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Study on the histology of the pineal organ of *Channa gachua*

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Abstract- Pineal organ is thought to be the seat of soul. In early vertebrate the pineal organ is photo sensory organ although during evolution it is transformed into an endocrine gland that secretes a hormone called melatonin. The main cellular component of fish pineal shared many features with the cone photoreceptor of retina. The pineal is located dorsal to the forebrain below or within skull roof. Pineal epithelium consists of photoreceptor cells neurons and ependymal interstitial cells.

Key words: Histology, Pineal organ, *Channa gachua*, photoreceptor cells, photo sensory organ

INTRODUCTION

The pineal gland is part of the endocrine system involved with rhythmic activity in e.g. fish. The main product of the pineal gland is the indole hormone melatonin, synthesised from the amino acid tryptophan. Melatonin is mainly synthesized when it is dark, as light inhibits production. For this reason melatonin is thought to be strongly involved in biological rhythms. The pineal gland is a photoneuroendocrine gland which secretes the hormone melatonin and conveys information to the brain via neural pathway. In fish the entire system (the photodetector, the circadian clock and melatonin synthesizing enzymes) is located in the pineal organ. Several experimental studies indicated that the pineal organ is able to translate environmental information (photoperiod and temperature) into rhythmic messages and the pineal hormone melatonin is the internal chemical messenger of environmental signal or *Zeitgeber* and controls a number of functions, especially reproduction, in vertebrates.

The pineal gland is considered to be part of the system regulating biological rhythmicity, mainly due to its main secretory product, the indole hormone melatonin.[1] In birds and mammals melatonin is strongly involved in the synchronization of diurnal and annual rhythms.

The pineal organ consists of the pineal gland and the parapineal organ. The parapineal organ is present in embryologic stages of development but is lacking in adult fish.[2,3] Whereas the role of melatonin in fish is less clear.[4] Three types of cells are considered the main content of the pineal gland, i.e. pinealocytes (photoreceptor cells), glial (supporting) cells and second order neurons (ganglion cells.[1,2] There are blood vessels supplying blood to all parts of the pineal gland, but they do not penetrate into the parenchyma of the gland.[5,6] The pinealocytes are both photosensitive, containing photopigments, and secretory, producing chemical substances. Pinealocytes have been

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shown to undergo morphological changes in response to changes in photoperiod.[2,3,7]

Several authors reported that gonadal function (wt. and histology) are inhibited with the administration of melatonin. It appears that pineal gland and melatonin are having inhibitory effect to thyroid hormone in fishes during gonadal development and maturation.[8]

The pineal organ develops from the roof of embryonic forebrain and it is a part of central nervous system. Although it was early inferred that the pineal organ of teleost fish is a photo sensory organ.[9,10] However electron microscopic study of main cellular component of fish pineal organ shared many features with the cone photoreceptors of retina that respond to changes in the environmental light conditions. First direct evidence of its photosensitivity was obtained in the rainbow trout (*Onchorhynchus mykiss*).[11] Extensive comparative electron microscopical and neurophysiological studies laid the foundation of our current understanding that during vertebrate evolution the pineal organ has transformed itself from a photosensory organ into an endocrine gland. The pineal organ synthesizes indolamine and the melatonin synthesis is indirectly controlled by the daily dark light cycle. In teleosts, the pineal gland and melatonin have been involved in the control of daily variation of locomotory activity, sleep like state, skin pigmentation or demand feeding and crucial annual function such as growth and reproduction are also influenced by melatonin from pineal gland.

MATERIALS & METHODS

For microscopic study of pineal gland of *Channa gachua*, fish is collected from local market of Muzaffarpur, Bihar, India. Live fish was dissected and the entire brain was separated from the body and was kept in the aqueous Bouin's fixative for 24 hrs. It was then washed thoroughly in tap water in order to remove the colour of Bouin's fluid completely. The material was then dehydrated in graded alcohol. It was washed by Xylene twice with ten minutes interval. By this time material became translucent and clear. It was then put in Xylol wax in the ratio of 1:1 and incubated at a temperature of 56-58^{o}C. Finally the material was infiltrated with wax for twice, each of half hour duration. Block was prepared and sections were cut at 8-10 microns and were subsequently spread and stained. Haemotoxyline-Eosin was used for normal histology. For histochemistry Periodic Acid Schiffs Reagent /Alcian Blue stains were used.

RESULTS & DISCUSSION

The pineal organ grows to form a relatively large vesicle located dorsal to the forebrain just below or within skull roof. In *Channa gachua* the pineal gland is a club shaped structure which is formed as an evagination from the roof of the Diencephalon located in between the Habenular and posterior commissure. The pineal organ is often differentiated into a proximal slender part, Pineal Stalk (PS) and distal part which is expanded called End Vesicle (EV). Length of Pineal Stalk and End vesicle vary from species to species. Pineal Stalk is half of the End vesicle in length. Through the hollow stalk the end Vesicle communicates with the third ventricle. The End vesicle is situated just below the roof of the brain almost between the lateral eyes in *Channa gachua*. The End Vesicle and Pineal Stalk remain in the same plain. The dorsal end of End vesicle is blunt. The ventral end tapers into Pineal Stalk. The cranium is thick over the pineal End vesicle but the scanty distribution of pigment cells over the pineal apparently renders the area. The lumen of both End vesicle and Pineal Stalk is conspicuous by their presence. At least some part of the content is secreted the lining cells is suggested apparently by PAS and AB positive homogenous coagulum and continuity between the luminal contents and the bordering cells through strand like extensions. In *Channa gachua* the wall of the pineal organ i.e. the pineal epithelium consists of photoreceptor cells (PR), neurons (N), and ependymal interstitial cells (IC). These are often called supportive cells and interstitial cells. Macrophages are found mainly in the central lumen. Oligodendrocytes form myelin sheath surrounding some neural axon are also present. Several forms of pineal photoreceptor cells can be distinguished in fishes. Though not cleare but are differentiated into intermediate or common type. In the apical (receptor) and the basal (effector) poles the distinguishing features are found. In the apical pole, the outer segment contains light sensitive photo pigments and the inner segment contains numerous mitochondria and longitudinal cytoskeletal element. The pineal parenchyma which surrounds the basal pole of the photoreceptor axon forms contact with post synaptic neurons or with the basal lamina. The apical pole may vary in shape and size. The lamellae in the outer segment forms a regular cone shaped

stalk, similar to that of retinal cone photoreceptor. However, more often they form a dome or cup shaped stalk. The stalk usually contain relatively few lamellae. The outer segments are irregular in shape. The outer segment consists of mixture of lamellar and tubular membrane formation. Inner segment is typically short, rounded structure. Inner segment is packed with mitochondria. However, in some photoreceptor cell, it is elongated, when it is usually attached to short cone shaped outer segment. The basal pole is also variable. Short axons are possessed by the large majority of the photoreceptor cells that is clearly presynaptic to intrapineal neurons.

Photoreceptor axon terminal impinging occurs mainly on the dendrites but it can also occur on the cell bodies and axon of intra pineal neurons. They typically contain so called synaptic ribbon have been observed in photoreceptor cell bodies. It may be involved in signal transmission to interstitial cells; such contacts allow photic control of synaptic activity in the interstitial cells. Finally, photoreceptor cells also form gap junction with adjacent photoreceptor cells.

The so called supportive cells or interstitial cells form a large proportion of the cells of the pineal parenchyma. They are located between the photo receptor cells. They are attached by tight junctions which, thus form a diffusion barrier between the CSF (cerebrospinal fluid) of pineal lumen and the extra cellular fluid surrounding the photoreceptor cell bodies and axon and the intra pineal neurons. In most species they appear to have widely extending basal poles that line the basal lamina forming a sheet that separates neural elements and the basal pedicles of most photoreceptors cells from the perivascular space.

Pineal arises as a middorsal neuroectodermal evagination from the roof of the diencephalon. It is one of the circum ventricular organ. The cranium over the end vesicle (EV) may show certain specialization, which has variously been called as pineal spot, fontanelle or pineal foramen in fishes. Pineal window is used as term for defining the translucent region of the head skin in some teleost. It was also observed that the specialization presumably is to allow photic stimuli to reach the pineal organ. Histologically the lumen of which is continuous with ventricle of brain lined by darkly stained epithelial cells. The pineal consists of two parts anterior broader part called as end vesicle and posterior narrow portion called pineal stalk. Fish pineal organ has been shown to be photosensitive in may fishes by behavioral. Fish pineal shows a photo sensory role which is demonstrated by electro physiological studies.

The principle site of synthesis and release of hormone, melatonin is the teleost pineal gland. Both the endocrine and exocrine role of fish pineal is well established. Melatonin is also believed to be a chemical transducer of the photic environment and has been implicated in regulating reproductive function also. A pineal control of gonadal maturation has been shown in fishes. Melatonin is known as good inhibitor which mediates the photosexual responses. The exocrine secretion in form of glycogen, of fish pineal has been shown by many investigators.

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