Book Reviews

An Advance in Cytogenetics

Chromosome Identification. Technique and Applications in Biology and Medicine. Proceedings of a symposium, Stockholm, Sept. 1972. TORBJÖRN CASPERSSON and LORE ZECH, Eds. Nobel Foundation, Stockholm, and Academic Press, New York, 1973. 256 pp., illus. $28.50. Nobel Symposium 23. Medicine and Natural Sciences.

The field of cytogenetics has been enlivened repeatedly with the introduction of a major new approach. The analysis of pachytene chromosomes of maize by McClintock in 1929 and of dipteran giant polytenic chromosomes in the early 1930's by Heitz and Bauer and by Painter facilitated integration of genetic and cytologic information. Hyposomatic treatment of cells to achieve spreading of the metaphase chromosomes, discovered in the early 1950's in Pomerat's and Hughes's laboratories, made possible accurate morphological analysis and enumeration of somatic cell chromosomes and led directly to the advent of human and medical cytogenetics. The use by Taylor of tritiated thymidine and autoradiography to study chromosomes, beginning in the mid-1950's, contributed to the understanding of duplication of the genetic material. The discovery by Nowell in 1960 that phytohemagglutinin induces mammalian blood lymphocytes to divide was important in the development of human population cytogenetics (and helped revolutionize our view of the lymphocyte itself). Another important new technique, by which chromosomes may be "banded" and identified, is the subject of this book.

Chromosome Identification is a collection of the papers read at a meeting appropriately convened by Torbjörn Caspersson four years after his group in Stockholm had introduced the latest and clearly one of the most significant of the techniques for studying the chromosomes of both plants and animals. For some time Caspersson's laboratory had made a directed search for means to demonstrate differentiation along the length of the chromosome, particularly nonhomogeneity in base composition of the DNA. Base-reacting compounds had been sought, particularly those producing fluorescence "because of the enormous sensitivity" of fluorescence methods. Caspersson in his introduction to the book describes how "the guanine-binding quinacrine mustard was picked out and proved to give such elaborate fluorescence patterns that they could be used for identification of chromosomes and chromosome regions." The 50 reports in this book, all short, describe the new banding techniques and their application to various problems in biology and medicine. They show that chromosomes can be banded —that is, that transverse striations can be made visible in a pattern characteristic for each of the chromosomes of a given complement. (It should be made clear that these bands are not comparable to bands of dipteran polytenic chromosomes.) Through such special staining techniques, each chromosome of the human and many other species can now be identified, and many subtle rearrangements and polymorphisms, signified by variant, misplaced, or deleted bands, become apparent. The patterns of alternating "Q [for quinacrine] bands" of enhanced or reduced fluorescence (regions relatively rich or poor in adenine and thymine) are readily apparent and characteristic for each chromosome, so that direct inspection, through the microscope or in photographs, permits not only the identification of a chromosome but also quantitation of the brightness of specific bands by use of suitable scanning equipment.

In 1971, several other laboratories, first that of J. Lejeune in Paris followed by the Medical Research Council cytogenetics unit headed by H. J. Evans in Edinburgh, reported other new techniques for obtaining banding patterns similar to those of the Q band techniques but using Giemsa stain. In short order, bands were appearing to more and more cytogeneticists using many different techniques. (In fact, it is surprising, if not slightly embarrassing, that banding patterns were not discovered long ago, because it is now evident that they are readily produced by many simple procedures.) The discovery of banding made it necessary to convene an international conference to develop and firmly establish a nomenclature system for communication among laboratories working on human chromosomes (the Paris Conference of 1971). Besides the Q bands, there are the G (for Giemsa) bands, the R (for a "reversed" pattern) bands, and the T (for trypsin) bands. C (for centromere-associated or for constitutive heterochromatin, as you please) bands were discovered in 1970 in the laboratory of J. G. Gall; they stain heavily after DNA denaturation-renaturation treatment and define the major chromosomal sites of highly reiterated DNA sequences.

As described in *Chromosome Identification*, application of the various new banding techniques is providing answers to many long-asked questions in cytogenetics. The book is a convenient collection of a multitude of such studies, which would ordinarily have been reported over a period of several years in various journals. (The subjects of the papers are so diverse that, except for the initial how-to-band section, the papers have been arranged by the authors' names in alphabetical order!) The volume should become a useful reference for cytogeneticists working with many different materials. The organizers of the symposium selected participants carefully, and the 39 contributors of papers represent well the cytogeneticists working in many different areas who have without delay boarded the banding wagon. In addition to their main purpose, a number of these papers include those quite unexpected, but interesting, observations often made during the somewhat undirected analysis of old biological material by new methods; these are often minor and beside the main point of the paper but at the same time may be provocative. The entire volume will be of interest to those working in cytogenetics. Only a few of the papers, for example a short introductory one by Lejeune, are reviews of an area, but scanning the reports concerning application of banding to this or that biological or medical problem will bring the noncytogeneticist interested in chromosomes up to date and orient him as to what can now be expected from the field. Interesting recent information concerning the following subjects appears in the book: the chemical differentiation that exists along the length of the chromosome, that is, the biochemical basis for banding, including characterization of the various heterochromatins; mapping of gene loci to specific chromosomes in the mouse and man; the impact of banding on medical cytogenetics; the importance of chromosome identification by banding patterns in experiments with somatic cell hybridization; the comparative study of banding in the analysis of the evolution of species, including primates; and the use of automated (computerized) systems for chromosome identification.

This book indicates quite clearly that cytogeneticists are happily at work with their new battery of techniques, each banding his "thing." Many new and interesting findings can be expected for several years to come. Then, after the field becomes calm again (or maybe even before), we can expect another surge forward when someone learns how to make chromosomes of somatic cells undergo a meiotic division in vitro, how to produce giant-sized polytenic chromosomes in vitro, or perhaps how to cause chromosomes to behave in some completely novel (but informative, naturally) way.

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Earth History and Biosphere Dynamics

Evolutionary Paleoecology of the Marine Biosphere. JAMES W. VALENTINE. Prentice-Hall, Englewood Cliffs, N.J., 1973. xvi, 512 pp., illus. $16.95.

"I should like to maintain that times of eruptive evolution may well be . . . related to important events in the physical history of the earth." This statement, made in 1949 by Preston Cloud, is in the tradition of many generations of paleontologists who have sought to explain the panorama of the fossil record in terms of unifying themes in earth history. Where in the late 1940's diastrophism was discussed as the controller of periodicity in the history of life, now continental drift and sea floor spreading have been rapidly incorporated into a model of biosphere dynamics. James W. Valentine's ideas on these matters have excited paleobiologists as if a light bulb such as one sees over cartoon characters had suddenly been lit. While Valentine's book is a useful and informative textbook of evolutionary paleoecology, it surely is most notable for its imaginative, if somewhat speculative, analysis of the history of life as being regulated by the many phenomena associated with plate tectonics.

One of the major themes of the book is that the history of life may be studied at many levels, which can be arranged in a hierarchy (community, province, biosphere), but that studies at a given level can be made without exhaustive knowledge or investigation of all the lower ones. Thus we can study the evolution of faunal provinces without a consideration of all the component species. The evolution of a province may be explained in terms of the changes in its component communities. This may sound like a truism, but it does much to dispel a common tendency in paleontology to regard with skepticism all generalizations that are made when all the details of lower levels of the hierarchy have not been worked out. We must not ignore the possibility that the available data are less than ideal, or even poor in some cases. But it is equally unacceptable to ignore the structure of the biosphere and to refuse to generalize theory from available data. Paleoecological efforts of the past decade largely have demonstrated that the present is the key to the past. Valentine, by contrast, has commendably examined the procession of life and told us that the past is the key to the present. He leaves us with the conclusion that the history of life cannot be understood without an extensive knowledge of earth history. The present is merely a point in a shifting equilibrium state that is governed by many crustal and climatic processes.

In the latter part of his book Valentine proposes a model that unifies modern ecological theories of the maintenance of diversity patterns and community structure with the dynamic rearrangement of the continents that has taken place in geologic history. The proposed alterations of climatic patterns, oceanic circulation, environmental stability and heterogeneity, and geographic isolation form a cogent model that is potentially testable with more refined data than are now at hand. In brief, Valentine proposes that periods of assembly of continental blocks are periods in which shallow marginal marine climates are controlled by continental interiors, nutrient availability is unstable, and there is little opportunity for evolutionary divergence; therefore we have low diversity. Conversely, times of fragmented continents are characterized by the control of shallow marine realms by ocean currents, which ameliorate climate (maritime climate), evolutionary divergence and provinciality, and less fluctuation in nutrients in shelf waters; therefore high diversity develops. Rates of sea floor spreading can also be related to transgressions and regressions of the ocean. Thus fluctuations in diversity over geologic time can conceivably be explained with reference to the degree of fragmentation of continental blocks.

At first glance, the data seem to bear out Valentine's thesis. The end of the Permian is a time of lowered diversity, continental assembly, and concomitant extinction. With subsequent fragmentation in the Mesozoic and Cenozoic, standing diversity steadily increases to a present-day maximum. Unfortunately the Paleozoic is not well enough understood as yet to show whether or not the theory holds up. The theory has been criticized mainly because the available data on standing diversity show a suspicious correlation with the volume of sedimentary rock existent for a given geologic system. Another disturbing aspect of the theory is that diversity almost seems like something that can be turned on and off like a faucet. Valentine gives no account of the evolutionary dynamics that would be involved in generating provinces of high diversity during times of fragmentation. It seems that a consideration of the data presented in the past few years by Stehli, Eldredge, Gould, and others might go a long way toward integrating models of the ecological regulation of diversification and the evolutionary dynamics of the diversification process. Without such an integration, we fall into the same trap as the modern ecologist who regards ecosystems as having had no previous history that contributes to present-day patterns.

These criticisms only further serve to suggest that Valentine has presented an imaginative and inspiring framework for future research. I must add parenthetically that those who have read Valentine's recent research papers will find here a more unified exposition of his ideas, but nothing dramatically different or more detailed. This section of the book therefore is of primary interest to those who are unfamiliar with Valentine's ideas.