systems specific to it, but the host recombination pathways also act on the phage. Furthermore, the method by which lambda packages its DNA in the head of the virus probably leads to a bias in the recombination events shown by the progeny. With T4 the complexity of the experimental results arises from the extraordinary genetic system that prevails in this phage, which has linear genomes that are circularly permuted with respect to one another. Although a concise account is given of the relevant results, it would be an advantage to students if they already had some knowledge of recombination studies with *E. coli* and these phages.

The book is addressed to graduate students and final-year undergraduates, but I fear that many will find it difficult reading. The problems at the end of each chapter will no doubt help towards a better understanding, though some of these will certainly present a severe challenge for students. Fortunately, the solutions are given later in the book. The clarity of thought that the book constantly demands is helped by a profusion of unnumbered small diagrams which form an integral part of the text. In some of the diagrams the differences in line thickness that indicate the parentage are easily overlooked, and there are no legends to draw one's attention to them. The author's entertaining, often colloquial, style helps to enliven the book.

Errors are few, but Figures 8-1 and 8-2 have been transposed and an incorrect reference is given in this chapter for data on *Sordaria* asci with 5:3 ratios for spore colour. In the previous chapter Rossignol and Haedens' work is discussed without reference to them. There is a useful glossary but Stahl's new term, 'splatch', is not included though freely used in the text. It is surprising in a book on genetic recombination to find no reference to the important contributions to the subject by Benbow *et al.*, Ephrussi-Taylor *et al.*, Spatz and Trautner or Tiraby *et al.*, even though their work relates to organisms other than those with which the book is primarily concerned.

My chief criticism of Stahl's book is that it does not give a balanced view of the current state of knowledge of recombination in eukaryotes. Hypotheses involving fixed pairing segments, such as his so-called "sex-circle" model, are discussed without drawing adequate attention to the conflict they present with a considerable body of data. He lists eleven features of the recombination data for *Saccharomyces cerevisiae* and implies that these results are so different from those found with other fungi as to demand a quite different explanation. But most of the results with yeast have also been found in other fungi; and to me the similarities are much more impressive than the differences. He supports the idea of break-and-copy by reference to work on phage f1 without acknowledging that the authors subsequently abandoned this hypothesis for a more conventional one depending on heteroduplex DNA. And why suppose that in fungi two crossovers (reciprocal exchanges) may occur in very close proximity in the same two chromatids when there is no evidence for this? Stahl repeatedly raises the subject of interference between crossovers, even to the final sentence of the text, where he says "... we would all feel better if a good molecular explanation for the facts of interference were neatly wedded to some of those models", referring to those he has been discussing. But he seems to overlook the very great distances, in molecular terms, over which interference often acts, and the lack of it across the centromere. It seems likely that interference is a phenomenon superimposed on the basic crossover mechanism rather than a primary feature of it. When discussing Holliday's recombination model in Chapter 8, Stahl argues that interference should lead to an excess of recombinant over parental flanking marker genotypes in association with conversion, but Holliday himself (*Phil. Trans. R. Soc.* **B277**, 367; 1977) draws the opposite conclusion.

Despite these criticisms, Dr Stahl is to be congratulated for producing such a challenging and thought-provoking, if controversial, work. It should draw attention to the many unsolved problems in this field and provide a stimulus for further research. □

H.L.K. Whitehouse is Reader in Genetic Recombination in the Department of Botany, University of Cambridge, UK.

Illustrated black holes

R.L. Znajek

Black Holes. By W. Sullivan. Pp.303. (Anchor Press/Doubleday: Garden City, New York, 1979.) $17.95.

SULLIVAN'S *Black Holes* begins with a bang. Literally. The first chapter is about the Tunguska event — the great Siberian explosion of 1908. This is tenuously linked to the title by a theory that the explosion was caused by a small black hole falling through the atmosphere (Jackson and Ryan, *Nature* **245**, 88–89; 1973). Like all good theories it made a prediction: the hole passed through the Earth and emerged over the North Atlantic Ocean, causing a similar explosion as it left. This should have caused atmospheric vibrations comparable to those detected from the original event. It turned out that no such vibrations were detected from the North Atlantic (Beasley and Tinsley, *Nature* **250**, 555–556; 1974), and so the theory now seems untenable. There is of course no shortage of other ideas, ranging from the exotic (an exploding nuclear-powered spacecraft) to the quite plausible (a small comet or meteorite). Sullivan tells us about all of them, and this gets him into digressions about anti-matter and carbon-14 dating. We are treated to maps, eyewitness reports and even photographs of a man who was blown off his porch by the blast. It is mostly quite interesting. Like the rest of the book, it has little to do with black holes. But the title presumably sells.

Black Holes is in fact an account of some of the more dramatic goings-on in modern astronomy. It deals with white dwarfs, pulsars, X-ray sources, quasars and cosmology, as well as with things that might have exploded over central Siberia. Sullivan, being Science Editor of the *New York Times*, writes in an appropriately journalistic 'who-did-what' manner. He emphasizes observations and is short on theory. The trouble is that black holes are inherently theoretical objects. They cannot, by definition, be seen or photographed. Events happening near a black hole can be observed, and the hole's presence deduced theoretically. A book about black holes should certainly explain why many astronomers think they exist, and this one does. It should also make a serious attempt to explain what they are, and this means more than just stating that gravity becomes so strong that not even light can escape.

I am not asking for a layman's guide to tensor calculus and the Einstein equations. I am suggesting that one can give a precise but non-mathematical account of relevant aspects of special and general relativity, such as light cones and frames of reference. By showing how light cones are tilted at the surface of a black hole, one can demonstrate why the surface is an 'event horizon' and why leaving it is precisely equivalent to travelling faster than light. (A spaceship that can travel faster than light can get out of a black hole. Scientists depicted in the recent film *The Black Hole* seem surprisingly ignorant of this fact.) Laymen may not understand mathematics, but most of them can read maps, and so any popular account of black holes should include plenty of space-time diagrams, which are just maps showing the location of events in space and time. The best example of what I have in mind is Kaufmann's book *The Cosmic Frontiers of General Relativity* (Little, Brown: Boston, 1977), which might almost be accused of being over-illustrated. Sullivan's book is crammed with photographs of astronomers, telescopes, rockets and galaxies, but I cannot

find a single space-time diagram in it.

Having made my complaints, I must confess I quite liked the book. All that is wrong with it is the market it is aimed at. It is basically an anecdotal history, and as such is more likely to interest astronomers than the general public. It provides a personal dimension which is normally absent in original papers and review articles. Sullivan records the comments of scientists in the process of discovering, debating or just feeling confused. The result is somewhat chaotic, but that is what science is often like. Sullivan himself describes his book as "an ongoing scientific mystery story". He provides an excellent set of "Selected References", the main merit of which is that they are not selected. Most of them are very inappropriate for laymen, but they are precisely what is required by astronomers wishing to get to the science behind the anecdotes. The book would be improved by the removal of some of the weaker attempts at popularization, such as the summing-up of diffraction as "light plus light equals darkness". There are a few inaccuracies, like the statement that in an accretion disk "gas would spiral in more rapidly were it not for friction". (Gas would not spiral in at all were it not for friction.) I can nevertheless recommend this book for the history section of any astronomical library. I would recommend Kaufmann's book to any layman who wants to know about black holes. □

R.L. Znajek is a King's College Research Fellow at the Institute of Astronomy, Cambridge, UK.

Thames revival

R.J. Wootton

The Tidal Thames. By Alwyne Wheeler. Pp.228. (Routledge and Kegan Paul: London and Boston, 1979.) £8.95.

THE tidal Thames runs from Teddington Lock, west of London, eastwards to the North Sea. Bisecting the capital city, this length of the river has streamed through British history, providing a means of transport for men and their commerce. Until the nineteenth century, it also supported flourishing fisheries which supplied London with such esteemed food fish as salmon, smelts, eels and whitebait. But thereafter a combination of events destroyed these fisheries and left a long stretch of the tidal river apparently lifeless. Only in the past two decades has this degradation of the river been reversed, and now fish can once again be found throughout the tidal Thames. Alwyne Wheeler, an ichthyologist at the British Museum (Natural History), has played an important role in recording the return of fish to the Thames. His book tells of the death and revival of the river as a habitat fit for fishes.

In the first half of the book, Wheeler describes the decline in quality of the river and its effects on the fisheries. Industrialization and population growth were the major factors. Pound locks were constructed to improve navigation on the river, but these hindered the movements of migratory fish and made their capture easier. Gas works and other industries poured their toxic by-products into the river. The primitive methods for the disposal of human excrement, cess pits with the night soil spread on agricultural land, became inadequate so that disposal through sewers was introduced, a development encouraged by recurrent outbreaks of cholera. At first the sewers discharged directly into the river in London, but this led to such gross pollution that on an infamous occasion in 1858, "the year of the great stink", committee meetings in the Houses of Parliament were suspended because of the stench. A great Victorian engineering scheme was initated, and in a few years 84 miles of sewers had been built which carried London's wastes eastwards to empty into the river downstream of central London. Sadly, the site for the outfalls was miscalculated, and the sewage was trapped in the water mass by tidal movements. This area of the river, receiving most of London's excrement, became so polluted it was claimed that suicides died of poisoning before they could drown themselves. If the outfalls had been a few miles downstream it is possible that the Thames would never have become lifeless. Although the situation had improved by the beginning of the twentieth century, two world wars, and the continued growth of population in the London area without adequate provision for sewage treatment, meant that by the 1950s there were no established fish populations in the Thames over a distance of 69 km. Most of this stretch had extremely low dissolved oxygen concentrations, the consequence of the massive organic pollution.

This intolerable state was recognized and major improvements in sewage treatment started. The effect of these improvements on the fish fauna was monitored in an original way. Wheeler arranged for the collection of fish caught on the filter screens of electricity generating stations which extracted cooling water from the Thames. These collections yielded a clear picture of the recovery of the fish fauna, as both the number of species and the number of individuals increased. This picture of a cleaner river was emphasized dramatically when salmon were recorded in the Thames for the first time in 140 years.

The second half of the book is a detailed description of the results of Wheeler's and other collections made since 1967, in which 72 species were recorded. This section makes difficult reading. Much of the quantitative data could have been relegated to an appendix for, as Wheeler himself notes, the method of collection provided a qualitative rather than quantitative picture of the recovery of the fish fauna. Yet some of the detail is inadequate: for some species inadequate morphological detail is given; and authorities are not given for the specific names while some common names are used inconsistently.

Finally, Wheeler notes that a cleaner river is more sensitive to environmental disturbances which would have been insignificant when the river was lifeless. Potential hazards include the effects of large power stations on water temperature and hence dissolved oxygen, the discharge of raw sewage during storm overflow, and the effects of flood prevention schemes. Although it is unlikely that commercial fishing will again flourish in the tidal Thames, the aesthetic and recreational benefits provided by established fish populations are incalculable. Wheeler's book illustrates how effective public spending, which is now under attack, can be in a civilized, industrialized state.

Although there are a few typographical errors and mistakes of chronology, the book is reasonably priced. Many of the illustrations are taken from Yarrell's *British Fishes* (1859), which links Wheeler's book with that of a naturalist familiar with the Thames before it died of pollution. □

R.J. Wootton is Lecturer in Zoology at the University College of Wales, Aberystwyth, UK.