Mercury risk from teeth

SIR—Mills in Scientific Correspondence[1] estimated the amount of mercury released into the atmosphere from crematoria. But in the case of the crematorium quoted, Mills assumed that each of the 3,831 people cremated in 1989 had five amalgam fillings in their teeth, based on an estimate[2] that 30% of adults in the United Kingdom had lost all their natural teeth and the rest had 7.5 restorations.

When the age distribution of the population is considered, the total number of deaths in England and Wales in 1988 was 571,408 (ref. 3). Of these, 161,587 (28.3%) were under 65 years old and 409,821 (71.7%) were aged 65 and over (24% aged 65–74 years and 47.7% over 75 years). Furthermore, 57% of the population aged 65–74 years old are edentulous, whereas the corresponding figure for those over 75 years old is 80% (ref. 4). In addition, each of the 59,000 65–74-year olds who has some natural teeth has 5.7 fillings, and only 3.7 teeth have been restored in each of the 54,500 people over 75 years of age.

If we assume that all the fillings are of amalgam, then the weight of mercury released from the 65–74-year-old group is $59{,}000 \times 5.7 \times 0.6$ g, or 201,780 g, and $54{,}500 \times 3.7 \times 0.6$ g, or 120,990 g, from those over 75 years. The number of people under the age of 65 who died was 161,587, each of whom had approximately nine fillings. This accounts for $161{,}587 \times 9 \times 0.6$ g, or 872,570 g, of mercury.

Thus, the maximum weight of mercury released annually in England and Wales is 482 kg. This is a generous estimate as not all restored teeth are of amalgam. Another fact which reduces this figure is that only 68% of the population are cremated[5]. Hence, the total amount of mercury released would be no more than $482 \times 68/100 = 328$ kg. Because this mass would be released by 571,408 individuals, the average mass released from each cremation would be approximately $482/571 \times 68/100 = 0.574$ g. Hence, for the crematorium studied by Mills, the mass of mercury released would be $3{,}831 \times 482/571 \times 68/100$ g, or 2,199 g, and not 11,000 g.

Mills suggests that careful ground and air sampling programmes should be initiated to assess any possible hazard. In the case of ground contamination, one investigation[6] has shown that the mercury contamination in soil in close proximity to a crematorium is no greater than 130 μg kg^{-1} (Mansfield District Council, unpublished report). It should be noted that the number of cremations in 1989 was 2,710 and that the total number of cremations since this crematorium was opened was 63,598 (ref. 7).

Although it can be assumed that no health hazard exists to the public at large, at exposure levels below 1 μg mercury m^{-3} in ambient air[7], the threshold limit value for occupationally exposed individuals is 50 μg m^{-3} over an 8-hour period[8]. In the case of crematoria, mercury may be released over an 8-hour working day, in which case the threshold limit value for this element of 50 μg m^{-3} in ambient air might be appropriate.

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MILLS REPLIES—I am glad that my estimate of the amount of mercury released from crematorium chimneys is probably too large. However, in view of the importance now attached to the safe handling of even small quantities of this toxic element in laboratories and in industry, an emission of 2 kg of the vapour from low chimneys in urban areas is, in my opinion, completely anomalous and a real cause for concern. Also, this figure may be expected to rise because of the increasing popularity of cremation and improved long-term dental care of the general population until an effective non-mercurial substitute for amalgam becomes both available and numerically significant. I therefore continue to call for careful air and soil surveys around operating crematoria, with the methods and results to be published in the open scientific literature.

I also query the Basu *et al.*'s proposed threshold limit value of 50 μg m^{-3}: because the general population (unlike a factory workforce) will include pregnant women, babies and young children, I prefer Gerstner and Huff's figure[7] of 1 μg m^{-3}. A limit for mercury should certainly be incorporated in regulations governing emissions from crematoria.

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Plants without chlorophyll

SIR—dePamphilis and Palmer report[1] that the plastid DNA of the achlorophyllous flowering plant *Epifagus virginiana* has lost numerous photosynthetic and *ndh* genes, while retaining ribosomal RNA, transfer RNA and ribosomal protein genes, open reading frames and the inverted repeat — they ask "why does *Epifagus* maintain a plastid genome?". We suggest that the remnant genome is necessary for biosynthesis of haem for mitochondria and other organelles, which will still be required by an achlorophyllous plant.

The available evidence indicates that the early stages of porphyrin biosynthesis in plants (leading to haem as well as chlorophyll) are restricted to plastids in non-photosynthetic as well as photosynthetic tissues. In particular, the enzymes 5-aminolaevulinic acid dehydratase and porphobilinogen deaminase (which catalyse early steps in porphyrin biosynthesis) are confined to plastids in pea leaves and *Arum* spadices[2]. The latter enzyme is also found in plastids of *Euglena*, streptomycin-bleached mutants of *Euglena*, and *Astasia longa*[3] (a morphologically similar achlorophyllous alga that, like *Epifagus*, retains a plastid genome depleted of genes for photosynthetic proteins[1]).

Furthermore, plant haem is labelled by glutamate (used as a precursor in the plastid) rather than glycine (used as a precursor in mitochondria from other organisms)[4]. Within the plastid, formation of 5-aminolaevulinic acid from glutamate for porphyrin biosynthesis requires activation of the glutamate by a plastid-encoded cognate transfer RNA[5]. Plastid DNA from achlorophyllous plants would therefore be expected to retain genes encoding at least this transfer RNA, RNA polymerase for its transcription and ribosomal proteins, ribosomal RNA and other transfer RNAs for synthesis of the RNA polymerase.

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