Minor Metals of the Geochemical Environment, Health and Disease

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The possibility of causal relationships between environmental factors and the occurrence of many degenerative diseases is slowly being recognized. One aspect of the environment—that concerned with the geochemistry of the rocks, soils, plants, and water—should be studied carefully and the distribution of minor elements be compared with geographic patterns of animal and human health and disease. We know that calcium, phosphorus, iron, copper, and all the other important inorganic nutrients somehow make their way from a never-ending source in the rocks that form our continents to the soils and waters, and from there into plants, animals, and finally man. But many questions come to mind. How is this transport accomplished and how easily do the various elements move into and through the food chain? What effects do climate and time have on this movement? What sort of interactions go on between the various elements as they come in contact with one another to enhance or hinder this process? How are these elements utilized by different kinds of organisms and what effects do even small excesses or deficiencies of any one ion have on the health of the plants or animals? These questions involve many complex interrelationships that cannot be solved by many scientists working in one field or by one scientist working in many fields. These questions should involve many environmental scientists in many parts of the world, and if we are to answer these questions it will require the rapid and effective exchange of information between workers in many disciplines. Answers to these questions are of much more than academic interest because they will pinpoint areas that might be changed or regulated to improve the health of man.

The geochemist knows the quantities of the elements that occur in the different kinds of rocks and sediments in different areas; the hydrologist, the composition of ground and surface waters; the soil scientist, the formation and composition of soils under different climatic conditions; the plant physiologist, the effects on plants of the ions available in the soil; the medical biochemist and physiologist, the use of the ions in physiological processes; and the veterinarian and physician, the effects of excesses and deficiencies in health and disease. But, again, there are broad gaps in this knowledge. Probably the greatest unknown in every area under consideration is that of ion availability in each transfer from one medium to another. How is the basic chemical behavior of the element at each step in the chain affected by the physical and chemical microenvironment in which it occurs? Some elements are released from rock-forming minerals during weathering more readily than others and some cations are bound more tightly than others in residual clays. Especially important in the physical environment are the behavior of iron and manganese in water under different conditions of *p*H and eH and their profound effect on the availability of a large suite of other metals. As more sensitive chemical tests become available, areas of anomalous geographic distribution of many minor metals are being recognized and the possible health effects of deficiencies of many metals, previously recognized as harmful only in large excesses, are being studied. Deficiency of selenium, for instance, causes white muscle disease in animals in interior and eastern states whereas, at the same time, the element is readily absorbed and accumulated in toxic amounts by plants growing on soils containing an excess of selenium in certain western states. The possibility of causal relationships between naturally occurring concentrations of minor metals (such as cadmium, chromium, molybdenum, strontium, arsenic, fluorine, and lithium) and the occurrence of many degenerative diseases in man is slowly being recognized.

With the appropriate multidisciplinary teamwork, the geographic patterns of element distribution in the physical environment can be compared with those of animal and human disease. We stand, then, on the threshold of discovery in an exciting area of multidisciplinary science that offers promise of constructive regulation of the environment of mankind.

Questions that arise concerning the availability of metals in various steps relating to transfer from rocks to man will be discussed at a day-long symposium to take place on 30 December at the Annual Meeting of the AAAS in Chicago. The absorption of selenium by plant communities and subsequently by animals under different soil conditions, such as eH and *p*H, will be compared with that of iron and manganese, the availability of which is complicated by many interrelated factors. The distribution and availability of minor elements in soils, plants, and human tissue will be reviewed. Heart disease will be discussed to illustrate a group of conditions that have been extensively studied in relation to trace element distribution in the environment. Finally, the anomalous geochemical distributions of a particular element, lithium, and its effects on human cells will be examined.

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