

Prof. Florence R. Sabin', the Johns Hopkins anatomist. The project was so complex that Sabin spent seven weeks with Ziegler working on the models. It is clear from Sabin's letters home that the process of modeling illuminated her understanding of the three-dimensional of the brain. These, and almost all of the models were associated with publications in learned journals, lending scientific authority to what might have been considered merely a commercial venture. Ziegler was a physician and considered himself a part of the academic community rather than an artisan who made his living making models. Indeed, he was rewarded with an honorary degree from the University of Freiburg.

Hopwood describes Gustav Born's method of making models that translated serial sections of embryos into serial slices of wax that could be assembled to make a whole, which reduced the amount of subjective interpretation required and made the process more mechanical. Interestingly, a similar process was followed by the early protein crystallographers who traced the electron density maps onto clear sheets of plastic, which were then stacked on one another.

It is unfortunate that Hopwood's writing is not always as stylish as the images in the book and some sentence constructions are hardly felicitous; for example, 'Ziegler had a certain status, then, though perhaps no better than as a drawing teacher he would have enjoyed...' or 'With a new generation of modellers in place, it is here that in the next chapter we return'. The Whipple Museum in Cambridge has produced a very attractive book but it is a pity that the size of the font is rather smaller than older readers will like, and it is regrettable that there is not an index. On the other hand, using the footnotes is much easier than usual because they are numbered consecutively through the book, rather than chapter by chapter.

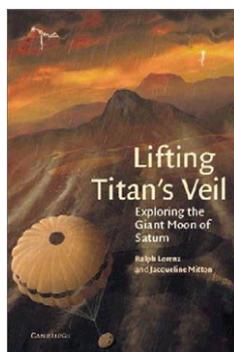
Hopwood discusses the decline of the models – how there was a move away from detailed morphological studies of developing embryos. This became ever more pronounced as embryologists transformed into developmental biologists and adopted many of the powerful new approaches being used in molecular genetics and cell biology. Yet morphology continues to be a key element of development – how could it be otherwise when the structural changes realized by an embryo are the bedrock of the developmental process? Today, the

colored waxes of the Zieglers' models are fluorochromes lighting up the three-dimensional patterns of gene expression or protein distribution; there are websites with three-dimensional representations of embryos that can be rotated. And yet, for all their realism, these images on a monitor cannot compare with the glories of the Zieglers' work. My next visit to Cambridge will include a detour to the Department of Anatomy to see some of the models in real life.

Jan Witkowski

Lifting Titan's Veil: Exploring the Giant Moon of Saturn

by *Ralph Lorenz and Jacqueline Mitton*
Cambridge, 2002. £19.95
(viii + 260 pages) ISBN 0521794583



Saturn's satellite Titan is larger than the planets Mercury and Pluto and is distinguished by a nitrogen atmosphere denser than that of the Earth. The satellite was discovered by Huygens in 1655, and in 1908 was observed by Comas Solà to be limb darkened, unlike any of the Galilean satellites of Jupiter. The inference was soon made that there was a dense atmosphere. Kuiper took the first near-infrared spectra in 1944, and found unmistakable evidence for methane. But real excitement about the atmosphere did not flare up until 1972, when Morrison, Cruikshank and Murphy applied newly developed instruments for infrared measurements and found that Titan's thermal spectrum is utterly unlike those of Jupiter's satellites. Trafton also presented rather weak evidence that there might be a large amount of hydrogen. It was suggested that the strange infrared appearance might be due to a warm surface, maintained by the greenhouse effect. It soon became evident, however, that part of the observed infrared emission is from a warm stratosphere. It was also deduced that

there is a ubiquitous stratospheric haze that totally hides the surface at visible wavelengths.

National Aeronautics and Space Administration (NASA) Headquarters, noticing these developments, sponsored the organization of a Titan scientific workshop, and later ones devoted to the entire Saturn system. In 1980, the close encounter of Voyager I yielded a mass of new information, and verified that the surface cannot be photographed at the visible wavelengths to which the camera is sensitive. All this information, discussed in many subsequent meetings, finally led to the launch of the Cassini–Huygens mission, with the large Cassini orbiter the responsibility of NASA, and Huygens (the Titan entry probe) that of the European Space Agency (ESA).

Most of these events, and many more recent ones, are recounted by Lorenz and Mitton. The nature of Titan and its atmosphere, as we understand them today, are well described. An interesting feature of the book is an occasional piece 'Ralph's Log', in which he describes some of his experiences studying Titan as an ESA engineer, as a graduate student or in designing and building one of the instruments now flying aboard the Huygens probe. All the material is at the level of an average reader, but it is also interesting and useful to the expert. The book is well illustrated, and there is an excellent color section showing, among other things, recent images of the surface obtained from the ground or the Hubble Space Telescope. These are obtained by using wavelengths in the near infrared at which there is a hazy view of Titan's surface.

There are excellent chapters on the discovery of Titan and up-to-date ones on the nature of the atmosphere and surface. The last two describe the Cassini–Huygens mission, destined to arrive at Saturn in 2004 for several years of orbital operations and many close encounters with Titan. There is more detail about the experiments on the Huygens probe than on the Cassini orbiter, and the Cassini instruments that do not relate to Titan are not described. The last chapter discusses what the mission will be like after arrival, and includes some ideas on possible future missions. The book is warmly recommended to the general reader and should be of considerable interest to the specialist.

Donald M. Hunten