GALILEO'S EXPERIMENTS FROM THE TOWER OF PISA

MR. PARTRIDGE'S declaration (SCIENCE, Sept. 17, 1920) that "we do not know exactly what experiment Galileo performed" from the leaning tower of Pisa appears to me too sweeping. In the first place, Vincenzio Viviani, in his life of Galileo, speaks of "repeated experiments" not of one "experiment." A series of trials is what one would expect. It is highly improbable that Galileo would perform an experiment before a university assembly which he had not previously tried out. The historic data are as follows: (1) Viviani tells us that Galileo at the leaning tower of Pisa used "different weights"; (2) Galileo in his "De Motu" (probably written before he left Pisa) speaks of dropping wood and lead from a high tower; (3) In his "Dialogues concerning two new Sciences,"[1] Galileo lets Sagredo say:

> But I, Simplicio, who have made the test can assure you that a cannon ball weighing one or two hundred pounds, or even more, will not reach the ground by as much as a span ahead of a musket ball weighing only half a pound, provided both are dropped from a height of 200 cubits.

Later Salviati says that "the larger (iron ball) outstrips the smaller by two finger-breadths." On the remark of Simplicio that perhaps the result would be different if the fall took place "from some thousands of cubits," Salviati replies:

> If this were what Aristotle meant you would burden him with another error . . . since there is no such sheer height available on earth.

It is true that in the above "Dialogue" Galileo does not give the place of experimentation and does not mention the leaning tower. But what other locality in Pisa would have been as favorable? From the above data it follows that Galileo dropped different weights of a variety of materials and noticed which of them fell faster.

[1] Translation by H. Crew and A. De Salvio, New York, 1914, pp. 62, 65, "First Day."

That Viviani was in a position to speak with authority follows from the fact that soon after Galileo had published his "Dialogue concerning two New Sciences," 1638, Viviani became his pupil and was in close contact with him for three years, receiving instruction which began with the theory of moving bodies. Favaro[2] advances evidence which shows that Galileo and Viviani became quite intimate, Viviani admiring the old sage and Galileo treating the young man as if a son.

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JONATHAN EDWARDS ON MULTIDIMENSIONAL SPACE AND THE MECHANISTIC CONCEPTION OF LIFE

IF the Einstein conception of space is multidimensional and inclusive of the essential conceptions of time and place, then Jonathan Edwards, whom John Fiske characterized as the greatest mind of the Western World, may prove to be the spiritual father of this geometry. Thus wrote Jonathan Edwards:[1]

> Supposing that there are two Particles or Atoms of Matter perfectly equal and alike, which God has placed in different Parts of the Creation. . . . If they are perfectly equal and alike *in themselves*, then they can be distinguished or be distinct only in those Things which are called *Circumstances;* as Place, Time, Rest, Motion, or some other present or past Circumstances or Relations. . . . If God makes two bodies *in themselves* every Way equal and alike, and agreeing perfectly in all other Circumstances and Relations but only *their Place*, then in this only is there any Distinction and Duplicity. The Figure is the same, the Measure is the same, the Solidity and Resistance are the same, and every Thing the same, but only the Place. . . . The Difference of Place, in this (the former) Case,

[2] Antonio Favaro, "Amici e Corrispondenti di Galileo Galilei. XXIX. Vincenzio Viviani." Venezia, pp. 8–19.

[1] "A Careful and Strict Enquiry into the modern prevailing Notions of that Freedom of the Will which is supposed to be essential to Moral Agency, Vertue and Vice, Reward and Punishment, Praise and Blame," 1754, p. 243; "Of God's Placing differently Similar Particles."

proves no more than the Difference of Time does in an (the) other.

Edwards, about to become president of the College of New Jersey, and at this date writing as a missionary to the Indians; "Pastor of the Church in Stockbridge," has in the same chapter, these Princetonian thoughts on evolution suggested by Sir Isaac Newton's "Laws of Motion & Gravitation."

Let us suppose two Bodies moving the same Way, in strait Lines, perfectly parallel one to another; but to be diverted from this Parallel Course, and drawn one from another, as much as might be by the Attraction of an Atom, at the Distance of one of the furthest of the fix'd Stars from the Earth; these Bodies being turned out of the Lines of their parallel Motion, will, by Degrees, get further and further distant, one from the other; and tho' the Distance may be imperceptible for a long Time, yet at Length it may become very great. So the Revolution of a Planet round the Sun being retarded or accelerated, and the Orbit of it's Revolution made greater or less, and more or less elliptical, and so it's Periodical Time longer or shorter, no more than may be by the Influence of the least Atom, might in Length of Time perform a whole Revolution sooner or later than otherwise it would have done; which might make a vast Alteration with Regard to Millions of important Events. So the Influence of the least Particle may, for ought we know, have such Effect on something in the Constitution of some human Body, as to cause another Thought to arise in the Mind at a certain Time, than otherwise would have been; which in Length of Time (yea, and that not very great) might occasion a vast Alteration thro' the whole World of Mankind.

Thus the describer of the Ballooning Spiders. Einstein, Conklin; Behold your King!

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SCIENTIFIC BOOKS

Heredity and Evolution in Plants. By C. Stuart Gager. Philadelphia, 1920. P. Blakiston's Son and Co. Pp. xiii + 265. Figs. 113.

This very readable book is in part a reprint of certain sections of the author's "Fundamentals of Botany" but with considerable new matter added and much of the old recast. An account of the life history of the fern lays the foundation for a discussion of cell structure and the fundamentals of cell behavior in reproduction and at the critical periods of fertilization and reduction. Then comes a chapter on heredity followed by a consideration of results from experimental studies of Mendel, Johannsen, and others.

Chapters entitled "Evolution," "Darwinism" and "Experimental Evolution" give the views of Lamarck, Darwin, Wallace and de Vries. The statement of the mutation theory of de Vries is excellent but there is nothing to indicate to the reader how difficult it is to distinguish between mutations and the results of segregation in impure species the breeding behavior of which is complicated by the presence of lethal factors. There is no reference to the remarkable genetical complications which are known for *Œnothera* material rendering it among the most interesting and puzzling under investigation although correspondingly less favorable for the demonstration of mutations.

The latter half of the book considers the evolutionary history of the plant kingdom from evidence supplied by comparative morphology and life histories, geographical distribution, and paleobotany. In this section is brought together much scattered information which together with the discussion is likely to prove of particular interest to the general reader not familiar with geographical botany and with the striking contributions of recent years from studies of ancient plant remains.

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NOTES ON CLIMATOLOGY AND METEOROLOGY

AEROLOGICAL WORK IN THE UNITED STATES

Meteorology, until recent years, has been largely a two-dimensional science. Indeed, so strongly has the conception become rooted in the minds of meteorologists, that now, when