Anatomy and Histology of the Liver of *Etroplus maculatus* (Bloch)

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Abstract- The liver is the key organ notable for its sensitivity to a great variety of environmental factors. It is a reddish brown organ and are trilobed and the right lobe bear the gall bladder. It is composed of a parenchyma covered by a thin capsule of connective tissue. It is divided into irregular lobules by the exocrine pancrease or hepatopancrease, associated to connective tissue. The distinctive histological feature of the liver is the exocrine pancreatic tissue surrounding the portal vein. In addition to these structural components, hematopoietic tissue and melanomacrophage centers (MMCs) occur in hepatic parenchyma. The hepatocytes are polygonal with centrally placed nuclei. The hepatocytes are radially arranged in cords around a central sinusoids. The portal triads are absent. Bile ducts are found in association with the exocrine pancreatic tissue surrounding the portal veins. The hepaocytes are radially arranged in cords around a central sinusoid. The liver anatomy and histology of *Etroplus maculatus* is similar to that of many other teleosts including fresh water and brackish water. The aim of the present work was carried out the normal anatomy and histological analysis of the liver of *E.maculatus*, one of the most common food fishes of Kerala by light microscopy.

Index Terms- liver, anatomy, histology, cichlids

I. INTRODUCTION

The liver is the “master gland” in vertebrates that controls and coordinates the majority of metabolic activites.The fish liver is a multifunctional organ that has an important role in detoxification, production of vitellogenin as well as the deposition and metabolism of carbohydrates and fat[1,2,3,4,5].The basic structural and functional unit of the liver is the acinus,which consists of hepatic lobules and portal triad(also called Glisson’s sheath [2,6].The hepatic lobules are the functional units of the liver[2,5,6]The sinusoids are capillary networks which are localized in the spaces between hepatic plates[2,5,6].The liver synthesizes bile which eventually empty into the gall bladder[2,5].In most teleost fish, the liver is divided into lobes located cranially and ventrally in the body cavity with a reddish-brown colour[7].The liver is surrounded by a thin capsule of connective tissue, the Glisson capsule, dividing the parenchyma into lobules and lobuli. The liver receives blood through both portal vein and hepatic artery. Most of its blood comes from the portal vein that conveys blood containing nutrients absorbed in the intestine.

In most teleost fish, the liver is divided into lobes located cranially and ventrally in the body cavity with a reddish-brown colour[3,7].Its size, shape and volume are adapted to the space available between other visceral organs[8].The head kidney, liver and spleen in some teleosts may present aggregates of macrophages called melanomacrophage centres(MMC).The MMCs are histologically distinguishable within the tissue for presenting macrophages with distint pigments such as melanin,hemosiderin and lipofucins[9,10,11].The analysis and quantification of granules can be a great indicator of the main metabolic activities by macrophages from MMCs[9,10,11].Moreover,presence,number and area of MMCs have been used as biological parameters in toxicology and environmental impact studies[9,11,12,13]The liver has two types of irrigation: one constituted by the hepatic artery, which provides arterial blood to the gland and the other derived from the portal vein, carrying blood from the oesophagic and gastro intestinal tracts, from spleen and pancreas [14].

The species of *E. maculatus* belongs to the family cichlidae, and the genus *Etroplus* is the most common and diverse. Due to the wild distribution, this species become economically important. It is used as a food and also an aquarium fish. Thus, this work aims to understand the anatomical structure and the normal histology of *E.maculatus* by the description of hepatocytes, sinusoids, melanomacrophages, blood vessels and exocrine pancreatic tissues.

II. MATERIALS AND METHODS

Specimens of *Etroplus maculatus* were collected from different parts of Kuttanad, Alleppy District; Kerala State. Fifteen specimens of *E.maculatus* were collected alive by using a net. Their length ranged from 40 to 80mm.The fishes were carried immediately to the laboratory, where they were stunned by a sharp blow on the head and the liver tissues were removed. For the histological study the liver tissues were fixed in Bouin'fixative during 24 hours. The organ was dehydrated with a series of alcohol and embedded in paraffin, cut in 5µm thick sections. The sections were stained primarily with with hematoxylin and alcoholic eosin (H & E).Stained sections were studied under a compound research microscope and photographs were made using photomicrography system.

III. RESULTS

In *Etroplus maculatus*, the liver is a dense reddish brown organ located ventrally in the cranial region of the body cavity. It is trilobed and united anteriorily.The right and left lobes are wing-shaped and equal in size and the middle lobe is conical and elongated (Fig.1). The right lobe bears the gall bladder which is tubular and bright green in colour with bile fluid.

The liver is encased in a fibrous connective tissue capsule. The hepatic parenchyma is made up of bicellular plates surrounded by sinusoids (Fig.2, A). Each plate shows polarized hepatocytes with a sinusoidal face for absorption and a biliary face for excretion. The parenchyma is very homogeneous and the hepatocytes are polygonal cells with spherical, centrally placed nuclei. Hepatocytes exhibit histological variability depending on the amount of stored fat and glycogen reserves in them. The hepatocytes appear condensed with eccentrically positioned nuclei (towards the nearest sinusoidal space), when they contain large quantities of fat and many glycogen granules. Between two adjacent sinusoids, the hepatocytes are arranged as cords usually two cells thick, but branching and anastomosing of cords can result in four or more layers. The parenchyma is not divided into distinct hexagonal lobules and hence there is no distinct interlobular connective tissue stroma.The true triads constituted by the ramification of the portal vein, the hepatic artery and biliary duct are absent.

The distinctive histological feature of the liver is the exocrine pancreatic tissue surrounding the portal veins (Fig.2, B). The periportal pancreatic tissue forms a compound tubuloacinar gland that lie within a well vascularised, thin, fibrous connective tissue stroma.The pancreatic tissue can be distinguished from the hepatic tissue by its acinar arrangement and its characteristic staining with hematoxylin and eosin. (The acinar cells have basophilic basal pole and cytoplasm rich in eosinpophilic zymogen granules).

Blood is carried into the liver by the hepatic portal vein entering the posterior side of the liver and the hepatic artery. Blood flows through the branches of these two vessels into the sinusoids in the liver parenchyma. From the sinusoids the blood flows into the central veins, which empty into the hepatic vein leaving the liver at its anterior aspect.Communicatation between hepatic arteries and veins and also between portal and hepatic veins is ensured by a capillary network of sinusoids. These sinusoids are radially disposed around the hepatic veins and are constituted by a simple squamous endothelium without basal lamina.

Branches of hepatic portal vein (Fig.2, C) are found randomly throughout the hepatic parenchyma. The portal venules are differentiated from the hepatic venules by a higher amount of periadventitial connective tissue in the former and by the absence of blood cells in the portal venules. Hepatic arteries are found associated within the hepatic parenchyma and they differ from the veins by their narrow lumen, thick wall with more elastic fibres and endothelial cells that are more voluminous than in veins.

Bile ducts (Fig.2, E) are found in association with the exocrine pancreatic tissue surrounding the portal veins. In addition to these structural components, hematopoietic tissue and melanomacrophage centers (MMCs)(Fig.2, D) occur in the hepatic parenchyma.Melanomacrophage centers are usually located in the vicinity of the hepatic arteries, portal veins or bile ducts. They concentrate heterogenous materials that play a role in neutralizing potentially toxic free radicals and cations produced during per oxidation of unsaturated lipids.

Figure 1.**Anatomy of the liver of *Etroplus maculatus* ,showing three lobes**

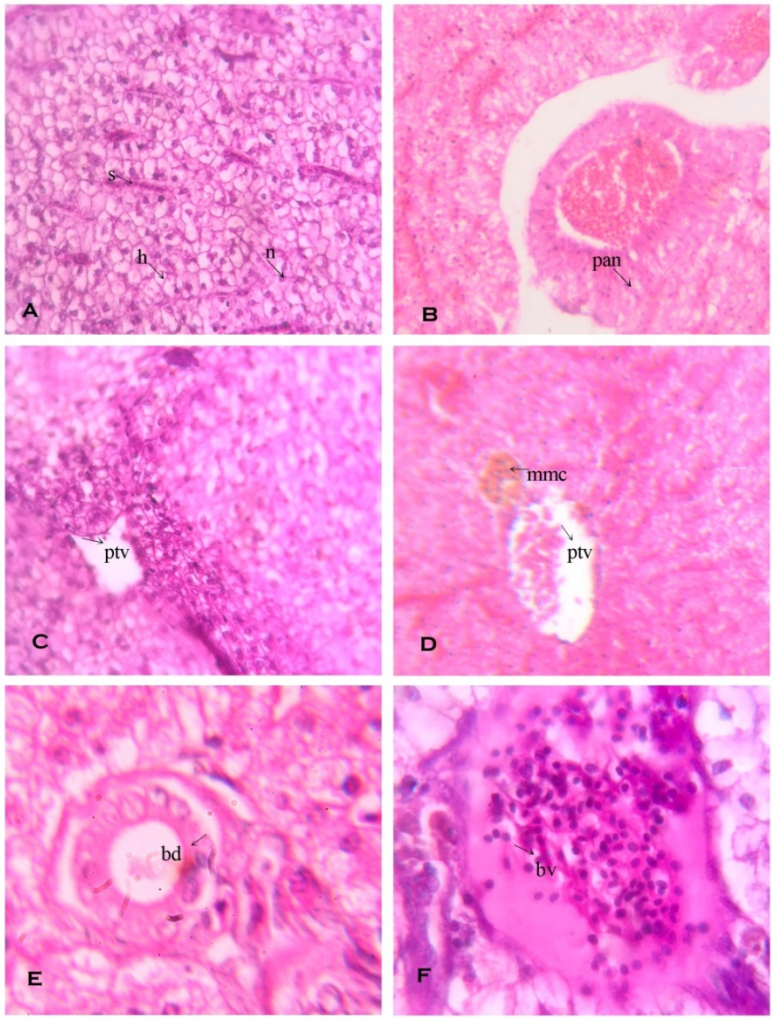

Figure.2 Histological sections of liver of *Etroplus maculatus*, by light microscopy, A. showing the nucleus (n) of hepatocytes (h,) sinusoids(S)(40X), B.exocrine pancreatic tissue (pan)940X), C.portal vein(ptv)(40X), D. melanomacrophage centre (mmc)(40X) ,E. bile duct (bd)(40X), F. blood vessels(bv).

IV. DISCUSSION

This paper describes for the first time the normal anatomy and histology of the liver of *Etroplus maculatus.* The liver is a key organ that controls many life functions and plays a prominent role in the physiology of vertebrates. The liver plays a vital role in various metabolic activities and the liver is an important organ for the analysis of fish diseases [15, 16].Fishes being poikilothermic their liver is a target organ for many biological and environmental factors that alter its structure and metabolism. In fish, liver is a digestive organ of endodermic origin and it belongs to the 'lower vertebrate category [17].The anatomical location of the liver was similar to other species [7], however the shape and number of hepatic lobes are variable. Teleosts do not have a defined hepatic lobe number and shape [18].Thus, it adapts to the size and shape of this cavity and the space used by other visceral organs.

In *E.maculatus*, the liver is a dense, reddish brown organ. The colour is due to the rich vascularisation. However, when fat storage is high, the colour tends towards yellow; yellow coloured liver has been reported in *Anguilla Anguilla, Dicentrarchus labrax* and *Sparus aurata* fed on artificial food[19].The liver of *G.brasiliensis* was yellow-brown,*H.aff.malabaricus* was reddish –brown and *H.francisci* was dark –yellow colour. Moreover, the liver can differ in weight, size and volume according to body weight and length of each animal. The liver of *Geophagus brasiliensis* was yellow-brown, *Hoplias* aff. *malabaricus* was reddish-brown and *Hypostomus francisci* was dark-yellow colour, believe that variation in liver colour may be related to different dietary habits. In fact, adult individuals of *G. brasiliensis* are omnivores, *H. franscisci* are detritivorous and *H.* aff. *Malabaricus* are piscivores [20, 21]. There are other factors associated with liver colour such as health conditions, vascularization and hepatocyte content [7].

In chondreichtyes and Dipnoi, there are only two lobes, mainly reported in, Oreochromis *niloticus* [8], *Hemisorubim platyrhynchos*[18]. But in some teleost species such as *Oncorhynchus mykiss*[22],*Micropogon undulates*[23],*Salmo gairdneri*[24],*Liza spp*.[25],*Lutjanus bohar[*25] and *Serranus cabrilla*[26],the liver is not lobulated.In *E.maculatus* , the liver is a dense, reddish brown organ located ventrally. It is trilobed: the right and left lobes is wing – shaped and equal in size and the middle lobe is conical and elongated and extends up to posterior most tip of the stomach.

In *E.maculatus*, the hepatic parenchyma is homogeneous and is made of bicellular plates (dual plated laminae) surrounded by sinusoids. The hepatocytes are polarized and this'muralium duplex' is different from that described by [23] in *Micropogon* undulates where muralium is restricted to only one cellular plate. In the lower teleosts (Salmonidae: *Oncorhynchus mykiss*, [24];Salmo salar, [27], the liver works like an anastomosed tubular gland in which four to nine hepatocytes surround a bile duct. But in higher teleost (Serranidae: Serranus cabrilla, [26] a similar numbers of hepatocytes surround each sinusoid.

In teleosts, the pancreatic exocrine tissue develops around the portal vein during ontogenesis[8] .Various authors have been reported that the pancreatic tissue developing around the portal vein can remain extra-hepatic or penetrate more or less deeply into the liver parenchyma depending on the species[18,28].In *E.maculatus* , the exocrine pancreatic tissue is extra –hepatic. Usually a thin septum of connective tissue separates the hepatocytes from the exocrine pancreatic cells. In the present study hepatic lobules and portal triads are absent and also recorded in many teleosts [8, 13, 28, 29].The net work of blood capillaries showed vessels that were anastomosed and drained by centre-lobular veins. These findings were similar to other teleosts (16, 29]. The bile ducts observed had a simple cubic epithelium, which becomes columnar in large ducts similar to other teleosts [8, 18].The exocrine pancreatic tissue has been recorded in other teleosts and its proportion depends on the species [18, 28].The exocrine pancreatic tissue is responsible for producing digestive enzymes that act in the intestine and aiding in food digestion [26].Moreover, endocrine part of this tissue can also secrete insulin and glucagon (Youson et al., 2006).

Pigment bearing macrophages are a prominent feature of piscine hematopoietic tissue [31].In higher teleosts, these cells form aggregates that occur frequently in spleen, kidney and liver [9, 11, 13]. [32] called these structures "melanomacrophage centers (MMCs)". They have also been called "macrophage aggregates" [33].These structures were observed in the liver of *E.maculatus*. The size, number and content of MMCs are highly variable depending on the species, age and health status[9,13].Melanomacrophage centers are believed to concentrate heterogeneous materials such as lipofuscin(natural yellowish color),melanin(natural brown or black colour), ceroid(PAS positive) or hemosiderin(Perls'positive)[9,10,11,31].Functions ascribed to MMCs include iron storage following erythrophagocytosis and antigen processing[31,34,35],as well as destruction, detoxification and recycling of endogenous and exogenous materials[9,31].Increased hemosiderin in hepatocytes(hemosiderosis) was found in teleosts in a disturbed environment[13].

The results obtained in this study enabled the characterization of the normal anatomy and histology of the liver of *Etroplus maculatus* by light microscopy, assisting in the analysis of adverse conditions, such as water contamination, nutritional status and health of fishes, which cause changes in the normal structure of the liver [36].

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