In my recent experiments made with Richard Whitall it was determined that often the bodies made five to ten revolutions per second around the axis of the helix, and the radius of this helical path is exceedingly large compared with the radius of the body. These facts can be easily understood. Optically active substances rotate the plane of polarization of light, and Faraday (1845), despite the scepticism of his contemporaries, succeeded in rotating the plane of polarization by applying a magnetic field parallel to the beam.

The helical paths have been observed with linear polarized light as well as with natural light, with and without parallel external magnetic field. This is to be expected, since the light scattered by a spherical body is for the most part linear polarized, and since our magnetophotophoresis experiments demonstrate that in the direction of the light beam there exists a static longitudinal magnetic field analogous to the electrostatic field therein predicted by Woldemar Voigt.[13] These fields can explain in some respect electro- and magnetophotophoresis with the movement of electrically charged bodies in the longitudinal electric field or magnetically charged bodies in the longitudinal magnetic field of the beam of light. Concerning the helical movement in the beam of light, the electric charge rotates around the longitudinal magnetic field and *vice versa*.

The helical movement of particles observed by me and Whytlaw-Gray can not be explained by the formulation of Maxwell-Poynting, on which point of view G. F. Hull has based his work on light pressure.

It has been found that light rotates matter, if matter is free to move with three degrees of freedom. The well-known principles of conservation of linear and angular momentum of electrodynamics (Poincare, Max Abraham) do not cover the experimental facts that light can exert forces of attraction, repulsion and torsion. Regarding the general theoretical conclusions it is evident that we have to add to the electrodynamic equations the expression for the true single magnetic charge and therefore the term for the magnetic current.[14] The formulations have to be broadened in such a way as to include the three actions listed above.

These observed actions require a modification of the relation $E = m c^2$, pronounced for the first time by Hasenoehrl (1904) for the radiation of black bodies,[15] generalized later on, as well as a revision of the more modern concepts which have been derived from the enunciation of A. Soldner (1801), entitled "About the Deflection of a Beam of Light from its Rectilinear Movement through the Attraction of a Celestial Body Near Which the Beam Passes."[16] In considering astrophysical questions it is clear that one must take into account not only the repulsive force of radiation but also the attractive and rotational forces.

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[13] Woldemar Voigt, Festschrift fuer Heinrich Weber, 1912.

[14] Oliver Heaviside, "Electromagnetic Theory," 1, 25, 1893.

[15] F. Hasenoehrl, *Ann. der Physik.*, 15: 344, 1904; 16: 589, 1905.

COLCHICINE AS A GROWTH STIMULATOR[1]

IN a recent paper, Loo and Tang[2] reported that colchicine in relatively low concentrations (10^{-5} M to 10^{-6} M) accelerated the germination of seeds of mungo bean, maize, cabbage, rice and wheat, but the treating of seeds for twelve hours at these concentrations was deleterious to subsequent early growth. Patton and Nebel[3] had previously observed that colchicine in a concentration of 10^{-4} M seemed to stimulate respiration slightly.

That colchicine or any toxic substance should act as a metabolic stimulant in very dilute concentrations is not surprising, but our observations on the results of the use of colchicine on seedling trees indicate that colchicine in effective concentrations short of that necessary for the production of polyploid cells does stimulate growth in some plants.

In the spring of 1944, more than twenty species and hybrids of tree seedlings were treated with a 0.4 per cent. solution of colchicine emulsion which included a wetting agent. The trees were treated by pipetting one drop per day on each apical meristem for four to, in some instances, twenty days. The usual cessation of apical growth and subsequent hypertrophy with some killing occurred, but in sixteen seedlings of four species of *Quercus,* two species and one hybrid of *Castanea* and three hybrids of *Corylus,* there followed marked increase of the rate and total length of apical growth. The order of increase was slightly more than double the best growth of the untreated controls. Allowing for differences in genetic and possibly environmental factors, the evidence seems to indicate that the increase in rate and total length of growth was due to the action of colchicine.

Whether the increase in growth was due to the direct stimulation of cellular metabolism or produced

[16] A. Soldner, Bode's Astronom. Jahrbuch, 161–172, 1804.

[1] This work was part of a program in forest genetics supported by a grant from the General Education Board.

[2] T. Loo and Y. Tang, *Am. Jour. Bot.*, 32: 106–114, 1945.

[3] R. L. Patton and B. R. Nebel, *Am. Jour. Bot.*, 27: 609–613, 1940.

by the initial inhibition of growth by the colchicine, thus permitting the accumulation of metabolic reserves in the meristems, which, released by the disappearance or reduction in effective concentration of the colchicine by the cessation of treatment resulting in a belated but greatly increased rate of growth, is not known.

All the plants which responded by increased growth to colchicine applications were those treated with four to seven applications of the 0.4 per cent. solution.

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TOADS IN THE MARIANAS

ON October 23, 1944, the junior author took advantage of a brief shore leave to explore the ruins of the town of Tenian on the Island of Tinian. He observed large numbers of toads and tadpoles in cisterns and numerous lily ponds of the former Japanese settlement. No exact counts were made, but a rough estimate of at least 12 adult toads in each of over 100 cisterns plus at least twice that number for the lily ponds yields a population of close to 4,000 adult toads at that time. Because the junior author was not certain that this was a species of toad desired by the senior author, he collected only 4 animals, two of each sex. On the voyage back to the United States one male was lost; it jumped overboard. The remaining three animals were utilized for several purposes, after their safe arrival. Blood smears were made and the intestines were used for the study of the intestinal fauna; testes and potential ovaries (Bidder's organs) of the surviving male were fixed for cytological study.

It appeared that the toads were typical specimens of *Bufo marinus Linnaeus,* an assumption which was confirmed by Arthur Loveridge, of the Museum of Comparative Zoology. One female is incorporated in the collection of the Museum of Comparative Zoology, while the other female and the male are deposited in the Museum of Vertebrate Zoology at the University of California under the numbers 40856 and 40857.

No records have been found of the occurrence of toads in the Mariana Islands; and while the introduction of *Bufo marinus* into the Hawaiian, Solomon and Fiji Islands was known, the newest record would add to the list of introductions. The observation of such large numbers even after the shelling of the town would indicate that the introduction resulted in a successful establishing of the species.

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BOTANISTS SOMETIMES IMPORTANT MILITARY TACTICIANS

MANY people look upon the average botanist as a rather theoretical and prosaic individual, whose talents are best spent in the quiet fields back of the lines rather than in the field of tactics of an active war front. This may be generally true, but one great English botanist, John Ball,[1,2] by his detailed knowledge of geographical botany in the Alps, pointed the way to victory for the Italian army fighting against Austria in 1866. Garibaldi was at that time feeding the Italian soldiers to the Austrian gunners in the Austrian fort of Val Ampola, near Lago di Ledro. John Ball, thoroughly familiar with the Alps from his long botanical studies and explorations of this region, gave the Italian War Office such valuable information that it soon led to the capture of this fort. For this timely advice the Italian staff decorated him.

John Ball was a most remarkable personality, as well as a distinguished botanist of the old school. He was a keen scientific philosopher, and an observant and discriminating naturalist, as his "Notes of a Naturalist in South America," published in 1887, attest. The style and interest of this work makes it a classic in its sphere.

It is of interest that Ball organized the Palliser Expedition to discover the best route across the Rocky Mountains of British America, and of the 4 passes first surveyed one, Kicking Horse, was used by the Canadian Pacific Railway.

It falls to the lot of few botanists to be as versatile and to become as distinguished in so many fields as John Ball. In spite of his varied accomplishments he complained that his fondness for society prevented his giving much time to scientific work.

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THE "U. S. BOTANICAL GARDEN" AGAIN

IN 1934 the director of the so-called U. S. Botanical Garden retired. Then the Honorable Kent Keller, Congressman from Illinois, chairman of the House Library Committee (which with the Senate Library Committee had jurisdiction over the institution), realizing the sad condition of the place and its worse reputation, strove to raise its standards. He sent questionnaires to every known botanical garden of the world, and sent Professor F. A. Varrelman, then at the American University in Washington, to Europe to inspect, photograph and gather information from

[1] Obituary by Sir Joseph D. Hooker. 16 pages. 1890. A reprint from the *Jour. Roy. Geog. Soc.*
[2] John Ball, F.R.S., by W. T. Thistleton Dyer. *The Jour. of Bot.,* 27: 365–370. 1889.