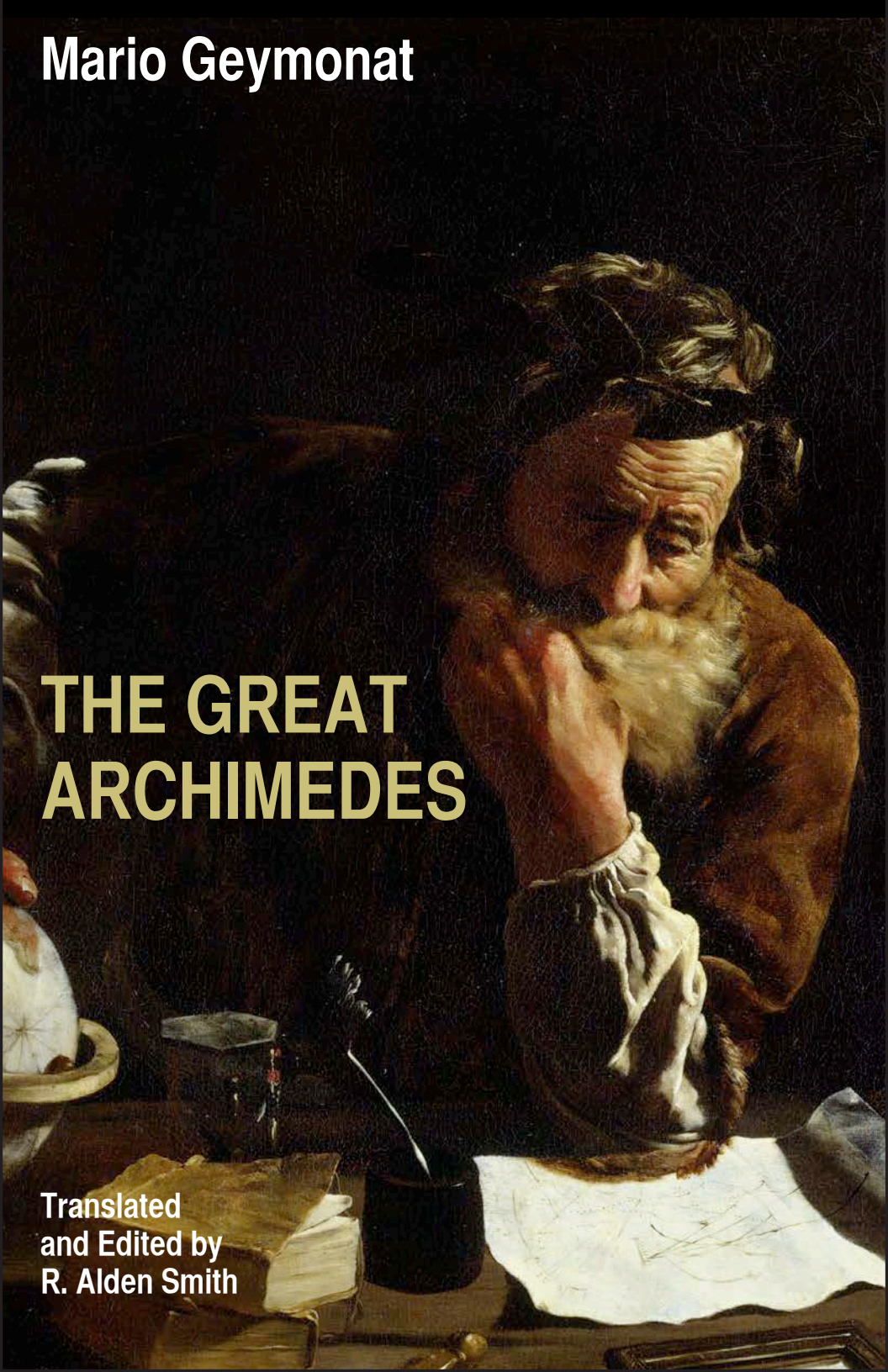
Mario Geymonat



THE GREAT ARCHIMEDES

Translated and Edited by R. Alden Smith

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R. Alden Smith
Translator and Editor

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To my father and my son, both Ludovico

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FOREWORD

Archimedes is one of the most original and prolific scientists in the history of humankind. Because of a prodigious mathematical imagination and a thoroughly advanced methodology, Archimedes was able to demonstrate proofs for an amazing set of geometrical theorems: on the quadrature of the circle, on the measurement of cylinders and spheres, on spirals, on conoids and other spherical shapes, and even on semi-regular polyhedrons.

In arithmetic, Archimedes made great strides by determining, with extraordinary precision, very large numbers, such as the number of grains of sand necessary to fill the entire universe. Archimedes' contributions to physics and engineering are equally important, especially his research on the lever, on the laws of mechanics, and on optics. He possessed an unparalleled ability to invent and build complex machines for both civilian and military purposes, such as the winch, the screw pump, some catapults, and possibly even "burning mirrors."

Like Galileo in the seventeenth and Einstein in the twentieth century, Archimedes responded to the civil and political problems of his day with intelligence and passion. He thus courageously devoted himself to defending his hometown, Syracuse, one of the largest and most advanced cities of antiquity. Tragically, it was precisely when the city had fallen into the hands of the invading Romans (212 BC) that Archimedes met his end, brutally killed by a soldier who could not fathom how, in so perilous a situation, Archimedes persisted in occupying himself with abstract geometry.

Historians, orators, architects, and poets, whether Greek or Roman (e.g., Polybius, Plutarch, Cicero, Vitruvius, and Virgil), included Archimedes in their writings. His reputation expanded throughout the medieval period. Moreover, during the Renaissance and the Reformation, translations of Archimedes' texts coupled with thorough study of his theorems provided a strong foundation for the development of modern science.

A number of rare and beautiful illustrations enrich Mario Geymonat's pleasantly uncomplicated yet dexterous *The Great Archimedes*. This work represents a major contribution to the dissemination of knowledge about and admiration for this extraordinary historical figure. With this fresh contribution, Geymonat ensures that Archimedes will continue to be an example of mathematical genius for generations to come, and will continue to stimulate further interest in complex and difficult scientific questions. In this way, the great Archimedes, our learned colleague from antiquity, offers confidence to a new generation as it faces its own challenges.

—Zhores Alferov

PREFACE

In this book, Archimedes is considered with great erudition from every point of view, including his contribution to the development of weaponry. In this regard, though he was not necessarily disposed to offering practical applications of his work, Archimedes proves to have been valuable and useful to his fellow men, as his machines engendered fear even in the Romans when they attacked his hometown. Among his most fascinating contrivances—the reality of which has been both called into question or attributed to exaggeration—are the famous "burning mirrors."

Mario Geymonat demonstrates the ways in which even the amatory poet Catullus was influenced by Archimedes, who proved to be a frequent source of fascination for writers, beginning with Plutarch. That biographer speaks about him at some length in the *Life of Marcellus*. Archimedes was even the subject of a romanticized biography in the work of the scientific writer Egmont Colerus (1888–1939), a pseudonym of Egmont von Geldern. Colerus was, among other things, the author of the

well-known *Von Pythagoras bis Hilbert* (*From Pythagoras to Hilbert*), *Die Epochen der Mathematik und ihre Baumeister* (*The Ages of Mathematics and Their Pioneers*), and the equally famous *Vom Punkt zur vierten Dimension: Geometrie für jedermann* (1939), translated from its subtitle into English by B. C. and H. F. Brookes as *Mathematics for Everyman* (in Italian, *Il romanzo della geometria*). Colerus also wrote a travel novel, published in 1926, entitled *Zwei Welten* (*Two Worlds*), and a widely circulated biography in 1934 entitled *Leibniz: Der Lebensroman eines weltumspannenden Geistes*.

Colerus entitled his book about Archimedes *Archimedes in Alexandria* (1939, reprinted in 1941 and 1950 by the Viennese publisher Zsolnay). The title reveals that Colerus' idea was to focus his biography of Archimedes on the scientist's dealings in Alexandria. At the height of the third century BC, that city was governed by a powerful Hellenistic monarchy and served as a cultural center of both literature and science. Here Archimedes had a fruitful interchange with the geographer Eratosthenes, the Greek mathematician Dositheus of Pelusium, and the Greek astronomer Conon of Samos. He speaks of Conon with the sincere affection of a student in a prefatory letter addressed to Dositheus:

> With regard to those theorems that you sent with Conon, the proofs of which you charged me to illustrate, the majority are in the books that Heraclides had brought to you, while the others are in the book that I am now sending you. Do not let it surprise you, however, that I only publish them now, for I had first wanted to show their genuineness to mathematicians. . . . But, before these experiments could be performed, our friend Conon died, and he certainly would have known how to illustrate them much better than I and, with his other discoveries, would have been in a position to advance the study of geometry.

Colerus' book, defined by Coppola as "a long fantasy novel," plunges Archimedes (and the reader) into the midst of the Greco-Egyptian capital of the Ptolemaic seat of power. Archimedes would have come to Alexandria after having been hired by Ptolemy II, and he must have lived there for quite a while until he was recalled home, when Syracuse was threatened by the Romans (213–212 BC).

Thus we see an Archimedes "in the upper room of the library and of the Museum," where he would have taken over the role Euclid had previously held. According to Colerus' imaginative reconstruction, "two women, Reality and Truth, revealed to Archimedes the secrets of science." Curiously, Professor Coppola concludes his review of Colerus' work with an enigmatic allusion: "Behold," he writes, "I think I have understood how it is that he [Archimedes] said one day that by leveraging a single point he could raise up the world (*da ubi consistam, caelum terramque movebo*), and why, without resentment [sic!] he was driven to burn enemy ships with a device that he kept saying would be 'a machine from hell.'" I have always wondered what he really intended with these words, whether these stark and unexpected final words did not contain some further message.

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Could no link have existed, then, between the more or less permanent residence of Archimedes in Alexandria and his deep commitment to the defense of Syracuse against the Roman siege? It is likely that, when so few scraps of evidence are available, our data will be not entirely clear and are possibly even corrupt; nevertheless, it is useful to recall the situation of Syracuse between the first and second Punic War. After the naval victory of Lutatius Catulus at the Aegades Islands (241 BC), Sicily came to Rome as a province. Two Sicilian cities, however, Syracuse and Messina, which remained faithful to their treaties with Rome and

thus had maintained their status as "allies," were exempted from taxation. Thus began the practice, so common then in Roman foreign policy, of holding as bound "allies" some powerful cities (such as Syracuse) that then maintained a semblance of independence within the framework of Roman sovereignty. When, after the Battle of Cannae (216 BC), Hannibal increasingly seemed to become the master of southern Italy (Lucania, Brutium, Tarentum), and while the Carthaginians also undertook the invasion of Sicily (Lilybaeum), Syracuse chose to defect (213 BC) from her powerful ally at a critical point. It seemed that a counterattack of the Greek world had begun. For Archimedes there could be no doubts.

—Luciano Canfora