Visual organ in Arthropoda

are called the *compound eyes*. These are characteristic of Arthropoda and do not occur elsewhere in the animal kingdom. All the ommatidia (about 2,500) are arranged radially and are similar in structure, each consisting of many cells arranged along its central axis. Their description is as follows :

(a) Cornea. The outermost convex layer of eye forming *cornea* is the transparent cuticle. In

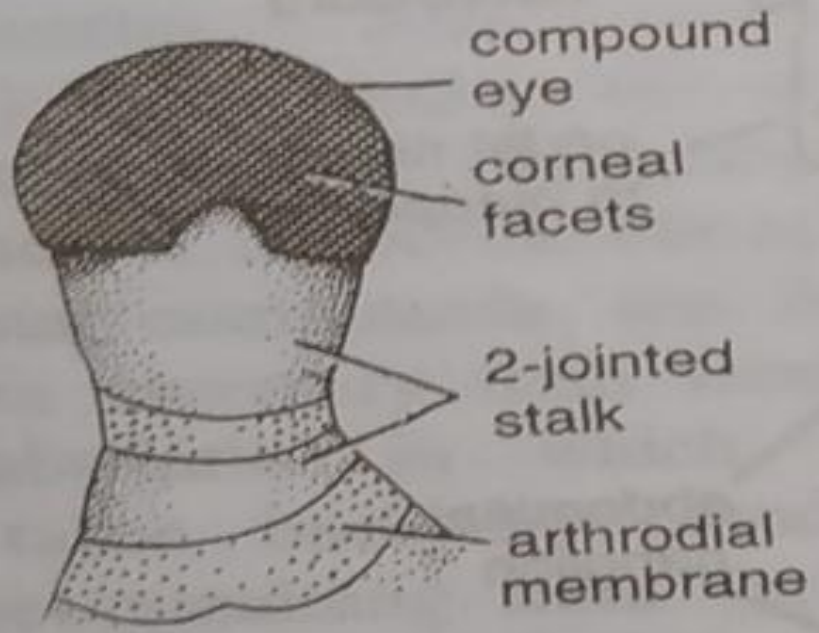


Fig. 29. *Palaemon.* Compound eye.

surface view, cornea exhibits a large number of squares or *facets* by clearly visible lines, thus giving the appearance of a graph paper. In insect eyes, the facets are not squares but hexagons. Below each facet lies one ommatidium.

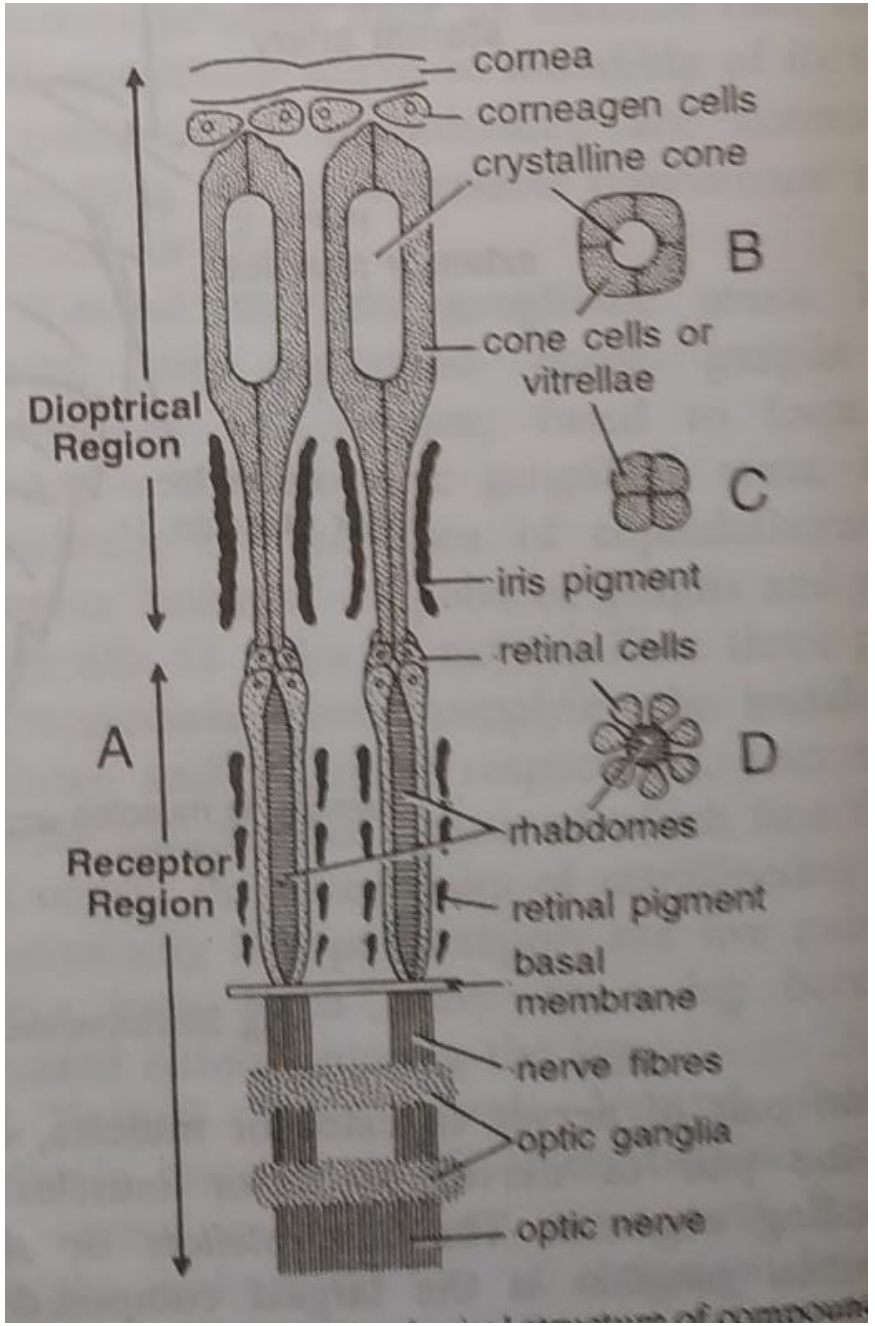
Below each

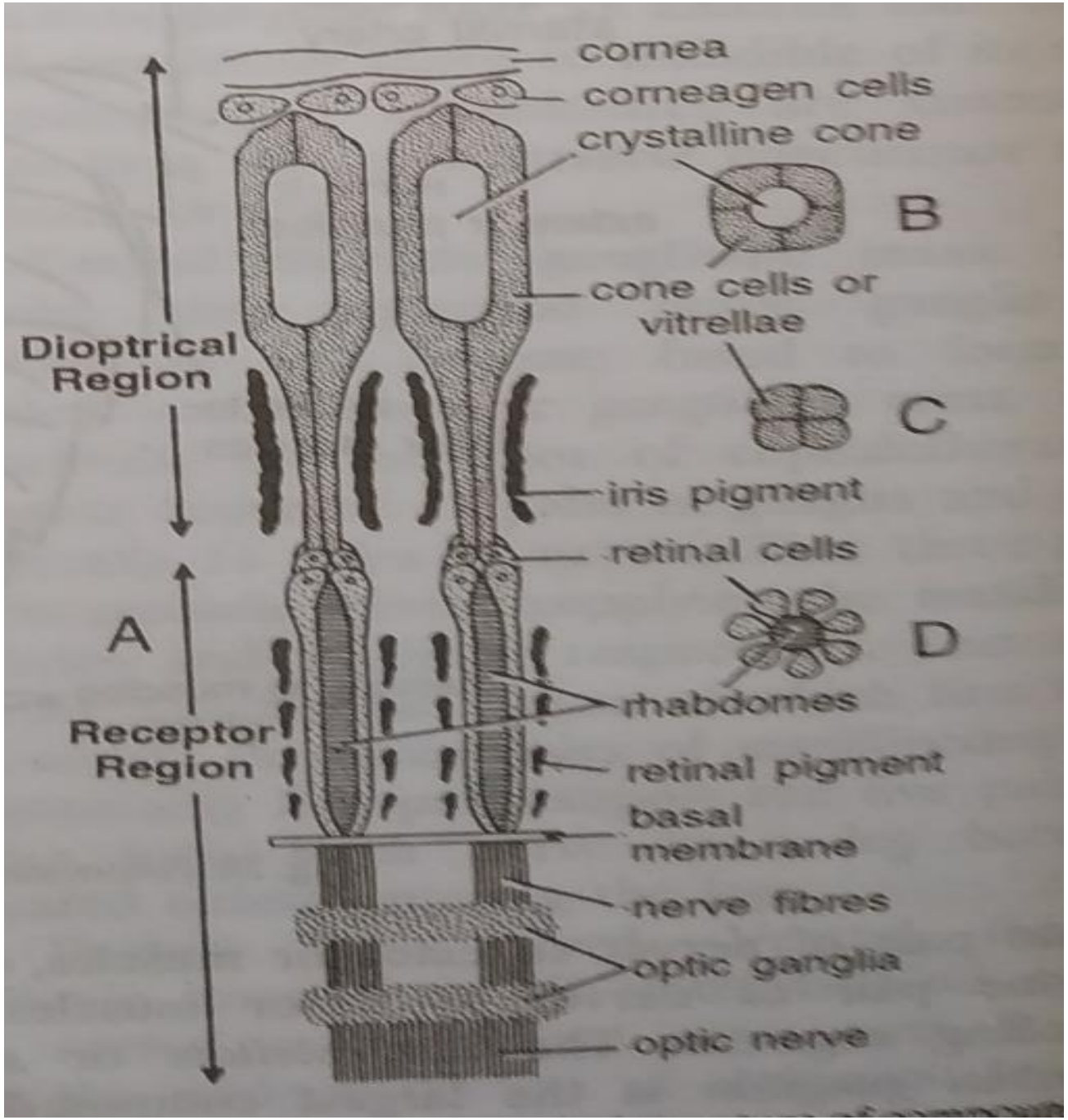
(b) Corneagen cells. Each corneal facet thickens in the centre to form a *biconvex corneal lens*. Beneath the lens lie two *corneagen cells* which are modified epidermal cells and secrete a new cornea as soon as the old one is cast off in moulting.

(c) Cone cells. Beneath the corneagen cells lie four elongated *cone cells* or *vitrellae* which constitute a transparent, homogeneous *crystalline cone*. Inner ends of cone cells are long and tapering.

The part of eye, from cornea up to extreme ends of cone cells, is known as the *dioptrical region*, which focusses light upon the inner sensitive part or *receptor region* of eye.

retinal cells. Inner ends of




cornea
corneagen cells
crystalline cone
B
cone cells or vitrellae
C
Dioptrical Region
iris pigment
retinal cells
D
A
rhabdomes
Receptor Region
retinal pigment
basal membrane
nerve fibres
optic ganglia
optic nerve

sensitive part of

(d) Rhabdome and retinal cells. Inner ends of cone cells lie upon an elongated, spindle-shaped rod, the *rhabdome*. It has a transversely striated appearance. Rhabdome is secreted and surrounded by a group of seven elongated *retinal cells*. Rhabdome and retinal cells together form the *receptor region* of eye. Inner ends of retinal cells rest upon a *basal membrane* beyond which they are continuous with sensory nerve fibres of *optic ganglia* which are connected with brain by the *optic nerve*.

(e) ***Chromatophores.*** Each ommatidium is cut off from its neighbours by a sheath of movable, amoeboid, dark *pigment cells* or *chromatophores* which are arranged in two series. Outer series lying along the cone cells is called *iris pigment,* and inner series separating the rhabdomes is called *retinal pigment.* Amoeboid pigment cells take up different positions according to the variations in the intensity of light.

The iris cells are provided with two types of pigment granules- black which absorb the light and pale or other coloured granules that reflect the light. The pigment prevents the entry of the oblique rays and by moving in up-down direction it maintains the illumination of the eye approximately constant with rapidly changing light intensities. The pigment of the iris cells, in fact, expands

2. Mosaic vision. Working of compound eye is very complex. It is deficient in focussing ability and clarity of image. But, such an eye is efficient for picking up motion and for *peripheral vision*. It functions as a very efficient organ for photo-reception. Mounted on a movable stalk, it can move on the head in much the same manner as the antenna of radar, and gives the animal almost 360-degree vision. Each ommatidium is capable of producing a separate image of a small part of the object seen. Therefore, in prawns and other arthropods possessing compound eyes, the image of the object viewed consists of several dark and light tiny pieces or spots, so that the total image of an object formed is a sort of a flat *mosaic*. Moving objects can thus be detected. The vision effected is said to be *mosasic vision* because of its similarity to mosaic art work.

The nature of composite image formed varies according to different intensities of light. Thus two types of images are formed. This is made possible by the movement of pigment cells.

(a) Apposition

...ovement of pigment cells.

(a) Apposition image. In *bright light* (during daytime), the pigment cells spread in such a way that they completely isolate optically the adjacent ommatidia. No light can pass through from one visual unit to the other. In this condition the rays of light, which strike the cornea obliquely, are absorbed by the pigment cells without producing a visual effect. Only those rays of light which fall perpendicularly upon the cornea, can travel

through the ommatidium and reach the rhabdome to form a point of image. As a result, the complete image formed is a mosaic of several components placed in juxtaposition in which the slightest movement is readily detected. In other words, each ommatidium responds to a fragment of the total field of vision and then these fragmentary images are fitted together into a single general picture. It is known as a mosaic or *apposition image*. Its sharpness depends upon the number of ommatidia involved and the degree of their isolation from one another. In butterflies, which are night-blind, the eyes are permanently set in this condition and are suited to see only in bright light. The image formed by this type of eye is never very good. It functions best at short distances only. Thus, most arthropods are always short-sighted.

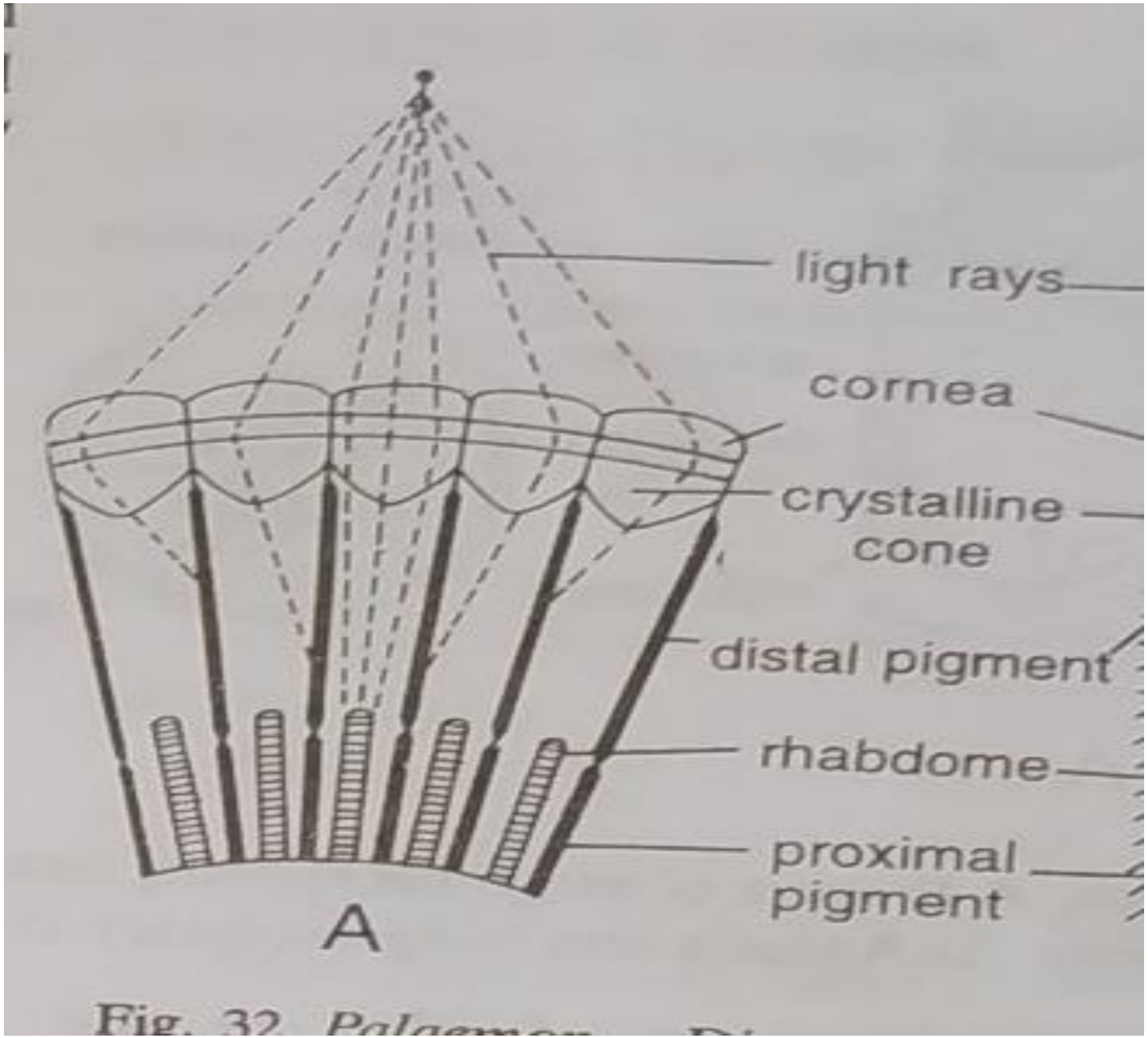
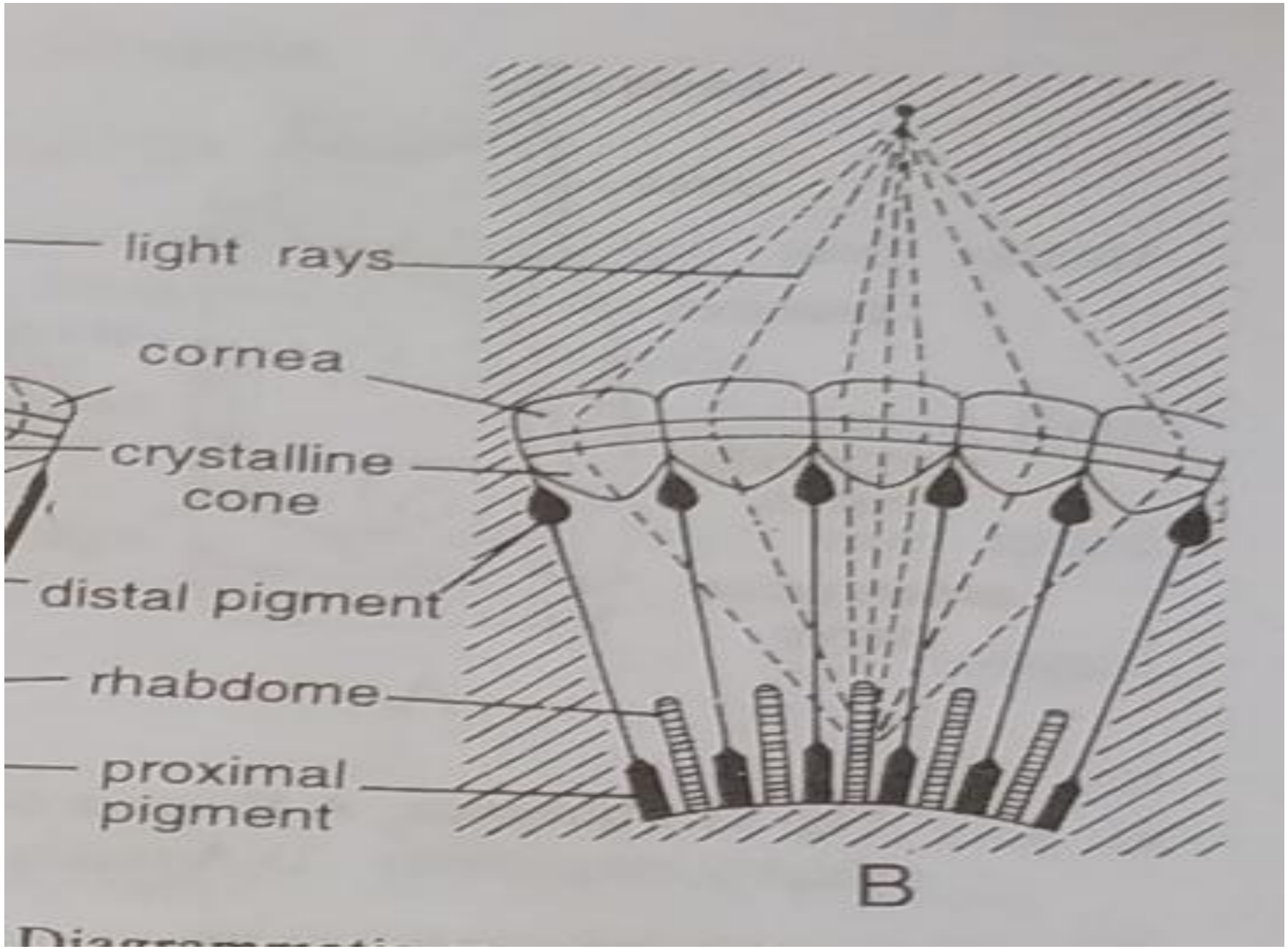


Fig. 32. *Palaemon*

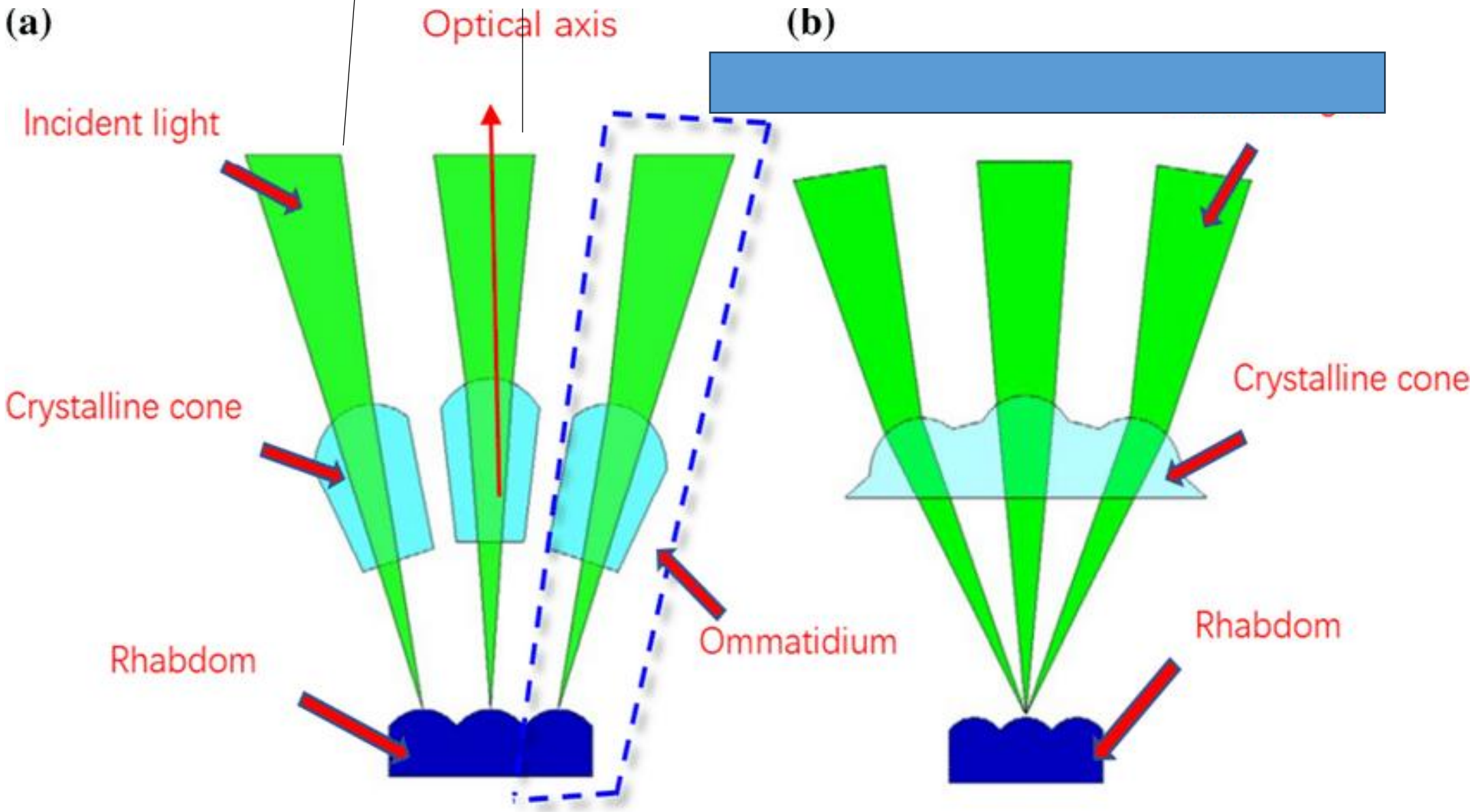

light rays
cornea
crystalline cone
distal pigment
rhabdome
proximal pigment
B

(b) Superposition image. In *dim light* (during night), the pigment cells migrate and become separated into distal and proximal pigments, so that the neighbouring ommatidia no longer remain optically isolated but work in unison. In this condition even oblique rays of light are capable of forming a point of image after passing through a number of ommatidia in their way. As a result, an overlapping of the adjacent points of image occurs so that a continuous or *superposition image* is obtained. It is not sharp

but the animal gets some sort of idea of the objects moving about in the surrounding. In some insects, like moths and fireflies, the eyes are permanently set like this, so that they are well adapted to see at night but are day-blind.

The prawns, like most arthropods, seem to adjust their eyes to form both types of images according to the prevailing intensity of light.

The *optic nerve* carries impulses (electro-chemical waves of energy) to the brain, where they are interpreted and registered as an upright *mental* image.


(a)
Optical axis
(b)
Incident light
Crystalline cone
Rhabdom
Ommatidium
Crystalline cone
Rhabdom

Reference:

- Modern Entomology, DB Tembhare
- Modern Textbook of Zoology, INVERTEBRATE, RL Kotpal
- Internet