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Study of Neurosecretory Cells of Freshwater Bivalve: *Lamellidens Corrianus* (Lea)

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Abstract

In the freshwater bivalve like *Lamellidens corrianus* neurosecretory cells have been detected in the cerebral, pedal and visceral ganglia. The number of functions of hormones/neurohormones of freshwater bivalves known at the moment is still rather small. In contrast the basic mechanism of some type of neurosecretory cells of gastropods are known in great detail, this is especially due to the fact that in some gastropods these neurons like their conventional neurons are giant cells. For this reason they are highly suitable for neurophysiological studies. The great progress made in this field and the importance of this work for neuroendocrinology in general. To extend the knowledge in this field, the present work has been undertaken on the freshwater bivalve species *Lamellidens corrianus* which is abundantly distributed along the banks of Godavari river at Jayakwadi backwaters (Nath sagar) near Paithan in Aurangabad district. The histological details of neurosecretory cells (NSCs) in cerebral, pedal and visceral ganglia have been studied which reveals the presence of Type A & Type B cell (with nucleus, nucleolus and axon) predominantly secrete neurosecretory material. The results are converse in illumination of neurosecretory changes.

Keywords: Freshwater bivalve, *Lamellidens corrianus*, Neurosecretory cells, Cerebral, Pedal, Visceral.

1. INTRODUCTION

Basically there are two extreme types of neural organization (with many intermediate forms). The chord system, in which the neural tree tapers and branches in smooth lines; and the ganglia system, which is characterized by knots of nerve cells called ganglia, bound together by nervous tissue consisting of slender elongations of the cells. The nervous and endocrine systems coordinate the activities of the various organs and the tissues in the body that the animals function as individuals. Majority of the neurons with granular activity are known to be necessary for the transmission of transient impulses, with their highly localized production of chemicals such as neurohumors/neurohormones, which are rapidly destroyed. Neurons have similar properties throughout the animal kingdom, although their morphology and arrangement may vary. The way in which nervous system operates may differ. Considerably between animal, depending on the number of neurons involved and the individual shape, size and spatial arrangement of the component about fifty percent of the nervous system is composed of non–excitable satellite glial cells which are packed

between and around the neurons. They are supposed to transport neurosecretory substance (Lubet, 1955a; Umiji, 1969), provide physical support for the neurons and can modify action of nerve cells as well as a barrier or receiver for ions, metabolites and transmitters (Leak and Walker, 1980).

Evidence for the occurrence of a wide variety of neurotransmitters in different tissues of *Lamellibranchs including* the nerve ganglia has been discussed from the functional point of view (Leak and Walker, 1980). Under the light microscope, neurons are characterized by the presence of abundant secretary materials in their perikarya. This material is seen also in the axons which oftenly end blindly adjacent to muscular spaces rather than innervating their target structures directly. These blindly ending terminals serve a storage release function and in the more advanced groups of animals such as crustaceans such compact structures are termed as neurohemal organ by Knowles and Carlisle (1956). The neurosecretory cells (NSCs) with their combination of neuronal and glandular capabilities are perfectly suited to translate a neuronal input into the hormonal output best suited to long-term process. In this capacity, the NSCs may produce hormones, which act directly upon the peripheral target or it may exert its effect.

Histologically, neurosecretory cells were recognized by a number of specific histochemical techniques, including light microscopic stain such as chrome-haematoxylin-phloxene, paralhydide fuchsin and azan (Rowell, 1976). Light microscopic staining has been used extensively with paraldehyde fuchsin and chrome-haematoxylin-phloxene in molluscs (Simpson et. al., 1966; Gabe, 1966) and insects (Rowell, 1976). Neurosecretory cells have been detected in the cerebal, pedal and visceral ganglia of the orders Protobranchiata, Filibranchiata, pseudolamellibranchiata, and eulamellibranchiata (Gabe and Rancruel, 1958), and their physiology has been studied to some extent (Lubet, 1955b, 1956).

2. MATERIALS AND METHODS

The freshwater bivalve molluscs, *Lamellidens corrianus* (Lea) were collected from Jayakwadi backwaters (Nathsagar) at Paithan, 45 km. away from Aurangabad, Maharashtra. After brought to the laboratory, the shells of the bivalves were brushed and washed with fresh reservoir water so as to remove the fouling algal biomass and mud. The animals of 80-85 mm shell length were selected for experiment and they were acclimatized for 24 h. at laboratory condition in fresh aerated reservoir water (with renewal of water at the interval of 12-13 h.) and stocking capacity was given during this period and no food was given to the bivalves during laboratory acclimatization and subsequent experimentation.

After 24 h., reservoir water was once again renewed and aeration was given. After a lapse of 1h. The animals extended their organs (foot, mantle, siphons) to maximum and soon urgical operations were done. For removal of both the celebral ganglia (bilateral cerebralectomy) active animals were chosen from the aquarium and a wedge (4-5 mm thick) was kept between the valves of the shell. Both the cerebral ganglia were removed by performing minimum injury to the animals within 30 seconds, with the help of fine, pointed sterilized forceps. Animals were fixed in Bouins Hollande for histological study of ganglia. The animals were soaked carefully with the help of filter paper and flesh of the animals was fixed in Bouins Hollande fixative for 24 hrs. The fixative was renewed for next 24 hr. to facilitate better fixation of the tissues. During experimental period ganglia were then removed and processed for preparation of paraffin blocks. Dehydration of ganglia was done through serial grades of ethyl alcohol and tertiary butanol respectively while xylene was replaced by toluene during the process of dehydration. The tissues were embedded in paraffin wax at 58˚C-60˚C and the sections of ganglia were cut 5.0 – 6.0 µm thickness using Spence-rotary-microtome. The sections of cerebral, visceral and pedal ganglia were stained with Gomories Chrome alum haematoxylene–phloxine, Mallary triple stain and Thionine Paraldehyde after permagnate oxidation (as shown by Illanes and Lubet, 1980). All the sections were observed under the research binocular microscope and wherever necessary, measurements were made before microphotography.

3. RESULTS

The histological details of neurosecretory cells in different ganglias of *Lamellidens corrianus* were given in Table:1 and Fig 1 (A, B and C). In cerebral ganglia Type A cell showed cell length 12.5714 ± 0.5345 µm. Cell width in Type A cell was 8.1428 ± 0.6900 µm. Nuclear diameter was 5.5714 ± 0.5345 µm. Axon length of Type A cell was 2.5714 ± 0.5345 µm. The cell diameter of Type B cell was 10.1428 ± 0.6900 µm. nuclear diameters was 6.000 ± 0.5773 µm. Visceral ganglia showed cell length 19.8571 ± 0.8997 µm. The cell width of A Type cell was 7.1428 ± 1.2149 µm. The nuclear diameter in was 5.2857 ± 0.7559 µm. Axon length of Type A cell was 2.1428 ± 0.3779 µm. The Type B cell showed cell diameter 9.7283 ± 0.8164 µm. The nuclear diameter was 5.7142 ± 0.4879 µm. In the pedal ganglia, Type A cell showed cell length 18.8570 ± 1.3451 µm. The cell width of A Type cell was 5.7142 ± 0.7559 µm. The nuclear diameter was 4.2857 ± 0.7559 µm. Length of axon in Type A cell was 1.2857 ± 0.4879 µm. The Type B cell showed the diameter 8.2857 ± 1.1126 µm. nuclear diameters were 5.5714 ± 0.5345 µm.

Table 1: Structural changes in Cerebral, Visceral and Pedal ganglionic neurosecretory cells in *Lamellidens corrianus* during experimental period (All the values are µm)

	Type A				Type B	
Group	**Cell length**	**Cell width**	**Nucleus diameter**	**Axon length**	**Cell diameter**	**Nucleus diameter**
Cerebral ganglia	**12.5714** ±0.5345	**8.1428** ±0.6900	**5.5714** ±0.5345	**2.5714** ±0.5345	**10.1428** ±0.6900	**6.0000** ±0.5773
Visceral ganglia	**19.8571** ±0.8997	**7.1428** ±1.2149	**5.2857** ±07559	**2.1428** ±0.3779	**9.7283** ±0.8164	**5.7142** ±0.4879
Pedal ganglia	**18.8570** ±1.3451	**5.7142** ±0.7559	**4.2857** ±0.7559	**1.2857** ±0.4879	**8.2857** ±1.1126	**5.5714** ±0.5345

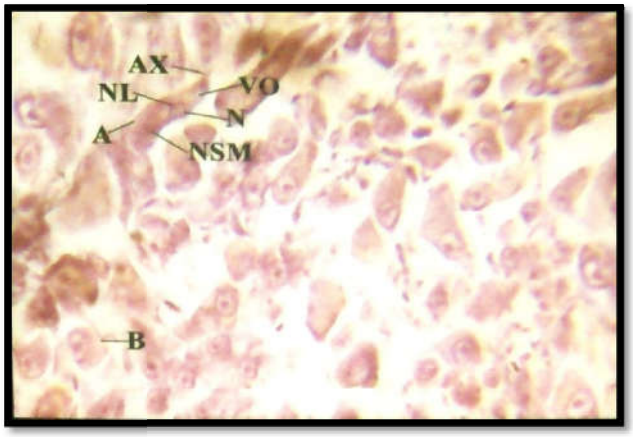

Fig. 1A: Cerebral ganglia

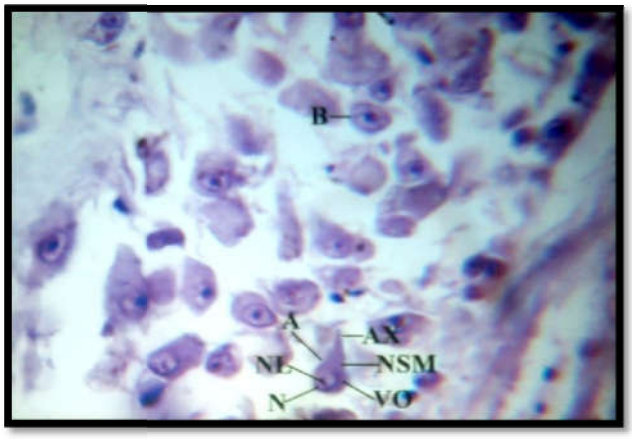

Fig. 1B: Visceral ganglia

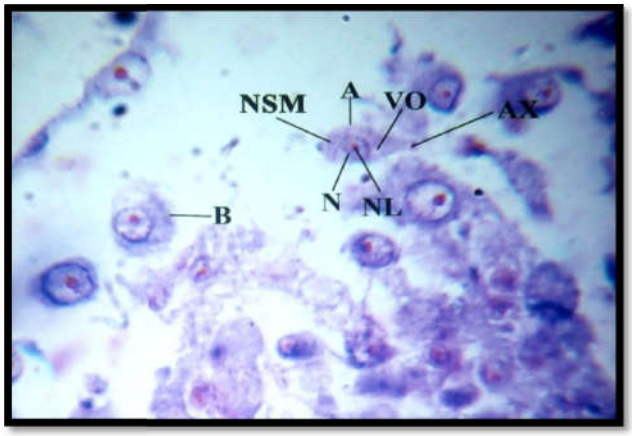

Fig. 1C: Pedal ganglia

A = Type A cell, B = Type B cell,

N = Nucleus, NL =Nucleolus,

NSM=Neurosecretory material,

AX =Axon, VO =Vacuole

Figure 1(A, B and C): Histological changes in the neurosecretory cells of cerebral, Visceral and Peadal ganalia of *Lamellidens corrianus*.

4. DISCUSSION

Neurosecretory Cells (NSCs) has been demonstrated by classic histological studies on a number of species. Their number and location vary among species. NSCs are located in the central ganglia. In higher lamellibranchs, NSCs are less numerous and more localized. These cells are generally found in the dorsal caps of cerebral ganglia and dorsal cell layer of visceral ganglia (Lubet, 1955a, Nagabhushanam, 1963, 1969; Mane, 1986). The NSCs were found to be less numerous in the cerebral ganglia than in the visceral ganglia. The presence of the NSCs in the pedal ganglia is controversial.

However, Gabe (1955) and Lubet (1955a) concluded that they are absent in *Mytilus edulis* or *Mytilus galloprovincialis*, but Umiji (1969) in *Perna perna* and Nagabhushanam *et al*. (1972) in *Mytilus viridis* have recovered their presence in the pedal ganglia. The NSCs have been reported to occur in all the ganglia of freshwater mussels, *Unio tumidus* (Fahrmann, 1961), *Lamellidens marginalis* and *Lamellidens corrianus* (Muley, 1985). In *Lamellidens corrianus* the NSCs in the ganglia are located on dorsal and lateral periphery in cerebral and visceral ganglia and on the dorsal periphery and the mid line of fusion in the pedal ganglia.

In most species NSCs are small or medium-sized; with an approximate diameter of 18 µm. Neurosecretory perikarya are ovoid or pyriform. The general histological features are similar to those of plasmochrome cells, but neurosecretory perikarya can be distinguished by the marginal position of the Nissl bodies and the presence of acidophilic secretions in the cytoplasm (Gabe, 1966). Different categories of NSCs have been distinguished based on their size and morphology. In *Mytilus edulis* and *Chlamys varia* some NScs are pear-shaped, unipolar and upto 25 µm, while others are small and multipolar (Lubet, 1959) Pear-shaped (Type I) and oval-shaped (Type II). NSCs were distinguished in *Crassostrea virginica* and *Meretrix casta* (Nagabhushanam, 1963). Different categories of NSCs have also been reported in the freshwater mussel, *Unio tumidus* (Fahrmann, 1961). In the present study, all the ganglia of *Lamellidens corrianus* showed two types of NSCs which are in accordance with those observed in *Teredo* (Gabe and Rancurel, 1958), in *Mytilus* and *Chlamys* (Lubet, 1955b), in *Crassostrea virginica* (Nagabhushanam, 1963) for Type A cells and in *Crassostrea virginica* (Nagabhushanam, 1963) and in *Katelysia opima* (Nagabhushanam and Mane, 1973) for Type B cells.

The appearance and position of neurosecretory products within the perikarya vary with the stage of the secretion (Lubet, 1955a, b; 1959; Gabe, 1966; Gabe and Rancurel, 1958; Nagabhushanam *et al*., 1972). In some cells, neurosecretory granules are few, while in others they are abundant and remain discrete. In still other cells, neurosecretory products are present in lumps or pools. The discharge of neurosecretory products is characterized by cytoplasm and the presence of small quantities of secretary products between the vacuole and axon hillock (Gabe, 1966). Signs of axon transport are not very distinct in marine bivalves. Neurosecretory products have been observed in the axon hillock and proximal parts of the inter-ganglionic paths of the axons, but they disappear in the neuropile and are not seen in the communicative branches, commissures or nerves leaving the ganglia. Endocrine glands or neurohemal organs have not been identified in bivalve molluscs. Umiji (1969) has reported that a neurohemal area exists on the cerebral commissure of Perna *perna.*

In the present study on *Lamellidens corrianus* axonal transport of the neurosecretory product is distinct in Type A cells. In Type B cells probably the transport is likely to be by diffusion. Vacuoles in both the type of cells are also distinct when the neurosecretory products disappear. The transport of neurosecretory substances by axons, intermediate cells, and possibly glial cells has been suggested by Lubet (1955b) and Umiji (1969). Several authors have suggested that glial cells play a role in storage and transport and that glial cells and epineurons can function as neurohemal organs (Fahrmann, 1961). However, the chemical nature, transport, and fate of neurosecretory products are not clearly established in bivalves.

In the present study, histological sections of cerebral ganglia revealed accumulation of neurosecretory material in Type A cells. In the current investigation histological studies on NSCs of the ganglia of *Lamellidens corrianus* revealed significant changes in the quantity of neurosecretory material in cerebral, visceral and pedal ganglia. It is not known what sort of effect might have occurred on neurohumors, however, studies on the activity of nerve ganglia by their removal or by severing the connectives were conducted by Nadort (1943), Salanki (1961). The cerebral ganglia control the tonus of adductors and their activity seems to be antagonistic to that of visceral ganglia. Neurotransmitters are also known to act on metabolism and on NSCs in bivalve molluscs. The wide occurrence of Ach, 5-HT and catecholamines (predominantly dopamine) in the nervous systems of various bivalves is well established (Cottrell and Laverack, 1968). These neurohumors are capable of inducing changes in the NSCs in the cerebral and visceral ganglia of the bivalves.

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