Letters

Regulation of PCBs

In his editorial "Excessive fear of PCBs" (26 July, p. 361) Philip H. Abelson distinguishes among the different industrial formulations of polychlorinated biphenyls (PCBs). He points out that the many less toxic congeners, especially the lower chlorinated ones, are eliminated by biological and chemical breakdown. However, more highly chlorinated congeners, non-ortho chlorinated congeners, and mono-ortho chlorinated congeners remain. These toxic congeners have been found in concentrated amounts in breast milk, fish, and meat (*1*). The Schaeffer study (*2*), cited by Abelson, is most pertinent for individuals who have been exposed to industrial mixtures (for example, for certain electrical workers).

A logical approach would be to identify the PCB congeners in food and environmental samples and calculate risk on the basis of actual PCB presence rather than on the basis of a comparison with a rather unrelated parent PCB formulation. Unfortunately, data about the long-term toxicity of individual PCB congeners and PCB mixtures in the food chain are lacking. Until further studies address these issues, adherence to current regulations based on Aroclor 1260 seems reasonable.

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Abelson argues that because PCBs with a chlorine content of 54% or less have not been shown to cause cancer at a rate which is statistically significant, their intensive regulation is not warranted. However, the non-cancerous health effects of PCBs and dioxins should be a major concern. Adverse physiological effects have been associated not only with 18 dioxin-like PCB congeners (*1*), but with a number of non-coplanar congeners, including lesser chlorinated congeners (*2*).

Current regulations are based on effects seen in adult organisms. Yet evidence from studies of wildlife and laboratory mammals shows that organisms exposed to PCBs and dioxins during embryogenesis and the perinatal period suffer different health consequences than do adults exposed to these same chemicals (*1, 3*).

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Reproductive dysfunction has been demonstrated in studies in which PCBs were fed to mammals. Abortions, stillbirths, neonatal mortality, low birth weights, and other effects have been noted in mink, European ferrets, white-footed mice, monkeys, and seals—all of which are more sensitive to PCB exposure than are laboratory rats (*1*). These effects were produced with concentrations of PCB similar to those found in some wildlife habitats.

High concentrations of PCBs have been found in the tissues of pinnipeds and cetaceans at the top of marine food webs (*2*). Rather than slowly disappearing, PCB concentrations are expected to increase in the world's oceans from PCBs that have already been produced (*3*). Our knowledge about the environmental occurrence and toxicity of specific PCB congeners is in its infancy. Further research is required in these areas before the scientific community can provide regulators with a clean bill of health for PCBs. Formulations resulting in such effects include Aroclors 1254, 1248, and 1242; as well as the pure 3,4,5, 3′,4′,5′-hexachlorobiphenyl congener.

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Sources of Acidity in Surface Waters

On the basis of predominance of nitrate and nonmarine sulfate, L. A. Baker *et al.* (Reports, 24 May, p. 451) conclude that 75% of lakes and 47% of streams surveyed in the eastern United States (*1*) that are acidic (acid neutralizing capacity ≤ 0) are so because of acidic deposition. Yet they also acknowledge research showing that such deposition-dominated waters were critically acidic before receiving acid deposition.

Baker *et al.* contend that the number of affected surface waters is even greater than stated above because biological effects are observed "when pH declines below 6.0 or even 6.5." While they discussed it extensively, Baker *et al.* did not report the key finding of Phase II of the Paleolimnological Investigation of Recent Lake Acidification project (PIRLA II): the average Adirondack lake is no more acidic now (1984 median pH = 6.37) than before acidic deposition (1844 median pH = 6.32) (*2*).

The PIRLA II finding is consistent with that of the Direct/Delayed Response Project (DDRP), which did not find any correlation between acidic deposition and surface water acidity, but did find surface water acidity to be correlated with watershed soil chemistry and land use (*3*).

The DDRP findings are consistent with a comprehensive compilation of soil experiments which show that, contrary to the large pH depressions predicted by anion dominance, acidic deposition has little measurable effect on the pH of water issuing from acidic soils: the correlation between "clean rain" and "acid rain" leachate pH is $R^2 = 0.989$; $n = 20$ (*4*).

That critically acidic clear and colored surface waters are comparatively common in acid soil regions of the world in the absence of acid rain (*4, 5*) further indicates the need to revisit assessments of aquatic acidification.

Finally, eastern forests are recovering from essentially pervasive cutting and burning (*6*). It is well known that forest recovery in extremely "acid-sensitive" watersheds makes soils and vegetation even more acidic than before disturbance occurred (*7*). Until such watershed acidification is scientifically studied, given the strong influence of soil acidity on water acidity, statements about the cause of any aquatic acidification that may be observed are speculation.

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4. E. C. Krug, in *Plant-Soil Interactions at Low pH*, R. J. Wright, V. C. Baliger, R. P. Murman, Eds. (Kluwer Academic, Boston, MA, 1991), pp. 123–138.
5. ———, *Assessment of the Theory and Hypotheses of the Acidification of Watersheds* (Report 457, Illinois State Water Survey, Champaign, IL, 1989).
6. For example, only 61,000 acres of the original 100 million acres of Northeast forest remains as virgin or old-growth forest [E. C. Krug and A. S. Lefohn, *J. Air Poll. Control Assoc.* **40**, 846 (1990)]; "Logging and fires changed the Adirondacks more drastically and rapidly than any factors since these mountains first rose above the sea" [G. D. Davis, *Man and the Adirondack Environment: A Primer* (Adirondack Historical Association, Blue Mountain Lake, NY, 1977), p. 36].
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Response: Krug and Warnick's comparison of median pre-industrial and current pH values gives a misleading picture of acidification history. Data from Phase II of the Paleolimnological Investigation of Recent Lake Acidification project (PIRLA II) (*1*) show that Adirondack lakes with a current pH of 6.0 or less (40% of the PIRLA II population) have undergone declines in pH, whereas lakes with a current pH of more than 6.0 (60% of the population) generally have not. Thus, for Krug and Warnick to state that "the average Adirondack lake is no more acidic now . . . than before acidic deposition" obscures the fact that acidification has occurred in more than one-third of the study lakes. PIRLA II data show that 80% of currently acidic [acid neutralizing capacity (ANC) ≤0] lakes have undergone a pH decline of more than 0.5 units (maximum = 1.0) with concomitant increases in toxic aluminum concentrations (*1, 2*). Other paleolimnological studies show that deposition-induced acidification has occurred in northern New England, southern Canada, and northern Europe; studies in low deposition areas indicate no acidification trends (*3*).

A key conclusion from geochemical studies is that acidification occurs only in watersheds with a low capacity for neutralizing acidic inputs. Because sensitive and nonsensitive watersheds are intermixed within any region (even within the Adirondacks), the absence of a simple correlation between acidic deposition and surface water acidity (*4*) is not unexpected.

Krug and Warnick overstate the importance of acidic soils in controlling surface water pH. For example, the Direct/Delayed Response Project (*4*) shows that soils in low-ANC watersheds in both Maine and the Adirondacks are acidic and virtually identical at the series level, yet only 1% of the Maine lakes (median wet sulfate loading of 14 kilograms per hectare per year) are acidic, compared with 14% of the Adirondack lakes (median wet sulfate loading of 29 kilograms per hectare per year) (*5*). Forest regrowth and other changes in land use also affect the acid-base chemistry of surface waters, but they cannot account for the observed pattern of recent acidification (*6*).

Most of the acidic surface waters in low deposition areas (such as the Amazon's Rio Negro basin) in papers cited by Krug and Warnick are highly colored systems that would fit into our organic-dominated category (*5*). Acidic waters with low dissolved organic carbon concentrations are rare in low deposition areas, occurring only in association with geological sources of sulfate (for example, with geothermal springs or acid mine drainage) and possibly in conjunction with extreme marine salt influence (*5*).

After 10 years of intensive acidification research, the conclusion that acidic deposition causes surface water acidification can scarcely be called "speculative." Regional chemical analysis, paleolimnological studies, experimental watershed studies, and geochemical theory all support our conclusion that acidic deposition has caused acidification of many U.S. lakes and streams (*7*).

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Imagine my surprise to see a photograph of Louis Leakey in ScienceScope (16 Aug., p. 727) captioned "Would Richard Leakey have sided with the biologists or the social scientists?" If you really want to know what Richard thinks about anything, just ask him. If, however, you are referring to his famous father, who is deceased, the answer to the question is of course debatable.

More to the point, Mary Leakey, Richard's equally famous mother, is very much alive. Her views about the merits of a proposed National Science Foundation directorate for the social sciences are certainly as informed by experience and knowledge as those that Louis Leakey might have expressed.

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