EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 4
Issue: 5
01-08
Year: 2017

HISTOLOGICAL STUDIES OF LARVAL DEVELOPMENT STAGES IN DIGESTIVE ANNEX GLANDS

Yashar Katouki*

Paygir Applied Science Education Center, Gorgan-Golestan-Iran.

***Author for Correspondence: Yashar Katouki**
Paygir Applied Science Education Center, Gorgan-Golestan-Iran.

Article Received on 21/02/2017 **Article Revised on 13/03/2017** **Article Accepted on 03/04/2017**

Chapter: 1
ABSTRACT
Bibliography and background: Concerning to the histological structures of accessory digestive glands in A.stellatus larvae few data is available. **Implication and statement of the importance:** Reading to the importance of sturgeons, economically the artificial rearing in Iran also necessitates studies relating to the G.I tract. **Hypothesis:** Due to absence of salivary glands in these fish and also their enzymatic because of abundance and variety of food stuffs and preys, immediate appearance of these glands is being expected. **Variable(s):** Independent. Objective(s): The object of this study is identifying the developmental process of liver and pancreas microscopically and clarifying the details for applying in feeding diet programs proper time.

KEYWORDS: Liver, Pancreas, Stellate Sturgeon Larvae, Histology.

INTRODUCTION

Sevruga is a most important member of sturgeon. Sturgeon is valuable among the different species of aquatic animal. Due to the abundance of various aquatic and the importance of fish protein on food intake in order to clarify the physical structure and textural properties of these organelles are important the microscopic studies of various visceral organelles.

In particular, studies on the evolution of organs in different species of larvae and juveniles have great impact in studies and planning of artificial reproduction. So aquatic resources should be enhanced and preserved.

It is necessary to achieve the information and more results of physical structure including histopathologic and physiological findings. Studies on aquatic larvae such as fish and frogs are good models for these early evolution findings. These organs studied histology and genetic or both combinations.

These studies could offer guidelines for further improve of artificial propagation and breeding sturgeon. However studies on sturgeon has been less but good studies been made till now on the gastrointestinal tract and partly reproduction that most studies have been on larval stages evolution of various organs in different species of sturgeon.

Histological studies in most cases have directly or indirectly important role to obtain an understanding of physiological fish condition. These studies results on the phenomenon reproduction of fish that lead to invent of new ways in larvae production.

History and importance of sturgeon

Sturgeon belongs to the northern hemisphere waters. Based on paleontology reviews these fish appeared on earth than a hundred million years ago. That are primitive when compared with other fish and their origin related to Paleozoic and Mesozoic era that due to more compromise with environment changes have been able to survive till today.

Specification of sturgeon: Acipenseridae

They have long tall that narrowing towards tail gradually. Body covered of five rows of highlights bony plates which are located a row behind, two rows on either side and also two rows in the lower abdomen. The muzzle is pulled forward more or less. The mouth is located under and head width, moving, not great usually but in some genera is very large jaws have not teeth but sturgeon have teeth in the embryonic stage and this is best reason for teeth existence in sturgeon ancestor in the past. Spinal cord is cartilage in sturgeon and chorde in all lifetimes remains unchanged. Skull is firmly cartilage which protected with coverage shell bone. In most species do not spawning every year but is every other year and or with more interval. Migration of sturgeon for

reproduction begins from fall and migration of some sturgeon to be continued in winter under the ice. Major migration of sturgeon to the river will do in spring and with thaw. Sturgeons that are released from the sea into the river in fall have a lot of time up to the maturity and evolution of genital cells and at this time the spawns are dark and rich of fat but sturgeons have complete genital gonad that migrated in spring. Areas and points of spawning are located at various distances of river.

Classification of sturgeon
Kingdom: Animalia
Phylum: Chordata
Subphylum: Vertebrata
Super class: Gnat stomata
Class: Chondrostei
Order: Acipenseriformes
Family: Acipenseridae
Genus: Acipenser
Species: Stellatus
Sturgeons have four genders:
1-Acipenser 2-Huso 3-Scaphirhynchus 4-Pseudoscaphirhynchus
In south coast of Caspian Sea exist Acipenser and Huso

Acipenser stellatus of Caspian Sea
Sevruga in the south coast of Caspian Sea is named: Acipenser stellatus natio cyrensis bergy that has following characteristics:
The dorsal fin radius 40-45 numbers
The anal fin radius 22-35 numbers
The back bone plaque 9-16 numbers
The lateral bone plaque 26-43 numbers
The abdominal bone plaque 9-14 numbers
Muzzle is too long, narrow, and compressed from top to bottom.
Lower lip is cloven. The first radius of pectoral fin is weak.

This fish has two shapes: North and South of Caspian Sea that in our study used of southern of Caspian Sea.

This fish prefer to spawning and reproduction in the water that is so sweet and the bottom of them covered with mud. This fish usually lives in the depths of the sea to a depth of 60 meters but pass of middle deep pits and southern of Caspian sea. This fish is spread during the winter in full depth of water and shallow area in the spring and summer.

Sevruga is spawning in the river area that the water flows fast and period of two spawning time is more than three years. Spawning of this fish is take place in May to August at the temperature of 16-25◦c. Sevruga after spawning move toward to sea with speed of 75km per day. Mature body length is generally 98 to 192cm. Sevruga duration life is 28 to 30 years old but most of the population belongs to the ages of 10 to 17 years old. Female fish weight up to age 30 is 25.5 Kg. Sevruga than a sturgeon is more compatible to hot water. Sevruga is preferred to live in the depths of 20 to 50 meters and areas with the water temperature of 6 to 14◦c in the winter.

Biological specification of sevruga species
Natural position
Sevruga is more pelagic than caviar species and move in the lower depths of the sea. In terms are rich in food supply. Spawning of sevruga is in the riverbed, especially in rocky area.

Emigration
This fish is Anadromous. Sevruga migrated for spawning from south and middle areas of Caspian Sea toward north area in spring. Then mature fish for spawning goes to Volga Urals and Georgia River. Sevruga after spawning in the riverbed migrated toward bottom of sea to feeding. Nutrition migration to food search causes continuity movement on the one side to the other side of the sea.

Nutrition
Type of nutrition is heterotrophic but nutrition of fish is more important. Sevruga is a destroyer species that used animal food as fish. When larvae reach to feeding level (5-9 days after hatching), their foods are included: Mysidae, Gammaridae, Chorophiidae, Polychaetae, Oligochaetae. The maximum amount of young sevruga food in the north area of Caspian sea are: Chorophiidae(%66) and Gammaridae (%23).

Reproduction and maturity age
Type of sexual reproduction is Gametogenesis.

Thermal condition in evolution steps
Fetal growth takes approximately 6 days at the temperature of 15◦c. Hatching takes 55-60hr after mating at the temperature of 25◦c. Larval takes16-20◦c, Youth2.4-29.5◦c, Maturity2.4-29.5◦C.

Digestive system of fish
Digestive system of fish composes of tract and digestive glands.

Gastrointestinal tract
Gastrointestinal tract started from mouth and continues to anal. In some species can be seen as piece by piece tract and in some as almost directly and separation incomparable. Usually digestive tract are recognizable parts that including: mouth, throat, esophagus, stomach and intestines. Histological of gastrointestinal tract wall is like higher vertebrates and consists of four main layers: mucous, sub mucosa, muscle, serous that these layers are divided to smaller layers.

Liver
Liver is one of the digestive gland that growth from embryo cavity. Hepatic artery and portal vein enter to liver. The main cells of liver parenchyma are: hepatocytes, endothelial cells, fat storage cells, liver macrophage cells, serous cells, fibroblasts. The interior

layout and specific organelles that known till now are change in species, age, season, gender, spawning time, kind of feed. The basis of liver as digestive gland is production and secretion of bile. Bile is secreted by liver cells and entry to capillary secretion of bile is joined together bad bile duct are formed that followed them have created liver duct. Then this duct leaves the liver and come into the duodenum. Liver cells in addition of bile secretion have many critical activities. These cells have important role in metabolism of protein, fat, and sugar. Very important action of them is neutralizing of toxins. Moreover in infancy erythropoietin and antibodies production is effective. Most importantly role is saving of some food. The main material storage in liver fish is glycogen and to much less fat.

Pancreas
Pancreas is composing from an exocrine part that secreted pancreatic fluid and other part is self inner that named langerhans and secreted hormones such as insulin and pancreatic.

Chapter: 2
MATERIAL AND METHODS
For microscopic study of digestive gland in the early stage of sturgeon life, forty larvae prepared from a hatchery and sturgeon fish farming in Dam Sangar Rasht. Larvae under study prepared randomly from the time of hatching till third week after hatching. Sampling in first, second, fourth, sixth, eighth days do respectively until twenty first days and then the samples immediately to fix in the preservative Bowen Solution.Following the full consolidation of samples in order to pass from the various dewatering stages, clarification, and colonization with paraffin. Samples transferred to tissue machine or autotechniquon and then from samples prepared paraffin blocks. Then from each sample prepared section with thickness of 6 micron by microtome and for samples coloring used usual way of hematoxilin and eosin.

Process stage
1-sampling 2-sample consolidation 3-dewatering 4-clarification 5-colonization with paraffin 6-molding 7-tissue cutting 8-coloring 9-lamel paste 10-study by optical microscope.

Consumable materials
A:%4 formalin(commercial formalin) **B:**ethyl alcohol **C:**bowen solution **D:**molybden phosphate %1 **E:**hematoxilin **F:**hydrochloric acid **G:**eosin **H:**xylol **J:**acetic acid **K:**paraffin **L:**acid fuchsine **M:**lithium carbonate **N:**lam **O:**glue balsams

Unconsumable material and instrument
A: tissue passage instrument **B:** microtome **C:** optical microscope **D:** scissor **E:** incubator **F:** ben murray **J:** ruler

Sampling
Sampling of larvae done randomly then overall length of larvae exactly measured by ruler and overall length and overall average of samples calculated.

Samples consolidation
After measuring the length of samples placed in Bowen stabilizer solution (contains of %5 acetic acid,%25 formalin,%75 picric acid) till consolidation and sustainability should be done.

Dewatering, Clarification, Colonization with Paraffin
Each three steps performed in autotechnicon. For dewatering use alcohol %50, %70, %80, %96, and absolute alcohol.

Xylol solution uses for clarification. In the tissue is penetration paraffin and samples prepare for molding.

Molding
After leaving the samples from autotechnicon put them in oven along with special basket then each samples put in special mould and then some molten paraffin pour on mould after cooling of paraffin and hardening of samples, the samples separated from mould and keep in the refrigerator.

Tissue cutting
Samples taken from the fridge, then placed in microtome to cutting for thickness of 6cm.

Paste section on slide
The slide for few seconds placed in alcohol (%70) then cleans the slides and then the slide by gelatin glue soaked and put a few hours to dry. Slides for drying and storage till staining put in the oven (37◦c).

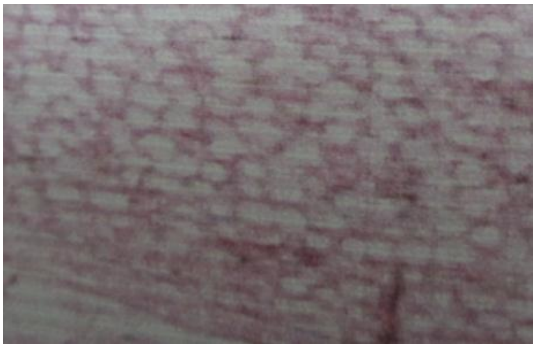
Staining
For this study used hematoxylin and eosin staining.

Staining steps
1-samples put in xylol I for 2min.
2-samples put in xylol II for 5min.
3-samples cross from alcohol (absolute alcohol). The number of moves is ten.
4-samples put in alcohol (absolute alcohol) for 2-5 min.
5-samples cross from alcohol (%96). The number of moves is ten.
6-samples cross from alcohol (%80). The number of moves is ten.
7-samples cross from alcohol (%70). The number of moves is ten.
8-samples wash in water for 1-2 min.
9-samples wash in hematoxylin for 1-2 min.
10-samples wash in water for 1 min.
11-samples crossing with speed in acid alcohol (%1)
12-samples wash in water for 1-2 min.
13-samples crossing from lithium carbonate for 3-4 min.
14-samples wash in water for 1-2 min.
15-samples put in water for 30 seconds.

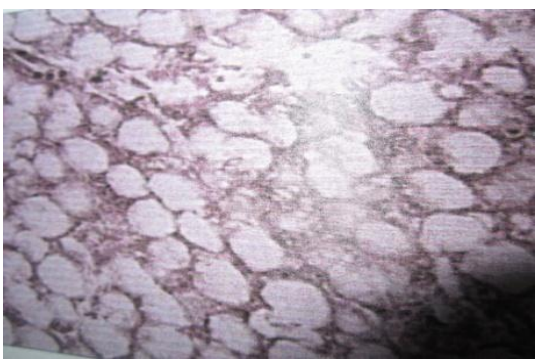
16-samples respectively cross in alcohol (%70, %80, and % 96, absolute alcohol) for each step 10 seconds.
17-samples cross from xylol for 1 min.
18-samples put in xylol for 5min.

Slide paste
Slides clean by methanol alcohol then slides cover by cover slip that used of balsams glue. The tissue drying and cutting to study then observe by optical microscope.

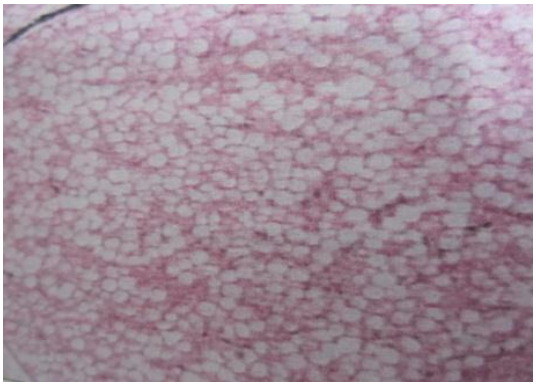
Chapter: 3
RESULTS AND DISCUSSION
Microscopic observation showed that in abdomen most of it accumulated from the yolk material on the first day. There are not clear effects of liver and pancreas. Liver is visible in dorsal heart and parallel midline upper body on the second day. Liver is visible as organ with spherical coarse cells as hepatocytes on the second day. Hepatocytes are spherical cells or multi-dimensional which has a spherical core in the cell center and often their core is euchromatin with one or two recognizable nucleoid. Liver establishment location in the microscopic section of stellate sturgeon larvae is in the middle of the body and nearby from above with heart and from sides with skeletal muscle wall and from the posterior in parallel to the anterior of the glandular stomach and non-glandular stomach. Hepatocytes are mononuclear and two nuclear some of them on the second day. Cytoplasm of liver cells is clear and full of fat vacuole but still is not observed glycogen particle.



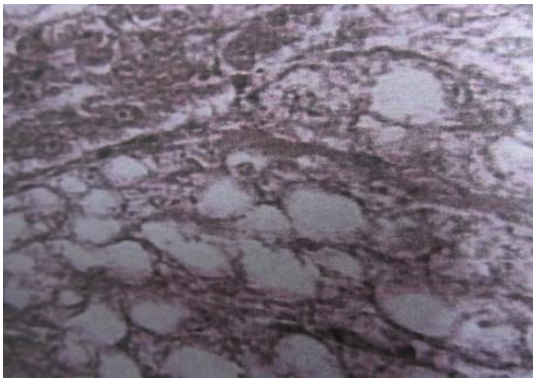
Picture1: hepatocytes of liver containing of clear vacuole on the second day.



Picture2: liver and hepatocyte on the second day (H&E*100) Liver is including of hepatocyte with fat vacuole that gradually reduced amount of fat during four to six day.'



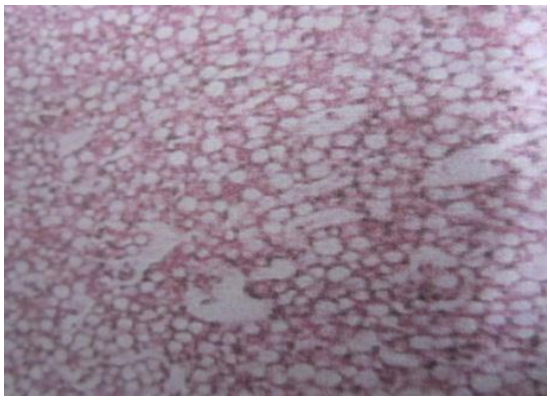
Picture3: liver on the fourth day. Many hepatocytes observed in front of stomach with clear vacuole.



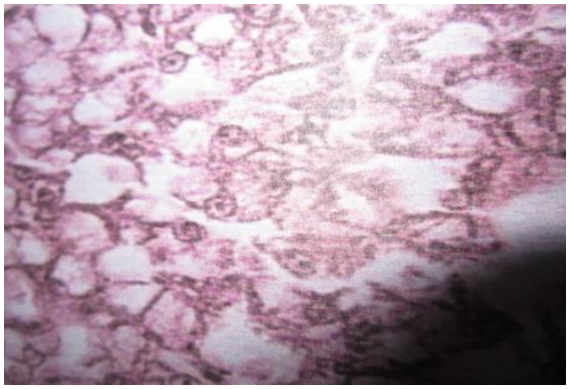
Picture4: liver zoom on the fourth day. In some hepatocytes, clear vacuole are acidophilus (H&E*100).

So by the end of the first week in addition to the large liver tissue, fat and vacuole content, some of them hepatocytes gradually replaced by particles and glycogen stores.

In addition, between groups of hepatocytes are formed small sinusoids which added gradually.



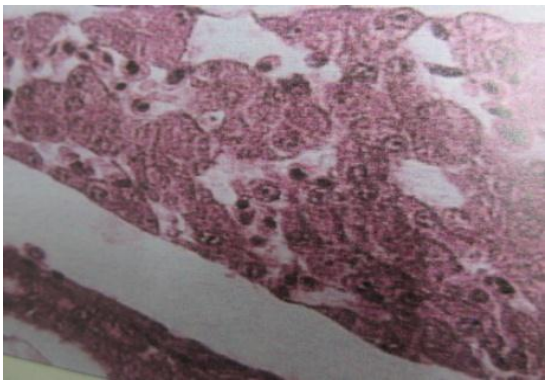
Picture5: liver on the sixth day- most of hepatocytes are containing abundant clear vacuole-sinusoid and blood vessels formation are observed in liver tissue.



Picture 6: liver on the eight day-cytoplasm of hepatocytes has been more colors acidophilic and the amount of vacuole light reduced and sinusoid observed between them.

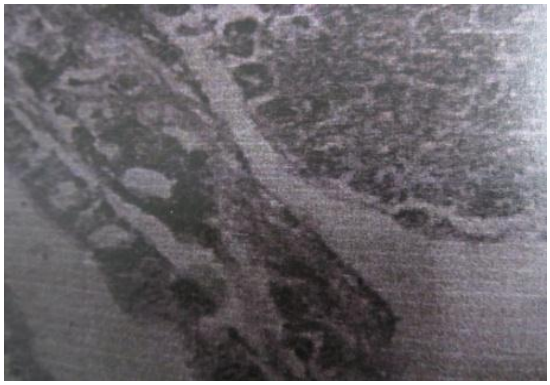
At the end of the first week or the eight day, effects of pancreatic tissue seen in the adjacent to the posterolateral of liver. At this time, the pancreas is somewhat lobulated which includes a number of globular acini with pyramidal cells. Each acini has a number of six to eight large pyramid cell with spherical nuclear which composed in the center of the cell or near the base of the cells.

Picture7: part of pancreas and acini with acini in cell center on the eighth day (H&E*100)

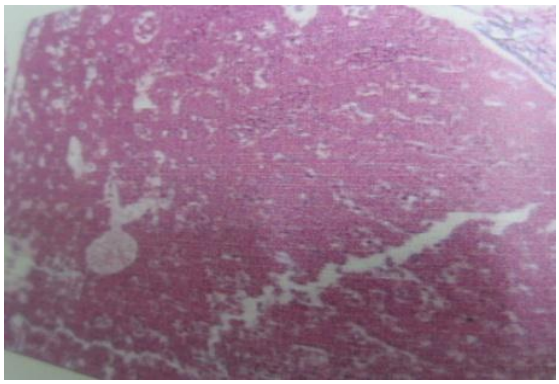


Picture8: liver with coarse hepatocytes, many acidophilus and interstitial sinusoids

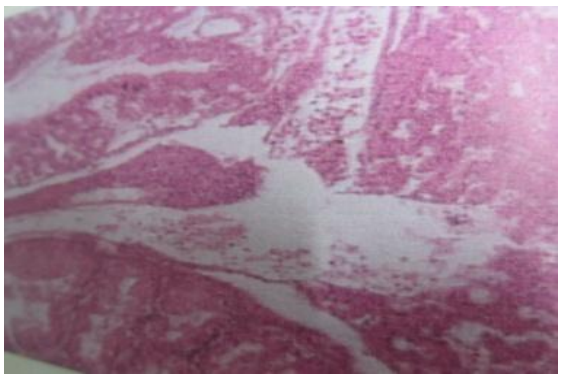
During the second week, with the increasing of acini number, gradually pancreas increases in the volume and extent. The tissue of liver and pancreas increases as the extent on the tenth to twelfth.



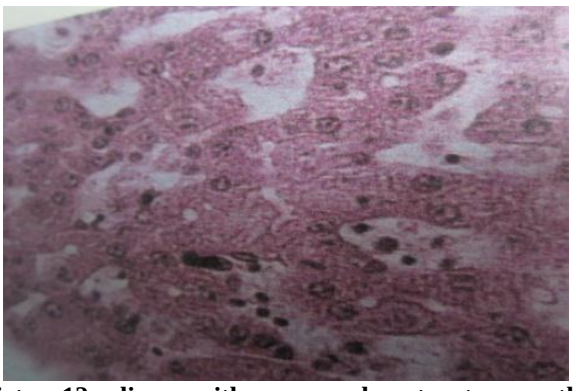
Picture9: pancreas with acini serous on the tenth day on the twelfth day



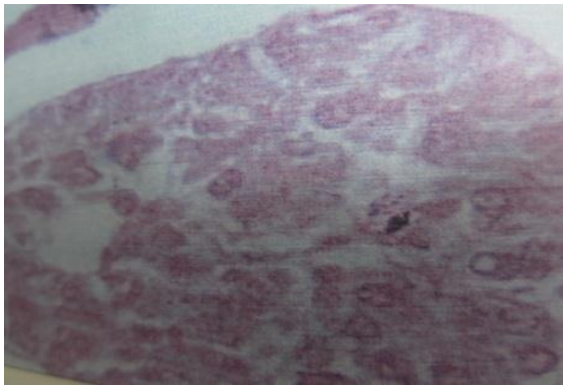
Picture10: liver with many hepatocyte acidophilus and multiple sinusoids Blood vessels and liver sinusoids development a lot on the sixteenth day



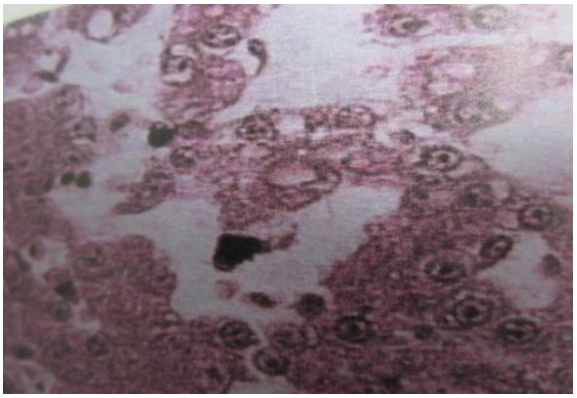
Picture11: liver and pancreas observed in the vicinity of the stomach on the twelfth day



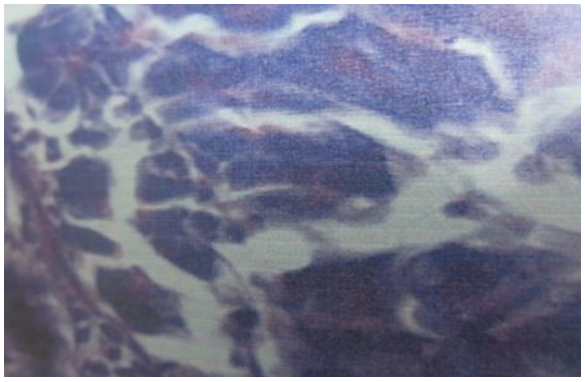
Picture12: liver with coarse hepatocyte on the fourteenth day



Picture13: pancreas including of the serous acini that contains of acini cells in the center on the fourteenth day (H&E*100)

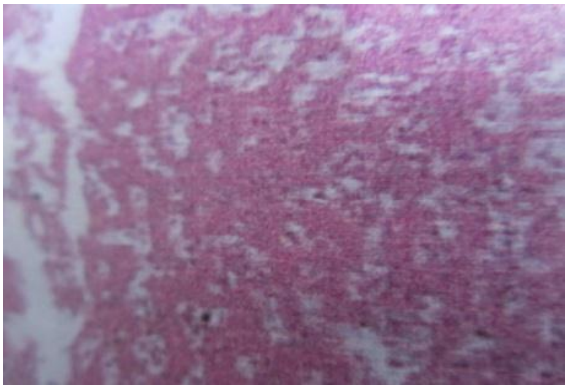


Picture14: accumulation of liver hepatocyte, mostly acini along with numerous dilated sinusoids on the sixteenth day (H&E*100)

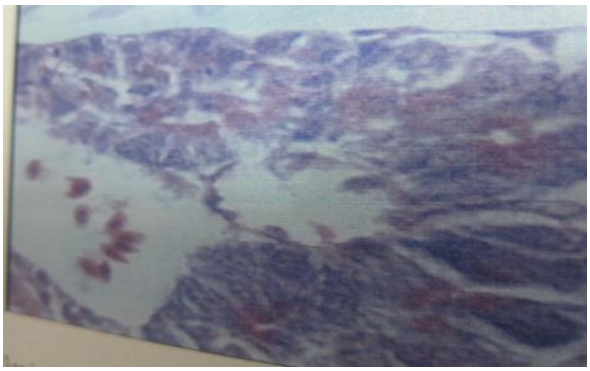


Picture15: pancreas including of large acini with pyramidal cells that contains of acidophilic zymogen granule on the sixteenth day (H&E*100)

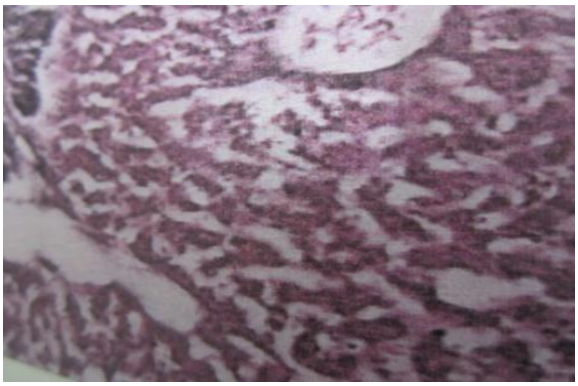
The most distinctive aspects of acini evolutionary present of numerous xiemogenic particles in the cephalic cytoplasm of pyramidal cells. As each acini cell has a rule basophiles and a cephalic acidophilic cytoplasm. Eventually by the end of the third week that means the eighteenth to twenty-first day continued growth and liver tissue evolution as increased hepatocytes and their glycogen content and liver sinusoid development. In regarding of pancreas tissue evolution, is including of increases the number of acini serous with more abundant xiemogenic granular content in acini cells.



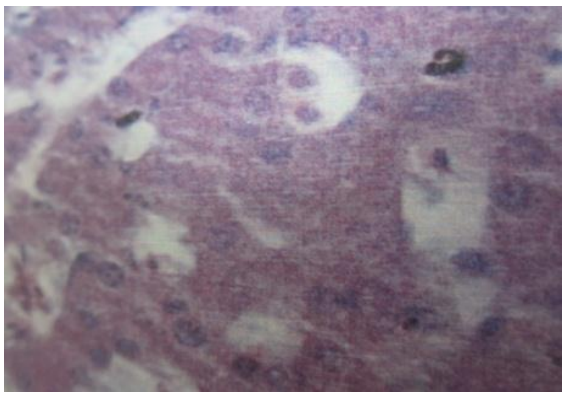
Picture16: extensive of liver with abundant of sinusoids on the eighteenth day (H&E*100)



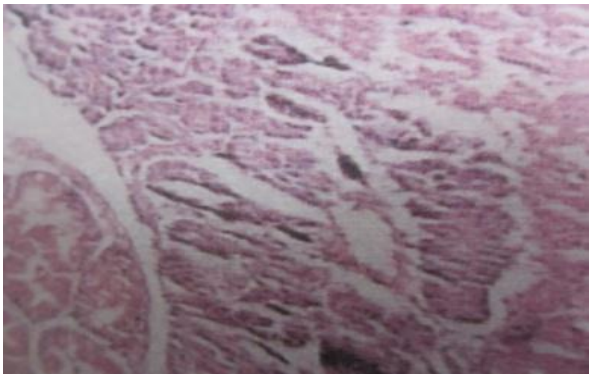
Picture17: pancreas with abundant of acini that contains of zymogenic granular and acini cell in the center



Picture18: liver has a large area as well as extensive and abundant of sinusoid on the third week



Picture19: liver zoom on the third week



Picture20: liver and pancreas observe highly developed at the end of third week

Chapter: 4
CONCLUSION

Digestive system is composing of two parts: Tubular and Glandular. Annex digestive gland is containing of secretions that involved supplementing in the digestion and absorption of food as directly or indirectly. According to variety of sturgeon food and the volume of food intake from digestive system in addition to the mucous cells secretion of tubular section needed to secretion and more digestive enzymes through a digestive gland. Liver and pancreas especially have various secretors. The liver being on track venous blood flow of intestinal is receiver the food intake. in addition to the storage in the liver, acts in metabolize of material and neutralizing or disposal of various toxic material. Pancreas as a gland has various secretor enzymes and also endocrine and exocrine secretor.

Liver cells or hepatocyte contains of large amounts of fat and glycogen vacuoles in fishes liver that are variable the amount of these materials and depends to activity and diet in different species. Such findings were evident in different species of sturgeon. In addition to very low consumption of carbohydrate in sturgeon is because of meat diet. The ability of carbohydrate consumption in fish is much less than mammals. Therefore it is essential that supply their energy requirements in other way such as body fat storage abundant of fat storage can be seen in the lower parts of sub mucosa in digestive system especially pharynx and esophagus in sturgeon. Liver and intestines in the early stage of larval development are first visible organs in sturgeon. The liver existence reported in the early days of evolution in other fish as white sturgeon in North America that liver contains of hepatocytes specified vacuolation in these vacuoles contains of fat two day after active feeding.

Sturgeon larvae feed from the yolk sac during first day gradually fat accumulation increased in liver as a result of digestive yolk. Liver in larval stage of salmon idée family well clearly during the first week and in the liver back can be seen. Pancreas including of globular sinuses and acini has three to five cell but still unclear endocrine part of pancreas and it seems do not be formed. Such findings in stellate sturgeon larvae in this study were obvious in first day. In addition to zymogen particles observed in secretors acini in twenty-five years and these acini has zymogenic red material with secretors exocrine that is a sign of exocrine cells activity. In exocrine part of pancreas observed zymogen particle in white sturgeon larval in North America in the second week. In addition to endocrine part of the pancreas is containing dispersed cells between acini at the age of forty days and in center of acini the acini cell center created small tract and is clear the lobulated pancreas. From this age do not seen another specific change except of getting large in liver and biliary and the overall structure of liver seems to completed at this age. In different fish species has been shown the size of hepatocyte that depends on the amount of their activity and the best example of this hepatocyte differentiation is cell body and their nucleus hypertrophy. Cytoplasms of hepatocytes especially the fat and glycogen storage show significant change according to their activity in different fish species. In sturgeon larvae decreased the amount of vacuole in liver cell from the sixteenth day and this is representing the practical change of fat metabolism in this species. The result of this study, it can be deduced the liver in the early days of larval life formed one of the first organ that quickly grew also is fast the evolutionary process of hepatocytes and sinusoid while was later growth and evolution of pancreas but has more growth during the first and second week in addition to in larval stage the early evolution of this gland compensate lack of salivary gland in the digestion and absorption of food in this fish. In addition to liver and pancreas are very similar to similar organs in other aquatic, although in some fishes the liver and pancreas merged to just a single organ that named hepatocytes but in larval and adults stage of sturgeon are separated from each other.

With using studies on histological structure of liver and pancreas in adult sturgeon can be observed that in the early stage of sturgeon larval life, the liver is lack of capsule structure in the adult liver also at this time in pancreas has not yet formed the tract and endocrine structure but these structure have more growth and evolution with starting of active feeding and increases of fish age.

The results showed that on the first day post hatch the abdominal cavity was filled with yolk sac and only same partial parts of digestive tract are developed. The yolk sac on the next days is disappeared and the growth of organs will develop. The presence of hepatic tissue as an independent organ, lacking a pancreatic tissue from the second day post hatch in vicinity of the cranial part of stomachs is distinguished. In the first week of formation of hepatocytes they are filled with lipid vacuoles which are gradually are decreased and glycogen deposits are replaced. In the next days this is forwarded and beside the development of sinusoids, the liver will be increased in size and cell volume. In the first days post hatch the pancreatic tissue is not well developed and observed, and it seems to be formed later than the hepatic tissue. But

from the second week, the pancreas also as an individual organ, in the posterior part of the liver, will be observed. At first only the acini are formed and then the zymogenic granules will be present in their cytoplasm.

Chapter: 5

REFERENCES

1. Boglione, C.et al, (1999) Aspects of early development in the Adriatic sturgeon, Acipenser naccarii. J. Ichthyol, 15: 207-213.
2. Buddington, R.K., Doroshov, S.I. (1986) Structural and functional relations of the white sturgeon alimentary canal (A.transmontaneous). J. Morph, 190: 201-213.
3. Buddington, R.K. (1986) Digestive secretions of lake sturgeon (A.fulvescens) during early development. Journal of fish biology, 26: 715-723.
4. Detlaff, T.A., Ginsburg, A.S., schmalhausen, O.I. (1993) sturgeon fishes. Development biology and aquaculture. Springer Verlag, P: 300.
5. Gawlicka, A.Teh.S.J, Hung. S.S.O Hinton. D.E De la Nove. J. (1995) a histochemical changes in the digestive tract of white sturgeon larvae during ontogeny. J. fish physiol. Biochem, 14: 357-371.
6. Gisbert, E., Sarasquete, M.C. Williot.P. And Castello-Orvay, F.(1999) Histochemistry of development of the digestive system of Siberian sturgeon.(a.baerii) during the lecitotrophic. stage. Fish physiol. and biochem, 22: 344-349.
7. Gisbert, E., Rodriguez, A.Castello-Orvay. F, Williot, P.L (1998) A histological study of the development of the digestive tract of Siberian sturgeon (A.baerii) during early ontogeny, Aquaculture, 167: 195-209.
8. Holcik, J. (1989) the fresh water fishes of Europe vol.I/II, General introduction to fish, Acipenseriformes.
9. Hung, S.S.O, Groff, J.M., Lutes, P.B. and Fynn aikins, F.K.(1990) Hepatic and intestinal of Juvenile white sturgeon fed different carbohydrates. Aquaculture, 85: 349-366.
10. Kawai, S. and Ikeda, S. (1971) studies on digestive system of fishes. I.Carbohydrases in digestive organs of several fishes. Bull. Jap. Soc. Sci. Fish, 37: 333-337.
11. Legeza, M.I. (1973) the present distribution of sturgeons (the family Acipenseridae) in the Caspian Sea.J.Voprosy Ichthyologii (Problems of Ichthyology)., 13 6(63): 1008-1015.
12. Ostaszewska, T. (2002) the sequential differentiation and formation of hepatic and pancreatic structures in Aspius aspius larvae. EJPAU, 5(I).
13. Pesseridi, N.I., T.N. Shubina and A.P. Slivka,(1972) Comparative characteristics of age composition of stellate sturgeon harvested in the Volga and Ural Rivers. Book of abstracts of reporting session. Astrakhan, 130-131.
14. Plotnikov, G.K. proskuryakov, M.T.(1984) Sturgeon digestive enzymes during early stage of ontogeny. Kuban state university, krasnodar. J. Evo. Biochem. Physiol, 20(1): 16-18.
15. Polyaninova, A.A.1979. Daily feeding and diets of Russian and stellate sturgeon in the Northern Caspian. In: Biological principles of sturgeon fisheries development in the USSR water bodies. Nauka Press. Moscow, 170-180.
16. Ribeiro, L., Sarasquete, C., Dinic, M.T.(1999). Histological and histochemical development of digestive system of Solea senegalensis larvae.Aquaculture, 171: 293-308.
17. Sarasquete, M.C., Polo, A.and Gonzalez de canales, M.L.(1993). A histochemical and immunohistochemical study of digestive enzymes and hormones during the larval development of the sea bream. Histochem. J, 25: 430-437.
18. Senger, H.et al.(1994) the development of functional digestive and metabolic organs in Turbot.Marine Biology, 119: 471-486.
19. Verreth, J.et al.(1992) the development of functional digestive system in the African cat fish,Clarias gariepinus. Burchell,J
20. Vitvitskaya, L-V,Maldov,D.G.,Tikhomirov,A.M kozlov, A.B. Nikonov, S.I. (1992) Enzyme induction and behavior of juvenile Russian sturgeon under the influence of different feeds. Moscow-Russia, Dokian, 323(6): 1186-1192.
21. Vlasenko, A.D., P.V. Veshchev et al (2001) Assessment of the status of Caspian stellate sturgeon stocks and predication of its catch in 2002. In: Fisheries research in the Caspian Sea. (Results of research work in (2000). Astrakhan, 155-163
22. Voronina, E.P.(1997). Anatomical and histochemical traits of the digestive tract of the salmonoidei. Journal of Ichthyology, 37(8): 641-653.