mice, and so is driven to the conclusion that somatic mutations have occurred in certain of the tumour cells. The general improbability of the occurrence of such mutations in so short a time apparently cannot count against the observed facts. Possibly there may be a slightly different explanation. The complicated mitotic phenomena are of course controlled by genetic factors. If we assumed (and the idea is not new) that the original tumour cells arose as the result of a breakdown in or disturbance of the mitosis-controlling factor or factors, this one change would seem to account for all the rest. The partially inadequate control would result in sundry mitotic errors, and those which led to the most prolific and 'non-specific' tumours would be perpetuated in preference to others. T. D. A. COCKERELL.

University of Colorado,
Boulder, October 23.

Mathematical Proof *versus* Observation.

THE history of the physical sciences offers many examples of theories which have been 'proved' mathematically and been set as foundation-stones in the edifice of science, only long after and when a superstructure has been reared upon them to be abandoned as untenable. The operation of taking out a 'foundation stone of science' presents all the difficulties which are encountered in extracting its physical parallel.

Mathematical formulæ to be applied practically require the use of numerical factors which are often wanting or are subject to such wide range that a large element of guessing enters into the computation. In actual practice a far greater source of error is one which might well be eliminated—the neglect to compare and check carefully the results of the mathematical treatment with the facts of observation.

A noteworthy example of the abiding faith in mathematical formulæ when not in harmony with observation, is afforded by a formula in common use where the disparity between the calculated and the observed numerical values is that between 26,000 and 200. A neglected factor has just been discovered which brings the theoretical and the actual values in this case into harmony. Obviously this example might be cited to show the value of mathematical treatment; but even more clearly it sounds the warning against putting our faith in any mathematical treatment of physical phenomena where a careful comparison has not been made to see that the results of the computation check with the observations.

Even when the mathematician has himself been careful to state the limitations to which his conclusions are subject because of the assumptions made, those who cite him are not so easily controlled. As a striking example it is stated in a recent review: "Dr. Jeffreys has recently demonstrated (*Quart. Jour. Roy. Met. Soc.*, vol. 52, p. 85, January 1926) that whatever superficial increase of pressure there may be over either pole or over Greenland, in consequence of the cold, this is a shallow surface effect, and that both poles are seats of low pressure"; as though such a fact could be proved by mathematical discussion alone. When we consult the original, we find that this eminent mathematician has stated that his discussion has not been developed for the actual earth on which we live; but for a hypothetical earth on which the atmospheric circulation is assumed to be symmetrically disposed with reference to the geographical poles, operates without friction, and is without interference from the irregular distribution of land areas. No one of the assumptions holds true of our earth.

It should be stated that Dr. Jeffreys has faithfully tried to compare his conclusions with observation, though without very happy results; for neither Greenland nor the north and south polar areas are regions of low atmospheric pressure. The north polar area is one of nearly normal atmospheric pressure, whereas the south polar region and Greenland are both notably areas of high atmospheric pressure. Observations are consistent in support of these statements. WM. H. HOBBS.

Ann Arbor, Michigan, October 28.

The Oscillations of Superposed Fluids.

THE explanation of Franklin's experiment quoted in NATURE of December 4, p. 823, is purely dynamical. When a stratum of oil rests on water the restoring forces of gravity called into play by any disturbance of the interface are comparatively small, owing to the slight difference of density. Free oscillations are consequently slow, and so in Franklin's case apparently came within the range of the imposed periods due to the motion of the ship.

The formula for the periods $(2\pi/\sigma)$ of waves of given length $(2\pi/k)$ in the case of two superposed liquids of depths h, h' and densities ρ, ρ' was given long ago by Stokes. The equation has two roots, which reduce to

$$\sigma^2 = gk \tanh k(h+h'), \quad \sigma^2 = gk\frac{\rho-\rho'}{\rho}\frac{\sinh kh \sinh kh'}{\sinh k(h+h')},$$

approximately, when the ratio $(\rho-\rho')/\rho$ is small. The former root corresponds to the motion of the fluid mass as a whole, as if it were of uniform density throughout. The second root is relevant to the observed phenomenon, the disturbance being confined to the neighbourhood of the interface. The ratio of the amplitudes at the upper and lower surfaces is in fact

$$-\frac{\rho-\rho'}{\rho}\cdot\frac{\sinh kh}{\sinh k(h+h')},$$

approximately. If the fluids are contained in a cylindrical vessel of radius a the admissible values of k are given by the roots of $J_n'(ka)=0$. The slowest oscillation of all corresponds to the smallest root of this in the case of $n=1$, namely, $ka=1{\cdot}841$. The interface then oscillates about a nodal diameter.

For a numerical example, probably not very different from the circumstances of Franklin's case, we may assume $h=h'=4$ cm., $a=4$ cm., $(\rho-\rho')/\rho=0{\cdot}9$. With the above value of ka this gives a period of 1·36 sec. The corresponding ratio of the amplitude at the upper surface to that of the interface is only 0·0155, or less than one-sixtieth. If the oil were removed the period would be 0·302 sec. H. LAMB.

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Rainfall Interception by Plants.

THE major part of the 'interception gain' found by Mr. Phillips in his experiments at Deepwalls, described in NATURE of Dec. 11, p. 837, is no doubt due to the screen catching rain which would otherwise have fallen on the lee side of the gauge. This would become negligible if a large area were covered by a comparatively close network of screens, except for a narrow strip at the edge of the area, where the gain would still be appreciable. This particular experiment does not appear likely to give information about the amount of water deposited on plants when there is no rain (or practically no rain) falling to the ground.

The percentage excess in Mr. Phillips' experiment should be greatest when the ratio of the velocity of the wind to the rate of fall of the raindrops is greatest.

E. GOLD.