Letters to the Editor

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Protective Inoculation against a Plant Virus

THE *X* virus of the potato, first described by Kenneth Smith[1], is capable of considerable variation in virulence, as shown by its clinical expression on several of the Solanaceæ. If tobacco plants be inoculated from the potato and the virus maintained by *passage* over a long period, the clinical expression may pass from a more or less mild mottling of pale and dark green, to a stage in which the pale areas are bright yellow, ending in one in which the lesions become extensively necrotic. Inoculation with the virus in this latter stage causes young tobacco plants to remain in a dwarfed and crippled condition.

Some four months ago, a series of experiments was instituted in which segments of about 2 mm. diameter were punched out of the green and yellow areas respectively of a leaf of a somewhat severely affected *X*-infected tobacco plant of the White Burley variety, and inoculated by needle into young and healthy seedlings of the same variety. It was at once evident that two distinct clinical conditions had ensued. From the green areas there resulted an exceedingly mild disease we may designate the *G* type of *X*, from the yellow areas a severe disease with large bright yellow patches on a pale green background accompanied by dwarfing; we may designate this the *L* type of *X*. So far, no further development of virulence has occurred in this type, although the *G* strain has, by selective sub-culture, been reduced to one giving an almost imperceptible reaction. Mixing the *G* and *L* tissue extracts in varying proportions *in vitro*, and inoculating tobacco seedlings with the same, has shown that a mixture of 1 *L* : 9 *G* produces a preponderantly *G* reaction, whilst mixtures with less of the *G* element call forth a reaction like that of *L*. Although plants infected with a 1 *L* : 9 *G*, or a 1 *L* : 19 *G* mixture behave, in general, like *G* infections, yet small areas of bright yellow, such as is common in the *L* type, do appear scattered on the otherwise almost normal green leaf. Sub-cultures from such yellow and green areas respectively, in these mixed infections, reproduce the original *L* and *G* types. There has been mixture of the two strains, not neutralisation of one strain by the other.

If tobacco plants inoculated with the mildest type of the *G* form of the *X* virus—no matter whether the ensuing reaction is definite enough to be recognised as a mottle, or so slight as merely to arouse a suspicion of its presence—are re-inoculated after nine days, either with the *L* strain or the most virulent necrotic type of *X* we possess, no further reaction ensues. Such plants retain their mild, almost imperceptible, *G* type of reaction, and present a solid immunity against the further attack of the *X* virus however virulent it may be. Later experiments have shown that this protection against the virulent strains of *X* is developed on the fifth day after the preliminary inoculation, and some four to five days before any systemic response to *G* is apparent. When from such doubly inoculated plants sub-cultures are made, only the *G* type of the *X* virus is obtained; the secondarily inoculated and severer type has failed to gain an entry. It would appear that once the plant cell has formed a symbiotic union with the non-virulent form, it has no capacity to enter into relations with any other virus elements of the same generic type.

The reactions recorded above have been repeated on *Datura strammonium*: in this species both the *L* and the necrotic forms of *X* produce a deadly effect. It is, however, only necessary to give the *Datura* plants a preliminary dose of the *G* form of the *X* virus, which induces but a mild mottle with little or no hindrance to growth, and subsequent inoculation a week later with the most severe *X* virus is without effect.

The protection afforded by the *G* strain holds good also for Miss Hamilton's[2] Hy IV, an *X* type of virus discovered in field crops of *Hyoscyamus*, but it is powerless against the *Y* potato virus of Kenneth Smith[1], as well as against that of the common tobacco mosaic, Johnson's No. 1.

The green 'veinbanding' islets, a late development on the leaves of tobaccos infected with the *Y* virus, have been examined by the same methods but with different results. Here neither evidence of a mild or symptomless *G* form, nor that of any adequate protective mechanism, has as yet been found. Indeed the central portions of such green islets appear to be free of virus. A similar condition was shown by Storey and McClean[3] to exist in streak-infected maize. How such green areas, surrounded by a solid mass of heavily infected cells, retain their freedom from virus, is a problem distinct from that of the corresponding areas in the *X*-infected plant.

Within the limits of this communication it is not possible to do more than refer very briefly to the results of others. McKinney[4] differentiated green and yellow strains in rosette disease of wheat, as has been done here with the *X* virus. Both Price[5] and Thung[6] have recorded observations which suggest a similar type of immunity. The phenomenon here described is, however, distinct from theirs, inasmuch as the protection afforded is achieved by a preliminary inoculation of a virus with an almost subliminal virulence, with the result that neither protective nor subsequent inoculation has any appreciable effect on the health of the plant.

REDCLIFFE N. SALAMAN.
Potato Virus Research Institute,
Cambridge.
March 6.

[1] Smith, Kenneth M., *Proc. Roy. Soc.*, B, **109**, 251; 1931.
[2] Hamilton, M., *Ann. App. Biol.*, **19**, 550; 1932.
[3] Storey and McClean, *Ann. App. Biol.*, **17**, 691; 1930.
[4] McKinney, H., *Science*, N.S., **73**, 650; 1931.
[5] Price, W., Contrib. of the Boyce Thompson Institute, **4**, 359; 1932.
[6] Thung, T. H., reviewed in R. A. M., **11**, 750; 1931.

Experimental Rickets as a Phosphorus Deficiency Disease

ALTHOUGH both prophylactic and curative technique against rickets is now highly developed, the pathogenesis of the disease is still far from being adequately understood. Recent experimental findings —some having already been published[1], others to be published shortly—are briefly summarised here since they afford, it would seem, strong support for the view that, whilst other factors play a part, and it would be idle to endeavour to dissociate phosphorus