

of herbivore pressure). Janzen chooses to disregard this latter statement of mine (2) reiterating it as his own. His objections are here answered. (i) I have never said that the compounds he cites are all "waste products." But some glycosides (for instance, arbutin and amygdalin) are harmless compounds of deadly toxic moieties which eventually harm the species that too freely deposits them in its environment, as in the peach "replant problem" described by Patrick (3). (ii) The production of immense quantities of a voided toxic compound widely dissipated (as are the volatile terpenes) and the heavy concentration of many non-volatile toxins in senescent leaves or other deciduous organs are indeed indicative of waste products. Animals avoid autointoxication by similar means, even if some species do hide behind their excrement for protection (4). (iii) Janzen's understanding of to "call forth *de novo*" is quite the opposite of mine. I had always assumed that biological characteristics originated ("*de novo*") as mutations, as I have consistently said, and that herbivores then applied selective pressure. (iv) I do not see how anyone could read the last paragraph of my challenged paper and fail to understand that I have said the same thing. I regret that the distinction between the qualities in common of "mutation," "*de novo*," and "primary" on one hand and those of "selection pressure" and "secondary" on the other hand is so difficult to explain. (v) In the condition "if not eliminated or used" lies the crux of the problem. Any chemical compound produced by an organism which is autotoxic if not eliminated is a metabolic waste. Any compound that is metabolically used, whether toxic or otherwise, is not, to the extent that it is used, a waste. *Qua re haec de lana caprina?*

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X-ray Integrated Reflection Coefficient of Lithium Fluoride

Meekins *et al.* (1) have measured the x-ray spectrum of solar flares using Bragg crystal spectrometers aboard the orbiting solar observatory OSO-4 spacecraft. In order to reduce the data to photon flux units, it was necessary to determine the integrated reflection coefficient R for LiF crystal.

In figure 2 of (1) a function designated "integrated reflectivity of LiF" is plotted against wavelength. Examination of their references [see (2)] suggests that this is the quantity usually called the integrated reflection coefficient and is identical to the function R_m below. However, their evaluation appears to be in error and cannot be calculated from diffraction theory, including their references (2). This error should be corrected, because LiF is a useful crystal for x-ray diffraction and will be used more widely in applications where knowledge of the variation of R with wavelength λ is necessary. Furthermore, diffracted intensity from actual LiF cannot be predicted from theory and must be experimentally determined with the actual crystal used. Examples for a typical crystal are shown and are $\frac{1}{4}$ to $\frac{1}{6}$ the values cited in (1).

Diffraction theory (2) predicts the limiting cases of x-ray diffraction from a perfect crystal and from a mosaic crystal. Equations for the integrated reflection coefficient are

$$R_p = \frac{4}{3\pi} N \lambda^3 |F| r_e \left\{ \frac{1 + |\cos 2\theta|}{\sin 2\theta} \right\}$$

$$R_m = \frac{N \lambda^3}{4\mu} |F|^2 r_e^2 \left\{ \frac{1 + |\cos^2 2\theta|}{\sin 2\theta} \right\}$$

where θ is the Bragg angle; λ is the wavelength; N is the number of scattering units, for LiF N is 1.53×10^{22} cm $^{-3}$; F is the structure factor, and for the (200) reflection from LiF at 22°C F is 29.5; r_e is the classical electron radius, 2.82×10^{-13} cm; and μ is the mass absorption coefficient (3). These functions are plotted as solid heavy lines in Fig. 1. The dotted line is from figure 2 in (1) and is about 1.5 times too large. The point 0 on the R_m curve at 1.54 Å is due to a calculation by Renninger (4). Diffraction measurements from LiF do not

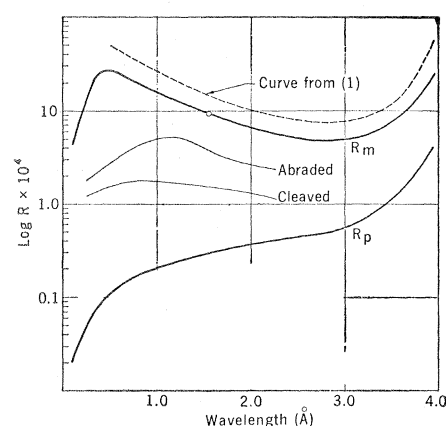


Fig. 1. Integrated reflection coefficient with unpolarized incident x-radiation for LiF (200) calculated for a mosaic crystal R_m and for a perfect crystal R_p . Thin solid lines are experimental data for cleaved and abraded crystals. The dotted curve from (1) is questioned.

agree with either case and fall somewhere in between, varying with each crystal and with surface treatment. Thin lines in Fig. 1 plot data for a typical crystal 1 cm thick with a fresh cleavage face on one side and an abraded surface on the other prepared by polishing on graded paper to a final 600-grit polish, which is a typical treatment for commercial spectrometer crystals. The data was obtained by integrating (1, -1) rocking curves at many points in the indicated wavelength range and correcting to account for the partial polarization of the x-ray beam by the first crystal. The full width at half maximum of the rocking curve was 1 to 2 minutes of arc and 5 to 6 minutes of arc for the cleaved and abraded crystals, respectively (5).

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References and Notes

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5. The value of 20 minutes of arc in (1) appears to be much too large for LiF.
6. I thank D. E. Sayers and R. G. Bingham for assistance in the experimental work and valuable suggestions.

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