nation. The synthesis, however, lacks references to the geomorphology and the different substrata.

The thirteen chapters that follow deal with specific regions and the editors deplore, in the introduction, the absence of very important portions of coastlines. Furthermore, in the areas covered, rocky coasts are mainly under consideration at the detriment of surficial deposit coasts. The two chapters presenting the Pacific and Atlantic coasts of Canada are written by eight co-authors, all Americans. Hence, it is not surprising that the Canadian portion is little developed, specially in the case of Québec. Numerous recent contributions mostly from Québec are not taken into consideration.

Finally, the last chapter deals with remote sensing of the benthic environment. This chapter is quite deceiving and with limited interest, most of the references restricted solely to American sources. No mention whatsoever is made of all the recent references in the field of macrophyte area identification and biomass estimation studies carried out in Canada, in Québec and in France, as well as to the quite conclusive tests carried out with high resolution airborne sensors.

Dr. Jean-Marie M. Dubois
Département de Géographie et
Télédétection
Université de Sherbrooke
Sherbrooke, Québec, Canada

Holocene Coastal Evolution and Sea-Level Changes in China, by Zhao Xitau, 1993. China Ocean Press, Beijing, 214p., ISBN 7-5027-3672-7.

This volume is a collection of sixteen of the author's published works, all in English, some translated for the first time from Chinese. In any case, the author's works are largely inaccessible at the present time, so publication of this book is very appropriate in view of the world interest in potential sea-level rise in the light of predicted global warming.

Professor Zhao is at the Institute of Geology, Academica Sinica in Beijing (P.O. Box 634, Beijing 100029), where, since 1974, he has concentrated his scientific energy on all sectors of the Chinese coastline, especially with the late Quaternary stratigraphy, ^{14}C dating, sedimentology, geomorphology, and neotectonics.

The main thrust of this collection is (1) the geochronology and genesis of the cheniers or beach ridge strand plains, *e.g.*, on Bohai Gulf; (2) the nature and age of beachrock, including the submerged beackrocks off Shantou City; (3) the Holocene coral reefs of Hainan Island; (4) the construction of a "standard" China sea-level eustatic curve for the last 20,000 years; (5) the mid-Holocene calcareous eolianites ("calcarenites" in the old terminology) of Putian (Fujian), and how they can be dated and shown to be distinct from beachrock; (6) the almost complete Holocene profile of Qingfeng (Jiangsu), which has been so thoroughly dated that it may well be offered as a world standard for Holocene sea-level chronology: (7) the building of a Holocene barrier-lagoon sequence with storm-surge deposits in the northern Jiangsu Plain. A more general article on the paleogeographic evolution of the Beijing Plain, more distantly related to sea level, is included. The collection is rounded out with a new overview of China's Holocene sea-level history which should be read by all coastal specialists.

Foreign specialists who have aided the author's endeavors are generously acknowledged, including N.A. Mörner, V. Goldsmith, N.P. Psuty, O. von de Plassche, P.G.E.F. Augustinus, and, not to forget the doyen of Chinese coastal experts, David K. Lin (Lin Guende), who in spite of some 20 years of incarceration and torture still survived to play an important role in China's coastal studies. Innumerable Chinese colleagues have also contributed to the work.

The present reviewer (R.W.F.) has been fortunate indeed to have been in touch with Professor Zhao over many years, and has often felt that this rich and varied coastline deserved more than scattered citations. Interspersed between localized areas of neotectonic activity, many extended sectors of China's coast are seen to be tectonically very stable, indeed a typical "Atlantic type" (passive) coast that is, oddly enough, facing the Pacific. These sectors provide ample justification for the author's plea that the richly studded record of ^{14}C dates be accepted as a world standard. Admittedly, it would not be reasonable to imagine any "standard" as universally applicable. One thing that emerges from global studies over the last half century is that each region possesses certain unique features, so that rigid concepts of amplitude in rise and fall of sea level are to be re-

jected. In contrast, however improving precision in dating techniques and field comprehension are beginning to create a clear chronology of events. Certain patterns in this history appear to be globally contemporaneous, although different lag times in $^{14}CO_2$ mixing, different admixture of "old carbon", and inexperienced correlations of calibrated and uncalibrated dates have all contributed to an impression in some minds that the global picture is either chaotic (see, *e.g.*, Fig. 13, p. 179) or grossly modified by assumed neotectonics where firm structural geologic evidence of such crustal instability was missing. Dr. Zhao strikes an important blow for sanity in the recognition of a fluctuating MSL during both the Holocene and late Pleistocene (see p. 180).

The subject of cheniers and chenier plains receives repeated attention. The terms are traced to their Louisiana roots: sandy ridges (often marked by oak trees, *i.e.*, chênes in French) that stand topographically 0.5–4 m above the level of intervening marshes or alluvial flats. Purely by coincidence, the Chinese word for them is "gang-shen". Each chenier is found to be a lens-shaped belt resting on pre-existing deltaic facies, ranging from 50 to >500 m across and up to several 100 km in length. They are often rich in molluscan shells, mainly of brackish types.

Although conforming to the same chronology and relating to the same fluctuations of sea level (eustatic and/or storminess cycles), beach ridges and beach ridge strand plains in China are distinct from the chenier plains in that the alluvial or paludal components are missing and the sedimentary association is dominated by beach sands. The chenier then "is a special type of beach ridge characteristic of muddy or silty coasts" (p. 91). Even in the Mississippi delta some sets of pure (sandy) beach ridges are known. Nevertheless, cheniers tend to be characteristic of paleoshorelines of rapidly prograding coasts, often marked by slow subsidence, whereas pure beach ridge strand plains are more often slowly emerging. The cheniers have frequently provided ancestral humans with campsites, so that archeological dates can yield invaluable evidence of their physical history (and the species of shellfish in the middens provide evidence of paleosalinity and thus of paleo-sealevel). A useful map of China's cheniers is shown (on p. 93) that includes those up to 500 km offshore on the edge of the East China Sea continental shelf (late Pleistocene); the water depths, in four series, are at water depths of 100 to 160 m. Surprisingly, the youngest is the deepest, documenting a rapid but fluctuating fall of sea level between 24,000 and 15,000 yr BP (^{14}C).

Internally, the cheniers consist of evenly laminated sand units dipping seaward at 4–6°, interspersed with units that dip landward at 10°, generally crossbedded (apparently overwash facies, though there seems to be no reference to this term, nor to Leatherman's valuable book on the subject). Within the same chenier the ^{14}C dates correlate longitudinally, with the upper samples younger than the deeper ones (thus, with only scattered evidence of reworking of the more durable shells). In some cases a younger chenier is superimposed on an older one (p. 100).

Cheniers did not form during the rapid rise of sea level, 15,000 to 7,000 BP, the average rate being 16.7 cm/yr, although several oscillations occurred, between which the annual rate must have been appreciably higher. Reading off from the curve (Fig. 11, p. 178) it must have been, from time to time, of the order of 50 cm/yr for a century or more, rising 34 m in 2,400 yr (8,400–6,000 BP ^{14}C). This sort of transgression is effectively "instantaneous" in geological time.

After "stabilization" of sea level around 6,000 BP, a slow, fluctuating regression was initiated, the cheniers evidently spanning the intervals of rise to high stands followed by slight regressions, *e.g.* (the reviewer attempts to synthesize), 6,500–5,700, 4,950–4,700, 4,200–4,000, 3,880–3,400, 3,300–3,200, ca. 3,030, 2800–2,400, 1,800–1,400, 1,150–1,000, 770–520 BP (^{14}C). (Readers should remember not to seek cyclic periodicities in such numbers, which have yet to be calibrated to sidereal years.) Evidently the chenier building episodes were quite brief and several of the above must represent superimposed sequences. The abrupt regional variations clearly relate to shifts of fluvial supply channels, as in Louisiana (p. 103).

Another topic treated in some detail is the question of calcareous eolianites. Although citations go back to Evans and Sayles, the various authors have missed the classical early 19th century descriptions by Charles Darwin on the Beagle expedition and extensive papers by Teichert and this reviewer in the present century. In southern China they offer evidence of paleo-wind directions which turn out to be comparable with the present-day NE monsoonal winds. Once incorrectly interpreted as beachrock, they are not useless for sea level studies as the author concluded, but in fact often disclose evidence of regressive intervals

when exposed foreshores (abundant sand), together with drier and cooler climates, favored accelerated wind velocities and dune building. Brief episodes of very heavy precipitation led to extensive slumping in places. Root structures (rhozoliths, or rhizoconcretions) may be useful in recognizing paleosol horizons and thus the more consistently humid intervals between those of intensive but brief dune building. The eolianite-palesol sequences deserve closer study.

Beachrock is a peculiarly unique facies precisely correlatable with MSL and in the vertical sense spanning no more than the contemporary tidal range. In the past, innumerable papers about them have been written by travelers with little knowledge of sedimentary petrology, geochemistry or Holocene history. A useful discussion of their development on Hainan Island (and southern China) is presented here (p. 7–22). From the paleoclimatic point of view an important observation is its far greater development in the mid-Holocene than today, reaching up to 500 km farther north than today and indicating mid-Holocene mean annual temperatures to be 2–4 °C warmer than today. Remembering the higher summer insolation then (due to precession), this observation provides a useful indicator from a region far removed from the former glaciated areas where some possibly confusing factors are involved.

More extended discussions of the many interesting observations in this collection must be set aside for the time being. The book is well printed and securely bound. Alas, it lacks indexes, both for citations and subject matter; the reader must perforce resort to a good deal of hunting and picking, but the rewards are numerous.

Rhodes W. Fairbridge
Columbia University and G.I.S.S.
New York, NY

Global Climate Change and Coastal Resources and Installations in Nigeria: Impacts and Response Measures, edited by John G. Tobor and A. Chidi Ibe, 1992. Francisgraphix Ltd., Lagos (Nigeria), 150p., ISBN 978-2345-092.

This slim volume contains much to commend it. For example: "Just as we have health insurance to guard against sickness, we need a global insurance policy to guard against a greenhouse crisis. The best policy should cost relatively little and carry other benefits as well, such as reducing air pollution and protecting the ozone layer . . ." (extract from an address by Dr. J.A. Adejokun, director, Federal Department of Meteorological Services, Lagos, Nigeria, p. 24).

What is so interesting about the volume is not so much what it contains but by whom it is written and to whom it is directed. The book is a collection of articles directed at the needs of one country alone, in "black" or sub-Saharan Africa, written by a distinguished cross section of local, *i.e.*, African, specialists, and directed mainly towards the literate public and leaders of that particular country, Nigeria. Inasmuch as Africa represents a continent that is most sensitive to the environmental effects of climate change and as Nigeria, with its miles and miles of barrier beaches, littoral lagoons and numerous estuaries, is a prime example of an African country that would be seriously affected by a sea-level change, this little volume can well serve as a basic text on the complex, interdisciplinary problems involved.

Ten chapters deal with the varied aspects ranging from the oceanography and meteorology to the social and urban planning. Of particular interest for our readers are those on the coastal environment (by Dr. Uka Nwangwu, exploration manager for the oil company, AGIP, in Lagos), and on the continental shelf and its response to climate change (by L.F. Awosika and A.C. Ibe, Nigerian Institute for Oceanography and Marine Research, Lagos).

Recognizing that Nigeria's coastline is of "Atlantic type", *i.e.*, "passive" in plate tectonic terms, the tectonic framework is the first consideration. Since the mid- to late-Mesozoic rifting of Gondwanaland, the marginal sedimentary wedges have accumulated up to 10–14 km of sediments that have undergone steady subsidence, complicated by downslope dynamics, such as growth faults, turbidity flows and gravitational slumping. The giant Niger delta is comparable in many ways to that of the Mississippi, and it is extensively transected by submarine canyons. Its subsidence rate often exceeds 1 cm/1,000 years. Seaward of its extensive estuaries and top-set marshes and lagoons, there is commonly a belt of overlapping beach ridge barriers or strand plains. The author recognizes that even a modest sea-level rise "could very well wipe out what we know today as the Niger Delta".