2007-08 AAPG Distinguished Lecture

Abstract

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Funded by the AAPG Foundation through the Allen P. Bennison Endowment

Rudist Evolution, Ecology and Environments

The bizarrely shaped sessile epifaunal bivalves known as "rudists" make their first appearance in the Oxfordian (Upper Jurassic) of the Mediterranean Tethys. By the close of the Jurassic they had spread across the Tethyan Realm and became among of the most characteristic occupants of its shallow carbonate platforms during the Cretaceous.

From the outset they were characterized by an outer shell layer of fibrillar prismatic calcite covering a thick aragonitic inner shell with massive dentition. Attachment to the substrate was by the left or the right valve, according to taxon. During their 93 Myr history, ended by catastrophic extinction at the close of the Cretaceous, they underwent a series of evolutionary radiations, punctuated by mass extinctions, which were closely tied with the episodic growth and demise of the platforms. In primitive forms, the umbones grew spirally, like rams' horns, due to the constraint of an external ligament that migrated backwards throughout life. They lived either attached to other shells or partially embedded in sediment, as spiralling 'clingers', often associated with corals.

In the Tithonian, some smaller forms attaching by the right valve invaginated the ligament and could thus grow uncoiled tubular valves. This innovation sparked an evolutionary diversification of ecological morphotypes ranging from partially embedded 'elevators', occupying areas of net positive sediment accumulation, to large 'recumbents' lying prone in areas of sediment bypassing. While elevators spread from outer to inner platform environments, forming laterally extensive biostromes in the latter, recumbents occupied energetic platform margins.

Extinction episodes struck the outer platform associations most intensely, and those of the early Aptian and terminal Cenomanian, in particular, witnessed the temporary disappearance of the predominantly aragonitic recumbents. Because the surviving elevators and clingers usually had significantly thicker calcitic outer shell layers, involved in mutual attachment, faunal turnover at these times was thus also associated with distinct shifts in the calcite/aragonite ratio of rudist shells, with interesting petrological implications.

The Episodic History of Cretaceous Carbonate Platforms: An Aptian Case Study

Late Aptian rudist faunas differed markedly from those of the Early Aptian, mainly because of the extinction of almost all the predominantly aragonitic caprinids and the radiation of forms with a thickened calcitic outer shell layer, such as the polyconitids and the first radiolitids.

However, the taxonomic turnover occurred not in a single event, but through the Early Aptian, in association with the regionally progressive demise of carbonate platforms. The inception of this phase in the earliest Aptian was accompanied by a widely documented negative $\delta^{13}C$ excursion, which has been interpreted as marking a methane-induced rise in atmospheric CO_2, with associated climatic warming.

Nevertheless, some characteristic Early Aptian rudists persisted in lower palaeolatitude platforms until the end of the Early Aptian, hinting that subsequent global cooling may account for their geographical retreat to eventual extinction. Such an interpretation would be consistent with (1) oxygen isotope data, (2) likely draw-down of atmospheric CO_2 accompanying the increasing ratio of organic-, to carbonate-carbon burial, and (3) geological evidence for yet cooler conditions in the Late Aptian. Moreover, if the previous maintenance of high rates of calcification on the platforms, despite elevated levels of atmospheric CO_2, had depended upon the thermal expulsion of aqueous CO_2 from the waters overlying them ('the kettle effect'), cooling could be expected to have had a deleterious effect on the system.

This factor might also explain why rudist taxa that occupied the platform margins – which would have been most susceptible to flushing by cooler open water masses – suffered the greatest extinction. These observations and inferences suggest an intriguing linkage between the episodic history of carbonate platforms and their biota, perturbations of the global carbon cycle, and climate in the unstable greenhouse world of the Cretaceous.

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Education:

1972 B.Sc. Geology, University of Bristol, UK.
1977 D.Phil., University of Oxford, UK

Experience:

2005–Present	Reader in Palaeobiology, The Open University, UK
1993–2005	Senior Lecturer in Earth Sciences, The Open University, UK.
1978–93	Lecturer in Earth Sciences, The Open University, UK.
1977–78	Smithsonian Institution Fellowship; U.S. National Museum of Natural History, Washington D.C., U.S.A., Department of Paleobiology.
1975–77	Senior Demonstrator in 'soft-rock' geology, Department of Geology, University of Liverpool, UK.

Publications and Awards:

Over 50 papers in journals including *Lethaia*, *Paleobiology*, *Palaeontology*, *P3*, *Cretaceous Research*, and numerous special volumes and conference proceedings, as well as teaching texts, instructional CD-ROMs and videoprogrammes/DVDs in the areas of evolutionary palaeontology, palaeoecology, Earth system science and carbonate sedimentology, and consultancy reports on rudist carbonates for various petroleum companies operating in the Arabian Gulf region.

Professional Memberships

Palaeontological Association
Palaeontographical Society
Geological Society of London
International Association of Sedimentologists
Linnean Society
Malacological Society
Sociedad Española de Paleontología
Wagner Society

Professional Interests:

General: Evolutionary Palaeobiology; Invertebrate Palaeontology; Carbonate Sedimentology.

Special: (1) Palaeobiology of rudist bivalves; (2) Stratigraphy and palaeogeography of the Cretaceous Tethyan Realm, especially its carbonate platforms; (3) Cretaceous climates; (4) Carbonate platform and reef development through time, in relation to global change; (5) Constructional and functional morphology of molluscs, especially bivalves, and their evolutionary/systematic relationships; (6) Evolution, especially modes and patterns of macroevolution.

Reviewer of research proposals from USA, UK, France, Italy, Denmark and Israel.

Executive council positions on Palaeontological Association (including Secretary), Malacological Society of London (including President) and Palaeontolographical Society.

Organizer of several international meetings and conferences for these and other bodies and invited speaker at many more.

External examiner for geology degree programmes in three UK universities and for PhD examinations in several countries.