light. This means that the *in vivo* photophosphorylation leading to starch formation in tobacco leaves is a non-cyclic process rather than cyclic process and that it utilizes molecular oxygen as a terminal electron acceptor.

It is not known with certainty why our results differ from those of Machlachlan and Porter. Flushing with high-purity nitrogen is probably more effective than evacuation as a means of removing small traces of oxygen that would be formed by accompanying photosynthetic fixation of carbon dioxide produced by anaerobic metabolism of glucose.

These results must not be interpreted as meaning that all ATP formed during photosynthesis is produced by a process utilizing oxygen as a terminal oxidant, even though that might prove to be the case eventually. The rate of starch formation here is probably far lower than the maximal rate of fixation of carbon dioxide attainable by the plant. These experiments indicate only that the ATP utilized for glucose uptake and starch formation is not formed by a so-called cyclic or anaerobic process in the intact tobacco leaf, but by a phosphorylation coupled to an electron transport system utilizing oxygen as a terminal acceptor.

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A. R. KRALL
ELAINE R. BASS

Departments of Biochemistry and Psychiatry,
University of Miami School of Medicine,
1600 N.W. 10th Avenue,
Miami 36.

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Taxonomic Disposition of *Allium*

THE rust fungi evolve in genetic balance with their host plants, and inevitably reflect their interrelationships. Although rust investigations usually merely confirm accepted classifications, occasionally, like studies in comparative biochemistry, they may suggest modifications of accepted ideas. A few such suggestions have already been presented¹, among them the indication that the occasional occurrence of *Puccinia asparagi* on *Allium* threw doubt on Hutchinson's² transfer of Allieae to Amaryllidaceae, a disposition followed by several recent authors. Hutchinson maintained, with apparent reason, that the umbellate inflorescence with an involucre of bracts, seen in Allieae and typical Amaryllidaceae, was of greater significance than the position of the ovary. However, new and more significant evidence from the rust fungi requires a reconsideration of this disposition.

I have recently shown³ that the rusts of *Allium* form a complex evolutionary series, with one group mainly in the North American Cordillera and a second, still inadequately studied, in Eurasia. The series illustrates a repeated tendency toward simpli-

fication of the life-cycle and the development of dispersive teliospores, but three separate morphological characters show the species to be related: the occurrence of numerous scattered germ-pores in the urediniospores; the occurrence of delicate and widely spaced ridges, tending to anastomose above, on the teliospore walls; and the very rare occurrence, or generally complete lack, of germ-pores in the teliospores. The first of these characters is not uncommon in *Puccinia* and *Uromyces*, but the others are so unusual as to command attention even if they did not occur together.

No rust is known on any amaryllidaceous host which shows these characters, singly or in combination; but, attacking *Bellevalia*, *Hyacinthus*, *Muscari* and *Scilla*, of the tribe Scilleae in Liliaceae, we find *Uromyces muscari* (with several *formae speciales*) and the closely related *U. circinalis* and *U. algeriensis*. These rusts are essentially short-cycled; but urediniospores are occasionally found in the telia and prove to have several scattered germ-pores. The teliospores are generally somewhat more distinctly sculptured than those of the *Allium* rusts, but show the same pattern of widely spaced ridges anastomosing toward the apex of the spore; and the teliospores lack germ-pores, germination taking place through an irregular split in the spore wall. The correlated occurrence of these characters, two of them practically unique in the rust fungi, is convincing evidence that these rusts are actually closely related to those on *Allium*. However, the shortened life-cycle, and the fully deciduous and more conspicuously sculptured teliospores, make it clear that the *U. muscari* complex is more highly evolved than are the *Allium* rusts.

It appears from this evidence that *Allium* is related to, but more primitive than, *Scilla* and related genera. If the inflorescence characters emphasized by Hutchinson are a reliable indication of relationship to the amaryllids, the most satisfactory disposition of Allieae seems to lie in restoring the group to family rank. Alliaceae may then be regarded as close to the immediate common ancestor of Liliaceae and Amaryllidaceae. Hutchinson's arrangement, with Amaryllidaceae derived from Liliaceae and containing Allieae, is unrealistic, both because it denies the proximity of *Allium* to Liliaceae, and because it suggests that Allieae are more modern than Liliaceae whereas the rust relationships indicate the reverse.

D. B. O. SAVILE

Plant Research Institute,
Central Experimental Farm,
Ottawa.

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VIROLOGY

Hæmadsorption to Single Cells in Suspension

IN work on the reproduction of viruses there is often need to determine the number of cells reaching a certain stage in the multiplication cycle at a given time. Techniques involving fluorescent antibody, autoradiography, staining for inclusion bodies or hæmadsorption satisfactorily identify the infected cells in a monolayer culture, but the negative cells