Science in Seventh-Century Armenia: Ananias of Širak

*By Robert H. Hewsen**

NOWHERE IN Sarton's *Introduction to the History of Science* do we find the name of Ananias of Širak,[1] Armenian mathematician and astronomer of the seventh century and contemporary of Isidore of Seville. Several other Armenian scholars are cited by Sarton, but it is Ananias of Širak who is regarded by the Armenians themselves as their greatest medieval scientist. Indeed, he has been called the "father of the exact sciences in Armenia."[2] The general neglect of Ananias is not surprising. Until recently only his geography was available in a Western language, and for three hundred years this work was mistakenly attributed to another Armenian writer, Moses of Xoren.[3] None of Ananias' other major writings was published until 1939, and even now he is almost totally unknown in the West.

The aims of the present paper are to summarize Ananias' life, introduce some of his scientific ideas, and indicate his works and the available literature concerning them. Certainly he justifies further study: his works need further evaluation and authentication, while the claims made for his contributions in Soviet Armenia invite closer scrutiny. Very few of Ananias' works have been published in the West, and those which have appeared in Russia and Armenia were issued in limited editions and only scantily circulated. Most of these are unobtainable in this country, and I have been able to examine personally only his *Geography, Itinerary, Autobiography, Discourses on Christmas and Easter,* and *Tables of the Motion of the Moon.* Fortunately, however, I did have access to valuable secondary sources in both Russian and Armenian which have made this introductory study possible.

Ananias of Širak was first cited in nineteenth-century studies on Armenian

* Glassboro State College, Glassboro, N.J.

1 The name is variously spelled. It is Anania Širakac'i in Armenian, using the Hübschmann-Meillet system for the transcription of the Armenian alphabet which I am utilizing throughout this paper, but would be Anania Shirakatsi in conventional English spelling. Anania being the Armenian form of the biblical name Ananias and Shirakatsi meaning "of Shirak," I propose either Ananias of Shirak or Ananias of Širak as the preferred form.

2 "Autobiographie d'Anania Širakac'i," French trans. by H. Berberian, *Revue des Études Arméniennes,* N. S., 1964, *1*:189.

3 Moses of Xoren (Arm: Movsēs Xorenac'i) was an author of the 5th century to whom is also attributed a *History of Armenia.* Internal evidence reveals both the *Geography* and the *History* to have been written much later, the *Geography* in the 7th century and the *History* in, probably, the late 8th. For the dating of the *History* see C. Toumanoff, *Studies in Christian Caucasian History* (Washington: Georgetown Univ. Press, 1963). For the *Geography* see Joseph Marquart, *Ērānšahr nach der Geographie des Pseudo-Moses Xorenac'i* (Berlin: Weidmannsche, 1901).

literature, and a few of his known works were published in the original classical Armenian by K. Patkanean of the University of St. Petersburg in 1877.[4] In 1896 some of his other works were published in *Ararat,* the official bulletin of the Armenian Church. Three of his lesser pieces were then translated into English and published by the British armenologist F. C. Conybeare: the treatise "On Christmas" appeared in 1896[5] and his autobiography and the treatise "On Easter," the following year.[6] A Russian translation of another work, *Problems and Solutions,* was published in 1918 by H. A. Orbeli, a member of the Russian Academy of Sciences.[7] None of these publications was widely circulated, however, and it was not until recent years that Ananias of Širak became well known even in the Soviet Union.

A. G. Abrahamean and S. T. Eremean have been the great students of the works of Ananias in Soviet Armenia. Abrahamean undertook the editing of Ananias' unpublished texts for the University of Erevan shortly before the late war, and it was he who identified many of his works which had come down to us as anonymous or under erroneous ascriptions. In 1939 Abrahamean published one of Ananias' arithmetical texts.[8] Two years later he published the *Cosmography and Chronology*[9] and in 1944 prepared a complete edition of his other known works.[10] Eighteen years later, Abrahamean identified still another text of Ananias which he published with a Russian translation under the title *Tables of the Motion of the Moon.*[11] Suren Eremean has devoted the past ten years to the study of the *Geography* and is currently preparing a definitive edition of this text for publication by the Armenian Academy of Sciences.[12] Together, these two scholars have managed to rescue Ananias from complete oblivion, but their works remain locked behind the barriers of the Russian and Armenian languages and are almost inaccessible outside the Soviet Union. The results of their researches have produced some echoes in the West, however. Brief résumés of Ananias' life and work have appeared in a French history of Armenian literature[13] and also in an American anthology of biographies of Armenian church figures.[14] Ananias' autobiography appeared in French in 1964,[15] and this is probably the best starting point for an investigation of his role in the history of science.

[4] K. Patkanean, *Ananiayi Širakunwoy Mnatsordk' Panic'* [The Collected Works of Ananias of Širak] (St. Petersburg, 1877), 75 pp. (In Armenian.)

[5] Ananias of Širak, "On Christmas," English trans. by F. C. Conybeare, *The Expositor,* 1896, 5th ser., *4*:121–137.

[6] Ananias of Shirak, "Autobiography," "His Tract on Easter," English trans. by F. C. Conybeare, *Byzantinische Zeitschrift,* 1897, *11*:572–584.

[7] *"Voprosy i Resheniya" Ananii Shirakatsi* [The "Problems and Solutions" of Ananias of Širak], Russian trans. by I. A. Orbeli (Petrograd, 1918), 77 pp.

[8] Anania Širakac'i, *T'uabanut'iwn* [Arithmetic] (Erevan, 1939), 75 pp. (In Armenian.)

[9] Anania Širakac'i, *Tiezeragitut'iwn ew Tomar* [Cosmography and Chronology] (Erevan, 1940), 95 pp. (In Armenian.)

[10] A. Abrahamean, *Anania Širakac'u Matenadrut'iwn* [The Works of Ananias of Širak] (Erevan, 1944), 412 pp. (In Armenian.)

[11] Anania Širakac'i, *Tablitsy Lunnogo Kruga* [Tables of the Motion of the Moon], ed. and Russian trans. by A. Abrahamean (Erevan: Izdatel'stvo Erevanskogo Gosudarstvennogo Universitet, 1962), 109 pp.

[12] Eremean's preliminary study of this work has already appeared under the title *Hayastanəəst "Ašxarac'oyc' "-i* [Armenia According to the "Geography"] (Erevan: Izdatel'stvo Akademii Nauk, 1964). (In Armenian.)

[13] H. Thorossian, *Histoire de la littérature Arménienne des origines jusqu'à nos jours* (Paris: Araxes, 1951), pp. 106–107.

[14] Dickran Boyajian, *The Pillars of the Armenian Church* (Watertown, Mass.: Baikar Press, 1962), pp. 156–162.

[15] "Autobiographie," trans. by Berberian.

Ananias of Širak is the only classical Armenian author to leave us an autobiography. He neglects to mention the year of his birth, but from internal evidence and from indications in later authors it is now generally thought to have been between 595 and 600.[16] He was born in the village of Anania in the canton of Širak in Ararat Province, the son of one John of Širak.[17] In some of the manuscripts of his works he is styled "Širakuni," a form which may suggest that he belonged to the house of Kamsarakan or Aršaruni, hereditary princes of Širak and Aršarunik'.[18] Apparently he was in possession of some wealth, for, as we shall see, he was able to finance his own extensive education. It is generally assumed that, like most classical Armenian authors, he was a monk in the Armenian Church,[19] but if he was it was apparently not until later in life, after he had concluded his years of study.

Ananias was educated in the local schools of his province, which must have been quite modest at the time. There he studied the scriptures as well as the various Armenian authors, but he wished to become a true scholar. To accomplish this he felt the need of a thorough grounding in mathematics, which he tells us he considered to be the "mother of all knowledge."[20] According to his autobiography, there was no one in Armenia capable of teaching mathematics in his time, and there were not even any books on the subject available to him. He therefore determined to study in the "land of the Greeks" (the Byzantine Empire). Crossing the frontier, he went first to Theodosiopolis (now Erzerum, in eastern Turkey) where a learned man named Eliazar told him of the mathematician Christosatur, who taught in the Byzantine province of Fourth Armenia.[21] Ananias went to Christosatur, studied under him for six months, but soon discovered that his teacher was of insufficient knowledge to meet his needs.

Preparing to move on to Constantinople, Ananias met some friends who had just returned from the capital. After hearing the reason for his proposed journey, they told him that while on the ship to Sinope they had met Philagrius, deacon of the Patriarch of Constantinople, and that he was leading a group of select students to Trebizond to study under a famous teacher named Tychicus (Arm: Tuxikos). Tychicus was described to Ananias as a man not only renowned among kings but possessed of a knowledge of both the Armenian language and its literature. Ananias hastened to Trebizond where he found Tychicus teaching at the monastery of St. Eugenius.[22] The learned doctor accepted Ananias as his pupil, and for eight

[16] K. T. Xrlopean, *Anania Širakac'u Ašxarhayac'kə* [The World View of Ananias of Širak] (Erevan: State Univ. Press, 1964), p. 180. (In Armenian.)

[17] The name of his father (Arm: Hovhannes) is found not in the autobiography, but at the end of the treatise "On Easter."

[18] Armenia was a highly feudalized state made up of 15 provinces and about 190 cantons, most of which were ruled by hereditary princes. The state was presided over by a weak king who was regarded merely as the first among equals by the rest of the princes. The monarchy was in abeyance from early in the 5th century until late in the 9th century.

[19] Of the classical Armenian authors only Gregory Magistros is known to have been a layman. Until the early 19th century the Armenian Church had an almost complete monopoly on Armenian educational and cultural activities.

[20] "Autobiographie," trans. by Berberian, p. 191.

[21] From 387 until 636 Armenia was partitioned in one way or another between the Byzantine and Persian Empires. Fourth Armenia was one of the divisions of Byzantine Armenia after 536; its capital was at Melitene (Malatya), and this is probably where Christosatur taught.

[22] There was a church on St. Eugenius on the farther side of the ravine to the east of Trebizond. It is now the *Yeni cuma cami,* or "Friday" mosque.

years the Armenian youth studied under his tutelage. During this time he acquired a thorough knowledge of mathematics as well as a foundation in the other sciences. At the school of Tychicus, Ananias found a rich library where he read the sacred and profane authors of Greek literature, scientific and historical works, books on medicine, and especially on chronology. Ananias tells us that he found great favor with his teacher, who treated him as a son, so much so that he incurred the jealousy of his fellow students from the imperial court.

At least a third of the autobiography is devoted to a biography of Tychicus.[23] He was a Greek of Trebizond, where he was born about 560. He served in the Byzantine army under the Emperors Tiberius II (578–582) and Maurice (582–602) during which time he was stationed in Byzantine Armenia, where he studied both the Armenian language and literature. He was wounded in a Persian attack on Antioch (*c.* 606/607) and after his recovery he left the army to fulfill a vow he had made while ill to devote the rest of his life to the pursuit of wisdom. He spent a month in Jerusalem, three years in Alexandria, and one year in Rome, after which he journeyed to Constantinople (*c.* 610), where he continued his studies under a famous Athenian scholar whom Ananias does not name. Upon completing his education in the Byzantine capital, Tychicus found his reputation so high that the Patriarch himself, as well as many other high personages of the city, begged him to stay on and teach there. Tychicus chose to return to Trebizond, however, and there he opened his own private school (*c.* 615). After the death of his Athenian master, the emperor himself invited Tychicus to return to Constantinople, but he refused. It was shortly after this (*c.* 620–628) that Ananias studied under Tychicus —a man whom Ananias considered to have been predestined by God for the introduction of science into Armenia.

After completing his studies in Trebizond, Ananias returned to Armenia, where he opened a school of his own, apparently the first in the country to teach the quadrivium.[24] Students flocked to him at first, but he complained bitterly of their laziness and dilettantism and of how they would leave before learning much more than the fundamentals and then would set about teaching students of their own, to the detriment of their master's reputation. He appears to have persevered, however, and assures us that he continued to accept all students who came to him.

With the money earned by his teaching, Ananias was able to finance his own researches in chronology, mathematics, astronomy and—as it now appears—in geography.[25] Over the years his fame spread not only in Armenia, but also in foreign lands. In 667, when already advanced in age, he was invited by Anastas, Catholicos of the Armenian Church (661–667), to come to the monastery of the Holy See at Duin[26] and there to prepare a perpetual calendar of the movable and immovable

[23] Paul Lemerle, "Note sur les données historiques de l'Autobiographie d'Anania de Shirak," *Rev. Étud. Arménn.*, N. S., 1964, *1*: 195–202.

[24] Xrlopean, *op. cit.*, p. 175, where Xrlopean ranks him with al-Kindi, John Italos, Averroës, and Avicenna.

[25] The attribution of the *Geography* [Ašxarhac'oyc'] to Ananias would appear to have been settled definitely, since most Soviet scholars date it to the 7th century (e.g., Toumanoff, *op. cit.*) and Armenian literary history knows of no other scholar of this period who concerned himself with such work. The whole question was brought up again by Eremean, who dated the work between 591 and 610—too early in the century for Ananias. My own researches, however, suggest a date as late as *c.* 636, which would bring it well within the lifetime of Ananias.

[26] The seat of the Catholicos of the Armenian Church varied across the centuries.

feasts of the Armenian Church. It was probably during this last period of his life that he wrote the treatises on the calendar which have come down to us. For two years he labored on the problem of reconciling the incompatibilities of the seven-day week, the lunar month, and the solar year. At the end of this time he declared that the dates chosen for Easter and the Epiphany were closely related and that the method used to determine them in the Armenian Church was more accurate than that accepted by the universal church at the Council of Nicaea in 325.

The perpetual calendar devised by Ananias is based on a cycle of 532 years. This cycle was first proposed by Victorius of Aquitaine in 457 and was adopted by the Church of Alexandria as a means of determining the dates of the movable feasts, which were then communicated annually to the rest of the Church. Cycle 532 is the combination of the solar cycle (which brings the days of the month back to the same day of the week every 28 years) and the lunar cycle (which brings the new moon back to the same day of the month every 19 years), the two coinciding every 532 years. With a calendar based on this cycle, a new calendar is unnecessary, the date of each movable feast being determined for all time.[27]

Ananias of Širak was a scholar of deep erudition in the learning of the past, and a fruitful study might be made into just how original some of his ideas were and from precisely which authors the unoriginal ideas were drawn. He taught that the world was a sphere and that when it was day on one side it was night on the other.[28] He described the earth as being like an egg with a spherical yolk (the globe)[29] surrounded by a layer of white (the atmosphere) and covered with a hard shell (the sky).[30] He also held the theory that the Milky Way is a mass of dense but faintly luminous stars[31] and agreed with earlier philosophers that the moon was a dark body by nature whose only light was that which it reflected from the sun.[32] His geography, based on that of Pappus of Alexandria, was the last work based on ancient geographical knowledge written before the Renaissance.[33]

In his book *The Ideas of Ananias of Širak,* the Soviet scholar K. T. Xrlopean goes to some length to prove that Ananias was an enemy of the church and a fighter against its "obscurantism."[34] The fact that he was the author of various treatises on the principal feasts of the church and that he was summoned to prepare a church calendar by the Catholicos himself would seem to disprove such an opinion. That he was an independent thinker of sorts, however, there is no doubt, and although his speculations usually dealt with the church's accepted interpretation of cosmography rather than with its dogmas, we shall see below how close he came to the heresy of dualism. K. Patkanean, G. Zarbanelean, N. Pigulevskaya, and, to a certain extent, Y. Manandean regarded Ananias as an ideologist of the church along the lines of Cosmas Indicopleustes. However, Ananias actually criticizes Cosmas: "Certain

---

It was at Duin, the capital of Persian Armenia, from 484 to 929. It is now back at its earlier location, the monastery of Ejmiacin in Soviet Armenia.

27 Boyajian, *op. cit.,* p. 160. For the concordance of these various cycles see V. Grumel, *Traite des études Byzantines. I. La Chronologie* (Paris: Presses Universitaires de France, 1958).

28 G. W. Abgarian, *The Matenadaran* [Manuscript Repository] (Erevan: Armenian State Publishing House, 1962), p. 46. (In English.)

29 *Ibid.*

30 Boyajian, *op. cit.,* p. 158.

31 Abgarian, *op. cit.,* p. 48.

32 *Ibid.*

33 Eremean, *op. cit.,* p. 7.

34 Xrlopean, *op. cit.,* pp. 182 ff.

ecclesiastics allege that the moon emits its own light . . . but I am of the same opinion as many philosophers who claim that it receives the light of the sun."[35]

Ananias disagreed with the interpretation of Genesis then prevalent which held that God created the perfect world in six days and that He thus indirectly created the four elements, fire, air, water, and earth, which constitute the material world. Ananias asserted instead that although matter had its own rational, nonmaterial, immovable mover, the uncaused cause (i.e., God) which directly created the elements and their qualities and planned their natural development, this immovable mover does not interfere with the "natural course of the development of things." To Ananias, each of the four elements had its characteristic quality, but, in addition, each had a corresponding weight and density, which also must be considered inseparable attributes.[36] The union of the elements in multiple ways accounts for the becoming, existence, growth, decrease, and decay of natural bodies and phenomena, which, according to Ananias, occur without the interference of God.

Atomists asserted that the four elements are represented by space and matter throughout the cosmos, but Ananias limited the differentiation of space and matter to the heavens. Time is a criterion of movement, not an attribute of matter. Natural change, then, is infinite in time, but limited in space. The four elements were imperfectly created but subject to change and improvement. In contact there is a transfer of qualities; humid air, for instance, may become dry. The natural mixing of the elements enables them to form an integral whole, thus making possible new syntheses which in turn contribute to still more formations and changes in nature. This is an old teaching—a view in which change is the result of the interactions of the elements that provide new properties. The inorganic and organic worlds are both syntheses of the four elements. The multitudinous variations of the elements account for the formation and durability of the universe. Causality and the interdependence of nature are integral to these views, as stated by Ananias. The material unity of the universe leads to constant change and progress, or, as Ananias writes:[37]

> The same [change or progress] is true in the case of blood or breathing or in the case of the origin and destruction of matter for the origin of matter is the beginning of its destruction and the destruction of matter is the beginning of its origin and the result of this harmless contradiction is the eternal universe.[38]

Ananias shared the view of earlier philosophers that in the organic world's process of becoming and developing, the decisive role is played by the combination of fire and humidity. The decay of a body thus represents the decrease in the amount of fire it contains.

Ananias, like astronomers before him, divided the material heavens into various spheres; unlike them, he based his division on the role of each sphere in the process of the becoming of the universe, rather than according to the orbits of the celestial bodies. In Ananias' descriptions, the topmost sphere was the "ether" (*arp'i*) in which originated all light and heat. The next was the "cold sphere" which neutral-

[35] *Ibid.*, p. 183.
[36] *Ibid.*, p. 184.
[37] G. B. Petrosean, *Mat'ematikan Hayastanəm Hin ew Miǰin Darerum* [Mathematics in Armenia in Antiquity and the Middle Ages] (Erevan: State Univ. Press, 1959), p. 399.
[38] Abgarian, *op. cit.*, p. 36.

ized the scorching heat descending from the ether. The third sphere, or "crater sphere," contained the sun. The "beautiful sphere" contained the moon and the five planets. Finally, there was the innermost sphere containing thunder, lightning, and other meteorological phenomena.[39] Ananias asserted that the sun receives its light and heat from the ether, in the furthermost of the seven layers of the universe. Before entering the earth this heat and light mixes with the coldness and the humidity of the other layers, and with the aid of the water already existing on earth, regenerates the soil. In this way, the four elements unite with one another and cause the earth to develop.[40]

Ananias doubted the opinion of some philosophers that the moon is a mirror of the earth and that it reflects its seas. Instead, he taught that the markings on the moon are due to the unevenness of its surface, the uneven areas absorbing the light of the sun rather than reflecting it. The phases of the moon he attributed to the fact that the constant movements of the sun and moon cause them to change their positions in regard to one another, which thus results in the change of contacts between the light of the sun and the moon's surface. Ananias was greatly absorbed in the study of the moon and correctly ascribed the tides to its influence. From his observations of eclipses, he believed the sun to be bigger than the moon, their different distances from the earth making them appear the same size.[41]

Ananias maintained that everything takes place according to laws of necessity. This led him to predict eclipses, to study the motion of the moon, and to define the orbit of its motion from the changes on its face. He recognized as supernatural only departures from natural laws. These natural laws he held to be recognizable by man because God does not normally interfere with the natural order of things. God is the author of matter and movement but not of becomings and changes, which take place according to a natural process.[42] He accepted Aristotle's theory of the soul and Ptolemy's theory of the structure of the universe. In describing the position of the globe in space, he held that it was conditioned by three factors: the layers of air which surround it, the equilibrium of the force created between the spontaneous movement of the layer of air and the weight of the earth (the weight tends to cause it to fall while the movement of the air prevents it from doing so), and the extremely great speed of the rotation of the atmosphere which encloses the earth.[43] Thus, according to Xrlopean, before the explanation of gravity Ananias attempts to explain the movements of celestial bodies in space by the influence of two opposing forces. Explaining his own views on the manner of conducting scientific investigations, Ananias wrote: "Without research it is quite impossible to penetrate into the essence of things and without nature it is impossible to carry out research."[44]

After his death some of the more revolutionary ideas of Ananias of Širak brought him under the suspicion of the Armenian Church and his works were proscribed.[45] It is probably for this reason that several of his works, including the *Geography,* were handed down to us anonymously while others, again like certain manuscripts of the *Geography,* were later attributed to other authors. In recent years, Abrahamean's research at the Matenadaran,[46] in Erevan, Armenia, has turned up several texts which are now recognized as those of Ananias.

[39] Xrlopean, *op. cit.,* p. 196.
[40] *Ibid.,* p. 186.
[41] *Ibid.*
[42] *Ibid.,* p. 193.
[43] *Ibid.,* p. 188.
[44] *Ibid.,* p. 187.
[45] *Tablitsy,* trans. by Abrahamean.
[46] The Matenadaran is the state manuscript

Հնգեակն՝ Ե, վեցեակն՝ Զ, լրումն լուսնի՝ ապրիլի Դ,
վերադիրն՝ ԺԱ (Թ), ԲԺ լուսին:

Ա

Ծնունդն ☽նի	Թա-նիք	Տիւ-գիշ	Ժամ	Մասն	Լրումն ☽նի	Թա-նիք	Տիւ-գիշ	Ժամ	Մասն
Յունուար	ԺԸ	գ	Ժ	Ա	Փետրուար	Բ	գ	Դ	Ա
Փետրուար	ԺԷ	տ	Ժ	Ա	Մարտ	Դ	տ	Դ	Ա
Մարտ	ԺԸ	գ	Թ	Դ	Ապրիլ	Դ*	գ	Գ	Դ
Ապրիլ	ԺԷ	տ	Թ	Դ	Մայիս	Բ	տ	Գ	Դ
Մայիս	ԺԶ	գ	Թ	Բ	Մայիս	ԼԱ	գ	Գ	Բ
Յունիս	ԺԵ	տ	Թ	Բ	Յունիս	Լ	տ	Գ	Բ
Յուլիս	ԺԴ	գ	Ը	Ե	Յուլիս	ԻԹ	գ	Բ	Ե
Աւգոստ.	ԺԳ	տ	Ը	Ե	Աւգոստ.	ԻԸ	տ	Բ	Ե
Սեպտեմբ.	ԺԱ	գ	Ը	Գ	Սեպտեմբ.	ԻԶ	գ	Բ	Գ
Հոկտեմբ.	ԺԱ	տ	Ը	Գ	Հոկտեմբ.	ԻԶ	տ	Բ	Գ
Նոյեմբ.	Թ	գ	Ը	Ա	Նոյեմբ.	ԻԴ	գ	Բ	Ա
Դեկտեմբ.	Թ	տ	Ը	Ա	Դեկտեմբ.	ԻԴ	տ	Բ	Ա

Quintile 5, sextile 6, full moon of April 4th
Epact 11 (9), 12th moon of the year

1.

New moon	Date	Day Night	Hour	Fraction	Full moon	Date	Day Night	Hour	Fraction
Jan.	18	N	10	1	Feb.	2	N	4	1
Feb.	17	D	10	1	Mar.	4	D	4	1
Mar.	18	N	9	4	Apr.	4	N	3	4
Apr.	17	D	9	4	May	2	D	3	4
May	16	N	9	2	May	31	N	3	2
Jun.	15	D	9	2	Jun.	30	D	3	2
Jul.	14	N	8	5	Jul.	29	N	2	5
Aug.	13	D	8	5	Aug.	28	D	2	5
Sept.	11	N	8	3	Sept.	26	N	2	3
Oct.	11	D	8	3	Oct.	26	D	2	3
Nov.	9	N	8	1	Nov.	24	N	2	1
Dec.	9	D	8	1	Dec.	24	D	2	1

A TABLE of the motion of the moon by Ananias of Širak, with a translation. (Armenian text from *Tablitsy Lunnogo Kruga,* ed. and Russian trans. by A. G. Abrahamean, Erevan: Izdatel'stvo Erevanskogo Gosudarstvennogo Universitet, 1962, p. 56.)

The style of Ananias of Širak is concise and to the point, with some signs of the Greek influence common to Armenian writers of his time, though not so noticeable as they are among authors of a century or two previously.[47] There are a certain number of obscure passages in his texts which are also replete with copyists' errors, but recent scholarship has been able to eliminate the majority of these.

The most important questions, of course, are the sources of this Armenian's ideas, the justification of their claims to originality, and their influence in later science. Xrlopean has addressed himself to the problem of the sources with some attention[48] and has found that Ananias was heavily influenced by Ełiše's *An Interpretation of Creation,*[49] by an *Interpretation of the Categories of Aristotle* by an unknown author, and by the works of David Anhaxt, who, beginning with Aristotle's views, criticized Plato, Pyrrho, and Porphyry and thereby firmly established neo-Platonism in Armenian thought.[50]

The conception of the importance of experience and observation, the relation between the sensual and rational practice and theory, and the classification of the sciences by David Anhaxt all had a definite influence on the formation of Ananias' views. Also obvious in his works are the ideas of Thales, Hippocrates, Democritus, Plato, Aristotle, Zeno the Stoic, Epicurus, and, as we shall see, of Ptolemy, Pappus of Alexandria, and Cosmas Indicopleustes. That Ananias of Širak was more than a mere "closet" scholar is proven by the use to which his works were put by later Armenian writers. There was already a certain acquaintance with the calendar and its problems among the Armenians, but Ananias pioneered in the study of the calendar from a scientific standpoint as well as in the study of meteorology. Later philosophers such as John the Deacon (Hovhannes Sarkavag, d. 1129), Vanakan (*c.* 1200–*c.* 1250), and others used his works, many of them incorporating large fragments into their own books. Often these fragments were altered, rearranged, compressed, or divided,[51] which would suggest that such writers did not hesitate to make changes to suit later evaluations of Ananias' work. To answer these and other questions we must await the complete publication of the corpus of his writings and, of course, their translation into one of the accepted languages of international scholarship. Most of his works are now available in Armenian or Russian, and I am preparing an English translation of his *Geography.* The list of the principal works of Ananias given below will present a clearer picture of the scope of his interests and the questions posed by each work.

Astronomical Works

1. *Cosmography and the Calendar.* This work consists of forty-eight chapters and has no general title, although the first chapter is headed "Mathematics in Fulfillment

repository of Soviet Armenia. Founded in 1939, it contains some 10,000 Armenian MSS besides another 1,000 in several other languages.

47 Thorossian, *op. cit.,* p. 107.

48 Xrlopean, *op. cit.,* p. 178.

49 Ełiše (Elisaeus or Elishe) was a 5th-century Armenian historian.

50 David *Anhaxt* (i.e., "the invincible," so-called from his ability to pass all examinations) was an Armenian philosopher who studied in Athens in the 5th century. Although little is known about him personally, his works were considered indispensable for the study of philosophy in the Armenian monasteries of the Middle Ages. He translated the *Eisagoge* of Porphyry of Tyre and the *Categories* of Aristotle into Armenian and wrote a commentary on both of these works.

51 M. Abegyan, *Istoriya drevnearmyanskoi literatury I* [History of Ancient Armenian Literature] (Erevan, 1948), p. 325.

of a Vow." The book falls naturally into two sections, the first of which consists of the ten chapters concerning cosmography, containing a description of the cosmos together with brief data on astronomy, meteorology, and physical geography. The remaining thirty-eight chapters deal with various questions relating to the calendar; it is clear that these were added at a later date. The first or introductory chapter is especially interesting because here Ananias speaks of his sources and explains the philosophy of his approach to pagan authors. Although he condemns the pagan philosophers in general, he does not hesitate to draw upon them to demonstrate the superiority of "the elevated mind," and he believes that one elevates the "superior" by contrasting it with that which is inferior. Thus, he contrasts the "bad philosophers" (i.e., the pagan or godless ones) with the "good philosophers" (those who are not Christians but who recognize the existence of one God as Creator of the universe). The sources he cites are works attributed to St. Gregory the Illuminator (d. 328 A.D.), apostle of Armenia, and those of St. Basil, Philo of Alexandria, and, apparently (from internal evidence), the writings of the fifth-century Armenian philosopher and theologian Eznik of Kolb (Eznik Kolbac'i). Together, the forty-eight chapters form a study in exhaustive detail of the relation between the science of astronomy and the meaning, dividing, and recording of time. Here Ananias denounces astrologers and dismisses the influence of the stars on the course of human events. Here he also advances the theory, derived from the ancient Greeks, that the earth is really a sphere. He accurately explains the causes of lunar and solar eclipses and, like Aristarchus, expounds the theory that the sun is the center of the universe.[52]

2. *Cycle 532 and the Calendar* (*Tiezeragrut'iwn ew Tomar*).[53] This is the perpetual calendar prepared by Ananias on the basis of Cycle 532. The Armenians adopted this cycle as their national calendar on 11 July 555 A.D.; the first year of the "Armenian Era," computed from 11 July three years previously, commences in 552, which is thus held to be the year 1. According to this calendar, therefore, 1965 would be the Armenian year 1413. Ananias took this cycle and in nineteen vertical columns recorded the days and dates of all the movable and immovable feasts of the Armenian Church as well as those of the vernal equinoxes and other annual events. On the same calendar he also coordinated the dates of the Armenian and Dionysian eras for the entire 532-year cycle.

3. *Table of the Motions of the Moon*[54] (*Lusni Parberasrzannerə*). Guided by the principles set down by the Greek astronomer Meton of Athens (5th century B.C.), Ananias made personal observations to ensure the accuracy of his predecessor and skillfully adjusted Meton's figures to conform to local time. This particular work was long attributed to the seventh-century Armenian chronologist John the Philosopher (Hovhannes Imastaser, 650–725), whose name appears on the five manuscripts of the work in the Matenadaran. Abrahamean discovered the true authorship in 1953 when examining a sixth manuscript preserved in the Armenian monastery at Antilias, Lebanon.

4–5. *On the Course of the Sun.* Ananias left two treatises by this name, each of

[52] Petrosean, *op. cit.*, p. 399.

[53] *"Voprosy i Resheniya"* . . . , trans. by Orbeli.

[54] Širakac'i, *Tiezeragitut'iwn ew Tomar.*

which is a study of the sun's apparent motion through the sky in the course of the year.

6. *Introduction to Astronomy.* This is a translation of a Greek work composed by Paul of Alexandria (*fl. c.* 378 A.D.).

Mathematical Works

7A. *Problems and Solutions.* This is a collection of twenty-four mathematical problems together with their solutions and is the earliest work of its kind in Armenian literature. It is especially interesting because so many of its problems are drawn from real life and give much data on history, topography, and customs. Six of the twenty-four problems deal with the princely house of Kamsarakan, sovereign in Širak. This work, once thought to have been left unfinished, is now known to be a part of Ananias' *Book of Arithmetic,* the remainder of which was discovered by Abrahamean in 1939.[55]

7B. *Book of Arithmetic* (*T'uabant'iwn*). A complete and comprehensive collection of addition, subtraction, multiplication, and division tables which is the earliest such work known. The highest number cited is 80,000,000. This work was originally accompanied by a sort of introduction dealing with the theoretical aspects of the tables. This introduction has been found but is concerned only with addition, subtraction, and multiplication, omitting any discussion of division. The whole work apparently was intended as a textbook for practical use, that, is, for the instruction of Ananias' pupils.

The table of addition consists of four groups: units, tens, hundreds, and thousands, each group consisting of nine tables and forty-five combinations, the average sum of each combination being 180. The table of subtraction contains thirty-six groups, each containing nine combinations—a total of 324.[56] The table of multiplication also contains thirty-six groups with four tables in each. Three of these tables contain nine products each, while the fourth contains ten. There are thirty-seven products in each group, totalling 1,332 in all. MS 1267 in the Matenadaran also contains a complete multiplication table said to be based on that of Pythagoras except that here the largest product is 80,000,000 and not 80.[57]

This *Book of Arithmetic* also contains a table of reverse magnitudes based on the number 6,000 which is arranged as follows:[58]

$$
\begin{aligned}
1 \times 6000 &= 6000 \\
2 \times 3000 &= 6000 \\
3 \times 2000 &= 6000 \\
4 \times 1500 &= 6000 \\
5 \times 1200 &= 6000 \\
6 \times 1000 &= 6000 \\
7 \times \ 875 &= 6000 \\
8 \times \ 750 &= 6000 \\
9 \times \ 667 &= 6000 \\
10 \times \ 600 &= 6000
\end{aligned}
$$

et cetera

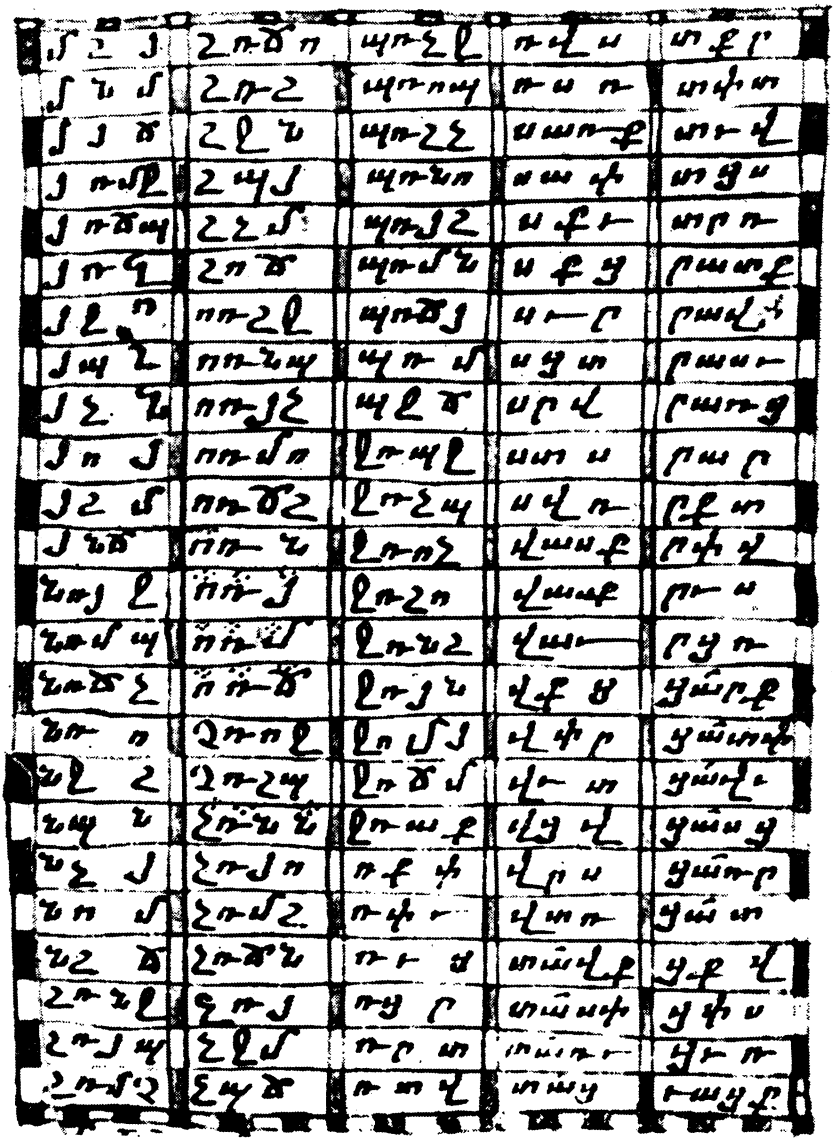
---

[55] Petrosean, *op. cit.,* p. 400.

[56] *Ibid.,* p. 401.

[57] *Ibid.,* p. 402. Pythagoras has left no works.

[58] *Ibid.,* p. 406.



A PAGE from the *Arithmetic* of Ananias of Širak. (From G. W. Abgarian, *The Matenadaran,* Erevan: Armenian State Publishing House, 1962, p. 45.)

8. *Arithmetic* (*Xaraxcanakank*). This textbook on arithmetic and Number 7 (A and B) have been drawn independently by Ananias from one source and written as two separate works.

9. *On Weights and Measures* (*Girk Vasn Kšroc' ew Č'apuc'*). The author seems to have drawn heavily on a similar work by Epiphanius of Cyprus (*c.* 315–*c.* 403), and this may be largely a translation from the Greek. Even if it is only a translation, however, it must surely have been reworked, for apart from the system of weights used

by the Greeks, Jews, and Syrians, it includes the systems in use by the Armenians and Persians. Concluding that by *litre* Ananias was referring to the Byzantine litra or pound, which we know contained 326.4 grams, Manandean was able to convert all of Ananias' measurements—Persian, Greek, and Armenian—into modern grams. The inclusion of Greek and Persian measures in the same table was the natural result of Armenia's geopolitical position between the Byzantine Empire and Sassanian Iran.[59]

Geographical Works

10. *The Geography* (*Ašxarhac'oyc'*). A summary of ancient geographical knowledge based on a lost geography by the Greek mathematician Pappus of Alexandria (*fl. c.* 300 A.D.) which, in turn, seems to have been based on Ptolemy. The text comprises an introduction in two parts and then a section each for Europe, Libya, and Asia. The latter section is by far the largest, containing a lengthy and detailed description of Armenia, the Caucasus, and the Persian Empire, much of which is unknown to us from any other source. The writings of Eusebius, Abydenus, Porphyry of Tyre, Marinus of Tyre, Cosmas Indicopleustes, St. Gregory of Nazianzus, St. Basil of Caesarea, and St. Gregory the Illuminator are also quoted in this work.

11. *The Itinerary* (*Mtonač'ap'k*).[60] A list of six different routes from Duin, capital of Armenia, to various parts of the world, together with the distances to the major cities along each route. The distances are given in "miles" (*młon*), *azparez,* and *netajik*. One "mile" equals five *azparez* and twenty *azparez* equals one *netajik* (or four "miles"), but the exact length of these three measurements as used by the Armenians has been disputed.

In his edition of the collected works of Ananias of Širak referred to above, Abrahamean considered the *Itinerary* to have been not only a work of Ananias but also to be a detached chapter from his *Geography*.[61] It is only fair to add, however, that Manandean, writing two years later (1946),[62] stated that there was not the slightest doubt that the Arab mile of 1,917.6 meters lay at the basis of the *Itinerary* and that both it and the *Geography* probably dated from the ninth century when the revival of Armenian trade made such works both useful and necessary to the new merchant class. Since the last point is purely conjectural and since the lifetime of Ananias of Širak spanned both the Arab and pre-Arab periods of Armenian history by a good thirty years either way, it does not seem to me that the detection of Arab influence in either work is a convincing argument that they were written by someone else at a much later date.

Works on Chronology

12. *Studies on Chronology* (*T'omar*). An examination of the principles of chronology utilized by the Greeks, Romans, Egyptians, Ethiopians, Jews, Syrians, and

[59] H. A. Manandean, *The Trade and Cities of Armenia in Relation to World Trade,* English trans. by N. Garsoian (Lisbon: Bertrand, 1965), p. 117.

[60] The *Itinerary* was published anonymously in Saint-Martin, *Mémoires historiques et géographiques sur l'Arménie* (Paris: Imprimérie Royale, 1819), together with the text and translation of the *Geography*. Another version of the same work is to be found in Manandean, *op. cit.*

[61] Abrahamean, *Anania Širakac'u Matenadrut'iwn.*

[62] Manandean, *op. cit.*, p. 172.

Caucasian Albanians. In this work Ananias also explains the names of the weeks and months and cites the names for the latter in thirteen different languages.

13. *Chronicle* (*K'ronikon*). A chronicle of world events based on information compiled from the writings of Eusebius (*c.* 260–*c.* 341), Andrew of Crete (7th century), and Hippolytus of Rome (*fl.* 325 A.D.), one of the possible sources of Moses of Xoren (late 8th century). An examination of this chronicle might reveal otherwise unattested historical data or might serve to corroborate facts already known.

Other Works

14. *Discourse on Christmas.* A discussion of the proper date for the celebration of Christmas. This work is especially valuable because it includes an excerpt from a lost document which Ananias ascribes to St. Polycarp, Bishop of Smyrna (martyred *c.* 155), who, being a disciple of St. John the Evangelist, was well qualified to pronounce on the date of the birth of Christ. This work was probably found by Ananias in the library of Tychicus. In his discourse, Ananias cites the opinion of the Church fathers as well as the testimony of sacred scripture to demonstrate that the Armenian celebration of Christmas and the Epiphany on the same date is more valid than celebrating them separately as is done in Byzantium and in the West. This and the other treatises on the feasts of the Church were regarded by Conybeare as commentaries on an elaborate calendar which Ananias tells us had been made by someone before him on the basis of Cycle 532 and which covered the years 828 to 1360 of the Alexandrian era. They are doctrinal commentaries opposing the Catholic (and Greek Orthodox) doctrine of the dual nature of Christ accepted at the Council of Chalcedon (451), which Council the Armenian Church rejects.

15A. *Discourse on Easter* (*Pan Vasn Tawni ew Ayln*). A lengthy discussion on the date of Easter. The author defends the date of the Armenian celebration of Easter as being based on data contained in the Bible and denounces the innovations introduced at Constantinople by one Iron (or Irion), a scholar of the Imperial Court.

15B. *Autobiography* (*Vasun Gnac' Ewroc'*). This text is found as an introduction to the *Discourse on Easter.*

16. *Homilies on Contrition and Humility* (*C'ark Vasn Xonarhut'yan*). These are religious discourses, and it is chiefly on the basis of these and on his concern for the exact dating of the feasts of the Church that Ananias of Širak is held to have been a monk in the Armenian Church.

17. *On Precious Stones.* This is based on a work on the same subject by Epiphanias of Cyprus (*De gemmis*). Ananias' work is more extensive, however, although it lacks the notation of medicinal value and place of origin which Epiphanias gives for each stone. A translation and several epitomés of Epiphanias' work exist in Armenian, and the former may have been made by Ananias himself before undertaking his own version of the work.

Besides the above texts, Ananias of Širak wrote on meteorology, heavenly signs, and the movements of the stars. He also tells us (at the beginning of his autobiography) that he collected Armenian literature, and it may be he who edited the many early Armenian texts which betray the hand of a later interpolator.