species, and contributed to the discoloration and defoliation of trees. Attention should be paid to such early warning signs, bearing in mind the high environmental value of forest growth potential. Past development, nonetheless, guarantees that during the next 10 to 20 years, wood resources are plentiful and can be allocated among traditional forest industries, eventual novel technologies such as ethanol production (3J), and nature protection and conservation purposes.

REFERENCES AND NOTES

6. In Germany, according to Agramanicht 1991 (Deutscher Bundestag, Bonn, 1991) the growing stock per unit land area was about 160 m³/ha.

RESEARCH ARTICLE

Oceanic Uptake of Fossil Fuel CO₂: Carbon-13 Evidence

The δ13C value of the dissolved inorganic carbon in the surface waters of the Pacific Ocean has decreased by about 0.4 per mil between 1970 and 1990. This decrease has resulted from the uptake of atmospheric CO₂ derived from fossil fuel combustion and deforestation. The net amounts of CO₂ taken up by the oceans and released from the biosphere between 1970 and 1990 have been determined from the changes in three measured values: the concentration of atmospheric CO₂, the δ13C value of atmospheric CO₂ and the δ13C value of dissolved inorganic carbon in the ocean. The calculated average net oceanic CO₂ uptake is 2.1 gigatons of carbon per year. This amount implies that the ocean is the dominant net sink for anthropogenically produced CO₂ and that there has been no significant net CO₂ released from the biosphere during the last 20 years.

The fate of CO₂ loaded into the atmosphere by fossil fuel combustion and deforestation has been uncertain. Direct measurements of the increase in atmospheric CO₂ levels, when compared to the rates of fossil fuel combustion and cement production, indicate that about 57 percent of the CO₂ produced from these sources has accumulated in the atmosphere (1). The other 43 percent of the industrially derived CO₂ is in either the biosphere or ocean, the two carbon reservoirs that can exchange significant amounts of CO₂ on the time scale of the anthropogenic perturbation. Two recent studies of the atmospheric CO₂ budget came to opposite conclusions with regard to whether the ocean or biosphere has been the predominant CO₂ sink (1, 2).

Our uncertainty about the fate of anthropogenically produced CO₂ results from the lack of direct measurements of changes in the carbon content of the biosphere and ocean. As a result we have had to rely on model parameterizations to estimate oceanic and biospheric CO₂ uptake rates (1–3). Because the uncertainty in these parameterizations is substantial, the question of whether the ocean or biosphere is the major CO₂ sink has remained unanswered.

In this article, we use measurements of the decrease in the 13C/12C ratio of the total dissolved inorganic carbon (DIC) in
the ocean since 1970 to determine the rate of oceanic uptake of anthropogenically produced CO₂. The \(^{13}\text{C}/^{12}\text{C}\) ratio, expressed as \(^{8}\text{C}\) (4), is a useful tracer of CO₂ derived from fossil fuel and deforestation sources. The tracer quality of the \(^{8}\text{C}\) value results from a difference between the \(^{8}\text{C}\) value of CO₂ in the atmosphere (about –8 per mil) and that of CO₂ released during the combustion of fossil fuels and biomass (about –27 per mil). The difference between the \(^{8}\text{C}\) values for plant material and atmospheric CO₂ results from the isotopic fractionation during photosynthetic fixation of CO₂ (5). Although the \(^{8}\text{C}\) values of terrestrial plants range from –27 per mil to –12 per mil depending on whether the plant uses a three-carbon or four-carbon intermediate to fix CO₂ (5), that is, C₃ or C₄ plants, the terrestrial biomass is overwhelmingly (>95 percent) C₃ plant material (6).

The \(^{8}\text{C}\) value of atmospheric CO₂ is decreasing because CO₂ input from fossil fuel combustion and deforestation has a \(^{8}\text{C}\) value about 20 per mil lower than the \(^{8}\text{C}\) value of atmospheric CO₂. The \(^{8}\text{C}\) value of atmospheric CO₂ has decreased by 1.4 per mil during the last 300 years on the basis of measurements of air bubbles trapped in ice (7). Direct measurements show that the \(^{8}\text{C}\) value of atmospheric CO₂ decreased from –7.5 per mil in 1978 to –7.8 per mil in 1988 (1). Similarly, the \(^{8}\text{C}\) value of DIC in the ocean should have decreased if anthropogenically produced CO₂ has entered the oceans. A decrease of about 0.5 per mil from 1900 to 1970 for the surface layer of the tropical ocean has been inferred from measurements of the \(^{8}\text{C}\) value of aragonite in a scleropissue (8). In order to quantify the amount of anthropogenic CO₂ taken up by the oceans we must determine the depth-integrated change in the oceanic \(^{8}\text{C}\) value on an oceanwide scale.

On three National Oceanographic and Atmospheric Administration research cruises during the last 3 years we measured the \(^{8}\text{C}\) value of DIC in the Pacific Ocean from 60°S to 60°N (Fig. 1). Seawater samples, poisoned with HgCl₂, were collected and stored in prewashed and baked (450°C) ground glass-stoppered bottles. In the laboratory, we extracted the CO₂ from seawater using a helium stripping technique (9). The efficiency of the extraction was 100 ± 0.5 percent based on gravimetrically prepared Na₂CO₃ standards. The overall precision of the \(^{8}\text{C}\) analysis was ± 0.02 per mil based on a replicate analysis of standards and seawater samples.

To recognize changes over decadal time scales we compared our \(^{8}\text{C}\) data with similar measurements made in 1970 and 1971. \(^{8}\text{C}\) values for the mixed layer in the Pacific Ocean in 1970 were measured during the Canadian HUDDSON-70 cruise along 150°W between 65°S and 55°N (10). Depth profiles were measured in 1970 at eight stations during the HUDDSON-70 cruise, five stations during the SCAN-X cruise along 190° to 114°W, five stations during the Tow-7 cruise along 165° to 171°W, and in 1971 at one station during the Antipodes-15 cruise along 172°W (11). We estimated the uncertainty in the \(^{8}\text{C}\) data from 1970 at ± 0.04 per mil on the basis of repeated replicate analyses (11).

Oceanic \(^{8}\text{C}\) decrease. Comparison of the data shows that the average \(^{8}\text{C}\) value of DIC in the mixed layer of the Pacific Ocean decreased by 0.4 per mil during the last 20 years (Fig. 2), if we assume that the values obtained in 1970 are representative of the latitudinal variations over the entire Pacific Ocean. This assumption is supported by the similarity in the \(^{8}\text{C}\) values measured along 110°W and 170°W in 1989 and 1990, respectively. Data from the two NOAA cruises in the southern ocean along 110°W and 170°W show average decreases of 0.33 and 0.36 per mil, respectively, and data from the northern ocean cruise along 150°W in 1991 shows a 0.45 per mil decrease. The average basin-wide decrease in \(^{8}\text{C}\) values for the mixed layer, calculated by weighting the latitudinal trends according to ocean surface area, is 0.40 per mil.

With the \(^{8}\text{C}\) data available for the water column (Fig. 3), we can compare the change in the oceanic depth distribution of \(^{8}\text{C}\) values in the Pacific ocean since 1970 at seven sites (12). The average depth-integrated \(^{8}\text{C}\) value has decreased by 203 per mil meters, with a range of 60 to 305 per mil meters (Table 1); the units represent the integration of the area between the \(^{8}\text{C}\) depth profiles measured in 1970 and 1989 to 1991. A comparison of \(^{8}\text{C}\) values measured at depths below 2000 m in 1970 and 1989 to 1991 (Fig. 3) indicates that there is no systematic offset in the data sets. The average difference between 14 pairs of samples collected at comparable locations and depths below 2000 m was −0.01 ± 0.06 per mil.

The largest decreases in mixed layer and depth-integrated \(^{8}\text{C}\) values occurred in the subtropical gyres; smaller decreases occurred in the equatorial and subpolar oceans (Fig. 4 and Table 1). These \(^{8}\text{C}\) trends are consistent with the increase in mixed layer and depth-integrated \(^{14}\text{C}\) activity (Fig. 4 and Table 2) resulting from nuclear weapons testing (13). The similarity of these carbon isotope changes is not surprising because both the \(^{13}\text{C}\) and \(^{14}\text{C}\) perturbations are input to the ocean by way of CO₂ gas exchange and affected by the same basin-wide patterns of upwelling and downwelling within the upper portion (<1000 m) of the Pacific Ocean. The
oceanic $^{13}$C and $^{14}$C changes are not likely to be completely correlated because the atmospheric source functions differ. The magnitude of the oceanic $^{13}$C and $^{14}$C changes indicate where these anthropogenically derived carbon tracers have accumulated and not, necessarily, where they have entered the ocean. For example, the small changes in the mixed layer $^{13}$C and $^{14}$C south of 50°S (Fig. 4) do not imply that there has been no anthropogenic CO$_2$ or bomb $^{14}$C uptake in this region.

We estimate an oceanwide decrease in the depth-integrated $^{8}$C by normalizing our measurements at seven sites to the increase in depth-integrated $^{14}$C activity resulting from atmospheric nuclear testing (bomb $^{14}$C) measured at nearby stations during GEOSECS (Table 2). The relation between the decrease in $^{8}$C values and increase in bomb $^{14}$C activity (Fig. 5) is:

$$^{13}C = -18.2^{14}C - 55.7,$$

where $^{13}$C is the depth-integrated decrease in $^{8}$C in per mil meters and $^{14}$C is the depth-integrated increase in $^{14}$C activity in $10^9$ atoms per square centimeter. The standard error (SE) of the slope and intercept is 5.0 and 45.2, respectively. From the oceanwide average bomb $^{14}$C burden of $8.4 \times 10^9$ atoms of $^{14}$C per square centimeter measured during GEOSECS (13), we calculate that the average ocean-wide decrease in depth-integrated $^{8}$C values was $208 \pm 45$ per mil meters; the uncertainty is the standard error of the estimate derived from the regression analysis.

Time rates of change of atmospheric $^{13}$CO$_2$ and $^{14}$CO$_2$. In order to determine the amount of fossil fuel CO$_2$ taken up by the oceans from the change in the $^{13}$C/$^{12}$C ratio of the DIC in the ocean between 1970 and 1990, we must examine the change in the $^{13}$C/$^{12}$C ratio and concentration of atmospheric CO$_2$ that occurred over this time interval. The change of atmospheric CO$_2$ concentrations between 1970 and 1990 depends on the time-integrated CO$_2$ releases from fossil fuel combustion and cement production ($S_{fr}$) and the biosphere ($S_{br}$), CO$_2$ uptake by the biosphere ($S_{br}$), and net CO$_2$ uptake by the ocean ($S_{o}$). This dependency is expressed as:

$$V(C_t - C_o) = (S_{fr} + S_{br} - S_{bu} - S_{o})\Delta t$$

where $V$ is the volume of the atmosphere ($3.9 \times 10^{18}$ m$^3$), $C$ is the atmospheric CO$_2$ concentration (grams of carbon per cubic meter), $t$ refers to 1990, $o$ refers to 1970, $S$ is a CO$_2$ source or sink flux (grams of carbon per year), and $\Delta t$ is 20 years. Because 99% of the carbon atoms exist as the $^{12}$C isotope, Eq. 1 represents essentially the time rate of change of the $^{12}$CO$_2$ species. The net biospheric CO$_2$ flux is represented by $S_{br} - S_{bu}$.

Because the net oceanic CO$_2$ uptake between 1970 and 1990 equals the oceanwide increase in the depth-integrated concentration of DIC, Eq. 1 can be expressed as:

$$v(C_t - C_o) = (S_{fr} + S_{br} - S_{bu})\Delta t$$

where $A_{oo}$ is the global ocean surface area ($361 \times 10^{12}$ m$^2$), DIC is the DIC$^{12}$C concentration (grams of carbon per cubic meter), and $x$ is ocean depth.

The change of the concentration of atmospheric $^{13}$CO$_2$ between 1970 and 1990 can be expressed, with the use of a formulation similar to Eq. 2, as:

$$v[C_t (^{13}C/^{12}C)_{at} - C_o (^{13}C/^{12}C)_{oa}]$$

$$= [S_{fr} (^{13}C/^{12}C)_{at} + S_{br} (^{13}C/^{12}C)_{br} - S_{bu} (^{13}C/^{12}C)_{bu}]\Delta t$$

where $S_{fr}$ is the atmospheric CO$_2$ production, $S_{br}$ and $S_{bu}$ represent the isotopic compositions of CO$_2$ in the atmosphere, CO$_2$ released from fossil fuel combustion and cement production, and CO$_2$ released from and taken up by the biosphere, respectively. $(^{13}C/^{12}C)_{at}$ represents the isotopic composition of oceanic DIC.

In order to determine the change in the atmospheric $^{13}$CO$_2$ concentration in terms...
of the measured change in the depth-integrated $^{13}$C/$^{12}$C ratio of the DIC, the change in the oceanic DIC $^{13}$C concentration is expressed as the sum of the changes in the oceanic DIC $^{13}$C concentration and the $(^{13}$C/$^{12}$C) of the DIC, as follows:

$$
[DIC]_{(^{13}$C/$^{12}$C)$_{atm} - DIC]_{(^{13}$C/$^{12}$C)$_{D}] + [DIC]_{(^{13}$C/$^{12}$C)$_{atm} - (^{13}$C/$^{12}$C)$_{D}]$$

The change in atmospheric $^{13}$CO$_2$ concentration can be expressed as:

$$
V[C_t} (^{13}$C/$^{12}$C)$_{atm} - C_o (^{13}$C/$^{12}$C)$_{atm}] = \left[\int \frac{DIC_t - DIC_o}{DAC\Delta} dt\right]
$$

where the $\{DIC_t]$ and $(^{13}$C/$^{12}$C)$_{atm} ]$ terms represent values averaged over the integration depth.

The net oceanic CO$_2$ uptake rate ($S_{oc}$) can be expressed in terms of the measured change in the concentration and $^{13}$C/$^{12}$C ratio of atmospheric CO$_2$ and changes in the depth integrated $^{13}$C/$^{12}$C ratio of the DIC by substituting for $S_{oc}$ and $A_{oc}$ in $\{DIC - D [IC]_D]$ in Eq. 5 as follows:

$$
S_{oc} [\{(^{13}$C/$^{12}$C)$_{atm} - (^{13}$C/$^{12}$C)$_{D}] = S_{fr} [(^{13}$C/$^{12}$C)$_{fr} - (^{13}$C/$^{12}$C)$_{D}] + S_{bu} [(^{13}$C/$^{12}$C)$_{bu} - (^{13}$C/$^{12}$C)$_{D}] + (V/\Delta)[C_t - C_o] (^{13}$C/$^{12}$C)$_{D} + (V/\Delta)[C_t - C_o] (^{13}$C/$^{12}$C)$_{D}$$

Rates of oceanic and biospheric net CO$_2$ uptake. Between January 1970 and 1989 the mean atmospheric CO$_2$ concentration increased from 324.0 to 351.0 ppmv (1). Detailed $^{13}$C measurements have been made only since 1978; between 1978 and 1988 the $^{13}$C concentration decreased from $-7.49$ to $-7.74$ per mil (1). We used an empirical relation between the changes in these data and CO$_2$ concentration ($^{13}$C/$^{12}$C = $-0.0147$ [CO$_2$] - 2.60, where $^{13}$C is in per mil and the CO$_2$ concentration is in parts per million; the SE of the slope and intercept is 0.0019 and 0.65, respectively) to estimate the atmospheric $^{13}$C in 1970 and 1990. The estimated $^{13}$C values were $-7.36$ per mil in 1970 and $-7.76$ per mil in 1990; for the latter value, we assumed that the atmospheric CO$_2$ concentration was 351.5 ppmv in January 1990, which was determined by a regression between CO$_2$ concentration and time derived from values measured between 1978 and 1988 (1). The oceanic change in the depth-integrated $^{13}$C/$^{12}$C ratio between 1970 and 1990 was $-208$ per mil meters based on our measurements in the Pacific Ocean and an oceanic extrapolation with the use of the bomb $^{14}$C burden, as discussed above. In order to determine $S_{oc}$ we assumed that the depth-averaged concentration of DIC in 1970, $[DIC]_{atm}$, was 2 mmol liter$^{-1}$ and that the depth-averaged $^{13}$C value for the DIC in 1990, $[(^{13}$C/$^{12}$C)$_{atm}]$, was 1.7 per mil on the basis of our measured values in the Pacific Ocean.

The amount of CO$_2$ released from fossil fuel combustion and cement production is estimated to have been 101.6 Gt of CO$_2$ between 1970 and 1990, on average 5.1 Gt yr$^{-1}$ (16). During the same period, the atmospheric CO$_2$ increase was 58 Gt of carbon or 2.9 Gt yr$^{-1}$, that is, 57 percent of the fossil fuel release. Our calculations indicate that the net oceanic uptake ($S_{oc}$) was 42 Gt of carbon C or 2.1 Gt yr$^{-1}$, that is, 41 percent of the industrial CO$_2$ release; we have assumed that the flux and time rate of change terms represented in Eq. 6 were constant between 1970 and 1990. If Eq. 1 properly represents all the major carbon reservoirs, then there has been little net CO$_2$ release from the biosphere, that is, $S_{oc} - S_{bu} = -0.1$ Gt of carbon per yr during the last 20 years. If deforestation was occur-
ring at 1.6 ± 0.8 Gt of carbon per year between 1970 and 1990 (16, 17), then the biosphere grew by almost an equivalent amount during this period. These results are similar to the conclusions reached a decade ago (18), but are not dependent on ocean ventilation models used for those and subsequent calculations of oceanic CO$_2$ uptake.

We evaluated the error of the calculated values of $S_{oc}$ using a numerical bootstrap procedure (19). The uncertainties in the three measured time rates of change were ±45 per mill for the depth-integrated $^{13}$C/$^{12}$C ratio (equal to the standard error of the estimate derived from the regression analysis of the depth-integrated $^{14}$C and $^{13}$C changes, as discussed above), and ±0.2 ppm and ±0.03 per mill for the changes of the concentration and depth-integrated $^{13}$C value of atmospheric CO$_2$, respectively (1). We estimated the uncertainties in $S_{bio}$, $S_{atm}$ ($^{14}$C/$^{12}$C)$_{atm}$, and $(^{13}$C/$^{12}$C)$_{bio}$ to be ±30 and ±10 percent and ±2 and ±1 per mill, respectively. The difference in $^{14}$C values between CO$_2$ currently fixed into and released from woody plant material was taken as ±0.6 ± 0.4 per mill. The estimated uncertainties in [DIC]$_{atm}$ and $(^{13}$C/$^{12}$C)$_{atm}$ were ±2 percent and ±0.3 per mill, respectively. On the basis of these uncertainties, we devised an error (±1 standard deviation) of ±15 Gt of carbon for $S_{oc}$ and $S_{atm}$. The error in $S_{bio}$ and $S_{atm}$ depends on primarily (about 50 percent) the uncertainty in the magnitude of the depth-integrated change in the $^{13}$C/$^{12}$C ratio of the DIC.

The uncertainty in $S_{oc}$ depends mainly on how well the measured depth profiles of the change in $^{14}$C values from 1970 to 1990 represent the entire ocean. Thus, improved estimates of $S_{oc}$ will be possible as more station comparisons are made, especially when $^{13}$C data from the Indian and Atlantic oceans are obtained. With the data available, the seven profiles we have compared appear to be fairly representative of the global ocean. The average decrease in $^{13}$C values for the mixed layer at these seven sites was 0.39 per mill, close to the Pacific Ocean average of 0.40 per mill, which is derived from the data presented in Fig. 2. For the GEOSECs stations in close proximity to the stations where the $^{13}$C values were compared, the average bomb $^{14}$C burden of 8.1 × 10$^9$ atoms $^{14}$C per square centimeter is close to the oceanwide average of 8.4 × 10$^9$ atoms $^{14}$C per square centimeter (13). The mean depth-integrated change in $^{13}$C values at the seven stations was −202 per millimeters at the oceanwide mean −208 per millimeters value derived from the bomb $^{14}$C normalization procedure. Our measurements indicate that the average penetration depth of the change in $^{14}$C values over the last 50 years was 520 m, that is, the depth-integrated $^{13}$C decrease divided by the mixed layer decrease (208 per millimeters/0.4 per mill).

This $^{13}$C depletion is consistent with the average ocean-wide penetration depth of about 350 m determined for the bomb-produced $^{14}$C (13) after consideration of the shorter time history (about 10 years) of the $^{14}$C perturbation at the time of measurement (1972 to 1978).

The measured time rates of change of atmospheric and oceanic $^{13}$C/$^{12}$C ratios yield values for oceanic net CO$_2$ uptake.

Table 2. The increase in $^{14}$C activity produced from testing of nuclear weapons measured at seven GEOSECs stations in the Pacific Ocean (13). These stations correspond to the stations listed in Table 1. The mixed layer $^{14}$C changes are in per mill (20) and the depth-integrated changes are in 10$^8$ atoms per square centimeter.

<table>
<thead>
<tr>
<th>Station</th>
<th>Lat.</th>
<th>Long.</th>
<th>Date</th>
<th>Mixed layer</th>
<th>Depth integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>213</td>
<td>31.0N</td>
<td>168.5W</td>
<td>9/73</td>
<td>237</td>
<td>11.3</td>
</tr>
<tr>
<td>227</td>
<td>20.0N</td>
<td>170.1E</td>
<td>11/73</td>
<td>235</td>
<td>11.1</td>
</tr>
<tr>
<td>334</td>
<td>0.1N</td>
<td>124.6W</td>
<td>5/74</td>
<td>143</td>
<td>3.5</td>
</tr>
<tr>
<td>351</td>
<td>4.6S</td>
<td>125.1W</td>
<td>5/74</td>
<td>111</td>
<td>2.4</td>
</tr>
<tr>
<td>262</td>
<td>16.7S</td>
<td>176.0W</td>
<td>1/73</td>
<td>187</td>
<td>8.9</td>
</tr>
<tr>
<td>303</td>
<td>38.6S</td>
<td>170.1W</td>
<td>3/73</td>
<td>160</td>
<td>10.6</td>
</tr>
<tr>
<td>296</td>
<td>44.9S</td>
<td>166.6W</td>
<td>3/73</td>
<td>135</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Table 1. Change in the $^{813}$C value of dissolved inorganic carbon in the mixed layer (in per mill) and integrated over depth in the Pacific Ocean (in per mill meters). Data for stations TOW-7, SCAN10, and ANTIPODES 15 are from Kroopnick (17). Lat., latitude; Long., longitude; HUD, HUDSON.

<table>
<thead>
<tr>
<th>Station</th>
<th>Lat.</th>
<th>Long.</th>
<th>Date</th>
<th>Mixed layer</th>
<th>Integrated</th>
</tr>
</thead>
<tbody>
<tr>
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<td>150W</td>
<td>5/70</td>
<td>23N</td>
<td>0.42</td>
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<tr>
<td>TOW 17-146</td>
<td>20N</td>
<td>166W</td>
<td>6/70</td>
<td>21.6N</td>
<td>0.25</td>
</tr>
<tr>
<td>HUDD EO</td>
<td>0S</td>
<td>150W</td>
<td>5/70</td>
<td>0.25</td>
<td>0.39</td>
</tr>
<tr>
<td>SCAN 10-38</td>
<td>6S</td>
<td>107W</td>
<td>1/70</td>
<td>4S</td>
<td>0.46</td>
</tr>
<tr>
<td>ANT 15-06</td>
<td>16.5S</td>
<td>170W</td>
<td>8/71</td>
<td>16.5S</td>
<td>0.41</td>
</tr>
<tr>
<td>HUD 282</td>
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<td>150W</td>
<td>5/70</td>
<td>37.5S</td>
<td>0.57</td>
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<tr>
<td>HUD 280</td>
<td>50S</td>
<td>150W</td>
<td>5/70</td>
<td>44S</td>
<td>0.24</td>
</tr>
</tbody>
</table>
what we know, or are troubled by, but don’t know that we know (or don’t admit that we are troubled by) because we don’t have a satisfying explanation.

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REFERENCES

The Search for Eve

Marcia Barinaga’s article “African Eve” backers beat a retreat” concerning the debate about modern human origins (Research News, 7 Feb., p. 686) contains many examples of the kind of thinking that still plagues the study of human evolution. It was clear by 1987 that new methods of phylogenetic analysis for reconstructing human history would be necessary, and not just new DNA sequences from more people or a 4.0 version of some existing software package that violated present knowledge of the system (unequal sample sizes and varying rates of evolution).

Breakthroughs in extraction of DNA from human fossils must now be accompanied by better methods to absorb large data sets for analysis of variance and clustering. DNA sequences from actual fossils, not reconstructed hypothetical ancestors, are the key. Further arguments are tedious and wasteful of limited resources and predispose observers to equate evolutionary biology with street theater.

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Corrections and Clarifications

The News & Comment article “Wilson slashes spending for antismoking effort” by Marcia Barinaga (13 Mar., p. 1348) erroneously stated that the California legislature approved the shut-down of California’s antismoking ad campaign. The legislature approved the removal of $29 million from the smoking-initiative budget, but those funds do not influence the ad campaign. The ad campaign funding was removed by an action of the governor that did not have legislative approval.

In Joseph Palca’s News & Comment article “AAAS in Chicago: Dawn of a new era” (21 Feb., p. 918), University of Miami philosopher Kenneth Goodman’s name was inadvertently misspelled.

The name of the associate vice chancellor for research at the University of Illinois, Tina Gundersen, was inadvertently misspelled in the News & Comment article “What’s left on the table” by David P. Hamilton (13 Mar., p. 1345).

AAAS–Newcomb Cleveland Prize

To Be Awarded for an Article or a Report Published in Science

The AAAS–Newcomb Cleveland Prize is awarded to the author of an outstanding paper published in Science. The value of the prize is $5000; the winner also receives a bronze medal. The current competition period began with the 7 June 1991 issue and ends with the issue of 29 May 1992.

Reports and Articles that include original research data, theories, or syntheses and are fundamental contributions to basic knowledge or technical achievements of far-reaching consequence are eligible for consideration for the prize. The paper must be a first-time publication of the author’s own work. Reference to pertinent earlier work by the author may be included to give perspective.

Throughout the competition period, readers are invited to nominate papers appearing in the Reports or Articles sections. Nominations must be typed, and the following information provided: the title of the paper, issue in which it was published, author’s name, and a brief statement of justification for nomination. Nominations should be submitted to the AAAS–Newcomb Cleveland Prize, AAAS, Room 924, 1333 H Street, NW, Washington, D.C. 20005, and must be received on or before 30 June 1992. Final selection will rest with a panel of distinguished scientists appointed by the editor of Science.

The award will be presented at the 1993 AAAS annual meeting. In cases of multiple authorship, the prize will be divided equally between or among the authors.