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Structural organization of the thyroid gland and interrenal tissue with reference to endocrine parenchyma in short mackerel, *Rastrelliger brachysoma* (Bleeker, 1851)

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ABSTRACT

The first investigations of the thyroid gland and interrenal tissue with reference to the endocrine parenchyma of short mackerel *Rastrelliger brachysoma* were subjected to histological analysis. Specimens were collected during the fishing season (October to November 2013) from the Upper Gulf of Thailand. Under a light microscope, the thyroid gland of *R. brachysoma* was distinctly found located within the branchial region. Within this gland, it consists of several follicles among afferent brachial arteries. Each follicle exclusively contained a colloid that was surrounded by a simple, cuboidal, follicle epithelium. Histological study showed that the localization of interrenal tissue was in the anterior kidney. This tissue was composed of two parts based on the structural compositions and cell types; (i) the stromal compartment was constituted of various interrenal cells and (ii) the interstitial compartment contained the connective tissue, leucocytes and blood sinuses, with reference to the lymphatic tissue.

Introduction

The structural and histological organization of the endocrine parenchyma of fish have been exclusively reported including the pituitary gland, urophysis, endocrine pancreas, corpuscles of Stannius, thyroid gland and interrenal tissue. All of these organs are very important because they are associated with the maintenance of a steady physiological state or homeostasis (Genten et al., 2008).

Among the endocrine parenchyma, the structure of the thyroid gland in a teleost has been described and it is considered as the largest endocrine organ (Genten et al., 2008). It is similar to a tetrapod (Genten et al., 2008). Its localization in several fish can be found in the branchial region of the head (Genten et al., 2008). Under a light microscope, the thyroid gland consists of numerous follicles surrounding the ventral aorta and the afferent branchial arteries. Each follicle is made up of a simple, cuboidal epithelium with an oval nucleus surrounded by the basophilic cytoplasm. These characterizations, as mentioned above, have been extracted and investigated in a variety of fish species including *Epinephelus aeneus* (Abbas et al., 2012), *Garra congoensis*, *Scyliorhinus canicula* and *Parachanna obscura* (Genten et al., 2008) and *Channa gachua* (Misra, 1990). Within another endocrine organ in the anterior part of kidney, the interrenal tissue was found containing several interrenal cells. These cells are histologically arranged as a cord among the blood vessels. Many observations indicated that the function of these cells is to directly secrete corticosteroids, known as a stress hormone (Genten et al., 2008). Moreover, other investigations reported that it was also related to the regulation of carbohydrate and protein metabolism and osmoregulation in fish species (Jung et al., 1981; Takahashi et al., 2013).

Up-to-date information regarding the thyroid gland and interrenal tissue in short mackerel, *Rastrelliger brachysoma* (Bleeker, 1851) has not been reported, despite the fact that this marine fish is commercially important, particularly to commercial marine aquaculture in Thailand. Therefore, an understanding of the basic details of the structural organization of the thyroid gland and interrenal

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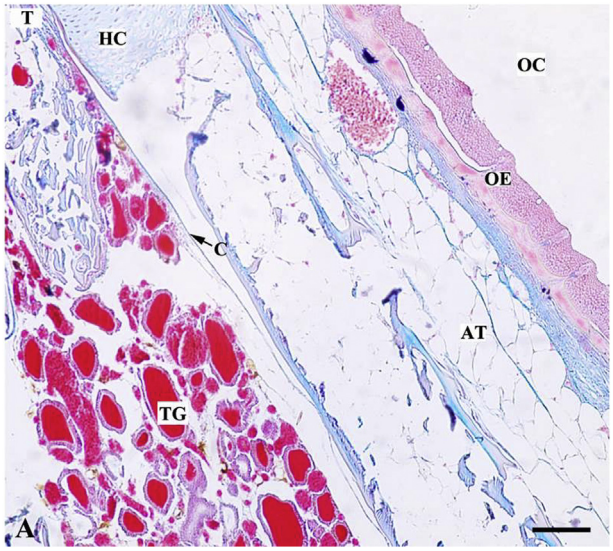

Fig. 1. Section through the branchial region: in this micrograph the thyroid gland (TG) can be seen and is surrounded by connective tissue (C). (AT = adipose tissue; HC = hyaline cartilage; OC = oral cavity; OE = oral epithelium; T = tongue). (Scale bar = 200 μm).

tissue of this species, using histological approaches, was a primary requirement prior to the investigation of the hormonal activities of the reproductive cycle in the future studies.

Materials and methods

Fish sampling

Live adult *R. brachysoma* (n = 10) samples were obtained during the fishing season (October to November 2013) using a bamboo strake trap in Samut Songkram province, Thailand in the Upper Gulf of Thailand (13°16′18.4″ N, 100°02′13.4″ E). The average standard length of all sampled fish was about 17.2 cm with a weight of approximately 70.8 g. The species identification was based on the identification key in Food and Agricultural Organization (1999).

Histological procedure

All fish were euthanized using the rapid cooling method (Wilson et al., 2009) and fixed in Davidson's fixative right after capture for 36–48 h. In each sample, the branchial regions and kidney were collected following the standard histological technique (Humason, 1979; Bancroft and Gamble, 2008). Paraffin blocks

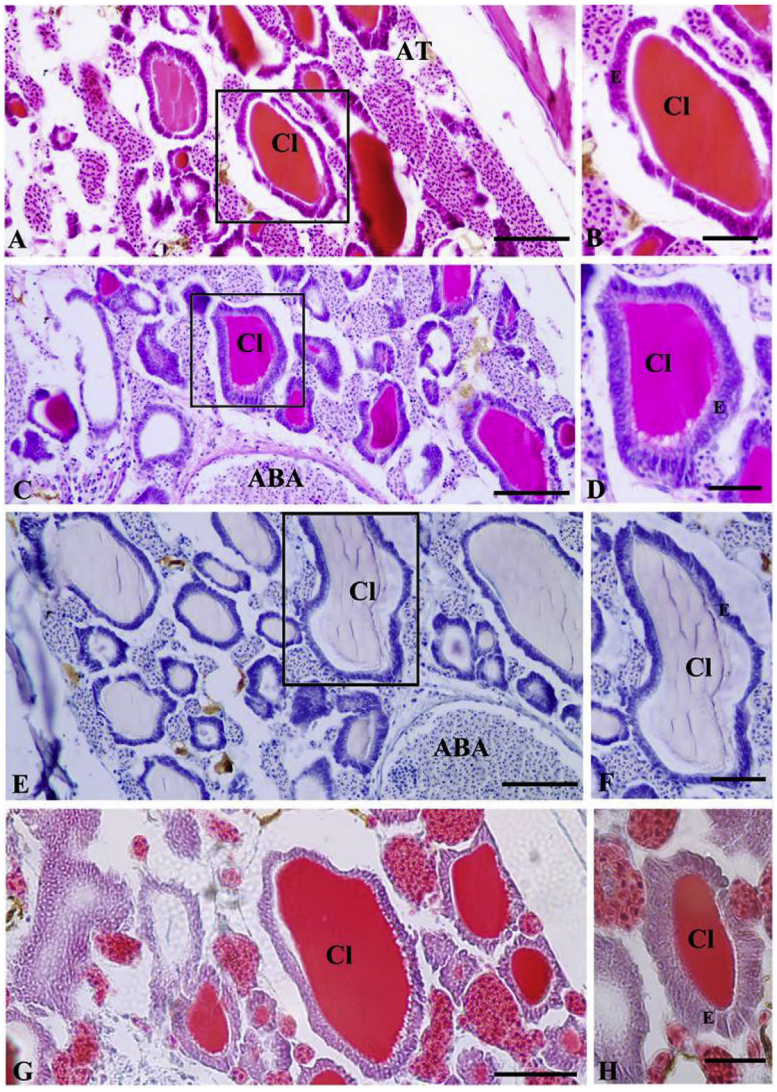

Fig. 2. Section through the thyroid gland containing several follicles (A–H): in this micrograph of a follicle, the surrounding simple, cuboidal epithelium (E) can be seen. It also contains the colloid (Cl). (ABA = afferent bronchial arteries; AT = adipose tissue). (Scale bars A,C,E,G = 100 μm; B,D,F,H = 20 μm; A,B, H&E; C,D, PAS; E,F, AB; G,H).

were cut at 5–6 μm thickness using a rotary microtome and stained with Harris's hematoxylin and eosin (H&E) for histology and Masson's trichrome (MT), periodic acid-Schiff (PAS) and aniline blue pH 2.5 (AB) for histochemistry (Humason, 1979; Bancroft and Gamble, 2008). The structures and details of the thyroid gland and interrenal tissue were determined under a light microscope.

Results and discussion

Histology and histochemistry of thyroid gland

The structural organization of the thyroid gland of *R. brachysoma* was observed in the branchial region. Histologically, a dense irregular connective tissue capsule covered the thyroid gland (Fig. 1A). This gland was generally not a compact gland, but it was obviously scatted, as shown by the follicles being located surrounding the ventral aorta and afferent branchial arteries (Fig. 2A); this is similar to those found in other teleosts (Genten et al., 2008). At higher magnification, the thyroid gland's follicle of this species was lined by simple, cuboidal, follicular epithelial cells. It is well known that the changing of the epithelium is generally correlated with reproductive status, as previously reported in some fish including *E. aeneus* (Abbas et al., 2012) and *C. gachua* (Misra, 1990). The changing of this epithelium starts from a cuboidal to a simple columnar epithelium during sexual maturation. Therefore, it is possible that all fish in this study were collected during the non-breeding season.

In detail, an oval nucleus surrounded by the basophilic cytoplasm was seen in the thyroid follicular epithelial cell. The layer of these cells was also surrounded by a mass of homogeneous substance in the central lumen, called the colloid (pinkish with H&E, Fig. 2B). Sage (1973) and Genten et al. (2008) reported that this mass contained two thyroid hormones—3,5,3-triiodothyronine and thyroxine together with precursors 3-monoiodotyrosine and 3,5-diiodotyrosine—in accordance with an observation in higher vertebrates (Menke et al., 2011). Moreover, the current histochemical studies of the colloid indicated that it positively reacted with PAS (Fig. 2C) and MT (Fig. 2H), indicating the presence of rich glycoprotein. This was similar to other fish species including *S. canicula* and *G. congoensis* (Genten et al., 2008) and other

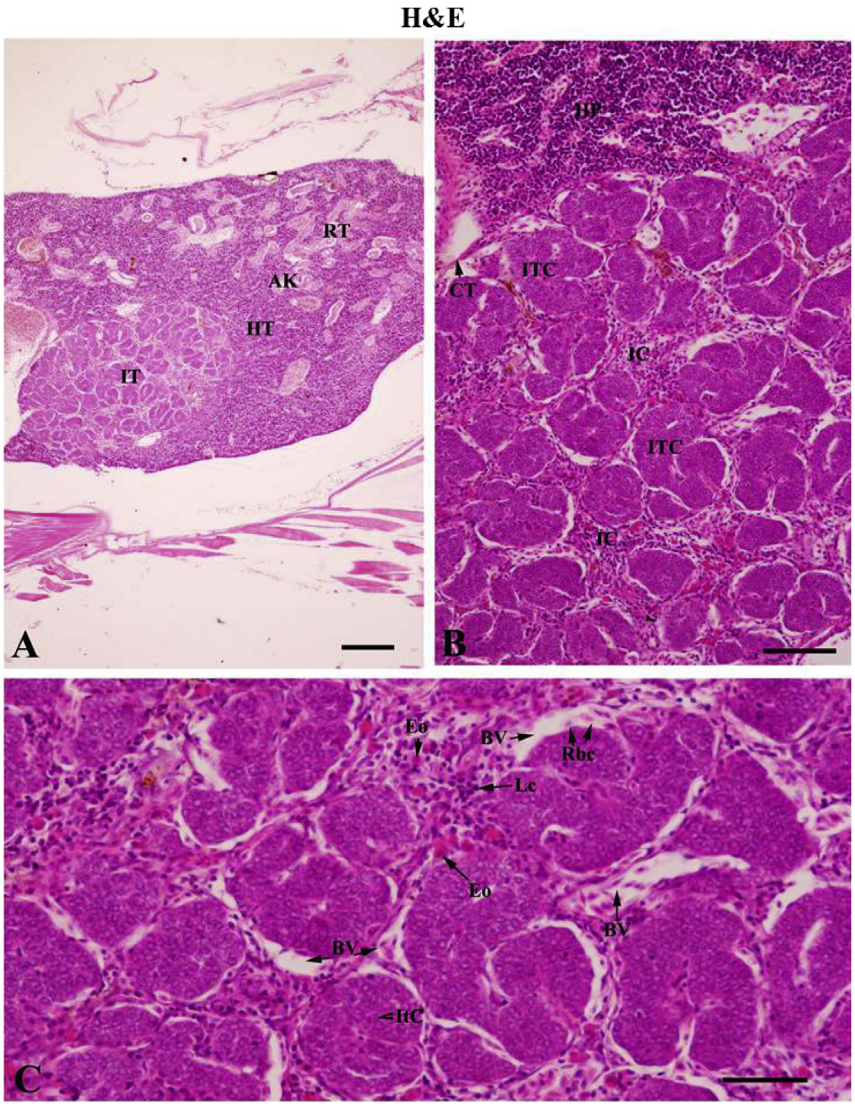

Fig. 3. Section through the anterior kidney (AK) containing the interrenal tissue (IT) (A–C). (BV = blood vessels; CT = connective tissue; Eo = eosinophil; HT = hematopoietic tissue; IC = interstitial compartment; ITC = interrenal tissue compartment; ItC = interrenal cell; cL = lymphocyte; Rbc = red blood cell; RT = renal tubules). (Scale bar A = 200 μm; B = 100 μm; C = 20 μm; H&E).

vertebrates, *Caiman latirostris* (Machado-Santos et al., 2013). However, the current observations also detected that it negatively reacted with AB, indicating that there is no acid mucopolysaccharide, similar to previous examination with another vertebrate, *C. latirostris* (Machado-Santos et al., 2013).

Histology of interrenal tissue

Localization of interrenal tissue was easily observed in the anterior kidney. This tissue was homologous to the adrenal cortex in mammals (Leatherland and Ferguson, 2006). The interrenal cell was embedded in the anterior kidney and separated from the hematopoietic tissue and renal tubules by a connective tissue capsule (Fig. 3A). The current study distinctly classified the interrenal tissue into two parts based on structural compositions and cell types: 1) interrenal tissue and 2) interstitial compartments (Fig. 3B). The interstitial compartment was found between interrenal tissues. It contained the connective tissue, leucocytes and blood sinuses, with reference to the lymphatic tissues. Among the lymphatic tissues mentioned above, several leucocytes, including lymphocytes and eosinophils, were found in all samples. While the eosinophil of this fish had a large eccentric nucleus surrounded by eosinophilic cytoplasm, the lymphocyte contained a large concentric nucleus and cytoplasm at the periphery. The interrenal tissue compartment formed into islets among various interrenal cells. The irregular shape of each cell had a large prominent nucleus with one or two nucleoli. The characterization of its cytoplasm was eosinophilic stained (Fig. 3C). Recently, it was believed that the interrenal cell secreted the steroid material including 1α-hydroxycorticosterone and the major corticosteroids in fish (Janz, 2000; Genten et al., 2008). In addition, osmoregulation, protein metabolism, growth, regeneration and anti-inflammatory reactions have also been reported as related functions of this cell (Janz, 2000; Genten et al., 2008).

There has not been a report on the histological organization of the thyroid gland and interrenal tissue in *R. brachysoma*. Therefore, this study provides new information on the architecture of the thyroid gland and interrenal tissue of this species. Histologically, the architecture of the thyroid gland was clearly composed of several follicles, which were lined by simple, cuboidal, follicular epithelial cells. The thyroid gland was generally contained by a homogenous mass, referred to as the colloid. On the contrary, the interrenal tissue was composed of interrenal cells, which were arranged as islets. The relationship between activities of the follicular layer and the levels of its hormones and reproductive cycle as well as the relationship to functional control, adaptation and environmental condition effects will be examined in future studies.

Conflict of interest

There is no conflict of interest.

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