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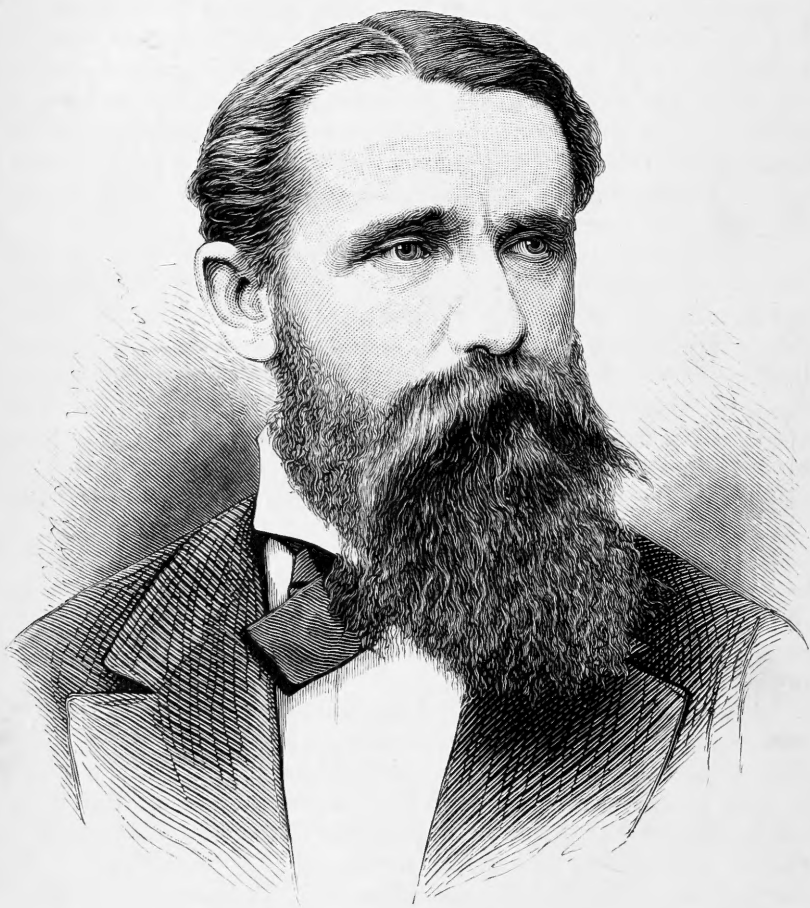




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Bathbun, R.







CHARLES FREDERIC HARTT.

SKETCH OF PROFESSOR C. F. HARTT.

BY RICHARD RATHBUN.

CHARLES FREDERIC HARTT, whose death by yellow fever occurred at Rio de Janeiro on the 18th of last March, was born at Fredericton, New Brunswick, August 23, 1840. For three years and a half before his decease, he had successfully withstood the fatigues of exploration and the labors of organizing and carrying on the geological commission of Brazil, an undertaking beset with many trying difficulties, only to succumb at last, the victim of an epidemic which caused him but two days of suffering.

Prof. Hartt's father was the late Jarvis William Hartt, for a long time closely connected with the educational interests of New Brunswick and Nova Scotia. The subject of our sketch received his early education mainly in Nova Scotia, under the direct supervision of his father. Later he entered Horton Academy, Wolfville, and afterward completed the academical course at Acadia College, where he graduated with honor in 1860. His connection with natural history dates from boyhood, and at the age of ten years he had already made a good beginning. Encouraged by Prof. Cheesman, he made rapid progress in his favorite studies, without, however, neglecting the other branches of learning. But his particular bent always lay toward natural history, language, music, and art. The former subject became his principal occupation, but the latter three, in which he made many original observations of great value, ever aided him much, especially in his studies in ethnology.

While a student at Acadia College, he undertook, under the direction of Dr. Dawson, extensive researches into the geology of Nova Scotia, which province he explored on foot from one end to the other. In 1860 he accompanied his father to St. John, there to establish a college high-school. This change of location brought him into another field for exploration, that of the geology of New Brunswick, and he commenced his new labors at once. The Devonian shales at the locality called Fern Ledges, in the vicinity of St. John, were the principal objects of his research. These shales occur on the shore of the bay of Fundy, and are situated mostly between high and low water marks, being thus very difficult of access. After a long siege of hard work, however, he was amply repaid by discovering an abundance of land plants and insects, of which the latter still remain the oldest known to science. Prof. Agassiz was attracted by this last discovery of the young Canadian naturalist, and invited him to enter his museum at Cambridge as a student. This he did in 1861, but in so doing his connection with provincial geology was not severed, for each vacation he returned,

either to New Brunswick or Nova Scotia, to continue his explorations, in the course of which he would often lecture in the different towns to obtain means of paying his field expenses. In 1864 Mr. Hartt was employed, with Profs. Bailey and Matthews, on the geological survey of New Brunswick, and, while engaged in this work, obtained the first full proof of the existence of primordial strata in that province. Many of his discoveries in Nova Scotia and New Brunswick were published in the Provincial Government reports, and also in Dr. Dawson's "Acadian Geology." Hartt's constitution, though well able to withstand the severest kind of fatigue in exploration, was not proof against the damp, chilly atmosphere of his native land, and from this cause he often suffered much; so it was probably fortunate for him that just about this time his attention was attracted toward a new field.

Upon the organization of the Thayer Expedition to Brazil, by Prof. Agassiz in 1865, he was appointed one of its geologists, and henceforth to the time of his death he was ever a most devoted investigator of South American natural history. As a member of Prof. Agassiz's party he explored the neighborhood of the coast from Rio de Janeiro to Bahia, and ascended many of the rivers, making large zoölogical collections, but finding little of interest in the geology. Aided by New York friends he returned to Brazil alone in 1867, this time examining with the greatest care the reefs of the Abrolhos Islands, and those of the coast, as well as the geology of a part of Bahia and Sergipe. With the material thus far collected he began the work of writing up his geological reports in the capacity of geologist to the Thayer Expedition. This report was to have been included along with those of his chief, but under Hartt's hands it grew to such size that it was published separately in 1870 as the "Geology and Physical Geography of Brazil." In addition to the account of Hartt's researches, it included the best results of all who had ever published on the geology of the country.

After his return from the Thayer Expedition, the time he spent in this country until 1868 was devoted mostly to scientific teaching and lecturing in and around New York City, where he attained much success and made many warm friends. Early in 1868 he was elected Professor of Natural History in Vassar College, a position he resigned in the fall of the same year, to accept the chair of Geology in Cornell University. Shortly after assuming his duties at Cornell, he was married to Miss Lucy Lynde, of Buffalo, New York, who is now left with two children. In 1869 he was made General Secretary of the American Association for the Advancement of Science, to serve at the meeting of 1870; but a third expedition to Brazil, which he had been planning, called him away before the Association met. This trip was made in company with Prof. Prentice and eleven students of Cornell University, and was the largest of his own organizations from the United States. With this party he entered what was really a new region for

geological exploration—the Amazonian Valley—hoping there to discover, at the falls of the different tributaries of the Amazonas, other fossiliferous formations than the Cretaceous, which latter alone he had found along the coast. He was well rewarded, and returned to the United States with large collections of fossils of the Palæozoic age, and sufficient other evidence to allow of his giving us a very accurate though general idea of the formation of the Amazonian Valley. His results were strongly opposed to the theory of Prof. Agassiz, of its glacial origin. Not entirely satisfied with the amount of material obtained on this last expedition, he returned again to the Amazonas in 1871 with Mr. O. A. Derby, who had accompanied him on the former trip. Together they carefully reexplored the same regions gone over before, adding much to the stores already brought to the United States, and also examining the ancient Indian mounds and shell-heaps of numerous localities. The two Amazonian trips of Prof. Hartt were rendered possible through the liberality of Mr. Edward Morgan, of Aurora, New York, in whose honor they have been called the “Morgan Expeditions.”

Returning from Brazil once more, he remained at Cornell University about three years, quietly working up the results of his later trips, and publishing his reports upon them; but his active spirit would not allow him to remain in this condition long. He conceived the idea of systematically exploring the entire empire of Brazil, a country possessing an area almost as great as the United States. In August of 1874, by request of the Brazilian Minister of Agriculture, he went to Rio de Janeiro to submit his plans for the organization of a Geological Commission of Brazil. He first suggested the forming of a very large party similar to those engaged in our own national explorations; but it was found that the existing appropriations would not suffice for so grand an undertaking, and he was forced to begin on a more modest scale, the commission dating from May 1, 1875. In addition to the chief, there were never more than five or six assistants at any one time, comprising two assistant geologists, one topographer, and two other assistants, and at times a photographer or other specialist. His former experiences in Brazil aided him in rapidly attaining good and important results. He took the old grounds which he had already examined as starting-points for his new explorations, and worked outward from them in all directions, quickly but carefully enlarging the known area of fossiliferous and other rocks. This kind of work he was, of course, able to carry out only on the Amazonas and in the northern coast provinces; but to the south of Rio he had everything to begin, and in those localities his examinations were more hasty, bearing the character of preliminary surveys; but they were also productive of valuable results.

On the reorganization of the National Museum at Rio, in 1876, Hartt became director of its department of Geology; but, on account

of his many other duties, he was soon obliged to resign that position. The results of his researches may be briefly summed up as follows : Before he went to Brazil on his second trip, in 1867, scarcely anything was known of fossiliferous deposits there, and thus no material existed toward the study of the systematic geology of the country. A few Cretaceous fossils had been recorded from Bahia ; the Danish naturalist Luns had very fully described the bone-caverns of Lagoa Santa in Minas Gerães, and we knew of coal-plants from Rio Grande do Sul ; but beyond this the paleontology of Brazil was a perfect blank. Hartt's greatest achievement in Brazil was probably his solution of the structure of the Amazonian Valley. It was founded on the best of paleontological evidence which proves the existence of an immense palæozoic basin lying between the metamorphic plateau of Guiana on the north, and that of Central Brazil on the south, and through which flows the river Amazonas. Silurian, Devonian, and carboniferous rocks, make up the series in regular succession, and in many localities are highly fossiliferous. He has explained the character of the isolated Cretaceous deposits, mostly discovered by himself, existing along the coast from Pará to Bahia, and of the Carboniferous and other regions south of Rio. He has shown us the manner in which the rocky structure of Brazil was built up, and has done much toward solving the relations of the crystalline rocks which compose by far the larger portion of its surface. He has explored the shell-heaps, burial-mounds, and other relic-localities of the prehistoric tribes from far up the Amazonas to the southernmost coast province. We owe to him also the first real satisfactory explanation of the reefs of Brazil, which he distinctly shows to be of two kinds—sandstone and coral. He spent much time in studying the customs and languages of the modern Indian tribes of the Amazonas and Bahia, and collected very much material toward a grammar and dictionary of the Tupé Indian language in several of its dialects. But to attempt a complete account of Prof. Hartt's Brazilian explorations and discoveries would require a longer article than we can give here. In connection with the Geological Commission of Brazil he founded a large museum in Rio de Janeiro, which will always bear testimony to his great final undertaking. His field-parties made very extensive collections of rock-specimens and fossils, and in the explorations of the reefs they gathered a large collection of marine invertebrate animals of all kinds. About a year ago, when the members of his survey were mostly recalled to Rio for the purpose of writing up their reports and of studying the material they had collected, it was found that some six hundred cases had been sent in from the field, and were awaiting suitable quarters. A large building was obtained, and in the course of several months there appeared a museum of geology and marine zoölogy that would have done credit to a much larger commission working a much longer time. It contained fossils, minerals, and rocks, from nearly every known geological locality in Brazil, and

thus formed the most complete repository of South American geology in the world. Among the collections of marine zoölogy those of the corals, crustacea, and mollusks, were notably large and complete. But one of the most interesting parts of the museum was its collection of antiquities, which comprised many new and curious forms of pottery and stone implements, and was also rich in human remains.

A start had just been made toward publishing the reports of the commission when the death of Prof. Hartt deprived it of its main support. But, though this will occasion some delay in the publication, it is to be hoped that we shall soon have before us the entire results of one of the grandest series of explorations ever carried on by an American in a foreign country.

Prof. Hartt's published works are not very voluminous. He was so confident of a longer life that he delayed too long, but still he was a constant contributor to American scientific periodicals. In addition to his large volume, "The Geology and Physical Geography of Brazil," he has given us the following, among other very valuable reports :

"Amazonian Drift" (*American Journal of Science*, vol. i., 1871, pp. 3).

"Brazilian Rock-Inscriptions" (*American Naturalist*, vol. v., 1871, pp. 9 and figures).

"The Ancient Indian Pottery of Marajó, Brazil" (*American Naturalist*, vol. v., 1871, pp. 13, many figures).

"On the Tertiary Basin of the Marañon" (*American Journal of Science*, vol. iv., 1872, pp. 6).

"Recent Explorations on the Valley of the Amazonas" ("American Journal of the Geographical Society of New York," 1872, with map).

"Morgan Expeditions 1870-'71." Contributions to "The Geology and Physical Geography of the Lower Amazonas—The Evevé, Monte Alegre District, and the Table-topped Hills" ("Bulletin of the Buffalo Society of Natural Science," January, 1874, pp. 35).

"Morgan Expeditions 1870-'71. Report of a Reconnaissance of the Lower Tapajos" ("Bulletin of Cornell University (Science)," vol. i., No. 1, 1874, pp. 37).

"Evolution in Ornament" (*THE POPULAR SCIENCE MONTHLY*, January, 1875).

"Notes on the Manufacture of Pottery among Savage Races" (Rio de Janeiro, 1875, pp. 70).

"Amazonian Tortoise Myths" (Rio, 1875).

"Nota sobre algumas Tangas de Barro cosido dos Antigos Indigenas da Ilha de Marajó" ("Archivos do Museu Nacional de Rio de Janeiro," vol. i., 1876, pp. 5, 3 plates).

CORRESPONDENCE.

THE LOGIC OF PROBABILITIES.

To the Editor of the Popular Science Monthly.

IN the April number—"Illustrations of the Logic of Science," p. 706—the writer says: "What is the probability of throwing a six with one die? The antecedent here is the event of throwing a die; the consequent, its turning up a six. As the die has six sides, all of which are turned up with equal frequency, the probability of turning up any one is one-sixth." Admitted; but is not this also true: that if you throw a single die, say twenty times, and fail to turn up a six, the probability thereafter of turning up a six is increased? One would say so; and for the reason that, *in the long run*, there must turn up as many sixes as ones or twos or threes or fours or fives. "The die has six sides, all of which are turned up with equal frequency." Of course, the greater the number of throws, the nearer will the numbers of times which each side of the die falls uppermost approximate each other—approaching relatively nearer all the way from six throws to sixty million, and on to infinity. If a six has failed to turn up for twenty throws, and if it must turn up as frequently as the other numbers, it must some time after the twentieth throw make up the deficiency. To *average up*, six must begin some time to turn oftener; that is, with each failure to fall uppermost, its chance or probability of doing so is increased.

On the other hand, suppose you have thrown the die twenty times, or twenty thousand times, and have failed to turn a six, even then the twenty-thousand-and-first throw, considered by itself, manifestly affords one-sixth (no more, no less) of a chance of turning up a six.

How is this logic to be reconciled?

Respectfully,

CHARLES WEST.

SAN FRANCISCO, CALIFORNIA, April 2, 1878.

WE insert this letter because it gives expression to a fallacious notion which is very current. At the gambling-places they distribute cards upon which the players can, by prickings, mark the number of times which black and red have turned up, so as to bet upon the color which is in deficiency. The confusion is between the following two statements, of which the first is true, the second false:

1. "If a die be thrown a sufficient number of times, the *proportion* of times with which it will turn up six, will approximate (within any desired limit) to one-sixth." This is true.

2. "If a die be thrown a sufficient number of times, the *number* of times with which it will turn up six will approximate (within any desired limit) to one-sixth of the total number of throws." This is plainly false. Suppose a die be thrown six times in all, then the number of times in which six comes up cannot differ by more than five from being exactly one-sixth of the total number of throws. But does anybody imagine that, if it were thrown six hundred times, the number of sixes would often lie between 95 and 105, or within five of one-sixth of the total number?

Recognizing this distinction, our correspondent's argument falls at once to the ground. Suppose that the first twenty throws of the die were to be *six*, and thereafter just one-sixth of the throws were to be six, then the frequency of sixes would be as follows:

After 20 throws, the frequency would be $\frac{20}{20} = 1$.

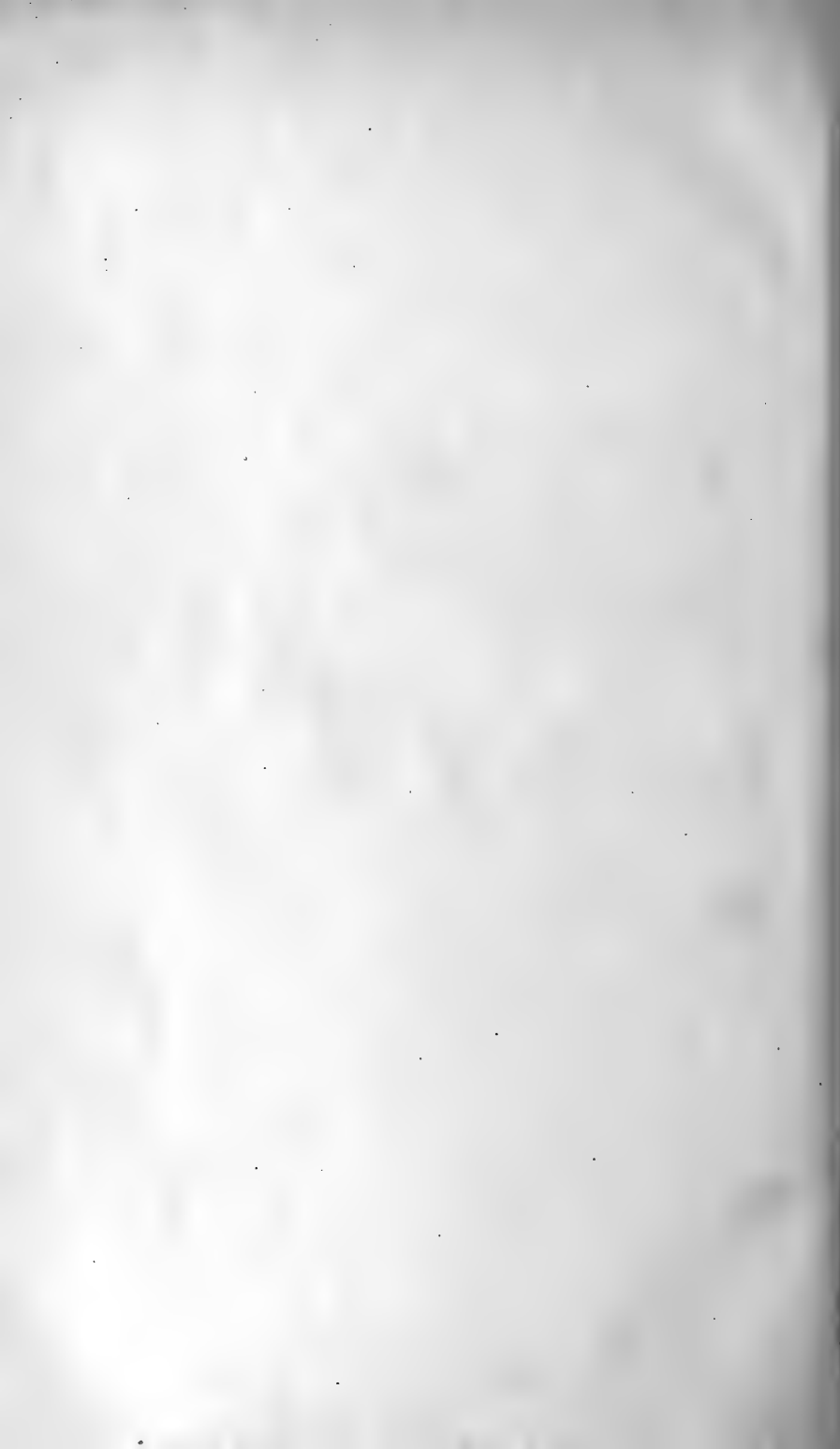
After 80 throws, the frequency would be $\frac{20 + 10}{80} = 0.375$.

After 620 throws, the frequency would be $\frac{20 + 100}{620} = 0.19354839$.

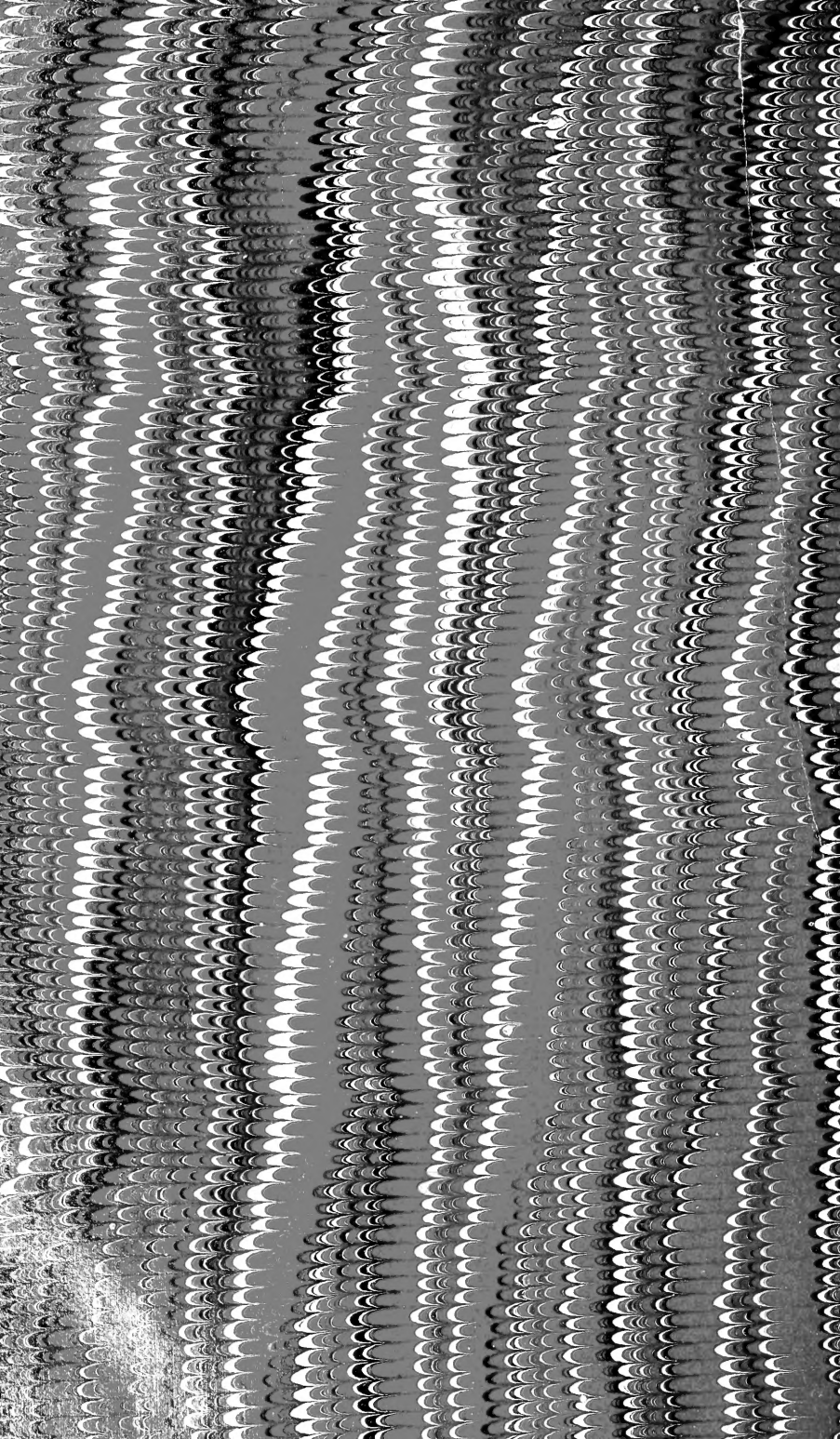
After 6,020 throws, the frequency would be $\frac{20 + 1,000}{6,020} = 0.1694352$.

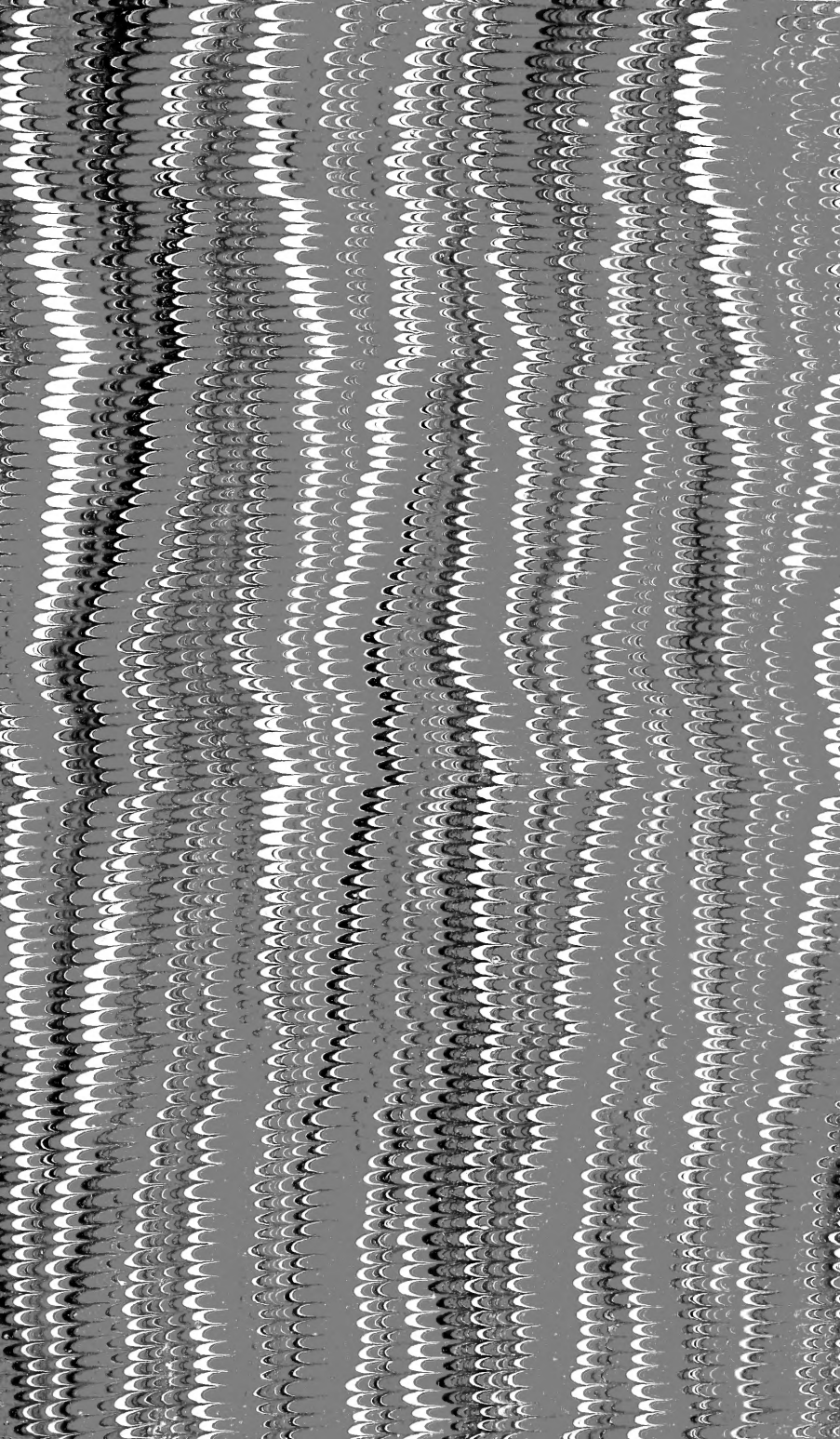
Thus the frequency would continually approximate toward one-sixth or 0.166666 . . . , although sixes were thrown exactly one-sixth of the time, after the run of twenty sixes. Our correspondent is, therefore, in error when he says: "If a six has failed to turn up for twenty throws, and it must turn up as frequently as the other numbers, it must some time after the twentieth throw make up the deficiency. To *average up*,











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