Tropical Paleotemperatures

In Richard A. Kerr's discussion of the results of CLIMAP (17 Feb., p. 961), it is stated that "species characteristic of warm tropical oceans were abundant even at the height of the last glaciation." Not so. In the equatorial Atlantic and the Caribbean, the three most temperature-sensitive tropical species, *dehiscens*, *obliquiloculata*, and *menardii*, were absent (*1*), showing that threshold temperature minimums for reproduction were violated and indicating a temperature drop of about 6°C. In the eastern equatorial Pacific, only *dehiscens* was absent (*2*), indicating a temperature drop of about 3°C. The worldwide, intertropical, area-weighted average temperature drop was about 5°C (*3*). That the tropics were significantly cooler during the ice ages is shown also by the striking changes in the aspect of the foraminiferal faunas (*4*), including sizes and morphologies (*5*).

The contention that the intertropical belt was "as warm or slightly warmer than today" (*6*) may result from the fact that the temperature-sensitive tropical species are outnumbered 10 or 20 to 1 by the less temperature-sensitive globigerinids (*sensu lato*) and by the practice of counting as few as 300 foraminiferal shells used by CLIMAP and, before CLIMAP, by Phleger and associates (*7*), a practice that discriminates against the rarer species which, in this case, are the ones most temperature-sensitive. In contrast, the visual method used by Ericson and Wollin (*1*), which considers a tray full of foraminiferal shells at a time and thus several thousand specimens, yields more realistic results. This may be appreciated by comparing the abundances of *dehiscens* in Swedish core 246 from the equatorial Atlantic [(*6*), table 17] with that in Lamont core A180-73 from the same region [(*1*), table 6] and by comparing both with the oxygen isotopic record [(*8*), figures 4 and 6]. An additional problem is the scarcity of *menardii* in several of the core top samples used by CLIMAP for calibration, which suggests that those samples may not be modern (*3*). This would add to the underestimate of the amplitude of the glacial-interglacial temperature change.

To clarify these matters, CLIMAP's database should be upgraded to counts of at least 1000 specimens per sample in order to better quantify the contribution of the rarer species and to constrain to less than 5% the error in species distribution (*9*); and the data should be analyzed by methods, such as that recommended by Malmgren and Kennett (*10*), that properly weigh the contribution of the rarer and more temperature-sensitive species. In addition, a recalibration using box cores, combined with oxygen isotope analysis at close stratigraphic intervals (1 to 2 centimeters) and with ^{14}C accelerator dating, should be undertaken (*3*) to ensure that the calibration truly rests on modern core-top samples representing modern surface temperatures and salinities.

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Global Warming and Health Effects in the Third World

The article "If the mercury soars, so may health hazards" (News & Comment, 17 Feb., p. 957) by Richard Stone provides a useful reminder that the environmental health hazards in less-developed areas are biological. It does not remind the reader, however, that the climate changes associated with a 2.5°C increase in global average surface atmospheric temperature are likely to become pronounced in the second 50 years from now. Rates of economic improvement in all continents except Africa would, if continued over the coming century, substantially change standards of living, sources of livelihood, resources available for public health, and available medical technologies. Hypothetically superimposing those future climate changes on today's less-developed societies may lead to an exaggerated assessment of their vulnerabilities after another half-century of economic development.

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