VISION IN ARTHROPODA

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Arthropods possess simple as well as compound eyes; the latter evolved in Arthropods and are found in no other group of animals. Insects that possess both types of eyes are considered to be the most successful animals on earth.

VISION IN CRUSTACEA (Prawn) – The Compound Eye

Crustacea includes prawns, crabs, lobsters, shrimps, barnacles, water fleas etc., which possess a pair of compound eyes for vision.

Prawn possesses a pair of large stalked hemispherical eyes on the anterior side of cephalothorax below the rostrum. Each eye is composed of a large number of independent visual units called ommatidia which are connected to the optic nerve. An ommatidium is divisible into the outer dioptrical region for receiving and focusing light rays and the inner sensory region for perceiving light and sending the nerve impulse to the brain, which analyses the impulses as image of the object.

The cuticle on the surface is modified as cornea over the ommatidia and gives the eye necessary protection and also allows the light rays to enter the eye. Below the cornea, a pair of corneagen cells secretes fresh cornea in case of wear and tear. A lens-like crystalline cone is located beneath the corneagen cells and serves to focus light rays inwards. The crystalline cone is surrounded by four cone cells or Vitrellae that serve to provide nourishment to the cone.

Next layer is of sensory cells called Rhabdomes which are elongated and transversely striated and are sensory in function. Seven retinalcells that surround the rhabdome and encircle it provide it nutrition and protection. Chromatophores are pigment cells which are responsible for separating one ommatidium from the other so that they remain as independent units. They are located around the cone cells and retinal cells and can shrink or expand to increase or decrease the intensity of light entering the eye.

THE MOSAIC VISION

The compound eye is incapable of giving distant vision and sharp vision but is efficient in picking up motion and in providing 360° view, as it is large globular and mounted on a movable stalk. Each ommatidium is capable of producing an independent image of a small part of the object seen and not the entire object. All these small images are combined in the brain to form a complete image of the object that is made of small dots or mosaic of dots and hence it is called mosaic vision. The range of the compound eye is not more than a foot and hence no single ommatidium can perceive the entire object. Movement of the objects can be detected much more efficiently by the compound eye because as the

object passes in front of the eye, the ommatidia switch on and off according to their location in relation to the object . This characteristic of the compound eye helps the animal in detecting the movement of the predators and escape before the latter can strike.

Another characteristic feature of the compound eye is its high flicker fusion rate, which means it can perceive action as successive independent frames of images and not as a continuous motion. The flicker fusion rate of the compound eye is about 50 frames per second as compared to 12-15 frames per second of human eye. By perceiving motion the compound eye helps arthropods to escape from predators.

The Apposition Image

This is perceived in bright light, when pigment cells in the dioptrical and sensory regions spread and completely separate the ommatidia from each other, so that the angle of vision of an ommatidium is only 1 degree and light rays coming directly from the front can only enter the ommatidium, whereas the light rays coming at an angle are absorbed by the pigment before they can reach rhabdomes. The image formed in brain is a mosaic of several dots, each one of which is formed by an ommatidium. Each ommatidium uses only a tiny portion of the total field of vision and then in brain these tiny images are grouped together to form a single image of the object. Since each dot is clearly separated from the other, it is called mosaic or apposition image. The sharpness of the image depends on the number of ommatidia and their isolation from one another.

The Superposition Image

This type of vision occurs in dim light in nocturnal arthropods. The pigment cells shrink to allow more light into the eye, so that the ommatidia no longer remain optically isolated from one another, enabling even oblique light rays to strike one or more ommatidia. This results in overlapping of the adjacent blotches of images formed by different ommatidia. This is called superposition image because overlapping images are formed in the brain. This image is not sharp but hazy because of overlapping images.

VISION IN ARACHNIDA (Scorpion) – The simple eye

Scorpion belongs to the class Arachnida and possesses only simple eyes. It has a pair of large median indirect eyes and three pairs of lateral direct eyes which function in different ways in different situations.

The Median Indirect eyes: The median eyes are large convex and covered with the thick cuticle that forms cornea or lens. The hypodermis forms a thick vitreous body that nourishes the lens. The sensory rhabdomes point backwards towards the reflecting layer called tapetum. The rhabdomes are

surrounded by many sensory retinal cells which transmit nerve impulses to the optic nerve and then to the brain. Median eyes of scorpion are used for vision in the night or in dark places because the dim light entering the eye is reflected by the tapetum to strike the rhabdomes again to form vision.

The Lateral direct eyes: Lateral eyes are small in size, 3 pairs and located on the lateral sides of prosoma. This eye is covered externally by a biconvex lens formed from the transparent cuticle. The epidermis forms a thinner vitreous body under the lens. Inside the eye cup are several rhabdomes which point directly towards the source of light as the tapetum is absent in these eyes. Each rhabdome is connected on the posterior end to a sensory retinal cell that is connected to the nerve. The lateral eyes are used to provide vision in day time or in bright light.

VISION IN INSECTA (Cockroach) – Simple as well as Compound Eyes

Insects possess one pair of compound eyes and 1-3 simple eyes or ocelli on top of the head. In cockroach the ocelli are rudimentary.

The Insect Compound Eyes: The compound eyes are sessile in the form of convex brownish-black, kidney-shaped structures on the lateral sides of head. Each eye contains about 2,000 ommatidia, similar in structure to those already described earlier.

The pigments separating ommatidia are not retractable in the eyes of cockroach since the animal is nocturnal and spends daytime in dark places. But the eye produces mosaic vision similar to the crustaceans. Compound eyes are specially adapted to perceive movements of objects. The insect compound eye is advanced structure because the number of ommatidia in insect eyes increases giving the eye sharpness of vision. Also the distance of vision increases in predatory insects and fast flying insects.

The Insect Ocelli. Ocelli are simple eyes, more or less similar to the simple eyes of arachnids and provide the eye with distant vision. Ocelli also give nocturnal vision to night flying insects, which find their way by aligning them at an angle with the moon or stars. By possessing both types of eyes, insects enjoy both types of visions, namely detection of movement with compound eyes and distant vision with simple eyes or ocelli.