humans to discussion of teratogen information services. Of particular interest to reproduction toxicologists are the papers comparing diethylstilbestrol teratogenesis in animals and humans (M. D. Hogan *et al.*), summarizing what is known about the etiology of human birth defects (R. L. Brent), and addressing the complex biological considerations that must go into accurate empirical human risk assessment (J. M. Manson).

The purpose of the conference notwithstanding, interchange of ideas among the three functional sections of the book is not notable. An important exception pertains to retinoic acid, which is mentioned or discussed in ten papers. Observed teratological effects of retinoic acid in humans and in vitro have been plausibly postulated to be caused by functional derangement of the cell adhesion molecules that constitute part of the normal mechanism of morphogenesis (discussed in papers by G. M. Edelman and W. J. Gallin and by R. M. Pratt *et al.*). However, the reader must search for this integrative thread. The value of the book is mainly in the quality of the individual contributions and the intrinsic interest of the three components.

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Morphology and Function

Axis and Circumference. The Cylindrical Shape of Plants and Animals. STEPHEN A. WAINWRIGHT. Harvard University Press, Cambridge, MA, 1988. x. 132 pp., illus. $22.95.

Although biology has one universal law in Darwinian evolution, the diversity of organisms arising from the operation of that law makes further generalizations difficult. Therefore any well-argued case for a major generalization must be taken seriously.

Wainwright makes such a case with respect to the form and structure of all multicellular animals and plants. Their shape is essentially cylindrical or their supporting and connecting structures are cylinders. The properties of cylinders and the materials from which they are made permit certain functions, and hence the possible habitat range of an organism. Communities are composed of organisms selected from among those with certain sets of form, structure, and hence functional properties. Wainwright's thesis thus has extensive explanatory and predictive capability.

Wainwright briefly documents the ubiquity of cylindricity in plants and animals. The bulk of the book considers explanations in terms of functional attributes of biological cylinders composed of various materials in numerous structures. Wainwright starts by carefully defining basic terms and then builds on these to examine the mechanics of shape. An important component of this discussion is beam theory. He then considers the physical properties of the materials making up structures. This is opposite to the usual presentation sequence but works well. Wainwright then identifies and defines three structural stystems, branched cylinders, hydrostats, and kinetic frameworks, that underlie the form of animals and plants. An especially interesting chapter suggests how the diversity of structures based on cylinders could have arisen as a result of a mere five simple and plausible evolutionary steps.

Having argued for a fundamental structural element in multicellular organisms, the book concludes with a brief consideration of some of the consequences for organismic shape and circumstances where exceptions occur. I felt this discussion detracted from the main thesis, because the topic far exceeds the scope of a short book such as this and the reader will already have been stimulated to consider the issues raised in it.

Wainwright not only seeks to make a sweeping generalization on form and function, he clearly illustrates the analytical approach that has proved so successful in modern functional morphology—to describe systems in terms of their properties, subsequently deducing functions that are subject to experimental test. Many of the principles of materials and structure have never, in my opinion, been suitably presented for a non-expert biological audience. For example, Wainwright provides the best explanation I know of for the novice of the term "second moment of area," which can be heard bandied about at meetings. Furthermore, the principles covered by the book constitute one of the foundation areas in the modern study of organisms. Therefore, teachers of functional morphology, who for years have had to use handouts in this area, will welcome the book. Their task will be further eased because Wainwright's style makes the book easy reading. Researchers will find an opportunity to review essential principles in the midst of numerous opportunities for further work. The general reader will be educated in principles and processes of a dynamic and exciting area of biological thought.

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Shattered Stars

Supernova Remnants and the Interstellar Medium. R. S. ROGER AND T. L. LANDECKER, Eds. Cambridge University Press, New York, 1988. xii, 540 pp., illus. $59.50. From a colloquium, Penticton, BC, June 1987.

One hundred and seventy thousand years ago, a supernova exploded in the Large Magellanic Cloud. Its light and other radiation (including neutrinos) reached Earth with the news at the beginning of 1987, three months before the colloquium of which this book is a record. The stellar event SN1987A and the 620 supernovas known prior to it have served to define the $t = 0$ initial conditions for the development in the interstellar medium of the large explosive structures called supernova remnants. Perhaps 200 supernova remnants are known, mostly in our Galaxy, but with handfuls in the nearest external galaxies, picked out by x-ray, radio, and optical studies. Only in half-a-dozen cases can a supernova remnant be connected with a particular supernova.

For the first few thousand years the explosion of a supernova is high-speed. What astronomers see is mostly produced by the ejecta from the shattered star. The ejecta appear as optical, ultraviolet, and x-ray emitting filaments that manifest the peculiar compositions appropriate to a dismembered thermonuclear fusion reactor (that is, the star). There are three sorts of supernovas, corresponding to the explosions of white dwarf stars (Type Ia supernovas), of massive stars (Type II), and of a third kind of star not well identified (Type Ib); there are three sorts of supernova remnants too, which seem to correspond to these types, and they show compositions with the expected kinds of anomalies.

The overall behavior of the explosion at its outset is dominated by the free expansion of the ejecta, but there are interesting side effects arising from the interaction of the ejecta with any material surrounding the exploding star. Stars are the sources of effluent blown into space by the stellar wind. The circumstellar material has been deposited around the progenitor star by the star itself. (My mental image is of Charlie Brown's playmate Pigpen.) The material forms a circumstellar cocoon that is ionized by the ultraviolet and x-ray emissions from the supernova. As the circumstellar material recombines, ultraviolet emission lines are detected. The magnetic fields embedded in the circumstellar material and in the lumps of ejecta are compressed in the explosion and become detectable by radio astronomers. A pulse of synchrotron radio emission was seen in the first few days from

SN1987A (the magnetic field here was presumably embedded in the surface of the star). Later a longer-lasting pulse of synchrotron radio emission occurs, as has been detected from recent supernovas in nearby galaxies (the magnetic field was more generally distributed).

After a few hundred years the ejecta from the supernova have swept through the circumstellar material and reached interstellar space—but the space is not completely empty: it contains the interstellar medium at densities of order 1 atom per cubic centimeter. Dents appear in the outflow of material as the ejecta encounter the denser clouds in the interstellar medium. The ejecta are moving very supersonically, and shock waves propagating outward and inward heat the ejecta and interstellar material. Thermal x-rays are created by the hot material. The hot material also reveals itself in x-rays and optically by spectral emissions from highly ionized common atoms (9- and 13-times ionized iron, for example). Synchrotron radio waves are the long-lasting result of electrons spiraling in the compressed magnetic field in the shocked interstellar zone. Infrared radiation comes from thermally heated interstellar dust.

The stationary interstellar material is swept up by the ejecta, which thus lose momentum. The ejecta lose their identity as they mix and coast to a halt over 10^5 years. As the explosion slows, the supernova remnants fade from individual discovery. Their general effects remain: cosmic rays, accelerated by the bulk motions of the outflowing clouds; supershells of interstellar material blown up around clusters of stars by energy deposited by successive supernovas; and effects in the evolution of entire galaxies, driven by supernovas.

The papers in this book follow the chronological development of supernova remnants as outlined above. Review papers pace the story, and the contributed papers mostly push it in the same forward direction. Some papers turn the story back with a provocative question or open gateways into fascinating side detours, down which readers can wander as the fancy takes them. Since the Venice symposium five years earlier, new observing equipment (the EXOSAT, IRAS, and IUE satellites, the Very Large Array of radio telescopes) and new theoretical techniques (able to handle lumpy ejecta and a lumpy interstellar medium) have left their mark on the subject. But the five years have been used mostly for thinking. The papers represent a good overview of the supernova story as it is currently understood from, say, $t = 1$ to $t = 10^6$ years.

Looking at the Large Magellanic Cloud supernova, astronomers have already followed a nearby supernova event in real time from $t = 0$ to $t = 1$ year. But, even given good health and some luck, few of us will get much past $t = 50$ years. If you can't wait, if you want to plan your observations of SN1987A for the rest of your life, or if you simply want to know its story finishes, read the book.

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Reprints of Books Previously Reviewed

Culture and the Evolutionary Process. Robert Boyd and Peter J. Richerson. University of Chicago Press, Chicago, 1988. Paper, $14.95. *Reviewed* **230**, 931 (1985).

Modeling Nature. Episodes in the History of Population Ecology. Sharon E. Kingsland. University of Chicago Press, Chicago, 1988. Paper, $11.95 *Reviewed* **230**, 799 (1985).

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Sexual Selection and Animal Genitalia. William G. Eberhard. Harvard University Press, Cambridge, MA, 1988. Paper, $14.95. *Reviewed* **232**, 1029 (1986).

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