decrease the toxic effects of other chemicals.

A. Breckenridge (University of Liverpool) described the effect of inducer drugs in rendering low dose oral contraceptives inactive. It is not clear whether brussel sprouts would have the same effect. A. McLean (University College Hospital Medical School) found no detectable effect on mortality of people with epilepsy of the inducing effects of anticonvulsant drugs. He suggested that the next line of investigation in toxicology should be to examine the response of cells to attack by activated toxic molecules. E. Farber (Toronto) also suggested that too much attention had been paid to the chemistry whereby a molecule of toxic material was activated and interacted with cell macromolecules. Not enough thought had been given to the response of the cell. If 10% of the genome was devoted to response to adverse conditions it would be a reasonable proportion, and leave an enormous range of built-in responses to toxic attack. Carcinogenesis might be the end stage exaggeration of such an adaptive response to a chemically unfavourable environment. A system for development of tumour nodules in a few weeks promised to be a favourable model for analysis of the cell response to carcinogens.

T. Connors (MRC, Carshalton) and J. Higginson (IARC, Lyon) started and ended the meeting by reference to the need to bring human and laboratory experience together, the need to understand tumour promotion as well as carcinogen activation, and the need to combine biochemistry and epidemiology. □

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The ecology of the footprint

from Peter D. Moore

THE ecological effects of recreational pressures on mountains, sand dunes and wetlands are reasonably well documented, and a great deal of work has been carried out and much has been written on the subject of trampling. What is surprising, in view of this, is that so little is known of the ecology of the footprint.

That the footprint has a distinctive ecology of its own was clearly demonstrated by some accidental experiments of Harper, Williams and Sagar some 15 years ago (*J. Ecol.* **53**, 273; 1965). They were in the process of examining the germination characteristics of three plantain species (*Plantago lanceolata, P. major and P. media*) in open plots, when an oversight led to the trampling of their plots by pigs involved in other experiments. Groups of *Plantago* seedlings appeared wherever a hoofprint had been made. Evidently the alteration of microtopographic, and hence microclimatic and microhydrological features of the soil surface by the impact of the hoof, had strongly influenced the germination and establishment of the plantains. Harper *et al.* developed these observations into a series of experiments in which they confirmed the importance of microtopography in seed and seedling behaviour.

Since then, many attempts have been made to examine the microclimatological changes associated with trampling, both above and below the soil surface. A range of soils, from chalk (Chappel *et al. J. appl. Ecol.* **8**, 869; 1971) to sand (Liddle & Grieg-Smith *J. appl. Ecol.* **12**, 893; 1975) have been looked at. But in these studies the emphasis had changed from the single footprint to the overall influence of continuous trampling in creating tracks and paths.

One habitat in which the individual footprint survives and remains a scar on the surface for a considerable time is the *Sphagnum* bog. All mire systems are sensitive to trampling for, instead of a mineral soil being compressed, the plant body itself and the organic detritus underlying it, receives the direct impact of the foot. Relatively deep depressions are formed which may fill with water, modifying the microenvironment and creating small scale pool successions. Slater and Agnew (*Biol. Conserv.* **11**, 21; 1977) have investigated the development of footprints at Borth Bog in west Wales. They estimated that the 1,890 visitors to the bog each year (mainly researchers and students) displaced a total of 4,228 m^3 of the bog surface by trampling. Taking a single footprint, about 50% of the displaced volume was restored in the first month, largely by the elastic response of the bog moss carpet. Subsequent recovery was far slower, being about 90% complete only after 18 months; often it took 30 months for all traces of the footprint to disappear. One species which seemed particularly well adapted to colonisation of disturbed sites was the white-beaked sedge (*Rhyncospora alba*), which, the authors contend, may increase the susceptibility of the vegetation to fire, adding to the ecological complications caused by trampling.

A further example of the distinctive ecology of the footprint has now been reported from the edges of a glacier in northern Norway by Theakstone and Knighton (*Arctic Alpine Res.* **11**, 353; 1979). The level of a lake at the outlet of the Austerdalsisen glacier has been lowered 70 m by the construction of a flood control tunnel, and the sediments exposed are now being invaded by terrestrial vegetation. The footprints of reindeer and man in the exposed silts have become colonised by the moss *Aongstroemia longipes*. The depressions are 1-2 cm deep and were first created in the summer of 1976. The colonisations observed in 1977 have persisted into 1978, the moss patches still displaying the shapes of the original foot or hoof prints. One suggestion is that the ponding of water in these hollows may have provided the appropriate hydrological conditions for the moss to establish itself. It is interesting to note that the first British report of *Aongstroemia longipes* was in the Ben Lawers area following soil disturbance as a result of dam construction (Crundwell, *Trans. Brit. Bryol. Soc.* **4**, 767; 1955).

Evidently the ecology of footprints warrants further study. Such research may confirm the old maxim that one plant's depression may be another's opportunity.

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Transformation and tumorigenesis

from R.E. Langman

AT a recent workshop on transformation mechanisms* M. Cohn (Salk Institute) opened with a plea that the meeting address the question of how many genetically determined events are required to convert a cell from the normal to transformed (tumorigenic) phenotype in the absence of any host surveillance mechanisms. In practical terms the change from anchorage-dependence to anchorage-independence (that is, the cells form colonies in agarose) is almost universally accepted as the assay for transformation. But we know virtually nothing about why colony formation in agarose indeed correlates so well with tumorigenicity, except to note that lymphohaemopoietic cells also normally grow as colonies in agarose, and are not obviously transformed or tumorigenic *per se*. In seeking possible generalisations, Cohn argued that there were few ways a cell could become transformed, one linked to anchorage-independence for non-haemopoietic cells, the other linked to whatever causes lymphohaemopoietic transformation.

I. Weissman (Stanford University) showed that individual lymphoma cell lines from mice produce a virus that binds specifically to that lymphoma, and monoclonal antibodies which block virus binding also block cell growth. Thus, it was argued in this case that virus, by perhaps acting like an antigen, provides the proliferative stimulus for the cell it infects. In general then one might view the lympho-

*An Armand Hammer Cancer Workshop was held at the Salk Institute on 12-16 November, 1979.

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