God's gaze

William R. Shea

Catching the Light: The Entwined History of Light and Mind. By Arthur Zajonc. Bantam: 1993. Pp. 388. \$24.95, £16.99.

WHAT is the nature of this invisible thing called light whose presence calls everything into view — except itself? Arthur Zajonc offers not a definitive answer but a fascinating account of what the question has meant over the ages. For the Ancient Egyptians, who sought a moral or spiritual answer, light was the gaze of God. For thinkers in the seventeenth century, who looked for a mechanistic account, it was explained by studying the geometry of refraction. In both cases, the quest was one-sided and, if this book has a moral, it is that we should read the full biography of light and not only the fragments that our own scientific community has written. Sight entails much more than just opening our eyes.

A few examples of colour vision among the Ancient Greeks and Romans convey some idea of the broad cultural and psychological basis of Zajonc's interdisciplinary study. Euripides writes in *Iphigenia* that blood made the side of the altar *ksanthon*. The word would therefore seem to mean red and Latin translators thus rendered it *ruber*. But Aeschylus in *The Persians* calls the leaves of the olive tree *ksanthon*, and in the *Iliad* the term is used for honey. Other colours receive an equally perplexing treatment at the hands of the Greeks. Both the Moon and fiery eyes are *glaukon*, so it is natural to think of this word as referring to yellow or red. But Plato uses it for the mixture of dark blue and white, associating it with sky-blue or blue-grey — *caesius*, as the Latins rendered it — whereas Euripides uses it for a vestibule decorated with leaves, relating it to the colour of vegetation. Translators seek a way out by rendering *glaukon* as 'brilliant' or 'shiny'. For instance, "glaukopis Athene" becomes "flashing-eyed Athene" in the Loeb Classical Library. But this solution is itself highly problematic because the eye disease we call 'glaucoma' does not give the eye a shiny but a turbid appearance. Perhaps the Greeks were colour-blind. But this radical solution is a counsel of despair. What is needed is not an eye doctor but a cultural anthropologist.

The Romans are closer to us and cannot be suspected of collective colour blindness. Those assuming that the English for *purpureus* is purple would find themselves in linguistic trouble when they discover that the poet Horace calls a swan *purpureus*. Indeed, the

Latins gave shiny black as well as shiny white objects the name purple. Or consider *caeruleus*, the word used to describe the sky, the sea and the eyes of Germans as well as the hair of Indians, the night and death! It is clear from these illustrations that a variety of different conceptual frameworks can be superimposed with equal validity on the order of 'coloured things'. The 'colours' that we encounter do not by themselves determine how we are to think of them independently of the apparatus of thought that we bring to the transaction.

Zajonc's catholic tastes and his rare gift of vivid characterization enable him to resurrect discarded images of vision such as the belief (shared by Plato, Euclid and even Galileo) that a visual ray emanating from the eye is essential for sight, or Aristotle's view that nothing streams from either eye or object but that illumination is a state or quality of the medium. Goethe's controversial ideas on colours are also displayed in their best light, and Rudolf Steiner's mystical musings on vision are examined against the interesting background of his quest for a science that would not belie genuine spiritual experience. The fundamental contributions of Faraday and Maxwell are lucidly described, and cur-

rent research in quantum optics is given a provocative slant. We are reminded throughout that theories are aids to reflection and should never be hardened into permanent and disabling truths.

Catching the Light is a treasure-house of telling quotations and it is a pity that the generally useful references are sometimes incomplete. In a work that ranges so far and wide, it is understandable that a few mistakes should have slipped in. The Berlin suburb of Grunewald, which is mentioned, indeed celebrated, at least a couple of times, is provided with a gratuitous umlaut. Descartes did not write his *Discourse on Method* in 1619 but in 1636. It is misleading to suggest that he explained the rainbow in terms of white and black, and although he could have written "Give me motion and extension and I will construct the universe", it seems more *ben trovato* than *ben documentato*. These and other trivial errors could easily be corrected to make the second edition not only a vastly enjoyable and stimulating work but a truly reliable one as well. □

William R. Shea is in the Centre for Medicine, Ethics and Law, McGill University, 3690 Peel Street, Montreal, Quebec H3A 1W9, Canada.

An essayist worth his saltations

Bryan C. Clarke

Eight Little Piggies: Reflections in Natural History. By Stephen Jay Gould. Norton/Jonathan Cape: 1993. Pp. 507. \$22.95, £18.99.

OH for J. B. S. Haldane's originality, Arthur Cain's encyclopaedic knowledge and Peter Medawar's skill in writing. Failing those, I would settle for Stephen Jay Gould's array of talents, perhaps with an added *souçon* of modesty and rigour. As the old proverb says, "If wishes were butter-cakes, beggars might bite". But you do not need to be a millionaire to appreciate a good meal, and this is a feast.

When Gould began writing, his essays were spottily pretentious, showing too obviously that he was a very clever fellow, sometimes with humorous results when they misfired. Moreover, it was difficult to forgive him, in his early advocacy of 'punctuated equilibria', for doing less than justice to the ideas of Simpson and Mayr. Even then, though,

he was patently struggling to perfect his art, and he consistently improved.

Time has passed, and the ugly duckling has grown into a swan, still with some neotenic imperfections it is true, but a veritable swan. His latest collection is a lovely mixture of bizarre facts, nice arguments, clever insights into the workings of evolution and a quality of writing that can make your skin prickle. Surely enough there is a trick to it. You start with a small commonplace or oddity, weave it into an exemplar of some general principle, patch in a few quirky or informative asides and then come back to view the beginning from a new angle. It is a trick, but a difficult trick to do, and Gould does it supremely well.

Inevitably he is uneven. My own favourites are the chapters on vertebrates' jaws, ichthyosaurs' tails and the head-shields of cephalaspis fishes. He seems less secure in three essays based on the fossil fauna of the Cambrian period. The first, about meeting someone who knew Charles Walcott (the discoverer of the Burgess Shales), leaves an unpleasant taste because it seems to patronize a modest and respected scientist. The second and third concern the animals themselves. We learn that two puzzling 'shelly' fossils, *Halkieria* and

■ Cambridge University Press has recently published volume 8 of *The Correspondence of Charles Darwin* edited by F. Burkhardt, D. M. Porter, J. Browne and M. Richmond. The volume covers 1860, a year dominated by the public and private response to the *Origin of Species*. £40, \$59.95.

Microdictyon, are respectively spicules from organisms that look suspiciously like amphineuran molluscs (although he does not say so) and plates from the sides of onychophorans.

The strangest of the Cambrian wonders, *Hallucigenia*, turns out to be an onychophoran too, not immediately recognized because it was interpreted upside down. In his earlier book, *Wonderful Life*, Gould argued that the Cambrian fauna, with extraordinary creatures such as *Hallucigenia*, displayed a level of anatomical diversity unequalled thereafter, and that the persistence of modern phyla was a matter of historical 'contingency'. Now, he uses the relegation of *Hallucigenia* to a modern phylum in making a case for the same view. One cannot avoid discomfort with a theory that seamlessly accommodates so complete a reversal of fact. Elsewhere there are other weaknesses. He does not realize that duplicating a gene can be favoured by natural selection either through a need for more of its product or as an escape from heterozygous advantage. He falls into the common trap of supposing that only the neutral theory predicts a faster evolutionary rate for smaller changes of phenotype, whereas selective theories do so too.

Gould is very good at finding sense in the work of scientists whose ideas have now been abandoned and who are often ridiculed in textbooks. The pieces on William Paley and Archbishop James Ussher stand out, but he is palpably ill at ease trying to justify Goethe's amateurish theories about the structure of plants. There are also some fine essays on general subjects, including a heartfelt and perceptive celebration of authenticity. Having read the piece, and mentally applauded, I chanced to look more carefully at the dustjacket. Here, in the US edition, there is a picture of some snails and the caption: "These sixteen Partula snails from Moorea . . . have all become extinct in the last ten years". The shells illustrated are *Partula nodosa* from Tahiti. So much for authenticity. Another piece tells how Gould was dismayed to find that he had misremembered the place of treasured meetings with his grandfather. It is true and touching, but in an earlier collection of essays he accused Teilhard de Chardin of the Piltown forgery because of a lapse no greater than his own. These peccadillos, however, are forgivable in one who writes so well. Gould has given us a feast, and the reader should enjoy it, taking some of the arguments with a pinch of salt. After all, a little salt improves the savour. □

Bryan C. Clarke is in the Department of Genetics, University of Nottingham, Nottingham NG7 2UH, UK.

Heavenly works

Fred Hoyle

Nicholas Copernicus: Complete Works in Two Volumes*. Johns Hopkins University Press: 1993. Pp. 452/373. Each volume \$48, £30 (pbk).

Johannes Kepler: New Astronomy†. Cambridge University Press: 1992. Pp. 665. £85, \$140.

BOTH publishers are to be congratulated on making these works, which form the foundations of modern astronomy, available to English readers uneasy with mediaeval Latin. Those who venture

NICOLAI COPERNICI
net, in quo terram cum orbe lunari tanquam epicyclo contineri
diximus. Quinto loco Venus nono mente reduciatur, Sextum
denique locum Mercurius tenet, octuaginta dierum spacio circū
currentes. In medio uero omnium refidet Sol. Quis enim in hoc

gualcherimo templo lampadem hanc in alio uel meliori loco ponere, quam unde totum simul posuit illuminare: Siquidem non inepce quidam lucernam mundi, alij mentem, alij rectorem uocant. Trimegitus uisibilem Deum, Sophodis Electra inuenit omnia, Ica profecto tanquam in folio regali Sol refidens circum agentem gubernat Astrorum familiam. Tellus quoque minime fraudatur lunari ministerio, sed ut Aristoteles de animalibus ait, maximā Luna cū terra cognitionē habet. Concipit interea à Sole terra, & impregnatur annuo partu. Inuenimus igitur sub hac

The first printed representation of the Copernican system as it appears in *De revolutionibus* (1543). Picture taken from *Early Physics and Astronomy* (2nd edn) by O. Pedersen. CUP, £50, \$75 (hbk), £19.95, \$27.95 (pbk).

between the covers of any of the volumes will be surprised to find out how much more complicated the work looks than popular potted versions would have it. Compilers of the popular versions, I suspect, do not really understand what the original authors sought to explain. But seen as the pioneers had to see it, the situation was devilishly complicated, as much so as any of the puzzles of recent science.

Two versions of *On the Revolutions* exist, one made in Copernicus's last

years by Rheticus, a visitor from Germany whose copy was used for the printed book set in Nürnberg in 1543; the other Copernicus's own autograph. Both versions were used to obtain what the translator, Edward Rosen, believes to be a superior rendering than either alone. Frankly, I would have preferred Copernicus's own manuscript, since it is not clear that the Rheticus copy ever had Copernicus's full approval.

It is scarcely possible to consider the constructions of Copernicus without comparing them with those of Ptolemy, who seems to me to have been dealt with more than harshly by scientific history. Copernicus discovered a geometrical construction for obtaining the motion of a planet, correct in the main to the first order in the eccentricity of its orbit, working in heliocentric coordinates. Then, to obtain a planet's position with respect to the Earth, in order to compare theory and observation, a subtraction had to be made, the planet's position minus the Earth's position. Ptolemy, on the other hand, discovered a construction that both gave the planet's position and made the subtraction with respect to the Earth, all in the same process. The outcome, so far as comparing theory and observation was concerned, was essentially the same. The science was the same. It was the inconsequential philosophy that people attached to the theory that was different.

Two small mistakes in the constructions of Copernicus provided the springboard for Kepler. In his construction for planets other than the Earth, Copernicus used a point related to the Earth when he should have used the Sun, a strangely non-copernican oversight. Kepler, when he had withstood the insults of Tycho Brahe and had eventually secured access to Brahe's observations, soon put the mistakes right, and might have rested content there. But discrepancies remained for Mars. Because the eccentricity of Mars is comparatively large, errors due to second-order terms were showing through in Brahe's data. How Kepler solved this problem is one of the great early stories of science, on a par with the "Eureka!" of Archimedes. Just what the solution was remains unexplained in Dreyer's classic *History of Astronomy*. Nor does it appear in Kaspar's biography of Kepler. And the avid reader will have a high old time digging it out of *New Astronomy*. Some hints may help.

Kepler's first move was to use an opposition of Mars (a situation when the terrestrial observer knows the heliocentric direction of Mars with respect to the distant stellar background) together with routine observations of Mars, to obtain the relative shape of the Earth's orbit to the highest possible accuracy. Then other oppositions of Mars, making use of

* *On the Revolutions* edited by J. Dobrzycki, translation and commentary by E. Rosen; *Minor Works* edited by P. Czartoryski, translation and commentary by E. Rosen with E. Hilfstein. † Translated by William H. Donahue.