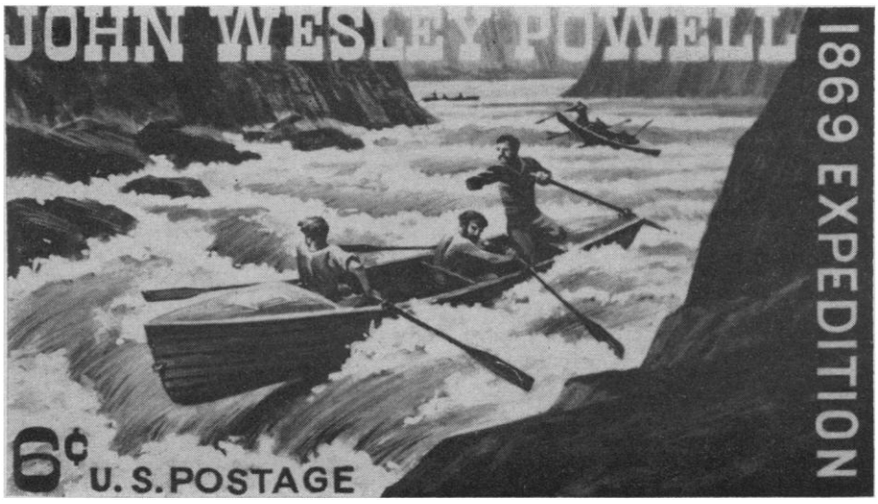

two spectacular unconformities near the base of the exposed section but also reminds the reader of earlier contributions by Jules Marcou and J. S. Newberry. Charles B. Hunt traces the geologic history of the Colorado River. Among other matters he reexamines Powell's hypothesis that the canyon of the Green River through the Uinta Mountains is antecedent—that is to say, the stream was there before the mountains were. As the area of the Uintas was uplifted, the river cut its canyon much as a saw revolving on a fixed pivot would cut into a log thrust against it. Hunt concludes that although this and other canyons in the Colorado drainage may have been deepened in this fashion, most of the canyons seem better explained as erosional results of streams superposed from alluvial covers or from erosion surfaces developed upon shale formations. Luna B. Leopold raises the question why there are no waterfalls in the long course along the canyons followed by Powell. He finds that the river profile, except for the alternations of pools and rapids, is remarkably straight. Despite its impressive rapids, the Colorado River has the characteristics of a river in balance, concentrating its erosive energy on the bumps along the bottom and thereby tending to reduce them and to make the whole stream bed uniform.

Professional Paper 670 is concerned with Powell's studies of the archeology and of the historic Indian tribes of the Canyon Country. Robert C. Euler describes archeological sites discovered by Powell and fits these into the prehistoric chronicle of the region. The Fowlers sketch the ethnography and reproduce extracts of Powell's notes related to the means of subsistence, animal food, traditions of courtship and marriage, and mythology of the Indians. They emphasize the timeliness of Powell's systematic observations of the Indians of the Colorado Plateau and Great Basin, coming as these did when many of the Indian groups were first interacting with the cultures of the white settlers. The paper is well illustrated with maps and photographs, including many reproductions of J. K. Hillers's classic studies of Indians taken in 1873.

Down the Colorado reproduces Powell's diary of his first trip, which, as is well known, recounts many events that actually occurred during his second exploration of the river. History or not, this is a stirring story of high adventure. The narrative is in the present tense, so that the reader soon feels he is a member of the expedition. Thus, for example,

> . . . the walls suddenly close in, so that the canyon is narrower than we have ever known it. The water fills it from wall to wall, giving us no landing place at the foot of the cliff . . . I stand on deck, watching with intensive anxiety . . . but we glide along, with no obstruction, no falls, no rocks, and, in a mile and a half, emerge from the narrow gorge . . . Now that it is past, it seems a very simple thing indeed to run through such a place, but the fear of what might be ahead made a deep impression on us.

The book is illustrated with 44 superb four-color photographs by Eliot Porter. About half of these pictures feature scenes of canyons and tributaries; the others focus upon smaller beauty spots such as flowers, rills, pools, falls, and sculptured rocks. Numerous drawings and photographs made by Powell's contemporaries appear at appropriate places throughout the text. The work is edited by Don D. Fowler, whose introduction contains a useful summary of explorations in the canyon country prior to the Powell expedition. In an epilogue, Porter tells something of the geological history of Glen Canyon and Grand Canyon. Also, he bitterly laments the construction of Glen Canyon Dam and the impounding of Lake Powell, which he describes as "a sink for sediments and the trash carelessly scattered about by throngs of visitors . . . one of the greatest frauds ever perpetrated by responsible government upon an unsuspecting people."

In 1950, when Darrah was writing the preface to his biography, he marveled that time had so quickly dimmed the memory of Powell. With all that has been written about "the Major" during the past two decades, and especially during this centennial year of his ride down the Colorado, this lapse has been largely corrected. Although the character of Powell remains somewhat enigmatic, even to those who have studied him most carefully, there is no doubt now that his varied accomplishments as explorer, geologist, anthropologist, conservationist, and statesman of American science were even more significant than his contemporaries could possibly have known.

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Some Diverse Landforms

Coasts. E. C. F. BIRD, M.I.T. Press, Cambridge, Mass., 1969. xvi + 246 pp., illus. $7.50. An Introduction to Systematic Geomorphology, vol. 4.

Coasts is the first published volume in a series of at least seven by Australian authors, edited by J. N. Jennings, provisionally scheduled to appear before 1972. The intent of the series is to cover geomorphology at the college level for both students and laymen having some familiarity with geological terminology. Volumes in preparation include *Humid Landforms, Desert and Savanna Landforms, Landforms of Cold Climates, Structural Landforms, Volcanic Landforms*, and *Karst*.

Bird's *Coasts* is lucidly written and compresses a surprising amount of information into a modest number of pages. The coverage is somewhat less complete than in André Guilcher's ex-

cellent *Coastal and Submarine Morphology* (1958) and may disappoint specialists in morphogenic processes, but the volume will be of value to most geomorphologists, many geologists, college students in earth sciences, and interested laymen. It presents both sides of many controversial questions and in some cases skillfully avoids commitments of preference. Its above-average figures and plates appear at appropriate places in the text. In early chapters an impression may be created that the "classical" ideas of W. M. Davis, F. P. Gulliver, and D. W. Johnson are regarded too seriously, but in subsequent discussions they are subordinated to modern concepts. The author's familiarity with coasts of western Europe and North America is evident, although the one or two well-chosen examples given for most coastal features are heavily weighted in favor of those occurring in Australia.

The emphasis on Australia is welcome because the continent exhibits such a diversity in coastal types. It spans tremendous contrasts in tidal ranges, has an adequate variety of rocks, and its climates include both arid and humid varieties extending from tropical rain forest in the north to Mediterranean in the southwest and cool maritime in Tasmania. Much of the coast is exposed to the high, persistent swell of the Southern Ocean, while wave energy is comparatively low in the lee of the Great Barrier Reef and coasts of the relatively shallow Timor and Arafuta seas. It is probably true that in diversity of coastal features Australia ranks second only to South America among continents.

A thoughtfully selected bibliography includes more than 250 references. Its value is somewhat weakened because nearly all refer to literature in English. Books or articles in Japanese, French, Italian, German, and Russian for the most part are neglected.

If succeeding volumes in the series are as informative as *Coasts* they deserve space on the earth science shelves of all libraries as well as in faculty and student collections. The smallest continent not only is characterized by many unique and inadequately known geomorphological features but in addition has developed a research community with many original insights that should become better known in other parts of the world.

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Evidence and Speculation on How Life Began

The Origin of Life. J. D. BERNAL. World, Cleveland, Ohio, 1967. xvi + 345 pp., illus. $12.50.

Genesis and Evolutionary Development of Life. A. I. OPARIN. Translated from the Russian edition (Moscow, 1966) by Eleanor Maass. Academic Press, New York, 1968. x + 206 pp., illus. $9.50.

Biochemical Predestination. DEAN H. KENYON and GARY STEINMAN. McGraw-Hill, New York, 1969. xviii + 302 pp., illus. Cloth, $12.50; paper, $4.95.

Casual observation shows that living organisms originate within their mothers, in eggs, or, spontaneously, in decaying organic matter. While it is no surprise that these conclusions are in part correct, it should be recognized that a long and important chapter in the history of biology is concerned with the experiments leading to the final rejection of the third possibility. It was only after the work of Pasteur and Tyndall had proved that life is no longer arising spontaneously in the nonliving world that the problem of origins in its contemporary form became acute.

During the latter half of the 19th and the beginning of the 20th century Pasteur's work was often misunderstood. Pasteur had shown that the spontaneous generation of living organisms is not a common event. It was not generally recognized that the possibility still remained that the evolution of life had required an enormous amount of time and had occurred only once, early in the history of the earth. This misunderstanding led to the widespread acceptance of the semimystical view that life is necessarily as old as matter. A few more perceptive scientists, while interpreting correctly Pasteur's work, believed that nothing useful could come of studies of the origins of life and doubted at least the wisdom of those who undertook them.

Two publications, one by Oparin (1924) and the other by Haldane (1929), mark the beginning of the modern approach to the subject. (Bernal's book includes both of these historically important works in full, as appendices.) Each author, independently, made the critical point that early in the history of the earth the atmosphere must have been reducing and hence have permitted the synthesis of organic compounds. This prediction was subsequently confirmed by Miller and others. Oparin also introduced at that time the notion that organic colloids, coacervates, played a key role in the further evolution of life; this controversial hypothesis has dominated his thinking up to the present time.

In his latest book, Oparin presents for the general reader his present views on the origins of life. The first chapter is a delightful history of the subject, but I regret that as an admirer of Oparin's earlier books I was disappointed by much of what follows. Oparin deals first with the origins of the earth's atmosphere and, more particularly, with the synthesis of very simple organic compounds within it. The central problem of the synthesis of more complex organic monomers such as sugars, amino acids, purines, pyrimidines, and nucleotides and of their condensation to polymers is treated in a brief 24 pages; the coverage is neither selective nor critical. The remaining three chapters deal with coacervates and with hypotheses concerning later stages in the evolution of life. The emphasis is too much on speculation and too little on experiment.

It is well known that Bernal has read nearly everything, and hence it is not surprising that his book is encyclopedic in character. In it one does not find many formulae, mathematical or chemical, but rather a consistent and almost always reasonable qualitative discussion of all topics related, however peripherally, to the origins of life. Turning the pages at random I came on the following section headings: Thickening the Primitive Soup; Coenzymes and Nucleic Acids; Microtubules and Cilia; The Principle of Self-Assembly; Panspermia; Civilization in Outer Space; The Coacervate Hypothesis; Criticisms of Spiritual Explanations of Life; Generalized Crystallography. I recommend this book to those who want a general account of the subject; it is not for the student who wants to know the facts and to draw his own conclusions from them.

Biochemical Predestination, despite its title, is a thoroughly professional book on the origins of life. It presents the best detailed account of the subject that I have read. The authors, perhaps because they never knew the bad old days, are not too concerned with the legitimacy of their subject but, writing as laboratory scientists, describe the relevant experiments and attempt to interpret them. After a brief historical introduction and a discussion of the special character of experimental work related to the origins of life, Kenyon