to be the plasma membrane and the endoplasmic reticulum. This association with general membrane structures has led to suggestions that the disease process, including replication of the agent, might be concerned with a steric rearrangement of the membrane lipoprotein matrix.

Dr D. L. Mould (Moredun Research Institute, Edinburgh) made a critical assessment of the state of knowledge of the chemical nature of scrapie agent, bearing in mind the considerable evidence against it being a virus. But deductions about its possible nature are complicated by the effects of chemical treatments. It is highly resistant to ionizing radiation, ultraviolet light and formalin, and is inactivated by strong acid or alkali, phenol, urea and periodate. If nucleic acid is involved, is it protected by a polysaccharide coat? The evidence is inconclusive. Fruitful chemical exploration must await purification of the agent. This in turn depends on the development of improved methods of culture and a more sensitive, accurate and rapid assay system.

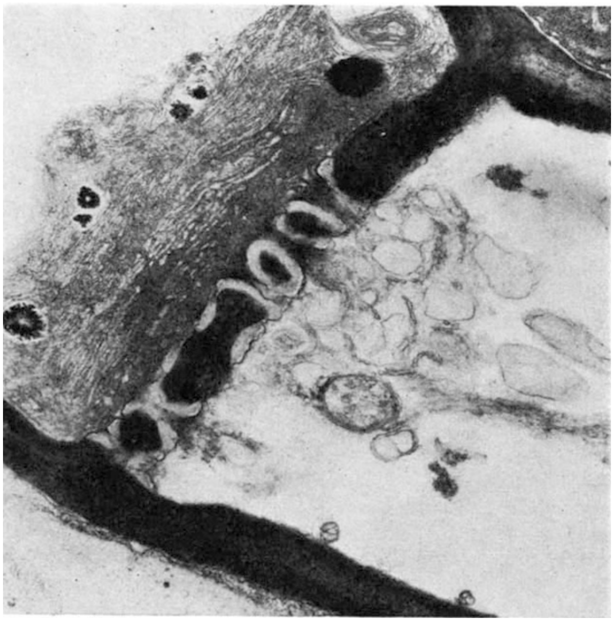
PLANT PHYSIOLOGY

Transport through Sieve Tubes

from a Correspondent

PROGRESS in many important aspects of plant physiology is often exasperatingly slow. The reasons are complex, but a large part of the answer must lie in the organization of plants. Animals may possess extensively modified organs and tissues for specific functions, but similar processes in plants are frequently carried out by relatively unspecialized cells and tissues. Vast amounts of data may be collected about a plant system, and explanations of its functioning put forward, but testing these hypotheses may defeat the most sophisticated of modern experimental techniques.

Such a problem is the transport of sugars in plants. It has been known for a very long time that large amounts of sugar are translocated in the sieve tubes of the phloem. In 1926, Münch suggested that bulk-flow was the mechanism for transport of the sieve tube contents (*Ber. Dtsch. Bot. Ges.*, **44**, 68; 1926). This means that sugar moves down sieve tubes under the influence of a hydrostatic or turgor pressure gradient. Although metabolic processes would undoubtedly operate at each end of the sieve tube, movement in the cell lumen would be effectively passive. Some thirty years later, D. C. Spanner (*J. Exp. Bot.*, **9**, 332; 1958) and D. S. Fensom (*Canad. J. Bot.*, **35**, 573; 1957), recognizing that sugar transport is an active, energy-requiring process, independently suggested that a metabolic pump is active in the sieve plate area, operating by a form of electro-osmosis. Movement in the lumen of the sieve tube, however, was still assumed to be passive.



A sieve plate in the phloem of *Phaseolus* (broad bean). The membranous material on each side of the plate, and passing through the holes in the plate, must be involved in the transport of food substances.

More recently, Robert Thaine of the Grassland Research Institute at Hurley has been providing convincing microscopical evidence that the lumina of sieve elements contain cytoplasmic strands which run the length of the sieve cell. These strands are continuous from cell to cell, the strands in individual sieve elements being continuous through the pores in the sieve plate. The structure which Thaine has proposed for these strands resembles a bundle of fine tubes inside a rather larger tube. The walls of this outer tube are believed to be made up of rings of protein filaments. Thaine's most recent suggestion (*Nature*, **222**, 873; 1969), based on microscopic observations from his own investigations and those of others, is that these protein filaments in the strand wall have a contractile function. Rhythmical, sequential contraction of the filaments could result in a peristaltic wave passing along the strand. Thaine suggests that this mechanism could pump the contents of the transcellular strands over long distances, at speeds perhaps as great as 300 cm/hour.

Thaine's idea is both attractive and provocative. It accounts for the speed of sugar transport and for its dependence on metabolism, and can explain how transport can take place in both directions in the same sieve tube. It may even be the basis for a circulatory system in the whole plant. There is no doubt that sufficient energy is available to run such a mechanism. Gardner and Peel using aphid stylets to tap willow phloem, and firefly lantern extract to measure ATP in the exudate, have been able to demonstrate large amounts of ATP in sieve cell sap (*Nature*, **222**, 774; 1969). Nevertheless there is a stumbling block in the way of general acceptance of Dr Thaine's theory. Each of the three most widely accepted hypotheses explaining phloem transport depends on a particular structure of the sieve plate and the sieve plate pores. Transcellular strands of the type which Thaine suggests are responsible for phloem transport have never been seen in electron micrographs of mature sieve elements. This could be the result of current methods of fixation and dehydration for electron microscopes, which may degrade the strands. Any kind of blockage in the sieve plate pore must count against the mass flow hypothesis of Münch, but will support the theories of Spanner and Fensom which depend on a charged osmotically active membrane at the sieve plate. Thaine's hypothesis depends on transcellular strands being seen in the sieve pores. Forty years after Münch wrote down his ideas on how plants transport sugar, the critical observations have yet to be made.