IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 6, Issue 11, November 2019

Histomorphological and Physiological Study of Ocelli in Adult Gryllodes Sigillatus (Walker) in Light and Dark Adaptation (ORTHOPTERA: GRYLLIDAE)

Dr. S. Kalaichelvi

Associate Professor, Department of Zoology, Sri G.V.G Visalakshi College for Women (Autonomous), Udumalpet

Abstract: The sense organs of insects present a great variety of forms, giving responses to different types of stimuli. The different kinds of sense organs are distinguished by the nature of the stimulus that acts on the sense organ. This stimulus may be mechanical, chemical and light stimulus. The photo stimuli are responded by various types of photoreceptors in animals but in the case of insects it is caused by compound eyes and simple eyes or ocelli. The ocelli are the complex and delicately organised sense organs in insects. Dorsal ocelli are found in adult insects. The numbers of ocelli in insects differ according to the family and order. The numbers of ocelli present in *Gryllodes sigillatus* are three, among them two are lateral ocelli and one median ocellus.The orthopteran insect *Gryllodes sigillatus* has well developed ocelli which are structurally adapted for diurnal and nocturnal activities. All the three are helping in vision like compound eyes by the presence of photoreceptive cells and also undergoing dark adaptation. The structure of ocelli consists of photoreceptive cells, lens, corneagen layer, retinal cells, rhabdom, pigment, retinual axon and oceller nerve.

Keywords: Gryllodes sigillatus, insects, Ocelli, median ocellus, photoreceptive cells, retinal cells, lens, corneagen layer, rhabdom, pigment, retinual axon and oceller nerve

I. INTRODUCTION

The present investigation undertaken to elucidate the morphology, anatomy, histology and physiology of the lateral and median ocelli and changes in their structure during light and dark adapted condition in an orthopteran adult insect, *G. sigillatus* (tropical house cricket)

Materials and Methods

1. **Collection of specimen:** The insects were collected from the crevices of kitchen.
2. **Rearing technique**: The insects were collected and reared in the aluminum mesh cage and fed with juicy vegetable like chow-chow.
3. **Histological technique:**

II. FIXATION

a. Light adaptation

Freshly moulted adult insects were collected and kept in day light and decapitated carefully and transferred into the alcoholic bouin's fluid for fixation. The materials were then, dehydrated in alcohol series, treated with acetone and cleared in xylol, and finally embedded in hard paraffin wax of high melting point (58°C to 60°C). The material was sectioned a 6 microns thickness by microtome. Meyer-albumin was used for bleeching the section. After de parafffinizing, the sections were hydrated through the grades of alcohol and stained in Ehrlich's haematoxylin and then counter stained with aquous eosin.

b. Dark adaptation experiment

A group consisting freshly moulted ten adult insects were kept inside the bottle for 2 days. The Outer surface of the bottle covered with a black paper to provide darkness inside. The mouth of the bottle was covered with a fine aluminum mesh to provide aeration. Small piece of chow-chow were kept inside the bottle as food material for the insects. Further these insects were kept in the dark room for 2 days. These dark adapted insects were immediately dropped into boiling water acts as a prefixative, and to ensure the movement of pigments and cells that did not occur during chemical fixation. After fixing the material in boiling water the head was decapitated and transformed into alcoholic bouin's fixative. The standard histological techniques were then employed for histological observations through high power of microscope.

III. RESULT AND DISCUSSION

i. Morphology of ocelli

The Dorsal ocelli of G.sigillatus are white in colour and they lie on the dorsal side of the head. The upper two ocelli are called lateral ocelli and median one is known as median ocellus. The lateral ocelli are oval in shape and they are situated on the vertex at the end of the ecdysial cleavage line. The median ocellus is situated on the frons and is spherical in shape.

The present investigation has revealed that the ocellus of *G.siggilat*us is of a typical orthopteran type as it has been reported for *Shistocerca greg*aria (Goodman et. al . , 1979), Schistocerca vaga (Goodman , 1974) and *Aceta domesticus* (Margaret koontz , 1976). In plecoptera, all of the ocelli are situated in frons, but in most insects, the paired ocelli have either migrated into the suture between the frons and the vertex (Jhon Henry Comstock ,1960).

ii. Structure of ocelli

a. Lens in lateral ocelli

Lateral ocelli bears a dome shaped common lens which is cuticular in origin. It is biconvex in Nature showing lens lamination and more (or) less spherical shape. The ocellus of *G. sigillatus* is characterized by the presence of corneal lens and retinal cells extending from the basement membrane the cornea as in the case of *S. gregaria (Goodman ,1970) and Acheta domestica (Margaret koontz ,1976)*

b. Lens in median ocellus

The cellular lens of the median ocellus is formed from a number of transparent polyhedral cells each possessing a oval shaped and flattened nucleus. Polyhedral cells are secreted by a corneagen layer. Similarly, the orthopteran insect *Acheta dometicus,* has been shown to contain three ocelli, two of them are located laterally near the antennal sockets, While the third one is amedial and more anterior in position. The cuticualar in position. The cuticular surface of the ocelli is flat and smooth and lacks the short sensory hairs that cover the surrounding head surface. The lateral ocelli are larger than the median ocellus (Magaret koontz , 1976),as in the case of G .sigillatus. In cleaon the epidermis is composed of transparent colourless small cells and is considered to be a corneagenous layer and is situated above the lens *(Ruck, 1964)* as in the case *of G .sigillatus*. Similarly, the lens of the median ocellus of Ephemeroptera is convex and it is formed from a mass of polyhedral cells lying beneath the corneagen layer (Ruck, 1957, Richards and Davies, 1977).

c. vitreous layer in median ocellus

The vitreous layer is present only in the median ocellus. The colourless epidermis beneath the lens is known as vitreous layer. The vitreous cells are slender and longer each with a spherical nucleus. In Lucilia the cup-shaped region between lens and retinal cells are filled with large, elongated vitreous cells or more rarely with a vitreous fluid (Goodman, 1970).

iv. Retinal cells in lateral and median ocelli

Fifteen retinal cells are identified in the lateral and median ocelli. They are slender and long cell bodies surrounding the entire length of the rhabdom up to the basement membrane. The spherical shaped nucleus of the retinal cells are located at the basal level. In cross sections the retinal cells appear to be hexagonal shaped. The lateral ocellus of the Agrion contains two layers of retinal cells as against a single layer of retinal cells identified in the lateral ocellus of *G. sigillatus*. The retinal cells of the median ocellus of the *G .sigillatus* are similar to those of lateral ocellus with respect to number and size.

v. Rhabdom of lateral and median ocellus

The rhabdom of lateral and median ocellus have similar structural organization. The fifteen rhabdomeres are associated with each other to form the rhabdom which appears to be a rod like structure. On the other hand, the Syrphid helophilus has been shown to contain a central rayed rhabdom (Goodman, 1970).

vi. Pigment cells of lateral and median ocellus

The lateral and median ocellui of *G. sigillatus* . The peripheral cells of the corneagenous layer, where it merges with the normal epidermis, contains dark pigments forming an 'iris' about the sensory element.The pigment cells are found between the retinal cells which is present in the peripheral region of ocellus. In *S.gregaria* the pigment granules are confined to the peripheral cells of the corneagenous layer just above the distal ends of the retinal cells (Goodman, 1970).

In Cloeon, Ceratopsylluscanis and Agrion a densely pigmented epithelium invests the whole ocellus and a rapid movement of the pigment in this sheath has been reported in response to changing light intensity (Lammert, 1925).

vii. Reflective layer and tapetum in median ocellus

Under lying the retinal layer is a white reflective layer which is called tapetum formed by the connective tissue. The cells of the reflective layer are tightly packed with granules *G. sigillatus*. Such a reflecting layer measuring 40 to 50 microns thickness is found around the base of the median ocellar cup in schistocerca and is extended upwards at the sides of the cup containing the granules and crystals resembling those of uric acid in structure *(Goodman 1970*). It has been found in *G. sigillatus.*

viii. Retinular axons in lateral and median ocelli

The retinular axons orginate from the basal part of the retinal cells and they penetrate the reflecting tapetum and then unite together to form a lateral and median ocellar nerves and directly joins with the proto cerebral part of the brain as it has reported for *S. gregaria (Goodman 1970).*

xi. Basement membrane

Basement membrane are delicate structure situated at the inner surface of the ocellus. The basal part of the retinal cells rest upon this layer. In *Ephestia* basement membrane is found to be a thin and indistinct one *(Horridge and Giddings, 1971*). In Sericesthis geminate It is a thick and amorphous structure (Meyer-Rochow, 1977). In *S. gregaria* the inner surface of the ocelli is covered bt a basement membrane which is penetrated by the proximal process of the retinal cells *(Goodman, 1970)* as in the case of G. sigillatus.

x. Light adaptation in lateral and median ocellus

In the light adapted state, the pigment granules are evenly distributed throughout the margin of the ocelli and these granules are found more closely distributed in retina *G. sigillatus.*
other insects such as *S. gregaria (Goodman, 1970*) and *Calliphora (Goodman, 1969).* In *S.gregaria* light adapation is similar like that of *G. sigillatus.*

xi. Dark adaptation in lateral and median ocellus

During dark adapted state, the pigment granules are seen to get concentrated near the basal part of the ocellus and the retinal cells. The rhabdom appears tobe situated distal to the lens of the ocelli. Similar migration of pigements in the cytoplasm of retinal cells during dark adaptation has been reported for other insects such as *S. gregaria (Goodman, 1970*) and *Calliphora (Goodman, 1969).* In S.gregaria dark adapation has been shown to be completed with in a range of 5 to 30 minutes, in phormia and calliphora, 100 minutes *(Goodman, 1970).*

IV. SUMMARY AND CONCLUSION

Histology

The Median ocellus in G. sigillatus varying in structure of lens, reflective layer and tapetum from the lateral ocelli.The lens of lateral ocelli are made up of cuticle in origin and the lens of median ocellus is made up of cellular lens. Remaining cells like retinal cells, rhabdom, pigment cells, retinular axons and basement membrane are same.

Physiology

Light adaptation

Both lateral and median ocelli are sensitive to light and the pigment granules concentrated near the lens and rhabdoms situated closer to the lens of the ocelli during light adaptation. The ocelli are maintaining equilibrium during flight. Hence the ocelli are always helping in vision and responding to light.

Dark adaptation

During dark adaptation the pigment granules concentrated near the basal part of the ocellus and the rhabdoms situated distal to the lens of the ocelli. So the ocellar pigments not responding during dark adaptation.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 6, Issue 11, November 2019

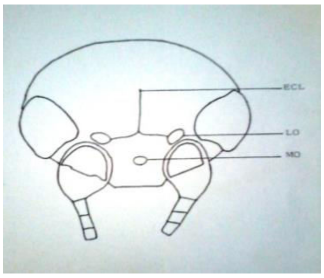

Fig. 1 Diagram showing the position of the median and lateral ocelli in the head of the adult G.sigillatus

ECL –Ecdyceal cleavage line; **LO** –Lateral ocelli;
MO –Median ocellus

Fig. 2 Insect Head

MO – Median Ocellus

LO – Lateral Ocelli

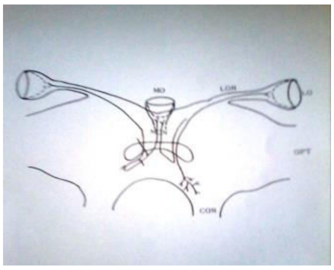

Fig. 3 Diagram showing the lateral and median ocellar connections with brain by ocellar nerves of the adult G.sigillatus.

OPT –Optic lobe; **LO**-Lateral ocelli; **MO**-Median ocellus;
CON-Circumesophageal connectives;
LON-Lateral ocellar nerve; **MON**-Median Ocellar nerve.

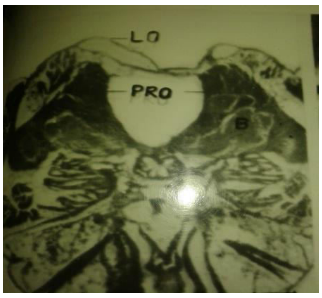

Fig.4 L S of **lateral and median ocellar connections with brain by ocellar nerves of the adult G.sigillatus.**

LO – Lateral Ocelli
PRO - Protocerebrum
B - Brain
Bouin's 6 µ, Ehrlich's haematoxylin and eosin

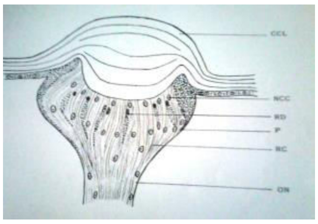

Fig. 5 Diagram showing the structure of lateral ocellus of the adult G.sigillatus

CCL –Cuticular corneal lens;
NCC –Nucleus of corneagen cell;
RD –Rhabdon; **P**-Pigment ;**RC**-Retinal cell ;
ON-Ocellar nerve.

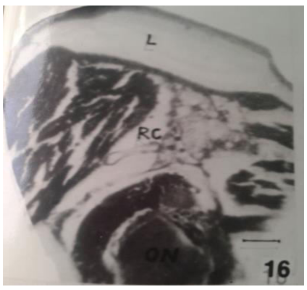

Fig. 6 LS of Lateral Ocellus

L- Lens
RC -Retinal cells
ON - Ocellar nerve
Bouin's 6 µ, Ehrlich's haematoxylin and eosin

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 6, Issue 11, November 2019

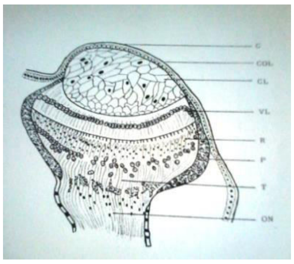

Fig. 7 Diagram showing the structure of median ocellus of the adult G.sigillatus

C-Cuticle ; **CON**-Corneagen Layer ;
CL-Cellular lens;
VL-Vitreous Layer;**R**-Retinulae;
P-Pigment;**T**-Tapetum;**ON**-Ocellar nerve.

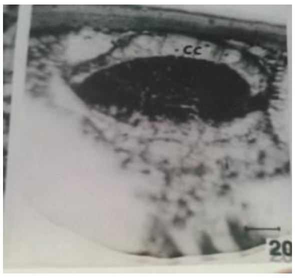

Fig. 8 LS of Median Ocellus

CON- Corneagenous cells
CL-Cellular lens;
VL-Vitreous Layer;**R**-Retinulae;
P-Pigment;**T**-Tapetum;**ON**-Ocellar nerve
Bouin's 6 μ, Ehrlich's haematoxylin and eosin

Fig. 9 T.S. of light adapted lateral ocellus
RH - Rhabdom
RC – Retinal cells (Note the occurrence of pigment granules close to the rhabdomere during light adapted state)
Bouin's 6 μ, Ehrlich's haematoxylin and eosin

Fig. 10 T.S. of dark adapted lateral ocellus
RH - Rhabdom
RC – Retinal cells (Note the movement of pigment granules away from the rhabdomere during dark adapted state) prefixed in boiling water.
Bouin's 6 μ, Ehrlich's haematoxylin and eosin

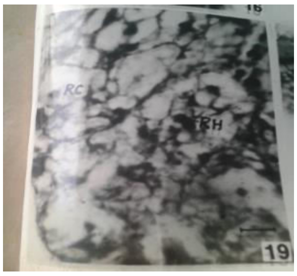

Fig. 11 T.S. of light adapted median ocellus showing the RH - Rhabdom and RC – Retinal cells PG – Pigment granules (Note the occurrence of pigment granules close to the rhabdomere during light adapted state)

Fig. 12 T.S. of dark adapted median ocellus showing the RH - Rhabdom and RC – Retinal cells PG – Pigment granules (Note the movement of pigment granules away from the rhabdomere during dark adapted state) prefixed in boiling water.

REFERENCES

[1]. Aizu, V. 1975 Comparison between the brain of the caterpillar and the image in pieris brassicae. Entom. Tid. Skr., 46: 43-52.
[2]. Brunnert, A., Wehner , R .,1973 Fine structure of light and dark adapted eyes of desert ants, Cataglyphis bicolor .J . Morph., 140: 15-30.
[3]. Benolken, R.M., 1962 Effects of light and dark adaptation processes on the generator potential of the Limulus eye. Vision Res., 2: 103.
[4]. Bozler, E., 1925 Function of ocelli; drosophila melanogaster. Z.vergl. physiol., 3: 145-182.
[5]. Carlson, S.D. and Chi. 1979 The functional morphology of the insect photoreceptor. Ann. Rev. Entomol., 24: 379-416.
[6]. Chanpman, R.M. and Lall, A.B. 1967 Electro retinogram characteristics and the spectral mechanisams of the median ocellus and the lateral eye in Limulus polyphemus. J. Gen. Physiol., 50: 2267-2287.
[7]. Chappell, R.L. and Dowling, J.E., 1972 Neural organization of median ocellus of Dragonflies – I
[8]. Intracellular electrical activity. J. Gen. Physiol., 60: 121-147.
[9]. Chappell, R.L. & Devoc, R.D., 1975 Action spectra & chromatic mechanism of cells of median ocellus of dragonflies. J.Gen. Physiol., 65: 399-419
[10]. Cooter, R.J., 1975 Ocellus and ocellar nerves of Periplaneta Americana L. (Orthoptera : Dictyoptera). Int. J.Insect Morph. Embryol, 4: 273-288.
[11]. Cornwell, P.B., 1955 Function of ocelli in calliphora and locusta(ortho). J. Exp. Biol., 32: 217-237.
[12]. Goodman, C.S., 1974 Anatomy of Locust ocellar interneurons: constancy and variability. J. Comp. Physiol –A, 95: 185-201.
[13]. Goodman, L.J., 1970 The structure and function of the insect dorsal ocellus. Adv. Insect physiol., 7: 97-190.
[14]. Goodman, L.J., 1975 The neural organization and physiology of the insect dorsal ocellus.
[15]. Goodman, L.F., Mobbs, P.G. and kiricham, J.B., 1979 The fine structure of the ocelli of Schistocerca gregaria. The neuronal organization of the synaptic plexus. Cell Tissue Res., 169: 487-510.
[16]. John Henry Comstock 1960 An introduction to entomology, Ninth edition. Ithaca, New York, Comstock Publishing Associates.
[17]. Koji Yamamoto and Yoshihiro Toh, 1975 The fine structure of the lateral ocellus of the Dobsonfly larva. J. Morph., 146: 415-430.
[18]. Lammert, A., 1925 Pigment movements in ocelli. Z. Vergl. Physiol., 3: 225-278.
[19]. Margaret Koontz, 1976 Neuronal pathways from the dorsal ocelli of the house cricket, Acheta domesticus. J. Comp. phtsiol.-A, 149(1): 105-120
[20]. Richards, O.W. and Davies, R.G., 1977 Imm's General Text Book of Entomology, 10th ed., London, Chapman and Hall, PP. 148-150.
[21]. Ruck, P. 1957 The electrical responses of dorsal ocelli in cockroaches and grasshoppers. J. Insect. Physiol., 1: 109-123.