

The Marvelous Eye

ט"ו.אב.תשפ"ב

DRAFT: Jonathan S. Ostroff, updated September 13, 2023

Tehillim 139

כִּי־אַתָּה קָנִיתָ כְּלִיָּתִי תִסְפְּנִי בְּבֶטֶן אִמִּי: אֹדְךָ עַל כִּי נִזְרַאתָ לִפְלִיתִי נִפְלְאִים מַעֲשֶׂיךָ וְנִפְשִׁי יִדְעֶת מְאֹד:

"For you formed my inward parts; you knitted me together in my mother's womb. I praise you, for I am fearfully and wonderfully made.

Abstract: The human eye is a marvel of engineering with a purposeful arrangement of parts and nano-machinery able to detect light down to a single photon. Organs of perfection such as eyes, wings and the mammalian brains are signs pointing to the enormous wisdom and kindness of the Creator. It is a scientific scandal for scientists to claim that these organs of perfection arise via unguided natural and accidental processes when a few honest scientists admit that this is just wishful speculation. The problem is that mainstream biologists continue to make desperate attempts to hang on to their materialistic philosophies.

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1 Introduction

For the background biology needed for this paper, please see <https://toriah.org/docs/> (ID 2).

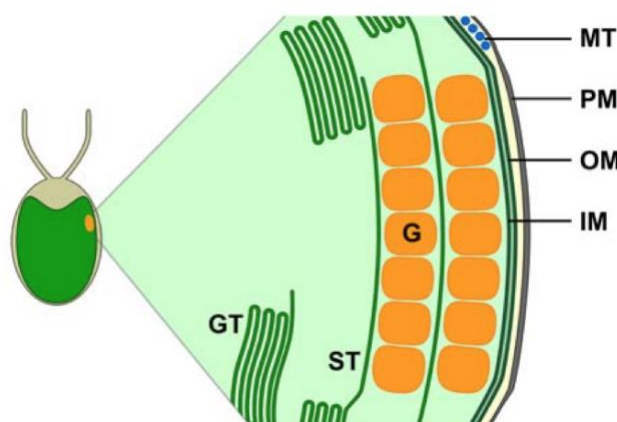
Despite much research the phenomenon of sight is still a mystery. The human eye is a marvel of engineering with a purposeful arrangement of parts and nano-machinery able to detect light down to a single photon.

Darwin wrote: “To suppose that the eye, with all its inimitable contrivance 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 possible degree.” Nonetheless, Darwin felt the seemingly insurmountable problem of the unguided evolution of what he called an organ of ‘extreme perfection and complication’ could be solved. Biologists continue to push Darwin’s “just so” stories but as we shall see these claims are just another variety of wishful speculations and a scientific scandal.

2 Complexity of Primordial light sensitive patches

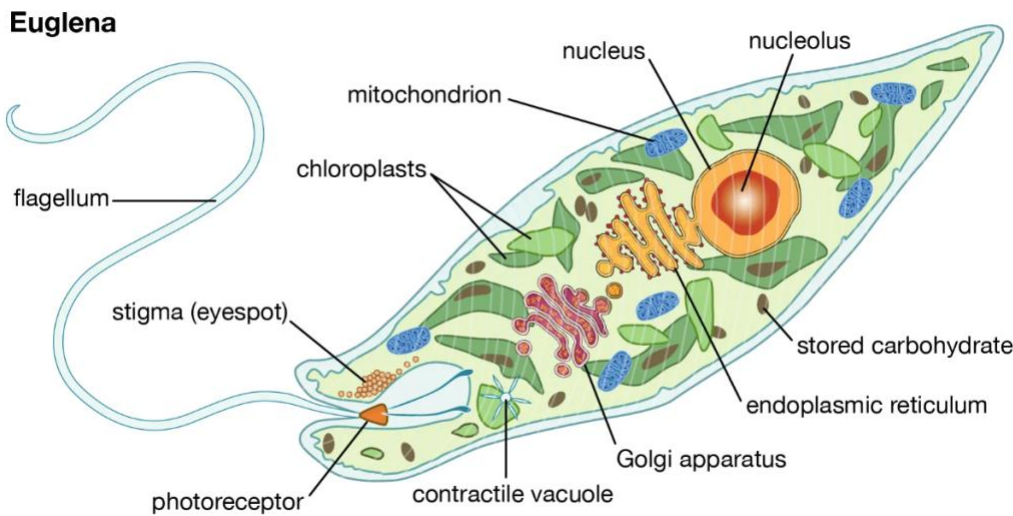
The simplest light sensitive patches in nature are “elaborate structures” in unicellular organisms made up of parts such as plasma membranes, chloroplasts, and eyespot globules and requiring “specialized microbial-type rhodopsins” [a receptor protein] involving the need to innovate proteins for their organization.¹ Even these simple structures are marvels of organized complexity.

“The ultrastructure of the functional green algal EA [eyespot apparatus]. a Schematic drawing of a typical green algal EA illustrating the components from different sub-cellular compartments forming this composed light sensor. PM plasma membrane; OM outer chloroplast envelope membrane; IM inner chloroplast envelope membrane; G carotenoid-rich eyespot globules; ST stroma thylakoid membrane; GT grana thylakoid membrane; MT”.



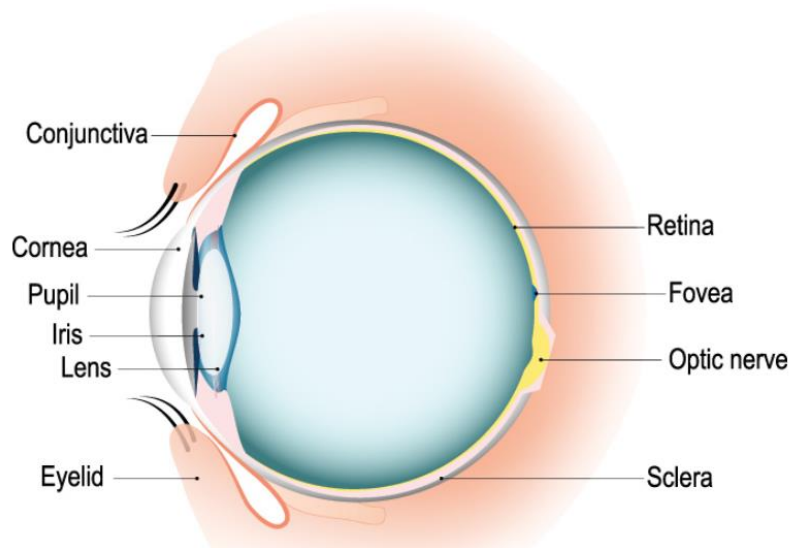
¹ Abstract: Most Xagellate green algae exhibiting phototaxis possess a singular specialized light sensitive organelle, the eyespot apparatus (EA). Its design principles are similar in all green algae and produce, in conjunction with the movement pattern of the cell, a highly directional optical device. It enables an oriented movement response with respect to the direction and intensity of light. The functional EA involves local specializations of different compartments (plasma membrane, cytosol, and chloroplast) and utilizes specialized microbial-type rhodopsins, which act as directly light-gated ion channels. Due to their elaborate structures and the presence of retinal-based photoreceptors in some lineages, algal EAs are thought to play an important role in the evolution of photoreception and are thus not only of interest to plant biologists. In green algae considerable progress in the molecular dissection of components of this primordial visual system has been made by genetic and proteomic approaches in recent years. This review summarizes general aspects of the green algal EA as well as recent progress in the identification of proteins related to it. Further, novel data supporting a link between eyespot globules and plastoglobules will be presented and potential additional roles of the EA besides those in photoreception will be discussed. DOI 10.1007/s00294-008-0224-8, Georg Kreimer, *The green algal eyespot apparatus: a primordial visual system and more?*, Current Genetics, 2009.

The image below shows further detail. The eyespot, also called *stigma*, is a heavily pigmented region in certain one-celled organisms that apparently functions in light reception. The term is also applied to certain light-sensitive cells in the epidermis (skin) of some invertebrate animals (e.g., worms, starfishes). In the green one-celled organism *Euglena*, the eyespot is located in the gullet, at the base of the flagellum (a whiplike locomotory structure). A cup-shaped mass of pigment rods shields a sensitive area of the flagellar base from light coming from the direction of the opposite end of the organism. The light-sensitive region apparently influences flagellar motion in such a manner that the organism moves toward light.

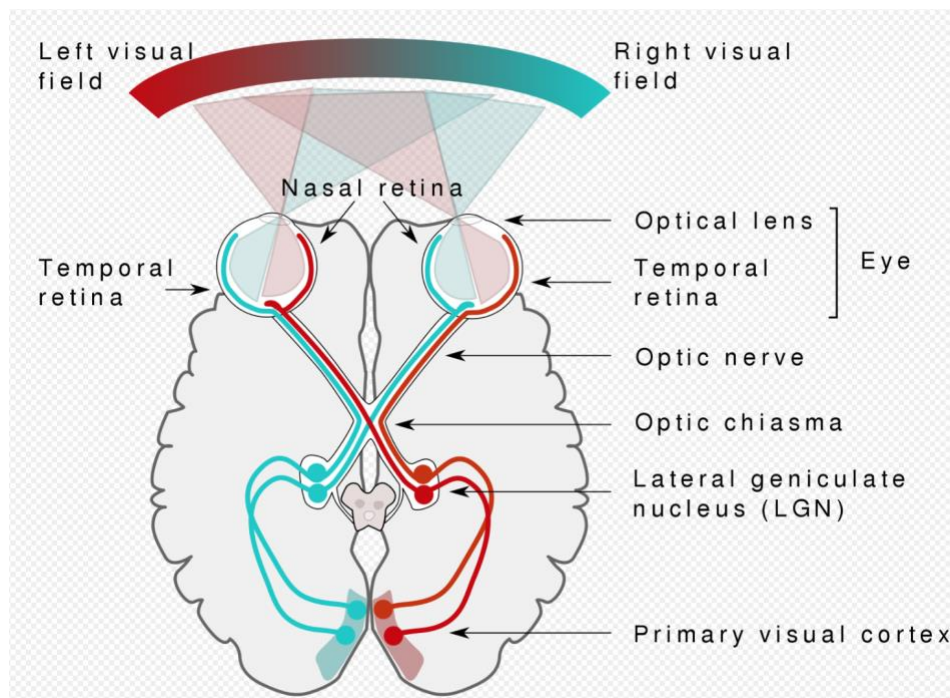


3 Purposefully arranged parts in the structure of the human eye

Light bouncing off an object goes into the eye, through the cornea and the oval-white lens, which focuses that light on the retina. That's a thin layer of tissue covering the eye's back wall (inside the sclera). The retina hosts the eyes' rods and cones. At the center back is the fovea. Most color-sensing cone cells are here. These cells relay signals that move through the optic nerve to the brain.



In order for the eye to function it must operate in concert with the brain as shown in the image below.

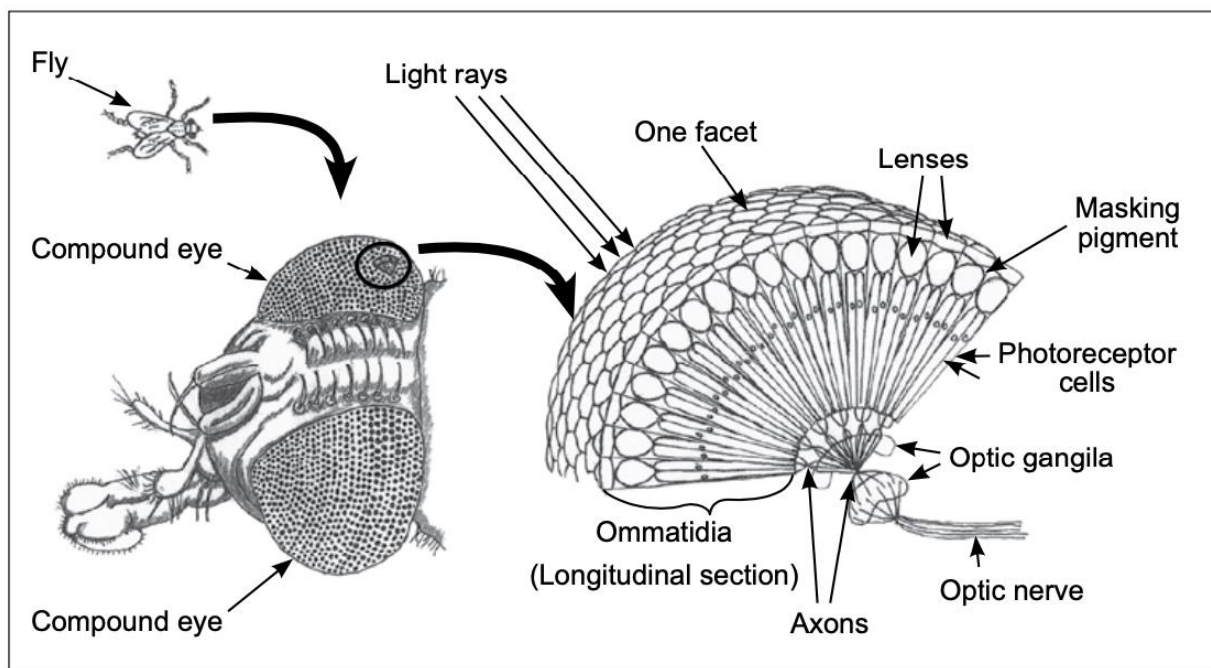


The visual system comprises the sensory organ (the eye) and parts of the central nervous system (the retina containing photoreceptor cells, the optic nerve, the optic tract and the visual cortex) which gives organisms the sense of sight (the ability to detect and process visible light) as well as enabling the formation of several non-image photo response functions. It detects and interprets information from the optical spectrum perceptible to that species to "build a representation" in the brain of the surrounding environment. The visual system carries out a number of complex tasks, including the reception of light and the formation of monocular neural representations,

colour vision, the neural mechanisms underlying stereopsis and assessment of distances to and between objects, the identification of a particular object of interest, motion perception, the analysis and integration of visual information, pattern recognition, accurate motor coordination under visual guidance, and more. The neuropsychological side of visual information processing in the brain is known as visual perception.

4 No detailed Darwinian pathways

The evolution of the eye has always been a dilemma for evolutionists from Darwin's time to the present. Although Darwin, Richard Dawkins and other evolutionists have tried to explain how an eye could evolve, their solutions are clearly unsatisfactory. Many kinds of eyes exist, but no progression of eye designs from simple to complex can be produced in the natural or fossil world. Furthermore, the simplest 'eye', the eyespot, is not an eye but pigmented cells used for phototaxis; yet even it requires an enormously complex mechanism in order to function as a vision system.



Above: The compound eye of an insect. Note that the eye consists of hundreds or more separate eyes which, in some ways is more complex than the human eye. (After Mitchell *et al. Zoology*, Benjamin Cummings, Menlo Park, CA, p. 279, 1988.)

Darwin wrote: "To suppose that the eye, with all its inimitable contrivance 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 possible degree."

Nonetheless, Darwin felt the seemingly insurmountable problem of the evolution of what he called an organ of ‘extreme perfection and complication’ could be solved. He included a three-page proposal of intermediate stages through which eyes might have evolved via gradual steps. These stages included the following:

1. photosensitive cell
2. aggregates of pigment cells without a nerve
3. an optic nerve surrounded by pigment cells and covered by translucent skin
4. pigment cells forming a small depression and then a deeper depression
5. the skin over the depression gradually taking a lens shape
6. evolution of muscles that allow the lens to adjust.

These stages in living animals are believed to constitute major evidence for the evolution of the eye.

The problem is that there are **no detailed Darwinian pathways** via mechanisms such as **random mutation and natural selection** to demonstrate all this.²

Advanced vision appears almost at the very beginning of the fossil record. The oldest eye in the fossil record, that of a trilobite, is a very complex faceted compound eye that ‘dates’ back to the Cambrian, conventionally dated about 540 million years ago. The fossil evidence shows that from the beginning of the fossil record eyes are very complex, highly developed structures.

5 David Berlinski—A Scientific Scandal

See David Belinski, *A Scientific Scandal*, Commentary Magazine, April 2003.³

In brief, in 1994, Dan E. Nilsson and Suzanne Pilger published a paper in the Proceedings of the Royal Society entitled, “A Pessimistic Estimate of the Time Required for an Eye to Evolve.” By “pessimistic,” they meant an estimate that, if anything, exaggerated the length of time required for the eye’s evolution. Even so, their conclusions were remarkable. “A light-sensitive patch,” they wrote, “will gradually turn into a focused-lens eye” in only a few hundred thousand years.

Darwin had himself been troubled by the existence of the mammalian eye, whose evolution by random mutation and natural selection has always seemed difficult to imagine. Nilsson and Pilger’s paper provided a welcome redemptive note. A few hundred thousand years and the job would be done. Authors have waited longer for their royalty checks.

As Nilsson and Pilger’s paper gained currency, it amassed content it did not actually possess. Biologists who failed to read what Nilsson and Pilger had written—the great majority, apparently—assumed that they had constructed a computer simulation of the eye’s evolution, a program that could frog-march those light-sensitive cells all the way to a functioning eye using nothing more than random variation and natural selection. (2) This would have been an impressive and

² See <https://toriah.org/docs/> (ID 2) for the details.

³ <https://cyber700.github.io/pdf/Berlinski-ScientificPretensions.pdf> and also <https://www.discovery.org/a/1509/>.

important achievement, a vivid demonstration that Darwinian principles can create simulated biological artifacts.

But no such demonstration has been achieved, and none is in prospect. Nilsson and Pilger's computer simulation is a myth. In a private communication, Nilsson has indicated to me that the requisite simulation is in preparation; his assurances are a part of that large and generous family of promises of which "your check is in the mail" may be the outstanding example.

What Nilsson and Pilger in fact described was the evolution not of an eye but of an eyeball, and they described it using ordinary back-of-the-envelope calculations. Far from demonstrating the emergence of a complicated biological structure, what they succeeded in showing was simply that an imaginary population of light-sensitive cells could be flogged relentlessly up a simple adaptive peak, a point never at issue because never in doubt.

Despite a good deal of research conducted over the last twenty years, the mammalian visual system is still poorly understood, and in large measure not understood at all. The eye acts as a focusing lens and as a transducer, changing visual signals to electrical ones. Within the brain and nervous system, complicated algorithms must come into play before such signals may be interpreted.

And no theory has anything whatsoever of interest to say about the fact that the visual system terminates its activities in a visual experience, an episode of consciousness. We cannot characterize the most obvious fact about sight—that it involves seeing something.

5.1 Details of the Scientific Scandal

Here is Berlinski's detailed response:

In "A Scientific Scandal," I observed that Dan-E. Nilsson and Susanne Pelger's paper, "A Pessimistic Estimate of the Time Required for an Eye to Evolve," was a critic's smorgasbord. There are so many things wrong with it that even the finickiest of eaters could leave the table well-satisfied and ready for a round of Alka-Seltzer. But, in itself, there is nothing here that suggests a scandal. Dan-E. Nilsson is a distinguished scientist. Witness his discovery that the mysid shrimp, *ptromysis pauciponisa* an organism whose eyes are at once simple and compound (D. Nilsson, R.F. Modlin, "A Mysid Shrimp Carrying a Pair of Binoculars," *Journal of Experimental Biology*, Vol. 189, pp. 213-236, 1994), or his precise work on the optical system of the butterfly (D. Nilsson, M.F. Land, J. Howard, "Optics of the Butterfly Eye," *Journal of Comparative Physiology*, A 162, 341-366, 1988). Together with Susanne Pelger, he has simply written a silly paper. It happens. And in the literature of evolutionary biology, it happens very often.

No, the scientific scandal lies elsewhere. Nilsson and Pelger's paper has gained currency in both the popular and the scientific press because it has been misrepresented as a computer simulation, most notably by Richard Dawkins. Word spread from Dawkins's mouth to any number of eagerly cupped but woefully gullible ears. Subsequent references to Nilsson and Pelger's work have ignored what they actually wrote in favor of that missing computer simulation, in a nice example of a virtual form of virtual reality finally displacing the real thing altogether. This

misrepresentation of scientific work is a species of fraud, no different in kind from plagiarism in journalism or the fabrication of data in experimental physics. It is the *indifference* to this fraud that I denounced as scandalous.

Recognizing so many fond familiar faces among my critics—Paul Gross, Jason Rosenhouse, Matt Young, and Mark Perakh have replied to previous essays of mine in Commentary—I hoped that self-interest, if nothing else, might have prompted a moment of critical self-reflection. No very delicate moral sense is involved in determining that fraud is fraud. If Richard Dawkins is one of their own, all the more reason to apply to him the moral standards that Messrs. Gross, Rosenhouse, Young, and Perakh are accustomed to applying to their intellectual enemies.

Reading their letters, I realize that they had no intention of saying boo. What could I have been thinking?

Dan-E. Nilsson is persuaded that I wrote my essay because I am moved to reject “uncomfortable scientific results.” He is mistaken. The length of time required to form an eye is a matter of perfect indifference to me; had he and Susanne Pelger been able to demonstrate that the eye was in fact formed over the course of a long weekend in the Hamptons, I would have warmly congratulated them. As I have many times remarked, I have no creationist agenda whatsoever and, beyond respecting the injunction to have a good time all the time, no religious principles, either. Evolution long, evolution short—it is all the same to me. I criticized their work not because its conclusions are unwelcome but because they are absurd.

The vertebrate eye, Nilsson and Pelger claim, emerged from a patch of light-sensitive cells. Climbing up evolution’s greasy pole, or adaptive peak, those cells got to where they were going by invagination, aperture constriction, and lens formation. In explaining the evolution of the eye in terms of such global geometrical processes, Nilsson and Pelger rather resemble an art historian prepared to explain the emergence of the *Mona Lisa* in terms of preparing the wood, mixing the paint, and filling in the details. The conclusion—that Leonardo completed his masterpiece in more than a minute and less than a lifetime—while based squarely on the facts, seems rather less than a contribution to understanding.

It is hardly surprising, then, that while theoretical optics serves *qualitatively* to justify the overall connection Nilsson and Pelger draw between morphology and visual acuity, nothing in their paper and nothing in their references justifies the *quantitative* relationships they employ to reach their quantitative conclusion. To be sure, Mr. Nilsson denies that this is so. “Contrary to Mr. Berlinski’s claim,” he writes, “we calculate the spatial resolution (visual acuity) for all parts of our eye-evolution sequence, and the results are displayed in figure 1 of our paper. The underlying theory is explained in the main text, including the important equation 1 and a reference to Warrant & McIntyre (1993), where this theory is derived.”

In fact, no underlying theory whatsoever is explained in Nilsson and Pelger’s main text, or in the legend to figure 1; and while they do assert that calculations were made, they do not say where they were made or how they were carried out. The burden of Mr. Nilsson’s denials is conveyed entirely by equation 1 and by his references.

Let us start with equation 1, and with figure 1b that this equation is said to control. It is in figure 1b that aperture constriction takes over from invagination in getting an imaginary eye to see better. The graph juxtaposes aperture size against detectable spatial resolution. Having dimpled itself in figure 1a, Nilsson and Pelger's blob is now busy puckering its topmost surface to form a pinhole in figure 1b.* In a general way, the curve they present is unremarkable. No one doubts that spatial resolution is improved in an eye when its aperture is constricted. But why is it improved in just the way that Nilsson and Pelger's graph indicates?

Equation 1 is of scant help in this regard, despite Nilsson's insistence that it is important. Drawing a connection among visual acuity, focal length, light intensity, and noise, the equation specifies the local maximum of a curve, the place where it stops rising. In other words, it specifies a point; and it does nothing more. "We can now use this relationship," Nilsson and Pelger nevertheless declare, "to plot resolution against aperture diameter." They can do nothing of the sort, at least not in my calculus class. Knowing that a man has reached the summit of Mt. Everest, we still know nothing about the route he has taken to get there. What is needed if Nilsson and Pelger are to justify their graph is the equation from which equation 1 has been derived by differentiation. It is not there, just where I said it would not be.

Similarly with Nilsson and Pelger's references, which do nothing to support their argument. Quite the contrary. Three papers are at issue: (1) A.W. Snyder, S. Laughlin, and D. Stavenga, "Information Capacity of the Eyes" (*Vision Research*, vol. 17, 1163-1175, 1977); (2) A.W. Snyder, "Physics of Vision in Compound Eyes" (in *Vision in Invertebrates*, Handbook of Sensory Physiology, edited by H. Autrum, vol. VII/6A, pp. 225-313, 1979); and (3) E. J. Warrant & P.D. McIntyre, "Arthropod Eye Design and the Physical Limits to Spatial Resolving Power" (*Progress in Neurobiology*, vol. 40, pp. 413-461, 1993). Of these papers, the first is recapitulated (and corrected) in the second, and the second is summarized in the third. In what follows, references to Snyder are always to the Snyder of his second paper.

As their titles might suggest, both "Physics of Vision in Compound Eyes" and "Arthropod Eye Design and the Physical Limits to Spatial Resolving Power" deal with *compound invertebrate* eyes. Nilsson and Pelger's work is devoted to the evolution of the *camera* eye characteristic of fish and cephalopods. Theoretical considerations that apply to bugs do not necessarily apply to fish or octopuses, the more so since their eyes are structurally different, as are their evolutionary histories. Writing about the compound eye, Nilsson himself has remarked that "it is only a small exaggeration to say that evolution seems to be fighting a desperate battle to improve a basically disastrous design" (Dan-E. Nilsson, "Optics and Evolution of the Compound Eye," in *Facets of Vision*, edited by D.G. Stavenga & R.C. Hardie, p. 3075, 1989). Whatever the desperate battle going on among the arthropods, there is no battle at all taking place among the vertebrates or the cephalopods. Nilsson and Pelger's eye moves from triumph to triumph with serene and remarkable celerity.

If the papers by Snyder and Warrant & McIntyre say nothing about fish or octopuses, neither do they say anything about evolution. No mention there of Darwin's theory, no discussion of morphology, not a word about invagination, aperture constriction, or lens formation, and *nothing* about the time required to form an eye, whether simple, compound, or camera-like.

The purpose of these three papers is otherwise. No less than any other system of communication, the eye represents a balance struck between signal and noise. There is the object out there in the real world—whether a point source like a star, or an extended source like a grating of light and dark lines—and there is its image trembling on the tips of the retina’s budded nerve cells. Slippage arises between what the object is and how it is seen. Noise occurs in the visual system as the result of the random nature of photon emission, and it also occurs as the result of inherent imperfections in the eye’s optical system. The theoretical optician abbreviates these limitations in one mathematical instrument.

Imagine one of Nilsson and Pelger’s plucky light-sensitive cells, and then extend two flanking lines from the cell up past the constricted aperture and out into space, so that the cell and those two flanking lines form a cone with a flat top. In the center of the cone, where a cherry would sit atop the ice cream, there is a light source. The cherry moves to the sides of the cone in angular steps; the cell dutifully responds. The correlation between moving cherry and twitching cell constitutes the optician’s “angular-sensitivity function.”

Equation B15 (p. 238) in Snyder’s “Physics of Vision in Compound Eyes” defines the signal-to-noise ratio of a hypothetical eye in terms of noise, modulation contrast (the difference in intensity between black and white stripes in a grating), and the modulation-transfer function, which is simply a mathematical transformation of the eye’s angular-sensitivity function (its Fourier transform). Lumbering in Snyder’s footsteps, Warrant & McIntyre split his equation into two of their own (equations 10 and 11 in Warrant & McIntyre, p. 430), the one describing the signal, the other the noise in a hypothetical visual system. They observe what is in any case obvious: whatever the parameters affecting visual acuity, signal and noise will always reach a point where the first is drowned out by the second and the system fails, a point evident enough to anyone trying to see in the dark.

These equations lead by primogeniture to Nilsson and Pelger’s equation 1, which, as it happens, does not appear anywhere in their sources in the form in which they express it. But neither Snyder’s original equation nor Warrant & McIntyre’s bright bursting clones in any way suggest that the tipping point between signal and noise is unique. The ratio of signal to noise in an optical system depends on a host of factors, including head size and eye movement, most of which Nilsson and Pelger ignore. Nor, for that matter, do these equations taken in isolation justify any particular quantitative conclusions. Until the angular-sensitivity function is specified, whether theoretically or experimentally, its role is ceremonial.

Such specification is no easy business. Determining the shape of the angular-sensitivity function is a little like trying to guess an astronaut’s weight in space. Scales are not likely to be of use. In an early paper dealing with this subject and devoted experimentally to flies, K.G. Götz noted that the angular-sensitivity function in *Drosophila* seemed to follow what is known mathematically as a Gaussian probability distribution (K.G. Götz, “Die optischen Übertragungseigenschaften der Komplexaugen von *Drosophila*,” *Kybernetik*, 2, pp. 215-221, 1965). It was an interesting idea, but one that led to very considerable computational difficulties.

Looking Götz-ward, and understandably recoiling, Snyder adopted a different strategy. In assessing the weight of an astronaut in space, it is simpler to count the calories he consumes and

the exercise he undergoes than to try to measure his weight directly. His weight, although unmeasured, follows inferential-ly. In just the same way, Snyder thought to consider the angular-sensitivity function indirectly by considering the structures that determined its shape. These, he assumed, were the eye's retinal receptive field—area of the retina responding to signals—and its optical “blur spot”—the smeared image represented on the retina corresponding to the sharp object being seen. Let them both, he declared, be identically Gaussian. Why not? Both parameters had simple mathematical natures. The retinal receptive field is given as the ratio of the rhabdom's diameter to its posterior nodal distance, the optical blur as the ratio of the wavelength of stimulating light to the eye's aperture. From this the shape of the angular-sensitivity function followed.

The result is known as the Snyder model. “*The great beauty of this model*,” Warrant & McIntyre remark (in words that they have italicized), “*is that if one knows some very simple anatomical information about the eye*” (i.e., the nature of its optical blur spot and retinal receptive field) “*one has the ability to predict . . . the approximate shape of the angular-sensitivity function*” (p. 434). In referring to Warrant & McIntyre, Nilsson and Pelger are, in fact, appealing to Snyder, the *maestre* behind their masters—for, like Snyder, they, too, assume that retinal receptive fields and optical blur spots are identically Gaussian (p. 54).

But theory is one thing, and living flesh another. Staking their all on Snyder's model, Nilsson and Pelger must live with its consequences. “Having considered the physical limitations to resolving power,” Snyder wrote, “in addition to the absolute sensitivity of eyes, we now apply our concepts to real compound eyes.” This is something that Nilsson and Pelger never do. And no wonder. For Snyder then added the rather important caveat that bringing theory to bear on life “requires *precise* knowledge [of various optical parameters] in the various regions of the eye” (Snyder, p. 276, emphasis in the original).

If precise knowledge is needed in applying Snyder's model, precise detail is what is lacking in Nilsson and Pelger's paper. Precise detail? *Any* detail whatsoever.

And for obvious reasons. When tested, Snyder's model turns out to be *false* across a wide range of arthropods. As Warrant & McIntyre note glumly, “The model, on the whole, works best for those eyes for which it was originally formulated—apposition compound eyes functioning according to geometrical optics—but recent careful and sensitive measurements of angular sensitivity reveal that even in these types of eye, the model often performs poorly.” Readers may consult figure 34 (p. 441) of Warrant & McIntyre's paper to see how poorly the Snyder model does. In studies of the locust *Locustia*, real and predicted angular-sensitivity functions do not even share the same qualitative shape.

Responding to my observation that no quantitative argument supports their quantitative conclusions—no argument at all, in fact—Mr. Nilsson has thus (1) offered a mathematically incoherent appeal to his only equation; (2) cited references that make no mention of any morphological or evolutionary process; (3) defended a theory intended to describe the evolution of vertebrate camera eyes by referring to a theory describing the theoretical optics of compound invertebrate eyes; (4) failed to explain why his own work has neglected to specify any relevant biological parameter precisely; and (5) championed his results by means of assumptions that his own sources indicate are false across a wide range of organisms.

In acknowledgments to their paper, Nilsson & Pelger thank E. J. Warrant for help with their computations; in the acknowledgments to *their* paper, Warrant & McIntyre thank Mr. Nilsson for critically reading what they have written.

Schnapps all around, I am sure.

I turn next to the morphological units that are missing from Nilsson and Pelger's paper. It makes no sense to say of a ruler that it is one long. One what? When the "what" has been specified, a physical unit has been indicated: one inch, say, in the case of length, one pound in the case of weight. If one inch and one pound are units, length and weight are their dimensions. Only an origin in zero remains to be specified to complete the picture.

In my essay, I observed that Nilsson and Pelger had not specified their unit of morphological change. Nilsson now asks me to consider again their remarks on p. 56 of their paper. There, he is certain, I will find the missing unit carefully explained. Here is what they write, and it is *all* that they write: "Our principles have been to use whole-length measurements of straight structures, arc lengths of curved structures, and height and width of voluminous structures."

Very well. These are the fundamental units. They are none too clearly explained—try estimating the volume of a donut by looking at its height and width—but I know roughly what Nilsson and Pelger are getting at. What they do not say is *how* these three separate fundamental units are combined in a single overall derived unit of change.

A homely example may make this more vivid. Except for the fact that it cannot see, a Swedish meatball is rather like an eye. And plainly it makes no sense to ask of two Swedish meatballs, one of them twice as greasy but half as wide as the other, which of them is bigger—at least not until units of grease and length have been *combined*. But this is, in general, no easy task, not even when shape alone is under consideration. "It is important to keep in mind," C.P. Klingenberg and L. J. Leamy write ("Quantitative Genetics of Geometric Shape in the Mouse Mandible," *Evolution*, 55(11), pp. 2342-2352, 2001), "that shape is a multivariate feature and cannot be easily divided into scalar traits without imposing arbitrary constraints on the results of the analysis." To see how difficult a conceptual problem Nilsson and Pelger have set themselves, readers may follow the trail of Klingenberg & Leamy's references to the badlands of current work on geometric morphometrics.

Operating perhaps on the principle that a difficulty disclosed is a difficulty denied, Nilsson and Pelger do mention this very point, citing an example of their own on p. 56 to show just how arbitrary can be the business of calculating combined or derived units. In then justifying their own procedure, which is never explained, they remark: "As we are going to relate our measure of morphological change only to general estimates of phenotypic variation—in visual acuity, "we will be safe as long we avoid unorthodox and strange ways of comparing origin and product."

Origin and product? I am sure they meant origin and unit. No matter. The remark speaks for itself. There is next the matter of random variation: the heart of the matter so far as I am concerned. Nilsson and Pelger's paper is not an exercise in theoretical optics. It is intended to serve polemical purposes. Thus, they write: "In this context it is obvious that the eye was never a real threat to Darwin's theory of evolution"(p. 58). By "this context," they mean one in which only "eye

geometry” and “optical structures” are up for grabs. But whether in this context or any other, it is as a defense of Darwin’s theory that Nilsson and Pelger’s theory fails most obviously.

Let me review the chief steps in their argument. There is morphological change on the one hand, visual acuity on the other. As their population of light-sensitive cells alters its geometry—by means never specified—visual acuity perks up. In all, they assert, 1,829 steps are involved in tracing a path from their first patch to their final “product.”

Just how do Nilsson and Pelger’s light-sensitive cells move from one step on that path to the next? I am not asking for the details, but for the odds. There are two possibilities. Having reached the first step on the path, the probability that they will reach the second (and so on to the last) is either one or less than one. If one, their theory cannot be Darwinian—there are no random changes. If less than one, it cannot be right—there is no way to cover 1,829 steps in roughly 300,000 generations if each step must be discounted by the probability of its occurrence.

Demonstrating the existence of a path between two points in the history of life is in general not hard. What is hard is determining how the path was *discovered*. (This was the point of the linguistic example I offered in my essay.) If one assumes, as Nilsson and Pelger do, that probabilities need not be taken into account because all transitions occur with a probability of one, there is no problem to be discussed—but nothing of any conceivable interest, either. In responding to this obvious point by generously suggesting that I need to spend more time by the lamp with D.S. Falconer’s *Principles of Quantitative Genetics*, Mr. Nilsson has covered an embarrassment by addressing an irrelevance. Neither population size nor natural selection is at issue.

A few minor matters. Falconer’s response variable R is a measure, all right: a measure of the extent to which the mean of some quantitative phenotypic character—snout length, crop yield, scab color, or scrotum size (examples from the literature, I am afraid)—rises or falls as the result of natural selection. Just what I said, just as I explained. Although I offered no definitions in my essay, the paraphrases I employed were harmless. Why not say “sensitivity to vision” instead of “visual acuity,” just to vary pace and prose? But in one respect, Mr. Nilsson is right: I did not distinguish between selection and intensity of selection. Neither does he. Neither does Falconer’s response statistic, which contains only one selectional parameter, and that one measuring the intensity of selection. Neither does anyone else in this context.

His paper with Susanne Pelger, Mr. Nilsson writes, has never been criticized in the peer-reviewed literature. I am certain that this is so.

Paul R. Gross takes the occasion of his current letter to assure readers that what he meant in his last letter he did not say and what he said he did not mean. Like golf, Mr. Gross suggested in the 1986 essay from which I uncharitably quoted in the March Commentary, science is rather a clubby affair, and just as a great many men prefer to cover the links sedately in the company of men like themselves—tassels on their shoes, alligators on their polo shirts—so scientists prefer to keep company with their own, men and women who share their tastes, point of view, outlook on life.

These are sentiments so candid that I was surprised to find Mr. Gross expressing them. But he is now prepared to disown what he said. The club is just fine, and just look at those splendid greens! The admissions board is to be faulted only when, by accident or inadvertence, it excludes one of its own, a scientist who like L.V. Heilbrunn has *published in the literature*. Such men are entitled

to wear the gold cufflinks with the crossed golf clubs; keeping *them* out would be irresponsible. But keeping out the others is not only good science but good sense. *Ipse dixit*.

A few other points deserve comment. In offering Nilsson and Pelger the oil of his approval, Mr. Gross affirms that I have misunderstood or misinterpreted critical elements of their paper. In keeping with his longstanding policy of never documenting his discontent, he does not say which elements. As I keep reminding him, this is not sporting. Still, it is inconceivably droll to see Mr. Gross excusing Richard Dawkins's misrepresentation of Nilsson and Pelger's work by appealing to the fact that Dawkins expressed his views in a *trade* book. Mr. Gross apparently believes that outside the country club, a man can say anything he wants, a policy that he would not dream of applying to critics of Darwin's theory.

A few of Mr. Gross's remarks suggest a need for remedial reading. I have never argued that 'evolutionary theory cannot explain the eye.' How on earth would I know *that*? And explain what in particular? Its emergence, its structure, its physiology, its biochemistry? What I contended specifically is that Nilsson and Pelger's paper is just nuts. Conspiracies and cover-ups are, in any case, not in my line, and I never suggested or supposed that evolutionary biologists who failed to criticize Richard Dawkins for misrepresenting Nilsson and Pelger did so as part of a conspiracy. Like *droshky* horses, they were only doing what comes naturally: turning a blind eye.

If the burden of Nilsson and Pelger's paper was to demonstrate the existence of "one possible evolutionary pathway to the geometry of a fish-like eye from a patch of photoresponsive cells," as Mr. Gross writes, they have surely wasted their time. The existence of such a path is hardly in doubt. Every normal human being creates an eye from a patch of photoresponsive cells in nine months.

I certainly agree that the "only explanation we have for the structure of the eye . . . is Darwinian evolution." But neither an orchestra nor an explanation becomes good by being the only game in town.

On the other hand, I disagree that Darwin's theory is as "solid as any explanation in science." Disagree? I regard the claim as preposterous. Quantum electrodynamics is accurate to thirteen or so decimal places; so, too, general relativity. A leaf trembling in the wrong way would suffice to shatter either theory. What can Darwinian theory offer in comparison?

Finally, I would hardly dispute Mr. Gross's claim that "with the discovery of the developmental regulatory genes, we have learned how subtle, how versatile, and yet how simple the mechanism can be for transforming one biological structure to another." If he were to re-read the correspondence (Commentary, September 1996) following the publication of my "The Deniable Darwin" (June 1996), he could not fail to be struck by my reply to his own letter, in which I specifically called attention to work on regulatory genes and eye formation—the very work that he now suggests I am keeping from my readers. Subtle and versatile, those genes? Yes, indeed. Absolutely astonishing? That, too. But hardly a triumph of Darwin's theory. For one thing, no Darwinian theorist had predicted the existence of these genes; for another, no Darwinian theorist has explained their emergence. The facts are simply far more fascinating than anything that poor drab Darwin, endlessly sifting time and chance, could possibly have imagined.

Citing those ever useful but eternally anonymous “creationists,” Matt Young argues yet again, as he did in our earlier exchange, that Nilsson and Pelger have given the lie to creationist claims. If it was their computer simulation that originally lent ardor to his asseverations, now it is their paper itself. Mr. Young is a man plainly prepared to rely on an endless series of fallback positions. In the end, he may have to argue that his refutation is its own best friend, and that Nilsson and Pelger’s paper is itself superfluous.

No one doubts that the eye has evolved. Not me, in any event. Fish have eyes; rocks do not. Those eyes came from somewhere—right?—and if coming from somewhere counts as evolution, count me among its champions. No one doubts, furthermore, that the “eye could have evolved in 350,000 generations.” As I remarked earlier, the eye could have evolved in a weekend. The issue is whether it could have evolved in 350,000 generations *given the constraints of random variation and natural selection*.

I have absolutely no idea. Neither do Nilsson and Pelger. And neither does Matt Young. Arguing now from the last trench before the bunker, Mr. Young writes that Nilsson and Pelger’s paper deals with the development of *invertebrate* eyes, and triumphantly chides me for overlooking this point. On p. 56 of their paper, Nilsson and Pelger write: “After constriction of the aperture and the gradual formation of a lens, the final product becomes a focused camera-type eye with the geometry typical for aquatic animals (e.g. fish and cephalopods).” Fish are, of course, vertebrates, as anyone who has picked the flesh from a flounder knows. Perhaps I will be forgiven if I refer to this exchange as shooting fish in a barrel.

Making the point that the emergence of even the most modest eye will require simultaneous and parallel evolutionary development, Mr. Young asks that I defend my claim that this process could not have taken place by quantitative steps. In the first place, I made no such claim, if only because its truth struck me as obvious. But were I to make such a claim I would observe, as Richard Dawkins does, that to the extent that simultaneous and parallel changes are required to form a complex organ, to that extent does the hypothesis of random variation and natural selection become implausible. It is one thing to find a single needle in a haystack, quite another to find a dozen needles in a dozen haystacks at precisely the same time. Surely the burden of proof in such matters is not mine. I am not obliged to defend such mathematical trivialities as the proposition that as independent events are multiplied in number, their joint probability of occurrence plummets.

I have no idea what Mr. Young means when he writes that the number 1.00005 is not a percentage. Every number can be expressed as a percent, and every percent is a pure number. But he gets half credit for spotting a slip: the figure of 1.00005 between parentheses on p. 33 in my text should have been .005. Mr. Nilsson, who also spotted the slip, gets the other half. Me? I blame my editors. Finally, I did not fault the scientific community for failing to criticize Nilsson and Pelger’s work. I did the job of criticism myself. I faulted the Darwinian community—Mr. Young included—for failing to denounce scientific fraud, specifically the misrepresentation of Nilsson and Pelger’s work by Richard Dawkins. Now I see that Mr. Young feels I have manhandled him in these exchanges. Too bad. Commentary is not some academic mouse hole.

Mark Perakh, a *sensei* of the “noted scientists say” school of self-defense, is right in one respect: the computer simulation missing from Nilsson and Pelger’s paper has no bearing on what they actually said and claimed. And right in a second respect: “The real question [is] whether an eye

could have developed in a geologically short time *via a Darwinian mechanism*”(emphasis added). But then, although quite confident that I am wrong in my criticisms, he offers nothing by way of rebuttal. Like so many of these martial-arts types, he is too busy preparing himself to run from the field with honor to bother doing battle.

Contrary to what Mr. Perakh asserts, not only can I imagine, I do not doubt, that “distinguished scientists,” many with a record of “substantial achievement,” can have an opinion different from my own. It happens all the time. I would not dream of accusing ten respected scientists of fraud simply because they passed on the opportunity to have a go at Nilsson and Pelger. The men and women I criticized earned my contempt the hard and dirty way, by saying nothing about scientific misconduct when it was right under their noses.

Like Mr. Perakh and Paul R. Gross, Jason Rosenhouse regards Richard Dawkins’s misrepresentation of Nilsson and Pelger’s work as a “minor error.” Some minor, some error. What, may I ask, is the difference between inventing data out of whole cloth and inventing a computer simulation out of whole cloth? Should not evolutionary biologists be held to the same standards as physicists? Or even journalists? What part of the declaration that fraud is fraud does he fail to endorse? These are not semantic issues. If I claimed in print that Mr. Rosenhouse has four eyes, his denials would not turn on what I *meant*. Two eyes, I am sure he would say, are not there. Two eyes, and one computer simulation.

Mr. Rosenhouse believes that Nilsson and Pelger made an important discovery: namely, “that there is a smooth gradient of increasing visual acuity linking a light-sensitive spot to a lens-bearing eye.” This is not their discovery, it is a restatement of their chief assumption. “The model sequence is made,” they write, “such that every part of it, no matter how small, results in an increase of the spatial information the eye can detect” (p. 53). Note: *made*, not discovered.

To repeat, the flaw in Nilsson and Pelger’s work to which I attach the greatest importance is that, as a defense of Darwinian theory, it makes no mention of Darwinian principles. Those principles demand that biological change be driven first by random variation and then by natural selection. There are no random variations in Nilsson and Pelger’s theory. Whatever else their light-sensitive cells may be doing, they are not throwing down dice or flipping coins to figure out where they are going next.

Mr. Rosenhouse’s conviction that the randomly occurring changes required by Darwin’s theory are nevertheless “plainly implied” throughout Nilsson and Pelger’s paper owes nothing to the facts and little to common sense. If changes in their model were really random, their temporal estimates would be apt to change by orders of magnitude, a point I made in my essay and again in my reply to Dan-E. Nilsson above. In my essay I also questioned Nilsson and Pelger’s decision to hold selection pressure constant over time. In this, I found myself echoing John Gillespie (*The Causes of Molecular Evolution*, 1991, p. 294). “[W]e must be concerned,” Gillespie writes, “with models of selection in variable environments. How could it be otherwise? Natural selection is a force adapting species to their environments. Environments are in a constant state of flux; selection coefficients must be in a constant state of flux as well.” What is good enough for Gillespie is good enough for me.

In approving of the value chosen by Nilsson and Pelger for selection pressure, Mr. Rosenhouse writes that it is “ludicrously low for almost any environment.” Is it indeed? The figure that Mr. Rosenhouse calls ludicrous, Nilsson and Pelger term pessimistic, and Mr. Gross reasonable. The correct term is arbitrary—as in, it is anyone’s guess what the variance among a bunch of fish might have been a couple of million years ago. Studies of variance and heredity typically deal with tiny populations and small periods of time. Studying the collard flycatcher, *Ficedula albicollis*, Merilla, Kruuk, and Sheldon collected eighteen years of data for 17,171 nestlings in order to reach some quite modest quantitative conclusions (J. Merilla, L.E.B. Kruuk, and B.C. Sheldon, “Natural Selection on the Genetic Component of Variance in Body Condition in a Wild Bird Population,” *Journal of Evolutionary Biology* 14, pp. 918-921, 2001). Nilsson and Pelger’s imaginary population ranges over space and time in a way that could not possibly be disciplined by the data.

Nick Matzke believes that Nilsson and Pelger provide a mathematical model for the development of the eye. Let us be honest: beyond a few finger-counting exercises, there is no mathematics in their model, and while their references do contain some legitimate mathematics (nothing beyond second-semester calculus, but also nothing to sneeze at), their references, as I have shown in patient detail, do not support their theory. The task of modeling the eye’s complicated geometry from light-sensitive cell to fully functioning eye is utterly and completely beyond our powers, as a glance at any textbook dealing with embryology would show.

Mr. Matzke devotes the greater part of his otherwise interesting letter to doing battle with various “creationist straw men.” It is useful work, I am sure, the more so since the creationists are never named. But whoever they are, I am not among them. Quite the contrary, I am as eager to do right by the snails as he is: why should he think otherwise? It is only when he passes to matters of fact that we part company.

Nilsson and Pelger’s theory is intended to encompass the evolution of the eye in fish and cephalapods. Fish indisputably have bones, an attractive skull, and for the most part two staring eyes. The cephalochordate *Branchiostoma* (*Amphioxus* in a now out-of-date system of nomenclature) is widely taken by paleontologists to be a very plausible ancestral model to the vertebrates. It has certain vertebrate features while lacking others. These others include bones, a skull, a brain, and *paired sensory organs*: in other words, it has no eyes. Mr. Matzke’s very confident assertion that cephalochordates have “primitive eyes” is simply untrue.

Now that I have swept away a few straw men of my own, let us see what is left to clean up. In my essay I wrote that Nilsson and Pelger made no attempt to discuss the cost-benefit payoffs associated with an improvement in visual acuity. My aim in discussing the reconstruction of the fish skull was not to argue that eyes came first or that bones did. Paired sensory organs *and* bones are characteristics of the vertebrates. Plainly they evolved together. Plainly, too, one function of the bony skull in vertebrates is to provide protection for the paired sensory organs located on their heads. The protection racket, as every Mafia boss is aware, does not come cheap; but Nilsson and Pelger, in adding up the benefits of visual acuity, did not ever bother to consider the vigorish. This is such an unobjectionable point that I cannot imagine why Mr. Matzke found it fishy.

I very much appreciate the letters from David Safir and Norman Gentieu.

6 Berra's Blunder

With a bit of help, even the layman can understand how weak the Darwinian argument is. To see this, watch the following two videos:

1. Dr. Eugenie C. Scott, *Intelligent Design, Irreducible Complexity, and the Eye: Creationism Debunked* (2009). In this neo-Darwinian video “Dr. Scott criticizes claims by proponents of creation science that the vertebrate eye is too complex a mechanism to have evolved by natural selection. Darwin discussed the eye in the *Origin of the Species*, and found evidence of a step by step process consistent with evolution. Dr. Scott discusses evidence from [a non existing] computer model [as discussed above] that the eye could have evolved over a period of 100 million years.” Scott is an American physical anthropologist, a former university professor and educator who has been active in opposing the teaching of young Earth creationism and intelligent design. Scott served as the Executive Director of the National Center for Science Education.⁴
2. *Be Grateful for the Intelligent Design of Your Eyes*, The Discovery Science News Channel, 2017.⁵ If you're looking for one more thing to express gratitude to the Creator, look no further than your eyes. We take them for granted, but our ability to interact with the world through vision is beyond remarkable. At the same time, the eyes are an evolutionary icon, in two senses. Darwin expected that eyes must have developed from simple forerunners through the usual (hypothesized) series of gradual steps. But at the earliest layers of the fossil record, the Cambrian explosion, we find clear evidence of both compound and camera eyes already in use by creatures among the first animals in the fossil record. BOOM: There they are without precursors. To deal with and demote the exquisite sensitivity of our vision—the ability to detect a single photon — Darwinists claim that vertebrate eyes are built backwards in testimony to the haphazard ways of evolution. But as biologist author Dr. Jonathan Wells explains, evolutionists are working with outdated science. It's not ID proponents, but entirely mainstream research, that increasingly reveals the optimal design of our eyes.

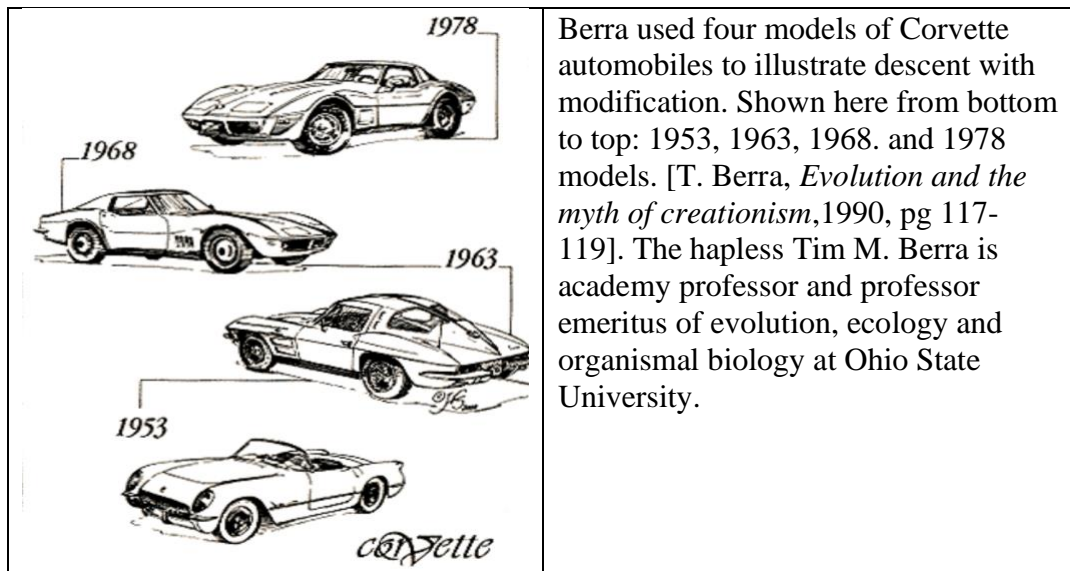
Eugenie Scott's video makes one wishful speculation after another while committing a variation of Berra's Blunder. It is amazing how little she has learned since Darwin's speculations.

Evolutionists like Berra often point to the slow, successive modification of man-made things over time as examples of how they interpret fossils or DNA sequences.

However, a putative succession of similar forms does not, in fact, furnish anything close a detailed explanation at the bio-molecular level. In Berra's example of the manufacturing of Corvettes from 1953 to 1978, the mechanism (intelligent human manufacturing) is directly observed, but in the succession of eyes an unguided biological mechanism is missing in action. Without a mechanism, how do we indeed get to the macro-steps described by Scott?

⁴ <https://youtu.be/KP3AY0iHEUA?si=VEbvdNfqwhgt1Njz>: Recorded at the 'Biology of Genomes' meeting at Cold Spring Harbor Laboratory, June 1, 2009. The Eye and Irreducible Complexity - Creationism Debunked.

⁵ https://youtu.be/kboUBQnMP8w?si=Rixsc8_Vt8eOojy4. Also <https://evolutionnews.org/2017/11/at-thanksgiving-be-grateful-for-the-intelligent-design-of-your-eyes/>.



Furthermore, there are no detailed Darwinian pathways even for Scott's simplest organisms such as the stigma (eyespot).

In the Discovery video, the human eye is correctly described as a remarkable feat of engineering capable of detecting light down to a single photon. This incredible organ is as a powerful tool that enables numerous technological and artistic wonders. Whether or not the eyes are the windows of the soul (as the ancients believed) they are certainly our windows into the world. Today, the human eye is a centerpiece in the debate over evolution. While the debate over evolution rages on, both sides claim the human eye as evidence for their arguments.

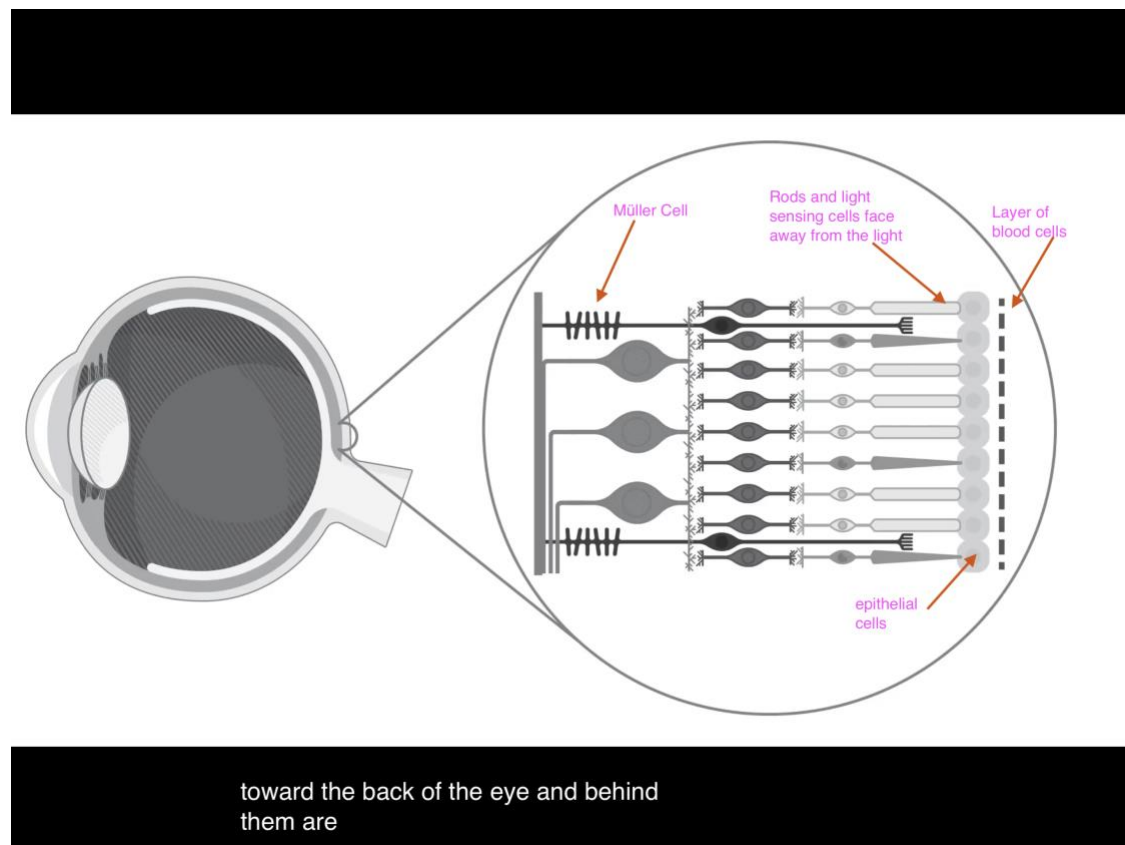
Charles Darwin initially expressed doubts about whether evolution could account for the complexity of the eye. He found it hard to believe that natural selection alone could create an organ with intricate features like adjustable focus, light intake variation, and correction of optical flaws. However, he proposed a potential solution: if a series of gradations could be found in the eyes of modern animals, ranging from simple to complex, then the objection to his theory might dissipate. In the present day, scientists do indeed observe a range of eye complexities among modern animals, from simple light-sensitive spots to the sophisticated human eye. This observation was foundational for Darwin and subsequent evolutionists in supporting their arguments. But, this is just to commit a variation of Berra's blunder!

Further, a significant challenge arises when examining the fossil record. The first animals with complex eyes, like trilobites during the Cambrian explosion, possessed advanced eye structures similar to those of modern insects. These creatures appeared suddenly in the fossil record, with no evidence of precursors. This lack of transitional forms poses a challenge to the theory that eyes evolved gradually.

Additionally, Darwinian evolutionists argue that the eye, despite its apparent perfection, is poorly designed. They claim that the human eye is "wired backward" because its light-sensing cells face away from the incoming light, unlike the forward-facing cells found in cephalopods

(such as squids and octopuses) or camera-like eyes. This "flaw" is attributed to the unguided nature of evolution, which had to work with existing structures.

However, closer examination reveals that the orientation of light-sensing cells in the human eye is highly optimal. The blood cells and the epithelial cells nourish the light sensing cells which have high metabolic requirements. If the cells were turned to face the lens, as suggested by evolutionists, the blood supply and support cells would obstruct the light, resulting in severe visual impairment.



Furthermore, recent research has uncovered the remarkable engineering of the Müller cell which act as waveguide to enhance image clarity. These specialized cells bring the light all the way through the retina and direct the light to light sensitive cells. Despite this evidence of optimal design, biologist and evolutionist Kenneth Miller maintained that the eye was initially flawed and that evolution "corrected" it over time by introducing improvements by adding these other cells. But, as before, there are no detailed Darwinian pathways to account for the organized complexity of Müller cell. Evolutionists continue to make desperate attempts to hang on to their materialistic philosophies.

Further, there is no historical evidence to support this claim of initial flaws, and the assertion of self-correction appears to be a desperate attempt to adhere to a materialistic narrative in the face of compelling evidence to the contrary. To summarize:

1. Via unguided processes, how do we get to the simplest single cell from dead chemicals?
2. How do we get from a simple bacteria-like organism such as the *Euglena* without an eyespot to one with an eyespot?

The mammalian eye has approximately 70 different cell types, each of those cells themselves complete factories. There are over 4000 different proteins (such as rhodopsin made up of over 300 amino acids) needed in the eye, each protein consisting of amino acids arranged in an order specified by the digital information encoded in the DNA.

3. So, there are many purposeful arrangements of parts needed for this supposedly simple light sensitive patch, but one of them is the need for the rhodopsin protein that converts light into an electrical signal. Provide a detailed Darwinian pathway just for this one protein? Do this without making the Dawkins METHINKS IT IS A WASEL blunder.⁶ Explain where the specified information in the code in the DNA come from — via biomolecular step-by-step unguided processes?

3. Then, having explained the origin of the various parts of the eyespot and accounted for the innovation of machinery to put those parts together, explain how the eyespot got wired to the flagellum (an outboard motor) so that the organism can use the eyespot to move. The flagellum itself needs the innovation or co-option of about 30 proteins all in a specified order coded via a sequence of amino acids. In the same way, the mammalian eye needs to be connected to the brain, an even great marvel of organized complexity.

4. Eugenie Scott produces a rabbit from a hat, not an actual scientific hypothesis, let alone a well-supported theory. Even worse, the clueless Eugenie refers to a computer program that supposedly shows how the light sensitive spot can be formed in a short span of time. Here she is referring to the paper by the scientists Dan E. Nilsson and Suzanne Pilger in the Proceedings of the Royal Society entitled, “A Pessimistic Estimate of the Time Required for an Eye to Evolve.”

Now, as David Berlinski reported in *Commentary*, this is a scientific scandal because he wrote to these eminent scientists and they admitted that there is no such computer program! It is actually much worse than that, once you examine the Nilsson paper in detail.

It is indeed a scientific scandal when evolutionist claim that Darwinian evolution is a well-supported theory when in fact it is just wishful speculation. The origin sciences have to do better than that.

⁶ See <https://toriah.org/docs/> (ID 2) for the details.