Comparative studies on histology and histochemistry of pancreas between *Labeo calbasu* (Hamilton, 1822) and *Mystus gulio* (Hamilton, 1822)

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Abstract: The cellular architecture and histochemical nature of the enzyme secretory acinar cells of pancreas have been investigated in two species of fish, *Labeo calbasu* and *Mystus gulio* having different feeding habits. Histological analysis illustrates that the exocrine pancreatic tissues are scattered within the hepatic parenchyma as hepatopancreas and spleen as spleenpancreas in *L. calbasu*. The structural analysis also shows that exocrine as well as endocrine pancreatic tissues are also diffused in the adipose tissues in between the intestinal coiling of *L. calbasu*. In *M. gulio* the discrete pancreatic tissue is attached to the outer wall of the stomach and formed cluster of acini interspersed with small areas of islet of Langerhans and blood vessels. The exocrine pancreatic acinar cells are provided with conspicuous nuclei and densely packed acidophilic zymogen granules. The endocrine component of pancreas, islet of Langerhans is encircled by a thin connective tissue and comprised of α, β and δ cells. Different cell types in the islets are differentiated based mainly upon their shape, position, staining intensity and density of the cytoplasmic secretory granules. α cells contain sparse cytoplasm and densely stained nuclei, are generally located to the periphery of the islet. Aldehyde fuchsin positive β cells bear spherical nucleus and granular cytoplasm, are in the center of islet of Langerhans contacted with blood vessels. δ cells are few in number with light stained nuclei disperse in the pancreatic islet. Histochemical detection displays that the zymogen granules of exocrine acinar cells showing variegated intensities of tryptophan reaction, the precursor of numerous pancreatic enzymes which probably related to the food and feeding habits of the fishes concerned. The zymogen granules are larger in size and heavily deposited in the acinar cells of hepatopancreas of *L. calbasu* in comparison to *M. gulio* may be correlated with the herbivorous feeding habit in respect to secretion of digestive enzymes.

Keywords: Histoarchitecture, Tryptophan, Pancreas, Structural analysis, Cyprinidae, Bagridae.


Introduction
In lower vertebrates particularly in fishes, the pancreas exhibits an immense diversity in structural modification and is greatly variable being distributed in the liver, spleen, intestinal wall or the mesenteries.
and secretes digestive enzymes into the gut, while the endocrine compartment regulates the production and secretion of peptide hormones into the bloodstream (Fortin et al. 2015). Variations with respect to morpho-anatomical and cytoarchitectural pattern of pancreas in teleosts have been investigated by several workers (Sheybani & Adibmoradi 2002; Naguib et al. 2009; Nejedli & Gaiger 2013; Faccioli et al. 2014; Mokhtar 2015; Ghosh et al. 2016). The pancreas as a definite gland was believed to be absent in fishes until Legouis (1873) reported its existence in a number of teleosts. He mentioned three types of pancreas in teleosts: compact pancreas, diffuse pancreas and disseminated pancreas. A separate and discrete pancreas is found in *Wallago attu* (Chakrabarti & Ghosh 2012), *Mystus aor*, *Clarias batrachus* and *Heteropneustes fossilis* (Khanna 1963). The pancreatic tissue however, is present in a diffuse state and lies dispersed within the lobes of the hepatic tissue and mesenteries to form hepatopancreas (Geyer et al. 1996; Petcoff et al. 2006; Sayrafi et al. 2011). In some species, the pancreatic tissue gradually invades the spleen, collectively known as spleenic pancreas (Khaksar Mahabady et al. 2012; Chakrabarti & Ghosh 2015).

Comprehensive investigations and information of endocrine pancreas of teleosts are well documented using immunocytochemical techniques (Klein & Van 1978; Abad et al. 1986; Elbal et al. 1988; Al-Mahrouki & Youson 1999; Youson et al. 2001; Fortin et al. 2015). Within the bony fishes, four cell types (A, B, D and F cells) have been recognized in islet of Langerhans which produce glucagon, insulin, somatostatin and pancreatic peptides (PP) respectively, but the density of the cells, distribution and localization within the islet tissues variegate considerably among teleosts.

Still lacunae exist on the morpho-histological details including histochemical nature of the pancreatic tissues in relation to feeding adaptations among Indian freshwater fishes. *Labeo calbasu* (Cypriniformes, Cyprinidae) is freshwater herbivorous, bottom feeder and feeds mainly on organic detritus matter including diatoms, green algae, desmids etc (Singh & Singh 2000). *Mystus gulio* (Siluriformes, Bagridae) primarily brackish water catfish; inhabits estuaries, tidal rivers and lakes, ascending to freshwater, often entering the sea (Talwar & Jhingran 1991). Its food mainly consists of crustaceans and insects (Pandian 1968; Hossain et al. 2015). The aim of the present investigation is to assess the structural and functional aspects of the pancreatic tissue in *L. calbasu* and *M. gulio* having different feeding habits by histological and histochemical analysis.

**Materials and Methods**

**Tissue collection:** Mature specimens of *L. calbasu* (ranged 26.41±3.81 cm in total length; n=10) were obtained from the local freshwater body of Burdwan (23.2333°N, 87.8667°E) and *M. gulio* (ranged 16.62 ±2.34 cm in total length; n=10) were procured from Regional Research Centre of Central Institute of Freshwater Aquaculture, Kalyani Field Station (22°58'60N, 88°28'60E), West Bengal, India. Fishes were deeply anesthetized with an aqueous solution of tricaine methone-sulphonate (0.1% MS 222, Sigma Aldrich) and sacrificed following the guidelines given by the Institutional Ethical Committee. The specimens were dissected out through longitudinal incision in the abdominal wall. Small pieces of the pancreas and some tissues suspected to contain gland associated with liver, spleen and intestine were removed and processed for respective studies. Fixation was done immediately after the death of the fish to avoid cell autolysis.

**Histological analysis:** The pancreatic tissues were kept in aqueous Bouin’s fixative for 16-18 hrs. After that the tissues were washed thoroughly in 70% ethanol, dehydrated with graded ascending series of ethanol and cleared in xylene. Then the tissues were infiltrated in paraffin wax of 56-58°C under a thermostat vacuum paraffin-embedding bath for a period of 1 hr. Serial paraffin sections were cut at 4 µm thickness using a rotary microtome (Weswox MT-1090A). After routine histological process
deparaffinized sections were stained with Delafield’s Haematoxylin-Eosin (HE), (Suvarna et al. 2013), Chrome alum haematoxylin phloxine (CAHP) (Gomori 1941) Mallory’s triple (MT) (Mallory 1936), Aldehyde fuchsin (AF) (Halami 1952) and Heidenhain’s azan (HA) stain (Kiernan 2008).

**Histochemical analysis:** Tissue samples for histochemical technique were fixed in 10% neutral formalin for 18 hrs. After proper dehydration in ascending series of ethanol followed by clearing in xylene, the tissues were embedded in paraffin wax at 52-54°C. Paraffin blocks were cut in 8 μm thick sections and subjected to Dimethylaminobenzaldehyde (DMAB)-Nitrate method for detection of Tryptophan (Adams 1957).

The staining slides were mounted with DPX, observed and photographed under LEICA EC3 compound microscope.

**Results**

**Histology**

***Labeo calbasu***: In *L. calbasu* (Fig. 1A), the exocrine pancreas occurs as a diffuse state in the three different regions viz., in the liver as hepatopancreas, in the spleen as spleenpancreas and in the adipose tissue located in between the coils of intestine (Fig. IC).

The pancreatic tissue dispersed within the lobes of the hepatic tissue and mesenteries to form the hepatopancreas. The hepatopancreas is a large, compressed, dark-brownish body, located ventro-laterally to the alimentary canal (Fig. 1C). It is made up of a typical ground hepatic tissue in which patches of various sized pancreatic tissue irregularly
scattered (Fig. 2A). The hepatic tissue is comprised of hexagonal or polygonal hepatic cells having granular cytoplasm with rounded nuclei. The hepatic tissue is supplied with a close network of hepatic ductules or capillaries. The pancreatic patches seem as rounded, oval or elongated in fashion, are mainly made up of exocrine acinar cells which are densely packed together and bounded by connective tissue through which numerous blood capillaries and pancreatic ductules run (Fig. 2B). The acinar cells are more or less pyramidal or cuboidal in contour, arranged in several layers and located close proximity to the blood vessels (Figs. 2B, C, D). A typical exocrine cell contains a broad basal homogenous portion and a narrow apical portion. The basal region is provided with a large spherical nucleus having distinct nucleolus. The apical portion is comprised of numerous zymogen granules which

Fig.2. Photomicrographs of histoarchitecture of hepatopancreas in *L. calbasu* stained with Delafield’s Haematoxylin-Eosin (HE), Mallory’s triple (MT) and Chrome alum haematoxylin phloxine (CAHP) stain. (A) Oval or triangle shaped pancreatic tissue (PT) containing acinar cells (AC) scattered among ground hepatic tissue (HT). Note the presence of blood vessels (BV) and bile ducts (broken arrows) (HE 100X). (B) Exocrine pancreatic tissue (PT) consists of AC packed with dense zymogen granules (ZG) in the apical part and conspicuous nuclei (N) at the basal part. Note the presence of BV adjacent to the bile ducts (broken arrows). HT indicates hepatic tissue (HE 400X). (C) Pyramidal or cuboidal AC of pancreatic tissue (PT) distinguishes from HT by septa of connective tissue (solid arrows). BV encompass by AC arranged in multiple series. Note prominent nucleolus in the nuclei (arrow heads) and diffuse ZG in AC (MT 400X). (D) Higher magnification exhibits typical AC of pancreatic tissue arranged in several rows encircling BV. AC contains basally located prominent nuclei (N) and numerous phloxinophilic ZG (CAHP 1000X).
are heavily deposited and relatively larger in size (Figs. 2C, D).

The exocrine cells of the pancreatic acini are present within the splenic tissue to form spleenpancreas. The spleen pancreas is reddish-brown lengthen organ situated on the mid region of digestive tract, ventrally to swim bladder (Fig. 1C). The acinar cells are distributed in the form of numerous clusters, encircling the blood vessels. The pancreatic acinar cells are distinguished from the splenic part by thin septa of connective tissue (Figs. 3A, B). Pyramidal acinar cell comprises a basal area, showing in close association with blood capillary and an apical part having profuse zymogen granules. The phloxinophilic zymogen granules are small in size and few in numbers. Acinar cells contain nuclei with central nucleolus located towards the base and their cytoplasm is basophilic in nature (Fig. 3C). The endocrine pancreas containing islet of Langerhans could not be identified in the hepatopancreas and spleenpancreas.

Structural analysis also showed that exocrine as well as endocrine pancreatic tissues are distributed widely as dissipated condition within the adipose
Fig. 4. Photomicrographs of cellular architecture of pancreas in L. calbasu stained with Mallory’s triple (MT) and Aldehyde fuchsin (AF) stain. (A) Distribution of pancreatic tissue within the adipose tissue (arrows) in between the coils of the intestine (IC) (MT 40X). (B) Langerhan’s islet (IL) surrounded by thin capsule (solid arrows) and blood vessels (broken arrows) are present in between the acinar cells (AC) of pancreatic tissue (PT). ADT marks adipose tissue (AF 100X). (C) Islet of Langerhans (IL) is enclosed by a thin connective tissue (solid arrows) and consists of α, β and δ (arrow heads) cells. Note the presence of AC packed with zymogen granules (ZG) and blood vessel (broken arrow) (AF 400X). (D) Higher magnification of IL shows AF positive β cells adjacent to BV, peripherally located α cells and scattered δ cells (arrow heads). Solid arrows indicate septa in between endocrine component and AC. Note prominent nucleus (N) and coarse ZG of AC (AF 1000X).
The endocrine part of the pancreas, islet of Langerhans is enclosed by a delicate connective tissue and consists of α, β and δ cells, interspersed with blood vessels. Various cell types in the pancreatic islets are recognized on the basis of their architecture, distribution, staining intensity and cytoplasmic ground substances. The position of α cell is confined to the periphery of islet, characterized with scanty cytoplasm and large distinct oval nucleus (Figs. 4C, D). Aldehyde fuchsin positive β cells are capacious, polyhedral in appearance and more in the center of islet of Langerhans, contact with blood cells. These cells bear spherical nucleus and granular cytoplasmic mass. δ cells are less abundant, solitary,
Fig. 6. Photomicrographs of sections of hepatopancreas (Figs. A-B), spleenpancreas (Figs. C-E) and adipose tissue pancreas (Fig. F) in *L. calbasu* showing histochemical test for tryptophan (Trypt). (A) Intense tryptophan reaction in the acinar cells of exocrine pancreatic tissue (arrows) and weak reaction in hepatic tissue (HT) (Trypt 40X). (B) Maximum reaction of tryptophan in the zymogen granules (ZG) of acinar cells (AC) in the pancreatic tissue. Note weak reaction in ground HT (Trypt 400X). (C) Strong tryptophan reaction in the AC of pancreatic tissue and weak reaction in splenic tissue (ST). Note moderate reaction in blood vessel (broken arrow) (Trypt 40X). (D) Spleenpancreas shows acute tryptophan reaction in ZG of AC and weak reaction in ST. Note moderate reaction of tryptophan in blood vessels (BV) (Trypt 100X). (E) Intense localization of tryptophan in ZG of AC encircling BV of exocrine pancreatic tissue. Note feeble reaction in ST. Broken arrow marks spleenic duct (Trypt 400X). (F) Strong intensity of reaction for tryptophan in ZG of AC and weak reaction in adipose tissue (ADT) (Trypt 400X).
variable in architecture having lightly stained nuclei and scattered anywhere in the pancreatic islet (Figs. 4C, D).

**Mystus gulio:** In *M. gulio* (Fig. 1B), the pancreas is separate and discrete in nature but relatively more organized in its structural architecture. The endocrine islets are present within the ground exocrine pancreas. The pancreatic mass is found to be adhered to outer layer of the stomach (Figs. 1D, 5A). The exocrine part is composed of a number of clusters of acinar cells which are closely compressed. Blood vessels and pancreatic ducts are found to occur here and there within the ground pancreatic tissue (Fig. 5B). However, acinar cells are more or less pyramidal in shape although oval or columnar types are found occasionally. They are full of zymogen granules. The granules are relatively smaller in size and number than that of *L. calbasu* and occupy almost the entire area of the cell concerned.

Endocrine units of pancreas are closely embedded within exocrine mass. Round or oval shaped islet tissues containing 3 cell types are surrounded by fine fibers of the reticular connective tissue which separate from serous acini (Figs. 5C, D). The islets are richly supplied with blood vessels (Fig. 5B). Predominating α cells are generally located outside in the islet of Langerhans. They are oval in shape and contain dense nuclei and acidophilic homogenous cytoplasm. Relatively larger β cells are found in group, towards the center of islets. These cells are stained purple with aldehyde fuchsin (AF). By Heidenhain’s azan (HA) stain, β cell shows orange coloured flocculent cytoplasm and large round central nucleus (Fig. 5D). δ cells are few in number, having faintly stained nuclei and found throughout the islets (Figs. 5C, D).

**Histochemistry: Tryptophan**

*Labeo calbasu:* In general, the exocrine pancreatic tissue shows relatively higher staining reaction for Dimethylaminobenzaldehyde (DMAB)-Nitrate test. Intense staining reaction for tryptophan showing deep blue colour has been detected in the hepatopancreas of *L. calbasu* (Figs. 6A, B). Cytoplasm containing copious zymogen granules of the pancreatic acinar cells stains deeply for tryptophan histochemical test. However, hepatic tissue itself shows weak reaction.

Regarding the localization of tryptophan content, the pancreatic part of spleenpancreas exhibits a puissant staining activity which is similar to hepatopancreas. The splenic tissue furnishes a moderate to weak reaction for this histochemical test. The blood vessels containing blood cells encircled by acinar cells shows pronounced reaction for tryptophan (Figs. 6C, D, E).

The acinar cells together with zymogen granules located in the adipose tissue are positively stained for tryptophan histochemical test (Fig. 6F). However, adipose tissue exhibits very weak reaction. The concentrations of the zymogen granules in the pancreatic acini of hepatopancreas are abundant and heavily loaded in comparison to spleenpancreas and adipose tissue pancreas.

**Mystus gulio:** Exocrine pancreatic tissue of *M. gulio* displays a strong positive result for tryptophan. The coarse zymogen granules of the acinar cells together with the nuclei stain darkly with this histochemical test confirming the presence of tryptophan in the said region (Figs. 7A, B). Moderately deposited zymogen granules exist as dispersed condition within acinar cells. The blood vessels in between the acinar cells also exhibit positive reaction for tryptophan.

**Discussion**

Fish exhibits great diversity in their food and feeding habits. The structure of the digestive tract along with associated organs also becomes modified accordingly. As a notable digestive gland and also as a principal endocrine organ, the pancreas is of universal adventure among vertebrates. In the higher vertebrates, the pancreas is a compact and lobulated organ whereas in the lower one, it is highly variable in nature. Among the teleosts, the pancreas shows a great diversity in its structure, morphology and anatomy. In the present study, the pancreas has been detected in *L. calbasu* and *M. gulio* either in a diffuse
condition and/or as a compact gland. Gonzalez et al. (1993) reported the presence of diffuse exocrine pancreas, which expanded through the mesentery and forms islets in the connective tissue around some digestive organs or disseminates within the intraperitoneal adipose tissue in *Serranus cabrilla*. In *L. calbasu*, the pancreas generally occurs as a primitive diffuse condition which exists in intrahepatic, intraspleenic and in the adipose tissues occurring among the loops of the intestine. Intrahepatic exocrine pancreatic tissue were also evidenced in *Oreochromis niloticus*, associated to afferent vases (Vicentini et al. 2005) and in *Dicentrarchus labrax*, the diffused pancreatic tissue was observed surrounding the digestive tract (Beccaria et al. 1992). In the present work, while in *M. gulio*, the pancreas is discrete in nature, adhered to the stomach wall and relatively more organized. Similar findings were also reported in *Glossogobius giuris* (Shrivastava & Chourasia 1976) *Mystus vittatus* (Dwivedi & Pandey 1982) and *Wallago attu* (Chakrabarti & Ghosh 2012).

In the present investigation, the exocrine acinar cells in the hepatopancreas and spleen pancreas of *L. calbasu* are organized into several rows encircling central blood vessel. Many fish possesses a diffuse pancreas which has an intimate association and admixture of cells with the spleen or liver known as spleenpancreas or hepatopancreas respectively (Khaksar Mahabady et al. 2012). In *L. calbasu*, the zymogen granules in the acinar cells are numerous and larger in size in comparison to *M. gulio*. In herbivorous, *L. calbasu* the intestine is enormously coiled showing adaptation for retention of food materials for a large period of time and the only source and copious amount of digestive enzymes are needed for effective of enzyme is the hepatopancreas digestion of food materials. The pancreatic juices along with bile juice after being secreted from the hepatopancreas is collected in the gall bladder and ultimately emptied in the alimentary canal. Yamane (1973) gave an account of the presence of amylase in the cytoplasm of the acinar cells in diffuse pancreas and confirmed that these cells were the centre of amylase production in the carp. The zymogen granules of acinar cells contain proenzymes responsible for the digestion of proteins, carbohydrates, fats and nucleotides (Alboghohobeish & Khaksar Mahabady 2005; Mokhtar 2015). Moreover, the magnitude of the zymogen granules in
the acinar cells of hepatopancreas in *L. calbasu* appears to be higher than that of the spleen pancreas and adipose tissue pancreas. Therefore, it may be assumed that the acinar cells of hepatopancreas are physiologically more active in respect to secretion of digestive enzymes. Khaksar Mahabdy et al. (2012) recorded that the spleen pancreas of *Barbus pectoralis* performed many functions such as lymphatic cell production and digestion of food materials. In *M. gulio* the acidophilic zymogen containing cells of the exocrine pancreas is for the production and storage of pancreatic enzymes that are delivered to the digestive tract through a network of ducts for effective digestion of protein-rich food materials. Field et al. (2003) reported that the exocrine pancreatic tissue produces digestive enzymes, such as trypsin, amylase and carboxypeptidase A for effective digestion of food in zebra fish (*Danio rerio*).

The endocrine pancreatic tissue exists as Langerhan’s islets and is surrounded by exocrine acinar cells in *L. calbasu* and *M. gulio*. The islets are bounded by thin capsule and consist of comparatively faintly stained cords of cells having conspicuous nuclei and interspersed with blood vessels. The endocrine pancreatic cells of *L. calbasu* are mainly distributed within the adipose tissue surrounding intestinal bulb, intestine and bile duct. Similar findings were also observed in Salmoniformes (Wang et al. 1986) and grass carp (Mokhtar 2015). In the present observation, α cells are the most dominant cell types and most common on the periphery that appeared ovoid structure bearing oval nuclei and intense acidophilic cytoplasm. Centrally placed β cells are comparatively larger in size, polyhedral in shape having granular cytoplasm. δ cells are less abundant, solitary and characterized with clear cytoplasm. Shyamsundari et al. (2006) mentioned that ovoid islets of Langerhans are usually with a central cluster of β cells and α cells in the periphery in lizard fish *Saurida tumblill*. Mokhtar (2015) opined that the endocrine part of *Ctenopharyngodon idella*, the ovoid α cells are dominant, β cells are polyhedral and they grouped in small clusters while δ cells are small, fusiform and argyrophilic cells. It has been marked that endocrine cells have contacts with the blood sinuses and sometimes the secretory contents of the cells are observed into the blood vessels. Therefore, it may be divined that after being secreted from the endocrine cells the hormones are carried out into the blood capillaries and thereby promoting movement of glucose. In *Carassius carassius*, *Cyprinus carpio*, *Tinca tinca* and *Silurus glanis* α, β and δ cells are shoot shaped, have contacts with the capillaries and the hormones from the endocrine cells is carried out via emiocytosis into the blood vessels (Iaglov 1978). The most significant hormones secreted by the islet of Langerhans are insulin from β cell and glucagon from α cells. Both perform a momentous role in proper metabolism of sugars and starches in the fish body. Insulin promotes the movement of glucose and other nutrients out of the blood and into cells. When blood glucose rises, insulin released from the β cells causes glucose to enter body cells to be used for energy. Moreover, it sometimes stimulates conversion of glucose to glycogen in the liver. Other hormone, glucagon from α cells promotes the movement of glucose into the blood when glucose levels are below normal. It causes the breakdown of stored liver glycogen to glucose, so that the sugar content of blood leaving the liver rises (Sorokin et al. 1982; Plisetskaya et al. 1985, 1986). However, δ cells, which secrete somatostatin, are reported to be dispersed mainly in the central region, intermingled with β cells (Stefan & Falkmer 1980; Abad et al. 1986).

The detection and localization of tryptophan content has been observed in the exocrine acinar cells at varied intensities in *L. calbasu* and *M. gulio*. Tryptophan, the precursor of pancreatic enzymes mainly associated with the zymogen granules of acinar cells. The concentration and magnitude of zymogen granules also differ from species to species. In the present investigation, thickly packed acinar cells are characterized with densely loaded zymogen
granules in herbivorous detritus feeder; *L. calbasu* and moderately loaded zymogen granules are observed in the carnivorous, *M. gulio*. Zymogen granules remain in an inactive form in the acinar cells of the exocrine pancreas. These granules secrete zymin in their secretory phase which helps to digest carbohydrate food materials (Sinha & Moitra 1975). Variable intensities of tryptophan content in the acinar cells of the aforesaid fishes may be related with the synthesis and secretion of pancreatic enzymes in different proportions according to their requirement relating to their feeding habits.

Further, transmission electron microscopical and immunocytochemical studies on the pancreas of *L. calbasu* and *M. gulio* are recommended to identify the cellular components and their proper functional significance.

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مطالعه مقایسه‌ای بافت‌شناسی و هیستوشیمی پانکراس \textit{Labeo calbasu} (Hamilton, 1822) و \textit{Mystus gulio} (Hamilton, 1822)

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چکیده: ساختار سلولی و طبیعت هیستوشیمی سلول‌های آسینار ترشح‌کننده آنزیم لوزالمعده در دو گونه ماهی \textit{Labeo calbasu} و \textit{Mystus gulio} با عادات غذایی متفاوت مورد بررسی قرار گرفت. تحلیل بافت‌شناسی نشان داد که در گونه \textit{L. calbasu} بافت‌های ترشحی برون‌ریز لوزالمعده در داخل پارانشیم‌های کبدی به‌صورت کبدی-لوزالمعده و در طحال به‌صورت طحال-لوزالمعده به صورت جسیبده بیافته‌تر هستند. همچنین تحلیل بافت‌های ترشحی در طحال، برون‌ریز لوزالمعده به صورت جسیبده بیافته‌تر هستند. در گونه \textit{M. gulio} بافت مجزای لوزالمعده به‌صورت جسیبده است و مجموعه‌ای از آسینی پراکنده شده در نواحی کوچک از جزایر لانگرهانس و رگ‌های خونی را شکل می‌دهد. سلول‌های آسینار ترشحی برون‌ریز لوزالمعده به‌صورت کبدی-لوزالمعده، جزایر لانگرهانس به‌صورت چسبیده به بافت‌های ترشحی برون‌ریز لوزالمعده و درون‌ریز لوزالمعده مشاهده می‌شود. تحلیل ساختار نشان داد که بافت‌های ترشحی برون‌ریز لوزالمعده به‌صورت چسبیده به بافت‌های ترشحی درون‌ریز لوزالمعده شکل می‌دهند.

سلول‌های آسینار ترشحی لوزالمعده با هسته‌های واضح و گرانول‌های زیموژنیک به شدت متراکم هستند. بخش درون‌ریز لوزالمعده، جزایر لانگرهانس به‌صورت یک بافت پیوندی نازک و متشکل از سلول‌های \(\alpha\), \(\beta\) و \(\delta\) محاط شده است. اعواع سلول‌های متغییر در جزایر عمداً براساس هاوای سیتوپلیسمی باجریت، ظاهراً براساس مکانیسمی مشابه با بستگی به‌صورت کبدی-لوزالمعده، جزایر لانگرهانس و هسته‌های با صورت کبدی-لوزالمعده مشاهده می‌شود. سلول‌های \(\beta\) به‌صورت کبدی-لوزالمعده در بافت‌های ترشحی لوزالمعده، جزایر لانگرهانس و هسته‌های با صورت کبدی-لوزالمعده مشاهده می‌شود.

کلمات کلیدی: ساختار بافت‌شناسی، ترشح‌کننده، سلول هیستوشیمیک، گرانول‌های زیموژنیک، گونه L. calbasu و M. gulio.