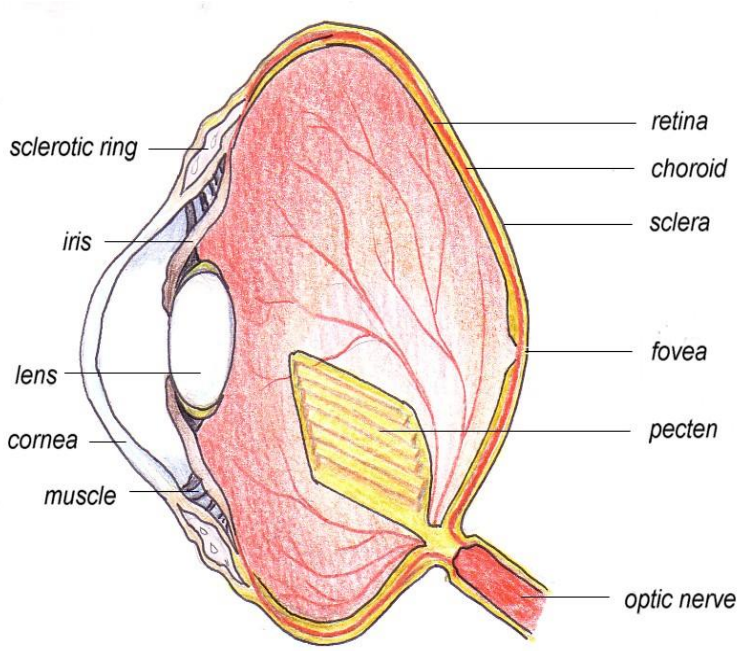
BIRD NOTES by Rick Pyeritz

A bird's vision is unrivaled in the animal kingdom. When compared with the human eye, the avian eye differs in size, shape, composition, location in the skull and the presence of a unique structure, the pectin. The optic lobes of the bird's midbrain are quite large and control the vision of relatively large eyeballs, 15% of the head weight in a bird compared with 1% in humans. Optic lobes are largest in birds of prey and smallest in the ratites (ostrich, emu, rhea, and kiwi). The eyeballs of birds have little movement; the ocular muscles are quite small. What the bird lacks in muscular function it makes up with an increased range of motion of neck—in some birds as much as 270^0 of rotation.



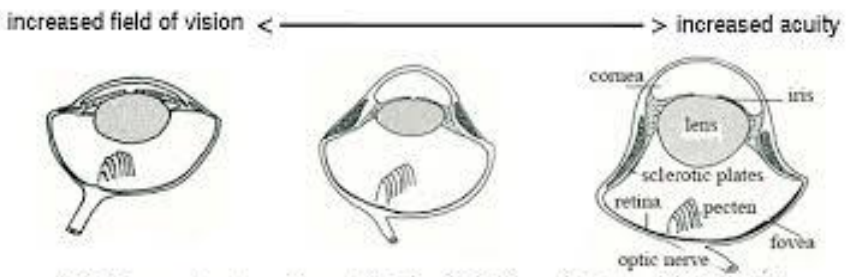
The pectin (refer to the illustration above) is thought to perform a number of functions; to provide oxygen to the retina, regulate ocular pressure, aid in the detection of movement, protect against the sun's glare and possibly act as a magnetic sensor for navigation. The retina is most important in producing sharp vision. The two types of cells in the retina are the rods and cones. The rods aid in acuity but are most concerned with dim-light vision. There are many more rods in bird's retina than the human eye, and rods are present in larger numbers in nocturnal birds, such as the Kiwi and Swallow-tailed Gull. The other cellular component of the retina, the cones,

is concerned with color discrimination and visual acuity. Compared with humans there are major differences with several features of cones. First of all, there is a higher concentration of cones in a bird's retina—120,000 mm^2 in a pipit compared to 10,000 mm^2 in a human. The greatest concentration of cone cells is found in the fovea, a slightly depressed area of the retina which has the sharpest vision. A vulture has around 1,000,000 mm^2 cones in the fovea which gives the bird at least 8 times the visual acuity of humans.

Another sight enhancing feature of a bird's eye is that each cone or rod cell has a one to one connection with the cells of the inner retina, which in turn has an individual connection with the nerve cells which comprise the optic nerve. In humans, numerous cones and rods connect with a cell of the retina, which is one reason visual acuity in humans is inferior to birds.

Ensuring good color vision is the presence of oil droplets in the cone cells of birds. The droplets are usually red, orange, yellow and green. The function of these droplets is thought to increase visual acuity, sharpen contrast, reduce glare and assist in color discrimination. Some birds have the ability to discriminate ultraviolet light. This means that birds may see a color which we may not be able to appreciate.

One can see that the shape of the avian eyeball varies with the type of bird. They are not spherical as represented in the pictures above and below. The various shapes of the eyeball are not as strong as the mammalian eye. The presence of a bony structure called the sclerotic ring helps support the bird's eyeball. The tubular shape of an owl's eye leaves it more unstable than most birds. The well-developed sclerotic ring in the owl's skull stabilizes the eyeball but permits little mobility. The owl compensates for the loss of field of vision by having an extremely flexible neck. Nocturnal birds tend to have large tubular eyes with a large retinal surface area, therefore lots of rods which permit excellent night vision as well as increased visual acuity. Birds with globular shaped eyeballs, especially raptors, sacrifice some visual acuity for increased field of vision. This allows them to spot predators without having to constantly scan the environment by moving their heads. Raptors sacrifice some field of vision to have good binocular vision which is essential for success in capturing prey. The unique structure of the eyeball in birds of prey allows light rays to bend outward which effectively magnifies the image by 30%. Birds may be looking at us with their built-in binoculars. The bird sees details of faraway objects in dim light with great acuity.



Birds' eye structure: Swan (l), Hawk, Falcon & Eagle (c), Owl (r)

Ground-dwelling birds do not need great depth perception to feed as their food sources, fruits and seeds, tend not to run away. Pigeons, doves, and shorebirds move their head back and forth as they walk as a way to compensate for their diminished depth perception. Woodcock's eyes are set high and back in the head so they have a 360^0 field of vision. This, also, allows them to have binocular vision in front and rear.

If you have any questions or comments about birds' remarkable sense of vision, please contact me at eapyeritz@gmail.com .