Tide-Gauge Records

Sea Levels, Land Levels, and Tide Gauges. K. O. EMERY and DAVID G. AUBREY. Springer-Verlag, New York, 1991. xiv, 237 pp., illus. $59.

That changes occur in the level of the sea relative to the land is well documented by geological and geomorphological records, and early humans had to live with sea-level rises approaching two centimeters per year and encroachments of the sea over low coastal plains approaching several kilometers per year. Models of the consequences of an enhanced greenhouse effect include scenarios in which such rapid changes may occur again, but with the greater concentration of populations on coastal plains and the constraints imposed by political boundaries, our ability to respond to them has been much curtailed.

The processes linking greenhouse emissions to atmospheric warming and to the concomitant sea-level response remain inadequately understood, with the consequence that predictions of future change remain unreliable. Good records of past sea-level change, coupled with detailed records of atmosphere and ocean temperatures, would provide a valuable data set for testing the various hypotheses and for placing better constraints on the predictive models. Emery and Aubrey's book is an examination of one part of the evidence: changes in sea level as recorded by tide gauges during the 20th century. The tide gauge records the change in the level of the sea with respect to the adjacent land, and the signal includes the short- and long-term variability of the sea surface, any movements of the land of tectonic or anthropogenic origin, and any movements of the tide gauge itself. Insofar as the instruments were rarely installed with scientific experimentation in mind, this last contribution is not insignificant. Emery and Aubrey discuss the nature of the tide-gauge record, the causes of relative sea-level change, the evidence of such change in the geological record, and previous analyses of the sea-level record. The major part of their book is devoted to detailed mapping of the tide-gauge records region by region around the world. They conclude with brief discussions of the significance of these regional results, of possible future change, and of the impact that such change may have on society.

Tide-gauge information has been laboriously compiled by the Permanent Service for Mean Sea Level (PSMSL) in the United Kingdom for more than 600 sites with record lengths ranging from a few years to nearly 100 years in a few instances. Emery and Aubrey's book is not the first attempt to analyze this vast quantity of data, but it certainly is the most comprehensive documentation of the global patterns of sea-level change. This is an important contribution because in most other analyses the emphasis has been on establishing the globally averaged trend, and the regional and local trends have formed part of the statistics only. The conclusions reached, however, are not very different from those reached in previous investigations: that the database is inadequate to establish a truly global pattern of sea-level change and that the tectonic and oceanographic signals are dominant. Emery and Aubrey recognize this and conclude that the records are inadequate for establishing the eustatic sea level before about 1930. Certainly the records are inadequate to constrain the models of future change.

Much of Emery and Aubrey's effort is directed at establishing local and regional patterns of sea-level change and in relating this to possible local and regional tectonic processes. Without an encyclopedic knowledge of the world's geology this can lead to a discussion of variable quality, to ill-assorted references and attributions, and to curious omissions and errors. The discussion of, for example, the Australian data contains examples of all these pitfalls. The evolution of the surrounding sea floor is summarized, but most of the geological evidence pertaining to vertical movements—or the lack thereof—in the Tertiary and Quaternary is ignored. The Newcastle December 1989 earthquake was not of magnitude 7.1 but only about 5.5, and it did not produce a strong relative sea-level displacement as claimed. Certainly such movements cannot be seen in the authors' figure as they state, if only because their records stop in the early 1980s. If I wished to know more about the tide-gauge records of the Australian region I would turn to the careful work of G. Lennon at Flinders University of South Australia, and I would discard the geological discussion in favor of the primary literature on Australian geology and geomorphology.

In a few instances the tide-gauge records extend further back in time than does the PSMSL compilation, as in the Stockholm and Brest records reported on by E. Ekman and D. Cartwright respectively, neither of which is mentioned. Nor is there any mention of the rather dramatic and complete record for Aburatsubo in Japan of the pre-, co-, and post-seismic deformation associated with a large earthquake, in this case the Kanto event of 1923. Another oddity that caught my attention is the discussion of the sea level for some of the Pacific islands. Much attention is focused on the expected subsidence of the sea floor with age, but the fact that the islands have generally experienced much more complex vertical move ments is mentioned only in passing, and none of the relevant Holocene and Late Pleistocene evidence is mentioned.

Geological processes generally operate on time scales of thousands of years and longer, and the short-duration tide-gauge records reflect primarily the "noise" component rather than containing a reliable signal of the underlying tectonic process. To extract tectonic information from the tide-gauge data alone without attempting to extend the record is therefore fraught with problems. But to add the geomorphological and geological evidence would have meant a much more ambitious book. As it is, the book does serve as a useful guide to recent sea-level change around the world, for nowhere else is this information so readily available, and readers who wish to examine the processes behind such change will find the book a useful starting point.

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Evolution and Physiology

Evolutionary Genetics and Environmental Stress. ARY A. HOFFMANN and PETER A. PARSONS. Oxford University Press, New York, 1991. x, 284 pp., illus. $75.

The struggle to understand adaptation has been one of the enduring themes of evolutionary biology since Charles Darwin created the field. But there are no general methods that readily reveal the population genetics of adaptation—not studies of electrophoretic protein variation, not studies of quantitative genetics, and not comparisons of species, although there have been isolated successes with each of these methods and each has its advocates. This situation may be contrasted with the study of phylogeny, where the use of molecular, statistical, and other techniques has made the unraveling of patterns of descent fairly straightforward.

Against this background, a number of evolutionary biologists have been attempting to strengthen the study of adaptation by the importation of techniques and ideas from physiology. To some extent, this attempt has been motivated by the conviction that study of adaptation without a mechanistic understanding of the functional attributes of organisms is inherently flawed, notwithstanding such traditions in evolutionary biology. On the other hand, some comparative physiologists have come to the realization that study of physiological functions without an understanding of evolu-

tionary genetic mechanisms is also likely to fail. Thus there has been a growing confluence between evolutionary genetics and organismal physiology. This book by Hoffmann and Parsons is perhaps the best embodiment of this confluence to date. Their treatment ranges over the spectrum of relevant work, from comparative biochemistry to evolutionary quantitative genetics. Moreover, the authors proceed naturally through all these fields, constructing intellectual bridges over undeveloped swamps as necessary. The particular theme of the work is evolutionary adaptation to stress, whether by evasion or by resistance, with stress being defined as an environmental factor that reduces fitness. With this definition, the authors can robustly connect the physiology of stress resistance to population genetics and thereby evade vacuity.

To some extent this is a work of advocacy for the importance of environmental stress. Though stress may not always be a key factor in fitness, the innumerable illustrations of its importance in the determination of ecological and evolutionary outcomes are a corrective to the old MacArthurian school's emphasis on competition. It is shown that stress is of potential importance for a considerable spectrum of biological phenomena, from mass extinctions in the fossil record to the preservation of endangered species.

Whereas the discussion of the evolutionary genetics of stress, particularly patterns of heritability and genetic correlation, achieves a high level of critical acumen, the discussion of fields like comparative biochemistry sometimes borders on the credulous. For example, the authors repeat assertions about the "conservation" of biochemical attributes, like the Michaelis constant (K_m), within a particular parametric range over a spectrum of species. The evidential basis for any such conservation is often limited; these "conserved" ranges are conveniently expanded as deviant species are discovered. Like many general assertions in comparative physiology, "conserved biochemistry" is a concept that needs dissection comparable to that which Hoffmann and Parsons perform with the quantitative genetics of trade-offs, for example. Any marriage between physiology and evolutionary biology requires that the lazy practices of both sides, not only those of evolutionary biologists, be reformed. In this regard Hoffmann and Parsons point out the critical weakness of comparative biochemistry in noting that enzyme variation is almost never quantitatively correlated with variation in fitness itself by comparative biochemists, a type of failing common among those who are not population geneticists.

The fixation upon stress itself comes to seem somewhat artificial, in that the authors become tangled up in discussions of metabolic rate and growth and thus deviate quite far from that overall theme. Their willingness to approximate a review of the many possible connections between evolutionary genetics and physiology only strengthens the book, however.

Overall, this volume helps to buttress recent efforts to connect evolutionary biology and physiology, particularly on the empirical side. No overarching theoretical framework is provided, so that the book sometimes seems to be mostly a review of particular studies of stress adaptations in vertebrates, insects, plants, and so on. But for now such a framework is not available from any source. This book directs us toward an important avenue for further research, poses a number of interesting problems, sketches possible solutions, and thus blazes trails rather than mapping settled territory.

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