degree of sclerotization and persistence, easily leading to fossilization. Hence not alone the fossil record, but cone structures and old types must be far more closely scanned before it is assumed that cones are older than flowers. Where then may sporophyll fusion and sex variation of an instructive form be first expected? Certainly in Ginkgo, perhaps even more primitive than the cycads, although the reverse view has been commonly held. Both are in fact very primitive, considering the lengthening out of geologic time; but we see neither until after the organization of unisexual cones, and the cycads are much out of the easy observation range.

Ginkgo, if not even recessive, is but little in advance of the Cordaites, and like them bears long-stalked seeds tending to run into bunches of three to five with much fusion, the normal number being two. These bunches appear sparsely grouped on the somewhat persistent short or spur shoots. They are hence seen in an open or sub-inflorescent stage. The same is true of the staminate cones. The conditions appear simpler than in conifers, and one of the first questions any one who has the opportunity to see Ginkgo in free fruiting may seek to answer is whether abnormal bisexual axes of any kind may ever occur as in conifers. For while botanists have seemed even to prescribe the possibility of varied types of ancient flowers, a trend of change from separate to united sexes has not once been proven in all the range of seed plants. Uniformly late separation of the sexes affords the first explanation of dioecism and usually also of monoecism. Though what actually constitutes separateness of sex in a tree as compared with an animal is very little seen or understood.

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SCIENTIFIC BOOKS

THE ICE AGE

The Changing World of the Ice Age. By REGINALD A. DALY. Yale University Press. Large octavo. 271 + xxii pages, 149 figures. $5.00.

DARWIN, Dana, Davis, Daly—delvers in the deep and doughty disputants! In this book the century-old problem of the genesis of coral reefs has its latest serious discussion; but not its last.

The debated subject is an excellent example of changing theory with increase of knowledge. When Charles Darwin brought the romantic topic of coral islands to public attention glacial science was yet unborn. And when, toward half a century later, James D. Dana revived scientific interest by his charming work on "Corals and Coral Islands" the fact that sea levels had been effectively changed, up and down, by the waxing and waning of the Pleistocene ice-sheets was not clearly recognized. But now pelagic science is involved with glaciology, and the latter closely with geophysics.

Darwin believed that the relation of coral growth and the building of barrier reefs and atolls implied submergence. Deepening of the ocean basins with subsidence of the reef-bearing floors was the simple and fully satisfactory explanation. This was accepted and emphasized by Dana and recently amplified by Davis. But they were in error in attributing the vertical oceanic-surface movement entirely, or even largely, to diastrophic movements of the earth's crust. The important factor in the shifting of sea level in later or Pleistocene time was the transfer of water between sea and land by the production and the destruction of the continental ice-sheets.

The "Glacial Control" theory has for more than twenty years been championed by Professor Daly. A student of glaciology and geophysics, he has traveled widely, studied the coral reefs at first hand, and with his active imagination and boldness in presentation of new views he has, by numerous writings, become the apostle of the later theory. A word of exposition is desirable.

The mass or volume of the two great existing ice caps, Antarctica and Greenland, is fairly estimated. The melting of those ice fields and the return of the water to the sea would lift the ocean surface by about 164 feet. During the recent Ice Age or Pleistocene vast areas of Europe and North America were deeply covered by solid water abstracted from the sea, and sufficient in volume to lower the ocean surface about 345 feet, in careful estimate. Taking into the account the involved diastrophic factor, the deformation of the globe by shifting of loads, Daly estimates an actual lowering of relative sea level of 90 meters or 295 feet. The final melting of the ice caps, a few tens of thousands of years ago, returned the borrowed water to the sea and lifted the ocean surface to practically its present position.

Whatever were the changes in glaciation and deglaciation of the lands during the Ice Age it is now apparent that the volume of the ocean was correspondingly altered. For clearer presentation of his theory the author groups the four generally recognized glacial stages into two major periods, with a long intermediate stage of deglaciation (interglacial) with

its warmer climate and higher ocean level. And he assigns the initiation of the present coral reefs to the phase of low sea level during the second, or latest, major period of glaciation, and their construction during the waning of the ice caps and in post-glacial time, while the sea level was rising. The reefs built during the long deglaciation interval were destroyed during the low-water stage of the subsequent glacial period. The history so conceived is graphically given in his figure 130. Abundant illustrations, 135 diagrams and maps and 14 photographs, supplement the author's descriptions and enforce his views.

This writing will provoke lively discussion and some friendly disagreement, especially relating to the age of the reefs and the origin and date of the level platforms from which rise most of the wall-like reefs. And the degree of diastrophic effect in comparison with the glacial control may also be subject of debate. But that the chief cause of changes in ocean level in later geologic time was the removal and the restoration of water by glacial processes appears to be well established. The author's "punching hypothesis" in explanation of the crustal downthrow and the recoil, instead of crustal flexure, will receive the attention of the geophysicists.

The arrangement of matter in the volume and the style of presentation are related to the origin of the work, a series of Silliman Lectures at Yale University. The matter relating to coral reefs is the closing part of the volume. The larger part of the handsome and richly illustrated volume is the description of the Pleistocene ice fields of Europe and America, and their diastrophic effects in elastic and plastic-flow distortion of the globe; all this leading to the coral reef problem.

European glaciology is well covered, and the references make a considerable bibliography of European glacial literature. American glaciology is treated briefly and with reliance on older writings and official and "authoritative" publications that are outdated. Later and individual writings are overlooked or neglected. Some omissions and errors in statement and maps are noted.

Admittedly the writing leaves a thousand questions unanswered. And with the author's fertility in hypothesizing it suggests many more than it settles. The great persistent interrogation in glacial science, the cause of Pleistocene glaciation, and especially of multiple ice stages, is untouched.

The work is a stimulating contribution to earth science. Pressing boldly into the area of the theoretic and speculative is more helpful to scientific progress than conservative standstill in acceptance of supposed fact and deference to authority.

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VARIETIES OF HYDROGEN

Orthohydrogen, Parahydrogen, and Heavy Hydrogen. By ADALBERT FARKAS. 215 pages. Cambridge University Press. 1935. Price, $3.50.

FOR the past few years the author of the present text has taken an active part in those rapid research developments which have transformed our knowledge of the element hydrogen. Prior to the discovery of the heavy isotope, deuterium, the ordinary isotope of mass 1 had been shown, by theoretical reasoning and the brilliant experiments of Bonhoeffer, Harteck and Eucken, to exist in two molecular forms, ortho- and para-, determined by nuclear spin. In the study of the chemical and physical properties of these molecules the author and his brother, L. Farkas, were able collaborators of Bonhoeffer. They studied, principally, kinetic properties of the two forms and the important rôle which paramagnetic substances may play in the interconversion of the molecules. It was not surprising, therefore, that they rapidly reoriented their work when the complexity of the element was still further increased by the discovery of deuterium, employing their already acquired technique to the rapid solution of new problems which obviously arose.

Dr. A. Farkas has placed all workers in the field under a debt of obligation to him by this monograph. He has wisely chosen to outline both ortho- and parahydrogen and heavy hydrogen because of the interdependence of the two fields. The book contains an excellent summary of the physical chemistry of both hydrogen isotopes, equally effectively presented on the theoretical, practical, historical and bibliographical sides. It is especially welcome to harassed workers in this feverishly active research field bringing into one volume, without exception so far as the reviewer can find, all the important contributions in the two spheres of work, up to the end of last year. No one can read this book without realizing how a major discovery of this kind has consequences of importance over a wide area of scientific interest. Fundamental problems concerning energy states of molecules, nuclear structure and properties, spectra, reaction kinetics, isotope equilibria, properties of solutions, mechanism in chemical and biological processes, all these have developed under the stimulus of the discoveries concerning the element hydrogen. All are presented in this book in outline, in an orderly presentation, excellently readable in spite of the fact that the author is writing in, to him, a foreign language. The book is indispensable to a wide variety of research men and to graduate students in physics and physical chemistry. It is the best approach that those scientists unfamiliar with the field can take to this new and fascinating development of the last six years.

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