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PHYSICS AND THE FUTURE[1]

By Professor ARTHUR H. COMPTON

UNIVERSITY OF CHICAGO

As the conversation turned to the problems faced by our children, my table companion was confident of the future. "During their generation," she asserted, "life can not change as it has for us. Experience will once more be usable as a reliable guide."

If advances in our mode of life are to cease, will it not be the result of a stagnation of our knowledge and techniques? Let us see what present trends indicate with regard to the direction and extent of such future changes.

No better guide can be found to the future than a review of what has happened in the past. Let us accordingly examine the trend of physics through history. Taking the broad view that the science of physics is concerned with the applications as well as the principles of mechanics, heat, electricity, etc., it will be seen that such a review must consider also the growth of techniques and inventions, for these embody some of the most important scientific advances.

In his recent book, "Science and the New Humanism," George Sarton has emphasized the fact that science is almost the only aspect of human activity which shows a definite and continuous growth throughout history. Though advances in other fields have occurred, they have come for the most part as a result of development of techniques based on growing science.

We are accustomed to speak of the stone age, the bronze age, the iron age and the machine age. This sequence reviews in quick outline the growth of man with regard to the tools with which he has done his work. Each stage has been ushered in as some inquirer, more persistent or more fortunate than his

[1] Based on a paper read at Ottawa, June 29, before the American Association for the Advancement of Science.

COLLETOTRICHUM CIRCINANS AS A SEMI-QUANTITATIVE TEST UNIT FOR THE GROWTH SUBSTANCE PRODUCED BY RHIZOPUS SUINUS

WHILE testing the filtrate of *Rhizopus suinus* Nielson on the growth of various species of fungi, it was noted that *Colletotrichum circinans* (Berk.) Vogl. gave consistent increments in yield over a limited range of concentrations. This characteristic response of the organism mentioned suggested its use as a means of measuring the relative growth substance concentration. Subsequent work has shown that this fungus will serve not only as a qualitative but also as a semi-quantitative test unit for the growth accelerator concerned. Nielson and Hartelius (1932) showed that the extract from *Rhizopus* exerted an influence on the dry weight yield of *Aspergillus niger* Van Tiegh., but gave negative results when tested with the oat coleoptile. Although its chemical structure is still unknown, it has properties which render it insoluble in common organic solvents, and it is stable to both oxidation and heat. Their results, which were duplicated in this laboratory, prove that it is not a nutrient and that it is not identical with heteroauxin.

In order to measure this substance, investigators have relied, heretofore, upon *Aspergillus niger*. The *Aspergillus* technique does present certain distinctive features, *viz.,* (1) the time involved is short and a large number of runs can be completed in a given time; (2) the effect is an initial one, and (3) the comparisons are based on dry weight yields, and thus an unevenness of growth does not invalidate the results. The *Colletotrichum* technique, on the other hand, has several definite advantages, *viz.,* (1) the change in yield is greater per increment of growth substance added; (2) the results of replicates show a lesser variation; (3) temperature fluctuations over a few degrees (standard 25° C.) are of little significance; and (4) successive daily changes in the growth rate for a given culture can be recorded and studied.

The method is essentially as follows: The *Rhizopus* mat is filtered from its liquid substrate and the resultant filtrate is concentrated, by partial evaporation, to one third or less of the original volume. This constitutes the stock solution. A 1 cc aliquot of the stock solution or a dilution thereof is placed in the bottom of a sterile 100 mm petri dish. To this is added 30 cc of a nutrient-agar solution containing M/400 $MgSO_4$, M/220 KH_2PO_4, M/16 NH_4NO_3, M/5.5 sucrose, 1.7 per cent. agar and a trace of ammonium tartrate.

Plates made in this manner are cooled and are inoculated with circular blocks (1 mm diam.) of non-fruiting hyphae of *Colletotrichum circinans* growing on an agar substrate. Diameter measurements are made every few days with the aid of a mimeoscope. These figures are compared directly or comparisons are made of the slopes of the plotted curves. Diameter comparisons, and not area measurements, are used since they more nearly approach the true values. This point will be presented in a subsequent paper.

The example below, which has been repeated several times, will serve to illustrate this technique. The actual diameters are measured every two or three days. The values for the third day are used as the starting point, since the transfer of the inoculum affects the initial growth, in an unpredictable manner, invalidating the use of the size of the planting as the criterion. Values for subsequent days are measured as increases over the values for the third day. These last are then corrected so that each test will have the same base line as the control.

These corrected diameters (in mm's) become:

	Days					
	3	5	7	9	12	15
Control	0	7.2	11.0	14.8	19.0	23.0
plus 1 cc	0	9.8	17.2	21.8	28.2	32.2
" 2 cc	0	11.2	18.2	24.2	32.8	38.6
" 3 cc* ...	0	10.4	18.6	26.0	35.4	44.4

* The value 3 cc refers to 1 cc of a stock solution three times as concentrated as the original filtrate.

The values for the fifteen-day period are most profitably used. When an unknown is run, it is necessary to interpolate for those which fall intermediate to the values listed above. This method, therefore, becomes of special interest for small changes in the amount of growth substance and can be used also for larger changes by concentrating or diluting the stock solution so that the test values will fall within this range.

CLAIR L. WORLEY
B. M. DUGGAR
PLANT PHYSIOLOGY LABORATORIES,
UNIVERSITY OF WISCONSIN

BOOKS RECEIVED

CATTELL, RAYMOND B. *Crooked Personalities in Childhood and After.* Pp. xi + 215. Appleton-Century. $2.00.

International Encyclopedia of Unified Science: Vol. I, No. 1, Encyclopedia and Unified Science, OTTO NEURATH and others. Pp. viii + 75. *No. 2, Foundations of the Theory of Signs,* CHARLES W. MORRIS. Pp. vii + 59. University of Chicago Press. $1.00 each.

PARK, WILLARD Z. *Shamanism in Western North America; A Study in Cultural Relations.* Pp. viii + 166. Northwestern University. $2.25.

Recueil des Travaux Chimiques des Pays-Bas, Tome 57, No. 6, June, 1938. LIVRE JUBILAIRE J. BÖESEKEN. Pp. 344. Illustrated. D. B. Centen's Uitgevers-Maatsch, Amsterdam. Dutch florins 3.

University of Missouri Studies; A Quarterly of Research. Vol. XIII, No. 2, April, 1938; Distance Geometries; A Study of the Development of Abstract Metrics, LEONARD M. BLUMENTHAL. Pp. 145. The University, Columbia. $1.25.

WIEMAN, H. L. *General Zoology.* Third edition. Pp. x + 497. 271 figures. McGraw-Hill. $3.50.

WILLIAMS, ROGER J. *A Textbook of Biochemistry.* Pp. x + 525. 17 figures. Van Nostrand. $6.00.

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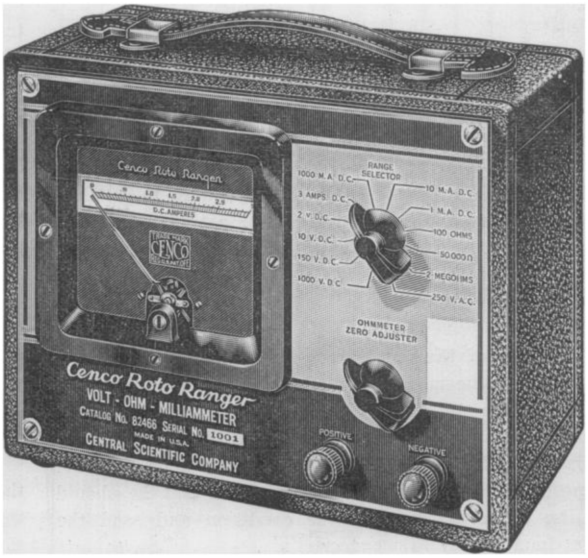

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