interesting conclusions suggest that the regular pub-goer "puts away" fifteen to twenty pints of beer a week; the more people in the pub, the more quickly do individuals drink their beer; drunkenness is not necessarily dependent upon the drinking facilities available; the usual assumption that the time a pub is open directly affects drunkenness is shown to be unrelated to demonstrable fact. Above all, the main text, which occurs as often as one would expect in a bad sermon, is that the true function of the pub is that of a safety valve, a means of allowing partial release from tensions accumulated in the stress of living. With which, no doubt, we all agree.

T. H. HAWKINS.

MARVELS OF THE VERTEBRATE EYE

The Vertebrate Eye and its Adaptive Radiation

By Gordon Lynn Walls. (Bulletin No. 19.) Pp xiv+785. (Bloomfield Hills, Mich.: Cranbrook Institute of Science, 1942.) 6.50 dollars.

LIMITATION of vision to a narrow range of wave-lengths of radiation is manifestly related to the absorption of radiant energy by protein and water. The importance of light as a directive agent is associated with a wide range of light detectors in invertebrates. As the pineal eye is relatively unimportant in vertebrates, these devices are crystallized in the two lateral eyes. These lateral eyes show a wonderful variety in structure and versatility in action. The whole subject of the vertebrate eye is discussed by Dr. Walls in his excellent book, which is a mine of information about the eyes of all sorts of vertebrates.

One of the outstanding problems is the difference between vision in air and vision in water. In the former, the difference in refractive index between cornea and air enables the cornea to exert a great effect on focusing the rays of light. In the latter, practically the whole of the focusing of light must be done by the lens. Therefore there is a general difference in the lenses of aquatic and aerial animals, those of the former being spherical and those of the latter flattened from before backwards. The case of Anableps is most interesting. These animals have two pupils. When swimming on the surface with their eyes half submerged they can see objects both above and below the surface. Through the upper pupil by the cornea and less curved sides of a pyriform lens objects above the surface can be focused on one part of the retina, while through the lower pupil and more curved ends of the pyriform lens objects below the surface are focused on another part of the retina.

When the animal is amphibious there are three possibilities. Its eye can be adapted for vision in water, its eye can be adapted for vision in air, or it may have a wide range of accommodation so that it can see fairly well in both water and air. The accommodation can be brought about in several different ways. The lens may be moved backwards and forwards, the curvature of the cornea can be altered, the lens can be compressed round its equatorial plane, the anterior surface of the lens may be made more curved by constriction of the lens by the iris, and finally the lens may become more curved due to the elasticity of its capsule on slackening the suspensory ligament by the ciliary muscles.

Adaptation to different intensities of light may be brought about by a wide diversity of processes. Diurnal, nocturnal and twilight vision are comparatively simple to accomplish. Vision in bright light is associated with the presence of cones in the retina. For dim light, rods sometimes supplemented by visual purple are used. When an animal is active in both bright and dim lights, a duplex retina with both rods and cones is present. Other devices are used to help in the process of adaptation. In some cases extreme variations in pupillary aperture are used. In other cases movements of the retinal pigment combined with movements of rods and cones occur, so that cones are exposed and rods shielded in bright light while rods are exposed in dim light. The linkage of the sensory receptor cells to ganglion cells is such that cones are best for good acuity. The action of the fovea in improving acuity is explained. Maculæ, sometimes two for each eye, are present in some species. The tapetum is recognized as a means of reinforcing the effect of weak light, thus making vision better for nocturnal animals. The pecten is said to be a means for bringing increased nutrition to the inner layers of the retina in species in which the blood supply to the ganglion cell layer is inadequate. The uniformity in number of cell layers in the retina is noteworthy. Sensory receptor cells, bipolar cells and ganglion cells are found in all retinæ. Is this uniformity due to some common physiological need, or does it indicate the stage of development of the cerebral cortex when the optic vesicles were first formed? The author considers that the original sensory receptor cells were cones, and that the rods were derived from cones. Cones are present in some diurnal animals although their phylogenetic predecessors have rods only. Dr. Walls suggests that these cones have developed from rods. Is it not possible that the power to develop either rods or cones is present in the early stage of the sense cells of any vertebrate? Visual purple has developed apparently independently in isolated species. Is it possible that there is some common feature present in many retinæ, although visual purple is produced in appreciable quantity in only some of them?

All these points and many others are adequately discussed in this volume: it is one which has been needed for some time. Where so much is excellent it may seem unnecessary to criticize details. The author considers that small multiple apertures in the closed irides of geckoes may enable them to obtain a greater depth of focus. The multiple images so produced would not be superimposed except by the action of the cornea and lens. If the openings were arrang l in a circle or if the pupil were reduced to an annular opening as in Plecostonus, then spherical aberration would be reduced to a minimum. On p. 75 the author states: "No one photosensitive substance could be entirely responsible for colour vision". This statement is misleading, because colour photography is possible with a single photochemical substance. The discussion on the function of coloured oil globules in eliminating scattered light is good, but surely the presence of colour filters in front of certain cones must cause a differential stimulation, and it is difficult to imagine that this differentiation would have no effect on the animal's colour discrimination. In the domestic hen the coloured globules are such as would give rise to a colour vision similar to that of man. Is it possible that trichromatism is a necessary result of some biological factor, or is it due to some physical property of light?

The author calls his book a text-book. It should certainly be read by all biologists, including medical men, interested in visual problems. H. E. ROAF.