Environmental sex determination in reptiles

SIR—Interest in environmental sex determination (ESD), particularly in reptiles, is growing, shown, for example, by the discussion in ref. 1.

Perhaps the most exciting speculations have centred on the phylogeny of sex-determining mechanisms in reptiles. The consensus appears to be that presence of genotypic sex determination in reptilian groups has evolved recently[1-3], with ESD being the plesiomorphic condition. This suggestion has prompted speculation concerning the cause of the extinction of dinosaurs at the end of the Cretaceous. As the story goes, dinosaurs possessed ESD and, when global temperatures dropped, offspring of only one sex were produced, effectively extinguishing the species[1,4,5]. Yet there is a disturbing aspect to this model. If changes in global temperatures selectively extinguished dinosaurs because they possessed ESD, then how can the persistence of many extant reptilian species which possess ESD be explained? Turtle, lizard and crocodilian species all crossed the Cretaceous–Tertiary boundary without showing significant extinction[6]. Further, the disappearance of viviparous dinosaurs (such as ichthyosaurs) that vanished before the end of the Cretaceous, and which probably had genotypic sex determination, must be explained.

In all likelihood, ESD did evolve during ancient times, but perhaps under conditions differing from those that exist today. Thus, attempts to ascertain the 'advantages' of ESD for extant reptiles could be misleading. Persistence of ESD in many reptilian species may not be adaptive; its presence merely may not be maladaptive. We suggest that biologists interested in mechanisms of sex determination in reptiles undertake carefully designed studies to address such mechanisms, rather than muddy the waters of empiricism with unfounded speculation.

Those species with genotypic sex determination may be the animals on which attention should be focused, because it seems more likely that their systems have evolved recently and for good reason.

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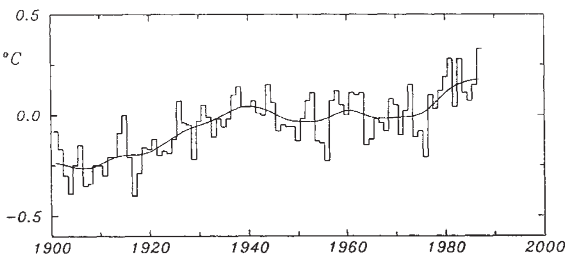
Evidence for global warming in the past decade

SIR—The global-mean surface air temperature is the most common measure of the state of the climate system. Variations of this parameter are probably determined largely by the sensitivity of the climate system to external forcing factors such as solar output, explosive volcanic eruptions and the changes in concentration of CO_2 and other radiatively active gases. Understanding the climate's response to changes in forcing is essential if we are ever to forecast future climatic change.

Increases of CO_2 and other radiatively active trace gases (methane, chlorofluorocarbons, nitrous oxide and tropospheric ozone) are expected to raise global equilibrium general circulation models[1] for a doubling of atmospheric CO_2. Up to now, the rise in equivalent CO_2 concentration (incorporating the radiative effects of the other trace gases) has lifted levels about 40% above their preindustrial level of around 280 p.p.m.v. (ref. 2).

In 1986, some of us reported[3] the first compilation of global mean temperature estimates, spanning the period 1861–1984. We have now extended this analysis to include 1985–87 and to improve the ocean and land coverage for the 1980s. The improved coverage for the 1980s slightly alters the original values for 1980–84. Our new estimates use the comprehensive ocean atmosphere data set (COADS) sea-surface temperature (SST) data for 1980–86. For the marine regions for 1987, we used SST data from the UK Meteorological Office. SST data are a good substitute for air temperature over the oceans[4]. These two sources of SST data are in excellent agreement during the 1980s. We have also updated the land temperature series for the two hemispheres[5-7].



Global surface air temperature, 1901–1987.

The time series for the land and marine areas for 1901–87 is shown in the figure. 1987 is the warmest year recorded, 0.05 °C above the next warmest, 1981 and 1983. The warmth of the 1980s is most evident in the Southern Hemisphere. Here, seven of the eight warmest years have occurred during the 1980s, with 1987 being the warmest. Warmth over the Northern Hemisphere in the 1980s is not so startling, yet the two warmest years are 1981 (the warmest) and 1987.

The global land air temperature in 1987 is about the same as the previous maximum in 1981 (updating ref. 8), the difference in the analysed temperatures for these years being less than the uncertainty caused by incomplete station coverage. The warmth is not just a surface phenomenon. The global radiosonde data network[9], which began in 1958, also confirms the warmth of the 1980s both at the surface and in the lower troposphere, particularly in 1981, 1983 and 1987. The network also provides data for the stratosphere, a region that models suggest should become increasingly cold as CO_2 levels increase. For global mean lower-stratospheric temperatures, the coldest years are 1985, 1986 and 1987.

It is likely that the record warmth in 1987 partly resulted from the strong 1986–87 El Niño/Southern Oscillation (ENSO) event[10,11], although this event was not as intense as the one in 1982–83. It is also possible that the stratospheric coldness in recent years is partly associated with the recent ozone depletion[12,13]. Nevertheless, the persistent surface and tropospheric warmth of the 1980s which, together with ENSO, gave the exceptional warmth of 1987 could indicate the consequences of increased concentrations of CO_2 and other radiatively active gases in the atmosphere.

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