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ON EYE OF THE GASTROPOD STROMBUS GIBBERULUS (GASTROPODA: STROMBIDAE) FROM THE RED SEA

(With 2 Plate)

By

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عين القواقع سترومبس فبريلس / قواقع: سترومبيدى من البحر الاحمـــر

حسنى أبو الدهـــب

قوقع السرومباك من القواقع التى تكثر فى البحر الاحمر والتى تحمل زوجاً من الاعين الكبيره نسبياً والمحمله على ساقين وتستخدم فى رؤية الفريسه .

ولقد بينت الدراسه ان عين هذا القوقع من النوع المغلق والموجود فى كثير من القواقع الاخرى مثل امامية الخياشيم الاخرى ، خلفية الخياشيم ، والرئويات .

ولقد بينت الدراسه أن العين تتكون من شبكيه وعدسه ، وقرنيه بالاضافه الى القزحيه .

الشبكيه تتكون من طبقه صبغيه داخليه وطبقه حساسه للضوء خارجيه . والطبقه الصبغيه تتكون من مجموعه كبيره من الخلايا الصبغيه السوداء والتى تحتوى على مجموعه كبيره من الصبغيات وأما الطبقه الحساسه للضوء تتميز الى نوعين من الخلايا مغزليه وبيضاويه تخرج منها أعصاب تتجمع لتعطى العصب البصرى .

ولقد وجد أن العدسه كبيرة الحجم نسبياً وتتميز الى طبقه مركزيه واخرى محيطيه . هذا القوقع يستخدم العينين لرؤية الاعداء والفرائس للانقضاض عليها اما بغرض الدفاع أو التغذيه .

SUMMARY

Strombus gibberulus which is a large, heavy and handsome shelled gastropod possesses a pair of eyes born on eye stalks which protrudes through the stromboid notch outside of the shell. The eye is of the closed type which is common in prosobranchs, opisthobranchs and pulmonates. It consists of a retina, lens cornea and conjunctiva. Retina consists of a pigmented layer and photoreceptor cells. The photoreceptor cells are differentiated into cones and rods. Lens is mosty spherical and large in size. The species uses its eyes to protect itself from predators and for feeding purposes. When it sights the predators, it quickly catches and cut them with its powerful corneous operculum.

Keywords: Eye, gastropoda:Stranbidae, Red Sea.

INTRODUCTION

The sense organs in Mollusca have a wide and diverse range of structures. The main sense organs in Gastropoda are eyes, tentacles, statocyts and osphradia. The majority of gastropods posses pair of cephalic photoreceptors as light detectors and important sense organs, while few others are blind as those living in very low light intensity and those pelagic forms of the genus *Lanthina (WILBUR and YONGE, 1966).* Some investigators studied eye structure and function of prosobranchs. Among those one can mention *COLTON (1905),* on *Strombus pugilis, YONGE (1937),* on *Aporrhais pes-pelecai* and *A.serresiana, ROBERTSON (1961)* on *Strombus sp.* and *ABBOTT (1962)* on *Terebellum terebellum.*Other workers as *WILLEM (1892), FRAENKEL (1928), RUSSEL (1929),BABA (1937) and BARTH (1964)* bludied eye of some opisthobranchs.

There are two types of gastropod eye; open and closed vesicle. The first type is common in primitive families of gastropods as Haliotidae, Fissurellidae and Patellidae while the second type is common in the rest of prosobranchs, opisthobranchs and pulmonates *(FRETTER and GRAHAM, 1962).*

Although, sense organs can perform a useful link between the functional morphology and behavioural activities of molluscan organisms yet, little is available to understand the functional properties of many of these organs.

The present species is one of the most important gastropod that uses its eyes to see the crustacean and fish predators and help in defense and feeding. So, the present study is

essentially important to know the link between the functional morphology of the eye and the behavioural activities in defense and feeding of the species.

MATERIALS AND METHODS

Specimens of the gastropod *Strombus gibberulus* were collected from a site placed 15km south of Safaga city on the Red Rea coast. The collection site is a rocky shore and has many patches of Mangrove plant. The cones are found in the rocky places of the tidal area and the collection was done during low tide. The snails were moved into plastic jars containing sea water. Some were dissected on the shore for histological studies. Dissected organ was fixed in Bouin's solution, dehydrated with a graded series of ethanol, cleared in xylene, embedded in paraffin wax, sectioned at 7um and stained with haematoxylin and eosin combinations.

RESULTS

The gastropod *Strombus gibberulus* is common in the Red Sea coast, being represented by a large number of individuals. The shell of the species is heavy, thick with a flared outer and extended lip. The shell has a low conical spire, consisting of 5 whorls, and an enlarged swollen body whorl. The extended lip does not extend to the full length of the body whorl. The shell has a stromboid notch at the anterior end of the aperture through which the snail can protrude its stalked eye outside the shell (Pl. 1, A, B). The operculum is powerful, corneous, sickle shaped and is not large enough to close the aperture. The species had been using its operculum in locomotion and as a defensive weapon against the crustacean and fish predators. The shell of the mature specimen measures about 5.5 and 2.5cm in length and width respectively, while the aperture is about 3.5cm in length. The outer surface of the shall and the extended lip are whitish in colour, while the aperture is brownish or red (PL. 1, A, B).

As in other prosobranchs, the present species possesses a pair of cephalic eyes, borne on long eye stalks on both sides of the head. A pair of reduced tentacles is originated from the ventral side of the eye stalks, at the mid way between their terminal and basal parts. In a top view, eyes appear as rounded or slightly oval shaped black-spots, each of which measures about 1000μm in diameter.

The whole eye is somewhat large in size and in the form of tapering cylinder or vesicle with itss long axis parallel to

the long body axis. The vescicle contains a relatinely large spherical lens (PL. 1, c, PL. 2, D).

The optic vesicle of the present species is bulged outside of the stalk, at which the epidermis is in a higher level than that of its periphery. The epidermis at the front of the optic vesicle is differentiated into outer and inner layers. The outer layer consists of columnar epithelial cells, while the inner one consists of collagen fibers. They were known by *NEWELL (1965)* as conjunctiva and cornea, respectively (PL.2,D).

Longitudinal sections show that, the optic vesicle is closed off from the skin surface of the eye stalk, hence, it is known as a clsed vesicle type, measuring about 1000μm and 900μm in long and short axes, respectively (Pl. 1, C, PL. 2, D).

Eye vesicle of the present species consists mainly of cornea, lens, retina and optic nerves. Lens is mostly an oval body, measuring about 500 μm in long axis. The lens was described by *PRINCE (1955)* as a hayline metachromatic body devoid of any cellular structures. In some stained sections, it can be differentiated into a central lightly stained region and a peripheral slightly darkly stained one (PL. 2, D). The eye vesicle contains a large homogeneous vitreous material separating the inner surface of the lens from the retina (PL. 1, D, PL. 2, B). The wall of the optic vesicle, except the region at the front of the lens, constitutes the retina. The retina consists of two distinct layers; an inner pigmented lining and an outer visual layer. The pigmented lining is formed of a number of elongated cells, densely charged with granules of black pigments and measures about 20 μm in thickness (PL. 1, C, D, PL. 2, A, C). According to *MUELLER* et al. *(1967)* the pigmented cells are light-sensitive and help the eye to distinguish the colour.

The visual layer is differentiated into two types of sensory cells. The inner sensory cells (rodes) are elongated spindle shaped structures containing elongated nuclei and having two tapering ends. Each cell measures about 16 μm and 6 μm in length and width, respectively. The peripheral sensory cells (cones) are almost oval in longitudinal sections; measuring about 7.5 μm in long and short axes, respectively, with relatively large oval nuclei (PL. 2, A, C). *MUELLER* et al. *(1967)* reported that the rod cells are used in night vision, while cones are used for daylight vision, and are capable of producing the clearest signals to the brain.

A nerve fiber arises from each sensory cell and passes through the basement membrane to leave the optic vesicle before it branches and makes synoptic with a bipolar nerve cell. The axons of the bipolar cells constitute the optic nerve which, in

gastropods, connect with the opposite cerebral ganglion (PL. 1, D, PL. 2, B).

The lens of the optic vesicle is separated from the corneal layer by a transparent region constituting the eye pupil. Eye pupil measures about 400 um in diameter (PL. 1, E, PL. 2, D).

DISCUSSION

The present species possesses a pair cephalic eyes as in many other gastropods. Some forms of gastropods are blind as those inhabiting the region with a very low intensity of light and those of the pelagic forms of the genus *Lanthina (FRETTER and GRAHAM, 1962)*. The absence of eyes in some forms of gastropods is difficult to explain specially for pelagic and predatory forms. *FRETTER and GRAHAM, (1962)* suggested that, in the pelagic genus *Lanthina*, the absence of eyes may be connected with the passive drifting with winds and water currents as opposed to a swimming predatory habit.

As in many other prosobranchs, eyes in the present species have their trend and are borne on eye stalks on the two sides of the head and protrude out through a stromboid notch at the anterior end of the shell to help the animal for watching its enemies from the predators and seeking for food. Also, eyes of the present species bulge outside the level of the skin as in *Littorina littorea*, at which the eye bulges outside and has a radius of curvature of about 250 μ and the eye is oriented to receive the light from above and from front of the head *(NEWELL, 1965)*. In opisthobranchs and some forms of prosobranch, eyes are sunk below the level of the skin as in the venomous gastropod *Conus textile* (Aboul-Dahab, in press).

In the present species, eyes are borne on long eye stalks while the tentacles are reduced and originated from the ventral side of the eye stalks themselves. In some prosobranchs as in some hydrobiid snails *(FRETTER and GRAHAM, 1962)*, the large crescentic eyes migrate to the midline of the head, between the two tentancles. Some species of Strombidae have reduced tentacles and elongated eye stalks *(YONGE, 1937; ABBOTT, 1962)*. The burrowing species of the genus *Terebellum* tend to elongate their eye stalks while the tentacles are absent *(ABBOTT, 1962)*. In opisthobranchs, eyes lie on the dorsal sides of the cerebral ganhlia and median to the cephalic tentacles *(WILBUR and YONGE, 1966)*.

Eyes in the present species are of the closed type as in the majority of prosobranchs. Also, this condition is common in opisthobranchs and pulmonates *(FRETTER and GRAHAM, 1962)*. Also, the eye of *Stromus gibberulus* is relatively large containing a large lens as in predatory gastropods, of the two genera

Pterotrachea and Carinaria (HESSE, 1900). Although, the eyes of the venomous and predatory snail *Conus textile* (Aboul-Dahab, in press), is also lage and closed, yet they sunk below the level of the skin. These characters in the previously mentioned gastropods are suitable for active predators relying on sight to catch their preys or defending themselves against predators.

In the present species, the wall of the optic vesicle, except the corneal region, consists of light sensitive cells lined with pigmented cells. This structure is suitable for the behavioural activity of the present species and slightly different from that of the swimming forms, in which the ventral wall of the optic vesicle has small unpigmented spots and small number of sensitive cells facing the large window in the opposing dorsal wall *(FRETTER and GRAHAM, 1962). CHARLES (1961)* suggests that, the structure of syes in the swimming forms enable them to detect movement in the water below.

CHARLES (1961) and NEWELL (1965) differentiated many concentric layers with different densities in *L. Littorea* lens. *NEWELL (1965)* measured the refractive indices of these layers which ranged from 1.40-1.40 for the outer layers to 1.045 for lens center. *(NEWELL (1965)* reported that the vitreous material is large, thick and has a function to support the lens with a refractive index of 1.38 in *L. littorea* eye.

The present species protrudes its long eye stalks through the strombold notch while the soft parts stay inside the shell far away from predators. So, the snail can see its enemy from crustacean and fish predators and uses its powerful and corneous operculum to defend itself. *WAYE (1991)* reported that stromboid spp. use the opercula and eyes for locomotion and defensive purposes.

REFERENCES

Abbott, D.P. (1962): Observations on the gastropod *Terebellum terebellum* (Linnaeus) with Particular reference to the behavior of the eyes during burrowing. Velgar 5: 1-3.

Aboul-Dahab H.M. (1994): The functional morphology of the eye in *Conus textile* (Gastropoda: Conidae) from the red sea. (In Press) Pull. Fac. Sci., Assiut Univ.

Baba, K. (1937): Contribution to the Knowledge of mudibranch, *Okadaia elegams Bab. Japan. J. Zool. 7: 147-190.*

Barth, J. (1964): Intracellular recordings from photosensory nerves in the eyes of a nudibranch mollusc *(Hermissenda crassicornis).* Comp. Biochem. physiol. 11: 311-315.

Chalers G.H. (1961): The orientation of *Littorina* species to polarized light J. Exptl. Biol., 38: 138-202.

Colton, H.S. (1905): Sexual dimorphism in *Stormbus Pugilis Linne* Nautilus, 18: 138-140.

Fraenkel G. (1927): Die photomenotaxis vom *Elysia Viridis Mont.* Z. Vergleich. Physiol. 6: 385-401.

Fretter V. and Graham A. (1962): British prosobranch Molluscs, 755 PP Ray Soceity, London.

Mueller C.G., Rudolph R, Dubos R, Mrgenau, H. and Snow C.P. (1967): Light and Vision. Time Inc. Press, London.

Newell G.E. (1965): The eye in *Littorina littorea.* Proc. Zool. Soc. London, 144: 75-86.

Robertson, R. (1961): The feeding of *Strombus* and related herbivorous amrine gastropods, with a review and field observations. Notulae Naturae, Acad. Nat. Sci. Philadelphia, 343: 1-9.

Risbec J. (1928): Contribution a letude des nudibranches Neo-Caledomies. Faune Colomies France, 2: 1-328.

Russel, L. (1926): The comparative morphology of the Elysoid and Aelidoid types of the molluscan nervous system and its bearing on the relationships of the Ascogossan mudibranchs. Proc. Zool. Sco. London. 99 (1): 197-233.

Wilbur K.M. and Yonge C.M. (1966): Physiology of Mollusca V. II. Chapter/13 Academic Press. New York and London.

Willem, V. (1892): Contributions a letude physiologique des organes des sens chez les molluscques. Arch. Biol. Liege, 12: 57-149.

Yonge C.M. (1937): The biology of *Aporrhais* pes-pelecani (L.) and *A. Serresiana* (Mich.). J. Marine Biol. Assoc. U.K. 21: 687-703.

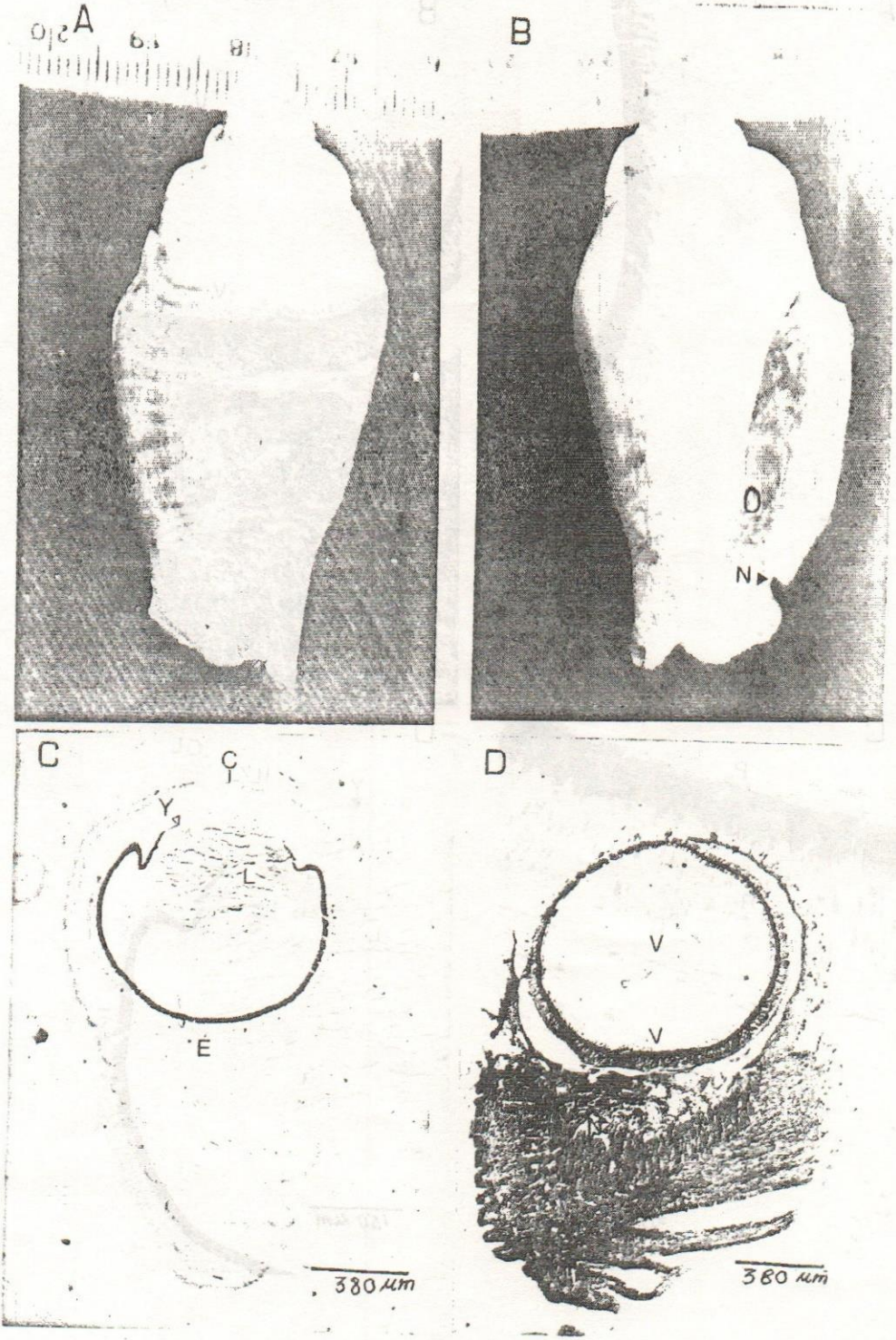
Waye, K.R. (1991): The encycolopedia of shells. Facts on File Press. New York, Oxford.

EXPLANATION of PLATES

PL. 1: **(A, B):** *Strombus sp.*, dorsal and Ventral views. N= Stromboidal notch; O= Shell opening.
(C, D): L.S. through eye of the present species. C= Cornea; E= eye stalk; L= Lens; N= Nervous tissue from the optic nerve; V= Vitrious materials; Y= eye pupil.

PL. 2: **(A):** Magnified part of (PL. 1, C) E= Epithelial lining of the eye stalk; N= Nervous tissue; P= pigmented layer of retina; S= sensory layer of retina;
(B): Magnified part of (PL. 1, D) Y= eye pupil. N= Nervous tissue; V= Vitreous materilas.
(C): Magnified part of (A). C= Cones; P= pigmented cells; V= vitreous material; R= Rodes.
(D): Magnified part of (PL. 1, C). EP= eye pupil; IL= Inner layer of cornea; OL= Outer layer of cornea.

PL. 1



PL. 2