Journal of Fisheries International 7 (3-6): 65-69, 2012
ISSN: 1817-3381

Cyclic Changes in the Hypothalamo-Neurohypophysial System of *Xenentodon Cancila* (Ham.)

[1]Zahida Khuroo and [2]R. Chauhan
[1]Department of Zoology, Government College Baramulla, Kashmir (J&K)
[2]Department of Zoology, Government Maharani Laxmi Bai Girls (P.G.), Bhopal, India

Abstract: Hypothalamo-neurosecretory complex of *Xenentodon cancila* consists of Nucleus Preopticus (NPO), Nucleus Lateralis Tuberis (NLT) and their axonal tracts. NPO is a paired structure situated on either side of the third ventricle anterodorsal to the optic chiasma. NPO is divisible into a dorsal Pars Magnocellularis (PMC) consisting of large neurosecretory cells and Pars Parvocellularis (PPC) formed of smaller neurons. Neurons of PMC and PPC contribute beaded axons to form neurohypophysial tract. Herring bodies are seen in the anterior as well as posterior neurohypophysis.

Key words: Hypothalamo-neurosecretory complex, tractus preoptico hypophyseus, *Xenentodon cancila*, NLT, PMC, PPC

INTRODUCTION

Hypothalamus of *Xenentodon cancila* comprises Nucleus Preopticus (NPO), Nucleus Lateralis Tuberis (NLT) and their axonal tracts. NPO is a paired structure situated on either side of the third ventricle anterodorsal to the optic chiasma. NPO is divisible into a dorsal Pars Magnocellularis (PMC) consisting of large neurosecretory cells and Pars Parvocellularis (PPC) formed of smaller neurons. NLT cells are distributed uniformly in the infundibular floor adjacent to the pituitary stalk. Neurons of PMC and PPC contribute beaded axons to form neurohypophysial tract. Neurosecretory colloid like material of varying sizes is encountered in NPO. The site of origin of the neurosecretory substance and of the neurohypophysial hormones is the hypothalamus, i.e., the preoptic or the supraoptic and the paraventricular nuclei (Bargmann and Scharrer, 1951).

Herring bodies are seen in the anterior as well as posterior neurohypophysis. Hypothalamus also contains receptors, specifically sensitive to the hormones which in turn, regulate its activity through feedback mechanism (Peter *et al*., 1991). There are increasing evidences to the effect that in fishes too, the hypophysial functions are controlled by the hypothalamic neurohormones but the regulatory mechanisms are not precisely understood (Peter *et al*., 1991). It has been shown experimentally (Gerschenfeld *et al*., 1960) that the elementary granules of the neurohypophysis are the submicroscopic structures which correspond to the neurosecretory substance (Gomori-positive material).

MATERIALS AND METHODS

Living specimens of *Xenentodon cancila*, procured from Lower Lake, Bhopal (Madhya Pradesh, India) were collected in the last week of every month for a period of 1 year which were dissected to expose the cranial cavity. The pituitary along with hypothalamus was carefully separated from the cranium and kept in the fixative. Fixation in formaline was done from 4-6 h; while, the material was kept in Bouin's fluid for 24 h. The material fixed in formaline was washed in running tap water for about 6 h and dehydrated in ascending series of alcohol, cleared in xylene and embedded in paraffin wax at 60°C. Serial sections of pituitary along with hypothalamus in paraffin were cut at 6 μm in thickness. Pituitary was stained in Mallory's triple, Aldehyde Fuchsin (AF) and Chrome Alum-Hemotoxylin-Phloxine (CAHP) methods as followed by Dawson (1953) and Sathyanesan (1968).

RESULTS

Histo-architectural changes in hypothalamus

Cytological variations in the Nucleus Preopticus (NPO): In *Xenentodon cancila* of present investigation, each NPO mass is in the form of inverted L shaped structure. It was situated along the sides of lateral recess of third ventricle anterior to the optic chiasma. The cytoplasm of nucleus preopticus cell of *Xenentodon cancila* was granular and there was no formation of neurosecretory droplets. Thus, the only visible changes in the nucleus

Corresponding Author: Zahida Khuroo, Department of Zoology, Governemt College Baramulla, Kashmir (J&K)

preopticus were noticed in the intensity of granular neurosecretory material in the cytoplasm by using different staining methods.

In *Xenentodon cancila*, the neurosecretory material was poorly accumulated and less concentrated due to which the vacuoles appeared in the cytoplasm during July, August and September, 2007 and June, 2008. This indicates that the accumulation of neurosecretory material was less than its release and it had poor staining intensity (Fig. 1). This condition continued till October to December, 2007; when the neurosecretory material in the cells started accumulating and also in the month of October and November, 2007; the cytoplasm of NPO cells showed vacuolization and lesser concentration of neurosecretory granules (Fig. 2). The cytoplasm showed less tinctorial affinity towards CAHP stain. This indicated that the NPO cells were exhausted and in less active phase as far as the production of neurosecretory material is concerned. During the study period from December, 2007 to February, 2008, the vacuoles disappeared from the cytoplasm of the NPO cells and the neurosecretory granules increased quantitatively and became denser (Fig. 3). The neurosecretory material showed greater tinctorial affinity towards CAHP stain. This showed that the production of neurosecretory material by the cell was accelerated. During March and May, 2008; the neurosecretory granules were more concentrated (Granulation) and uniformly distributed within the cytoplasm and showed deep staining intensity (Fig. 4). This was due to the accumulation of neurosecretory material in the cytoplasm at a comparatively higher rate.

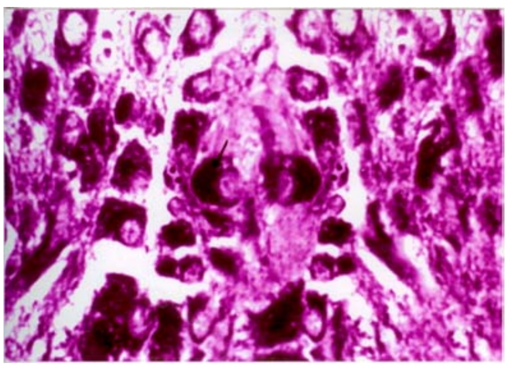

Fig. 1: The cells of nucleus preopticus in the month of August with large number of vacuoles and sparsely distributed neurosecretory material 1000x (arrow)

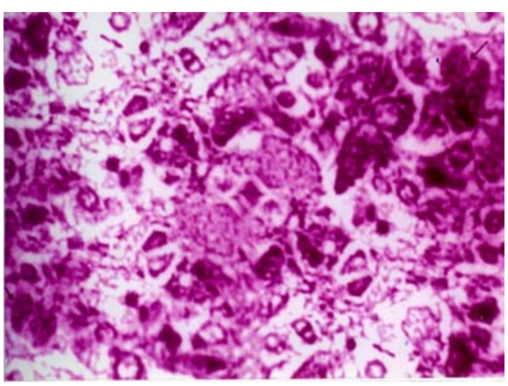

Fig. 2 : The cells of nucleus preopticus in the month of October with vacuoles and lesser concentration of neurosecretory material 1000x (arrow)

Cytological variations in the Nucleus Lateralis Tuberis (NLT): The course of the distribution of the neurosecretory material in the nucleus lateralis tuberis cells were studied in different months of the year. In July, 2007 and June, 2008; the neurosecretory granules in the cytoplasm were sparsely concentrated. This indicated that the elaboration of the neurosecretory material was less than its release (Fig. 5). In October and November,

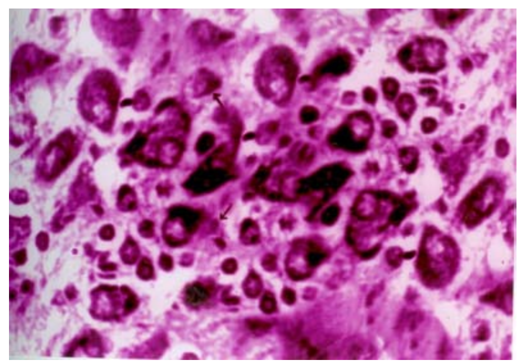

Fig. 3: The cells of nucleus preopticus in the month of February with more concentration of neurosecretory material 1000x (arrow)

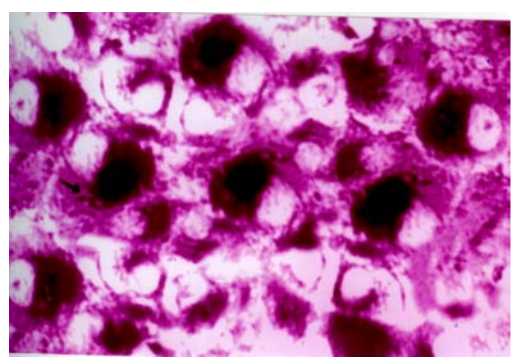

Fig. 4: The cells of nucleus preopticus in the month of May with greater accumulation of neurosecretory material 1000x (arrow)

2007; the cells and their nuclear sizes were very small and there was a very thin layer of cytoplasm around the nucleus. The cytoplasm contained very little amount of neurosecretory material which indicated the inactive phase of NLT cells (Fig. 6). In May and early June, 2008; the nucleus of the NLT cells became large in size. The neurosecretory granules in the cytoplasm were closely concentrated (Fig. 7 and 8). These changes indicated that the secretion of neurosecretory material was intense during the month of May, 2008.

Cyclic variations in the tractus preoptico-hypophyseus and neurohypophysis: The intensity of neurosecretory material in the tractus preoptico-hypophyseus exhibited significant variations during different months of the study period. In the months from August to November, the intensity of neurosecretory material in the tractus preoptico-hypophyseus was minimum. This was due to the fact that the NPO cells were exhausted. During the months from December to February, the intensity of the neurosecretory material was less as compared to the observation from May to September, 2008 (Fig. 9). From

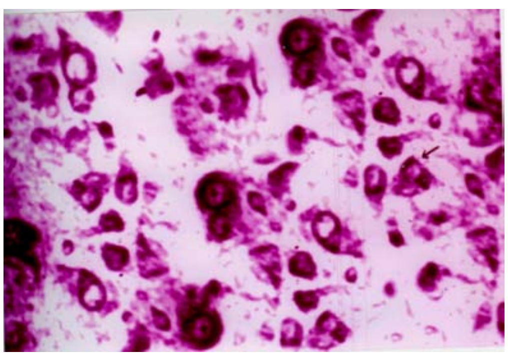

Fig. 5: The cells of nucleus lateralis tuberis in the month of June with lesser concentration of neurosecretory material 1000x (arrow)

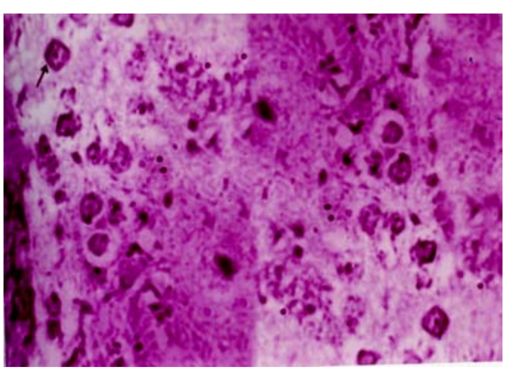

Fig. 6: The cells of nucleus lateralis tuberis in the month of October with a poor accumulation of neurosecretory material 1000x (arrow)

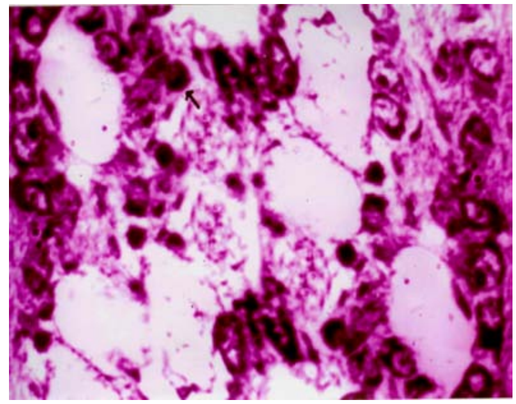

Fig.7: The cells of nucleus lateralis tuberis in the month of January with more concentration of neurosecretory material 1000x (arrow)

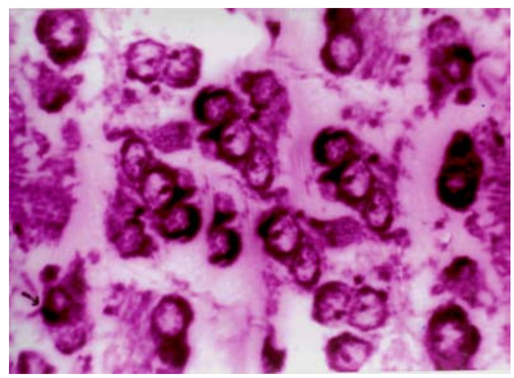

Fig. 8: The cells of nucleus lateralis tuberis in the month of March with greater concentration of neurosecretory material 1000x (arrow)

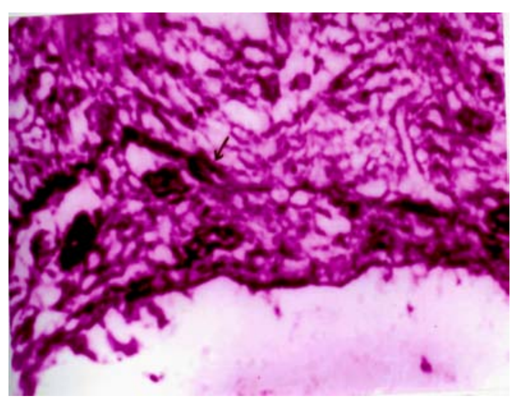

Fig. 9: Tractus preoptico-hypophyseus with more intensity of neurosecretory material; 1000x (arrow)

April to June, 2008; the intensity of the neurosecretory material was maximum due to higher rate of the release of neurosecretory material from NPO.

The intensity of the neurosecretory material in neurohypophysis also showed noticeable variations during different months of the year. In the month of August to November, the intensity of the neurosecretory material was minimum and from December onwards the intensity of the neurosecretory material tends to increase gradually. In the month of March to July, the deposition of the neurosecretory material in neurohypophysis was found to be maximum due to heavy transformation of the neurosecretory material through the tractus preoptico-hypophyseus.

The nuclear volume of the nucleus preopticus cells in the September, 2007 and May, 2008 was higher from that of the observation during January to April, 2008 which indicated its high degree of metabolic activity. In the month of October to December, 2007; the nuclear volume of the nucleus preopticus cells were very less, indicating a lower metabolic activity after September. From January to April, 2008; the nuclear volume of the cells increases steadily and significantly indicating the increased activity of cells.

DISCUSSION

The nucleus preopticus mass exhibits variations in its shape, position and extension in different teleosts in different months of the year. The paired NPO was slightly S-shaped in roach (Fridberg and Samuelson, 1959; Ekengren, 1973), handle-shaped in *Phoxinus phoxinus* (Bhargava, 1965) and *Mystus vittatus* (Bais, 1977), U-shaped in *Clarias batrachus*, Bizzare type in *Ophiocephalus punctatus* (Chandrasekhar and Khosa, 1972) and knob-shaped in *Glossogobius giuris* (Saksena, 1974). In *Xenentodon cancila*, the present investigation showed each NPO mass was situated in the form of inverted L-shaped structure along the side of the lateral recess of third ventricle (preoptic recess) anterior to the optic chiasma which resembles with that of *Anguilla anguilla* (Leatherland *et al*., 1966); *Macrognathus aculeatus* (Haider and Sathyanesan, 1971); *Catla catla* (Sathyanesan, 1973).

In *Phoxinus phoxinus* (Bhargava, 1965), G*lossogobius giuris* (Saksena, 1974) and *Mystus vittatus* (Bais, 1977), it was observed that the neurosecretory droplets are invariably present inside the cell. Belsare (1967) has described that the presence of vacoules in the cytoplasm and colloidal droplets as the indication of neurosecretory activity of the nucleus preopticus in *Channa punctatus.* In *Xenentodon cancila*, the cytoplasm of the cell contains granular neurosecretory material. The granules get accumulated in the cytoplasm but the droplets were not observed, some researchers have already reported on some fishes like; *Misgurnus fossilis* (Jasinski, 1968), *Glossogobius giuris* (Saksena, 1974) and *Mystus vittatus* (Bais, 1977).

The nucleus lateralis tuberis forms the second hypothalamic nuclear centre which in *Xenentodon cancila* was situated in the ventral and ventro-lateral region of the hypothalamus. The distributional pattern of the neurons of NLT as described by Charlton (1932) was fundamentally accepted by Ekengren (1973) in fishes studied by them. Hild and Brehm have suggested that the direct release of neurosecretory material of NLT in the ventricular lumen by the rupturing of large cytoplasmic vessels. In *Xenentodon cancila* similar to *Heteropneustes fossilis* (Haider and Sathyanesan, 1972a-c) and *Catla catla* (Sathyanesan, 1973) some additional NLT cells were found scattered, beyond the 2 groups of NLT and the size of these cells was comparatively large and their axonal fibres joined the preoptico-hypophysial tract during its course towards pituitary. Observations on the axonal transport in the present investigation gets gets support from the suggestion made by Billenstien (1963) and Sathyanesan (1973).

In *Glossogobius giuris* (Saksena, 1974), the granulation, degranulation and the intensity of the neurosecretory material were the base of the cytological variations during different months of the year. In *Alburnus albidus* and *Alosa fallax* (Pavlovic and Pantic, 1973), *Torpedo ocellata* and *Coregonus autumnalis migratorius* (Tischenko *et al*., 1976), the cytological variations were based on the quantity of the neurosecretory substance and vacuolisation.

CONCLUSION

Many researchers have reported that large masses of neurosecretory material are present at different intervals in the tractus preoptico-hypophyseus (Pickford and Atz, 1957; Dodd and Kerr, 1963). Sathyanesan (1965a,b) in *Priochthys notatus*, Chandrasekhar and Khosa (1972) in *Heteropneustes fossilis*, *Clarias batrachus* and *Ophiocephalus punctatus* have observed, darkly stained AF^+ colloid in the tract. However, there was no sign of the degeneration of nucleus preopticus cells in these cases as in *Glossogobius giuris* (Saksena, 1974) and *Mystus vittatus* (Bais, 1977), the neurosecretory droplets or the colloid were not observed in the tract of *Xenentodon cancila*.

RECOMMENDATIONS

The present investigation suggests that if the pituitary collection for induced breeding is done in appropriate time, i.e, when the neurosecretory activity is maximum on the impact of the extract from such pituitary will give better result.

REFERENCES

Bais, V.S., 1977. Studies on the functional morphology of some endocrine glands in fresh water fishes with special reference to their control of reproductive cycle. Ph.D. Thesis, University of Sagar, Madhya Pradesh, India.

Bargmann, W. and E. Scharrer, 1951. The site of origin of hormones of the posterior pituitary. Am. Scientist, 34: 255-259.

Belsare, D.K., 1967. Vascular supply of the pituitary gland in *Channa punctatus* Bloch. Nature, 206: 211-211.

Bhargava, H.N., 1965. The intra-hypophysial vascularisation and the hypothalamo-hypophyseal vascular relationship in the minnow (*Phoxinus phoxinus* L.). Read at the symposium on comperative endocrinology held at Jaipur in 1965. Bull. Natl. Inst. Sci. India, 36: 137-153.

Billenstien, D.C., 1963. The seasonal secretory cycle of the nucleus lateralis tuberis of the hypothalamus and its relation to reproduction in the Eastern brook trout, *Salvelinus fontinalis*. Gen. Comp. Endocrinol., 2: 111-112.

Chandrasekhar, K. and D. Khosa, 1972. Histomorphological studies on the neurosecretory system of three genera of freshwater teleostean fishes. Proc. Indian Acad. Sci. Sect. B, 6: 257-265.

Charlton, H.H., 1932. Comparative studies on the nucleus preopticus pars magnocellularis and the nucleus lateralis tuberis in fishes. J. Comp. Neurol., 54: 237-275.

Dawson, A.B., 1953. Evidence for the termination of neurosecretory fibers within the pars intermedia of the hypophysis of the frog, *Rana pipiens*. Anatomical Rec., 115: 63-69.

Dodd, J.M. and T. Kerr, 1963. Comparative morphology and histology of the hypothalamo-neurohypophysial system. Proc. Symp. Zool. Soc. London, 9: 5-27.

Ekengren, B., 1973. The nucleus preopticus and the nucleus lateralis tuberis in the roach, *Leuciscus rutilus*. Zeitschrift Zellforschung Mikroskopische Anatomie, 140: 369-388.

Fridberg, G. and B. Samuelson, 1959. The secretory condition in the pre-optico hypophysial system of the Roach (*Leuciscus rutilus*) and during histogenesis. Acta Zool., 40: 255-283.

Gerschenfeld, H.M., J.H. Tramezzani and E. de Robertis, 1960. Ultrastructure and function in neurohypophysis of the toad. Endocrinology, 66: 741-762.

Haider, S. and A.G. Sathyanesan, 1971. Hypothalamo neurohypophysial complex of teleost *Macrognathus aculeatus* (B). Acta Zool., 52: 235-239.

Haider, S. and A.G. Sathyanesan, 1972a. An *in situ* study of the hypothalamic neurosecretory system of the freshwater catfish *Ailia coila* (Ham.). Acta Zool., 53: 23-30.

Haider, S. and A.G. Sathyanesan, 1972b. Comparative study of the hypothalamo-neurohypophysial complex in some Indian freshwater teleosts. Acta Anat., 81: 202-224.

Haider, S. and A.G. Sathyanesan, 1972c. The nucleus lateralis tuberis of the freshwater teleost, *Heteropneustes fossilis* (Bl.). Acta Anat., 82: 75-84.

Jasinski, A., 1968. Modifications in the neurosecretory system of the fish, *Misgurnus fossilis*, induced by lasting inanition. Zeitschrift Zellforschung Mikroskopische Anatomie, 88: 537-548.

Leatherland, J.F., P.E. Budtz and J.M. Dodd, 1966. *In situ* studies on the hypothalamo-neurohypophysial complex of the European eel *Anguilla anguilla* (L.). Gen. Comp. Endocrinol., 7: 234-244.

Pavlovic, M. and V. Pantic, 1973. Nucleus preopticus and nucleus lateralis tuberis in teleostea *Alburnus albidus* and *Alosa fallox* in various stages of sexual cycle. Arch. Biol. Nauka Beograd., 25: 9-16.

Peter, R.E., V.L. Trudeau and B.D. Sloley, 1991. Brain regulation of reproduction in teleosts. Bull. Inst. Zool. Acad. Sin. Monograph, 16: 89-118.

Pickford, G.E. and J.W. Atz, 1957. The Physiology of Pituitary Gland of Fishes. New York Zoological Society, New York, USA., Pages: 613.

Saksena, D.M., 1974. Hypothalamo-hypophysial neurosecretory system in fresh-water fish, *Glossogobius giuris* (Ham.). Ph.D. Thesis, University of Sagar, Madhya Pradesh, India.

Sathyanesan, A.G., 1965a. The hypophysis and hypothalmo hypophysial system in the chimaefold fish, *Hydrolagus csolleil* (Lay and Bennett) with a note on their vacularisation. J. Morph., 116: 413-450.

Sathyanesan, A.G., 1965b. Hypothalamohypophysial system in the normal and hypophysectomized teleost, *Porichthys notatus* Girard and its response to continuous light. J. Morph., 117: 25-48.

Sathyanesan, A.G., 1968. Neurosecretory axonal pattern in the hypothalamus of some fishes. Roc. Zirkumventrikulare Organe und Liquor. Bericht uber Symp. Sch. Reinhardsbrunn, 13: 255-259.

Sathyanesan, A.G., 1973. Hypothalamo-hypophysial neurosecretory system of freshwater teleost *Catla catla* (Ham.). Zool. Beritrage, 19: 163-178.

Tischenko, N.T., M.N. Yorisova and A.L. Polenov, 1976. The preopticohypophysial neurosecretory system in the Baikal teleost, *Coregonus autumnalis migratorius*, during the prespawning period. Z. Evol. Biochem. Fisiol. Moskva, 12: 439-443.