Book Reviews

Developmental Biology

Pattern Formation. A Primer in Developmental Biology. GEORGE M. MALACINSKI and SUSAN V. BRYANT, Eds. Macmillan, New York, and Collier Macmillan, London, 1984. xxviii, 626 pp., illus. $58.

Any subject of inquiry in which the issues are major but the progress has been slow warrants an occasional book to assess the situation. How cell activity is orchestrated into the harmonious progression of structure in developing organisms is the issue here. One wants to understand why muscle protein is prominent in the limbs and not in the liver. Further, why does muscle protein run along the limb rather than wrap itself around the bone in the ring-like configuration found in the lips? Specific geometrical features of large organisms are inherited as rigorously as are the biochemical traits of eye and petal color. The question is, how is it done? Efforts to provide answers have had to cope with three challenges: the developmental progression has myriad states; it involves intricate geometrical changes over large distances; and it must be efficiently encoded in the genome.

This well-edited book on pattern comprises 26 chapters that introduce the questions and the biological systems that have been studied and the modes of analysis that have been employed to answer the questions. The book is quite readable. The editors have enforced guidelines for style and clarity, prodded the authors with stimulating questions, and even provided a short glossary to explain the sometimes painfully abstract jargon of the field. The book is suitable for motivated individuals, or classes, with a year's experience in biology.

A striking feature of development is that the parts of the organism are almost always in a locally harmonious arrangement. Even in monsters, such as two-headed snakes, the details of local construction are quite normal. This can be explained, according to Winfree, by a pervasive continuity principle. The idea is that epithelia tend to maintain, or restore, gentle gradients in two variables, the gradients being at right angles. This principle of gradual change can explain not only the normal coherence of structure but also the otherwise bizarre responses to certain animal transplants in which superfluous limbs sprout from the junction of limb grafts. The unexpected limbs are the organism's extraordinary effort to restore smooth continuity in two variables between the highly different partner tissues of the original graft. Details of the cellular and molecular basis of the gradients are lacking. As far as one knows, the gradients could be of anything: voltage, surface stickiness, elasticity, *p*H. Most models for biological form and pattern reduce the problem to phenomena in a plane. Hence, the two-dimensional gradient principle is of major importance.

A major premise, still shakable, is that much of developmental pattern can be explained on the basis of "morphogens," postulated chemical substances whose concentrations serve as position indicators. The chemicals are thought to exist in gradients expressly for this purpose. The idea is that consecutive levels in the gradient are "interpreted" into specific structure by consecutive cells along the line. The different couplings between level and structure bring on pattern. Obvious difficulties are that the gradient must be measured precisely and that the interpretations must be large in number. This latter leads Karlsson to suggest that maybe for the most part one thing just leads to the next without constant reference to position indicators. Morphogens, in their most powerful sense, have not been isolated. Retinoid compounds, which are discussed by Maden, come closest to being morphogens in that they consistently modify limb regeneration.

Once it is assumed that morphogens do exist and that the problem of converting their concentrations into structure is not too serious, a variety of ingenious model systems can generate appropriate morphogen patterns to explain much of the course of development. Positional information concepts, including the polar coordinate model and limb polarization, are presented by several authors. Reaction-diffusion schemes, which use two interacting morphogens, are especially powerful in producing progressively more intricate spatial patterns, exactly what is needed. Several authors deal with this approach.

The organisms chosen for consideration range across the entire spectrum. The list includes higher plants, Protozoa, and especially *Drosophila*, in which genetic approaches have been well developed. Bacteria, yeast, and nematodes are not included.

The book makes it clear how a relative still water, such as pattern formation, can elude the clarifying onrush of modern biology. Molecular biology deals beautifully with linear issues, such as sequence. This takes us up to the point where an amino acid chain folds up into a functional three-dimensional protein. That is one thing. How gene products can cause the progeny cells of a hen's egg to fold up into a chicken that can fly, and perhaps think, is another. Fully convincing dogma pertinent to the multicellular aspects of this process is still to come. For those interested in the best current tries at it, *Pattern Formation* is recommended.

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Laurentide Ice Dynamics

Late Pleistocene History of Northeastern New England and Adjacent Quebec. HAROLD W. BORNS, JR., PIERRE LASALLE, and WOODROW B. THOMPSON, Eds. Geological Society of America, Boulder, Colo., 1985. x, 159 pp., illus. Paper, $22.50. Special Paper 197. From a symposium, Bangor, Maine, April 1981.

The wastage of the Wisconsinan Laurentide Ice Sheet affords an analog that has been invoked in projecting the future interaction of Antarctic ice and rising sea level due to current climatic change. Evolving views on the recession of the Laurentide Ice Sheet therefore have implications for our understanding of ice sheet wastage in general.

For the past century, the prevailing view has been that the ice sheet retreated generally northward from the sub-parallel moraines of coastal New England to the Laurentian uplands. In recent years, however, Canadian geologists have reported increasingly convincing evidence of northward ice flow toward the Gulf of St. Lawrence in late Wisconsinan time, supporting views proposed independently by R. N. Ells and Robert Chalmers in 1887.

The contributors to this volume of proceedings from a symposium of the Geological Society of America focus on "the role played by local glaciers during the growth and subsequent dissipation of the principal late Wisconsinan" ice sheet, coincidentally vindicating the views of Ells and Chalmers. The contributions describe geomorphic relationships in representative areas at scales that range from a multiple-till exposure on Nash Stream in northern New Hampshire (Koteff and Pessl) to moraines north of the St. Lawrence River (Dubois and Dionne).

Most of the papers focus on the style of retreat, each seeming to tighten our view of Laurentide ice wastage. According to the current model, rapid but not uninterrupted recession of the marine-based ice margin across the coastal belt of southern Maine occurred about 13,500 years before the present. Topography controlled the development of an ice stream with minimal basal shear and a low surface gradient draining northeast through the Gulf of St. Lawrence and Cabot Strait. Subsequent retreat of a calving bay southwestward exposed the St. Lawrence Valley to inundation. While the Laurentide ice border continued in northward retreat, ice flowed north toward the Champlain Sea from residual masses in the Appalachians of Quebec and Maine.

A contribution by a group at the University of Maine (Hughes *et al.*) takes a more esoteric approach, distinguishing between first- and second-order glacial features. The former are large, involving, for instance, concentric zones of relative erosional and depositional effectiveness. Reconstruction of Pleistocene ice sheets on the basis of first-order features relates to the "steady-state flow regime" and maximum extent of glaciation. In contrast, moraines, drumlins, and eskers—second-order features examined in studies in this volume—relate to conditions during deglaciation. Though Hughes *et al.* endorse the model developed largely by Canadian geologists, they nonetheless continue the dispute concerning Laurentide ice dynamics, asserting that "over-reliance on second-order glacial geology is at the root of the dispute."

In the closing chapter, Bonnichsen *et al.* direct attention from the style and causes of deglaciation to its implications for humans migrating into the newly deglaciated land.

The volume is well illustrated, and it is edited to the usual high standards of G.S.A. Special Papers. Sketch maps and line drawings in each chapter facilitate the location of place names, but a map showing all report areas in relation to each other would have been useful.

Little overlap exists between the volume and an earlier symposium volume, *Late Wisconsinan Glaciation of New England* edited by Larson and Stone (Kendall/Hunt, 1981). The geographic focuses and the thrusts of the two volumes are complementary. Only one paper in the earlier volume even takes note of the model that is essentially the theme of this one. Together, however, the two volumes go a long way toward summarizing Quaternary research of recent decades in glaciated northeastern North America. The two belong side by side on the library shelves of all who study the Quaternary geology of North America.

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Antarctica and Its Biota

Antarctic Ecology. R. M. LAWS, Ed. Academic Press, Orlando, Fla., 1984. In two volumes. Vol. 1, xviii pp. & pp. 1–344, illus., + index. $55. Vol. 2, xviii pp. + pp. 345–850, illus., + index. $75.

"Ecology is a youthful science and nowhere so young as in the Antarctic." So begins the preface of this two-volume review of Antarctic ecology. Actually, ecology is relatively an old science and perhaps nowhere so old as in Antarctica, where the early expeditions included the leading naturalists of their times. Indeed, in no other area is the past of the science so visible day to day as in Antarctica. What the editor probably means is that ecology in general, and antarctic ecology especially, have been slow to mature into a science based on rigorous testing of relevant and interesting hypotheses. These two volumes, which constitute the most complete review of the subject ever written, are certain to accelerate the maturation of antarctic ecology.

The first volume has five chapters, all concerned with non-marine habitats. The first chapter is a remarkable attempt to integrate geology, climate (including high-altitude jets, winds, and microclimates), and soils. The second chapter, which is the most complete review in the volume, deals with plant biology. The third chapter attempts to cover microbiology, invertebrates, and ecosystems, though, partly because the literature has few innovative examples, it falls short on the last. The other two chapters deal with introduced mammals and inland waters. The discussion of introduced mammals offers interesting ecological insights into the community effects of exotic grazers, and the discussion of lakes is especially useful for its efforts to compare patterns with similar situations in the Arctic. Though some ecologists might wish for a more evolutionary perspective, the syntheses provided by these chapters are by far the most complete I have seen on their subjects.

The chapters in volume 2, dealing largely with marine habitats, differ somewhat in character. First, they tend to be more specialized, focusing on somewhat narrower topics. Second, the collection is particularly valuable because several of the papers integrate and make available a large amount of obscure literature. The short paper on physical oceanography offers a summary of large-scale physical patterns. Because most antarctic coastal marine ecology is done in relatively small areas, field scientists could have benefited from more discussion of regional and small-scale patterns that drive the coastal systems. A chapter on the marine flora covers a great deal of material, from intertidal lichens and algae to large subtidal algae to phytoplankton, the treatment of the last taking into account a large and sometimes conflicting literature. The chapter on the benthos is a solid review of the literature with a welcome comparative and evolutionary perspective. Chapters on zooplankton, fish, and marine interactions are workmanlike reviews of a diverse international literature. These chapters are particularly important in light of the expanding krill fishery. The most outstanding chapter is the one on seabirds by J. P. Croxall. It may be the best paper on seabirds ever written, for it integrates zoogeography, energetics, food webs, foraging, and breeding behavior into a remarkably complete evolutionary perspective of a multitude of populations foraging in the same habitat. The chapter by Laws on seals is also unique in its integration of a tremendous amount of little-known literature, which may be especially available to Laws because of his far-ranging biopolitical activities. The chapter on whales similarly takes advantage of a difficult and obscure literature from the whaling industry to synthesize an exceptionally complete review of antarctic cetaceans. Unfortunately it does not attempt the ecosystem and evolutionary perspective of the seabird and seal chapters. Finally, because of the growing politicization of the Antarctic and Southern Ocean, the articulate and carefully reasoned chapter on conserva-