Cretaceous Endings

Cretaceous/Tertiary Boundary Events. Symposium. Copenhagen, Sept. 1979. University of Copenhagen Institute for Historical Geology and Paleontology, Copenhagen, 1979. In two volumes. Vol. 1, The Maastrichtian and Danian of Denmark. TOVE BIRKELUND and RICHARD G. BROMLEY, Eds. 210 pp., illus. Paper, $15. Vol. 2, Proceedings. W. KEGEL CHRISTENSEN and TOVE BIRKELUND, Eds. 250 pp., illus. + addendum. Paper, $15.

Incomplete sequences of sediment characterize the transition from the Maastrichtian Stage to the Danian Stage in Europe and elsewhere. In the type area of northern Europe, this discontinuity is indicated by a planktonic faunal and floral break which has come to define by general (but not universal) agreement the Cretaceous-Tertiary boundary. In Denmark, the boundary occurs in a localized thin clay rich in fish remains in the midst of a sequence of chalks and bryozoan limestones, described in a paper by Bromley and in four guides to stratigraphic sections in the work under review.

A decision about a stratigraphic boundary is strongly influenced by how many persons work on which groups, and planktonic taxa have a lot of students doing a lot of work. (In these volumes Perch-Nielsen is an author or coauthor of six papers on coccolith zonation.) This effort reflects the primacy of position of foraminifera and coccolithophorids in correlation of European Cretaceous and Tertiary boundary deposits, following the petroleum companies' immense emphasis on planktonic microfossils. (Very detailed recent papers also on correlation of the European Cretaceous, including papers with paleogeographic maps, notably by Owen for the Albian, and paleoceanographic charts, notably by Hart and Bailey on mid-Cretaceous planktonic foraminifera, appear in *Aspekte der Kreide Europas*, edited by Jost Wiedmann [Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 1979; 688 pp., DM 198].)

The consensus concerning the boundary used not to exist. And in the Copenhagen symposium collections from many European sections of genera of regular echinoids (Gravesen; Stokes), bryozoans (Voigt; Håkansson and Thomsen), crinoids, asteroids, ophiuroids (Rasmussen), bivalves (Heinberg), corals (Floris), and brachiopods (Surlyk) continue to support the view that prevailed in the premicropaleontological era of decades ago: these taxa in the Danian have at least as strong biologic affinities with the underlying Maastrichtian as with overlying Tertiary strata. Thus on the evidence of these groups the Cretaceous-Tertiary boundary might as well be placed above the Danian. Even in the U.S.S.R., where some taxa are reported (by Naidin) to have stronger Tertiary affinities than their counterparts in Europe, taxa are grouped into those that became extinct at the end of the Maastrichtian, those that were moderately affected at the boundary, and those that were little affected. Finally, add to these disparate observations the conclusion (of Romein) that stratigraphic sections in Israel provide a complete record of deposition across the Maastrichtian-Danian boundary and that the Maastrichtian species "disappear gradually from the record in lowermost Danian." How can these conflicting results be resolved, and what do they mean for the born-again currently hot idea of an extraterrestrial factor in end-of-Cretaceous extinctions?

Kauffman sheds considerable light on the question of how extinctions for different groups have occurred at different levels in different places in the Maastrichtian-Danian deposits. He reports that taxa of the tropical-subtropical Tethyan region were far more dramatically affected at the end of the Maastrichtian than were those of the temperate zone, and especially in comparison with those of the northern temperate region. In north temperate American and Danish localities "many lineages cross the boundary without significant evolutionary interruption." In contrast, few dominant Cretaceous taxa crossed the boundary in Tethys. In addition to providing this paleogeographic constraint, Kauffman notes that the affected taxa had all or a major part of their life histories in the upper pelagic zone, a fact that points to "severe changes in this one environment," in this one latitudinal zone.

What do these conclusions imply for groups like the ammonites and dinosaurs that catastrophists are fond of citing as having become extinct en masse? The fossil record is pretty sketchy. Birkelund reports that juvenile ammonites assigned to seven genera and nine species (five of uncertain assignment) occur in the topmost Maastrichtian chalk, owing to preservation on a hardground. The absence of adult specimens in the hardground or in immediately overlying deposits probably doesn't mean much. More broadly, Wiedmann (in *Aspekte der Kreide Europas*, cited above) writes, "The final decline of the ammonites is by no means a sudden event, but continues through the higher part of the Upper Cretaceous and can be related to marine regressions." My own recent review of the dinosaur literature supports the view that the problem of the extinction of the dinosaurs boils down to the rather trivial question of what happened to a score of species inhabiting the river and floodplain habitats adjacent to the North American Western Interior seaway. Apparently all that happened was that, as sea level fell by more than 100 meters, seasonality significantly increased and vegetation changed, baselevel was lowered, and as living space was reduced extinction was the normal course of events for animals requiring thousands of square kilometers for the maintenance of reasonable population sizes. Much more needs to be done with basic biostratigraphy to increase the resolution of the timing of events. In a continuing march in that direction, approximately half of the contributions in the Copenhagen symposium are concerned with the correlation of sections occurring in most of Europe, the U.S.S.R., Israel, Turkey, Pakistan, Japan, Tunisia, and even China (three brief reports).

What about the extraterrestrial cause of marine and nonmarine extinctions? Well, as Hickey noted in these pages recently (*Science* **210**, 1200 [1980]), the "lights out" scenario of Alvarez *et al.* (*Science* **208**, 1095 [1980], and in abbreviated form in the Copenhagen symposium) is, for reasons cited above, dimly regarded by most paleontologists who have examined the data. As is well shown in the Copenhagen volumes, different taxa go extinct in different times and in different places. Similarly, support for the arctic freshwater spillover idea of Gartner and of Theirstein and Berger (also reported in the Copenhagen volumes) has dried up as more data have accumulated. In sum, the Copenhagen symposium is quite timely, and together with the Wiedmann volume indicates yet

again that biostratigraphers, rather than reveling in a blind obsession with an interminable morass of detail, are engaged in solving some of the most interesting intellectual puzzles in geology.

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Maya Architecture

The Puuc. An Architectural Survey of the Hill Country of Yucatan and Northern Campeche, Mexico. H. E. D. POLLOCK. Harvard University Peabody Museum of Archaeology and Ethnology, Cambridge, Mass., 1980. xxx, 600 pp., illus., + packet of figures. Paper, $50. Memoirs of the Peabody Museum, vol. 19. Published in cooperation with the Carnegie Institution of Washington.

The Puuc hills of the northwestern Yucatan Peninsula provide the only relief in what must be one of the world's flattest landscapes. They were the locus of the finest architectural achievements of the ancient Maya. The beauties of such sites as Uxmal, Kabah, Labna, and Sayil are familiar to archeologists and tourists alike and have influenced such modern masters as Frank Lloyd Wright.

For a knowledge of the Puuc architectural style, until now we have largely relied on John Lloyd Stephens's 1843 *Incidents of Travel in Yucatan*, with Frederick Catherwood's magnificent engravings. With the publication of Harry Pollock's long-awaited survey of Puuc sites, our concept of the style is on firmer ground. Long a staff member of the Carnegie Institution of Washington, Pollock began his fieldwork in that hot, tick-infested land as far back as 1932 and continued it until 1940, with an additional field trip in 1948. During that time, he was able to locate about 140 Puuc sites within an area of 7000 square kilometers, a remarkable density that must indicate one of the heaviest populations in the native New World.

A figure, shown in a modern wall, from the Main Palace, or Palace of the Figures, at Xculoc, Campeche. [From *The Puuc*. Peabody Museum, Harvard University; photograph by Carnegie Institution of Washington]

In the preface, Pollock frankly admits to the volume's shortcomings, most of them stemming from a research plan that would now be considered outmoded. The most glaring one is the total absence of data from excavations. Remarkably, no Puuc site—not even Uxmal with its nightly *son et lumière* extravaganza—has been properly excavated. Evidence from stratigraphy and reliable radiocarbon determinations is thus nonexistent. This means that we cannot now date the Late, or Classic, Puuc style accurately (it may cover the span from about A.D. 800 to 1000); that we have no idea of the function of Puuc buildings, other than ball courts; and that any proposed sequence of architectural development remains purely hypothetical.

A second shortcoming, typical of most but not all Carnegie fieldwork of the period, is a lack of concern for what we would now call settlement pattern. Were sites like Uxmal real cities, like those of Aztec Mexico, or were they relatively empty "ceremonial centers"? Only a few sites (Sayil, Kabah, and Oxkintok) have been adequately mapped, and not even for these do we have data on house mounds; for Uxmal, Pollock has been forced to rely on the hopelessly inadequate Tulane map of 1930. We thus do not know the degree of ancient urbanization in the Puuc area.

The volume does contain first-class architectural plans, sections, and elevations of individual buildings; it provides a definitive record of much standing architecture, which is a considerable

One of the major architectural assemblages at Sayil, Yucatan, looking northeast. Situated at the northern end of a causeway that roughly bisects the city, the structural complex looks southward to other major architectural assemblages located midway along the causeway and at its southern terminus. [From *The Puuc*. Peabody Museum, Harvard University; photograph by Carnegie Institution of Washington]