

A Histological Study on the Nephrons in *Rutilus frisii kutum* of Caspian Sea

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Abstract

Rutilus frisii kutum is a cyprinid fish, distributing along the Caspian Sea, from Atrak River (Turkmenistan) to Kura River (Azerbaijan). This fish is one of the commercially important fishes in the south of the Caspian Sea. This species is normally a medium-sized fish, typically reaching 45-70 cm in length, weighing up to 5 kg. The kidney of the vertebrate is the main organ which balances the body fluid homeostasis. A histological study was carried out on the nephron of *Rutilus frisii kutum* for the first time. A total number of ten adult fish from the southern Caspian Sea fishing region were subjected to this investigation. The kidneys were removed and immediately fixed in 10% buffered formalin for 24 hours. Then, they were transferred into the tissue processor. Paraffin blocks were made and thin sections of five microns were cut. The sections were subjected to staining by Haematoxylin & Eosin. They were studied under the light microscope and photomicrographs were taken. The different parts of nephron were renal corpuscles, two types of proximal convoluted tubules, an intermediate segment and collecting ducts. There were no evidence for distal convoluted tubules and henle loops.

Keywords: Histology; Kidney; Nephron; *Rutilus Frisii Kutum*

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1. Introduction

Fish protein provides about 20 percents of animal protein needs of human being and has a special importance due to high levels of necessary amino acids and mineral elements such as calcium, phosphorus and iodine. Mahisefid (*Rutilus frisii kutum*) is a cyprinid fish, distributing along the Caspian Sea, from Atrak River (Turkmenistan) to Kura River (Azerbaijan). It is typically a medium sized fish, reaching 45–55 cm in length, rarely 70 cm, and weighing up to 4.00 kg, rarely 5.00 kg (Figure 1).



Figure1. *Rutilus frisii kutum*.

In March and April, *Rutilus frisii kutum* species migrate from Iranian waters (southern part of Caspian Sea) into estuaries and rivers for spawning. This species has a life span of 9-10 years in southern part of Caspian Sea with males and females attaining sexual maturity between 2-3 and 3-4 years, respectively [1]. This fish is one of the

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commercially important fishes in the south of the Caspian Sea [2]. It used to be very common and was harvested commercially. Iranian fish hatcheries release more than 200 million fingerlings every year to improve the stocks [3]. The total catch of Mahisefid in Iran ranges from 10,000 to 18,000 tons per year [4]. The population seems to have collapsed due to over exploitation and marine pollution.

In different groups of fishes (Elasmobranchii, Acipenseridae, Teleostei), the adaptation to freshwater or seawater environment may lead to diverse changes of nephron structure. The kidneys of euryhaline teleosts capable of living in fresh water may be aglomerular, as are those of some marine fishes. In contrast, the diameter of glomeruli in some marine fishes is larger than in true freshwater fishes [5]. In teleostei, kidneys are mesonephric form which are dark brown and extend longitudinally against the ventral aspect of vertebral column.

In chondrostei and teleostei a clear zonation is not apparent. However renal structures apparently are not distributed at random. Frequently, the glomeruli are located in the vicinity of the collecting duct system even though a close contact point between the distal segment and the vascular pole is lacking in the differentiated nephron. Because the teleost kidney is presumably phylogenetically younger than the zonate kidney of the ancient Polypetridae, the lack of the zonation and the lack of contact points, as well as the disappearance of nephron segments in the advanced fishes, clearly give evidence of regressive processes in the evolutionary line leading to modern teleosts [6].

This study is performed due to the important role and function of kidneys in fishes.

2. Methodology

This histological study was carried out on the nephrons of *Rutilus frisii kutum* for the first time. A total number of ten adult fish from the southern Caspian Sea fishing region were subjected to this investigation. The kidneys were removed and immediately fixed in 10% buffered formalin for 24 hours. Then, they were transferred into the tissue processor. Paraffin blocks were made and thin sections of five microns were cut. The sections were subjected to staining by Haematoxylin & Eosin. They were studied under the light microscope and photomicrographs were taken.

3. Results

The kidney of *Rutilus frisii kutum* is located in a retroperitoneal portion against the ventral aspect of vertebral column. It is dark brown extending through out the length of the body cavity. A smooth connective tissue called renal capsule surrounds the kidneys. In Caspian Sea *Rutilus frisii kutum*, cortex, medulla and lobulation are not present and kidneys are divided into two portions: anterior (head of kidney) and posterior (excretory kidney). The head of kidney is an important haematopoietic organ and has morphological similarities with the bone marrow in higher vertebrates. All development stages of lymphoid cells are present within the haematopoietic tissue. Excretory kidney is composed of nephrons that are typically small and consists of renal corpuscles and renal tubules. Renal corpuscle includes glomerulus and Bowman's capsule. Transitional cells are dense masses lies on the surface of glomerular capillaries and have a dark nucleus and a limited cytoplasm. Bowman's capsule has two layers. Parietal layer (Outermost layer) is formed from simple squamous epithelial cells and the visceral layer (innermost layer) called podocytes in *Rutilus frisii kutum*. There are juxtaglomerular cells in the afferent artery wall which secretes rennin (Figure2).

Renal tubule includes two proximal convoluted segments, an intermediate segment (between the first & the second proximal segment) and the collecting tubules system. The first and second proximal convoluted segments are established consequently by eosinophilic cuboidal epithelial and simple columnar epithelial cells which bear a brush border and have a conspicuous apical cytoplasmic rim containing few cell organelles, ciliated cell, mucous cells and dark cells (Figure3).

Intermediate segment is similar to the proximal convoluted segment and is established by short cuboidal epithelial cells which bear brush border (Figure4).

In addition to the head of the kidney, this layer acts as a haematopoietic tissue with a notable reticular tissue and blood vessels. Collecting tubules are formed from cuboidal to columnar epithelial cells which are characterized by division of their cytoplasm into a dark apical half and a light basal half.

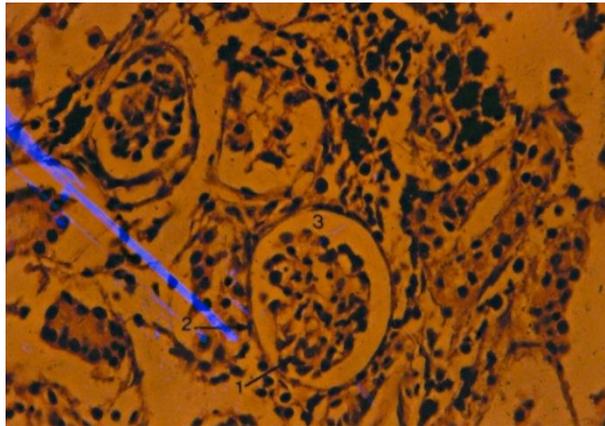


Figure 2. Renal corpuscle (H&E ×560). 1-Visceral layer, 2-Parietal layer, 3-Bowman's space.

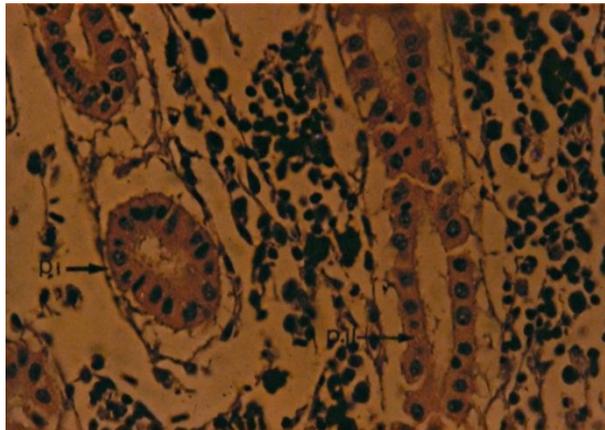


Figure 3. Renal tubules (H&E ×560). PI: Proximal convoluted segment type I. PII: Proximal convoluted segment type II.

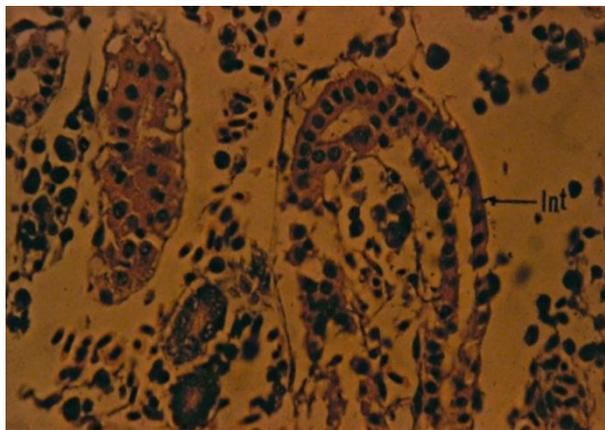


Figure 4. Renal tubules (H&E ×560). Int: Intermediate segment.

4. Discussion and Conclusion

The kidney of the vertebrate is the main organ which balances the body fluid homeostasis [7]. In fish kidneys receive majority of postbranchial blood and renal lesions may be expected to be good indicators of environmental stresses [8] (Kurtovic et al., 2008). Haematopoiesis, phagocytosis, hormones secretion and excreting the end-products of body metabolism are performed by

kidneys [9]. Fresh water fishes absorb minerals and excrete excessive water mostly by kidneys in order to maintain the osmotic balance [10].

The morphology of kidney in fishes varies [11]. The kidney of species (*H. Huso*, *A. persicus*) is paired and slender which is elongated from the anterior to caudal part along the spinal cord that resembles with Silver sea bream (*Sparus sarba*) [12] and Killfish (*Fundulus heteroclitus*) [13], but the kidney of trout is a long couple with massive body [14]. The

kidney of *Rutilus frisii kutum* is located in a retroperitoneal portion against the ventral aspect of vertebral column. The kidney of Cyprinids has a homogene structure and there is not any distinction between the head and caudal part. Therefore, the anterior and posterior part may not be distinguished. The kidney is composed of anterior, which consists of hematopoietic tissue without any renal tubules and glomeruli and the posterior, which contains of hematopoietic tissue and excretory parts like in Perciformes and Sturgeons [15]. The kidney consists of nephrons, which are functional and structural units [16]. Glomerular structure in the fish is similar to mammals. Bowman's capsule and juxtaglomerular apparatus are present in fishes. Proximal convoluted tubules are characterized according to their epithelial cells that are cuboidal or columnar with brush border and eosinophilic cytoplasm [17,18]. Renal tubules in *Rutilus frisii kutum* have no Henle loop compared to the mammals and no distal convoluted tubules compared to the freshwater fishes.

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