

liness, Thoreau sees in it an antidote for the wasteful ways of his fellow Americans.

The selections from Cato mentioned here afford an indication of the extent and variety of Thoreau's interest in the ancient agriculturist. When one has considered them in full detail, the feeling is strongly borne in upon him that Thoreau would not have gathered them without a purpose, and this design was the composition of an American *De Re Rustica*, which was to lean heavily upon Cato the Censor.

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Pythagoras and Musical Concords

Although modern scholars are inclined to credit Pythagoras with the discovery of the numerical ratios of the fundamental musical concords,¹ the ancient account of the way he chanced upon his discovery, reported by a dozen or more classical authors, has long been rejected. According to Nichomachus' account,² which is the most detailed, Pythagoras happened to be passing by a blacksmith shop and heard smiths beating iron on an anvil. The sounds coming forth produced the intervals of a fourth, a fifth, and an octave. After making tests, he decided that the difference in weight of the hammers was responsible for the difference in pitch. He recorded the weights of the hammers and attached other weights, equal to those of the hammers, to strings of the same material, length and thickness. He found that the same intervals resulted: weights of twelve and six units produced the octave, of twelve and eight or nine units gave the fifth, of twelve and nine or eight and six the fourth, and weights of nine and eight units gave the tone.

The physical impossibility of such a result has long been recognized. The vibrations of the strings are not proportional to the number of units of weight but rather to the square root of these units. I do not know who first drew attention to this truth. It is noted by E. Zeller, *Die Philosophie der Griechen* (Leipzig 1869), 1.346, and by D. B. Munro in the article "Musica" in Smith's Dictionary of Greek and Roman Antiquities. Assuming that the linear density of two similar strings of equal length remains constant, one weight (or the tension) would have to be four times as great as the other to produce the octave.

That the account is fabricated and that it is not

¹ J. Burnet, *Greek Philosophy*, Part I (London 1914), 45; T. Heath, *A History of Greek Mathematics* (Oxford 1921), 1.85; F. E. Robbins in Robbins and Karpinski, *Studies in Greek Arithmetic* (University of Michigan Studies, Humanistic Series 16, 1926), 18. Heath in *The Legacy of Greece* (Oxford 1928), 109.

² *Manuale Harmonicum* 6 (*Musici Scriptores Graeci*, ed. C. Jan, 245-8).

simply a matter of discrepancy arising from incorrect numerical values for the weights is shown by the repetition of the experiment. If one beats a piece of iron upon an anvil with hammers of different weights, there is little if any difference in the pitch of the sounds. When a one-pound hammer and a two-pound hammer were used, it was not possible, if one turned his back, to tell which hammer was striking the metal.

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A Control Experiment in Antiquity

In *Devils, Drugs, and Doctors* (New York 1929), 351, we find Howard W. Haggard making the following statement: "All that is necessary to do to prove whether antimony is or is not a cure for typhoid fever is to administer the drug to a hundred patients with typhoid fever and to keep a record of the number who recover; and as a 'control' to keep a record of the number of recoveries among a hundred patients with typhoid who are not treated with antimony." On the same page he says: "This simple method for determining the curative value of drugs did not come into use until the nineteenth century."

When did the procedure of control experiments originate? Pliny the Elder, who mentions many kinds of *experimenta*, seems to preserve records of only three or four that were carried out in a truly scientific attitude of mind, and in none of these was a control used.¹ The device was known to the ancients, however, for a description of a control experiment is given by Athenaeus in the *Deipnosophists*, 3.84 d-f:²

I am well aware, too, that when the citron is eaten before any food, dry or liquid, it is an antidote to every poisonous ingredient; I learned this from a townsman of mine who was entrusted with the governorship of Egypt. He had sentenced some convicted criminals to be devoured by wild beasts, and they were to be thrown among the creatures called asps. As they were entering the theatre assigned for the punishment of the robbers, a peddler-woman in the street gave them in pity some of the citron which she was holding in both hands and which she was eating. They took it and ate, and when after a short time, they were thrown among those cruel and monstrous creatures, the asps, they received no injury when bitten. Perplexity seized the magistrate, and finally he questioned the soldier who guarded them to see whether they had eaten or drunk anything; when he learned that the citron had been given them, he ordered next day that a piece of citron be given, exactly as before, to one convict, but not to the other, and the one who ate suffered no injury when bitten by the reptiles, but the other died the moment he was struck. And so, since the same result has been attested in many instances, the citron has been proved to be an antidote to every poison.

¹ See Lynn Thorndike, *A History of Magic and Experimental Science during the First Thirteen Centuries of Our Era* (New York 1923), 53-7, especially 55.

² The translation is that of C. B. Gulick in the Loeb Classical Library.

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