A study on the optic glands of *Sepioteuthis lessoniana* from the Red Sea

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Abstract: In the present work the optical glands of the reef squid *Lessoniana lessoniana* were are found in young and adult individuals. They are paired small elongated organs that lie at the aboral end of the olfactory lobe, on a level with the optic tract. Histological, the cells of the optical gland are large, with about 60 um in diameter and have spherical nuclei (20 um in diameter). Their cytoplasm is coarsely granulated. Neurosecretory granules were seen in cells of optical glands and stained with paraldehyde fuchsin. No distinct neuropil was observed in these glands and these glands are rich in blood supply. The optic glands were found to be connected with optic nerve fibres to the dorso-lateral lobes of the brain. The function of the optical glands of *Sepioteuthis lessoniana* was also discussed in this study.

[Waheed M. Emam and Tarek G.Ali. **A study on the optic glands of *Sepioteuthis lessoniana* from the Red Sea.** *Life Sci J* 2014;11(4):327-331]. (ISSN:1097-8135). http://www.lifesciencesite.com. 45

Key Words: Optic gland, reef squid, *Sepioteuthis lessoniana,* Cephalopods, histology, neurosecretion**.**

1. Introduction

The structure and function of the optic glands in dibranchiate cephalopods had been studied by many authors (Wells and Wells, 1959, 1969, 1975; Wells, 1960; Björkman, 1963; Richard, 1966, 1967 a, b, 1970; Defretin and Richard, 1967; Durchon and Richard, 1967; O´Dor and Wells 1973; Wells *et al*., 1975; Wodinsky, 1977; Mangold, 1987; Le Gall *et al*., 1988; Dwight, 1999).

The coral reef squid *Sepioteuthis lessoniana* (Cephalopoda: Loliginidae) represents one of the most common squids in the Red Sea. Its morpholgy, morphometry, age and growth for specimens from the Gulf of Suez have been studied by Emam *et al.* (2007); Emam and Ali (2010, 2011). However, its nervous system and optic glands were not studied till now. Therefore the present study aimed to study the structure and the proposed function of the optic glands of the coral reef squid *Sepioteuthis lessoniana* from the Gulf of Suez and compare them with those in other related cephalopods.

2. Material and Methods

Specimens of *Sepioteuthis lessoniana* were brought alive and dissected to expose the brain. The optic glands with the optic lobe and the optic stalk were immersed in Bouan fixative and then well washed in running tap water, dehydrated and embedded in paraffin. Paraffin sections (6 µm) were stained with Hematoxilyn-Eosin (HE). Paraldehyde fuchsin stain was also used for neurosecrtion of optic gland cells. Also, the brain with optic glands of some specimens was prepared for Cajal silver impregnation to show nerve fibers that supply the optic glands.

3. Results and Discussion

The optic glands are small elongated paired structure located at the posterior edge of the optic brain tract over the helium of the optic lobes and between peduncle and olfactory lobes of the brain (Figures 1, 2 and 3). This site is similar to that in other cephalopods (Boycott and Young 1956).

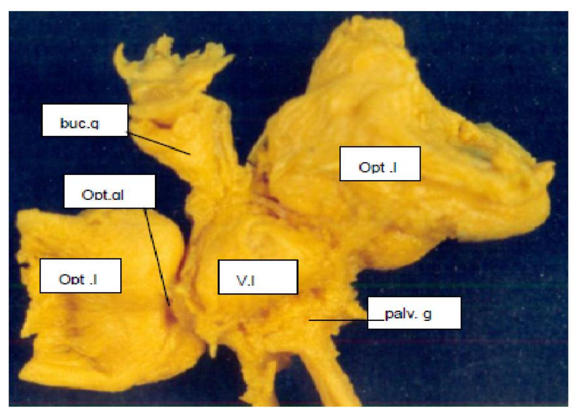

Figure 1: Dorsal view of the brain of *Sepioteuthis lessoniana* showing the optic gland (opt.gl) accossiated with the optic lobe. The other brain structures are also shown (ventricle lobe:v.l., buccal ganglion: buc.g., pallioviseral ganglion: palv.g.).

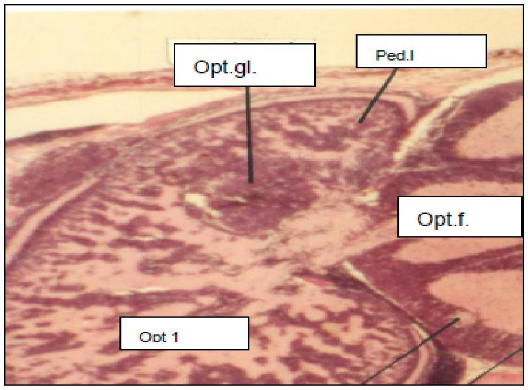

Figure 2: Transverse section of the brain of juvenile *S. lessoniana* showing the left optic gland (opt.gl.) in relation to optic lobe (opt.l) and optic fibres (opt.f.) and peduncle lobe (ped.l). Stained with Hx-E., 50X.

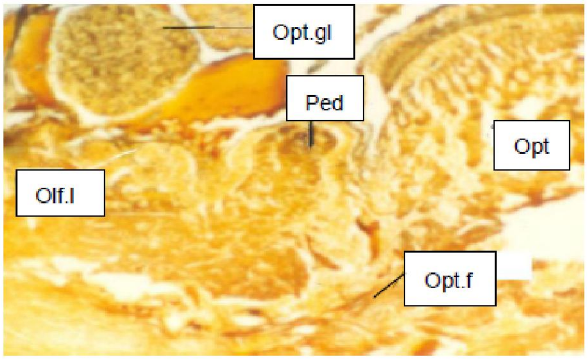

Figure 3: Transverse section of the brain of adult *S. lessoniana* showing the left optic gland (opt.gl.) in relation to optic lobe (opt.l) and optic tract fibres (opt.tr.f.), olfactory lobe (ol.l.) and peduncle lobe (ped.l.). Stained with Cajal Silver impregnation, Magn. 100X.

Histologically cells of the optic glands are well differentiated from the cerebral tissue where they form a compact mass, whereas cerebral cells are larger, and form layers surrounding eosinophylic nerve fibers (Figures 2 and 3). No distinct neuropil was observed in these glands. The cells of the optical gland are small in size in smaller individuals and large in mature individuals.

(Figure 4), and reach about 60 um in diameter and have spherical nuclei (20 um in diameters). Their cytoplasm is coarsely granulated (Figure 5). The blood vessels are shown dispersed throughout the optic glands.

Björkman (1963), Nishioka *et al*. (1966), Barber (1967), Bonichon (1967), Froesch (1974) and Mangold and Froesch (1977) reported that the optic glands in *Loligo opalescens*, *Octopus vulgaris*, *O. bimaculatus, Eledone moschata* and *Sepia officinalis*, consist of main or secretory cells, blood vessels, nerve cells and support cells.

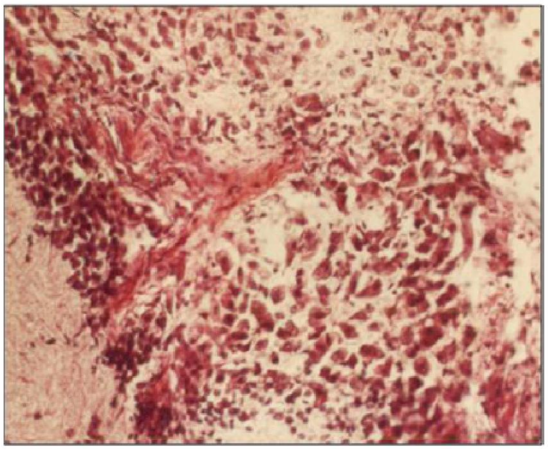

Figure 4: Cells of optic gland in immature *S. lessoniana* showing its small size and blood vessels. Stained with Hx-E, 100X.

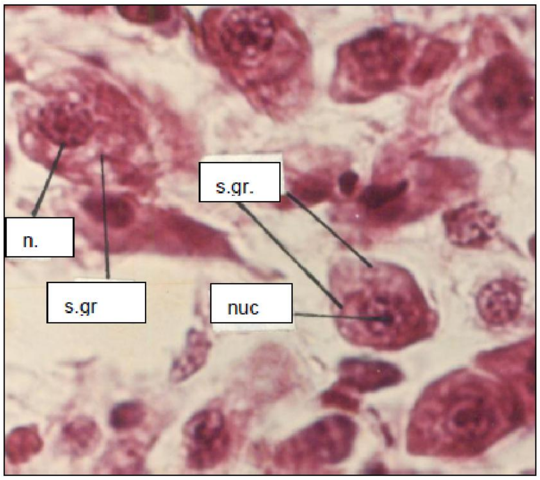

Figure 5: Cells of optic gland in mature female *S. lessoniana* showing its large size cells with rounded nuclei and granulated cytoplasm. Stained with Hx-E, 200X.
(n: nucleus , nuc: nucleolus, s.gr.: secretory granules)

The secretory cells of the optic gland in *S. lessoniana* are stained with paraldehyde fuchsin. They are the most numerous cells, and they are nearly ovoid with cytoplasmic processes and their nuclei are circular with a dense nucleoli (Figures. 6 and 7). These cells with their nuclei are larger in size in large individuals than in small ones in both sexes. Dwight (1999) showed that the organelles inside the secretory cells of the optic glands of the tropical *Sepioteuthis sepioidea* have differences in their abundance between the sexual maturity stages: at the juvenile and immature stages there are numerous mitochondriae, endoplasmic reticulum cisterns are thin and dispersed in the cytoplasm, the Golgi apparatus has a curved profile and actively secretes granules of different densities, whilst in the IV maturation stage (females) and reproductive individuals (males) secretory cells are almost depleted of mitochondriae, endoplasmic reticulum cisterns are dilated and well developed in a concentric fashion, and the Golgi complex actively secretes electron dense granules which are dispersed in the cytoplasm. Some of these are close to the lipofuchsin granules and to the cellular membrane, suggesting a possible secretory mechanism through the blood vessels.

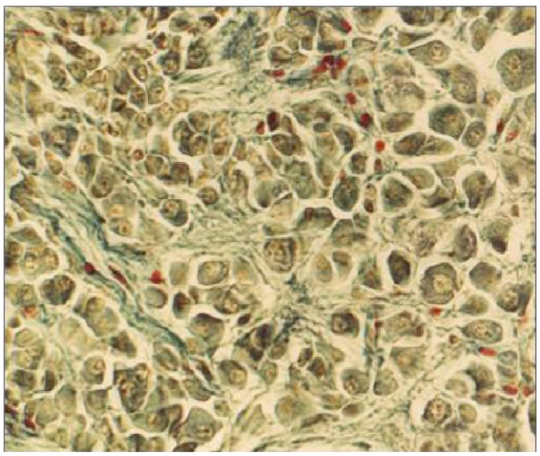

Figure 6. Neurosecretory cells of optic gland in mature female *S. lessoniana* showing the stained granules scattered in the cytoplasm and the rounded nuclei and granulated cytoplasm. Stained with Paraldehyde fuchsin, 200X.

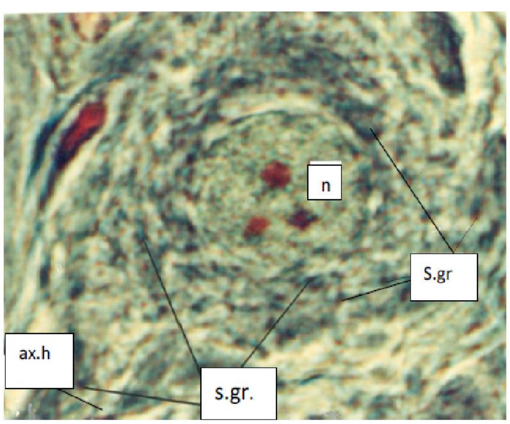

Figure7. Enlarged neurosecretory cell of optic gland in mature *S. lessoniana* showing the stained granules scattered in the cytoplasm and its axon. The nucleus is rounded with three nucleoli. Stained with Paraldehyde fuchsin, 200X. (ax.h.: axon helick, n: nucleus, s.gr.: secretory granules).

On the other hand, Dwight (1999) demonstrated the secretory activity of optic gland in *S. sepioidea* by the production of electron dense secretory granules in the sexually mature stage.

Defretin and Richard (1967) demonstrated that when *S. officinalis* is kept in a dark photoperiod the optic gland secretory cells produce three kinds of secretory granules, suggesting that they are filled with the same product in different stages of synthesis. Wells (1964) reported that the optic gland in *Octopus vulgaris* occurs both in the nucleus and secretory cell cytoplasm after cerebral surgery, while Boyle and Thorpe (1984) indicated that enlargement in optic gland of *Eledone cirrhosa* was associated with female gonad maturation, and it is suspected that this process occurs normally. The cellular changes in *S. officinalis* optic gland histology was found during sexual maturation and the main cell secretory activity was correlated with a peak of mitogenic activity in both sexes (Koueta *et al.,* 1995).

The optic glands were found to be connected with optic nerve fibres to the dorso-lateral lobes of the brain (Figure 3).

Young (1967) mentioned that optic glands have a nervous origin and probably originated from cells of the olfactory lobes in Octopus, however Young (1977) stated that the dorso-lateral lobes are the source of fibres of these glands in Loligo and Octopus.

The role of the optic glands in *Sepioteuthis lessonia* seems to be similar to that reported by Wells and Wells (1959, 1969); Wells (1960); for other cephalopods and is correlated with controlling of sexual development. On the other hand, Durchon and Richard (1967); O´Dor and Wells (1973); Wells *et al*., (1975); Wodinsky (1977); Mangold (1987) mentioned that these glands also regulate protein synthesis in the ovaries, stimulate gonadal mitosis, mating behavior, feeding and longevity. Wells and Wells (1975); Defretin and Richard, (1967); Richard (1966, 1967 a,b, 1970) found that the optic glands hormone is species specific, not sex specific, and glandular secretions have periodic oscillations associated with temperature and photoperiod. The glands are controlled by a reactive peptidergic inervation (Le Gall *et al,*. 1988), and their activity varies during the life cycle, associated with the multiplication of reproductive cells (Koueta *et al*., 1995).

The optic glands of dibranchiate cephalopods are the source of a hormone that controls the state of the gonad and of its ducts. Animals can be forced into precocious maturity by cutting an inhibitory nerve to the glands from the central supra-oesophageal part of the brain (Wells and Wells, 1959, 1972). Richard (1970) has shown that fragments of the ovary from *Sepia* will carry out oogonia-to-oocyte cell divisions in organ-culture experiments only if optic glands are present. Wells and Wells (1975) found that optic glands transplanted from one *Octopus wlgaris* into another cause enlargement of the gonads and ducts of the recipient. Enlargement occurs whether or not the gland was secreting when implanted and regardless of the sex of the donor or recipient. Also they found that optic glands derived from *Eledone moschata* or *Octopus macropus* implanted into *O. vulgaris* are as effective as glands derived from *O. vulgaris.* However, optic glands implants derived from *Sepia officinalis* or *Loligo vulgaris* appear to be ineffective. Wodinsky (1977) found that removal of both optic glands in cephalopods after spawning results in cessation of broodiness, resumption of feeding, increased growth, and extended life span. He stated that optic gland secretions may cause death of most cephalopods, and may control population size. Boyle and Thorpe (1984) indicated that optical gland size varies as a reproductive character together with ovary and oviducal gland size and this was not associated with other cerebral organs. Di Cosmo and Di Cristo (1998) reported the neurosecretion function of optic gland of *Octopus vulgaris*. They found that optic gland secret also gonadotropin hormone.

The fine structure of the gland suggests that it has several functions. Björkman (1963) suggested that the secretory cells had a high rate of synthesis. The presence of abundant mitochondriae implies that the gland may secrete a steroid hormone (Froesch, 1979). In *S. officinalis*, however a peptidic like hormone was shown to be present in the optic glands and hemolymph (Koueta *et al*., 1992). The lipofuchsin granules have been related to the resorption of metabolic residues inside the secretory cells (Froesch and Mangold, 1976; Mangold and Froesch, 1977; Froesch *et al*., 1987).

On the other hand, the fine structure of optical gland in tropical squid *sepiotheutis sepioidea* was discussed by Dwight (1999). He found that the optic gland showed the same cellular types described in other cephalopods, with slight differences. The secretory cells in young individuals present a dendritic profile with thin cytoplasmic processes, numerous circular mitochondriae with tubular crests and abundant ribosomes. At the last stage of maturity the secretory cells contain rough endoplasmic reticulum in the form of dilated cisternae, with an active Golgi apparatus, secreting electron dense granules. Mitochondriae are scarce and lipofuchsin granules show an increase in size. Secretory cell nucleus length and organelle abundance showed oscillations associated with the life cycle.

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