method of deactivating bombs which would considerably reduce this risk.

Liquid nitrogen is relatively safe and easily handled. A bomb sprayed with it for several minutes would be cooled to an extremely low temperature. This would have two effects. First, the battery used to detonate the explosive would become ineffective. I have verified this in the following way. Three brands of dry cell battery (Ever Ready, Winfield, Ray-O-Vac) were cooled to the temperature of liquid nitrogen and tested in a small torch. None of the batteries tested caused the torch to light. When the batteries were allowed to warm up, however, complete efficiency was restored.

Second, the detonator and explosive might reasonably be expected to be unreactive at such low temperatures. A bomb deactivated in this manner could be safely transported to a disposal site in an insulated container partially filled with liquid nitrogen.

Yours faithfully,

GEORGE DAVIDSON

K.R.U.F. Institute of Renal Disease,
Royal Infirmary,
Cardiff

Foraminifera

SIR,—The recent review of Dr J. W. Murray's book¹ by Dr J. R. Haynes

(*Nature*, **245**, 442; 1973) may have confused a number of palaeoecologists by seeming to advocate absolute abundance rather than standardised abundance for the plotting of species distributions. The latter method, now widely employed, is admittedly suspect because it makes the *a priori* assumption that all the foraminifera of an assemblage are competing.

This is not as unsatisfactory, however, as the absolute abundance method which is, of course, much affected by rates of sedimentation. As a result, plots of species using this method are often difficult to distinguish. Standardisation of data reduces this 'background noise' and furthermore enables the calculation of basic ratios (such as benthonic: planktonic or Textulariina: Miliolina: Rotaliina) which are now valuable aids to the palaeoecologist. Obviously, if the approach is biological rather than geological, then the biomass of a species per unit area is the better index.

Yours faithfully,

M. D. BRASIER

Geology Department,
The University,
Whiteknights,
Reading RG6 2AH

¹ Murray, J. W., *Distribution and Ecology of Living Benthic Foraminifera* (Heinemann, London, 1973).

As suggested in my review, paucity of data and lack of control of sample material may force us to express species abundances in percentages rather than absolute numbers per unit area of volume of substrate. The desperate inadequacy of this method, however, is shown by the tables in Chapter 1 of Dr Murray's book. Not only does this method impose reciprocal relationships but the percentage figures may show a rise for a particular species between stations when the absolute numbers have fallen and *vice versa*.

At present our understanding of the autecology of foraminifer species is almost nil. Progress towards an evolutionary ecology requires knowledge of the abundance of individual species both in their habitats and when dead as part of the sediment. The variations in numbers and sorting brought about by sedimentary processes which make plots "difficult to distinguish" are precisely what concern geologists and represent the challenge that has to be met before we can properly interpret the geological record. Even where it is thought valuable simply to estimate certain crude ratios these are as easily derived from absolute numbers.

JOHN R. HAYNES

Obituary

Leonard Carmichael

DR LEONARD CARMICHAEL, Secretary of the Smithsonian Institution from 1953–64, died on September 16 in Washington, DC, at the age of 74. He was the National Geographic Society's Vice-President for Research and Exploration at the time of his death.

A distinguished physiological psychologist, Dr Carmichael also achieved renown as a science administrator in the worlds of academia, museology and government. The central unifying interest in his career, which lasted 50 years, was research: his own research and the administration and funding of the research of others.

Dr Carmichael was born on November 9, 1898, in Philadelphia, where his father was a successful physician. In 1917 he entered Tufts University, where his grandfather, Charles Hall Leonard, had for many years been Dean of the Crane Theological School. Here he became interested in zoology and psychology, and later recorded that the

two men whose books had the most influence on him as an undergraduate were the biological ultramechanist Jacques Loeb and the proponent of emergent evolution C. Lloyd Morgan.

Following graduation from Tufts, *summa cum laude*, he began graduate work at Harvard in psychology, developing an interest in a basic biological approach to the science. He later wrote that the accidental finding of a German publication of William Preyer, *Spezielle Physiologie des Embryo, Untersuchungen über die Lebenserscheinungen vor der Geburt*, in the Harvard Library, was a turning point in his life, opening his eyes to a specific area of research in his chosen field of the sensory and neural control of behaviour on which he was to spend many years. "Here at last I saw a way to investigate the topic of major interest to me—the morphological growth of the receptors and nervous system in relation to changes in behaviour as responses are released at various stages during the early ontogenetic development in each mammal

before learning begins, or at least before it becomes important."

He completed his PhD studies and theses and did a year of graduate work at the University of Berlin before beginning his teaching career at Princeton in 1924. Later he taught at Brown, where he gained his first administrative experience as Director of its psychology laboratory, and at Rochester, where he was Dean of the arts and sciences faculty. At Brown, in addition to his teaching and administrative activities, Dr Carmichael began studying the prenatal development of behaviour in mammals. With Dr H. H. Jasper he developed the electroencephalograph and published in 1935 what is believed to be the first report of such work in America.

In 1938 Dr Carmichael returned to Tufts to become, at 39, one of the youngest presidents in the college's history, but during World War II he was summoned from the campus to fill various posts in Washington. As director of the National Roster of Scien-