

Continuity and Discontinuity of the Sciences in the 5th to the 10th Centuries A.D.

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Abstract

The question of continuity and discontinuity is addressed with four case studies on the disciplines of astronomy, medicine, alchemy, and mathematics. Astronomy disappeared from papyrological records for three and a half centuries from papyrological records. The same holds for alchemy which disappeared for at least four centuries. Literary and archaeological sources point to a longer survival of astronomy at Alexandria for about a century. Medicine survived on a very basic and practical level. The same can be said of mathematics.

Keywords

Late Antiquity, Continuity, Sciences

The so-called Dark Ages are an extensively debated topic in Byzantine studies.¹ It is undisputed that there is a conspicuous lack of sources in many domains of cultural production in the territory of the Eastern Roman empire. The period in question encompasses the 7th and 8th centuries, but was extended by some from the mid-6th to the 9th centuries. The term Dark Ages has a double meaning. In a subjective sense it was used to refer to an «epoch which is in the dark for us», since not much is known about it because of a lack of sources. In an objective sense it was used to point to an «epoch, dark in itself» as opposed to enlightenment, an epoch of intellectual decline. Many different kinds of investigation were undertaken to prove or disprove a decline in the Byzantine world. It had been argued that the seemingly Dark Ages are just a kind of optical illusion caused by the different degrees of preservation of source material. In order to test such an assumption, investigations should be done on source material which does not depend on cultural transmission of later generations. Archaeological evidence is discussed at length in the recent book by Michael Decker. He comes to the conclusion that the term Dark Ages is justified for designating the epoch in question, if one avoids a morally pejorative connotation. A depopulation of cities and a massive

¹ Decker 2016; Pontani 2015, 312-314.

reduction of economic activities are undeniable facts based on hard archaeological evidence. Economic decline might have gone hand in hand with a decline in intellectual life, but this is mere speculation, if no direct evidence concerning intellectual activities is available.

It is conspicuous that no papyrological study has been undertaken so far in the context of the problem of the Dark Ages. Decker points to the importance of Egypt in this instance, and states vaguely that «Greek, Coptic, and Arabic papyrus documents from Egypt are a wealth of untapped knowledge that would no doubt richly repay our efforts».² The aim of this paper is to tap into some papyrological evidence on the question. In doing so I will concentrate on astronomy, the major mathematical discipline among the natural sciences, and on medicine, the major discipline among the empirical sciences with a much demanded social need. I will conclude with some comments on alchemy and mathematics.

Astronomy

A substantial amount of Greek astronomical papyri has been found and studied. 187 papyri were found in Oxyrhynchus alone.³ Among them are fragments of theoretical texts, of primary tables, of ephemerides and almanacs, of miscellaneous tables and 69 horoscopes. They stem from the 1st to the 5th centuries with a maximum in the 3rd century. The latest Greek horoscope was made for the year 508 A.D.⁴ The latest ephemeris is a yearbook of 489 A.D.⁵ No later astronomical documents have been detected so far among the many thousands of Greek papyri of the 6th to the 8th centuries. While a greater number of Demotic horoscopes of the two first centuries are extant, only one Coptic horoscope exists, which was made for the year 95 A.D.⁶ It seems to be the only astronomical document in the Coptic language known so far. From the 3rd to the 5th centuries astronomy seems to have been confined to the sphere of the Greek language.

Immediately after the Arab conquest of Egypt, Arabic documents on papyrus were produced. However, no astronomical texts of the first two centuries of Arab rule were found. The earliest Arabic horoscope on papyrus was made for the year 869 A.D. (P.Vind.Inv. A.P. 4732). A second horoscope seems to consist of pure text and was made for the year 894 A.D. (P.ThomannDernierHoroscope).⁷ After the switch from papyrus to paper, further astronomical

² Decker 2016, 189-190.

³ Jones 1999.

⁴ Jones 1999 I 281-282, II 416-417.

⁵ Jones 1994.

⁶ Černý / Kahle / Parker 1957; Neugebauer / Van Hoesen 1959 28–38.

⁷ Thomann 2012.

documents exist: An almanac for 910 A.D. (P.ThomannAlmanac), an ephemeris for 931 A.D. (P.ThomannEphemeris931).⁸ More astronomical documents on paper for the years 933 (unpublished), 954 (P.ThomannEphemeris954), and a greater number at the turn of the 10th to the 11st centuries exist (P.ThomannEphemeris1026 and unpublished).⁹

A brief remark must be made on the Greek literary tradition of astronomy. There are a few authors known to have lived in the 7th century. Leontios wrote a commentary on Aratos, and on the circle of the zodiac, both not works of mathematical astronomy.¹⁰ There are two Syriac authors, the famous Severus Sebokht, who lived in the Sassanian Empire in the East and wrote on the astrolabe, and a shadowy figure by the name of Abiyūn al-Biṭrīq, mentioned only once in an Arabic source.¹¹ There is a prolific Armenian author, Anania of Shirak (ca. 610-ca. 685 A.D.) who wrote on the peripatetic system of the world.¹² The only work on mathematical astronomy written in the 7th century is a commentary on Ptolemy's *Handy Tables* attributed to Stephanos of Alexandria, a commentator of Aristotle, who worked in Alexandria and during the reign of emperor Herakleios (reg. 610-641 A.D.) in Constantinople. His authorship is not well established in the sources, but from example calculations in the text it is clear that the commentary was written in Constantinople during the year 618/619 A.D.¹³ This source points to the fact that mathematical astronomy was taught much longer than papyrological evidence would indicate. But most papyri were found in Middle and Upper Egypt and are thus not representative for the North of Egypt. There is archaeological evidence that scientific teaching continued in the 6th century in Alexandria. Excavations have brought to light a complex of lecture halls. They were rebuilt or restored in the mid-6th century and abandoned most likely around the middle of the 7th century.¹⁴ There is literary evidence that in this late period, astronomy was still part of the academic curriculum. A lecture series of Olympiodoros of Alexandria based on the astrological work of Paulos of Alexandria is preserved.¹⁵ The lectures took place in 564 A.D. in Alexandria. The fact that horoscopic astrology was taught implies that the calculation technique for casting horoscopes was available too. For that, Ptolemy's *Handy Tables* were the perfect tool, and the way how they were presented is well documented in the commentary attributed to Stephanos of Alexandria. However, it becomes clear that astronomy as a proper mathematical discipline, as represented in Ptolemy's *Almagest*, was not part of the academic curriculum anymore.

⁸ Thomann 2017a; Thomann 2015a, 2015 c.

⁹ Thomann 2013, 2014a, 2015b, 2015d, 2015e, 2015f, 2015g, 2015h, 2016; cf. 2019a, 2019b.

¹⁰ Keyser / Irby-Massie 2008, 504.

¹¹ Keyser / Irby-Massie 2008, 737-738 (Siam Bhayro) and 30 (Kevin van Bladel).

¹² Keyser / Irby-Massie 2008, 70-71 (Edward G. Mathew, Jr.).

¹³ Lempire 2016, 107, 89, 291.

¹⁴ Majcherek 2007, 37-38.

¹⁵ Westerink 1971; Szabat 2007, 281.

Medicine

A similar survey of papyrological evidence concerning medical activities may be helpful. According to the «Digital Corpus of the Greek Medical Papyri» 301 documents with medical content exist.¹⁶ The earliest of them belong to the 3rd century B.C.¹⁷ Regarding their content they show a wide range of topics in medicine, from handbooks of the famous authors to practical prescriptions they cover almost all fields of theoretical and practical medicine. The works of Hippocrates, Galen and other others were not only read in the big cities, but also in the provinces of Middle and Upper Egypt. In contrast to astronomical documents, which disappear after 500 A.D., a number of medical documents exist which are dated to the 6th and 7th centuries. However, there are only four documents which are definitely dated to the 7th century.¹⁸ Two of them are labels and one is a medical tag. These belong entirely to everyday practical work of physicians or druggists and do not allow for any conclusions on scientific activities. But there is one Greek papyrus from Antinoopolis which belongs to a medical encyclopedia (P.Antin. III 127).¹⁹ The site of Antinoopolis is particularly rich in medical papyri. They might have belonged to the library of a physician which contained high-quality medical books. Among them were works of Hippocrates and Galen.²⁰ The medical school of Antinoopolis seems to be a rare case of late survival of Greek learning on a high intellectual level in a local center. However, it did not survive the 8th century when Greek learning and culture was eclipsed in Egypt.

Antinoopolis with its living Greek scientific tradition seems to have been rather an exception. Elsewhere the education of physicians declined much earlier. This is shown by a Coptic document on the distribution of pepper among the guilds of Edfu (London, British Library Or 8903, SB Kopt. 1 242).²¹ It is datable to the 7th century. The leaders of the guilds confirm to have received a certain amount of pepper and assure to pay the full price for it. Among the guilds of craftsmen, such as potters and patch cutters, appears also the guild of the physicians. Its leader Dius is mentioned, but at the place where his signature should have been made one reads «He [the leader Dius] asked me to sign for him, since he cannot write».²² The fact that the man with the highest rank among the physicians was illiterate sheds light on the low level of scientific education of physicians in Egypt. Presumably they were mere practitioners who were orally instructed and practically trained by their

¹⁶ [<https://docs.google.com/spreadsheets/d/1B9yLyTo8GzSw-qKFtmHUi0PgdaRycX5dljFHvxHaNFc/edit#gid=0>] (14 March 2020).

¹⁷ P.Hib. II 191; P.Grenf. II 7 b + P.Ryl. I 39 + P.Heid. Inv. 401 + P.Hibeh II 190; P.Hamb. II 140; SB XIV 12074.

¹⁸ P.Ant. III 127; P.Prag. III 249; MPER XIII 17; MPER XIII 18.

¹⁹ Corazza 2016, 107-133; Neugebauer 1964, 58.

²⁰ Corazza 2016, 12-18.

²¹ Crum 1925; Buchheim 1960.

²² Crum 1925, 110.

predecessors. Coptic medical documents of the 9th and 10th centuries show already Arabic influence and are no more than collections of medication recipes and instruction of their usage.²³ These texts are untouched by the spirit of Galenic medicine. The same is true for Arabic medical documents. At the same time when in the East of the Islamic Empire the works of Galen were translated into Arabic and learned commentaries were written on them, the Egyptian documents are simple lists of drugs and recipes. Nevertheless, the names of the drugs indicate some connection to the scholarly literature. Albert Dietrich in his edition of the large Heidelberg papyrus of drugs was able to identify most of the names with those found in Greek, Coptic and Arabic works (P.DietrichDrogenhandel).²⁴

As in the case of astronomy, a look at the literary medical sources in late antiquity may be helpful.²⁵ The writings of Hippocrates and Galen were still studied in the 7th century. A certain Ioannes who worked during the first half of the 7th century in Alexandria held lectures on Hippocrates' *Epidemics* which were put into writing. He is also the author of commentaries on Galen's *De sectis* and Hippocrates' *De natura pueri*.²⁶ Stephanos of Athens (6th/7th centuries A.D.) wrote commentaries on Hippocrates' *Prognosticon* and *Aphorisms*, and on Galen's *Therapeutica*.²⁷ It is disputed if he is identical with Stephanos of Alexandria.²⁸ Paulos of Aigina (ca. 630-670 A.D.?) wrote extensively on gynecology and pediatrics.²⁹ It remains possible that academic teaching of medicine continued for some time in Alexandria after the Arab conquest (641 A.D.).³⁰ However, there seems to be no positive evidence for that.

Alchemy

There are more scientific disciplines of which papyrological evidence exists both in ancient Greek papyri and in Arabic documents, but they are much less numerous. Such is the case with alchemy. An entire literary corpus of ancient Greek works is preserved in late Byzantine manuscript tradition, but there is papyrological evidence from antiquity too. The most famous examples are the Leiden Papyrus (P.Leid. X) and the Stockholm Papyrus (P.Holm.).³¹ Both formed parts of books.

²³ Chassinat 1921.

²⁴ Dietrich 1954.

²⁵ I thank Antonio Ricciardetto for his valuable information on recent scholarship concerning that topic; cf. Pormann 2010, 421-23.

²⁶ Szabat 2007, 264; Jouanna 1999, 360; Manetti 2015, 1205-1206.

²⁷ Szabat 2007, 311; Jouanna 1999, 360; Manetti 2015, 1205-1207.

²⁸ Positive: Szabat 2007, 311 and Wolska-Conus 1989; negative: Roueché 2011; neutral: Keyser / Irby-Massie 2008, 761 (Keith Dickson).

²⁹ Keyser / Irby-Massie 2008, 629 (P. E. Pormann); Szabat 2007, 288-289; Jouanna 1999, 360.

³⁰ Pormann 2004, 6-7; Jouanna 1999, 360.

³¹ Halleux 1981; Caley / Jensen 2008.

The Leiden Papyrus was written in the mid-3rd century, the Stockholm Papyrus around 300 A.D. There are also para-literary documents. One is an *ostrakon* (O.LeidenSijpesteijn 25) of the 2nd century A.D. It contains the description of a substance which is indestructible by heat.³² Another document is a papyrus which is potentially of alchemical content (P.Bodl., Summary Catal. 31958 and 31959 = Oxford, Bodleian Library, MS. Gr. Class. e 41 and 42).³³ There are more Coptic documents of the 9th and 10th centuries. They are being analyzed by Sebastian Richter, according to whom they show strong Arabic influence.³⁴ The timespan between the ancient Greek documents and the Coptic document of Islamic time is more than five centuries.

Mathematics

The chronological distribution of Greek mathematical papyri is similar to that of astronomical papyri with a peak in the 3rd century. However, there are also a few late documents which might have been produced in the 7th century. They belong to the practical sphere of numerical calculation. One Greek document is of particular interest (P.Berol. 10506).³⁵ It is a wooden table on which a student of a *gymnasion* solved his exercises. These are not anymore elementary exercises, as they appear on other contemporary documents. It has been argued that the student received a training in higher education as a preparation for a position in the administration, which was at that time still predominantly Greek. It is conspicuous that no Arabic mathematical documents on papyrus seem to exist. For practical purposes, Greek numerals were used for centuries, as a multiplication table from the 11th or 12th century shows (P.Vindob. A.Ch.7266 = P.Rain.UnterrichtKopt., Taf. 128).³⁶ According to books on arithmetic written in the 9th and 10th centuries in the East of the Islamic Empire, Indian numerals were used for calculation but they seem not to have been common in Egypt until much later.³⁷ Arithmetic, or more precisely the art of calculation, is a case of a long continuity in the written tradition from late antiquity until the Fatimid epoch. However, this art was limited to the use of the four species in calculation. This had not much in common with the classics of Greek mathematics by Euclid and Archimedes. Their works were translated in the East of the Islamic Empire, but they needed at least a century to reach Egypt.

³² Bagnall / Sijpesteijn / Worp 1980, I 145 No. 333 "Text of Unknown Character", II Plate 86; Uebel 1971, 178 No. 1414 "Alchemie, Chemie".

³³ Marganne 1981, 138; Neugebauer / Van Hoesen 1961, 59; 119 No. 31948 and 31949; Madan / Craster 1924, 119 No. 31958 and 31959.

³⁴ Richter 2009; Richter 2014; Richter 2015.

³⁵ Plaumann 1913, 21-23.

³⁶ Hasitzka 1990, I 268-270, II Taf. 127.

³⁷ Folkerts 1997; Thomann 2018, 169-175.

Conclusion

Papyrological evidence corroborates clearly that the Dark Ages were not confined to a decline in population and economy, as described by Decker. Scientific learning was in decay too, and either was reduced to practical procedures used in everyday life, as in healing or calculating, or they disappeared entirely, as in the case of astronomy and alchemy. Many reasons for this decline were put forward. The imperial policy was to monopolize knowledge and to make independent teaching institutions disappear.³⁸ With the decline of the cities education became the matter of private initiatives which soon slackened.³⁹ Among Christian representatives the mathematical sciences were discredited by their connection to astrology.⁴⁰ Besides these cultural developments, natural phenomena such as climate and disease were discussed as factors.⁴¹

It would go too far here to discuss the reasons for the renaissance of the sciences in the Islamic world in the 8th century. A short remark on this might be appropriate nevertheless.

The acquisition of the Greek scientific literature took place in the east of the Islamic Empire, and would not have happened without the stimulus of scholars from India and Central Asia, the only regions where some of the disciplines of Greek science survived in a living tradition.⁴²

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³⁸ Fögen 1993.

³⁹ Marrou 1965.

⁴⁰ Stuckrad 2000.

⁴¹ Harper 2017.

⁴² Thomann 2014 b; Thomann 2017 b, 909-918.

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