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THE NEUROSECRETORY CONTROL OF THE ANNUAL REPRODUCTIVE CYCLE IN THE FRESHWATER PRAWN, *MACROBRACHIUM KISTNENSIS*

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ABSTRACT

The changes in the neurosecretory cells of the brain, thoracic ganglion and eyestalks in *Macrobrachium kistnensis* during annual reproductive cycle have been described. The A and D cells from the thoracic ganglion and brain showed active synthesis during reproductive period. Contrastingly the C cells of optic ganglion were not active in this period.

INTRODUCTION

There are experimental evidence that the brain and thoracic ganglion neurosecretory cells (NSC) secrete the gonad stimulating hormone (GSH) and eyestalk NSC secrete the gonad inhibiting hormone (GIH) in crustaceans[1-3]. It has been reported in *Crangon crangon* that GIH activity in the cyestalks is responsible for the resting phase of the ovary[4,5]. Very little is known about the cell types which synthesize these hormones[6]. A preliminary survey has been made on the neurohormonal control of reproduction in freshwater prawn, *M. kistnensis.*

MATERIALS AND METHODS

M. kistnensis were collected from Kham river, near Aurangabad for one year, from May 1977 April 1978. The prawns were kept in aerated aquaria for 2 to 3 days. The brain, thoracic ganglion and eyestalks of the intermoult prawns were fixed in Bouin's fixative. The tissues were dehydrated and paraffin embedded. Sections were cut at 6-7 μ and stained with Mallory's triple stain[7] and Gomori's Aldehyde fuchsin[8].

RESULTS

Histology of the neurosecretory cells

A knowledge of types of neurosecretory cells and their structure is necessary before attributing any role towards reproductive activity. There are four types of cells A, B, C and D. The A cells are large, few in number and present in the brain, thoracic ganglion

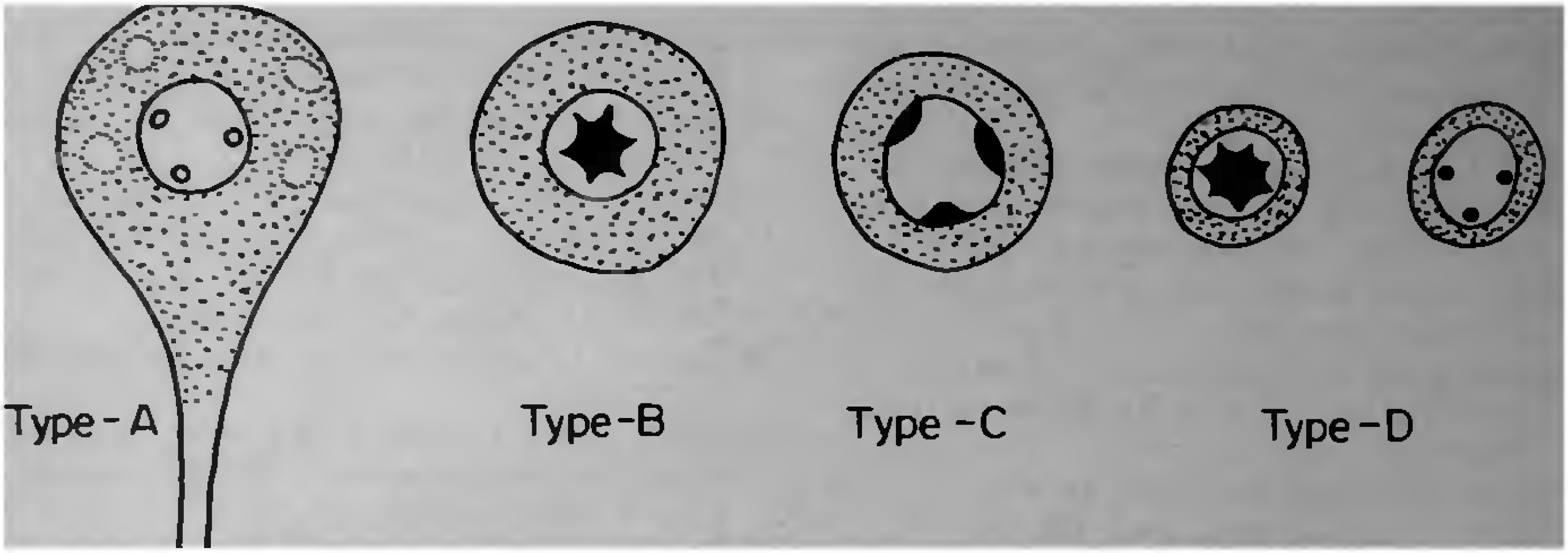

Figure 1. Diagrammatic representation of the neurosecretory cell types present in brain, thoracic ganglion and eyestalk of the freshwater prawn, *Macrobrachium kistnensis*

and eyestalks. The B cells are more in number and present in all neuroendocrine centres. The C and D cells are abundant in number and they are very tiny cells. The detailed description of the cell types and their distribution in the neuroendocrine centres is given in figures 1 & 2.

Relation between the reproductive cycle and neurosecretion

The serial sections of brain, thoracic ganglion and optic ganglion were observed monthly for one year. The cell and nuclear diameter, total number of cells and the intensity of neurosecretory material were noted. The results are shown in tables 1–3.

The increase of cell and nuclear diameter was observed in August, September and October. The neurosecretory cell count was increased in these months but active synthesis of neurosecretory material (NSM) was observed only in August and September (tables 1,2). The increase in cell and nuclear

TABLE 1

Cell count and neurosecretory material intensity changes in the 'A' and 'D' cells in the brain of freshwater prawn, M. kistnensis for the period of May 1977 — April, 1978.

Month	Total number of cells ± SD		NSM intensity	
	A	D	A	D
1977				
May	2.0 ± 0.7	25.0 ± 2.5	+	-
June	1.7 ± 0.4	27.9 ± 4.9	+	-
July	2.5 ± 1.0	27.5 ± 6.2	++	+
August	2.7 ± 0.8	58.7 ± 8.2	++++	+++
September	3.5 ± 2.2	70.0 ± 10.2	++++	+++
October	1.7 ± 0.6	60.0 ± 7.8	++	+
November	2.0 ± 0.7	35.0 ± 3.3	+	-
December	4.5 ± 1.1	13.5 ± 9.0	++	+
1978				
January	5.5 ± 1.5	27.5 ± 2.8	++++	+++
February	4.7 ± 1.0	110.0 ± 8.9	++++	+++
March	2.2 ± 0.1	60.0 ± 3.5	++	+
April	2.0 ± 0.0	40.0 ± 5.2	+	+

NSM intensity + less, ++ moderate, ++++ high

TABLE 2

Cell count and neurosecretory material intensity changes in the A and D cells in thoracic ganglion of freshwater prawn, M. kistnensis for the period of May 1977—April, 1978.

Month	Total number of cells ± S.D.		NSM intensity	
	A	D	A	D
1977				
May	3.0 ± 0.2	18.2 ± 3.5	+	-
June	2.3 ± 1.6	15.9 ± 5.2	+	-
July	4.0 ± 0.0	20.0 ± 2.3	+	-
August	5.0 ± 0.2	28.3 ± 6.9	++	++
September	2.3 ± 2.1	31.2 ± 14.2	+++	++
October	1.5 ± 0.05	-	++	-
November	1.3 ± 0.1	-	+	-
December	2.1 ± 0.1	33.3 ± 3.7	++	+
1978				
January	4.2 ± 2.0	54.0 ± 6.7	+++	+
February	4.0 ± 2.2	68.3 ± 12.9	++++	+++
March	3.0 ± 0.9	28.7 ± 9.2	++	+
April	3.0 ± 0.0	21.0 ± 8.3	+	-

NSM Intensity + less, ++ moderate, +++, ++++ high

diameter and total count of cells accompanied by active NSM synthesis was observed in December, January and February (tables 1,2). It was observed that only A and D cells from the brain and thoracic ganglion took active part in synthesis of neurosecretory material during reproductive phase. *M. kistnensis* showed two peaks in the annual reproductive cycle[3].

The C cells of the eyestalks showed activity which was antagonistic to those of A and D cells of brain and thoracic ganglion. The C cells were active during reproductive quiscence and showed less NSM during active reproductive phase of prawn (table 3).

DISCUSSION

According to cell shape, size and staining properties the neurosecretory cells are morphologically classified by many worker's[9-11]. Here in *M. kistnensis* the A cells and C cells corresponds to the A cell and B cell described by Matsumoto[9]. The D cell of *M. kistnensis* showed similarity with cell type three reported in *Procambarus simulans*[12]. In *M. kistnensis* it was found that A and D cells from the brain and thoracic ganglion show distinct relationship with the reproductive phase. These cells showed active synthesis of NSM during sexual cycle of the prawn, contrastingly the C cells of the optic ganglion were less active during this period but they were active during reproductive quiscence. From these histological observations it can be suggested that the A and D cells from the central nervous system might be synthesising gonad stimulating hormone (GSH) and C cells from optic ganglion might be producing gonad inhibiting hormone (GIH).

The distinctive staining of B cells of the x-organ supported the view that these cells produce GIH and MIH[9]. Adiyodi[6] in *Paratelphusa*, after eyestalk excision experiments, suggested that the 'C' cells of the eyestalk take part in production of GIH. Perryman[12] working on *P. simulans*, proposed that the x-organ (type 'one' cells) produce the inhibitor and the cell type 'three' from brain and eyestalk produce (i) inhibitor of new oocytes (ii) accelerator of the ovulation. These findings coincide with the present results in *M. kistnensis*.

There are reports on other crustaceans like isopods and barnacles that the cerebral secretory product effects reproductive cycle[13,14]. Demassieux and Balesdent[15] reported in an isopod that acidiophilic secretion of the neurosecretory cells corresponds to their inhibitory effect on vitellogenesis. They found in males and females (during the annual non-breeding

TABLE 3

Cell count and neurosecretory material intensity changes in 'C' cells of eyestalk of prawn, M. kistnensis for the period of May 1977. — April 1978.

Month	Total number of cells ± S.D.	NSM intensity
1977		
May	33.3 ± 11.2	+++
June	33.2 ± 15.1	+++
July	28.3 ± 9.7	++
August	17.8 ± 4.1	+
September	18.9 ± 5.6	++
October	12.0 ± 2.6	++
November	20.0 ± 8.7	++
December	15.5 ± 5.2	+
1978		
January	10.0 ± 5.2	+
February	11.0 ± 3.4	+
March	28.7 ± 7.3	++
April	48.3 ± 10.3	+++

NSM intensity + less, ++ moderate +++ high.

season) only a basophilic secretion in β-cells and an acidophilic secretion appeared in cells when females showed a rapid growth of the oocytes. The β-cells were most acidophilic when greatest storage of vitellogen occurred. Huberman *et al*[16] successfully isolated and purified the neurodepressing hormone from the eyestalks of *P. bouvieri*.

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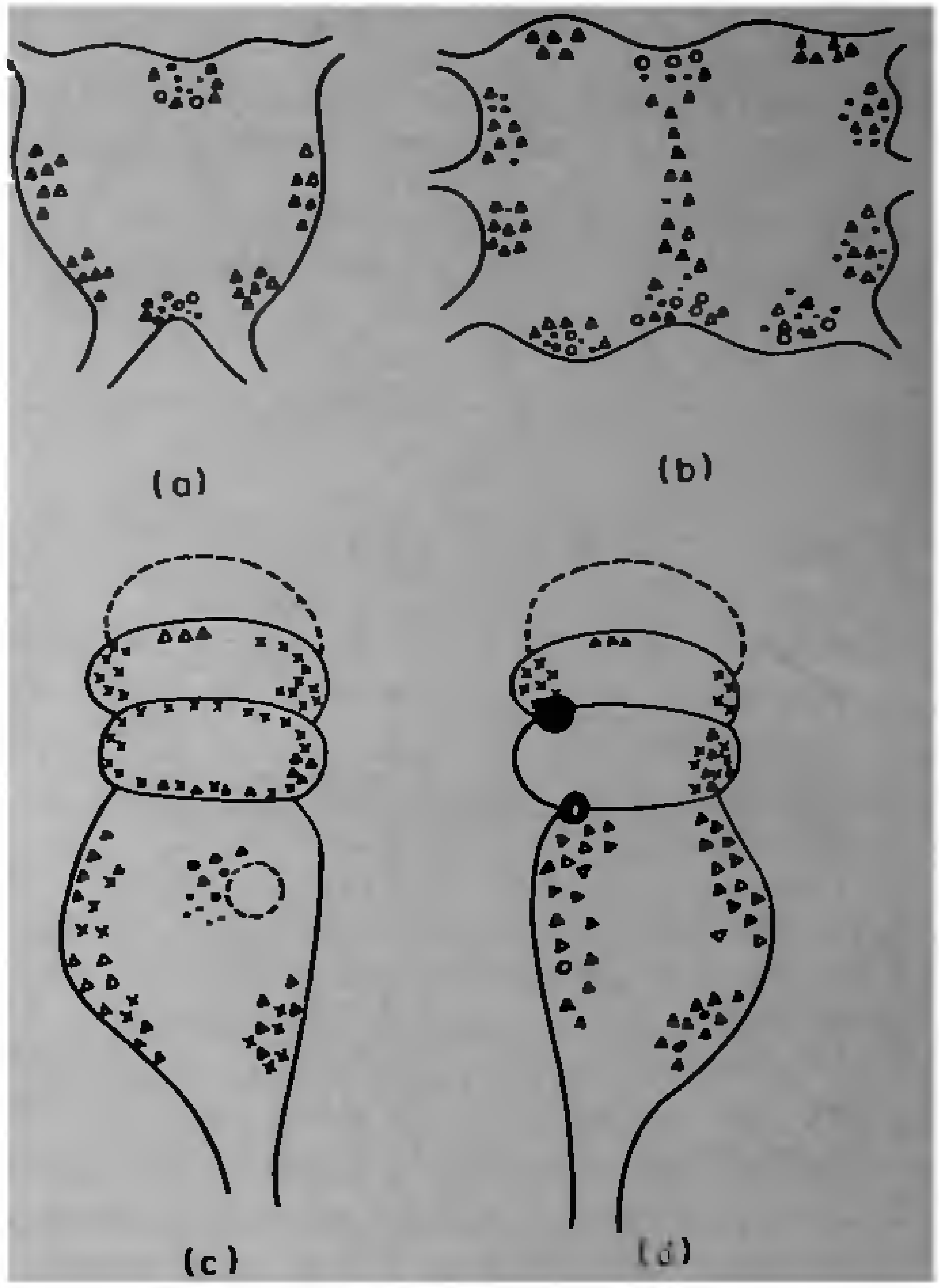

Figure 2. Diagrammatic representation of the brain, thoracic ganglion and eyestalk of the freshwater prawn, *Macrobrachium kistnensis*. Indicating the locations of neurosecretory cell groups and distribution. (open triangle) – A cell (open circle) – D cell (closed circle) – C cell (big open circle) – Giant neuron (big closed circle) – Sinus gland

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