J. Ecophysiol. Occup. Hlth. 10(2010) 71-76

Hypothalamo-neurosecretory system of the marine teleost, *Decapterus russelli* (Ruppell 1830)

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Abstract : *Hypothalamo-neurosecretory system of Decapterus russelli (Family Carangidae) mainly comprised nucleus preopticus (NPO), nucleus lateralis tuberis (NLT) and their axonal tracts. NPO was a paired structure located on either side of the third ventricle slightly above and anterior to the optic chiasma. It was highly vascularized with broad anterior and narrow posterior ends. NPO was divisible into a dorsal pars magnocellularis (PMC) comprising larger neurosecretory cells and ventral pars parvocellularis (PPC) with smaller neuronal cells. Acid fuchsin-positive colloid-like neurosecretory droplets of various sizes were encountered in the NPO and NLT of the scad. Neurons of PMC and PPC contributed beaded axons to form the neurohypophysial tract. A few small herring bodies (HB) were also seen in the anterior neurohypophysis (ANH).*

Key Words: *Hypothalamus, Nucleus preopticus, Nucleus lateralis tuberis, Herring bodies, Decapterus russelli.*

Introduction

Hypothalamus in the vertebrate brain comprises of groups of neurosecretory cells that mediate the organismic endocrine responses and adjustments to the environmental changes through the secretion of various tropic hormones of the pituitary by elaborating releasing, (RH) and inhibiting hormones (IH) (Ball, 1981; Maksimovich, 1987; Peter *et al.*, 1991; Peter and Yu, 1997). Hypothalamus also contains receptors specifically sensitive to the hormone which, in turn, regulates its activity through feedback mechanism (Maksimovich, 1987; Sherwood and Hew, 1994; Evans, 1998). There are increasing evidences that in fishes too, the hypophysial functions are modulated by the hypothalamic neurohormones but the regulatory mechanisms have not yet been clearly defined (Maksimovich, 1987; Peter *et al.*, 1991; Evans, 1998). Though several workers have described the hypothalamus of various teleosts inhabiting freshwaters (Maksimovich, 1987), such studies are very few among the brackishwater (Lal and Pandey, 1998) as well as marine species (Rizkalla, 1977; Zolotnitskiy, 1980; Pandey, 1993a, b; Pandey and Mohamed, 1993, 1997, 1999). Therefore, an attempt has been made to record the hypothalamo-neurosecretory system of the commercially important marine teleost, *Decapterus russelli*.

Materials and Methods

Thirty specimens of *Decapterus russelli* (Family Carangidae) (both sexes; size 12-15 cm TL) were collected by operating FAO trawl net on Board Sagar Sampada (Cruise No. 49) from the North-East coast (1840.5' N; 84° 35'E) (Bay of Bengal). Their brain along with the pituitary and a piece of gonads (to judge their maturity stage) were surgically removed and fixed immediately in freshly prepared Bouin's solution. The tissues were Than washed thoroughly in running tap water, dehydrated in ascending series of alcohol, cleared in xylene and embedded in paraffin wax at 60°C. Serial sections (sagittal, frontal and horizontal) were cut at 6-8 mm. Brains were stained in Mallory's triple, aldehyde fuchsin (AF) and chrome-alum-hematoxylin-phloxine (CHAP) whereas gonads were stained in hematoxylin-eosin.

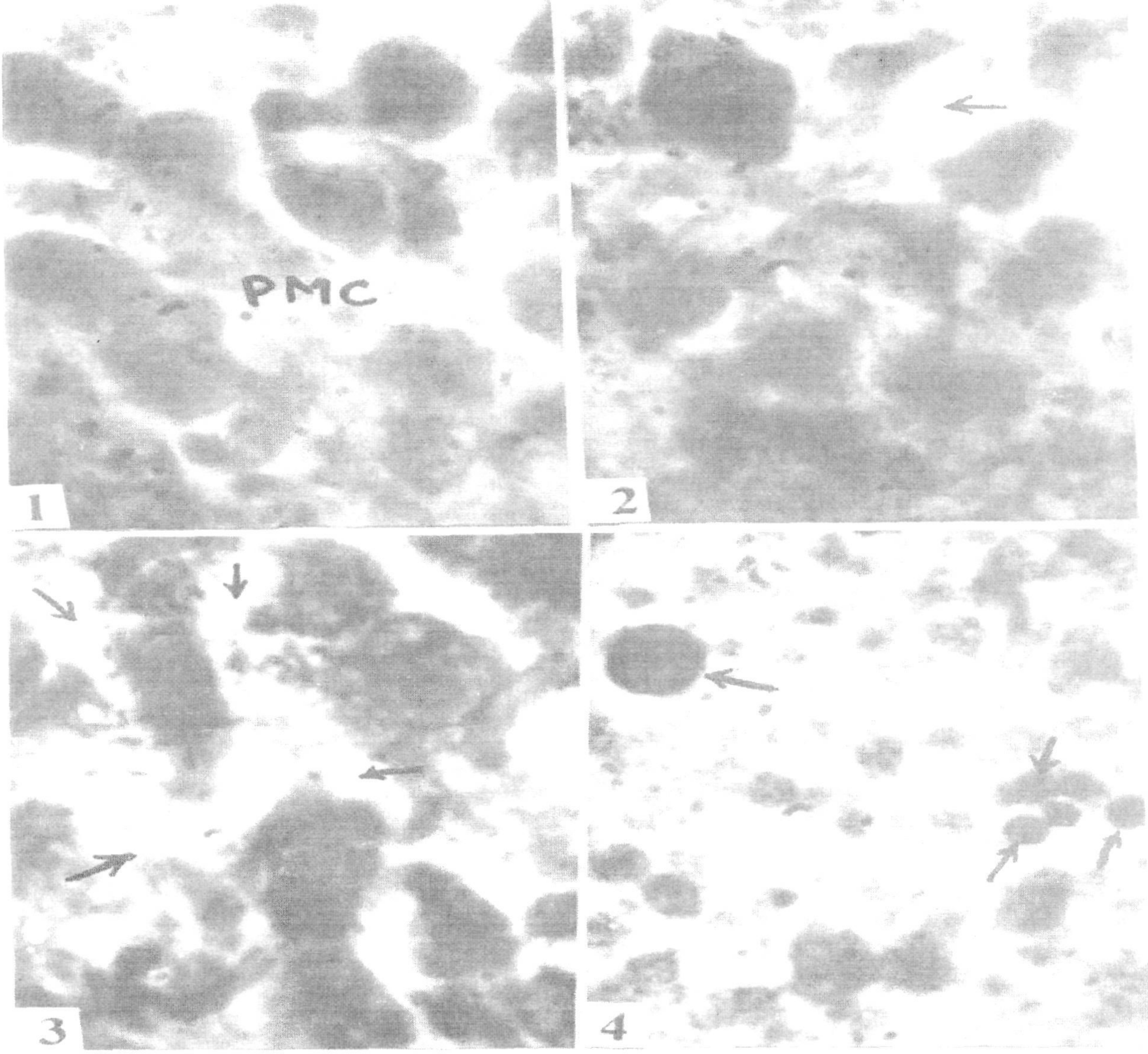

Fig. 1. Nucleus preopticus (NPO) of maturing (stage vi) male *Decapterus russelli* exhibiting pars magnocellularis (PMC) with large neurosecretory cells containing neurosecretory material. Mallory's triple. x 1,000.

Fig. 2. NPO of maturing (stage iv) female *D. russelli* showing PMC with large neurosecretory cells ladden with neurosecretory material. Mark partial vacuolization in the neurosecretory cell (arrow). Mallory's triple. x 1,000.

Fig. 3. NPO of matured (stage v) female *D. russelli* depicting PMC with large neurosecretory cells possessing neurosecretory material. Note the excessive vacuolization in the neurosecretory cells (arrow). Mallory's triple. x 1,000.

Fig. 4. NPO of matured (stage v) female *D. russelli* showing dorsal PMC and ventral pars parvocellularis (PPC) containing varying sizes of acid fuchsin-positive neurosecretory droplets (arrow). Also, mark the excessive vacuolization in the neurosecretory cells. Mallory's triple. x 600.

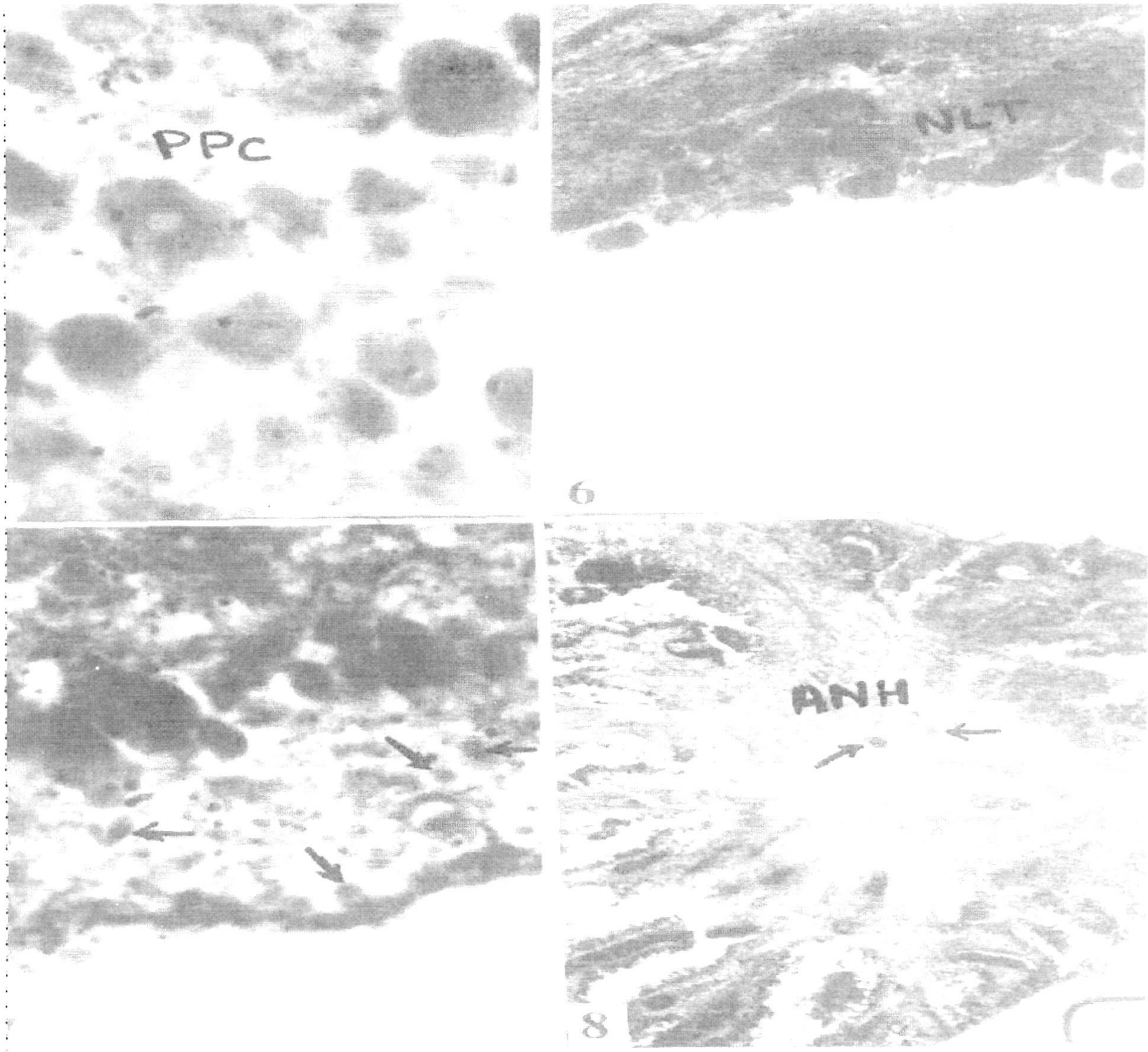

Fig. 5. NPO of matured (stage v) female *D. russelli* showing PPC neuronal cells laden with the neurosecretory material. At places, vacuolization of cells are also noticed. Mallory's triple. x 1,000.

Fig. 6. Nucleus lateralis tuberis (NLT) of matured (stage v) male *D. russelli* showing active neurosecretory cells. Mallory's triple. x 600.

Fig. 7. NLT of matured (stage v) female *D. russelli* showing active neuronal cells laden with the neurosecretory material. Also, mark the acid fuchsin-positive neurosecretory droplets (arrow). Mallory's triple. x 600.

Fig. 8. Anterior neurohypophysis (ANH) of the matured (stage v) female *D. russelli* showing acid fuchsin-positive Herring bodies (arrow). Mallory's triple. x 200.

Results and Discussion

Histological examination of the gonads (both sexes) revealed the fish to be in iv and v stages of maturity. Hypothalamo-neurosecretory system of *Decapterus russelli* mainly comprised nucleus preopticus (NPO), nucleus lateralis tuberis (NLT) and their axonal tracts. NPO was a paired structure located on either side of the third ventricle slightly above and anterior to the optic chiasma. The broad dorsal end consisted of sparsely distributed neurosecretory cells whereas these cells were closely placed towards the middle and ventral portion of NPO.

The nucleus preopticus (NPO) was divisible into a dorsal pars magnocellularis (PMC) consisting of large neurosecretory cells (Fig. 1, 2) and a ventral pars parvocellularis (PPC) with small neuronal cells (Fig. 5). Thus, a progressive reduction in the size of neurosecretory cells was seen from the dorsal to the ventral aspect of NPO. The NPO was a highly vascularized structure and the neurosecretory cells were positive to aldehyde fuchsin (AF), chrome-alum-hematoxylin-phloxine (CAHP) and acid fuchsin (in Mallory's triple stain). The cells of PMC and PPC were laden with the neurosecretory secretory material in maturing (stage iv) whereas they are partially vacuolated in mature specimens of both the sexes of the scad (Fig. 3). Interestingly, acid fuchsin positive neurosecretory droplets-like material of varying sizes were encountered in PMC and PPC in matured (stage v) specimens of both the sexes (Fig. 4). Most of the PMC and PPC neurosecretory cells were bipolar and contributed beaded axons to form the neurohypophysial tract.

In nucleus lateralis tuberis (NLT), the neurosecretory cells were distributed unevenly in the infundibular floor adjacent to the pituitary stalk (Fig. 6). These cells are negative to aldehyde fuchsin (AF) and chrome-alum-hematoxylin-phloxine (CAHP) but stain readily with acid fuchsin in Mallory's triple stain. Based on distribution and size of the neurosecretory cells, the nucleus lateralis tuberis (NLT) was divisible into pars anterior, pars posterior and pars inferior. The neurosecretory cells of NLT were variously shaped and their sizes ranged from very small to the larger ones with polymorphic nuclei. These neurons were generally bipolar but a few multipolar cells were also observed in NLT of *D. russelli.* NLT was a highly vascularized structure and a few neurosecretory cells were seen in close association of blood vessels. Further, a few acid fuchsin-positive neurosecretory droplets were encountered in the NLT of matured (stage v) specimens of both the sexes (Fig. 7). The neurohypophysial tract (NHT) enters the pituitary through infundibulum. Varying sizes of acid fuchsin positive Herring bodies (HB) were also seen in the anterior neurohypophysis (Fig. 8).

The basic cytoarchitectural pattern of *Decapterus russelli* hypothalamo-neurosecretory system resembles to those reported for a number of freshwater teleosts (Sathyanesan, 1965; Bhargava, 1969; Sundararaj and Viswanathan, 1971; Chandrasekhar and Khosa, 1972; Saksena, 1979; Maksimovich, 1987). Generally, the neurosecretory cells of NPO stain with AF and CAHP but they are also stainable with acid fuchsin in *Decapterus russelli*.. Similar staining responses have also been recorded in *Notopterus chitala*, *Rastrelliger kanagurta* (Pandey, 1993a), *Megalaspis cordyla* (Pandey, 1993b), *Decapturus tabl* (Pandey and Mohamed, 1993), *Lates calcarifer* (Lal and Pandey, 1998), *Sphyrena obtusata* (Pandey and Mohamad, 1997), *Arioma indica* (Pandey and Mohamad, 1999) and *Tor putitora* (Pandey *et al.*, 2000).

There are reports that NPO are involved in spawning activities and its secretion (s) influences gonadal maturation among teleosts (Viswanathan and Sundararaj, 1974a; Saksena, 1976; Zolotintskiy, 1980; Rai and Pandey, 1986; Subhedar *et al.*, 1987; Das and Sinha, 1988). Vaculation was observed in the neurosecretory cells of PMC and PPC of matured (stage iv)

Decapterus russelli. Viswanathan and Sundararaj (1974a) *Heteropneustes fossilis*, Tischenko *et al.* (1976) *Coregonus autumnalis migratorius*, Saksena (1979) *Glossogobius giuris*, Moitra and Medya (1980) *Cirrhinus mrigala*, Zolotnitskiy (1980) *Scopthalamus maeoticus* and Rai and Pandey (1986) *Colisa fasciata* have also noticed depletion of neurosecretory material during breeding season or after estrogen administration.

Acid fuchsin-positive neurosecretory glouble-like materials have been observed in PMC and PPC of *Decapterus russelli*. Such structures have also been reported in the NPO of maturing (stage iv) and matured (stage v) specimens of *Porichthys notatus* (Sathyanesan, 1965), *Phoxinus phoxinus* (Bhargava, 1969), *Channa punctatus*, *Clarias batrachus*, and *Heteropneustes fossilis* (Chandrasekhar and Khosa, 1972), *Glossogobius giuris* (Saksena, 1979), *Scophthalamus maeoticus* (Zolotnitskiy, 1980), *Notopterus chitala*, *Rastelliger kanagurta* (Pandey, 1993a), *Megalaspis cordyla* (Pandey, 1993b) and *Decapterus tabl* (Pandey and Mohamed, 1993).

Nucleus lateralis tuberis (NLT) is the second important neurosecretory centre in the teleostean hypothalamus (Dixit, 1967; Maksimovich, 1987; Peter *et al.*, 1991), however, there are reports of its absence in a few fishes (Charlton, 1932; Kabayashi *et al.*, 1959; Saksena, 1979; Kobayashi *et al.*, (1959) had remarked that season or age factors might be responsible for the absence of stainable neurosecretory material in the NLT. The neurosecretory cells of NLT pars anterior, pars posterior and pars inferior of maturing *Decapterus russelli* appear active and stain readily with acid fuchsin. NLT cells of other marine teleosts like *Rastelliger kanagurta* (Pandey, 1993a), *Megalaspis cordyla* (Pandey, 1993b), *Decapterus tabl* (Pandey and Mohamed, 1993) and *Sphyrena obtusata* (Pandey and Mohamad, 1997) also exhibited almost similar staining response. NLT cells of *Heteropneustes fossilis* (Viswanathan and Sundararaj, 1974b) and *Colisa fasciata* (Rai and Pandey, 1986) appear active during breeding season or after estrogen administration indicating its role in the reproductive physiology of the fish. Interestingly, acid fuchsin-positive neurosecretory material was observed in NLT of maturing *Decapterus russelli*.

Herring bodies (HB) are seen in the anterior neurohypophysis of *Decapterus russelli*. Sathyanesan (1965), *Porichthys notatus*, Bhargava (1969) *Phoxinus phoxinus*, Saksena (1979) *Glossogobius giuris*, Zolotnitskiy (1980) *Scophthalamus maeoticus*, Pandey (1993a) *Rastrelliger kanagurta*, Pandey (1993b) *Megalaspis cordyla* and Pandey and Mohamed (1993) *Decapterus tabl* have also recorded a similar distribution of such structures which are assumed to be accumulated in the neurosecretory material (Sathyanesan, 1965; in The Bhargava, 1969; Saksena, 1979; Zolotnitskiy, 1980).

Acknowledgements

The author is grateful to Dr. P.S.B.R. James and Dr. V. N. Pillai, former Director, and Dr. K.M. Kasim, Principal Scientist, CMFRI, Cochin for their valuable help and cooperation.

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