter of the small round follicles was 96.001 ± 0.03 µm, and that of the medium round follicles measured 180.18 ± 0.07 µm, while that of the large round follicles was 240.01 ± 0.08 µm. The epithelial cell heights of the small, medium and large-sized follicles were 7.52 ± 0.05 µm, 7.31 ± 0.01 µm and 7.12 ± 0.06 µm respectively.

Discussion

The two lobes of the thyroid were symmetrically positioned in the grasscutter, but some authors, such as Venzke (1975), McDonald and Pineda (1989), have reported asymmetry in the positioning of the thyroid lobes only in certain adult animals: e.g., equines, cattle, dogs and sheep. Hajóvská (2002) found smooth asymmetry of the left lobes in the cranial direction in all foetuses in the period from the 32nd to the 36th day of embryonic development of the thyroid in sheep. In our study we failed to observe a glandular isthmus connecting the two thyroid lobes, but in the horse the thyroid is connected by an insubstantial isthmus; in the cattle the isthmus is a broad parenchymal tissue, while in small ruminants it is inconstant, and when present is merely connective tissue (Dyce et al., 2002; Hajóvská, 2002). In the rat and the mouse, an isthmus is present and located at the caudal end of the lobes (Ingbar, 1985).

In our study, the two thyroid lobes had a mean weight of 0.23 ± 0.02 g and a relative thyroid weight (thyroid weight/body weight) of 0.03 ± 0.01 g/kg. In the adult dog, the thyroid weight is about 1 g (Capen and Martin, 2003). The relative thyroid weight is about 0.07-0.24 g/ kg in eutherian mammals and 0.03-0.1g /kg in other marsupials (Lawson and Carrick, 1998). The ratio of total thyroid weight to body weight (relative thyroid weight) in the elephant seal is 0.175± 0.018 g/kg. Thyroid weight varies between domestic and wild animals and it depends on the size and weight of the animal. Little (1991) showed that there was no significant change in total thyroid weight with increasing age in the pups of newborn elephant seals (*Mirounga leonina*) during the first 20 days of life. Thyroid weight has also been shown to bear a linear relationship to body weight in seals from the mid-foetal period to 8 months after birth.

Each thyroid lobe measured 1.50 ± 0.06 cm in mean length, 0.61 ± 0.05 cm in width (short axis), and 0.42 ± 0.02 cm in thickness (height). The values for the dog are 3 cm in length and 7 mm at their greatest width; for the pig 5-6 cm in length and a weight of about 5 g in the adult (Venzke, 1975). In the horse the values are 5.0 cm in length, 1.5-2.0 cm at its greatest width and 2.7 cm in height (thickness) (Venzke, 1975).

The general histological features of the thyroid glands of the grasscutter were similar to those of other mammals (Norris, 1985; Abdel-Magied et al., 2000). The histological sections also revealed that the shape and size of the profiles of the follicles is not homogenous, since large follicles were usually found in the peripheral and small ones were located centrally. This is in agreement with the report of Hartoft-Nielsen et al. (2005) in several mammals. This observation in the grasscutter is in contrast to the arrangement reported by Sanap et al. (1998) in cattle and Baishya et al. (1986) in Assam barbari goats. In addition, we observed some adipose tissue in the capsular layer, close to the large follicles. Tomonari (1959) and Mathur (1971) reported that in the cow, pig, dog, buffalo, rabbit and guinea pig, large follicles had a flattened epithelium, whereas small ones had columnar epithelial cells. The present observations are in agreement with these findings. The mean diameter of the differently-sized follicles in our results is in agreement with the range of 20-500 µm for follicle diameter reported for other mammals (Banks, 1993). Variations in follicular size and epithelial height in the grasscutter are in agreement with those seen in humans and other mammals (Gould et al., 1985; Abdel-Magied et al., 2000; Kausar and Shahid, 2006). The presence of peripheral irregularities and vacuoles in the differently-sized follicles suggests thyroid activity; these were mostly present in the small follicles. In an inactive follicle, the periphery has a smooth profile and no vacuoles are present. The size of the follicles as well as their epithelial height is an indicator of follicular activity. Follicular activity is inversely proportional to the diameter of the follicle (Banks, 1993).

Few parafollicular cells (C cells) were observed in all sizes of follicles of the thyroid gland. In a study of the thyroid gland of the camel, Abdel-Magied et al. (2000) failed to observe parafollicular cells. Those authors concluded that this may be due to physiological regression of the gland. Our findings on the location of the C cells in the subfollicular position and in the follicular epithelium are in agreement with the observations made in the cow, buffalo and pig (Kameda, 1987).

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