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power stations. Possible methods of dis-
posal include elimination by nuclear trac-
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This last suggestion was considered in
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I agree with Dare that an anthropocen-
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Rowe in his letter asserts: “the purpose
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W. H. MURDY
Department of Biology, Emory
University, Atlanta, Georgia 30322

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implications of such schemes, pointing out that, although past research has already generated much valuable scientific information for these investigations, national committees should encourage governments to support further studies.

Concurrently, Battelle Northwest Laboratories has examined many possible disposal schemes (2). For disposal in the ice sheet, three main concepts were developed: (i) surface storage; (ii) anchored emplacement at a depth of 200 to 500 meters; and (iii) "melt-down," in which canisters containing radioactive material would melt through the ice sheet. These concepts, and the earlier one (1), were based on analyses by Budd, Jensen, and Radok (3). With extreme values for some parameters, their models predicted that in part of East Antarctica the ice sheet base was well below melting point and that the "residence time" for snow falling there was greater than 250,000 years—the time the waste must be isolated from the biosphere.

A meeting was held in Cambridge, England, on 25 September 1974, of representatives of ICSI, the SCAR Working Group on Glaciology, and the International Antarctic Glaciological Project, from eight countries (4). They determined that the primary requirement in any disposal concept is that the oceans and atmosphere must not be contaminated by the dissemination of radioactive wastes, including that initially contained in canisters if the canisters are not retrievable.

With present technology we cannot recover canisters that have sunk deep into the ice sheet, even if they remain intact; the recovery of "melted-down" material will always be more difficult than with the other concepts. The waste and canisters could be constructed with the same density as ice and, if aged to thermal inertness before emplacement, would follow flow lines, increasing their residence times. "Tethered-canisters" probably are retrievable unless the mooring system fails.

In the last 2 years, radio echo sounding has shown that many lakes underlie the East Antarctic ice sheet, and over extensive areas the base is melting. Water may flow from these areas to the oceans very quickly. The implications for ice sheet disposal are obvious.

The major question with all these concepts, however, is the ice sheet's durability. In the last 250,000 years northern ice sheets have come and gone, although the Antarctic ice sheet may have changed only 10 percent. Our knowledge of the mechanisms for initiation and disappearance of ice sheets and of future natural and man-made changes in climate and in geothermal flux is insufficient for long-range pre-

(Continued on page 658)
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RESEARCH NEWS

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tween real and randomly generated systems. He discovered that real clades of shallow water marine invertebrates that originated in the Cambrian and Ordovician periods differ from randomly generated clades. These clades fill up more quickly with species and die out more slowly than the random clades. However, during these periods, which occurred early in geological history, the earth was filling up with species. After the Ordovician, during the Silurian period, all major taxonomic groups were established and no new phyla originated. At this time, presumably, species diversity could have reached equilibrium. Gould found that the clade shapes for shallow water marine invertebrates during and after the Silurian resembled those of the randomly generated clades.

Not all investigators accept the models and conclusions drawn by Raup, Gould, Schopf, and Simberloff. Arthur Boucot of Oregon State University, for example, thinks the models are too simple. They are “clever, polished, but of limited use,” he says. Randomness in evolution is not unexpected, Boucot points out. And major geological events, such as climatic changes, are correlated with major evolutionary events, such as massive species diversifications and extinctions. However, such correlations are not considered in the models that treat all species and all geological times alike.

Another criticism of the stochastic models of evolution is voiced by Karl Flessa and Jeffrey Levinton of the State University of New York at Stony Brook. These investigators used the independent statistical techniques of factor analysis and the runs test to argue that the originations of various taxa in the real world did not occur at random and that there are nonrandom patterns of taxonomic diversity in the fossil record. In other words, they believe that many of the patterns in the fossil record could not have been randomly generated. Gould and Schopf, however, are not convinced that Flessa and Levinton have demonstrated patterns above and beyond those that could be derived from random processes.

Although equilibrium models in paleobiology are still a new concept, Schopf believes that they are leading to a revitalization of that field. Investigators devoted the past century to studying the histories of individual species, but were unable to solve some major problems. Now that a new conceptual framework has been introduced, says Schopf, “it will be fun to see where things go.” —GINA BARI KOLATA

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