



Observations of the Owl (13)

For Your Eyes Only

Eyes are a very special topic in biology. Just take us owls. Can you imagine what it means to be a fast-flying nocturnal-hunting bird? Yes, our vision must be exceptionally good.

Even at the risk of digressing, I'll try to give you an impression of just *how* good. On the darkest of nights, in the deepest of forests, you're sitting

in the highest of trees vigilantly watching the ground when there's a sudden flicker of movement in the dark, just beneath a bush about 60 metres away. A mouth-watering mouse? Within a tenth of a second you swoop off the branch as silently as possible, nose-diving through the dim darkness of the forest. During the breakneck flight your eyes remain fixed to the spot, hoping to catch another glimpse of your potential prey. And indeed, with only four metres to go you see your target, a mouse. It spies you at exactly the same moment and darts off to the right but your reaction is superb. In a flash you follow and pow! Dinner in the dark.

Now you at least have an idea of just how important the eyes are for us owls. They are not only large (weighing up to 5 percent of our total weight) but we owls actually have the best stereoscopic vision of all birds, vital for judging distances. Why, my relatives, the Tawny Owls, are even said to have the best developed eyes of all vertebrates, being about 100 times more sensitive at low light levels than your human eyes.

However, there is one price we have to pay for having developed such perfect night vision: we are long-sighted and cannot focus on objects that are too close. (So you might well be wondering how I read all those articles. I admit, I do look slightly ridiculous behind a pair of thick-lensed spectacles and my eyes appear even larger than ever.)

After all this, it probably doesn't come as a surprise that I also take a special interest in eye research. It's a pleasure, therefore, that the eye has always played a central role in biological science and debate, particularly in evolutionary biology.

Look at good old white bearded Charles Darwin, for instance. He chose the development of the eye as a prime case to illustrate his theory of evolution by gradual change. In chapter six of *The Origin of Species* (1859) "Organs of extreme Perfection and Complication", he wrote: "To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest degree." A sentence, which has frequently been torn out of context and misquoted by deniers of evolution.

In fact, the sentence was just a simple rhetorical question. Two sentences further on Darwin continued: "Reason tells me, that if numerous gradations from a simple and imperfect eye to one complex and perfect can be shown to exist, each grade being useful to its possessor, as is certainly the case; if further, the eye ever varies and the variations be inherited, as is likewise certain-

ly the case and if such variations should be useful to any animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, should not be considered as subversive of the theory." And over the following three pages he continued describing a sequence of plausible intermediate stages between eyelessness and human eyes, giving examples from existing organisms, with no difficulty at all.

Okay, old stuff! On the other hand, a more recent story is quite amusing. In 1995, Richard Dawkins (yes, the "Selfish Gene" man) claimed in his book "Climbing Mount Improbable" that "... eyes have evolved no fewer than forty times, and probably more than sixty times, independently in various parts of the animal kingdom. In some cases, these eyes use radically different principles. Nine distinct principles have been recognised among the forty to sixty independently evolved eyes." When the book was still in print, however, a Swiss group published a paper in *Science* (Vol. 267: 1788-92), which showed that the same gene controls the development of the vertebrate's lens eye as well as that of the compound eye in the fruit fly. The authors concluded: "The observation that mammals and insects, which have evolved separately for more than 500 million years, share the same master control gene for eye morphogenesis indicates that the genetic control mechanisms of development are much more universal than anticipated." Bad luck, Mr. Dawkins.

But what about organisms that "lost" their eyes after having turned to a "dark lifestyle"? Okay, it's clear that eyes make no sense when living in complete darkness (*reeeeal* darkness, not the dimness of a dark forest). But why discard such beautiful and complex organs?

US researchers recently presented an apt example. They compared eyed species of *Astyanax* fish with cave-inhabiting relatives from the same genus that have lost them. The molecular details revealed that the eye loss isn't simply caused by messing things up and turning genes off. To the contrary, all the genes for eyes are there and functional in the blind species. What actually happens is an increased expression of the gene Sonic hedgehog (*Shh*), which in turn inhibits the expression of *Pax-6*, the master regulator of eye development. The blind fish, however, has an even more valuable gain from the adaptational expansion of *Shh*: stronger jaws and a more sensitive skin. And that's what the fish finds really useful, instead of eyes, when rooting about at the bottom of dark underground rivers to find food. Hence, it's not a *loss* but an active suppression of eye expression, a *positive* change in development.

The message? Well, what is worth to be selected for, and what is not, completely depends on the demands of the respective environment. Or vice versa, apparently, no trait is selected for *per se* – not even the eyes. Nor intelligence, nor longevity, nor feathers...

Hard to believe for owls... and humans.

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"No trait is selected for per se – not even the eyes."

