Linear scale for acid rain?

SIR — "Acid rain" is a scientific issue for which careful presentation of results is of considerable importance, especially as the issue has entered the domain public debate in the United Kingdom. It is therefore right to ask whether we always present the results of acidity measurements of rainfall and freshwaters in the most appropriate way. The answer, I believe, may be no.

The acidity of rainfall and freshwater bodies is commonly reported in terms of the *p*H. This is a long established scale and one that is particularly convenient for expressing concentrations of hydrogen (H^+) ions (strictly speaking H^+ activity) when they range over several orders of magnitude. Difficulties in its use can arise from a failure to recognize that, being logarithmic, the *p*H scale is not linear. Confusion on this count, particularly in nonscientific circles is easy to imagine. Even in scientific circles a drop in *p*H of say 0.5 units appears at times to be treated as being equivalent, whether it occurs from *p*H 6.0 or from *p*H 5.0. In fact, the former case represents an increase in the H^+ ion concentration of some 2 microequivalents per litre, the latter of around 22 microequivalents per litre.

To give a more specific example, definition of trends over time in acidity levels has been commanding a great deal of attention. This is of some importance in establishing the relationship between emissions of sulphur dioxide and nitrogen oxides and subsequent acidification of the environment. Unfortunately, records of *p*H measurements of both rainfall and natural water bodies go back only several decades and even then there are problems over the continuity and quality of the data. Diatom stratigraphy in lake cores appears to provide one means of overcoming these problems, as demonstrated in the recent paper by Flower and Battarbee[1]. By measuring the changes in the diatom population in a ^{210}Pb dated sediment core they were able to reconstruct the *p*H history of a lake in the south-west of Scotland over the last 400 years or so (Fig. 1*a*).

It is at this point, however, that caution needs to be exercised. Interpreting trends on the basis of the data as presented in Fig. 1*a* is not straightforward, due to the use of *p*H on the abcissa. Expressing the results in terms of H^+ ion concentration on a linear scale gives a significantly different impression of the trend over time in this lake (Fig. 1*b*).

To emphasize this point, the results in Fig 1*a* indicate that about half the total change in *p*H had taken place by around 1900. Furthermore, almost all of the change had taken place by 1930 with very little change after 1940. In other words the major *p*H change took place early in the first half of the present century. But in terms of H^+ ion concentration, half of the change had taken place by the later date of around 1920, while there was a further steep increase from around 1950 to the present (Fig. 1*b*).

The use of a linear representation of concentrations provides the most appropriate means of representing the magnitude of any changes in concentration. (This is not to say though that effects are necessarily related linearly to concentration.) It is therefore encouraging to see a move to the use of a linear scale in reporting rainfall chemistry data in the United Kingdom[2]. Indeed a widespread adoption of the linear concentration scale when reporting H^+ ion concentrations, especially in acidic rainfall and freshwaters, would appear to be overdue.

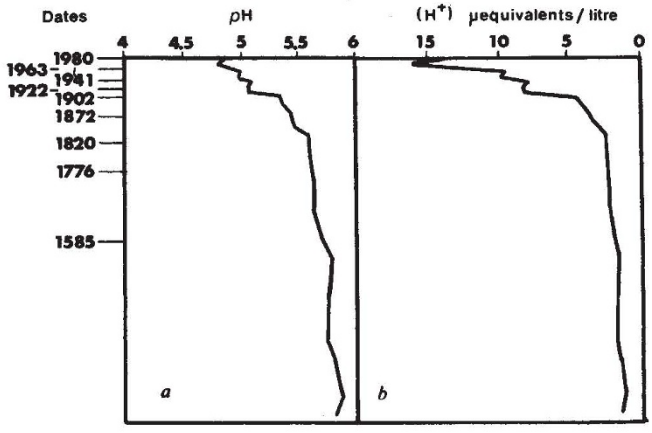

Fig. 1 Reconstruction of H^+ ion concentration history in Round Loch of Glenhead. *a*, Using *p*H scale (logarithmic); *b*, using linear concentration scale. (Based on ref. 1.)

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1. Flower, R.J. & Battarbee, R.W. *Nature* **305**, 130–133 (1983).
2. Barrett, C.F. *et al. Acidity of Rainfall in the United Kingdom — A Preliminary Report* (Warren Spring Laboratory, Stevenage, 1982).

Alphabet and the Western mind

SIR — The unprecedented genius of Greece is unexplained. I conjecture that the modern study of the mind provides some tentative answers.

Before the Golden Age of Greece, the Greeks had developed their alphabet. This writing system is unique in possessing, by symbolizing vowels as well as consonants, a fully phonetic representation of language. This is achieved at the cost of limiting the representation of writing in the brain, as only the left cerebral hemisphere contains areas which are competent in the required phonetic analysis[1]. This has led to the ubiquity of the association, in the alphabet-dominated modern world, between injuries to the left hemisphere and impairments of writing and reading skills. This, however, is not a necessary restriction with all writing systems. Non-phonetic writing systems can use reading strategies involving the right hemisphere. Indeed, neurological studies show that hemispheric representation of non-alphabetic writing systems differs markedly from that encountered with alphabetic ones. Hatta[2,3] and others[4,5] have shown that logographic characters are more efficiently recognized by the right hemisphere. Sasanuma[6] has shown that *Kanji*, the non-phonetic writing system of Japanese, is vulnerable to different areas of brain injury from *Kana*, the phonetic system of Japanese writing.

There is evidence that reading retardation is associated with reduced involvement of the left hemisphere in reading[7]. In its absence such readers rely on the right hemisphere, which has been shown to have the ability to read simple English words independently of the left hemisphere[8]. In the absence of left-mediated phonetic analysis, the reading of frequent lexicals can occur through a non-phonetic strategy of logographically recognizing them from their shapes. It has been shown that retarded readers can learn to read Chinese logograms with their English translations more proficiently than their alphabetic equivalents[9]. Present studies of right hemispheric reading competence uses alphabetic lexicals which require left hemispheric phonetic decoding skills that disadvantage it rather than logographic ones which do not. I therefore suggest that the reading ability of right hemispheres for these and other non-Western writing systems will be found to have been underestimated. The right hemisphere, I conjecture, is fully competent, probably more so than the left hemisphere, to read, at the level of understanding which ancient societies used them, hieroglyphics, logograms and other non-alphabetic writing systems.

There are independent reasons for believing that pre-alphabetic writing systems were represented in the right hemi-