than transfer of BP from particulates to biological membranes (mainly phospholipids and globular proteins[3]). As a monomolecular layer of surfactant containing DPPC exists at the air–liquid interface in the lung, BP adsorbed onto inhaled particulates would be at least partially transferred to lung surfactant before transfer to cell membranes would be initiated.

I suggest that the reported[1] increased rate of transfer for BP adsorbed to particulate silica or amosite asbestos as compared with BP in a microcrystalline form is principally a result of the adsorption of the mobile DPPC vesicles onto the particulate surface, rather than increased solubilisation of BP in an aqueous phase. It has been shown that DPPC readily adsorbs onto the surface of glass fibres and various types of asbestos, including amosite[4]. The adsorption is controlled by coulombic interactions between the ionic head group of the DPPC and the electrostatic charge of the particulates. The particulate surface charge also is significant in determining particulate-membrane interactions[4]. While the particulate surface charge controls DPPC adsorption, the particulate specific surface area and the form of the adsorbed BP (such as microcrystalline or monomeric[1]) determine the surface area covered with BP at the particulate–liquid interface and thus the availability of BP for transfer to adsorbed DPPC or cell membranes. The interfacial availability of BP would govern relative transfer rates for particulates, such as silica and amosite, which display essentially the same surface charge[4]. On the basis of these comments, I suggest that the preferential interfacial transfer of carcinogens to cell membranes and/or lung surfactant at the particulate surface may be an important factor in co-carcinogenesis.

W. G. LIGHT

*Technology Development
    Department,
Walden Division, Abcor, Inc.,
850 Main Street,
Wilmington, Massachusetts 01887*

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LAKOWICZ *ET AL.* REPLY—we are aware that DPPC is a major component of lung surfactant; however, it is not known whether carcinogens which are adsorbed to particles are eluted during contact with surfactant or after subsequent contact with cells. For this reason we are investigating the effects of asbestos and silica on uptake of BP into natural membranes, namely rat liver microsomes and 3T3 cells. Again we find that these particles enhance BP uptake and that asbestos is

more effective than silica. Thus, it is clear that the particle-enhanced uptake of BP is a more general phenomenon which could occur not only in lung surfactant but also in lung cells.

The mechanism of the transfer process has not been elucidated. We suggested that the particle enhancement of uptake results from an increased rate of solubilisation of the BP in the aqueous medium, whereas Light proposes that the transfer of the BP is to vesicles which have become bound to the particulates. The basis for our argument comes from more detailed studies of the particle-enhanced uptake of another polynuclear aromatic hydrocarbon (PAH), 1,2-benzanthracene, into DPPC vesicles[1]. In that instance we measured virtually the same uptake kinetics over a wide range of particle to DPPC ratios. For this reason we propose that the enhanced uptake results from an increased rate of solubilisation of these PAH by virtue of their association with the particulate materials. We do not intend to indicate that the particles can increase the equilibrium solubility of the PAH.

J. R. LAKOWICZ
J. L. HYLDEN
D. R. BEVAN

*Gray Freshwater Biological Institute
    and Department of Biochemistry,
University of Minnesota
P.O. Box 100,
Navarre, Minnesota 55392*

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The evidence for species guilds is an artefact

THE evidence cited by McNaughton[1] that ecosystems are loosely linked sets of species guilds seems to be based on an unfortunate artefact. Although the independent occurrence of species in samples is appropriately tested using the point correlation coefficient (V), it is effectively precluded by the sampling method used. This leads to a non-zero expectation for the point correlation coefficient for species whose spatial distributions are independent.

The dependence introduced by the sampling method may be demonstrated analytically. If an area occupied by a number of species distributed independently in space is sampled and the resulting distributions of the ath and bth species (A and B) among samples are independent, then

$$P\{A \cap B\} = P\{A\}P\{B\} \qquad (1)$$

Where the events A and B are the occurrence in a sample of A and B, respectively. However, if it is sampled in the manner described by McNaughton it can be shown that

$$P\{A \cap B\} = P\{A\}P\{B\} - (1 + (k-1)$$
$$\times (h+1) + k^2 g_a g_b) f_a f_b / (g_a g_b) \qquad (2)$$

In this, f_i is the proportionate cover of the ith species, $g_i = 1 - f_i$, and, summing over all species except A and B, $h = \sum_i f_i$ and $k = \sum_i f_i / g_i$. As $g_i \leqslant 1$ for all i, $k \geqslant h$, so that equation (2) implies

$$P\{A \cap B\} \leqslant P\{A\}P\{B\}$$
$$- h^2 (1 + g_a g_b) f_a f_b / (g_a g_b)$$

Hence, as long as A and B occur, together with at least one other species (that is $0 < P\{A \cap B\} < 1$),

$$P\{A \cap B\} < P\{A\}P\{B\}$$

This contradicts equation (1). It follows that if two species independently distributed in space are sampled by this method and a point correlation can be calculated between them, its expected value is negative.

Due to its dependence on k, this bias declines with increased numbers of species as long as the form of the species abundance curve remains consistent. To determine the extent to which this might account for the effects observed by McNaughton, the sampling method was simulated on a computer, the first individual of each sample being selected at random from the species complement, the second at random from all species except that of the first. The average interaction term i and connectance c were estimated for sets of 100 sample points in the manner used by McNaughton, calculating V only when both species were represented by at least 10 individuals.

The extent of the bias in V depends on the frequency distribution of species abundance. It was postulated that the ranked population frequencies of the
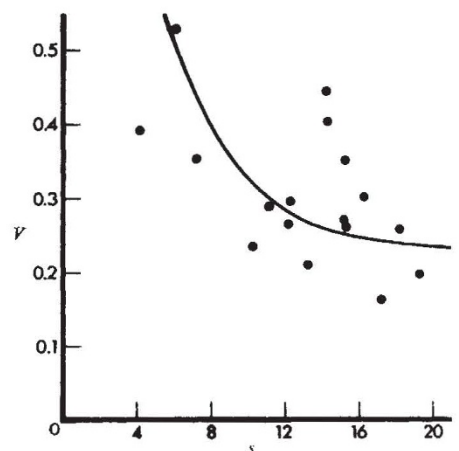

Fig. 1 The relationship between average interaction strength and number of species generated by the use of the sampling method of McNaughton[1] on species distributed independently in communities with log-series species abundance curves (solid line) for comparison with that reported for African grasslands.