of growth between bolters on one hand and short-day adapted potatoes when grown under long day on the other. It seemed possible that the bolter condition might be due to one or more gene mutations controlling the photoperiodic response, changing the normal long-day adapted domestic potato variety into one more adapted to short days as are most of the Andean potato varieties from which our own potatoes were originally derived.

As is well known, the 'bolter' differs from the normal in the direction of 'wildness', that is to say, it possesses certain characters typical of wild potatoes, chief among them being long stolons, later maturity, more abundant flowering, taller growth, especially in the low-growing first earlies, and other characters. Now, these features are just what are to be found in varieties of *Solanum andigenum* when grown under the long summer days in Britain (see Driver and Hawkes⁵). The tetraploid Andean potato is adapted to the short twelve-hour days of the tropics where most varieties possess short stolons and moderately quick maturity. When grown under long days, however (*loc. cit.*³, p. 28), the majority form very long stolons, take much longer to mature and grow generally more than twice as tall as equivalent plants under short day (*loc. cit.*³, pp. 30-31).

The inference that may be drawn from this is that in many cases stolon length and time of maturity are due to the photoperiodic response of the potato to any given condition of length of day. The parallel between the 'Andean' potatoes and 'bolters' would seem to be very close, the latter presumably differing from the normals in their adaptation to short days just as *S. andigenum* differs from *S. tuberosum* chiefly in this respect. 'Bolters' arise from normals in one or two stages by quite sudden change, and it would seem possible that they might be due to the sudden mutation of one or more relatively unstable genes controlling response to day length.

The following preliminary experiments were designed to check this hypothesis.

Tubers of the potato variety King Edward, both normals and 'bolters', were grown under long and short days, the latter being of about 10 hours duration. All plants were grown in insect-proof glass-houses.

The 'bolter' and normal plants under short days showed very little differences in respect of height of plants, and in all cases the stolons were very short, less than 0.5 in. long. On the other hand, under long-day conditions the bolters were considerably taller than the normals and the stolons were relatively very long. Thus the normal plants varied from 39-42 in. in height while the 'bolters' were from 62-84 in. high. The normal plants under long day possessed stolons of less than 0.5 in. Of the four bolter plants under long day the first had stolons of 15, 8, 17.5 in., the second of 12, 9, 6 in. and the third 2.5, 2.5, 2 in. respectively. The fourth bolter plant was of particular interest in that it had been mistakenly given twenty-seven short days and was then removed to the long day house, where it received 102 long days. At the end of this time, of course, the day length was much shorter and the plant had reached maturity. On harvesting, it showed a small group of three rather old soft tubers clustered at the base of the stem on stolons of not more than 0.25 in. long; these would have been formed under the first period of twenty-seven short days. In addition, there were three tubers on stolons of 2.5, 3 and 7 in. respectively that had obviously been produced during the period of long days.

Maturity relationships were not so clear cut since the short days given were less than twelve hours, and under these conditions both 'bolters' and normals matured after ninety-nine days. Under long days the normals matured somewhat earlier than the bolters, but unfortunately it was not possible to take records of this. The 'bolters' reached maturity in about 144 days.

These preliminary experiments, although not on a sufficiently large scale to be capable of statistical analysis (only sixteen plants in all being grown), nevertheless give a very definite indication that the bolter condition is due to a genetical alteration of some nature, converting the plant from a long-day to a short-day type. Under short days the 'bolter' grows normally, but shows various 'wild' characteristics under long days, as with the short day adapted *S. andigenum* when grown under the long summer days of temperate latitudes.

It is hoped in 1946 to be able to continue the experiments on a much larger scale and with several varieties from different maturity groups.

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¹ Thomas, P. T., *Nature*, 155, 242 (1945).

² Carson, G. P., and Howard, H. W., *Nature*, 154, 829 (1944).

³ Driver, C. M., and Hawkes, J. G., Imperial Bureau of Plant Breeding and Genetics (Cambridge, 1943).

Incidence of Defective Colour Vision

DIFFERENCE of opinion exists as to the incidence of defective colour vision among the male members of the population. Wright¹ has given a figure of 8 per cent, and the value of 7.95 per cent of v. Planta² and 8.01 per cent of Waaler³ agree very closely. Vernon and Straker⁴ gave a lower figure of 7.49 per cent for examinations carried out for entrance to the Navy; the testing in the Navy was done by 'Wrens' working in different centres. In Germany, Schmidt⁵ gives 7 per cent for males and 4 per cent for females from the examination of 20,000 persons.

In the Royal Air Force, among 16,180 candidates for air crew (young healthy men aged 18-30 years) 1,068 (6.63 per cent) were found to have defective colour vision. These examinations were all carried out by the same person working at different times in London, Oxford, Birmingham, Blackpool, Belfast and Doncaster, and the criteria for defective colour vision remained the same throughout.

The procedure in the Royal Air Force has been to classify colour defectives, not according to the nature of the colour defect, but according to whether the defect was such as to render the candidate

unsafe in the air. To achieve this end, all candidates were shown the Ishihara Plates in random order in good daylight (northern window). Those who made more than one or two slips were further tested on the Giles Archer Colour Perception Unit (Aviation Model); those who made no mistakes on this lantern were passed as normal; those who made slight errors such as calling white amber, or amber white, were classed as safe, and those who made more serious errors were classed as unsafe. 109 (10.2 per cent) of the 1,068 defectives were in the safe category.

It is readily appreciated that this method is entirely practical, and that by the use of some form of anomaloscope a higher percentage of colour defectives would be obtained. There is, however, sufficient evidence to show that the incidence of defective colour vision is not less than 6.63 per cent, and that by the more detailed examination of Wright, the figures quoted by him, and by the other authors, are not far from the true incidence.

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¹ Wright, W. D., "The Measurement of Colour", 52 (London: Hilger).

² von Planta, P., *Arch. Ophthalm.*, 120, 25 (1928).

³ Waaler, G. H. M., *Z. Indukt. Abstamm. und Vererb. Lehre*, 45, 279 (1927).

⁴ Vernon, P. E., and Straker, A., *Nature*, 152, 690 (1943).

⁵ Schmidt, I., unpublished data (1945).

Relation Between Dark Adaptation and Age

It is well known that the night vision of most elderly persons is poorer than that of the young. This is believed to be due mainly to progressive senile changes, such as yellowing of the ocular media, by which an increasing fraction of the light entering the eye is absorbed before reaching the retina. Any test of night vision, which makes use of the normal range of dark adaptation of healthy persons as a standard by which to evaluate abnormal states, requires to take into account this progressive deterioration with advancing age. Since little information is available on this matter, the following data, obtained in the course of investigations on vitamin A deficiency during 1941-42, have been analysed with reference to the age of the subjects.

The measurements are of the final stable dark-adapted visual threshold, obtained with the Wald-Steven adaptometer^{1,2}, and adjusted to a standard pupil diameter of 5 mm. The sample of 628 persons is composed of families investigated during nutritional surveys in Oxford and Accrington, students at the Universities of Oxford and London and at Heythrop Jesuit College, and children at an orphanage in Oxford. No cases are included of night blindness due to any diagnosed cause.

The sample has been treated in six 10-year age classes, from 10 and under to 51 and over, and the results of analysis are presented in the table and figure. With the exception of the youngest, there is a progressive deterioration of the mean performance of each successive age-class of about 0.05 log units in 10 years up to about forty years of age, increasing in more elderly persons. The data are too few to permit more detailed analysis of the older classes. The relatively poor performance of the youngest class is probably due to the difficulty in obtaining accurate measurements from young children, and should not be taken to indicate that the night vision of children is worse than of young men and women.