CHAPTER-III

Histogenesis of the hypothalamo-hypophysial neurosecretory system in *Catla catla* (Ham.)
INTRODUCTION:

The developmental events such as growth, sex differentiation and other functional activities are influenced by the secretion of endocrine glands. The study of developing endocrine glands carries a special significance, not only from the viewpoint of their differentiation and functional secretion, but also from the viewpoint of their participation in the metabolic regulation during development of the organism. In spite of great advances made in knowing various aspects of endocrine glands, a study of developmental endocrinology has received little attention. The description of the development of hypothalamo-hypophysial system is limited to few teleosts like *Leuciscus rutilus* (Fridberg and Samuelsson, 1959), *Lebistes reticulatus* (Follenius, 1965), *Anguilla japonica* (Imai, 1965), *Salm osalar* (Klein, 1967), *Clarias batrachus* (Belsare, 1976), *Nandus nandus* (Saxena, 1980) and *Notopterus notopterus*, *Oxygaster bacaila* and *Xenentodon cancila* (Saini, 1984).

Influence of various hormones in understanding certain developmental steps during embryology is very important (Cambre et al., 1990). It has become a well-known fact that growth, sex differentiation and maturity etc. are directly under influence of endocrine secretion. Though a lot of work has been done on the structural and functional aspects of hypothalamo-hypophysial system in teleosts, much remains to be done on the developmental aspect of this system. Most of the work done in this field relates to the
studies made in frog chick and mammals (Gorbman and Bern, 1962). It is interesting to note that in reptiles, birds and mammals, Rathke's pouch, almost from the time it is first formed, is in contact with the infundibulum, a pouch growing out of the floor of the diencephalic part of the brain. In fishes and amphibians, in which there is not so pronounced head fold, the adenohypophysial anlage must grow more actively to reach the infundibulum (Belsare, 1976). Furthermore, in fishes the anlage is often solid instead of vesicular so naming it as "pouch" or pocket (as in case of reptiles, birds and mammals) is not justified.

The development of the pituitary gland and differentiation of its cell types have been studied in several species of teleosts like trout (de Beer, 1926), Fundulus heteroclitus (Matthews, 1937), Gasterosteus aculeatus (Bock, 1928), Salmo salar (Woodmann, 1939), herring (Buchmann, 1940), Abramis (Irikhimovich, 1948), Perca fluviatilis (Kerr, 1949), Chanos chanos (Tampi, 1951). Albula vulpes (Rasquin, 1955), Ophiocephalus punctatus (Belsare, 1963), Xiphophorus maculatus (Schreibman, 1964). Clarias batrachus and Mastacembelus armatus (Malaviya, 1972 and 1980), Nandus nandus (Saxena, 1980), Notopterus notopterus, Oxygaster bocachula and Xenentodon cancila (Saini, 1984), Rasbora daniconius (Pathak, 1986) and Dicentrarchus labrax (Cambre et al., 1990). Nobuko Naito et al., (1993) have morphometrically analysed the growing pituitary glands of chum salmon revealing the precise architectural arrangement of the adenohypophysis and neurohypophysis which is
important to establish the functional hypothalamo-hypophysial system in teleosts.

The histogenesis of nucleus preopticus has been studied in several species of teleosts like Leuciscus rutilus (Fridberg and Samuelsson, 1959), Salmo salar (Arvy et al., 1956 and Klein, 1967), Phoxinus phoxinus (Bhargava, 1969), Clarias batrachus (Belsare, 1978), Nandus nandus (Saxena, 1980), Notopterus notopterus, Oxygaster baciaia and Xenentodon cancila (Saini 1984) and Chum salmon, Oncorhynchus keta (Naito et al., 1993).

**OBSERVATION:**

**Histogenesis of the pituitary gland of Catla catla (Ham.)**

Following stages have been observed during the course of development of pituitary gland.

**A-Proliferation of buccal epithelial cells (5 mm stage)**

At this stage, the development of pituitary gland is characterised by few cells proliferated from the dorsal side of buccal epithelium just infront of notochord in the region of post-optic lamina (Fig.33,34 p.101).

**B-Development of adenohypophysial anlage (6-7 mm stage)**

At this stage the proliferated cells are noticed to accumulate to a greater extent in elongated fashion just in front and dorsal to the notochord. This accumulated mass of cells is known as adenohypophysial anlage which is a small cluster of cells in the form of a solid mass attached to the
Photomicrograph of the vertical longitudinal section of the pituitary gland of *Catla catla* (Ham.).

**FIG.33** : showing the first appearance of adenohypophysial anlage in 5 mm stage (CAHP).

**FIG.34** : showing the development of adenohypophysial anlage in 6 mm stage (CAHP).

**ABBREVIATIONS :**

A.A. - Adenohypophysial anlage
B.E. - Buccal epithelium
NO. - Notochord
floor of diencephalon. At this stage the adenohypophysial anlage also gets separated from the buccal epithelium and reaches near the floor of diencephalon. This adenohypophysial anlage is the progenitor of pituitary gland. (Fig. 34, p. 101; 35, p. 104).

C-Development of neuroectodermal union and undifferentiated pituitary (7-17 mm stage)

At this stage the nervous tissue and blood vessels penetrate the adenohypophysial anlage and a neuro-ectodermal union is established and the pituitary gland is formed. However, various regions of the pituitary gland and its cells are still undifferentiated (Fig. 35, p. 104; 37 p. 106).

D-Development of saccus infundibulum (8-13 mm stage)

During the 13 mm stage the adenohypophysial anlage enlarges and becomes flattened and comes in close contact with the basal hypothalamus. A diverticulum is developed in the ventral floor of the hypothalamus in infundibular region due to the presence of adenohypophysial anlage against it. It is known as saccus infundibulum. The adenohypophysial anlage is enclosed in a connective tissue capsule.

E-Development of neurohypophysis and the differentiation of the cells of the pituitary gland (17-25 mm stage)

The nervous tissue and blood vessels are visible in pituitary gland. Adenohypophysis gives rise to the anterior
Photomicrograph of vertical longitudinal section of the head of *Catla catla* (Ham.).

FIG. 35: showing neuro-ectodermal union and the formation of undifferentiated pituitary gland in 7 mm stage (CAHP.).

FIG. 36: showing the undifferentiated pituitary in 7 mm stage (CAHP.).

ABBREVIATIONS:

- I.R. — Infundibular recesses
- NO — Notochord
- P. — Pituitary gland
Photomicrograph of vertical longitudinal section of the head of *Catla catla* (Ham.).

FIG. 37: showing pituitary gland in 10 mm stage (CAHP.).

FIG. 38: showing the formation of neurohypophysis in pituitary gland in 17 mm stage (CAHP.).

**ABBREVIATIONS**:

ADH - Adenohypophysis

NH. - Neurohypophysis

P. - Pituitary gland

III V. - Third ventricle
FIG. 39: Photomicrograph of vertical longitudinal section of the head of *Catla catla* (Ham.). showing the adenohypophysis differentiating into pars distalis and pars intermedia in 25 mm stage (CAHP.).

FIG. 40: Photomicrograph of transverse section of the head of *Catla catla* (Ham.). showing the attachment of pituitary gland with brain through pituitary stalk in 30 mm stage Mallorys triple.

ABBREVIATIONS:

P. - Pituitary gland
P.D. - Pars distalis
P.I. - Pars intermedia
ST. - Pituitary stalk
pars distalis and the posterior pars intermedia, accompanied by development of the anterior and posterior neurohypophysis (Fig. 38 p. 106). Blood vessels are observed running in a rostro-caudal direction, although they are scanty in adenohypophysis. Most of the cells of glandular region are of acidophilic nature which are Al and PAS negative. Beside this very few basophil cells Al and PAS positive in nature, also appear. It seems that acidophil cells appear first and then the basophil cells.

F-Development of pituitary stalk (25-30 mm stage)

In the 25-30 mm stage definite pituitary stalk is noticed to form (Fig. 39, 40 p. 108). The size of gland and number of glandular cells increases. At this stage, the gland is oval in shape.

G-Formation of neurohypophysial recesses (30-48 mm stage)

During this stage branching of neurohypophysis is noticed. The branches of neurohypophysis penetrate into adenohypophysis as neurohypophysial recesses (Fig. 39, 40 p. 108). Number of blood vessels also increase in neurohypophysis. Neurosecretory material is thus transported through these branches. This is an important function performed by this system. The ramification of neurohypophysial recesses is maximum towards the posterior region of the pituitary gland.
H-Differentiation of adenohypophysis (48 mm stage)

During this stage the adenohypophysis is divided into two parts, the anterior pars distalis and posterior pars intermedia. The cells of pars distalis are oval in shape and are in close association with nerve fibers of the anterior neurohypophysis. The pars distalis contains acidophil and basophil cells. In the pars intermedia region the cells are comparatively few, arranged in compact nature and are of the same size and acidophilic in nature (Fig. 41 p.112).

I-Adenohypophysis differentiated into three regions (65-90 mm stage)

During these stages ranging from 65 to 90 mm in length, the glandular region is divided into three parts, rostral pars distalis, proximal pars distalis and pars intermedia (Fig. 42 p.112). The rostral pars distalis is situated on the anteroventral side of the pituitary gland. It is composed largely of acidophil cells and few basophil cells. The proximal pars distalis is the largest part which occupies approximately 2/3 rd of the glandular region extending from antero dorsal part of the pituitary gland towards its posterior region. Thus proximal pars distalis is best described to be situated in between rostral pars distalis and pars intermedia. It is largely composed of acidophils and basophils and few chromophobe cells. Pars intermedia is situated in the posterior caudal region of the pituitary gland. It is composed of acidophil cells.
Photomicrograph of vertical longitudinal section of the head of *Catla catla* (Ham.).

**FIG. 41**: showing the differentiation of adenohypophysis into three regions: rostral pars distalis, proximal pars distalis, and pars intermedia in 48 mm stage (CAHP.).

**FIG. 42**: showing the structure of pituitary gland in 65 mm stage (CAHP.).

**ABBREVIATIONS**:

NH. - Neurohypophysis
P.I. - Pars intermedia
P.P.D. - Proximal pars distalis
R.P.D. - Rostral pars distalis
S.V. - Saccus vasculosus
III V. - Third ventricle
Photomicrograph of vertical longitudinal section of the head of Catla catla (Ham.).

FIG. 43: showing the structure of pituitary gland in 100 mm stage (Mallory's triple).

FIG. 44: showing the structure of pituitary gland in 150 mm stage (Mallory's triple).

ABBREVIATIONS:

NH. - Neurohypophysis
P.I. - Pars intermedia
P.P.D. - Proximal pars distalis
R.P.D. - Rostral pars distalis
ST. - Pituitary stalk
J-Further differentiation in the pituitary gland (100-250 mm stage)

During this stage the gland is oval in shape, pointed a little posteriorly. The rostral pars distalis is composed of two types of cells, acidophils and basophils. Acidophil cells are small in size and are arranged around the neurohypophysial recesses (Fig. 43, 44 p. 114). They are round or oval in shape and have fine granules in the cytoplasm. The basophils are oval in shape. Proximal pars distalis is made up of acidophils, basophils and some chromophobe cells. The lightly staining acidophils are round in shape which are scattered throughout the proximal pars distalis, without any definite arrangement. The basophil cells, which are AD, PAS and CAHP +ve, are spherical or oval in shape and are larger than acidophil cells (Fig. 14, p. 114). The basophils of proximal pars distalis are differentiated into two types on the basis of their tinctorial properties. Darkly stained basophils (or Basophil-I) are closely packed and show a follicle-like arrangement around the neurohypophysial recesses. They possess granulated cytoplasm. The lightly staining basophils (Basophil-II) are few in number scattered among groups of acidophils or Basophil-I. They are polygonal in shape and have lesser granulated cytoplasm than the Basophil-I.

Pars intermedia is situated in the posterior region of the pituitary gland. This region is composed of mainly
acidophils and a few basophil cells which are similar to Acidophil II and basophils of rostral pars distalis in their cellular nature and tinctorial properties. The acidophil cells are rounded or oval in shape. These cells are present in groups along the neurohypophysial recesses.

**Histogenesis of Nucleus Preopticus**

**Stage-I: First appearance of nucleus pre-opticus pars magnocellularis (10-25 mm)**

In 10 mm stage a few NPO cells are seen just behind the heubunular ganglion occupying a anterolateral position. These cells have been identified as pars magnocellularis cells of NPO (Fig. 45, 46 p.118). Each nucleus pre-opticus cell is oval or round in shape and possesses a round nucleus. The neurosecretory material is very scanty in this stage, which is lightly AF+ve.

**Stage-II: First appearance of nucleus preopticus pars parvo cellularis cells (50mm)**

During this stage the pars magnocellularis cells increase in number situated just anterior to optic chiasma on the lateral side of III ventricle. A little ventral to this group of cells, a few smaller neurosecretory cells also appear which are designated as pars parvo cellularis cells. These cells are oval in shape with a very faintly stained cytoplasm which is devoid of neurosecretory material (Fig. 47, p.120).
Photomicrograph of vertical longitudinal section of the brain of *Catla catla* (Ham.).

FIG. 45: showing the first appearance of nucleus preopticus cells in 20 mm stage (CAHP.).

FIG. 46: showing the nucleus preopticus pars magnocellularis cells in 30 mm stage (AF.).

ABBREVIATIONS:

I.NPO. - First appearance of the nucleus preopticus cells

P.MC. - Pars magnocellularis
Photomicrograph of vertical longitudinal section of the brain of *Catla catla* (Ham.).

FIG. 45: showing the first appearance of nucleus preopticus pars-parvocellularis cells in 50 mm stage (AF.).

FIG. 43: showing the structure of NPO mass in 70 mm stage.

ABBREVIATIONS:

P.MC - Pars magnocellularis cells
P.PC - Pars parvocellularis cells
Stage-III : Differentiation of Neucleus preopticus cells and Nucleus preopticus mass (70-100 mm)

With further development, the cells of pars magnocellularis increase in size and number. The gap between pars magnocellularis and pars parvocellularis cells decreases and both these groups lie in close vicinity of each other (Fig.48, p.120). Both these groups of cells are differentiated from each other on the basis of their cell size and staining properties. The pars magnocellularis cells are larger in size and more deeply AF+ve in comparison to pars parvocellularis cells. Thus both these groups together constitute a compact NPO mass which is elongated dorsoventrally and a little comma shaped. The number and size of cells of NPO mass increases gradually with the appearance of neurosecretory material. A few cells show prominent axons also.

Stage-IV : Further histological differentiation in nucleus preopticus mass (125-350 mm)

In the subsequent stage of development (125 to 350 mm) the cells of NPO mass become more and more AF and CAHP+ve with the accumulation of more and more neurosecretory material in their cytoplasm. The structure of NPO mass also changes from comma shape to inverted "L" shape with the increase in number of neurosecretory cells where the smaller arm of inverted "L" shape is made up of pars magnocellularis cells whereas the larger arm, which projects
Photomicrograph of vertical longitudinal section of the brain of *Catla catla* (Ham.).

FIG. 49: showing pars magnocellularis and pars parvocellularis cells in 125 mm stage (AF.).

FIG. 50: showing pars magnocellularis and pars parvocellularis cells in 225 mm stage (Alcain blue/PAS).

ABBREVIATIONS:

P. MC. - Pars magnocellularis cells
P. PC. - Pars parvocellularis cells
ventrolaterally, is made up of pars parvocellularis cells. The pars magnocellularis cells are markedly larger than the pars parvocellularis cells (Fig. 19.50 p.123). The granulated cytoplasm of both types of neurosecretory cells are heavily loaded with neurosecretory material. The axons of both types of cells contribute in the formation of right and left tractus preopticohypophyseus. The neurosecretory material appears in the neurohypophysis in 125 to 150 mm stage whereas in tracts preopticohypophyseus it appears in 300 to 350 mm stage.

Histogenesis of nucleus lateralis tuberis:

Stage-I : First appearance of nucleus lateralis tuberis cells (70mm)

At 70 mm stage, few nucleus lateralis tuberis cells appear on the ventral floor of the hypothalamus just anterior to the pituitary. These cells, which are 6 to 7 in number, are small in size and oval in shape containing faintly AF+ve neurosecretory material (Fig.51, p.127).

Stage-II : Formation of ventromedian group of nucleus lateralis tuberis cells (90mm-150mm)

At this stage the NLT cells increase in number in the ventromedian region of hypothalamus to constitute a definite group of cells termed as ventromedian group of cells or ventro-median component of nucleus lateralis tuberis (Fig.52, p.127: 53.54, p.130). These cell are round or oval
in shape with a definite centrally placed nucleus. around which is present faintly stained neurosecretory material.

Stage-III: Formation of ventro lateral group of nucleus lateralis tuberis cells (105-180 mm)

During this stage few nucleus lateralis tuberis cells appear ventrolaterally in the hypothalamus anterior to the ventro median group of cells. These cells are larger in size in comparison to ventro median group of cells and are round or oval in shape. The neurosecretory material in the cytoplasm is in greater quantity which is deeply AF+ve. CAHP+ve and Mallory's triple stain +ve. These cells show both unipolar and multipolar axons which contribute in the formation of tractus preopticohypophyseus (Fig.55, 56, p.131).

Stage-IV: Further differentiation of nucleus lateralis tuberis cells (150-240 mm)

During the latter stage of development, both these group of cells further differentiate in the form of two definite components of nucleus lateralis tuberis. The cells increase in size and number. Ventro lateral group of cells are also noticed along the ependymal lining of the third ventricle (Fig.55, 56 p.131).
Photomicrograph of vertical longitudinal section of the brain of *Catla catla* (Ham.).

FIG. 51: showing the first appearance of nucleus lateralis tuberis cells in 70 mm stage (CAHP.).

FIG. 52: showing the first appearance of ventrolateral group nucleus lateralis tuberis cells in 90 mm stage (CAHP.).

ABBREVIATIONS:

I.NLT. - First appearance of nucleus lateralis tuberis

NLT.V.M. - Nucleus lateralis tuberis ventro median group.
Photomicrograph of vertical longitudinal section of the brain of *Catla catla* (Ham.).

FIG.53 : showing the ventro-median group of nucleus lateralis tuberis cells in 150 mm stage (Alcian blue/PAS).
FIG.54 : showing the axons of ventro-median group of nucleus lateralis tuberis cells in 225 mm stage (Alcian blue/PAS).

ABBREVIATIONS :

AX. - Axon
N. - Nucleus
NLT.V.M. - Nucleus lateralis tuberis is ventro-median group.
Photomicrograph of vertical longitudinal section of the brain of *Catla catla* (Ham.).

FIG. 53: showing the axons of ventro lateral group of nucleus lateralis tuberis cells in 240 mm stage (Alcian blue/PAS).

FIG. 54: showing the ventro lateral group of nucleus lateralis tuberis cells in 160 mm stage (Mallory's triple).

ABBREVIATIONS:

AX. - Axon

N. - Nucleus

VLT.V.L. - Nucleus lateralis tuberis is ventro-lateral group.
DISCUSSION

The study of developing endocrine glands carries a special significance because of their role in metabolic regulation of developing organisms through their secretion. The teleost pituitary gland consists of two parts, the glandular part or the adenohypophysis and the nervous part or the neurohypophysis. Both these are different from each other embryologically as well as structurally and functionally. The adenohypophysis arises as an ectodermal upgrowth from the dorsal side of buccal cavity and neurohypophysis originates as a downgrowth from the floor of diencephalon. In Catla catla, the cells proliferated from the roof of buccal epithelium accumulate in a small cluster of cells known as adenohypophysial anlage. The proliferation of ectodermal cells takes place just in front of notochord where the buccal cavity is close to the diencephalon. This pattern of origin is also found in Petromyzon (de Beer, 1923), teleosts and amphibians (de Beer, 1928), Lepidosiren (Kerr, 1933), Fundulus heteroclitus (Mathews, 1937). Cyprinus carpio (Robson, 1938), Salmo salar (Woodman, 1939), Ophioccephalus punctatus (Belsare 1963), Mastacembelus armatus (Malaviya, 1972), Clarias batrachus (Malaviya, 1972 and Belsare, 1976), Nandus nandus (Saxena, 1980), Notopterus notopterus, Oxygaster barbaila and Xenentodon cancila (Saini, 1984), Rasbora daniconius (Pathak, 1986) and chum salmon (Nubuko naito, 1993).
In *Chanos chanos* (Tampi, 1951), *Elops saurus* (Olsson, 1958) and *Engraulis telea* and *Gadusia chapra* (Sathyanesan, 1963) the pituitary gland originates as a pouch from the buccal region and the cavity of the pituitary gland is called as buccohypophysial cavity. Prasada Rao (1965) has studied the pituitary gland of forty species of teleosts and has drawn the conclusion that the presence of hypophysial cavity in certain species indicates a lower grade of organisation whereas the absence of such cavity shows highly evolved pituitary among the teleost. As in *Mastacembelus armatus* (Malaviya, 1972 and 1980), *Nandus nandus* (Saxena, 1980), *Notopterus notopterus*, *Oxygaster bacaila* and *Xenentodon cancila* (Saini, 1984), in *Catla catla* also, the hypophysial cavity has not been observed at any stage of the development of the pituitary gland. Looking to the observations of Prasada Rao (1965) it can be concluded that the development of pituitary gland in *Catla catla* indicates its highly evolved nature.

In the early stages of the embryo of *Chanos chanos*, Tampi (1951, 1953) has observed that the anterior end of the pituitary gland and buccal cavity are connected by means of a diverticulum, the bucco-hypophysial canal. Such a connection of pituitary gland with the buccal cavity has also been reported in *Elops saurus* (Olsson, 1958) and *Gadusia chapra* and *Engraulis telea* (Sathyanesan, 1963). Gorbman and Bern (1962) are of the opinion that bucco-hypophysial canal of teleosts can not be homologised with the "Rathke's pouch"
of higher vertebrates which is in contact with the infundibulum right from the beginning of its diverticulum. As in *Mastacembelus armatus* (Malaviya, 1972 and 1980), *Clarias batrachus* (Malaviya, 1972) and *Nandus nandus* (Saxena, 1980), in *Catla catla* also bucco-hypophysial canal has never been observed during the course of development of the pituitary gland.

The first appearance of the ectodermal thickening is seen in 5mm stage in *Catla catla*. In later stage (6-7mm stage) the adenohypophysial anlage is found which gets separated off from the buccal epithelium due to pressure of developing mesodermal cells below and around its surface and makes contact with the floor of the diencephalon. In later stage (up to 10mm stage), the nervous tissue and blood vessels penetrate the adenohypophysial anlage forming neuro-ectodermal union. Similar mode of development has also been observed in *Mastacembelus armatus* (Malaviya, 1972). *Clarias batrachus* (Malaviya, 1972 and Belsare, 1976), *Nandus nandus* (Saxena, 1980). *Notopterus notopterus*, *Oxygaster bacaila* and *Xenentodon cancila* (Saini, 1984). At this stage an undifferentiated but a definite pituitary gland is formed. In 10mm stage of *Catla catla*, saccus infundibulum is formed in the ventral floor of the hypothalamus due to the impushing of adenohypophysial anlage. Saccus infundibulum, has also been reported to be formed in *Notopterus notopterus*, *Oxygaster bacaila* and *Xenentodon cancila* (Saini, 1984) in 10mm, 9mm and 11mm stages respectively.
In *Catla catla*, the neuroectodermal union and undifferentiated pituitary is formed in 7-10mm stage. Sasayama and Takahashi (1975) have also reported that at 9mm stage a definite pituitary is formed in *Tilapia mossambica* but it is undifferentiated. At 11mm stage most of the constituent cells begin to be stainable with acidic dyes, thus suggesting an early differentiation of pro-adenohypophysis. In chum salmon, Nuo naito (1993) has observed that 3 weeks after hatching the glandular cell cords are formed in the proximal pars distalis as well as follicle-like structure in the rostral pars distalis, in close association with nerve fibers of the anterior neurohypophysis. In the pars intermedia, however no cell cord was observed. As regards the cellular differentiation in the pituitary gland in *Catla catla*, it is observed that in 17-25mm stage the acidophil cells appear first and then the basophils cells.

First appearance of acidophil cells is also observed in *Clarias batrachus* (Belsare, 1976), *Nandus nandus* (Saxena, 1980) and *Notopterus notopterus* and *Oxygaster bacailia* (Saini, 1984). In *Clarias batrachus*, Malaviya (1972) observed the presence of basophils prior to the appearance of acidophils some of which become chromophilic in the later stages. Saint Remy (1892), Benda (1900) and Collin (1933) suggested that acidophils and basophils represent two different physiological states of the same cell type. Bretschneider and Duyvène de wit (1947) have suggested that acidophils represent a state of formation of hormones whereas the basophils represent a state of liberation of
these hormones. Baranikova (1950) has reported that the basophilic granules become acidophilic on hardening. The presence of acidophilic granules in the basophils have been reported in certain species of teleost (Schreibman, 1964; Rai, 1967 and Prasada Rao, 1969). According to Belsare (1976) these represent transitional stages of acidophilia to basophilia in teleosts. Rampf and Smith (1928) in some foetal mammals and Belsare (1963) in Ophiocephalus punctatus are of the opinion that the insufficiency of the chromophilic cells in the pituitary at early development stages indicates a later hormonal activity. According to Belsare (1976), whether the basophils are differentiated from other cells which give rise to the acidophils is not clear.

The central role played by the PAS procedure in pituitary studies has been often emphasized (Herlant, 1960). This technique distinguishes cells with non glycoprotein granules (PAS negative) from cells with glycoprotein one (PAS positive), a distinction approximately corresponding to the older division between acidophils and basophils which are also often marked by the terms serous cells and mucoid cells respectively (Herlant, 1964). Belsare (1976) suggested that the gonadotropin or thyrotropin or both are secreted at an early stage and they may play a significant role in the maturation process. Belsare's suggestion received further support by the findings of Schreibman et al., (1982) who were able to detect immuno-reactive gonadotropic hormone (GTH) and luteinising hormone releasing
hormone (LHRH) in cells located in both the caudal pars distalis and the pars intermedia of pituitary gland of neonatal platy fish and they have suggested that GTH from these regions may directly effect the maturation of brain-pituitary-gonad axis in young fish. In *Catla catla* the PAS+ve granules in basophil cells of proximal pars distalis have been observed in the later stages of development.

Kerr (1942) classified the teleostean pituitary into two types on the basis of the presence or absence of pituitary stalk and infundibular recess. Type A includes the pituitaries which have a definite stalk and obliterate infundibular recess, whereas type B includes those pituitaries which are without a definite stalk and have an open infundibular recess. These two types (A and B) correspond to the leptobasic and platybasic types of Bretschneider and Duyvende wit (1947) respectively. In *Nandus nandus*, Saxena, (1980) observed that during development a leptobasic type of attachment found in the earlier stages becomes platybasic in later stages and he concluded that the leptobasic type of arrangement is primitive to platybasic type. In *Oxygaster bacaila* and *Xenentodon cancila* (Saini, 1984) a leptobasic type of attachment is present and in *Notopterus notopterus* (Saini, 1984) a platybasic type of attachment is found and a definite pituitary stalk is not observed. In *Catla catla* a definite pituitary stalk (leptobasic type) is observed from 25mm stage onwards. A platybasic type of attachment is never seen.
In *Catla catla* the pars magnocellularis group of NPO cells appears first in 10mm stage, whereas the pars parvocellularis group of NPO cells appears later in 30-50mm stage. During this stage these two groups of cells are separate from each other. In later stage (70 to 100mm stage), with the increase in number and size of cells, both these groups lie in close vicinity of each other. Similar pattern has also been observed in *Phoxinus phoxinus* (Bhargava, 1969), *Nandus nandus* (Saxena, 1980), *Notopterus notopterus*, *Oxygaster bataila* and *Xenentodon cancila* (Saini, 1984) and *Rasbora daniconius* (Pathak, 1986). Bhargava (1969) has suggested that during the course of evolution, the neurobiotic factors have further separated these two masses (groups of cells) to give rise to two nuclei of higher vertebrates. The observation in *Catla catla* further confirms the views of Scharrer and Scharrer (1940, 1945), Green and Maxwell (1959) and Bhargava (1969) that the pars magnocellularis and pars parvocellularis are homologus to supraoptic and paraventricular nuclei of higher vertebrates.

The transport theory of Bargmann and Scharrer (1957) states that the site of origin of the stainable neurosecretory material is the perikarya, from where it is transported through the processes of the neurosecretory cells to the terminals of these cells where it may either be delivered directly into the body fluids or be stored before it is released. This theory very well explains the appearance of neurosecretion in tractus pre-optico-neurohypophyseus as a
result of the storage of more material in the neurohypophysis than being released in blood for circulation. The light microscopical observations on the histogenesis in *Leuciscus rutilus* (Fridberg and Samuelson, 1959) and *Salmo salar* (Klein, 1947) however show that the neurosecretory material is seen first in the neurohypophysis and then in the cell bodies of nucleus preopticus. These observations apparently indicate the importance of terminal regions of the neurosecretory system in the synthesis of secretion and favor the view expressed by Bodian (1951) and Diepen et al., (1954) on the neurosecretory phenomenon. An alternate explanation for the late appearance of neurosecretory material in cell bodies as given by Fridberg and Samuelson (1959) and Klein (1967) is that the secretion exists in meagre quantity and which is not revealed by histological techniques. Follonius (1965) has demonstrated electron microscopically that the neurosecretory material, which is elaborated in the form of sub microscopical granules, is detectable with the help of light microscope only after reaching certain concentration in young animals and thus supports the view already expressed by several authors (Fridberg and Samuelson, 1959; Mazzi, 1954; Scharrer and Scharrer, 1954 and Rodeck and Caesar, 1956).

Arvy et al., (1956) have reported that first visible secretion in the nucleus preopticus is observed on third day and in the neurohypophysis on eight day after hatching in *Salmo salar* whereas in the same fish, Klein (1957) is able to detect it in the neurohypophysis one day after hatching, in
the nucleus preopticus on 5th day and in the tractus pre-optico-hypophysae on fifteenth day after hatching. Fridberg and Samuelson (1959) have noted that the neurosecretory material in Leuciscus rutilus appears in the neurohypophysis two days after hatching, in the tractus pre-optico-hypophyseus twenty two days after hatching and in the nucleus preopticus when the fish is more than one year old. In Clarias batrachus (Belsare, 1976), the neurosecretory material is detected in the NPO and the neurohypophysis on seventh day of hatching, but in the tractus pre-optico-hypophyseus six weeks after hatching. It does not seem impossible that in different species, difference in the secretory process already exists during early life of the fish. In Nandus nandus, Saxena (1980) has reported that the neurosecretory material appears first in the nucleus pre-opticus cells and later in the neurohypophysis during early stages of development whereas the appearance of neurosecretory material in tractus preoptico-hypophyseus takes place much later. This is in confirmation to the present findings in Catla catla and earlier findings in Notoperus notopterus, Oxygaster bacatla and Xenentodon cancila (Saini, 1984).

In Catla catla, the nucleus lateralis tuberis cells appear after the formation of nucleus preopticus mass. At 90mm stage, these cells form a definite group of cells termed as ventro-median group. At 105-150mm stage, another group of cells, the ventro-lateral group appears in the hypothalamus anterior to the ventro-median group of cells. In Nandus
nandus (Saxena, 1980) and Oxygaster bacaila (Saini, 1984), the nucleus lateralis tuberis cells are present in only one group. In Xenentodon cancila (Saini, 1984), two groups of nucleus lateralis tuberis cells are present where the posterior ventro-lateral group of cells appear first and anterior ventro-lateral group of cells appear later. The observation in Catla catla confirms the finding of Belsare (1978) in Clarias batrachus, Saxena (1980) in Nandus nandus and Saini (1984) in Oxygaster bacaila and Xenentodon cancila that preoptico-hypophysial neurosecretory system develops earlier than the development of tubero hypophysial neurosecretory system.