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HYPOTHALAMO - NEUROSECRETORY SYSTEM OF THE MARINE TELEOST, *MEGALASPIS CORDYLA* LINNAEUS

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ABSTRACT

Hypothalamo-neurosecretory complex of *Megalaspis cordyla* 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 and looks inverted L-shape in the sagittal section. NPO is divisible into a dorsal pars magnocellularis (PMC) consisting of large neurons and ventral pars parvocellularis (PPC) formed of smaller neurosecretory cells. 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. Other neuroendocrine centres like nucleus preopticus basalis lateralis (NPBL) and nucleus preopticus periventricularis (NPP) have also been described in this species.

INTRODUCTION

HYPOTHALAMUS is a strategic point in the vertebrate brain where several exteroceptive neural stimuli converge. It comprises groups of neurosecretory cells which control the secretion of the pituitary trophic hormones by elaborating, releasing (-RH) or inhibiting (-IH) hormones (Ball, 1981; Maksimovich, 1987). 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 that hypophysial functions in fishes are also mediated by hypothalamic neurohormones but the regulatory mechanisms are not properly defined (Peter *et al.*, 1991). Though several workers have described the hypothalamus of teleosts inhabiting freshwater (Ball, 1981; Maksimovich, 1987), such studies are rare among marine fishes (Zolotnitskiy, 1980; Pandey, 1993; Pandey and Mohamed, 1993). Therefore, attempt has been made to identify the various hypothalamo-neurosecretory centres of *Megalaspis cordyla* which belongs to Family Carangidae.

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MATERIAL AND METHODS

30 specimens of *Megalaspis cordyla* (both the sexes) were collected by operating FAO trawl net on board FORV *Sagar Sampada* (cruise No. 49) from the north-east coast (19° 52.2′ N and 86° 36.5′ E, Bay of Bengal). Their brain along with pituitary and a piece of gonad (to judge the maturity stage) were removed and fixed immediately in freshly prepared aqueous Bouin's solution. After reaching laboratory, the tissues were washed thoroughly in running tap water for 24 hrs, dehydrated in ascending series of alcohol, cleared in xylene and embeded in paraffin wax at 60°C. Serial sections (horizontal as well as sagittal) were cut at 6-8 μ. Brains were stained in Mallory's triple, aldehyde fuchsin (AF) and chrome-alum hemotoxylin - phloxine (CAHP) whereas gonads were stained in hematoxylin-eosin.

RESULTS

Histological examinations of gonads revealed the fish to be in IV and V stages of maturity.

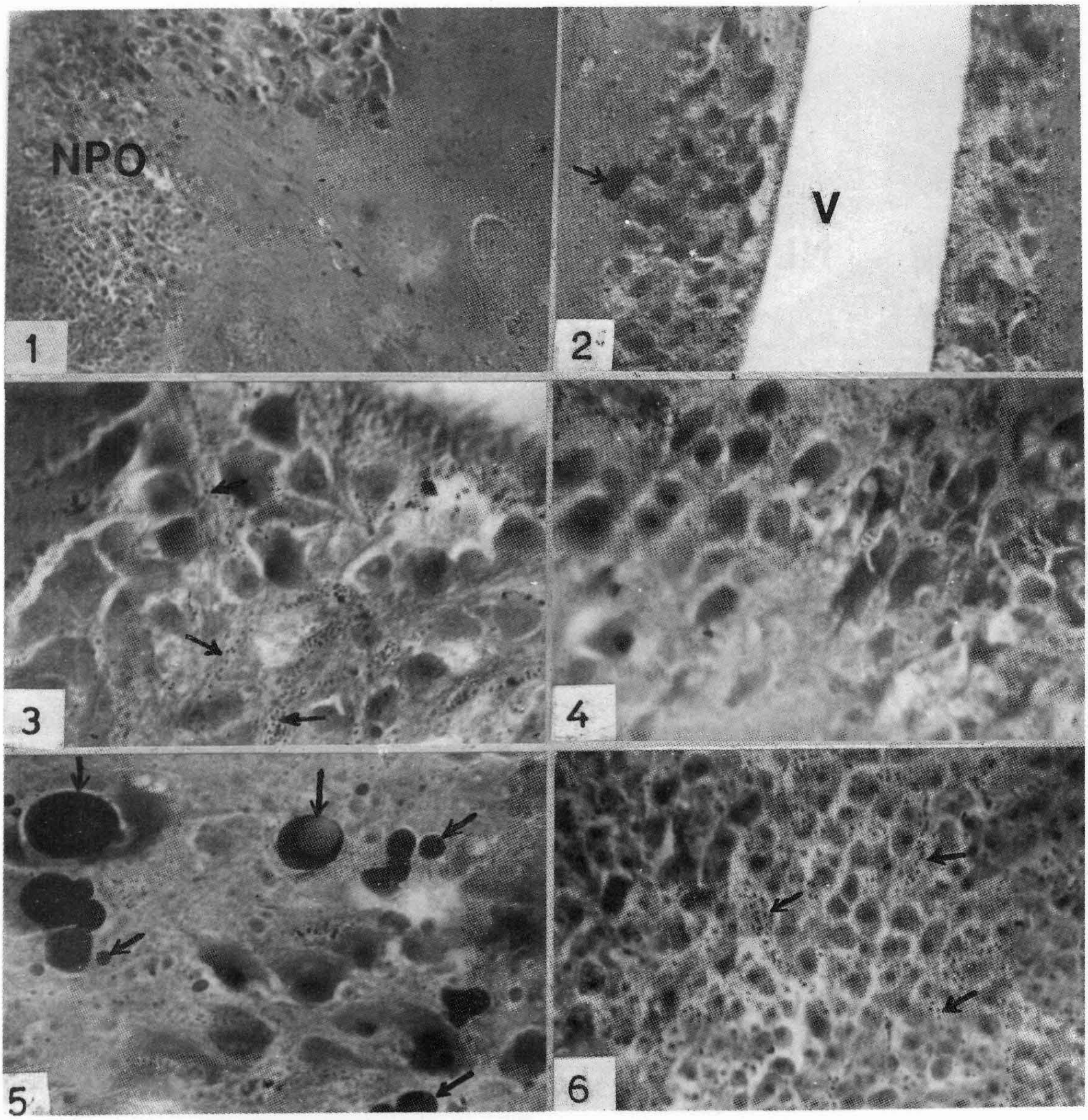

PLATE I 1) Sagittal section of brain of female *Megalaspis cordyla* showing the inverted L-shaped nucleus preopticus (NPO). Mark the progressive reduction in size of the neurons from dorsal to the ventral aspect of NPO. Mallory's triple × 100. 2) Horizontal section of the brain of male *M.cordyla* exhibiting the paired structure of NPO lying on the either side of third ventricle (V). Note the presence of acid fuchsin +ve neurosecretory globule (arrow). Mallory's triple × 200. 3) Magnified view of the neurons of the pars magnocellularis (PMC) of female *M.cordyla* depicting the bipolar neurons. Mark the presence of blood vessels in PMC (arrow). Mallory's triple × 400. 4) Magnified view of another part PMC of female *M.cordyla* to show a gradual reduction in the size of neurons. Mallory's triple × 400. 5) Pars magnocellularis (PMC) of matured female *M.cordyla* exhibiting acid fuchsin +ve neurosecretory globules of varying sizes (arrow). Mallory's triple × 400. 6) Pars parvocellularis (PPC) of female *M.cordyla*. Mark the size of cells and blood vessels (arrow). Mallory's triple × 400.

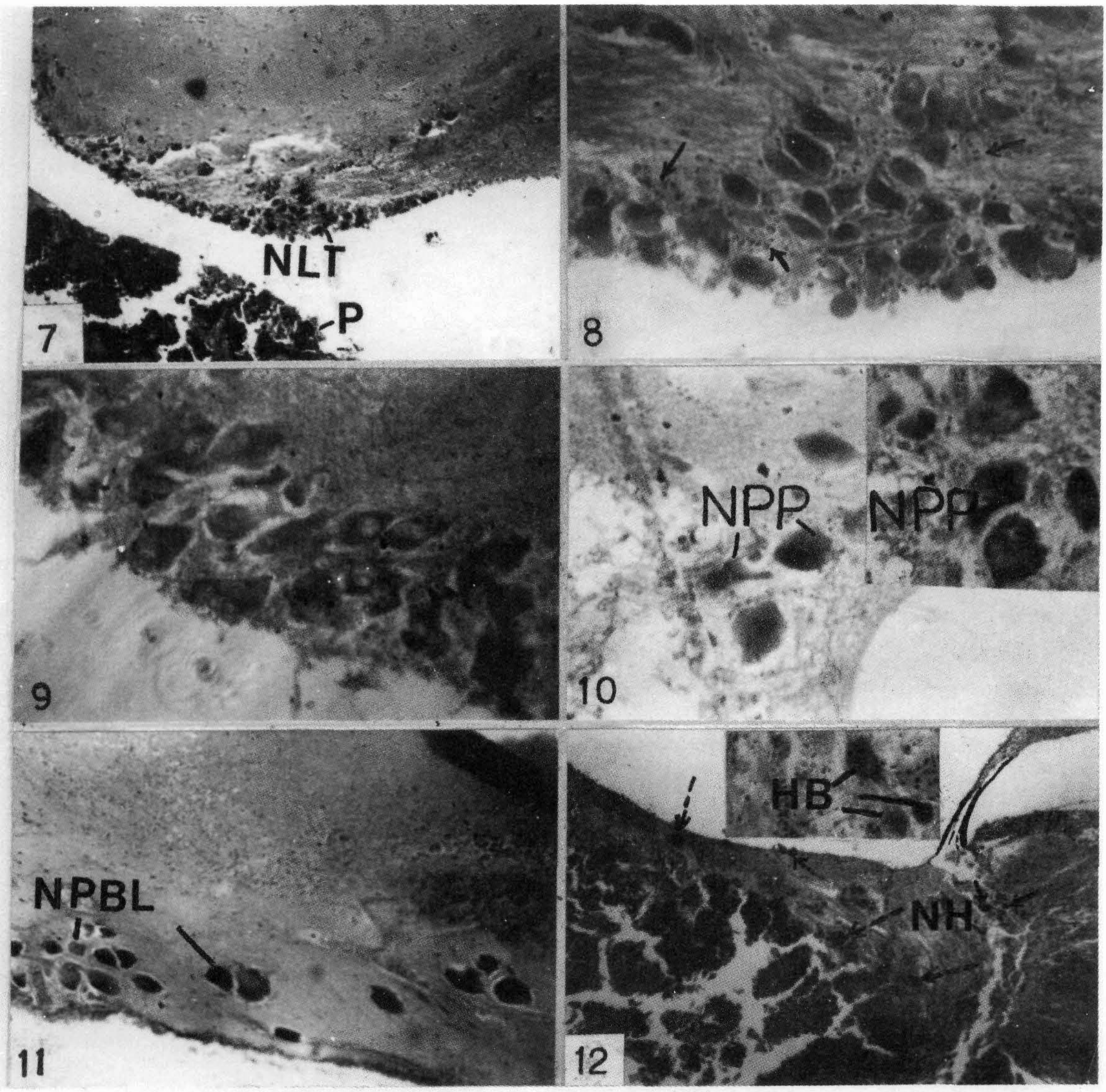

PLATE II 7) Sagittal section of brain of matured female *M.cordyla* showing the distribution of nucleus lateralis tuberis (NLT) neurons. P=Pituitory. Mallory's triple × 100. 8) Magnified view of Fig. 7 showing NLT pars posterior. Mark the active neurons in the region and their blood vascularization (arrow). Mallory's triple × 400. 9) Magnified view of Fig. 7 exhibiting NLT pars anterior. Note the active bipolar neurons in the region. Mallory's triple × 400. 10) Nucleus preopticus periventricularis (NPP) of maturing female *M.cordyla* showing the bi-and multipolar neurons and their beaded axons. Inset-Mark the darkly stained neurons of the matured female. Mallory's triple × 400. 11) Nucleus preopticus basalis lateralis (NPBL) of the matured female *M.cordyla*. Mark the bi-and multipolar neurons and their acid fuchsin +ve nature. Mallory's triple × 400. 12) Pituitary gland of male *M.cordyla* showing its attachment with stalk or infundibulam (partly drawn). Note the presence of Herring bodies of varying size (arrow) in the neuro-hypophysis (NH). Acid fuchsin +ve neurosecretory globules (broken arrow) are also seen. Mallory's triple × 40. Inset - Magnified view of anterior neurohypophysis to show the Herring bodies (HB) × 400.

Hypothalamo-neurosecretory complex of *Megalaspis cordyla* consists mainly 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 dorsal to the optic chiasma and looks inverted L-shape in sagittal section (PL-I, Fig. 1, 2). The horizontal limb of NPO comprises sparsely distributed neurons (PL-I, Fig. 1,3-5) whereas the neurosecretory cells are closely packed in the vertical limb (PL-I, Fig.1,6). NPO is divisible into dorsal pars magnocellularis (PMC) formed of larger neuronal cells (PL-I, Fig.3,4) and a ventral pars parvocellularis (PPC) comprising smaller cells (PL-I, Fig. 6). Thus, a progressive reduction in the size of neurons from dorsal to the ventral aspect of NPO is discernible (PL-I, Fig. 1). NPO is highly vascularized structure (PL-I, Fig. 3,6) and its neurosecretory cells are positive to aldehyde fuchsin (AF), chrome-alum-hematoxylin - phloxine (CAHP), and acid fuchsin in Mallory's triple stain. Interestingly, in the matured specimens (both sexes) acid fuchsin +ve globule-like neurosecretory materials were encountered among PMC cells (PL-I, Fig. 2,5). Generally, neurons of PMC and PPC are bipolar (PL-I, Fig. 3,4,6) and contribute beaded axons to form left and right neurohypophysial main tracts.

NLT cells are distributed uniformly in the infundibular floor adjacent to the pituitary stalk (PL-II, Fig. 7). They are negative to AF and CAHP but stain readily with acid fuchsin (PL-II, Fig. 7-9). These neurosecretory cells are variously shaped and their size ranged from very small to the larger ones with polymorphic nuclei (PL-II, Fig. 7-9). The neurons are usually bipolar but a few uni or multipolar cells are also seen (PL-II, Fig. 8,9). Based on the distribution and size, NLT neurons are divided into pars anterior, pars posterior and pars inferior. This structure is highly vascular and several neurons are seen in close association with the blood vessels (PL-II, Fig. 8). Neurohypophysial tract enters the pituitary through infundibulum (PL-II, Fig. 12). Varying sizes of Herring bodies (HB) are encountered in anterior and posterior neurohypophysis (PL-II, Fig. 12, inset).

Besides these prominent neuroendocrine centres, a number of other acid fuchsin-positive cells arranged in groups are also observed. Nucleus preopticus basalis lateralis (NPBL) of *M. cordyla* lies anterior to the optic chiasma and contains acid fuchsin-positive neurosecretory globules in the matured specimens (PL-II, Fig. 11) whereas neurons of nucleus preopticus periventricularis (NPP) lie close of NPO (PL-II, Fig. 10). It comprises 6-8 bi-and multipolar neurons which depict increased staining response in the matured specimens (PL-II, Fig. 10, inset).

Discussion

The basic cytoarchitectural pattern of hypothalamo-neurosecretory system of *M. cordyla* resembles to those described for a number of freshwater teleosts (Dodd and Kerr, 1963; Sathyanesan, 1965; Bhargava, 1969; Sunderaraj and Viswanathan, 1971; Chandrasekhar and Khosa, 1972; Thomas and Sathyanesan, 1982; Prakash *et al.*, 1984; Subhedar and Rama Krishna, 1988). Generally, the neurosecretory cells of NPO stain with AF and CAHP (Maksimovich, 1987) but they are also stainable with acid fuchsin (in Mallory's triple preparation) in *M. cordyla*. Prakash *et al.* (1984), Pandey (1993), Pandey and Mohamed (1993) have also observed a similar staining response in *Notopterus chitala*, *Rastrelliger kanagurta* and *Decapterus tabl*, respectively.

There exist reports that NPO is involved in the spawning activities and its secretion does influence gonadal maturation among teleosts (Viswanathan and Sunderaraj, 1974; Saksena, 1976; Tischenko *et al.*, 1976; Zolotnitskiy, 1980; Prakash *et al.*, 1984; Pandey and Mohamed, 1993). Increased acid fuchsin +ve neurosecretory globules (colloid-like materials) are noticed in the pars magnocellularis (PMC) region of matured *M. cordyla*. Similar neurosecretory (but AF +ve) materials have also been recorded during the breeding season in *Porichthys notatus* (Sathyanesan, 1965), *Phoxinus phoxinus* (Bhargava, 1969), *Clarias batrachus*, *Heteropneustes fossilis* and *Ophiocephalus punctatus* (Chandrasekhar and

Khosa, 1972), *Glossogobius giuris* (Saksena, 1976, 1979), *Notopterus chitala* (Prakash *et al.*, 1984) and *Decapterus tabl* (Pandey and Mohamed, 1993).

The NLT has been described as second important neurosecretory centre in the hypothalamus of fishes (Maksimovich, 1987) but it is reported to be absent in some species (Kobayashi *et al.*, 1959; Dodd and Kerr, 1963; Saksena, 1979). Since NLT is implicated in the control of gonadotropin secretion, it is not probable that this might be absent in some fish. Kobayashi *et al.*, (1959) have remarked that season or age factors may be responsible for the absence of stainable granules in the NLT. Neurosecretory cells of pars anterior, pars posterior and pars inferior of NLT in *M. cordyla* are quite active (PL-II, Fig. 7-9) suggesting its secretions to be involved in the gonadal maturation in the fish.

Herring bodies (HB) of varying sizes were encountered in the anterior and posterior neurohypophysis, and also towards the zone of the proximal pars distalis (PPD) of *M. cordyla* (PL-II, Fig. 12). Similar distribution of Herring bodies have also been recorded in *Porichthys notatus* (Sathyanesan, 1965), *Glossogobius giuris* (Saksena, 1979), *Scophthalamus maeoticus* (Zolotnitskiy, 1980), *Notopterus chitala* (Prakash *et al.*, 1984), *Rastrelliger kanagurta* (Pandey, 1993) and *Decapterus tabl* (Pandey and Mohamed, 1993) which are assumed to be accumulated neurosecretory material that help increase the surface area for release of biologically active principles in the blood circulation (Sathyanesan, 1965; Bhargava, 1969; Saksena, 1979; Zolotnitskiy, 1980).

Nucleus preopticus basalis lateralis (NPBL) and nucleus preopticus periventricularis (NPP) have been described in a very few species (*Carassius auratus* Peter, 1973; *Clarias batrachus* Subhedar and Rama Krishna, 1988; *Clarias gariepirus* Resink *et al.*, 1989). These nuclei are well developed in *M. cordyla* too (PL-II, Fig. 10,11). The recent localization of luteinizing hormone-releasing hormone (LH-RH) immunoreactivity in NPO, NLT, NPBL and NPP of fish indicates that neurosecretory cells of these centres are involved in synchronization of the reproductive processes with the environmental cues.

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