Upper Cretaceous Fossil Molluscs in South America and West Africa

OVER the past few years there has been a great revival of interest in the theory of continental drift, owing largely to the results yielded by palaeomagnetic investigations. Whereas most geologists a decade ago were inclined to be sceptical about the possibility of the continental land masses having wandered, the evidence now avilable appears much more convincing.

The close relationships in the floras and in the reptile associations of the Gondwanic continents have long been one of the mainstays of the hypothesis of the existence of Gondwanaland. It seems, however, that little attention has been paid to eventual biological similarities of a later age. The object of this communication is to present observations on some mollusc species that occur in the Upper Cretaceous of the northern half of South America and in Nigeria and Cameroon. Knowledge of (particularly South American) Cretaceous molluscs is still not very advanced and it might reasonably be expected that more common species will show up in the future, for example, when the vascoceratid associations of Brazil are investigated.

Table 1 lists the species known to occur in both regions (see also ref. 1).

Table 1. OCCURRENCE OF WEST AFRICAN MOLLUSCS IN SOUTH AMERICA

Species	Age	Occurrence
Pachyvascoceras costatum Reyment (ammonite)	Turonian	Peru, Eastern and Northern Nigeria
Hoplitoides ingens (von Koenen) (ammonite)	Turonian	Colombia, Cameroon, Northern Nigeria, Eastern Nigeria
Benueites benueensis Reyment (ammonite)	Turonian	Brazil, Colombia, Northern Nigeria
Benueites spinosus Reyment (ammonite)	Turonian	Trinidad, Peru, Colombia, Northern Nigeria
Solgerites brancoi (Solger) (ammonite)	Coniacian	Cameroon, Colombia, Peru
Lima pseudohoernesi Riedel (pelecypod)	Turonian	Peru, Cameroons, Gabon, Northern Nigeria

The interest in connexion with the geographical distribution of these molluscs lies in the problem of their dispersal which, for the ammonites, has to be viewed in the light of their necroplanktonic buoyancy properties (cf. Reyment[2]), and consequently with respect to oceanic currents.

Pachyvascoceras costatum Reyment has a moderately inflated and slightly evolute shell, approximating in form to *Nautilus*. There is little doubt that it, like the living *Nautilus*, could have been posthumously transported by ocean currents over considerable distances.

Hoplitoides ingens (von Koenen) has an involute, fairly strongly compressed shell of a shape bordering on that of the type considered by me[2] to have been unable to remain buoyant after the death of the animal, unless the body chamber has been largely broken off. Both the species of *Benueites* have small involute to slightly evolute and fairly compressed shells with thin walls, and may not have been capable of wide necroplanktonic dispersal.

Solgerites brancoi Solger has a round whorl section and is slightly evolute and had certainly good necroplanktonic floating properties. It should finally be mentioned that all these ammonites are "typical West African forms" and, apart from a doubtful report of *H. ingens* from North Africa, seem only to have been found in the northern part of South America, outside West Africa.

To sum up, it seems that only two of the five ammonite species might have survived dispersal across an Atlantic Ocean of the width of the present day, assuming favourable currents existed. The case of *Lima pseudohoernesi* Riedel is even more difficult to explain, for if the mechanics of the dispersal of the ammonite shells poses problems, that of a benthonic pelecypod species is very much greater. We have the fact that most of the known occurrences of these species are on 'the wrong side' of South America, but there may have been a shallow sea in existence in northern South America at that time.

Although it is far too early to make anything even approaching a positive statement on the subject, and although this will not be possible until much more published taxonomic information becomes available from South America, it seems that these molluscan distributions might offer some support for the palaeomagnetic results obtained by Creer[3], Runcorn[4] and others. Their work suggests that Brazil and Nigeria of to-day mark the point of contact of the continents in the Upper Palaeozoic (and thus supports the finding made by fitting coastlines and Pre-Cambrian tectonics[5] and that the rift took place during Upper Permian[3] and widened during the Mesozoic[3].

Although there is marine Devonian known in Ghana, the first dated marine transgression for the critical central area is the Upper Middle Albian incursion in Nigeria. Older Cretaceous occurs some distance north and south of Nigeria, but there is no marine Jurassic. This might be interpreted as evidence that the two continents were still very close together during early Cretaceous time. The existence of a narrow sea during the Upper Cretaceous, similar to the Red Sea of to-day, would go a long way towards explaining the distribution of the Upper Cretaceous molluscs here discussed.

R. A. REYMENT

Department of Geology,
University of Ibadan,
Nigeria.

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CHEMISTRY

Octahedral Metal Clusters

THE bonding in the $Mo_6Cl_8^{4+}$ and $Ta_6Cl_{12}^{2+}$ cations, both of which contain an octahedron of metal atoms, has recently been rationalized in terms of a 40-electron model[1]. The edges of the metal octahedron define the orientation of twelve bonds (type A) while the faces of the octahedron define the position of another eight (type B). In $Mo_6Cl_8^{4+}$ twenty-four metal electrons fill the A orbitals and sixteen chlorine σ electrons fill type B. In $Ta_6Cl_{12}^{2+}$ the roles of the sixteen metal and twenty-four chlorine σ electrons are interchanged. It is now possible to speculate on the occurrence of other metal octahedra if we require that this 40-electron rule be obeyed.

There are two other possible atomic arrangements with O_h symmetry. These are: (a) that in which there are ligands above both faces and edges of the metal octahedron; (b) that in which there are no ligands at all. We consider these separately. A possible molecule of type (a) is $(Al_6Cl_{20})^{2-}$ in which both A and B bonding orbitals are filled by chlorine σ electrons. There should be no specific metal–metal bonding and a consideration of ionic radii makes it evident that there would be considerable steric interaction between the chlorine ions. It therefore seems most unlikely that such molecules exist.

If orbitals of types A and B are filled by metal electrons then no ligand need be incorporated (type (b)). There would be no de-stabilizing steric interactions, and if the charge on the octahedron were small it seems highly probable that the species would be stable. The molecule Re_6I_2 (actually $Re_6^{2+}2I^-$) satisfies these conditions. The iodide anion is suggested since it is large and singly charged; there are many plausible alternatives. Although no such species has been found in the manganese– or rhenium–iodine systems, it is possible that reactions in which the metal appears to have been produced (for example, thermal decomposition of $Mn(CO)_5I$) may, in fact, have led to their formation. The 'isoelectronic'

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