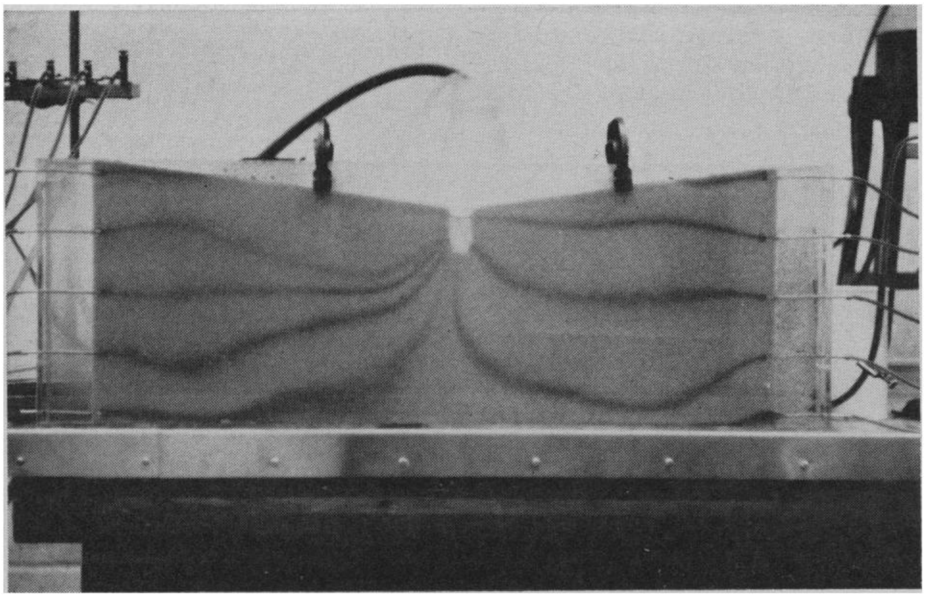

Fig. 3. Model of an effluent stream. It contains a porous medium of anisotropic permeability.

the stream become horizontal as they connect points of equal hydraulic head on opposite sides of the stream. The groundwater flow which crosses these equipotentials at right angles must therefore move vertically upward in this region.

The increased potential with depth beneath the effluent stream was verified in the model. Two wells were drilled in the stream channel and screened at different depths. The water levels in the wells rose to different heights above the level of the stream itself. The deeper of the two wells had the higher water level which indicates the higher potential at greater depth.

The model (Fig. 1) contains a homogeneous medium with an isotropic permeability which resulted in a set of flow lines following smoothly curving paths. Figure 3 shows a model of an effluent stream similar to the one in Fig. 1. The consolidated medium was sand of the same type as Fig. 1, but packed unevenly. Variations in packing caused variations in permeability, which in turn caused the tortuous paths of the flow bands (Fig. 3). Although the model in Fig. 1 was more convenient for theoretical studies of flow, the pattern of flow near an effluent stream in nature may be much less predictable because the permeability is not generally uniform.

Comparison of the rates of movement of the flow lines (Fig. 1) shows that the flow along the base of the aquifer is much slower than at points higher in the model. This knowledge is very important in studying streams near the sea which are subject to onshore winds and salt water tides. The salt water may move up the stream during a storm and raise the water level, and thus temporarily reverse the groundwater gradient. During this temporary flow reversal, salt water moves from the stream into the ground water body and because of its high density may eventually sink to the bottom of the formation (*4*). A salt-water mound is thereby formed beneath the stream channel; this mound may have a long-lasting, detrimental effect on water-supply wells in the deep portion of the aquifer near the stream channel. Although the original groundwater gradient may be resumed soon after the stream subsides, a long time will be required to wash out all the salt by the comparatively slow movement of groundwater through the deep zone. A town's water supply can be temporarily impaired beyond use by this phenomenon, but this occurrence can be avoided if water-supply wells are placed at a safe distance from the bank of any stream subject to salt-water tides.

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Malate Dehydrogenases in the Rusted Bean Leaf

Abstract. *Rust growth in the bean leaf was accompanied by the appearance of one new malate dehydrogenase isozyme and continuation of one otherwise lost during the development of the healthy leaf. The new isozyme was contributed by the fungus, the other by the leaf. Both enzymes were cytoplasmic proteins. Rusting caused the loss of a mitochondrial isozyme.*

Postinfection changes in metabolism of the host-parasite complex have been the subject of numerous papers, but changes in either host or rust fungus have only been suggested. A fuller knowledge of the two infection parameters would bring a clearer understanding of what constitutes resistance and susceptibility. We have separated proteins from rusted and healthy leaves by gel electrophoresis and surveyed their enzymatic activities.

Ten days after seeds were sown, primary Pinto bean leaves from pruned plants were inoculated by spraying with a suspension of *Uromyces phaseoli* Schw. uredospores. Ten leaves were extracted with a Pirie press (*1*) in 40 ml of $0.1M$ tris buffer, *p*H 8.0, supplemented with 17 percent sucrose, 0.1 percent ascorbic acid, and 0.1 percent cysteine-HCl. Undialyzed extracts containing 0.2 to 0.4 mg of protein were pipetted onto prepared polyacrylamide gels (*2*). When extracts of uredospores were required, 1 g of spores was ground with 10 ml of buffer and sand in a Potter-Elvehjem homogenizer. Malate dehydrogenase was detected on the gels with nitroblue tetrazolium (*3*), while breis were assayed spectrophotometrically (*4*). Mitochondria were obtained by the usual differential centrifugation techniques and purified further on sucrose density gradients.

Two malate dehydrogenase isozymes were found in the cytoplasm from healthy leaves; in contrast, there were four isozymes in rusted leaves at a late stage of infection (Fig. 1, *A* and *B*). Uredospores contained three isozymes (Fig. 1*C*).

Uredospore band 1 had the same mobility as band 1 from the infected leaf, and the substance in each was destroyed by heating at 50°C for 5 minutes. This isozyme was found only in the infected leaf; it was not detected in petiole, root, or stem. Its fungal origin seems clear and indicates little physical difference between mycelial and uredial forms. Uredospore bands 2 and 3 were close together, had lower mobilities than leaf band 2, were not observed in the infected leaf at any stage of infection, and were not destroyed by 5-minute heat treatments at 50°C.

Leaf band 3 was found in the supernatant but not in mitochondria of young uninoculated leaves. It faded as healthy leaves grew older but did not when healthy leaves were infected. It also was heat stable. The enhancement of band 3 during rusting indicates that the host cells were stimulated to continue its synthesis. In this way both host and parasite contributed to the enzymatic structure of the host-parasite complex.

Bean leaf band 4 was found in mitochondria as well as in supernatant from healthy plants, but was nearly absent from mitochondria in infected plants. The amount of malate dehydrogenase in mitochondria from healthy 22-day old leaves was four times that in the supernatant. The amount from rusted leaf cytoplasm was about the same as in healthy leaf cytoplasm.

Failure to detect band 4 in mitochondria from infected leaves indicates mitochondrial destruction during the course of disease development. Yet much of the metabolic capabilities of the tissue must have been retained as indicated by the resynthesis of band 3 in rusted leaves as well as starch synthesis around the pustules (*5*). Electron micrographs of rusted tissue (*6*) confirm the mitochondrial destruction and tissue disorganization in cells invaded by haustoria. If the work with black rot of sweet potatoes can serve as a model (*7*), band 3 originates by an enhanced protein synthesis in nearby, uninvaded host cells, whose mitochondria seem to be less stable than normal. Otherwise band 4 from these mitochondria should have been detected.

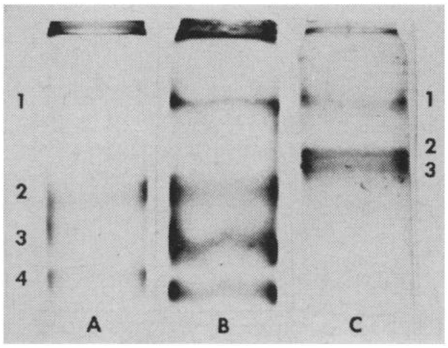

Fig. 1. Polyacrylamide gels stained for malate dehydrogenases from uninoculated 22-day-old bean leaves (*A*), bean leaves rusted 12 days (*B*), and bean rust uredospores (*C*).

These studies with malate dehydrogenase and other multiple enzyme systems in rusted leaves suggest that host-parasite interactions control enzyme synthesis in the infection complex. It appears that the host alters the number and form of the rust isozymes, while the fungus alters the rate of synthesis of enzymes by the host, enhancing some while repressing others (*8*).

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8. Supported in part by grants from the Rockefeller Foundation and the Frasch Foundation. One of us (R.C.S.) was on leave from Boyce Thompson Institute for Plant Research, Inc., Yonkers, N.Y. Published with the approval of the director of the Wisconsin Agricultural Experiment Station.

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Basalts Dredged from the Northeastern Pacific Ocean

Abstract. *Volcanic rocks dredged from seamounts, fault ridges, and other major geological features of the northeast Pacific Ocean include a wide variety of basalts. Most of these are vesicular, porphyritic types with near analogues in the Hawaiian and other oceanic islands. In addition, aluminous basalts and diabasic tholeiites impoverished in potassium also occur. There is no simple correlation of composition, degree of oxidation, vesiculation, or hydration of these basalts with texture, or depth of dredge site. Most samples appear to have been extruded at much shallower depths than those now pertaining at the dredge site. The distribution of these basalts suggests that the andesite line coincides with or lies on the continent side of the foot of the continental slope.*

During recent years expeditions of the Scripps Institution of Oceanography into the northeast Pacific Ocean have made about 150 dredge hauls from seamounts, pinnacles, submarine fault ridges, and irregular slopes. Seismic studies indicate that the thickness of crustal layer 3 (the "oceanic crust") at and near dredge sites ranges from 4.5 km to 6.4 km whereas the average thickness of layers 1, 2, and 3 in this region is 6.3 km (*1*). This typically deep ocean crustal structure continues to, or almost to, the foot of the continental slope as plotted in Fig. 1. Extended studies of heat flow from localities near the several dredge sites indicate a wide range of values from 0.1 to 5.8×10^{-6} cal cm^{-2} sec^{-1}, with a mean of about 1.4 (*2*). Some of the lower and higher values (0.1 and 5.8) occur respectively along the south and north sides of the Mendocino lineament, in the vicinity of samples 16 and 17 (Fig. 1).

Depths of dredged sites vary up to 4000 m. All of the igneous rocks from the dredge hauls in the Pacific Basin that appear to be indigenous (*3*) to the dredge sites are basalts, but these vary widely in composition. Petrographic and chemical studies indicate that alkali basalts, tholeiites, and high-alumina basalts are present in the northeast Pacific.

Studies of the original igneous rock types are hampered by extensive rock alteration and weathering. More than 90 percent of the rocks are encrusted with and variously replaced by hydrated manganese and iron oxides and weathered rinds. Many samples are veined and replaced by carbonates, phosphates, palagonite, chlorite, iddingsite, zeolites, and clay minerals.

Most of the recognizable igneous rocks from seamounts and pinnacles are porphyritic and vesicular basalts, with a glassy to microcrystalline groundmass. Flow banding and pillow structures are common. Several dredge hauls include fragments of glass and scoria. These forms and textures suggest that most of the rocks in the dredge hauls from seamounts are from the surficial parts of lava flows and cones.

Vesicles persist in basalt from the deepest dredge haul, at about 4000 m, and there is no uniform decrease in vesicles as a function of depth. Korzhinsky also reports vesicles in basalts dredged from depths of as much as 4885 m (*4*). It is probable, however, that