The Bioscan 7 (3) : 409-413, 2012
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

HISTOMORPHOLOGICAL STUDIES ON THE NEUROSECRETORY CELLS IN THE BRAIN OF THE BEETLE *CYBISTER TRIPUNCTATUS* (OL) (COLEOPTERA: DYTISCIDAE)

U. S. INDURKAR AND D. B. TEMBHARE[1]*
Department of Zoology, Shri Dnyanesh Mahavidyalaya, Chandrapur – 441 223, Nawargoan,
[1]Department of Zoology, RTM Nagpur University, Nagpur - 440 033
E-mail: dr.umeshindurkar@rediffmail.com

KEY WORDS
Nervous system
Neurosecretory cells
C. tripuntatus

Received on :
28.04.12

Accepted on :
14.08.2012

***Corresponding author**

ABSTRACT
The cephalic neuroendocrine system is well developed in the adult water beetle, *Cybister tripuntatus*, consisting of the neurosecretory cells in the brain, corpora cardiaca and carpora allata. The brain is well distinct, bilobed structure situated on mid-dorsally on the pharynx in the head of adult beetle. The neurosecretory cells are distributed symmetrically and distinguished into five-paired groups viz. medial, lateral, ventral, posterior and optic in each hemisphere of the brain.

INTRODUCTION

The neurosecretory cell of the brain and other ganglion of the central nervous system are extensively studied in large number of the insect in order to explore their structure and function (Novok, 1975). To a great extent the cytomorphological details, neurosecretory cells types and distribution as paired medial, lateral and ventral neurosecretory cells in the brain of *Cybister limatus* (Prasad, 1979). Beside this Barde (1981) has already reported the presence of optic neurosecretory cells in optic lobes in *Cybister regulosus*.

With the help of various specific staining techniques, the neurosecretory cells (NSC) are distinctly recognized in various region of the brain. These techniques not only provide topographical picture of the neurosecretory cell but evaluate both, the qualitative and quantitative characteristic of the neurosecretory material so that different cell types and stages of activity of the neurosecretory system during physiological state can easily be recognized.

In Coleopteran, most of the literature is available on phytaphagous rather than carnivorous insects and there is perhaps, no substantial work in the cephalic neuroendocrine system of various respects in *Dytiscid* beetles. During the present study the histomorphology, classification and distribution of the neurosecretory cells (NSC) in the brain of the water beetle, *Cybister tripunctatus* have been elucidated for the first time.

MATERIALS AND METHODS

The beetles were mainly collected from the perennial ponds and rice fields located at Pauni, District Bhandara and acclimatized in the laboratory. The brain of adult beetle was dissected out, gently fixed in Bouin's fluid for 18-24h, dehydrated in 30% to absolute alcohol, cleared in xylen and embedded in paraffin wax at 58-60ºC. About 4-6μ thick sections were cut and mounted on the slides and stained with Bergmann's chrome-alum-haematoxylene phloxine (CHP), Delphin's Alcian Blue phloxine (ABP),Gurr's Azan and Ewen's aldehyde fuchsin (AF) staining techniques.

RESULTS

The brain is a bilobed structure situated on the dorsal surface of the pharynx in the middle of the head region. It is anteriorly connected to the frontal ganglion with the paired frontal connectives, and distally with the paired corpora cardiaca (CC) with the nervi corporis cardiac interni (NCC I) and nervi corporis cardiaci externi (NCC II). Each CC is connected to the corpora allata (CA) with a nerve, nervi corporis allati (NCA), (Fig. 1). With the help of various specific staining techniques, the neurosecretory cells (NSC) are distinctly recognized in various region of the brain. The NSC consists of large glandular bodies filled with variable quantity of neurosecretory material (NSM). The NSM is also observed in the axon of the NSC and they terminate into the corpora cardiaca (CC).

Cytomorphology and classification of the NSC (Fig. 2)

On the basis of cytomorphological characteristics, such as, shape, size, cytoplasmic contain and cyclical activity of the nuclei and staining affinities of the NSM in the cell bodies and axons of the NSC (Table 1), they are classified into various

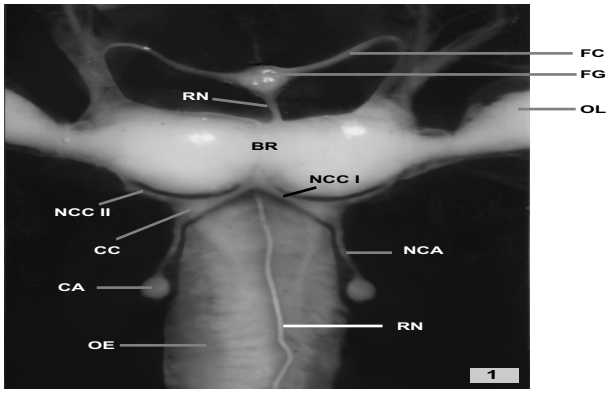

Figure 1: *In situ* structure of cephalic neuroendocrine system in the beetle

BR: Brain; CA: Corpora allata; CC: Corpora cardiac; CE: Compound eye; FC: Frontal connective; FG: Frontal ganglion; NCA: Nervi corporis allati.;NCC-I: Nervi corporis cardiaci interni; NCC-II:Nervi corporis cardiaci externi; OE: Oesophagus; OL: Optic lobe; RN: Recurrent nerve

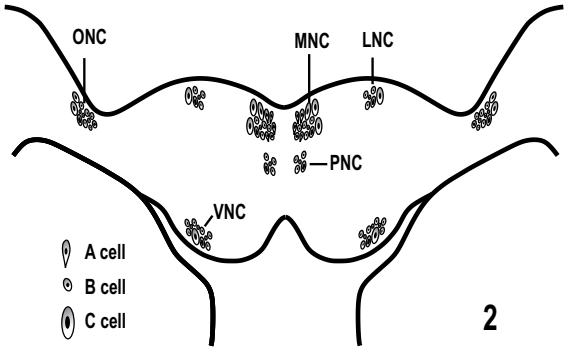

Figure 2: Diagrammatic representation of distribution of neurosecretory cells in the brain

LNC: Lateral neurosecretory cells; MNC: Medial neurosecretory cells; ONC: Optic neurosecretory cells; PNC: Posterior neurosecretory cells; VNC: Ventral neurosecretory cells

types as follows:

A cells

They can easily be identified from the other NSC due to their specific staining affinities. They stain blue black with CHP, purple with AF, blue with ABP and red with Azan. They are mostly pyriform in shape. They measured 18.45± 2.05μ m and their nuclei about 10.25±2.05μm diameter. The A cells bear large number of granules stained deeply with CHP and Aldehyde Funchsin. The granules are scattered throughout the cytoplasm.

B cells

The B cells stain red with CHP, ABP, green with AF and blue with aniline blue of Azan stain techniques. The NSM stain well in the cell bodies with phloxin of CHP and appears as fine granules, while in AF, the NSM as well as the cytoplasm stain uniformly as green. The B cells are spherical in shape. The B cell can be classified into two subtypes on the basis of their size as follows.

The B_1 cells: They measures about 14.35±2.05μm and nuclei 10.25±2.05μm in diameter.

The B_2 cells: They measures about 18.45±2.05μm and nuclei 9.57±1.367 μm in diameter.

C cells

The C cells are larger than A cells and are ambhibious in staining affinity. The NSM stains blue in CHP, light purple in AF, blue in ABP and red in azan staining techniques. The cytoplasm stains with the counter stains. They are spherical or oval in shape. The C cells can be classified into two sub types as follows:

The C_1 cells: They measures 22.55±2.05μm and nuclei measure about 9.56±1.36μm in diameter.

The C_2 cells: They measures 28.70±2.36μm in cell and 14.35±2.05μm nuclear diameter.

The distribution of the NSC

The NSC are located in five regions in the brain and form five paired distinct groups as follows:

The medial neurosecretory cells (Figs. 3 and 4)

Two groups of the neurosecretory cells, the medial neurosecretory cells (MNC) lie close to each other in the anterodorsal region of the pars intercerebralis medialis in the protocerebrum on either side of the median furrow. Both the MNC groups are so closely situated that, it is often difficult to recognize them separately. Each group is composed of 8 A cells, 20 B_1 cells and 7 C_1 cells. The A and B_1 cells are intermingled with each other while the C_1 cells are situated peripherally at anterior and posterior region.

The lateral neurosecretory cells (Fig. 5)

A small group of lateral neurosecretory cells (LNC) is situated in the pars intercerebralis lateralis region of the protocerebrum

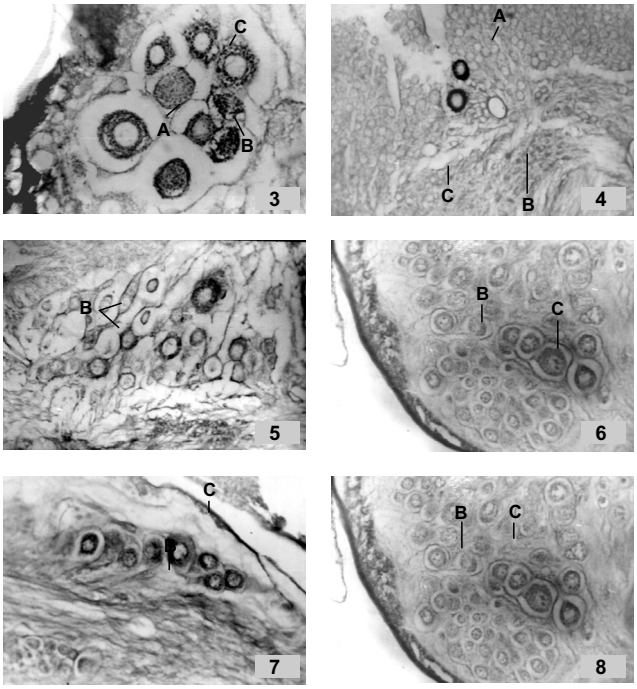

Figure 3 to 8: Section passing through the brain showing (3) **medial A, B and C neurosecretory cells (AF, X80)** (4) **medial, A, B and C neurosecretory cells, magnified (AF, X160)** (5) **lateral B neurosecretory cells. (AF, X128);** (6) **ventral B and C neurosecretory cells (AF, X128)** (7) **posterior B and C neurosecretory cells (AF, X128)** (8) **optic B and C neurosecretory cells (AF, X128)**

Table 1: Cytomorphology, classification and distribution of neurosecretory cells in the brain

Cell type	Staining Affinity CHP	AF	ABP	Azan	Size (μm) Diameter Cell	Nuclei	Shape Cell	Nuclei	Distribution Group	Number
A cell	Blue-Black	Purple	Dark blue	Dark red	18.45 ± 2.05	10.25 ± 2.05	Pyriform	Spherical	MNC	8
B_1 cell	Dark red	Purple NSG in greenish	Dark red	Dark blue	14.35 ± 2.05	10.25 ± 2.05	Spherical	Spherical	MNC	20
									LNC	5
									PNC	14
B_2 cell		cytoplasm			18.45 ± 2.05	9.57 ± 1.36	Spherical	Spherical	VNC	7
									ONC	7
C_1 cell	Blue-black NSG in redish cytoplasm	Purple NSG in brownish cytoplasm	Blue NSG in redish cytoplasm	Red granules in bluish cytoplasm	22.55 ± 2.05	9.56 ± 1.36	Spherical	Spherical	MNC	2
									PNC	7
C_2 cell					28.70 ± 2.36	14.36 ± 2.05	Oval	Spherical	LNC	3
									VNC	3
									ONC	3

CHP - Chromalum Haematoxyline Phloxin; AF – Aldehyde Fuchsin; ABP – Alcian blue; MNC, LNC, PNC, VNC, ONC – Medial, Lateral, Posterior, Ventral, Optic neurosecretory cells respectively.; NSG – Neurosecretory granules.

in each hemisphere of the brain. They are located in the anterior region in between the MNC group and corpora pedunculata in each half of the protocerebrum. Each LNC group contains 5 B_1 cells and 3 C_2 cells. The B1 cells form the single cluster and the C_2 cells lie on the periphery of the LNC group. The A cells are absent.

The ventral neurosecretory cells (Fig. 6)

The NSC, constitute a distinct group of ventral neurosecretory cells (VNC) in the lateral part of each tritocerebral lobe. Each VNC group is composed of 7 B_2 cells and 3 C_2 cells. These cells are scattered amongst large number ordinary and some giant neurons. The A cells are lacking.

The posterior neurosecretory cells (Fig. 7)

The paired groups of posterior neurosecretory cells (PNC) are observed in the midposterior region of the protocerebrum. Each PNC group consists of 14 B_1 cells and 2 C_1 cells. The A cells are lacking.

The optic neurosecretory cells (Fig. 8)

A distinct group of optic neurosecretory cells (ONC) is observed at the root of each optic lobe. Each ONC group is composed of 7 B_2 cells and 3 C_2 cells. The A cells are lacking.

DISCUSSION

During the present study the histomorphology, classification and distribution of the neurosecretory cells (NSC) in the brain of the water beetle, *Cybister tripunctatus* have been elucidated for the first time.

The localization of paired medial, lateral and ventral NSC (MNC, LNC, VNC) in the brain of *Cybister tripunctatus* resembles with that in other beetles (Fletcher, 1961; Lalitha *et al.,* 1979; Gundevia and Ramamurty, 1972a; Prasad, 1979; Rajendran and Ramalingam, 1979b; Sidhra *et al*., 1983; Gundevia, 1983; Panov and Melnikova, 1986; Panov, 1989). Besides MNC, LNC and VNC, some workers reported presence of optic neurosecretory cells (ONC) in the optic lobes, Noirot (1957) in *Calotermis flavicollis*, Thomsen (1965) in *Calliphora erythrocephala*, Baettie (1971) in *Periplaneta americana*, Khan (1976) in *Blatta orientalis*, Tembhare and Thakre (1976a) in *Orthetrum chryris*, Barde (1981) in *Dineutes indicus* and *Cybister regulosus*, Prasad (1981) in *Poekilocerus pictus*, *Periplaneta americana*, *Belostoma indicum*, *Polistes hebraeus* and *Sandrocottus de jeani*, Andrew (1988) in *Tramea virginia* and Tembhare and Paliwal (1990) in *Apis dorsata*. The presence study also reveals the presence of well-defined paired groups of neurosecretory cells in optic lobes of *Cybister tripunctatus*.

The number of NSC constituting various groups appears to be the species-specific phenomenon. The presence of a small number of comparatively large size NSC in the pars intercerebralis (PI) of *C. tripunctatus* corroborates to the findings of Fletcher (1961), Siew (1965a), Gundevia and Ramamurti (1972a), Govardha *et al*. (1978), in Coleoptera and also in other insects (Deoras and Bhaskaran, 1966-1967a; Hsiao and Fraekel, 1966; Dogra, 1967a; Raina, 1974; Kurad and Thakare, 1980). On the other hand some workers have reported presence of NSC of small size occurring in large number (Highnam, 1961; Dogra, 1967d; Awasthi, 1969; Dogra and Even, 1970; Tembhare, 1973).

On the basis of staining affinity and other cytomorphological characteristics, earlier workers (Thomsen, 1952; 1954b; Nayar, 1955; Highnam, 1961; Delphin, 1965; Hinks, 1971a; Thakare and Tembhare, 1975; Panov, 1979, 1980) classified the NSC of various groups into the cell types like, A, B, C and even into subtypes like, A_1, A_2, A_3 etc. The A cells seem to occur in PI of almost all the insects (Raabe, 1982). In Coleoptera maximum number of cell types was described by Fletcher (1961) who ascribed 13 types of cells in the beetle, *Blaps mucronata* and 7 types by Schooneveld (1970) in *Leptinotarsa decemlineata*. In *C. tripunctatus*, moreover, only three types of the NSC viz. A, B and C can be recognized similar to that in *Galeruca tunaceti* (Siew, 1965a) and *Mylabris pustulala* (Sidhra *et al*., 1983). The B and C cells in various groups in the brain of *C. tripunctatus* are further classified into two subtypes B_1 and B_2 and C_1 and C_2 respectively on the basis of their size variations. The neurosecretory cells of various groups in the brain of *C. tripunctatus* frequently show change in cell and nuclear size and quantity of cytoplasmic inclusion in the perikarya and axons suggesting cyclical activity of synthesis and release of neurosecretory material in accordance with the physiological, reproductive or developmental requirement of the insects. (Gawande, 1969; Khan, 1969; Singh and Arif; 1981; Muszynska-pytel, 1987; Lee *et al*., 1991; Peric-Mataruga V *et al.,* 2008).

REFERENCES

Andrew, R. J. 1988. Studies on the developmental changes in the neuroendocrine system, reproductive organs and haemolymph intermediary metabolites in the last instar nymph-adult dragonfly, *Tramea virginia* (Rambur) (Anisoptera: Odonata). Ph.D. Thesis: Nagpur University.

Awasthi, V. B. 1969. Studies on the neurosecretory system of active and hibernating adults of the house cricket, *Grydlodes sigillatus* (Walk), *Anat. Anz*. **125:** 256-272.

Barde, S. P. 1981. Neurosecretory cells in the optic lobe of two aquatic Coleopteran species, *Dineutes indicus* and *Cybister rugulosus*. *Hydrobiologia* **76(1/2):** 97-102.

Beattie, T. M. 1971. Histology, histochemistry and ultrastructure of the neurosecretory cells in the optic lobe of the cockroach *Periplaneta americana*. *J. Insect physiol*. **17(10):** 1843-1855.

Delphin, F. 1965. The histology and possible function of neurosecretory cells in the ventral ganglia of schistocera gregaria Forskal (Orthoptera: Acrididae) *Trans. R. Ent. Soc*. Land. **117:** 167-214.

Deoras, P. J. and Bhaskaran, G. 1966-1967a. Studies on the neuroendocrine system in the Indian housefly, *Musca nebulo* Fabr. III. Adult organs. *J. Bombay Univ*. **35:** 59-72.

Dogra, G. S. and Ewen, A. B. 1970. Histology of the neurosecretary system and the rectrocerebral endocrine glands of the adult migratory grasshopper, *Melanoplus sanguinipes* [F.] (Orthroptera : Acrididae), *J. Morphol*. **130**: 451-466.

Dogra, G. S. 1967a. Studies on the neurosecretory system of *Ranatra elongata fabricius* (Hemiptera: Nepidae) with reference to the distal fate of NCC I and NCC II. *J. Morph.* **121:** 223-240.

Dogra, G. S. 1967d. Studies on the neurosecretory system of the female mole cricket, *Gryllotalpa africana. J. Zool*. (Lond.). **152**:163-178.

Fletcher, B. S. 1961. The diversity of cell types in the neurosecretory system of the beetle *Blaps mucronata. J. Insect physiol*. **15:**119-134.

Gawande, R. B. 1969. Neurosecretion in the V instar nymphs of *Schistocerca gregaria Forsk. ACTA Entomologia Bohem*. **66(2):** 70-84.

Govardhan, T. L., Shyamasundari and Rao, K. H. 1978. The structure and cytochemistry of the neurosecretory cells in the cerebral and ventral ganglia of *Hydrous triangularis say* (Insecta: Coleoptera). *Bull. Zool*. **45:** 307-314.

Gundevia, H. S. 1983. The ultrastructural study of brain neurosecretory cells of *Hydrophilus olivaceus* (Polyphaga: Coleoptera). *Z. Milkrosk. Anat. Forsch.(Leipz.)* **97(4):** 615-625.

Gundevia, H. S. and Ramamurty, P. S. 1972a. Histological studies of the neurosecretory and retrocerebral complex of the water beetle. *Hydrophilus olivaceus Fabr*. (Insecta: Coleoptera*). Z. Morphol*. **71(4):** 355-375.

Highnam, K. C. 1961. The histology of the neurosecretory system of the adult female desert locust, *Schistocercs gregaria. Quart. J. Microsc. Sci.* **102:** 27-38.

Hinks, C. F. 1971a. Histochemical analysis of the neurosecretory cells in the adult brain of *Triphaena pronuba* (Lepidoptera: Noctuidae). *Can. Ent*. **103:** 1639-1648.

Hsiao, C. and Fraenkel, G. 1966. Neurosecretory cells in the central nervous system of the adult blowfly, *Phormia regina Meigen*. (Diptera: calliphoridae). *J. Morphol*. **119:** 21-38.

Khan, T. R. 1969. Activity of neurosecretory system during embryonic and post-embryonic development of the cockroaches, *Periplaneta americana* and *Blatta orientalis. Ind. J. Zool.* **X(3):** part I.

Khan, T. R. 1976. Neurosecretory cells in the brain and frontal ganglion of the cockroaches *Periplaneta american* (L.) and *Blatta orientalis* (L). *Zool. Anz. Jena*. **197(1/2):** 117-124.

Khurad, A. M. and Thakare, V. K. 1980. Cephalic neuroendocrine system of the buffalo-fly *Lyperosia exigua* (De maijere) (Diptera : Muscidae). *J. hirnforsch*. **21(5):** 523-530.

Lalitha, G., Shyamsunddari, T. K. and Rao, H. 1979. The structure and cytochemistry of the neurosecretory cells in the cerebral and ventral ganglia of *Hydrous triangularis* (Insecta: Coleoptera). *Bull. Zool.* **45(4):** 307-314.

Lee, B., Jeon, M. J., Moon, M. and Kim, W. 1991. Metamorphic changes of cephalic neurosecretory cells, corpus cardiacum and corpus allatum in cabbage butterfly, *Pieris rapae*. *Korean J. Entomol*. **21(4):** 167-174.

Muszynska-Pytel, M. 1987. Allatatropic activity of the median neurosecretory cells of *Galleria mellonella* (Lepidoptera) larval brain. *Experientia* (Basel). **43(8):** 908-909.

Nayar, K. K. 1955. Studies on the neurosecretory system of *Iphita limbata* Stal. I. Distribution and structure of neurosecretory cells of the nerve ring. *Biol. Bull. Woods Hole*. **108:** 296-307.

Noirot, C. 1957. Neurosecretion et sexualite chez le Termite a cou jaune *Calotermis flavicollis*. F. International congress of IUSSI, wegeningen. The Netherlands. p. 12.

Novak, V. J. A. 1975. Insect Hormone.

Panov, A. A. 1979. Neurosecretory cells in the pars intercerebralis of Geocorisae (Heteroptera: Inssecta). *Zool. Anz*. **203(5/6):** 289-315.

Panov, A. A. 1980. The cerbral neurosecretory system of *Tipulidae* (Diptera: Insecta) *Zool. Anz*. **205(5/6):** 345-358.

Panov, A. A. 1989. The histology of the cerebral neurosecretory system in several representatives of Cleroidea (Coleoptera, Insecta). *J. Hirnforsch.* **30(1):** 5-10.

Panov, A. A. and Melnikova, E. J. 1986. The cerebral neurosecretory cells and corpora cardiaca of the longicorn beetles (Coleoptera: Cerambycidae). *Zool. Jb. Anat.* **114:** 205-219.

Peric-Mataruga, V., Prolic, Z., Nenadovic, V., Vlahovic, M. and Mrdakovic, M. 2008. The effect of a static magnetic field on the morphometric characteristics of neurosecretory neurons and corpora allata in the pupae of yellow mealworm Tenebrio molitor (Tenebrionidae). *Int J. Radiat Biol.* **84(2):** 91-8.

Prasad, O. 1979. Studies on the neurosecretory system of three quatic beetles: *Hydrus indicus Cybister limbatus* and *Sandrocottus dejeani* (coleoptera). In: *J. Hirnforsch* **20(6):** 657-61.

Prasad, O. 1981. Optic lobe neurosecretory cells in *Poekilocerus pictus* (Opthoptera), *Periplaneta americana* (Dictyoptera), *Belostoma indicum* (Hemiptera), *Polistes hebraeus* (Hymenoptera) and *Sandrocottus de jeani* (Coleoptera). *Z. Mikrosk. Anat. Forsch*. (leipz.) **95(3)**: 477-483.

Raabe, M. 1982. *Insect Neurohormones*. Plenum Pess, New York.

Raina, S. K. 1974. Studies on the neuroendocrine system in the earwig, *Labidura riparia* (pallas) (Labiduridae: Dermaptera). Ph.D. Thesis: Nagpur University.

Rajendran, R. and Ramalingam, N. 1979b. Studies on the neursecretory cells in the brain of the adult female *Mylabris balteata pallas* (Coleoptera: Polyphaga). *Curr. Sci.* (India) **48**:1023-1025.

Schooneveld, H. 1970. Structural aspects of neurosecretory and corpus allatum activity in the adult Colorado beetle. *Leptinotarsa decemlineata* (Say) as a function of day length. Netherlands. *J. Zool*. **20(2)**: 151-237.

Sidhra, D. V., Thakare, V. K., and Tembhare, D. B. 1983. The cephalic neuroendocrine system of the beetle, *Mylabris pustulata* (Thunb) (meloidae: Coleoptera). *J. Hinnoforsch*. **24:** 71-78.

Siew, Y. C. 1965a. The endocrine control of adult reproductive diapause in the chrysomelid beetle, *Galeruca tanaceti* (L). *I. J. Insect*

physiol. **11:** 1-10.

Singh, Y. N. and Arif, M. 1981. Morphology and secretory activities of the postembryonic development of Poekilocerus *pictus* (Acridoidea: psrgomorphidae). *Arch. Biol*. **92(1):** 35-52.

Tembhare, D. B. 1973. Studies on the neuroendocrine system in the dragonfly, *Orthetrum chrysis* (Selys). (Libellulidae: Odonata) Ph.D. Thesis: Nagpur University, Nagpur.

Tembhare, D. B. And Paliwal, G. N. 1990. Cephalic neuroendocrine system of the rock honeybee, *Apis dorsata* (F.) worker. Proc. Of 11th International Congr. IUSSI, pp. 137-138.

Tembhare, D. B. And Thakare, V. K. 1976a. The cephalic neuroendocrine system of the dragonfly *Orthetrum chrysis* (Selys) (Anisoptera: Libellulidae). Odonatologica (Utr). **5(4):** 355-370.

Thakare, V. K. And Tembhare, D. B. (1975). Histochemistry of the neurosecretory cells of the pars intercerebralis of the dragonfly, *Orthetrum chrysis (Selys). Odonatologic*a. **4:** 225-235.

Thomsen, E. 1952. Functional significance of the neurosecretory brain cells and the corpus cardiacum in the female blowfly, *Calliphora erythrocephala. Meig J. Exp. Boil*. **29:** 137-172.

Thomsen, M. 1965. The neurosecretory system of the adult *Calliphora erythrocephala*. II. Histology of the neurosecretory cells of the brain and some related structures. *Z. Zellforsch. Mikrosk. Anat.* **67:** 693-717.

Thomson, M. 1954b. Observation on the cytology of neurosecretion in various insects (Diptera and Hymenoptera). *Publ. Staz. Zool. Napoli*. **24:** 46-47.

NATIONAL ENVIRONMENTALISTS ASSOCIATION

AND ITS OFFICIAL ORGAN

The Bioscan

An International Quarterly Journal of Life Science

Started in 1988, the National Environmentalists Association has been reorganized in 2006 and now is an association functioning with full vigour and new impetus to meet its objectives with the co-operation of like minded environment conscious academicians from different parts of the nation.

MEMBERSHIP OF THE ASSOCIATION

Any graduate having interest in environmental conservation and protection of nature and natural resources can be the member of the association.

To be the member of the association the application form given below should be duly filled up and sent to the Secretary of the association along with a demand draft of Rs. 750/- (After the 25% concession) for annual membership and Rs. 7500/- (After the 25% concession) for life membership.

FELLOWSHIP OF THE ASSOCIATION

The Association is awarding FELLOWSHIP to deserving academicians / researchers /scientists who are LIFE MEMBERS of the Association after reviewing their bio-data by the Fellows and the Executive Members of the association. The Fellows are privileged to write **F.N.E.A.** after their names **.**The prestigious Fellowship also includes a citation in recognition of their contribution to society in general and the endeavour for the noble cause of environment in particular.

AWARDS OF THE ASSOCIATION

The Association in its Seminars and Conferences provides the following category of awards on annual basis.

1. **The young scientists award** : It is given to the researchers below the age of 35 years.

2. **The senior scientists award** : It is awarded to the academicians above the age of 35 years.

3. **The best paper award**: It is awarded to the contributor of the Journal **The Bioscan** during the year.

4. **The best paper presentation award** : It is awarded to the scholar whose presentation is the best other than the young scientist category.

5. **The best oration award** : It is awarded to the scholar who delivered invited speech.

6. **The recognition award** : It is awarded to those senior scholars who have contributed to the subject through their continued research .

7. **The environmental awareness award** : It is awarded to those who, apart from their research contribution, have done commendable extension work for environmental betterment.

The number of recipients of award in each category will vary depending upon the recommendation of the panel of judges and the executive committee. The association has the provision to institute awards in the name of persons for whom a with desired sum is donated in consultation with the executive body.

PUBLICATION OF THE ASSOCIATION

In order to provide a platform to a vast group of researchers to express their views and finding of research as well as to promote the attitude of quality research among the scholars of younger generation the association publishes an international quarterly journal – **THE BIOSCAN (ISSN:0973-7049).** For the benefit of the potential contributors **instructions to authors** is given separately in this journal. However, the details regarding the journal and also the association can be seen on our website *www.thebioscan.in.*

Cont. ..... P. 418