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21 November 1956

Fallout and the Strontium-90 Hazard

In a recent paper (*1*) Andrews discussed the hazard from Sr^{90} where the total fission products from a nominal atomic bomb have fallen on one small area. His calculation relating to food assumes uniform dispersal of the Sr^{90} over an area of 2 square miles, and his calculation dealing with water is based on complete mixing in Lake Mead (volume, 600×10^9 cubic feet). He estimates that, to accumulate the maximum permissible body burden of Sr^{90}, a man would have to consume the fission products deposited on 4 square feet of food, or drink 50,000 cubic feet of the Lake Mead water. The latter figure has recently been cited by another author (*2*).

Andrews' conclusion that there is a negligible Sr^{90} hazard might be correct, but both of the calculations on which it is based are in error by two orders of magnitude. The maximum permissible body burden quoted from Handbook 52 (*3*) should be 1.0 microcurie (0.005 microgram) of Sr^{90}, not 1.0 microgram as he states. Andrews' estimates are therefore low by a factor of 200, and the corrected figures for human consumption are 3 square inches of food and 250 cubic feet of water.

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9 November 1956

Root-Nodule Bacteria of Prosopis stephaniana

The most dominant of the leguminous plants that grow wild in Iraq is *shok* or *kharnub, Prosopis stephaniana* (Willd.) Spreng. This plant is found in desert, in open fields, along irrigation ditches, on river banks, in orchards, and in the foothills of the Iraqi mountains. It is a perennial plant with long roots. Some of the roots grow deeper than 2 m, and they branch in all directions. Some of the branches are more than 5 m long. The top shoot sheds its leaves in December, and new leaves and branches are formed in May; the plant blooms in late June and the fruits are green in color in late July, turning reddish-brown in late August.

Prosopis stephaniana seems to be a very ancient native of Mesopotamia. The old records of the Sumerians (3600–3000 B.C.) mentioned this plant and called it *eri-til-la,* meaning "the plant of the city of life." The Akkadians (3000–2300 B.C.) called it *kharubu,* which is very similar to the Arabic name *kharub* or *kharnub* (*1*). It is likely that the plant was in Mesopotamia earlier than is indicated by the written records so far discovered.

Winsherst (*2*) mentioned *Prosopis* and considered it to be an indicator of a good soil. He suggested the presence of nodulous bacteria, but he was unable to find nodules on the roots. I was able to grow *Prosopis* from seeds (*3*), and seedlings grown under greenhouse conditions had nodules when they were examined 3 months after planting. Microscopic examination of the nodules showed the presence of *Rhizobium* bacteria. A search was made to find young roots which might have nodules in the field. One-year old roots were found to have nodules which are reddish in color. Old roots were also found to have nodules, but they were not as conspicuous as those on the young roots. The bacterium found was motile and rod-shaped.

Rhizobium species from *Prosopis* are not mentioned in Bergey's *Manual* (*4*), and this could be a new species that has not been described before; its host is *Prosopis stephaniana.* There is another leguminous plant that is usually associated with *Prosopis*—camel thorn, *Alhagi maurorum* Medic., but the bacteria isolated from the nodules of *Alhagi* are different from those isolated from *Prosopis.* Further study is needed for the determination of these *Rhizobium* species.

Preliminary tests showed that *Prosopis* nodules contain large amounts of nitrates (*5*), the presence of which is attributed to fixation of the atmospheric nitrogen by bacteria. Large amounts of nitrates are being added every year to the soils of the Tigris and Euphrates valley through direct derivation from nodules and from the leaves that are shed every winter. The addition of nitrates to the soil increases the fertility of the land. The land of Mesopotamia, which has been under cultivation for more than 5000 years, is still fertile because of the constant supply of nitrogen provided by *Prosopis* plants. Winsherst in 1920 even suggested that *Prosopis* should be cultivated in lands where it does not grow in order to increase the fertility of the soil.

The Iraqi farmers have always used the fallow system. They do not use chemical fertilizers or the crop-rotation system to enrich their lands. In the fallow system, they cultivate half their land for 1 year and the other half the second year. *Prosopis* grows on the fallow land and adds to the fertility of the soil.

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14 September 1956

Ultrasonic and Electron Microscope Study of Onion Epidermal Wall

The wall structure of the cortical cells of the root of the onion, *Allium cepa,* as observed under light and electron microscopes, has recently been described in detail (*1*). In this report, certain results of similar studies on the epidermis of the onion leaf are summarized. The structure of the onion leaf has been described by numerous anatomists, including Hayward (*2*). The gray "bloom" conspicuous on the older green blades consists of ubiquitous, minute wax rodlets about 2 to 4 μ in length, the majority 1 to 2 μ in diameter, and a minority, random in distribution, about twice this thickness. The underlying cuticle stains clearly with Sudan III.

The entire cell wall, as indicated by standard microchemical tests, consists in the main of cellulose and pectic substances. The latter are particularly abundant in a thin layer immediately beneath the cuticle. As is usual in the epidermis, the external wall of the cell is 2 or 3 times as thick as the inner tangential and the anticlinal walls. Within the living protoplasts, refringent, minute droplets of fat stainable with Sudan black (*3*) are seen to be most numerous next to the outer wall—that is, comparatively near the cuticle.

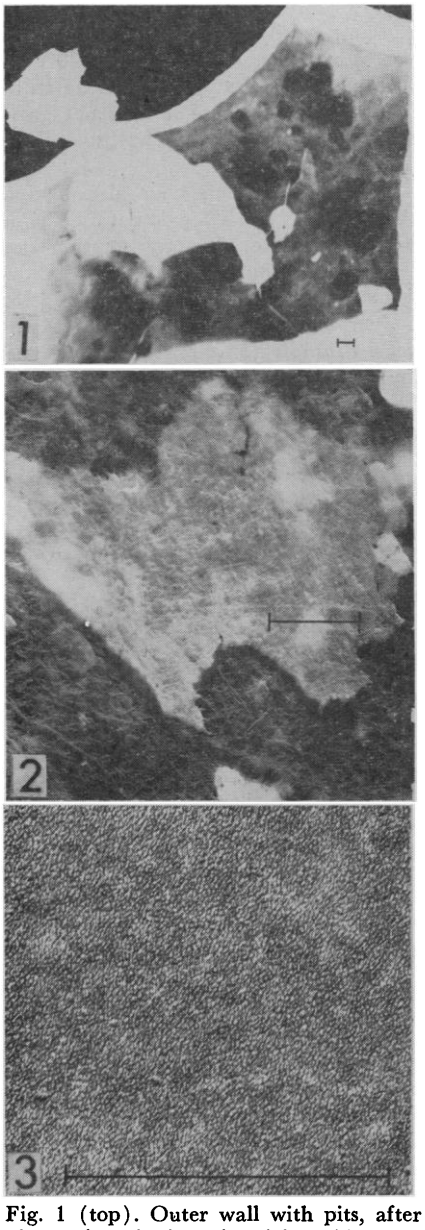

Fig. 1 (top). Outer wall with pits, after ultrasonic stripping of cuticle; white area is a fragment of cuticle. Black line, 1μ (×1800). Fig. 2 (middle). Outer wall, transition from amorphous pectic layer to underlying cellulose microfibrils. Black line, 1μ (×12,750). Fig. 3 (bottom). Cuticle isolated by pectinase treatment. Black line, 1μ (×44,000).

The distribution of wax rodlets on the surface of the cuticle indicates that pathways or canals are present in the underlying wall (*4*). Pits and plasmodesmata are demonstrable in material that is macerated in IKI-H_2SO_4. However, the distortion, primarily shrinkage in volume and thickening of the wall, caused by this drastic chemical treatment inevitably fails to give an accurate, detailed picture of the pit distribution on each cell face.

Maceration of the epidermis without visible distortion of the tabular cells is effectively produced by ultrasonic treatment. In the ultrasonic generator at present in use, a General Electric G 3, 500,000 cy/sec, the epidermis is reduced to shreds in about 2 hours. The material, when examined under the light microscope, is seen to consist of small groups of cells, solitary cells, fringed fragments of the cell wall, and protoplasmic debris. The cuticle is partially or wholly ripped from the wall surface, torn to ribbons usually spirally coiled, or to ragged, curling platelets. Staining with Sudan III and ruthenium red gives excellent results, and pit distribution may be seen on all cell faces. When the cuticle is rolled back or torn, the pitting on the outer wall of the cell is clearly seen. These are ubiquitous, minute pits interspersed with a random scattering of somewhat larger pits. Pits are also fairly evenly distributed on all other cell faces.

Ultrasonically shattered epidermal wall fragments were prepared for electron-microscope study. Repeated washing cleared away the bulk of the protoplasm, and the shreds of wall were then mounted on grids, shadowed, and examined in the usual way. In the electron micrographs obtained, the pattern of pit distribution outlined under the light microscope is revealed in detail. In certain fragments, through luckily-placed minute tears in the cuticle, the surface of the structural cell wall may be seen. The layer immediately beneath the cuticle is amorphous and presumably consists mainly of pectic substances. Below this pectic layer, cellulose microfibrils begin to appear, and there is a gradual transition to the typically interwoven meshwork of the structural wall. A certain amount of amorphous material is present in the interstices of the cellulose mesh, and the fibrils are frequently partially enclosed in fragmentary tubular sheaths of amorphous substance (Figs. 1 and 2).

For the intensive study of the cuticle, segments were isolated by treatment of the epidermis with pectinase, or with sulfuric or chromic acid, or by bacterial action (*5*). Some were treated with petrol ether in order to remove the bulk of the waxy substances, visible rodlets, and the submicroscopic platelets (*6*). Whatever the methods of isolation and treatment, the cuticle under the electron microscope resembles a sheet of very fine artificial rubber sponge. Neither in the onion nor in the cuticle of several other species examined is there any trace of definitive pores, equal in diameter to the wax rodlets. The appearance of the cuticle remains virtually unchanged under increasing magnification, and at ×16,000 still appears to be uniform throughout (Fig. 3).

It is thus evident that the pattern of wax distribution on the onion leaf differs from that in *Mesembryanthemum* and other species (*8*). Since in the cuticle of the onion no definitive canals comparable in diameter to the ubiquitous wax rodlets have been observed, the mechanism of wax extrusion remains an unsolved problem. The wax precursors, in liquid form, presumably pass outward along the innumerable plasmodesmata of the external wall. Thereafter they are extruded through the apparently uniform cuticle, and, on reaching the surface, they harden into rodlet form. It is also possible that, in the turgid living cells, functional sievelike canals are actually present in the cuticle but are not observable in the dehydrated, shrunken electron-microscope preparations. This idea derives a certain amount of support from a faintly indicated mosaic pattern that is evident in certain electron micrographs (*9*).

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18 December 1956