

Anterior Kidney of the Yellow Mystus, *Hemibagrus filamentus* (Fang and Chaux, 1949)

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Abstract

There is no available report on histological observation of the anterior kidney of the yellow mystus *Hemibagrus filamentus* (Fang and Chaux, 1949). Thus, the histology of the anterior kidney of specimens from the Tapee river, Chawang district, Nakhon Si Thammarat province, Thailand, was investigated under a light microscope in this study. The results revealed that the anterior kidney of *H. filamentus* consists of 3 distinct parts; pro, mid and hind anterior kidneys. Based upon different observations of the excretory portion and tissue types, this presented study is considered to be the first such report from Thailand. The pro-anterior kidney comprises of interregnal and exclusively hematopoietic tissues. The mid-anterior kidney is moderately composed of hematopoietic tissue and an increase of the melanomacrophage center (MMC) with renal tubules. The last part of is the anterior kidney, which contains mainly renal tubules with a lesser amount of interstitial hematopoietic, which an increase in the glomerulus.

Keywords: Anterior kidney, hematopoietic tissue, *Hemibagrus filamentus*, Nakhon Si Thammarat province, Thailand

Introduction

The microanatomical structure of the teleostean kidney was investigated by histological analysis, which is an accurate technique for determining feather tissue [1-4]. Generally, the structure of the kidney is divided into 2 distinct parts based upon the dominant tissue and cell types, called the anterior and posterior kidneys. The anterior kidney is exclusively composed of hematopoietic tissue, interregnal tissue, chromaffin, and adrenocortical endocrine cell types, with a few renal tubules contained in this distal anterior part. The posterior kidney exclusively composed of renal tubules, with a lesser amount of interstitial hematopoietic and lymphoid tissues; therefore, it functions as an osmoregulatory and excretory organ [1].

Hemibagrus filamentus is a commercially important in Thailand [5-7]. Up until now, only in the microstructure of the testicular tissue [8], esophagus and stomach [9] have been reported. The anterior kidney microstructure have not been histologically studied. Hence, the objective of this study was to describe the structure of anterior kidney of the yellow mystus, *H. filamentus*, using histological techniques. The knowledge of this tissue gained could be used as the basis of further biological applications.

Materials and methods

During the local fishing season in April 2012, specimens of mature fish ($n = 30$) were taken from the Tapee river, Chawang district, Nakhon Si Thammarat province, Thailand ($8^{\circ}28'10''$ N, $99^{\circ}29'45''$ E). All fish were euthanized by a rapid cooling technique [10]. The anterior kidneys were kept and immediately fixed in Davidson's fixative (about 24 - 36 h). After then, they were processed using standard histological techniques [11]. Sections at 5 - 6 μ m thick were cut and stained with Harris's haematoxylin and eosin (H&E). A histological structure of the anterior kidney was investigated under a light microscope (LM).

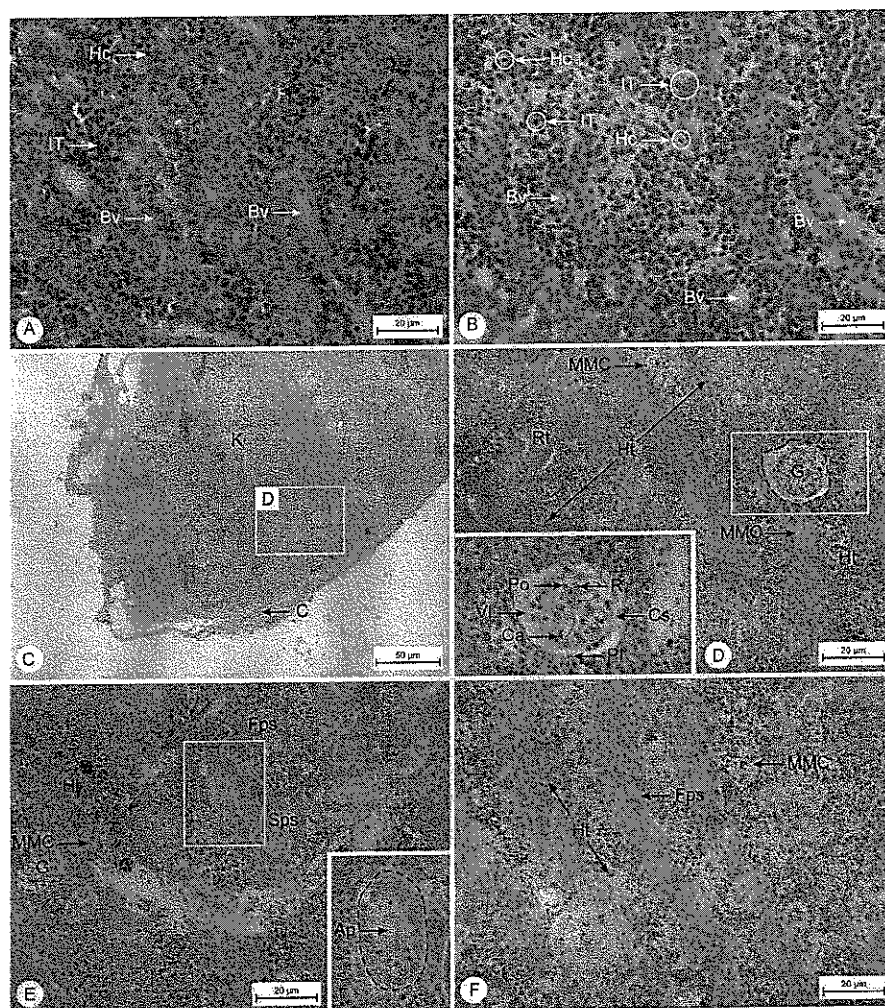


Figure 1 Micrograph of anterior kidney of *Hemibagrus filamentus*; (A-B) pro-anterior kidney, 20 μ m; (C-D) mid-anterior kidney, C = 50 μ m, D = 20 μ m; (E-F) hind-anterior kidney, 20 μ m. (H&E stain); Hc = haematopoietic tissue, IT = internal tissue, Bv = blood vessel, C = capsule, K = kidney, Rt = renal tubules, MMC = melanomacrophage center, G = glomerulus, Po = podocyte, Cp = capillary, Vl = visceral layer, R = red blood cell, Cs = capsular space, Pl = parietal layer, Fps = first proximal convoluted tubule segments, Sps = second proximal convoluted tubule segments, Ap = apical brush border.

Results and discussion

Histological structure of kidney

The anterior part of the kidney was surrounded by a capsule of a loose connective tissue and supported by smooth muscle. The parenchyma of each kidney consisted of complex hematopoietic tissue, interrenal tissue, leucocytes and renal tubules. No chromaffin cells were observed; however, it does not mean *H. filamentus* does not have this cell. Previous studies have mentioned that the major role of the anterior kidney was as a blood forming organ [2,3], like *Cyprinus carpio* and *Poecilia reticulata* [1]. In this current study, the anterior kidney can be divided into 3 parts, based on different histological structures, as follows;

Pro-anterior kidney (Figure 1A-B)

This part is composed of interrenal and exclusively hematopoietic tissues as a primary site for hematopoiesis, in close association with numerous blood vessels, as a renal portal vein [1]. No renal tubules were found. The morphology of the interrenal tissue was not very distinctive due to embedding in the hematopoietic parenchyma. They had rounded or oval shapes (1 - 2 μm) with small nuclei. The function of interrenal tissue is to synthesize and secrete cortisol, the major corticosteroid of teleost fish. Cortisol has a major role in physiologic response to physical and chemical stressors [12]. The interrenal cells contain numerous mitochondria with tubular cristae, and a well-developed and highly organized smooth endoplasmic reticulum (SER). The absence of lipid droplets contrasted markedly with the abundance of SER [13]. Whereas haematopoietic cell had small cells in size with basophilic cells compare to internal cells (Figure 1A-B). Mumford *et al.* (2007) [14] stated that the renal hematopoietic tissue, consisting of the blast or undifferentiated stem cells within reticuloendothelial tissue, was similar to that the bone marrow of mammalian biology. Ultrastructural observation by Abdel-Aziz *et al.* (2010) [15] mentioned that the erythropoiesis, granulopoiesis, lymphoplasmapoiesis and thrombopoiesis are contained within the anterior kidney.

Mid-anterior kidney (Figure 1C-D)

In this part, numerous melanomacrophage center (MMC) were mainly observed among moderate amount of interstitial hematopoietic tissue. The melanin pigments were observed as yellow brown granules. It has functional concerned immune responses in lower vertebrate including teleost fish e.g., *Sparus aurata* [1], differed from higher vertebrate no observed [12]. Hematopoietic tissue levels were gradually decreased when compared with the pro-anterior kidney. In contrast, renal corpuscles and tubules were increased. The renal corpuscle of *H. filamentus* is composed of glomerulus and Bowman's capsule, which has two layers; visceral and parietal layers. The visceral layer is a network of glomerular capillaries and podocytes. The epithelium is surrounded by a single layer of simple squamous epithelium, called the parietal layer. The space between the 2 layers of the renal corpuscle is called the capsular space. The renal tubule or urinary tubules showed 2 proximal convoluted tubule segments. The first segment of proximal convoluted tubules was a high simple columnar epithelium with a well-developing apical brush border. They had a spherical nucleus with a slightly eosinophilic cytoplasm. The second proximal convoluted tubule segment was surrounded by a low simple columnar epithelium. Their nucleus was oval in shape with less-apical brush border. Anderson and Mitchum (1974) [16] speculated that the role of this segment may be concerned with divalent-ions.

Hind-anterior kidney (Figure 1E-F)

The structure in this part contained mainly renal tubules with a lesser amount of interstitial hematopoietic, where the glomerulus was gradually increased.

Conclusions

The anterior kidney of *H. filamentus* consisted of 3 distinct parts; pro, mid and hind anterior kidney, based upon different observations of the excretory portion and tissue types; what is presented here is

considered to be the first report on this matter in Thailand. The pro-anterior kidney consisted of interregal tissue and exclusively hematopoietic tissue. The mid-anterior kidney composed of hematopoietic tissue with increasing MMC and renal tubules. The anterior kidney contained mainly renal tubules with a lesser amount of interstitial hematopoietic, where the renal tubules and glomerulus were gradually increased.

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References

- [1] F Genten, E Terwinghe and A Danguy. *Atlas of Fish Histology*. Science Publishers Enfield, NH: USA, 2008.
- [2] J Boomker. The haemocytology and histology of the haemopoietic organs of *Clarias gariepinus* and *Sarotherodon mossambicus*. *J. Vet. Res.* 1979; **46**, 217-22.
- [3] J Boomker. The haemocytology and histology of the haemopoietic organs of South African freshwater fish. III. The leucocytes, plasma cells and macrophages of *Clarias gariepinus* and *Sarotherodon mossambicus*. *J. Vet. Res.* 1981; **48**, 185-93.
- [4] H El-Saydah, BS Abdel, A Suzan and FF Tamer, ES Ali. Haemopoiesis in the head kidney of tilapia, *Oreochromis niloticus* (Teleostei: Cichlidae): a morphological (optical and ultrastructural) study. *Fish. Physiol. Biochem.* 2010; **36**, 323-36.
- [5] T Amornsakun, S Chiayvareesajja and AB Hassan. Starvation and initial delay of feeding on larval green catfish, *Mystus nemurus* (Cuv. & Val.). *Songklanakarin J. Sci. Technol.* 1996; **18**, 443-6.
- [6] T Amornsakun, AB Hassan, AB Ambak and S Chiayvareesajja. The culture of green catfish, *Mystus nemurus* (Cuv. & Val.). I: Feed and feeding scheme of larvae and juveniles. *Songklanakarin J. Sci. Technol.* 1998; **20**, 379-84.
- [7] Inland Fisheries Division. *Hemibagrus filamentus* (Fang and Chaux, 1949). National Inland Fisheries Institute, Department of Fisheries, Ministry of Agriculture, Bangkok, 1895.
- [8] K Intarit. 2006, A study on the morphofunction of the male reproductive organ in the green catfish, *Mystus nemurus* (Cuv. & Val) (Teleostei: Bagridae), M. Sc. Dissertation. Prince of Songkla University, Songkhla, Thailand.
- [9] S Senarat, J Kettratad, P Poolprasert and W Yenchum. Histological structure of the esophagus and stomach in yellow mystus, *Hemibagrus filamentus* (Fang and Chaux, 1949). *Thammasat Int. J. Sci. Tech.* (in press).
- [10] JM Wilson, RM Bunte and AJ Carty. Evaluation of rapid cooling and tricaine methanesulfonate (MS222) as methods of euthanasia in zebrafish (*Danio rerio*). *Am. Assoc. Lab. Ani. Sci.* 2009; **48**, 785-9.
- [11] JD Bancroft and M Gamble. *Theory and practice of histological techniques*. Churchill Livingstone, London, 2002.
- [12] A Hontela. Interrenal dysfunction in fish from contaminated sites: *in vivo* and *in vitro* assessment. *Environ. Toxicol. Chem.* 1998; **17**, 44-8.
- [13] B Jung, M Moritz and J Berchtold. Fine structure and function of interrenal (adrenocortical) cells of dexamethasone-treated trout (*Salmo fario* L.). *Cell Tissue Res.* 1981; **214**, 641-9.
- [14] S Mumford, J Heidel, J Smith, J Morrison, C MacConbell and V Blazer. *Fish Histology and Histopathology*. National Conservation Training. 2007.
- [15] EH Abdel-Aziz, BBS Abdu, TE Ali and HF Fouad. Haemopoiesis in the head kidney of tilapia, *Oreochromis niloticus* (Teleostei: Cichlidae): a morphological (optical and ultrastructural) study. *Fish. Physiol. Biochem.* 2010; **36**, 323-36.
- [16] BG Anderson and DL Mitchum. *Atlas of Trout Histology*. Wycming Game and Fish Commission Bulletin. 1974.