

Science and Technology
in Islam

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Edited by
Fuat Sezgin

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SCIENCE AND TECHNOLOGY IN ISLAM

VOLUME IV

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OF INSTRUMENTS OF THE INSTITUTE FOR THE HISTORY
OF ARABIC AND ISLAMIC SCIENCES

by

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Chapter 7

Medicine



We do not seem to possess the prerequisites to draw definite conclusions about many problems. Even so, it is important to state our views on these matters in accordance with our abilities. For, it is not ruled out that discoveries may be made later, through which certainty can be achieved in many matters which we cannot solve today.

Ibn Rušd (Averroes, d. 595/1198)

INTRODUCTION

1. Medical Instruments

As in the fields of mathematics, astronomy, physics, chemistry, zoology, botany and geography, Arabic literature provides us in the field of medicine also with examples which show that the people in the Arabic-Islamic cultural area were well acquainted as early as the 3rd/9th century with the method of depicting human figures to illustrate medical matters. It is beyond doubt that in this process the Arabic-Islamic scholars and illustrators were following the tradition of their Greek predecessors. The only illustrations known to me in the field of medicine dating from the 3rd/9th century are to be found in the Cairo manuscript¹ of the well-known «Ten Treatises on the Eye»² by Ḥunain b. Ishāq (d. 260/873)³: «Five illustrations of the eye, three of them identical, adorn the manuscript; these are painted in black and red water colours; the vitreous body of the eye was painted in some other colour which apparently attacked the heavy paper, because it disintegrated in all illustrations exactly where it corresponds to the vitreous body.»⁴ Published in 1910 by M. Meyerhof and C. Prüfer, the illustrations were made known to a wider public in the edition of the entire book published by Meyerhof⁵ in 1928. From the point of view of the development of the history of medicine it is highly significant that

towards the end of the 4th/10th century the Andalusian physician Abu l-Qāsim Ḥalaf b. 'Abbās az-Zahrāwī⁶ already describes and illustrates more than 200 instruments in the 30th treatise of his book on surgery which encompasses the entire art of healing. When he laments the neglect of surgery in his country and age,⁷ stating that from the books of his predecessors just a few illustrations were known, we should understand this lament in a limited sense and see it rather in relation to a narrow geographical area. At any rate az-Zahrāwī does not neglect to often mention the provenance and the inventor of an instrument which he describes. He also stresses that, even though there are innumerable medical instruments, a capable surgeon ought to be in a position at any time to develop new instruments if need be.⁸

Whatever may have been the motivation for the author of the *K. at-Taṣrīf* and from whatever sources and circles the material covered may originate, az-Zahrāwī is, according to our knowledge, the first and perhaps even the only surgeon in the history of medicine before modern times, to describe more than 200 instruments (which, according to his own account, he did not invent) and to provide these descriptions with illustrations. The importance of his achievement is even enhanced by numerous illustrations of scenes of treatment where the use of the instruments is depicted.

¹ Dār al-Kutub al-Qaumīya, ms. Taimūr, ṭibb 100.

² *Tarkīb al-‘ain wa-‘ilaluhā wa-‘ilāghuhā ‘alā ra’y Iḥwārāt wa-Ġālīnūs wa-hiya ‘aṣr maqālāt*, pp. 314-318 of the manuscript.

³ v. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 3, pp. 247-256.

⁴ M. Meyerhof and C. Prüfer, *Die Augen-anatomie des Ḥunain b. Ishāq. Nach einem illustrierten arabischen Manuskript herausgegeben*, in: *Archiv für Geschichte der Medizin* (Leipzig) 4/1910/163-191, esp. p. 165 (repr. in: *Islamic Medicine*, vol. 23, pp. 45-73, esp. p. 47).

⁵ *The Book of the Ten Treatises on the Eye ascribed to Hunain ibn Ishāq (809-877 A.D.) ... edited ... by Max Meyerhof*, Cairo 1928 (repr. Frankfurt 1996 as *Islamic Medicine*, vol. 22).

⁶ v. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 3, pp. 323-325.

⁷ *at-Taṣrīf li-man ‘aḡiza ‘an at-ta’līf*, facs. ed. Frankfurt 1986, vol. 2, p. 461; *Albucasis. On Surgery and Instruments. A Definitive Edition of the Arabic Text with English Translation and Commentary*, by M. S. Spink and G. L. Lewis, London 1973, p. 3.

⁸ *at-Taṣrīf*, facs. ed., vol. 2, p. 4; *Albucasis. On Surgery and Instruments*, op. cit., p. 285.

[4] Az-Zahrāwī and his book on surgery enjoyed and continue to enjoy in the Occident a much greater fame than in the Islamic world. The text was translated by Gerard of Cremona into Latin barely 200 years after it was written. It was also translated into Hebrew and into Provençal. Soon thereafter the first important work on surgery, the *Cyrurgia* by Guglielmo da Saliceto⁹ (ca. 1275), appeared in the Occident. This was followed in the next century by the much more voluminous work by Guido de Cauliaco¹⁰ (Guy de Chauliac, d. ca. 1368). Of course, the books by Abū Bakr ar-Rāzī (d. 313/925), ‘Alī b. al-‘Abbās al-Mağūsī (last quarter of the 4th/10th cent.) and Abū ‘Alī Ibn Sīnā (d. 428/1037) had a greater influence on the two western works than az-Zahrāwī’s book. The importance of the 30th treatise of his book for the development of the new surgery in Europe, which began in the 13th century, seems to have lain more in the varied descriptions and illustrations of the medical instruments and scenes of medical treatment. It is highly astonishing to see how widely the manuscripts of the translation of az-Zahrāwī’s surgery are disseminated in European libraries. To these should be added the incunabula, the first of which appeared in 1497. Since the Basel edition of 1541, az-Zahrāwī’s treatise has also circulated under the title *Methodus medendi certa, clara et brevis*.

The study of az-Zahrāwī’s surgical treatise from the point of view of Arabic studies and history of medicine began with the *Albucasis de Chirurgia* by Johannes Channing (Oxford 1778), in which he translated the text into Latin on the basis of the two Oxford manuscripts, Huntington 156 and Marsh 54, together with their illustrations. Later, in 1861, Lucien Leclerc¹¹ published a successful French translation with plates containing his copies of the illustrations of 172 instruments. He relied primarily on a Parisian manuscript which he described as «le manuscrit d’Abulcasis de la bibliothèque de la rue Richelieu»; besides Channing’s work and the Latin manuscripts, he consulted one more Arabic manuscript which he had «discovered» in Algeria. In 1898, in the first volume of his *Geschichte der*

Chirurgie und ihrer Ausübung, E. Gurtl¹² included a summary of the French translation by Leclerc together with 102 of Leclerc’s illustrations of instruments.

In 1918, in the second part of his *Beiträge zur Geschichte der Chirurgie im Mittelalter*, Karl Sudhoff¹³, compiled «the illustrations of instruments of the Latin Abulqâsim-manuscripts of the Middle Ages». There he reproduced more than 200 illustrations. It is also of interest for the history of medicine that at least two manuscripts of the Latin translation contain coloured illustrations of scenes of medical treatment, namely the manuscript in the Austrian National Library, Vienna, with the shelf mark S.N. 2641 and the Cod. 15 of the University Library in Budapest, and also, the Turkish version prepared in 1465 by Şerefeddin Şabuncuoğlu for the Ottoman ruler Mehmed Fâtih. Both the Vienna codex¹⁴ with 68 illustrations and the Paris codex (MS suppl. turc 693) of the Turkish version¹⁵ with 140 illustrations have been made accessible in facsimile editions in recent years.

[5] Eva Irblich, who edited the Latin facsimiles, deals in her informative introduction with the provenance of the miniatures by comparing the pictures of the Latin translation and of the Ottoman version: «The ‘naive’ Turkish miniatures of surgery of Charaf ed-Din in MS suppl. turc 693 in the Bibliothèque nationale at Paris demonstrate the simplicity of the pictorial representation of the medical text where the figure of the physi-

¹² Berlin 1898 (repr. Hildesheim 1964), pp. 620-648 with plates IV and V.

¹³ *Beiträge zur Geschichte der Chirurgie im Mittelalter. Graphische und textliche Untersuchungen in mittelalterlichen Handschriften*, 2nd part, Leipzig 1918, pp. 16-75 (repr. in: *Islamic Medicine*, vol. 37, pp. 166-247).

¹⁴ *Abu’l Qâsim Ḥalaf ibn ‘Abbās al-Zahrāwī, Chirurgia. Lateinisch von Gerhard von Cremona. Vollständige Faksimile-Ausgabe im Originalformat von Codex Series Nova 2641 der Österreichischen Nationalbibliothek*, commentary by Eva Irblich; and *Chirurgia Albucasis* (facsimile), Graz 1979.

¹⁵ Şerefeddin Sabuncuoğlu, *Cerrâhiyyetü ’l-Ḥāniyye* ed. İlter Uzel, 2 vols. (transcription of the text and facsimile), Ankara 1992. The illustrations of the manuscript were published, some in colour but most of them in black and white, with French explanations by P. Huard and M. D. Grmek, *Le premier manuscrit chirurgical turc rédigé par Charaf ed-Din (1465) et illustré de 140 miniatures*, Paris 1960.

⁹ v. G. Sarton, *Introduction to the History of Science*, vol. 2, part 2, Baltimore 1931, pp. 1078-1079.

¹⁰ *ibid.*, vol. 3, part 2 (1948), pp. 1690-1694.

¹¹ *La chirurgie d’Abulcasis* (Arabic: *Abu l-Qâsim Ḥalaf b. ‘Abbās az-Zahrāwī*) traduite par ..., Paris 1861 (repr. Frankfurt 1996 as *Islamic Medicine*, vol. 36).

cian and that of the patient are drawn mainly from the front next to each other and not as interacting with one another. Here the differences between an Oriental miniature drawn in two dimensions in a decorative and flat style and an Occidental painting delineated with plasticity, depicting a scene with a three-dimensional or decorative background stand out most clearly.»¹⁶

«The dark skin colour of the figures, certain architectural elements such as the tent, the coffered wall or the round cupolas and the figure of the physician with a turban lead to the conclusion that the miniatures could go back to Arabic models. However, other elements such as the curtains, the flat cupolas, sculptures on pillars as bearers of cupolas or of curtains recall in their pictorial idiom components of the paintings of antiquity. Other pictorial elements, such as those of the human figures, the gothic architecture, the beginnings of landscape painting or of the two-dimensional decorative background of the pictures, reflect the southern European style of painting, which, despite its individuality, could be seen as part of the south Italian style of painting.»¹⁷ However, «the area of origin of the Latin version of the text in the school of translators of Toledo is more closely related, and it is also possible that the painting of the manuscript was influenced by antiquating and orientalizing stylistic elements of Moorish Spain.»¹⁸

Concerning Eva Irblich's informative analysis, I wish to clarify the following. In contrast to the Latin translation with its 68 illustrations, the Turkish version of 870/1465 offers roughly 140

miniatures of medical scenes. Moreover, the Latin version does not contain any illustrations of medical instruments. Leaving this aside, there is nevertheless so much agreement in both versions, not only in the depiction of the medical scenes, but also in the text that a common origin can be assumed. We can be sure of the fact that a copy commissioned by the author was provided with qualitatively good or at least adequate illustrations of instruments and medical scenes. Usually such tasks were executed by professional painters who belonged generally to the minority groups. It is, no doubt, possible that the illustrations deviated from the original in the course of time through repeated copying before, during and after the translation. I am inclined to think that the miniatures of the original were of a tolerably good quality.

Among the models of ophthalmological instruments in our collection, there are several that were not produced according to the illustrations of the *Taṣrīf* by az-Zahrāwī, but after the drawings from the *Kitāb al-Kāfī fī l-kuḥl* by Ḥalīfa b. Abī l-Maḥāsin al-Ḥalabī (written before 674/1275). This book, of which two manuscripts¹⁹ are extant, was studied and translated into German by Julius Hirschberg.²⁰ In his descriptions of the instruments, Ḥalīfa included two plates of illustrations which are reproduced below from the Istanbul manuscript of the Yeni Cami collection. Moreover, in Ḥalīfa's book there is also an illustration of the optic nerve crossing which could originally go back to 'Ammār b. 'Alī al-Mauṣilī's (4th/10th cent.) ophthalmological work (see below, p. 27).

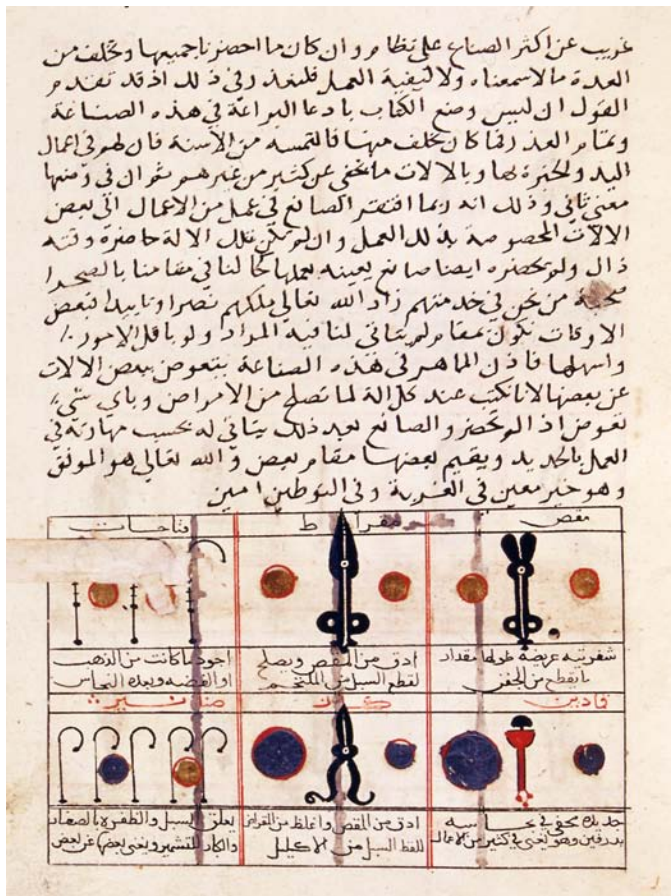
¹⁶ Abu'l Qāsim Ḥalaf ibn 'Abbās al-Zahrāwī, *Chirurgia*, op. cit., commentary p. 31a.

¹⁷ *ibid.*, pp. 31b-32a.

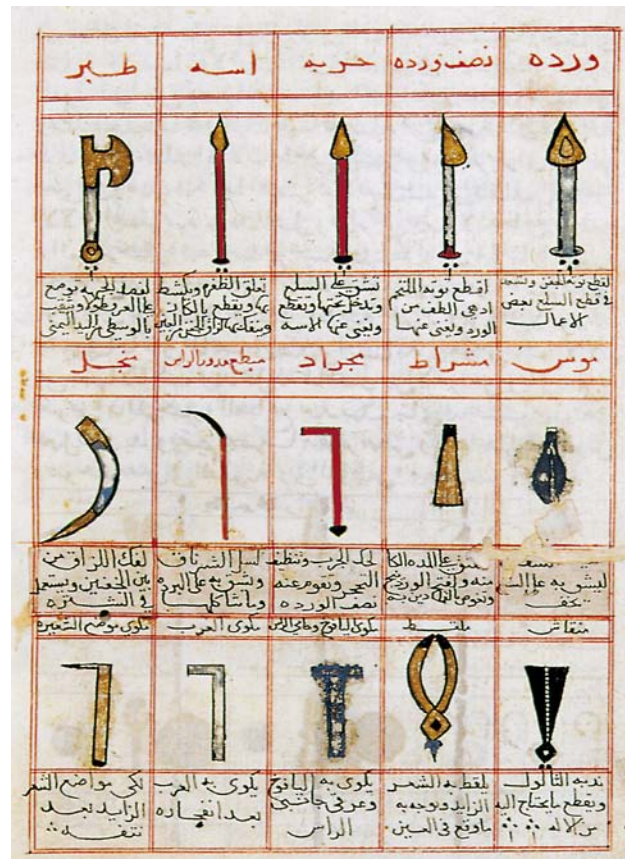
¹⁸ *ibid.*, p. 32a.

¹⁹ Istanbul, Yeni Cami 924 and Paris, Bibliothèque nationale, ar. 2999; v. C. Brockelmann, *Geschichte der arabischen Literatur*, suppl. vol. 1, p. 899.

²⁰ 'Ammār b. 'Alī al-Mauṣilī: *Das Buch der Auswahl von den Augenkrankheiten*. Ḥalīfa al-Ḥalabī: *Das Buch vom Genügen in der Augenheilkunde*. Ṣalāḥ ad-Dīn: *Licht der Augen*. Aus arabischen Handschriften übersetzt und erläutert by J. Hirschberg, J. Lippert and E. Mittwoch, Leipzig 1905 (repr. Frankfurt 1996, *Islamic Medicine*, vol. 45); cf. J. Hirschberg, *Geschichte der Augenheilkunde*, Leipzig 1908, pp. 150-153.



Ophthalmological instruments from the *Kitāb al-Kāfi fi l-kuhl* by Ḥalīfa b. Abī l-Maḥāsīn al-Ḥalabī (written before 674/1275), from the Istanbul manuscript of the Süleymaniye Kütüphanesi, Yeni Cami 924.



2. Series of Anatomical Pictures

There are extant several series of five or six pictures each from Islamic medicine which attracted scholarly interest in the first decade of the 20th century. I have in mind particularly the illustrations of the book *Tašrīḥ-i Maṣṣūrī* by the Persian physician Maṣṣūr b. Muḥammad b. Aḥmad b. Yūsuf¹ from the late 8th/14th century. The illustrations in the book, which had been published several times in India since 1848, were studied by K. Sudhoff² in connection with his investigations into the anatomical illustrations. The pictures show diagrams of the bone system, the nerve system, the muscles, veins and arteries in the human body and the artery system of a pregnant woman. Sudhoff came to know of other pictorial representations, certainly older, of the bone system, the system of veins, muscles and arteries from the Oxford manuscript³ of the *Daḥira-i Ḥwārazmshāhī* by Ismāʿīl b. Ḥasan b. Aḥmad al-Ġurġānī (d. 531/1137 or 535/1141). While comparing the pictures and the texts of the Persian manuscripts with the corresponding material in Occidental books, Sudhoff comes to the conclusion that the series of anatomical diagrams and their texts must have reached the Occident outside Spain at two different periods of time and perhaps through two different channels. He sees an important point for differentiation in the fact that the 13th century manuscript from Provence, now preserved in Basel, is the only manuscript to contain a diagram of a skeleton, a diagram of the female genital organs (without a drawing of the embryo) and a leg-

end which is added to the skeleton.⁴ Moreover, he discovers that both the diagram of the skeleton with the legend and the drawing of the female genitalia (here with a sketch of the embryo) appear in the Persian book of anatomy.⁵ He states that the group of those Latin manuscripts which are different from the Basel family of manuscripts had their precursors in a codex of 1154 in the cloister at Prüfening (near Regensburg) and another one in the cloister at Scheyern (ca. 1250).⁶ He is of the view that they show «such a clearly discernible agreement that a rather close connection between the two must be assumed.» But, he asserts, it is impossible that the Prüfening codex could have served as a model for the younger codex.⁷ From this he concludes that the text from Provence, preserved in Basel, «has been combined from two distinct compilations of the 11th and 12th century which originated in Salerno»,⁸ and comes to the following conclusion: «There is a close connection between the pictures from Prüfening, Scheyern and Oxford. I assume that they date from Antiquity and came down to us via Byzantium. The pictures from Provence preserved in Basel also originated in Antiquity, but perhaps their path of transmission was quite different.»⁹

Towards the end of the study Sudhoff expresses his views on the origin of the Persian illustrations: «It seems to me that, also through Arab medicine, the Persian manuscripts at London and Oxford point to a path of transmission of technical diagrams of anatomy [8] from Antiquity which perhaps goes back to those very same diagrams from Alexandria, of which we have already received distorted tidings in Occidental written records – perhaps! However, we do not yet have the faintest idea of how many

¹ Adolf Fonahn, *Zur Quellenkunde der persischen Medizin*, Leipzig 1910 (repr. Leipzig 1968), pp. 3-4; C. A. Storey, *Persian Literature*, vol. 2, part 1, London 1958, repr. 1972, pp. 225-227; Āġā Buzurg aṭ-Ṭāhrānī, *ad-Darīʿa ilā taṣānīf aš-šīʿa*, vol. 4, Teheran 1360/1941, pp. 184-185.

² *Ein Beitrag zur Geschichte der Anatomie im Mittelalter, speziell der anatomischen Graphik nach Handschriften des 9. bis 15. Jahrhunderts* (= Studien zur Geschichte der Medizin, Heft 4, Leipzig 1908), section 5: *Eine anatomische Sechsbilderserie in zwei persischen Handschriften*, pp. 52-72; E. Seidel and K. Sudhoff, *Drei weitere anatomische Fünfbilderserien aus Abendland und Morgenland*, in: *Archiv für Geschichte der Medizin* (Leipzig) 3/1910/165-187 (repr. *Islamic Medicine*, vol. 93, Frankfurt 1997, pp. 99-123).

³ MS Fraser 201, Bodl. 1576, v. *Cat. of Pers., Turkish, Hindūstānī* ... Mss., ed. Hermann Ethé, vol. 1, Oxford 1889, columns 951-952; v. K. Sudhoff, *Ein Beitrag*, op. cit., p. 52: «The six anatomical diagrams are to be found ... on the flyleaves at the end of the second volume.»

⁴ *Ein Beitrag zur Geschichte der Anatomie im Mittelalter*, op. cit., p. 29.

⁵ *Drei weitere anatomische Fünfbilderserien*, op. cit., p. 187 (repr., op. cit., p. 121).

⁶ *Ein Beitrag zur Geschichte der Anatomie im Mittelalter*, op. cit., p. 3.

⁷ *ibid*, p. 3.

⁸ *ibid*, p. 23.

⁹ *ibid*, p. 28.

groups of anatomical illustrations may have been made in Antiquity and how many may have been handed further down ...»¹⁰

In a study dealing with the same subject, which was published two years later and mentions E. Seidel as a co-author, Sudhoff concludes: «But today it can already be said with the utmost probability, it can almost be asserted with historical evidence, that these illustrations together with the text must be based on a short illustrated anatomical textbook in Greek, which was written in Alexandria and was provided with schematic drawings, probably after available models. The transmitted Latin text is completely free from Arabic influence, therefore it originates directly in the Occidental tradition from Antiquity. This text together with its illustrations was, of course, also known to the Arabs, but since the anatomical drawings could not be handed down for religious considerations, the text also is difficult to locate. But probably that will happen some day.»¹¹

Sudhoff explains his notion of an ancient illustrated text on anatomy that reached the Occident directly and without any intervention by the Arabic-Islamic culture area in the following manner: «The strict school of thought of Islam to which all our Arabic authors on medicine belong, namely that of the Sunnis, made it impossible to preserve and hand down to us through further copying the Alexandrian anatomical drawings which, undoubtedly, must have been known to these authors as well»¹² «The more liberal school of thought of the Persian Shiites, for whom the drawing of a human figure and thus anatomical drawings were not completely prohibited, intervenes in the transmission quite successfully, with its own contribution. Because, however much these illustrations (e.g. in the drawing of the liver) deviate from the other paths of tradition, they also point to Alexandria, even though perhaps to a different author or to another period of Alexandrian medicine. Nothing definite can be said about this at this point. Did Maṣṣūr ibn Muḥammad ibn Aḥmad change much in the drawings that were

available to him or that he used? I believe he changed hardly anything, but through how many competent and through how many more incompetent hands had these illustrations passed, since the time they were first drawn on sheets of papyrus in Alexandria!»¹³

I wish to say a few words on Sudhoff's explanations or hypotheses and offer my own explanation. There is no doubt that the Arab physicians adopted the science of medicine primarily from the Greeks. They make no secret of it and in their books mention their sources with a precision unknown in other culture areas. It has not yet been clearly established how widely spread anatomical illustrations were among the Greeks. If such illustrations reached the physicians of the Arabic-Islamic world, we must assume that, like the development of medical knowledge as a whole, they too did not remain in the same state as they had been received. A full investigation of this still awaits to be done. At the moment we know of only the three illustrations of the anatomy of the eye which Ḥunain b. Isḥāq passed on to us on the basis of Galen's work.

But if we then encounter some anatomical sketches of the human body in Latin and also Persian manuscripts, and if both have obviously some connection with each other, then we are not justified in regarding them as unrelated loans from Greek sources. If one of those Latin manuscripts dates from 1154 and is preserved in a south Frankish cloister, then the present level of knowledge of the history of development of medicine allows us to connect the content of that manuscript [9] with those activities that began in Salerno in the first half of the 11th century through the person of the converted Arab Constantinus Africanus¹⁴ (ca. 1015-1087) and through the Arabic books which he brought with him, translated and circulated, some of them under a different name. The many books that Constantinus Africanus brought with him included the voluminous textbook of medicine by 'Alī b. al-'Abbās al-Mağūsī (4th/10th cent.), in which as many as 110 chapters are devoted to anatomy and

¹⁰ K. Sudhoff, *Ein Beitrag*, op. cit., p. 72.

¹¹ *Drei weitere anatomische Fünfbilderserien*, op. cit., p. 185 (repr., op. cit., p. 119).

¹² *ibid*, p. 186 (repr., p. 120).

¹³ *ibid*, pp. 186-187 (repr., pp. 120-121).

¹⁴ A large part of the studies on Constantinus Africanus and on the medicine at Salerno was reprinted in: *Islamic Medicine*, vol. 43, Frankfurt 1996, v. also Heinrich Schipperges, *Die Assimilation der arabischen Medizin durch das lateinische Mittelalter*, Wiesbaden 1964, pp. 17-54.

surgery.¹⁵ It is highly probable that a copy of this work with anatomical drawings reached Salerno. Incidentally, it may be mentioned that the book circulated in Latin translation in Europe for about 200 years as the work of Constantinus Africanus until it was translated once more into Latin and thus the true author became known. In any case, the book by ‘Alī b. al-‘Abbās was the only one with anatomical and surgical chapters to reach Salerno through Constantinus Africanus. That the origin of the well-known «Salernitanian Anatomy» was directly dependent on this book was already mentioned by Robert von Töply,¹⁶ a contemporary of Sudhoff. It is revealing that more advanced illustrations with more precise descriptions are to be found in the Persian anatomy book and that here the number of figures increased from four to six. Of course, we do not wish to interpret this fact as the achievement of this particular author in whose book we encounter them, but rather as one of the many fruits brought forth by medicine in the Arabic-Islamic culture area to the end of the 8th/14th century. We only need to recall the significant progress in the knowledge of the anatomy of the eye that occurred between Ḥunain b. Ishāq and Ibn al-Haiṭam, or Kamāladdin al-Fārisī, as the case may be. To conclude, we may say a few words on Sudhoff’s view that «the strict school of thought of Islam, to which all our Arabic medical authors belong, namely that of the Sunnis» had made it «impossible to ... preserve the Alexandrian anatomical drawings and to hand them down to us by copying», a mentality from which he excludes «the more liberal school of thought of the Persian Shiites».

This judgment or reasoning with which he seems to credit the Shiite physicians in the six-hundred years under discussion here with a contribution which merely consisted in the preservation of the knowledge inherited from the Alexandrians is completely irrational and contradicts the present level of knowledge in the research¹⁷ on the history of Arabic medicine: indeed, it ought to have occurred to Sudhoff that not an insignificant development took place between the extant anatomical drawings of the *Daḥīra-i Ḥwārazmšāhī* (ca. 505/1110) and those of the *Tašrīḥ-i Manṣūrī* (ca. 800/1400).

¹⁷ v. e.g., R. von Töply, op. cit., p. 63; H. Schipperges, Die Anatomie im arabischen Kulturkreis, in: Medizinische Monatsschrift (Stuttgart) 20/1966/67-73; idem, Arabische Medizin im lateinischen Mittelalter, op. cit., pp. 38-52, esp. p. 39 where he says: «For a systematic overview of Arabic surgery one must primarily consider anatomy, especially because it had been regarded since Antiquity as a propaedeutic to surgical procedure. In this field, we must dispense with many preconceived notions which assume that the dissection of human corpses polluted the Muslim, and that therefore tradition was only receptive and brought no benefit of any kind for scientific research. Moreover, it has been handed down again and again that the reproduction of the human figure was impossible for a Muslim to imagine.»

«Arab physicians like ‘Alī b. al-‘Abbās or Avicenna include in their textbooks hundreds of anatomical monographs where not only the Alexandrian teachings of Hellenistic surgery but also numerous Old-Persian and Indian sources were absorbed. It is in the course of this literary assimilation that anatomy and surgery also found their secure position and continuous enrichment in the textbooks. Thus, Rhazes had already treated anatomy in 26 chapters in his ‘Almansor’. ‘Alī b. al-‘Abbās includes in the 9th book of his ‘Liber Regius’ no less than 110 chapters on anatomy and surgery, furthermore, the 10th book contains teachings on surgical medicine. Apart from a systematic anatomy, Avicenna’s ‘Canon medicinae’ also refers to his own ‘ilm al-ḡirāḥa’ (knowledge of surgery). Ibn al-Haiṭam had an exact knowledge of the anatomy and physiology of the eye»; v. also Emilie Savage-Smith, Attitudes toward dissection in medieval Islam, in: The Journal of the History of Medicine and Allied Sciences 50/1995/67-110.

¹⁵ v. H. Schipperges, *Arabische Medizin im lateinischen Mittelalter*, Berlin, Heidelberg, New York 1976, p. 39.

¹⁶ *Studien zur Geschichte der Anatomie im Mittelalter*, Leipzig and Vienna 1898, p. 88; cf. Ynez Violé O’Neill, *The Fünfbilderserie reconsidered*, in: Bulletin of the History of Medicine (Baltimore) 43/1969/236-245; idem, *The Fünfbilderserie a bridge to the unknown*, in: Bulletin of the History of Medicine (Baltimore) 51/1977/538-549.

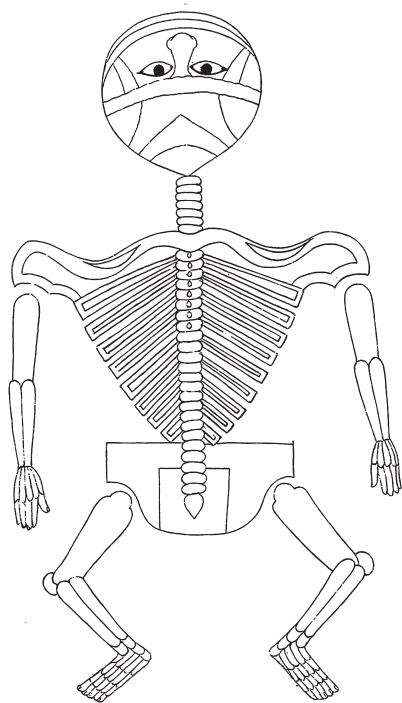


Fig. 1: System of the Bones.

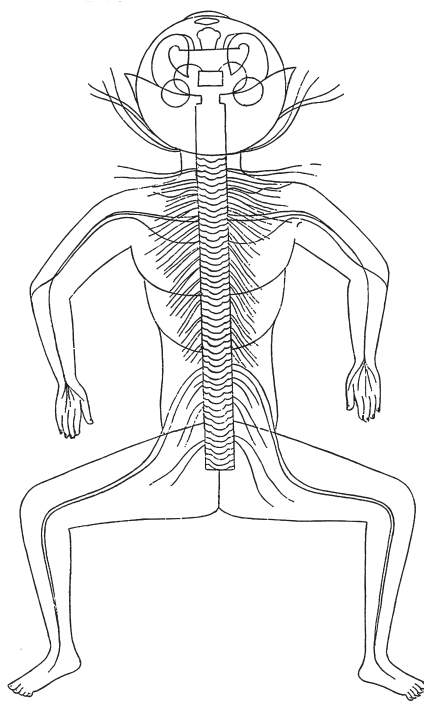


Fig. 2: System of the Nerves.

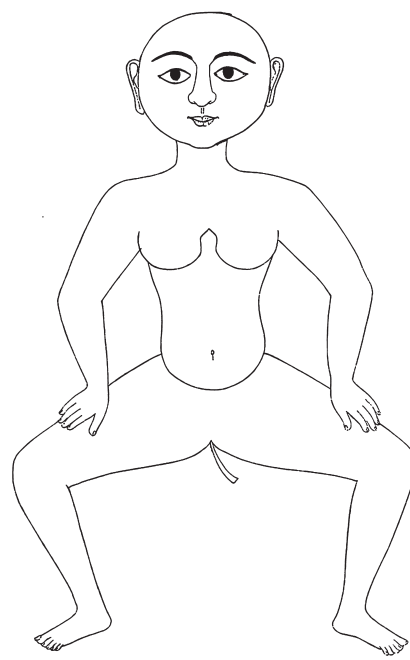
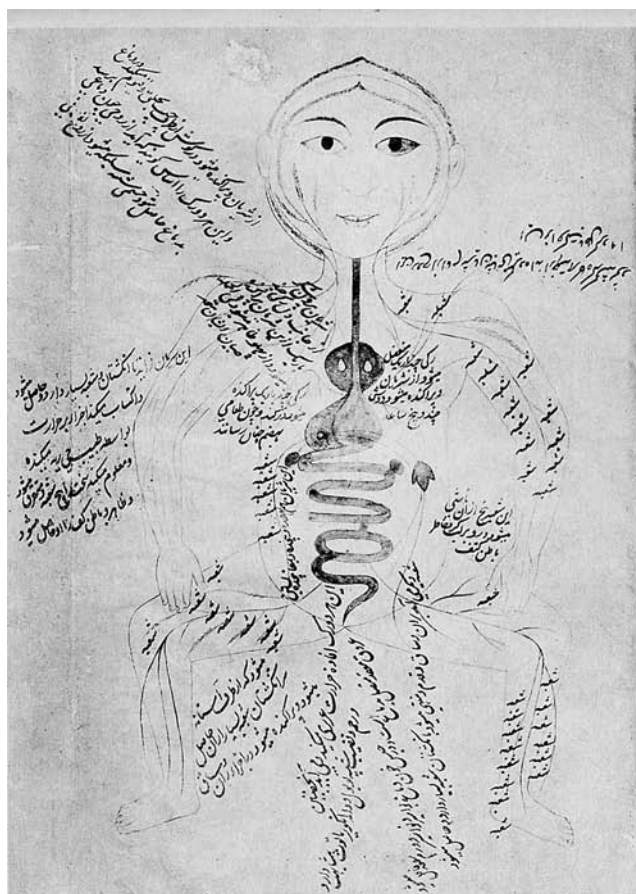
Fig. 3: System of the Muscles
(without label.)

Fig. 4: System of the Veins.

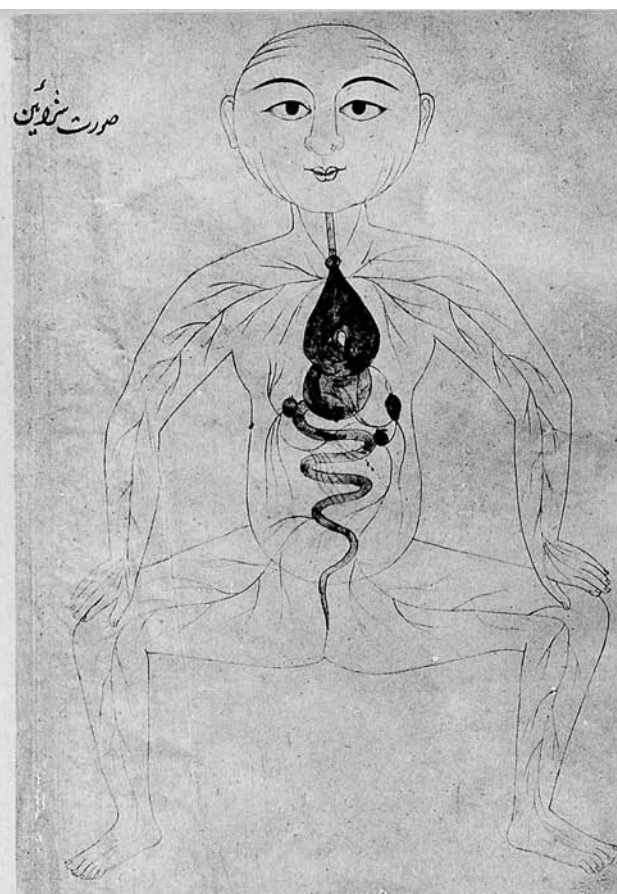


Fig. 5: System of the Arteries.

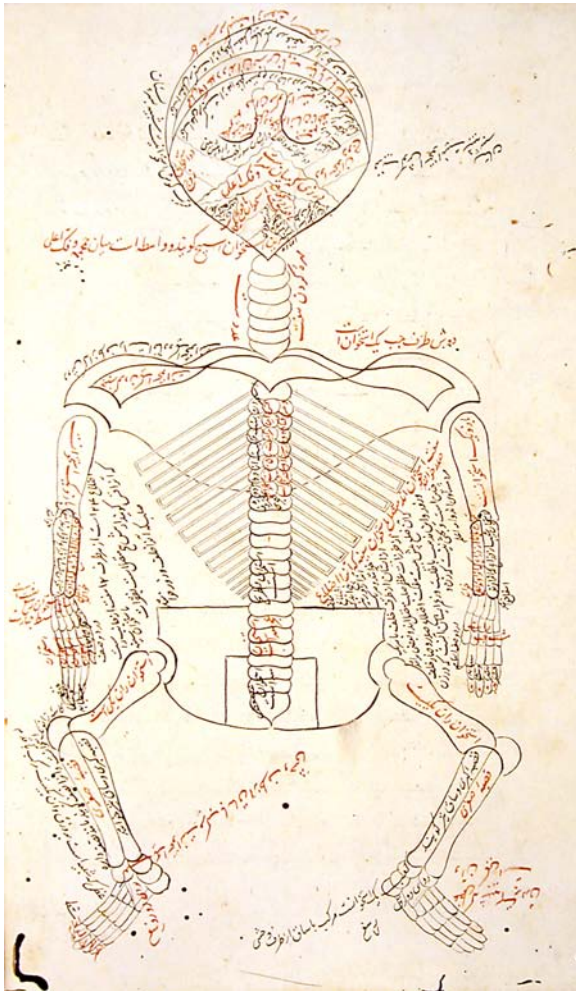


Fig. 6: System of the Bones.

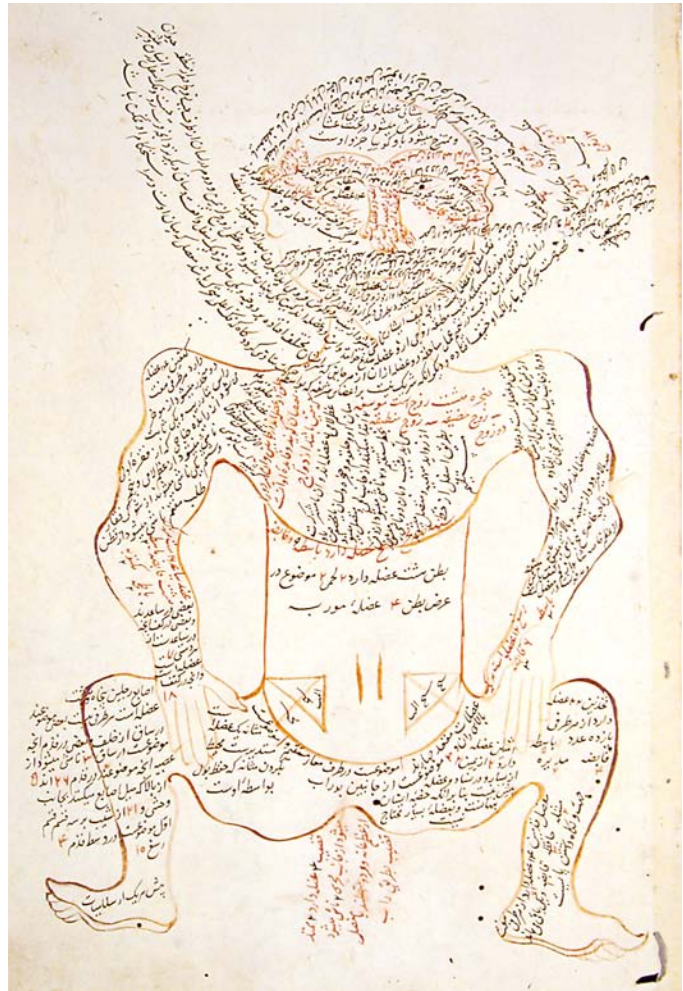


Fig. 7: System of the Muscles.

Figs. 6–11: Anatomical Illustrations from *Taṣrīḥ-i Manṣūrī* (ca. 800/1400), MS Ayasofya (İstanbul) 3598.

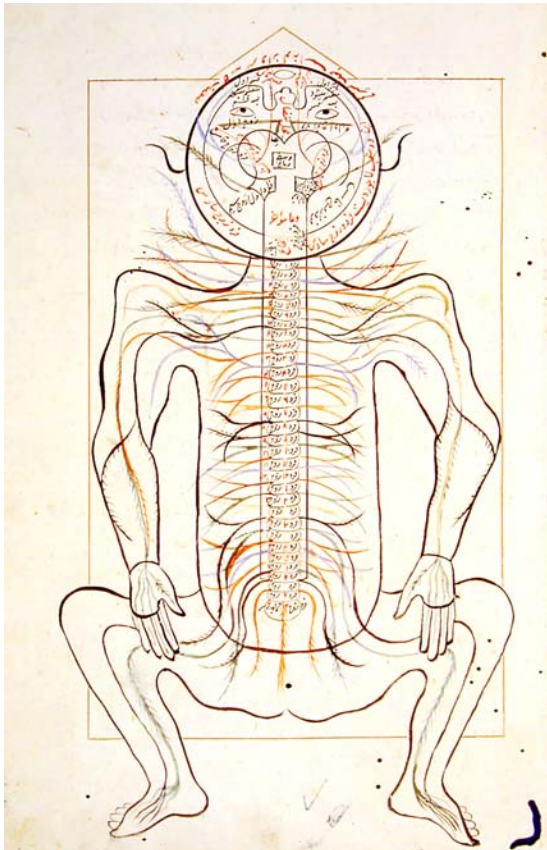


Fig. 8:
System
of the
Nerves.

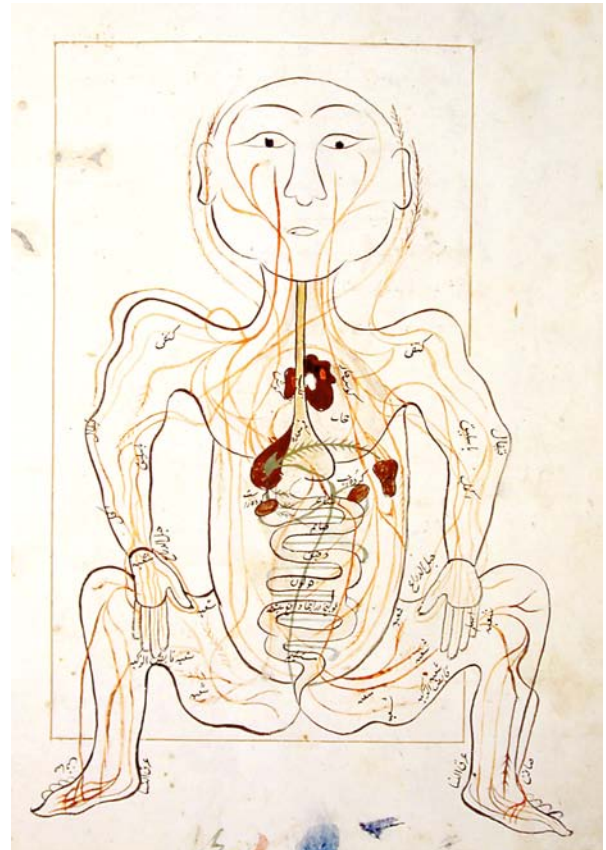


Fig. 9:
System of
the Veins

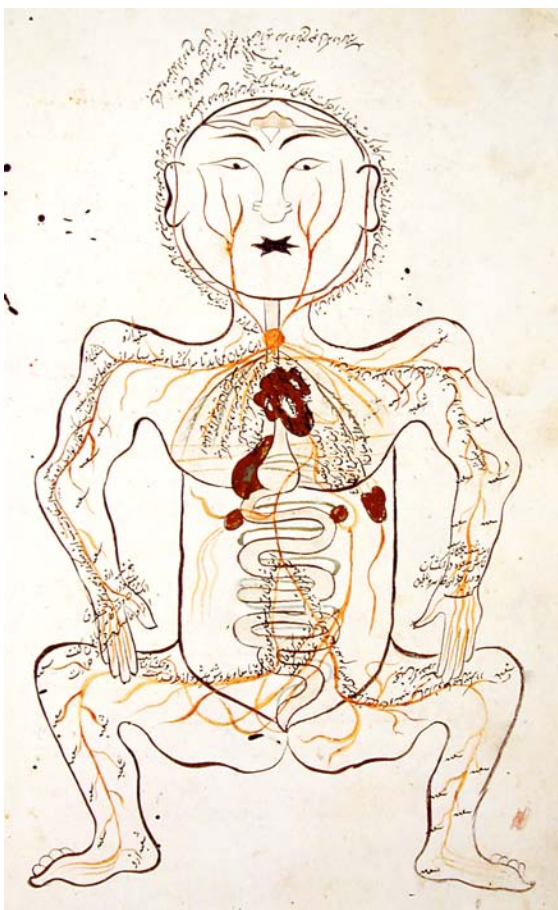


Fig. 20:
System of
the Arteries

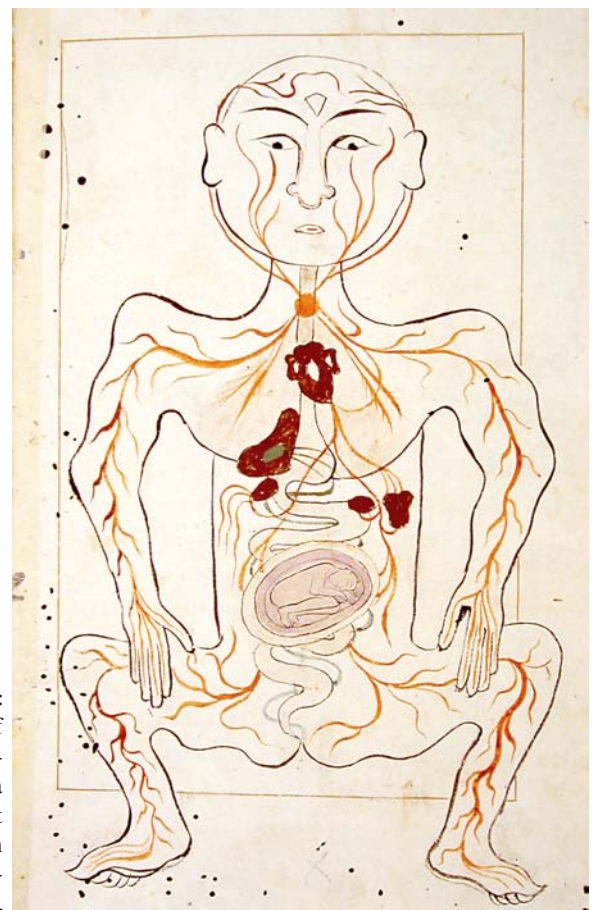


Fig. 11:
System of
the Arte-
ries of a
pregnant
woman
with em-
bryo.



Fig. 12: System of the Bones, from *Taṣrīḥ-i Maṣṣūri*.

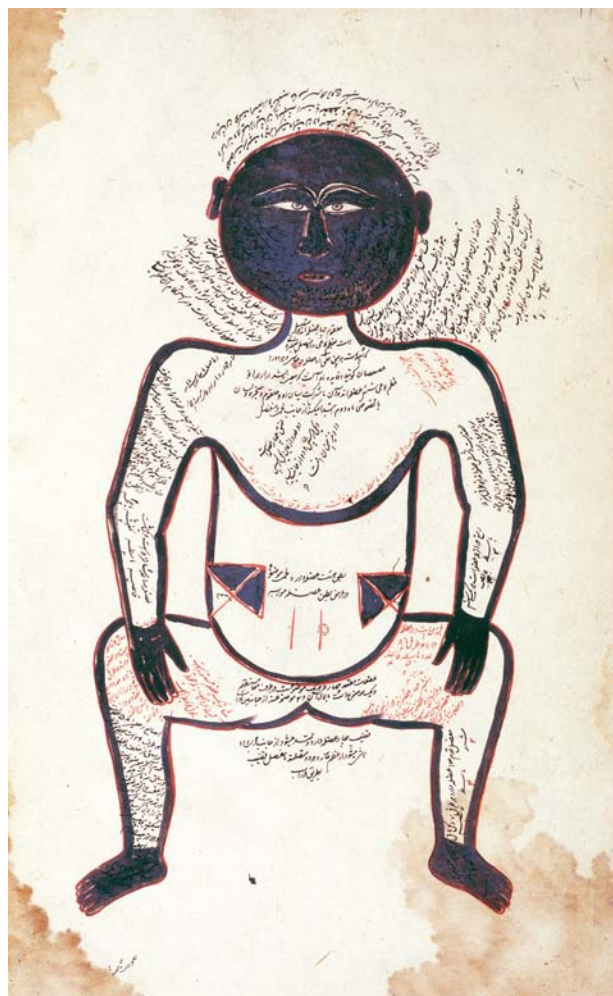


Fig. 13: System of the Muscles, from *Taṣrīḥ-i Maṣṣūri*.

Figs. 12–17: From *Taṣrīḥ-i Maṣṣūri* (ca. 800/1400),
MS India Office (Londres) 2296.

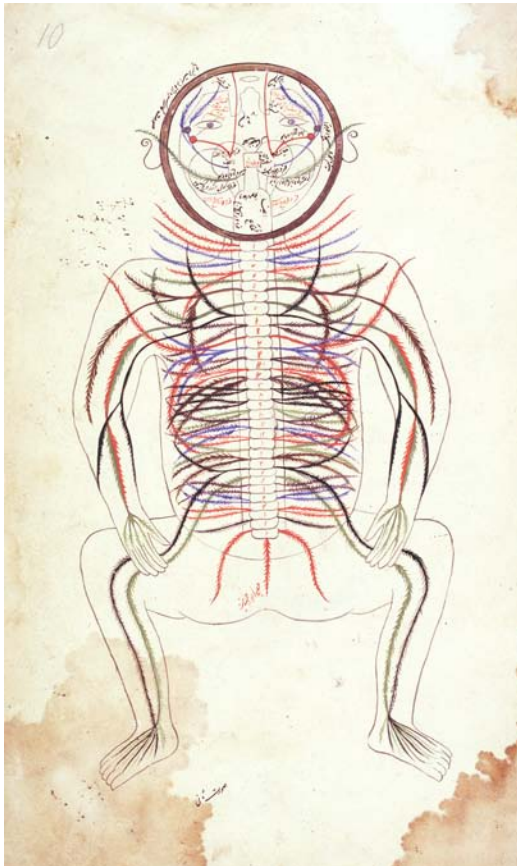


Fig. 14:
System of
the Nerves,
from *Taṣrīḥ-i*
Maṣṣūrī.

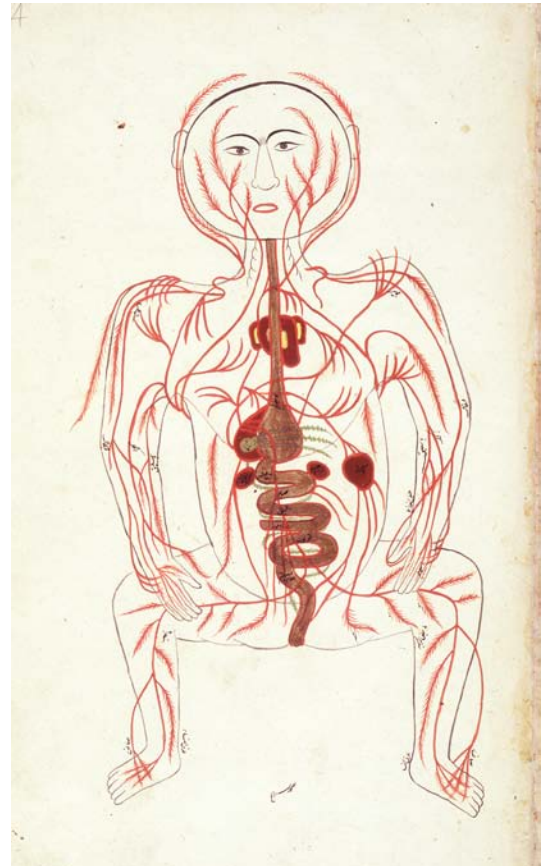


Fig. 15:
System of
the Veins,
from *Taṣrīḥ-i*
Maṣṣūrī.

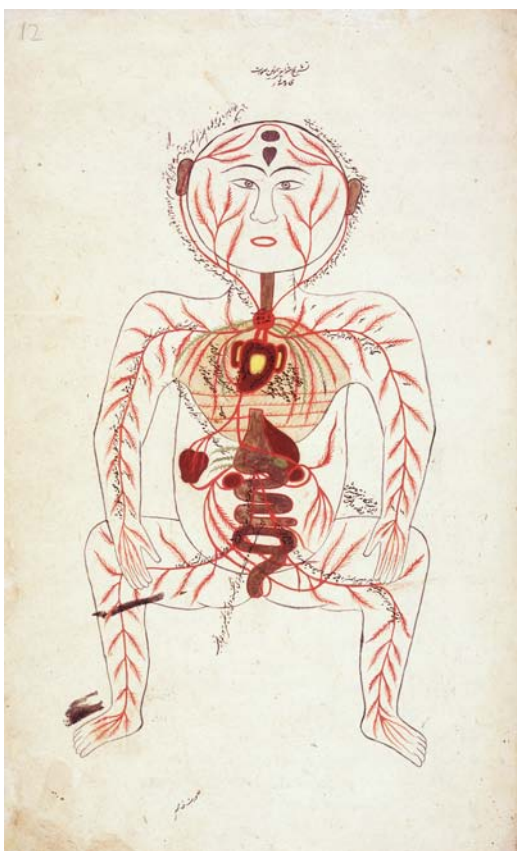
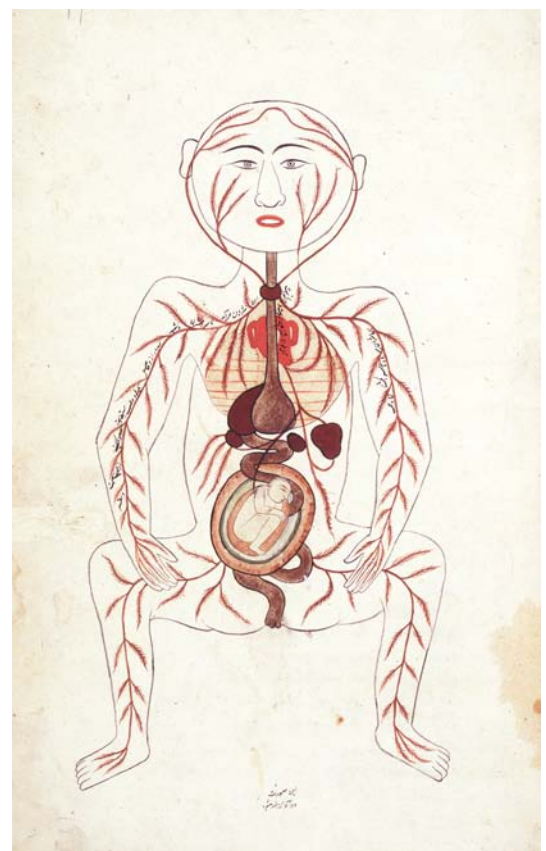
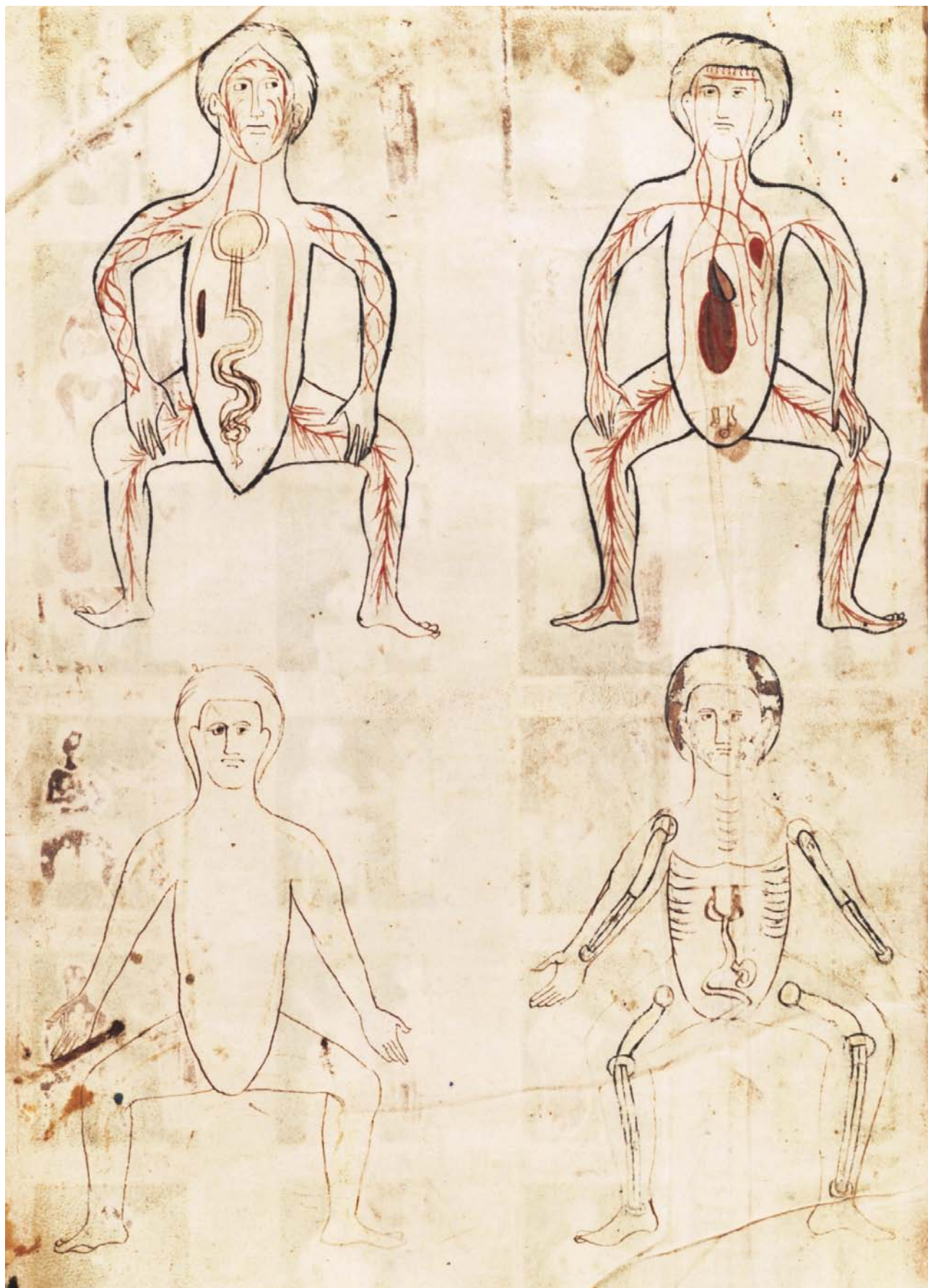


Fig. 16:
System of
the Arteries,
from *Taṣrīḥ-i*
Maṣṣūrī.

Fig. 17:



System of the
Arteries of a
pregnant woman
with embryo,
from *Taṣrīḥ-i*
Maṣṣūrī.



An incomplete series of Latin anatomical illustrations from MS Oxford, Cod. e. Museo 19.

3. Anatomical Illustrations of the Organ of Vision

One weak point of Arabic literature is that textual descriptions are not illustrated, as is desirable, with figures and sketches, with the exception of the fields of mathematics and astronomy. But even in these fields it happens not infrequently that the spaces for figures are left empty by the copyists, probably in anticipation that a specialist would be entrusted with this work. Those who are familiar with Arabic manuscripts are aware of the fact that in many cases autographs, if they are extant, contain illustrations whereas these are missing in the copies. During my studies of the history of Arab sciences and the question of their reception in the Occident, I gained the impression that many Arabic manuscripts with illustrations had the good fortune, as it were, to reach the Occident at an early stage so that their illustrations are preserved in the Latin translations. I am thinking here of the fine scenes of surgical treatment by Abu l-Qāsim az-Zahrāwī (see above, p. 5), which are missing in the Arabic manuscripts and which appear only in the Turkish version in an inferior quality.

In 1908 J. Hirschberg¹ lamented the state of manuscripts circulating without the illustrations of the originals: «The Arabs began ... at an early date to embellish their textbooks of ophthalmology with anatomical illustrations of the organ of vision. Thus, according to the express mention of Ḥalifa, the (for us lost) book 'of information about the diseases of the eye' by Ḥubaiš, the son of Ḥunain's sister, from Baghdad (from the 9th century of our era) was provided with an illustration of the eye. The textbook of ophthalmology by 'Alī b. 'Īsā from Baghdad from the beginning of the 11th century, which was a classic for the Arabs, did not contain any figures except a diagrammatic representation of the adhesion of the retina to the vitreous body. Unfortunately, this diagram is missing in all the five manuscripts which we could use. We make the same lament about the work by 'Ammār of Mosul, which dates from about the same time: the text, although only in the Hebrew translation, speaks

of figures, but shows only the empty spaces where those were meant to be entered.»

Julius Hirschberg, the great savant of Arabic-Islamic ophthalmology, did not yet know the three anatomical illustrations of the eye by Ḥunain b. Ishāq (d. 260/873, see below, Figs. 1-3) which are preserved in the Cairo manuscript. Their discovery two years later was left to his younger colleague, Max Meyerhof. Hirschberg also did not yet know the Arabic original of the pictorial representation of the eye by Ibn al-Haiṭam whose Occidental successors can be traced up to the end of the 16th century. About the oldest Arabic drawing of the eye known to him, he says: «Fortunately we have this illustration of the optic nerve crossing together with that of the eye and the brain in a later Arabic text on ophthalmology, that by Ḥalifa from Syria, from about 1266 our era, but only in the Jeni [Cami] manuscript of this work, not in the manuscript from Paris».² «First of all one must appreciate that the Arab ophthalmologists since Ḥunain had made real efforts to exploit the anatomy, the physiology and the pathology of the brain for their patients. Therefore we do not wish to criticize them for having dragged the optic nerve crossing unnaturally to the front in this imaginary stylized representation of the brain in order to be able to illustrate it at all; we also do that in our diagrams.»³

In connection with the anatomy of the eye and its nomenclature, Hirschberg says: «Not really from the Greeks, but rather from the Arabs, [17] i.e. from the medieval Latin translations of the same do we have the names for the membranes and the moistures of the eye which are in use today.»⁴

About the anatomy of the eye Hirschberg goes on to say: «Among the most important things which ar-Rāzī's [d. 313/925] *Kitāb al-Manṣūrī* period⁵ hands down to us is the contraction of the pupil upon the incidence of light. The fact that the pupil of the healthy human eye contracts when there is brightness and dilates in darkness,—a fact which the first thinking human being ought to have noticed at each dusk in the eyes of his companion,—is, strangely enough, not to be found in the extant

² *ibid*, p. 150.

³ *ibid*, p. 152.

⁴ J. Hirschberg, *Geschichte der Augenheilkunde*, op. cit., p. 154.

⁵ v. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 3, pp. 281-283.

¹ *Geschichte der Augenheilkunde*, 2nd and 3rd volumes: *Geschichte der Augenheilkunde im Mittelalter und in der Neuzeit*, Leipzig 1908, p. 150.

writings of any of the Greek authors, neither of the philosophers, nor of the physicians.»⁶
 «Moreover, this is not just a casual remark by Rāzī, but the articulation of a fact that he recognized as important: he even wrote a special treatise on it under the title: ‘Why pupils contract in light and dilate in darkness’.»⁷ Here we may also mention the unusual chapter of a book on ophthalmology about «the differences of the eyes of animals compared to human eyes and the special characteristics of the latter». It is the sixth chapter of the *Kitāb al-ʿUmda* by Ṣadaqa b. Ibrāhīm aš-Šādīlī from the second half of the 8th/14th century:⁸ «This is rather a peculiar chapter, to a certain extent the seed of a comparative anatomy and physiology of the organ of vision: let us recall that even the detailed and classical textbooks of ophthalmology of the first two thirds of the 19th century, by J. Beer, Mackenzie, Artl, did not tackle this unwieldy topic; that only in our time did the most voluminous handbooks of ophthalmology, such as that by Graefe-Saemisch in the first edition II, 2, 1876, and our second edition which is not yet complete, after that also the *Encyclopédie française d’ophtalmologie* which is appearing just now, undertake to deal with this topic meticulously and scientifically. Thus we will not demand too much from our Šādīlī.»⁹

Julius Hirschberg wrote his general history of ophthalmology at a time when Arabic studies and research into the history of the Arabic-Islamic natural sciences were still at a rather primitive level. Nevertheless, what Hirschberg brought out and published from Arabic-Persian literature on the subject of the anatomy of the eye retains its path-breaking significance for the subject even now. But if the modern historian of medicine misses an adequate impact of the insights gained by Hirschberg about Arabic medicine in general and the anatomy of the eye, in particular, in the subsequent historiography of the subject, the main reason probably lies in the fact that from the beginning a renowned and most prolific colleague like Karl Sudhoff continuously entertained a negative view towards the results

presented by Hirschberg. It was not so much a well-founded scepticism towards the results arrived at by Hirschberg that motivated Sudhoff, but rather his fundamentally Eurocentric attitude towards the status of the Arabic-Islamic culture area in the history of science. According to his view, which is expressed again and again in his works, he not only denies any creative role in the history of science by the Arabic-Islamic culture area, but even denies it the role of a mediator between the Greeks and the Occident in the Middle Ages. He is of the opinion that the Occident got to know the works of the Greeks without the mediation of the Arabs and translated them directly into Latin, even if they had been translated into Arabic [18] and even if these translations might have reached the Occident.

The first scholar who opposed this attitude was, as far as I know, S. L. Polyak. In 1941 he wrote¹⁰: «The knowledge of the structure of the eye and of its function, possessed by western Europe during the Late Middle Ages, including the pictorial representation, manifestly was transplanted from the Near East, from the so-called ‘Arabs’, mostly by way of Spain, together with many other intellectual and practical pursuits, such as philosophy, medicine, alchemy, etc. It could not have been an indigenous product. This, if one realizes how completely annihilated was the Greek thought in the territories of the Christianized Teutonic barbarians and the degraded Latins of the West, is what could be expected. The belief that there was a tradition regarding the structure of the eye preserved in western Europe from classical Greek times, or possibly taken over directly from the cultural sphere of Alexandria, and even more so the claim that the early eye diagrams were a product of indigenous European efforts and thus independent from the Arabic Civilization and indirectly from the Greek Civilization (Sudhoff 1907, 1915; Bednarski 1935) seem, therefore, not to be well founded.»

In the ninth chapter of his book on *Arab diagrams of the eye and their influence in Europe upon the anatomy and physiology of the visual organs*,¹¹ Polyak offers the best discussion of the subject by a non-Arabist that we know of, aside from Hirsch-

⁶ J. Hirschberg, *Geschichte der Augenheilkunde*, op. cit., p. 155.

⁷ *ibid.*, p. 156.

⁸ *ibid.*, pp. 84-85; C. Brockelmann, *Geschichte der arabischen Literatur*, vol. 2, p. 137.

⁹ J. Hirschberg, *Geschichte der Augenheilkunde*, op. cit., pp. 156-157.

¹⁰ *The Retina. The anatomy and the histology of the retina in man, ape, and monkey, including the consideration of visual functions, the history of physiological optics, and the histological laboratory technique*, Chicago 1941, p. 128.

¹¹ *ibid.*, p. 114 ff.

berg. He considers Ibn al-Haiṭam and his commentator Kamāladdīn al-Fārisī (ca. 700/1300) as important representatives of physiological optics and connects¹² the well-known works on optics written in Europe in the 13th century with the works of Ibn al-Haiṭam and Ibn Sīnā which had been available for more than a century in Latin translations. Witelo's *Perspectiva*, fundamentally an «analytical commentary on the work of Ibn al-Haiṭam and the first product of European endeavors in the field of optics,» strangely coincides with the commentary written in Persia by Kamāladdīn al-Fārisī, as far as the time and contents are concerned. The translation of Ibn al-Haiṭam's book and the appearance of Witelo's work mark, according to Polyak, the beginning of a long sequence of more or less important treatises on optics, among them the first and most popular works being those by Roger Bacon (ca. 1219-ca. 1292) and John Pecham (Peckham), the archbishop of Canterbury (ca. 1235-1292). Polyak considers all the European diagrams of the eye that were drawn for European works until the end of the 16th century, including those by Leonardo da Vinci, to be dependent on Arabic models.¹³ Polyak, who was not an Arabist, was the first to publish and realize the importance of the Arabic diagrams of the eye by Ibn al-Haiṭam and Kamāladdīn al-Fārisī which are preserved in libraries in Istanbul. In the 1940s, following in the footsteps of the famous Eilhard Wiedemann, the Egyptian scholar Muṣṭafā Naẓīf¹⁴ presented—to use the words of Matthias Schramm—«the optical achievements of Ibn al-Haiṭam in an exemplary fashion and extensively.» Twenty years later one more «exemplary» work on Ibn al-Haiṭam appeared. It is entitled *Ibn al-Haiṭams Weg zur Physik*.¹⁵ The scientist who enriched the scholarship on the history of Arabic-Islamic sciences with this book was Matthias Schramm himself. Here, I will not venture the difficult task of evaluating it in an adequate manner. However, it is not in this work, but in another, likewise excellent study that supplements this work, that Schramm pointed out a perspective which is completely novel for our topic. In this article, entitled *Zur Entwicklung der physiologischen Optik in*

der arabischen Literatur,¹⁶ he informs [19] us about Ibn al-Haiṭam's endeavors «to combine anatomical and optical reflections with one another».¹⁷ From the point of view of physiological optics, the spherical form of the cornea was «no more a mere fact noticed by doctors of anatomy, but becomes a necessity: it alone guarantees the unbroken penetration of the rays which advance from all sides to the centre of the eye and to the centre of vision.» Thus Ibn al-Haiṭam gains «as a result of his physical contemplations ... the first hypothesis of the construction of the eye, clearly defined by means of geometry».¹⁸ Of great significance is also the fact that Schramm, by way of further developing physics and physiological optics as presented by Ibn al-Haiṭam, finds a work of high standard in the commentary by Kamāladdīn al-Fārisī, who was active three hundred years later. Of Schramm's statements, the one that refers to Kamāladdīn's theory on the image of the pupil¹⁹ may be cited here because of its connection to our particular topic. Kamāladdīn states that the idea of Galen and his followers is untenable and that, through dissection of the eye of a slaughtered wether, he comes to the conclusion that during the formation of the image in the pupil the reflection takes place on the upper surface of the lens. Kamāladdīn's achievement is appreciated by Schramm²⁰ in the following words: «Through his deliberations and experiments Kamāl al-Dīn has been led to a result which was achieved afresh only in 1823 by Johannes Evangelista Purkyně. Kamāl al-Dīn was the first to detect definite proof for the reflection on the upper surface of the lens and gave reasons for it in the context of his theory in an excellent manner.»

¹² *ibid*, p. 126.

¹³ *ibid*, p. 128.

¹⁴ *Al-Ḥasan b. al-Haiṭam, buḥūṭuhū wa-kuṣūfuhū l-baṣariya*, 2 vols., Cairo 1942-1943.

¹⁵ Published in Wiesbaden, 1963.

¹⁶ in: Sudhoffs Archiv für Geschichte der Medizin 43/1959/289-328.

¹⁷ *Zur Entwicklung der physiologischen Optik*, op. cit., p. 295.

¹⁸ *ibid*, p. 296.

¹⁹ Kamāladdīn explains Galen's theory on the image of the pupil as follows: «Galen and those who follow him maintained: It is this (that is to say the layer which is like a spider's web) in which we see our image (*ṣūra*) if we look into the eye of somebody who is near us in the same way as we see in a mirror (*mir'āt*)» (*Tanqīḥ al-Manāẓir*, ed. Hyderabad 1347-48/1928-29, vol. 1, p. 65, translated by Schramm, *Zur Entwicklung der physiologischen Optik*, op. cit., p.308.)

²⁰ *ibid*, pp. 315-316.

The oldest preserved anatomical illustration of the eye is by Ḥunain b. Ishāq (d. 259/873)²¹

[20] On the importance of this diagram of the eye, S. L. Polyak²² wrote the following in 1941: «In his *Book of the Ten Treatises on the Eye* (*Kitāb al-‘ashr maqālāt fī al-‘ain*) he gives a good description of the parts composing the eye, of the optic nerve and its connection with the brain, and also of the physiology of the visual system, besides the pathology and the treatment of eye diseases. In an Arabic manuscript of this book discovered by Meyerhof (1911), especially noteworthy are the diagrams of the eye. The best of these [v. ci-dessus, fig. 3] shows the inner structures of the eyeball in an imaginary horizontal cross-section inclosed in a frame representing the two lids as seen in a living person. Of the several circular layers, or coats, the most outward is the conjunctiva, to which the oculomotor nerve is attached on each side; the next is the sclera, together with the cornea; then the chorioid membrane, with the uvea (iris); and finally the retina, the innermost. This latter membrane, according to the text, is made up of two components—a hollow nerve, which apparently is the retina proper, and the blood vessels. The inner space of the eye is divided by a cross-partition into an anterior compartment, filled with the aqueous humor, and a posterior compartment, the vitreous. The crystalline lens is represented in the very center of the eyeball as a circular sphere, whereas in the text it is correctly described as flat. A thick semicircular line in front of the lens and continuous with the cross-partition represents the arachnoid membrane—in modern terminology the <anterior capsule> of the lens—together with the ciliary zonule and perhaps also the ciliary body. The most anterior portion of the outward tunic, facing upward and correctly showing the cornea with a smaller radius of curvature, is left unlabeled in the figure. The pupillary opening is represented by a small circle behind the cornea, inclosed in a cres-



Fig. 1: The eye according to Ḥunain b. Ishāq, MS Cairo, Dār al-Kutub, Taimūr 100, p. 319.



Fig. 2: *ibid.*, p. 346.

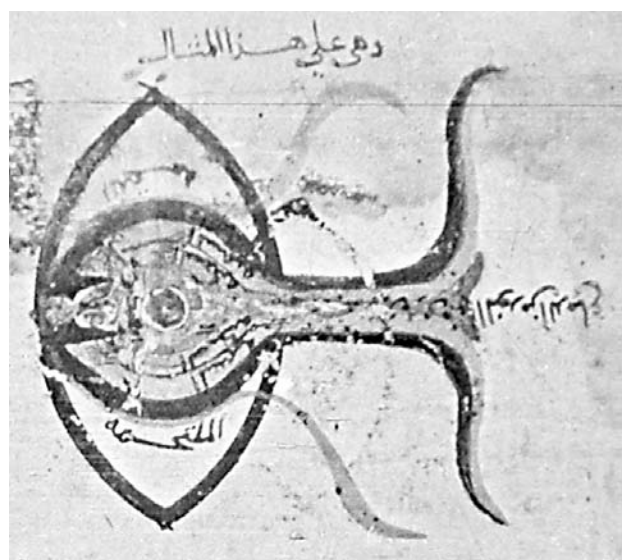


Fig. 3: *ibid.*, p. 318.

²¹ *Tarkīb al-‘ain wa-‘ilaluhā wa-‘ilāghuhā ‘alā ra’y Ibruqrāt wa-Ġālīn’s wa-ḥiya ‘aṣr maqālāt*, MS Cairo, Dār al-Kutub al-Qaumiya, collection Taimūr 100, pp. 314-318. Max Meyerhof (ed), *The Book of the Ten Treatises on the Eye Ascribed to Hunain ibn Ishāq (809-877 A. D.)*, Cairo 1928 (repr. Frankfurt 1996, *Islamic Medicine* vol. 22); M. Meyerhof and C. Prüfer, *Die Augen Anatomie des Ḥunain b. Ishāq. Nach einem illustrierten arabischen Manuskript herausgegeben*, in: *Archiv für Geschichte der Medizin* (Leipzig) 4/1910/163-191 (repr. Frankfurt 1996, *Islamic Medicine* vol. 23, pp. 45-73).

²² *The Retina*, op. cit., pp. 106-107.

cent-shaped structure which represents the uvea, or the iris. The optic nerve is hollow. The two sheaths enveloping the nerve, the dura and the pia, continue directly into the scleral and the chorioid tunic, respectively, while the optic nerve itself spreads out into the retina.»

«The obvious mistakes in this Arab diagram, which, like the text, is in all probability a copy or an adaptation from the Greek original of Galen's *On the Utility of the Parts of the Human Body* or from a similar treatise now lost, are at once apparent. First, the eyeball is too small in comparison with the palpebral fissure. Its walls are disproportionately thick, the anterior chamber too spacious, the posterior absent, and the vitreal cavity far too small. The two chief errors of the Greek anatomy—the location of the lens in the center of the eyeball and the channeling in the center of the optic nerve—have been faithfully copied by the

Arabs. Yet, in spite of this, the figure gives a fair idea of the disposition of the minute structures of the eye and is unquestionably more correct than the confused geometrical diagrams which decorated numerous Latin manuscripts in Europe from the thirteenth to the fifteenth century and even later. Thus, for instance, the arrangement or sequence of the tunics of the eyeball and of the optic nerve is correct. Even the positions of the lens, with its suspension in the araneal tunic, and of the zonular ligament are nearer actuality than those represented in the above-mentioned geometrical schemes of the early European writers. Altogether, this venerable Arab diagram is more natural than the later, highly schematized, artificial Western figures. In one respect, viz., the curvature of the cornea, it is even more correct than the diagram of Vesalius, whose copy was published in Alhazen's and Vitello's joint edition (A.D. 1572).»



Some more, historically very important figurative representations of the anatomy of the eye follow, which are, moreover, suitable for depicting the paths of reception:

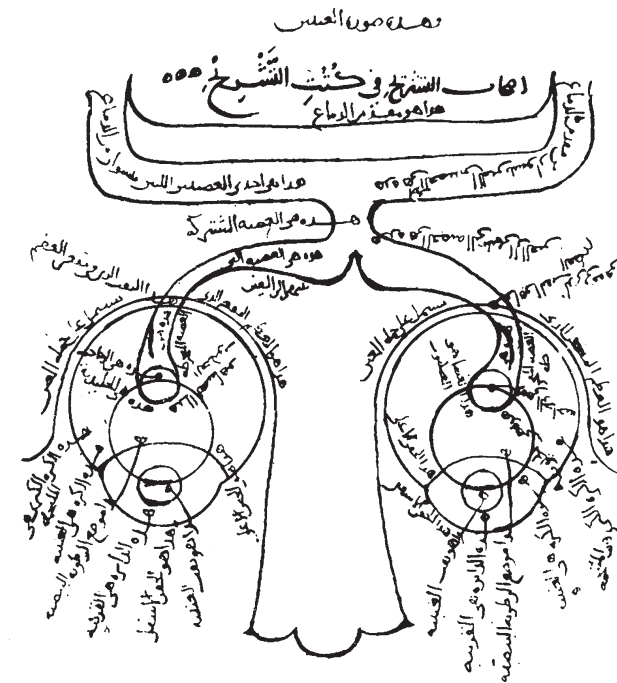


Fig. 4:
Illustration of the human organ of vision in the *Kitāb al-Manāẓir* by al-Ḥasan Ibn al-Haiṭam (ca. 432/1041), MS Istanbul, Süleymaniye Kütüphanesi, collection Fatih 3212, fol. 81b.²³

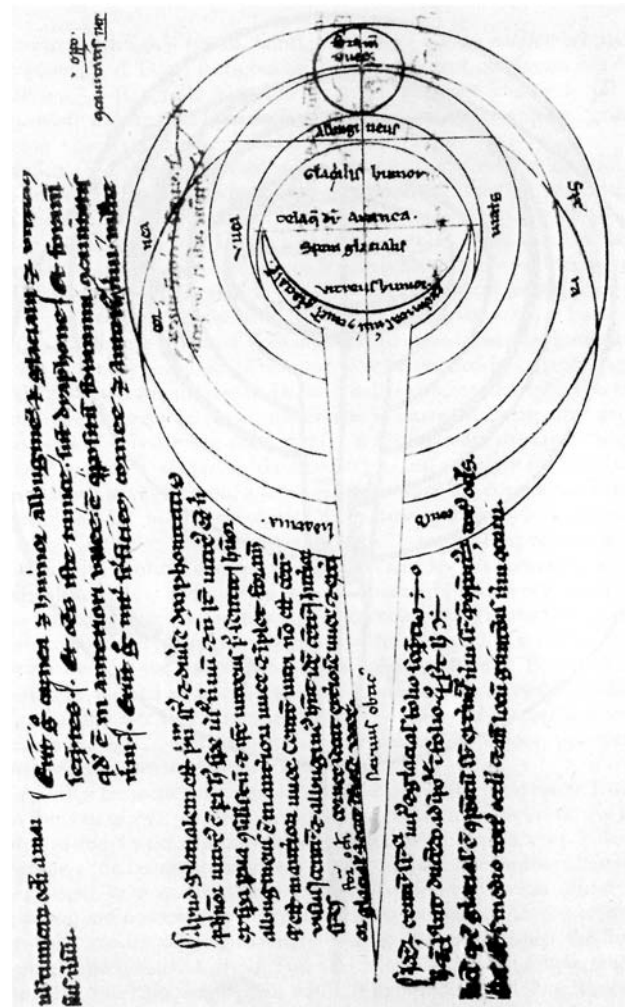


Fig. 5:
Longitudinal section of the human eye according to Ibn al-Haiṭam in the Latin translation of his optics, MS Edinburgh, Crawford Library of the Royal Observatory.²⁴

²³ v. S. L. Polyak, *The Retina*, op. cit., fig. 8; David C. Lindberg, *Theories of Vision from al-Kindi to Kepler*, Chicago and London 1976, p. 68; A. I. Sabra, *The Optics of Ibn al-Haytham*, vol. 2, London 1989, p. 42, pl. 1.

²⁴ v. S. L. Polyak, *The Retina*, op. cit., fig. 13; A. I. Sabra, *The Optics of Ibn al-Haytham*, op. cit., p. 42, pl. 3.

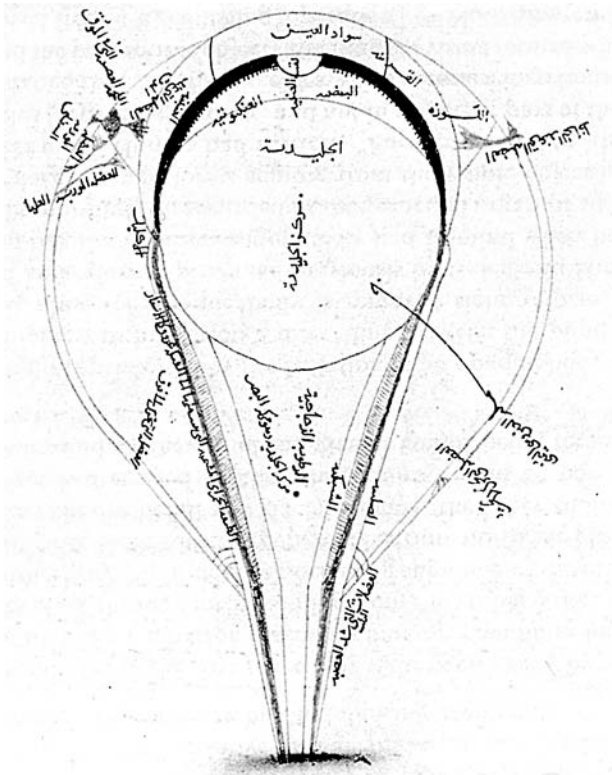


Fig. 6:

Longitudinal section of the human eye according to Kamāladdīn al-Fārisī (ca. 700/1300), *Tanqīḥ al-Manāẓir*, MS Istanbul, Topkapı Sarayı, Ahmet III, 3340, fol. 24b.²⁵

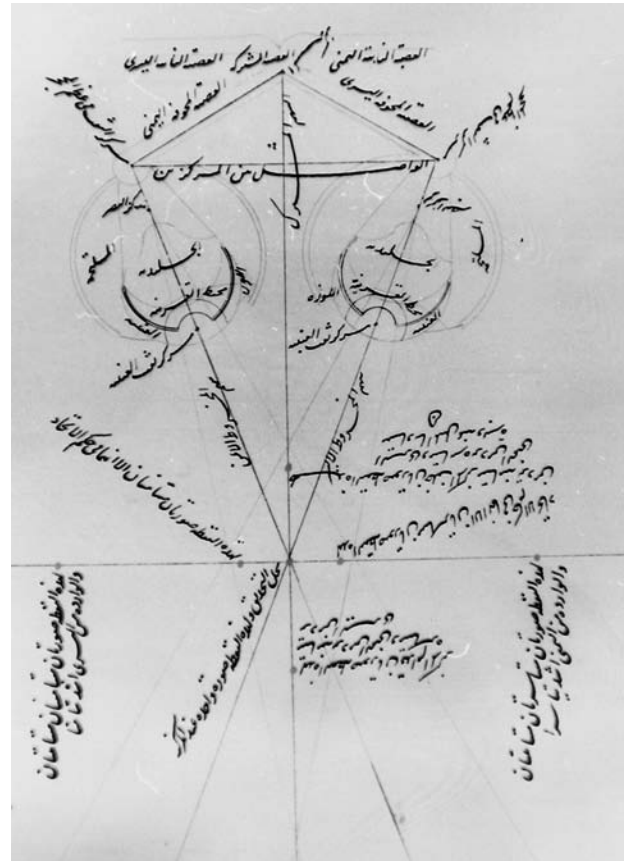


Fig. 7:

One more sketch of the human organ of vision according to Kamāladdīn al-Fārisī (ca. 700/ 1300), from his book *al-Baṣā'ir fī 'ilm al-manāẓir*, MS Istanbul, Süleymaniye Kütüphanesi, collection Ayasofya 2451, fol. 42b.²⁶

²⁵ v. S. L. Polyak, *The Retina*, op. cit., fig. 9; D. C. Lindberg, *Theories of Vision*, op. cit., p. 70; A. I. Sabra, *The Optics of Ibn al-Haytham*, op. cit., p. 42, pl. 2.

²⁶ Cf. S. L. Polyak, *The Retina*, op. cit., fig. 12.

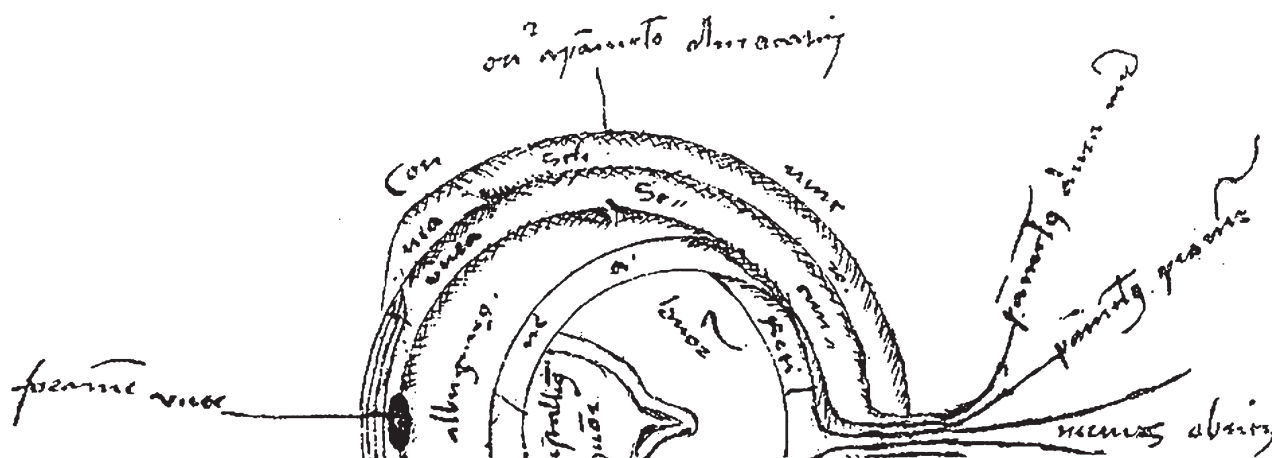


Fig. 8:

Latin rendering of an Arabic diagram which shows a longitudinal section through the eyeball.

The illustration became well known because it was included in the edition of the Latin translation of Ibn Sīnā's *Qānūn* of 1479.²⁷ K. Sudhoff²⁸ published the same diagram in 1907 after the Leipzig Codex 118 (folio 217) to provide proof «that even independently of the Arab tradition a longitudinal section through the eye must have been part of the inheritance throughout the Occidental Middle Ages.»

To this J. Hirschberg replied in a letter to Sudhoff: «It is true, the great textbooks of ophthalmology by Halifa and Salah ad-Din from Syria, which were provided with illustrations of the eye, were totally ignored by the Latin world of the European Middle Ages; but the latter got to know, among others, 'The Treatise on the Eye' of the Christian from Toledo, 'Salomo filius de Arit, Alcoati', from 1159; I was the first to show that it was written originally in the Arabic language and that it was derived entirely

from Arabic sources. This work contained, in the first book, a figure of the eye of which the author is quite proud ... The illustration in your manuscript is probably from this manuscript. Unfortunately, the figure was omitted in the only complete manuscript of Alcoati (No. 270 of the Amplon. Library at Erfurt), which was first published by our friend Pagel and which Pansier printed once again.»²⁹ Sudhoff took note of this statement by Hirschberg, at first, with some discomfiture³⁰ but, after another eight years, dismissed it: «I do not quite believe that this picture originated from Alcoati as Hirschberg assumed at that time (Archiv für Geschichte der Medizin, I, p. 316), particularly not after the Occident taught us several other graphic representations of the construction of the eye, and also because Alcoati positively detests transferring the cornea outside the conjunctiva. Alcoati had nothing of his own in his ophthalmology, least of all [24]

²⁷ Robert Töply, *Anatomia Ricardi Anglici* (c.a. 1242-1252), Vienna 1902, p. 39 (Additamenta), fig. 3.

²⁸ *Augenanatomiebilder im 15. und 16. Jahrhundert*, in: Studien zur Geschichte der Medizin, Heft 1, Leipzig 1907, pp. 19-26, esp. pp. 22-23.

²⁹ *Zum Leipziger Augendurchschnittsbilde aus dem Ende des 15. Jahrhunderts*, in: Archiv für Geschichte der Medizin (Leipzig) 1/1907/316.

³⁰ in: Archiv für Geschichte der Medizin 1/1907/316.

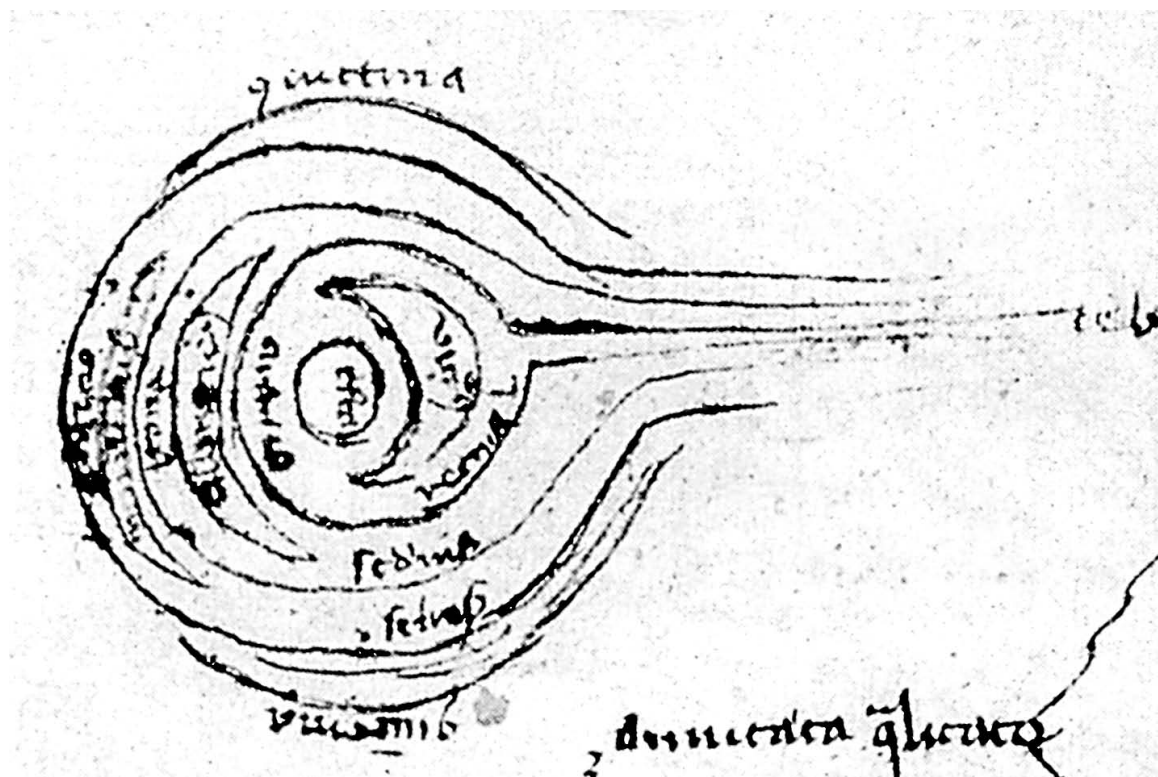


Fig. 9: Longitudinal section of the human eye after a Latin manuscript (Leipzig 1183, fol. 217) from the first half of the 15th century.

in anatomy. This has its origins entirely among the Greeks and came from them to the Arabs and into the Occident and to Salerno and other schools of physicians through all sorts of channels, and finally once more on the path of the Latin translations from the Arabic.»³¹

Then Sudhoff reproduces the illustration of the longitudinal section of the eye from the Leipzig manuscript 1183, fol. 217:

In 1941 S. L. Polyak³² expressed his view on the two diagrams of the Leipzig Codex (15th cent.) and the incunabulum of the *Liber Canonis* by Ibn Sīnā (1479) and stated that they were either rough copies of the drawing by Kamāladdīn al-Fārisī or, more likely, of that drawings' common source in the book of optics by Ibn al-Haiṭam. In my view,

we should rather suppose that both the diagrams (of Avicenna and of the Leipzig Codex) as well as the illustrations by «Alcoati» are connected to a stage of development that took place in the Arabic-Islamic culture area after Ibn al-Haiṭam but before 1159, a development which obviously also influenced Kamāladdīn al-Fārisī. It may also be pointed out that the 5th book of the Arabic original of «Salomo filius de Arit Alcoati» (written in 1159), has come to light,³³ the author of which could perhaps have been called Sulaimān b. Ḥarīṭ al-Qūṭī.

³¹ *Weitere Beiträge zur Geschichte der Anatomie im Mittelalter*, in: *Archiv für Geschichte der Medizin* 8/1914-15/1-21, esp. pp. 9-10.

³² *The Retina*, op. cit., p. 128.

³³ Escorial 894 (44a-76a), v. J. Hirschberg, *Geschichte der Augenheilkunde*, Leipzig 1908, pp. 70-71. Editions, studies and translations of the book were published in *Islamic Medicine* vol. 56, Frankfurt 1996.

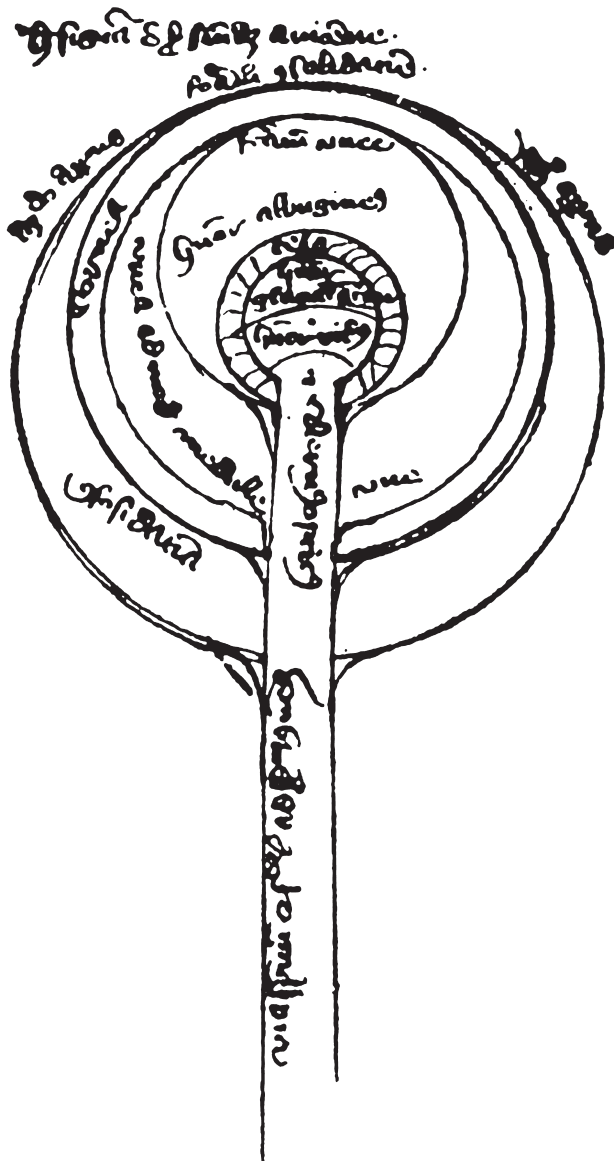


Fig. 12: Longitudinal section of the human eye after John Pecham (Peckham, or similar other forms), the archbishop of Canterbury (ca. 1235-1292), in the manuscript F. IV. 30 (fol. 128b) of the Basel university library.³⁶

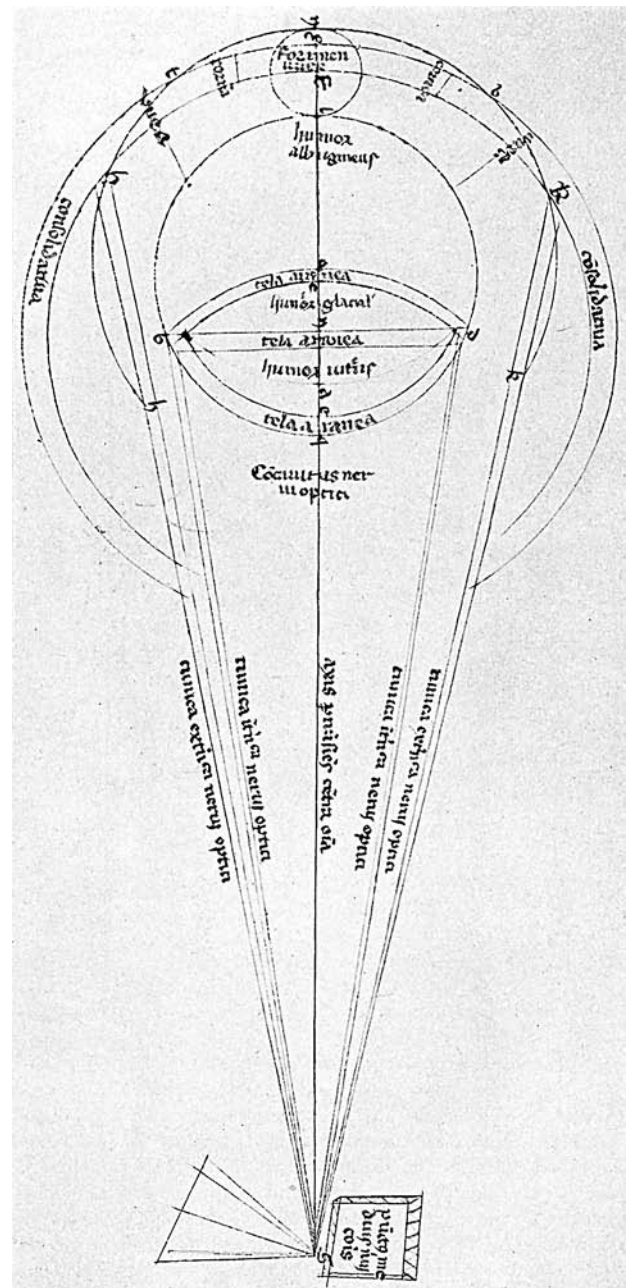


Fig. 13: Illustration of the human organ of vision after that in Witelo's (ca. 1230-ca. 1279) *Perspectiva*, Oxford, Bodleian Library, MS Ashmole 424.³⁷

³⁶ v. A. Bednarski, op. cit., p. 65; cf. S. L. Polyak, *The Retina*, op. cit., fig. 15.

³⁷ v. S. L. Polyak, *The Retina*, op. cit., fig. 16.

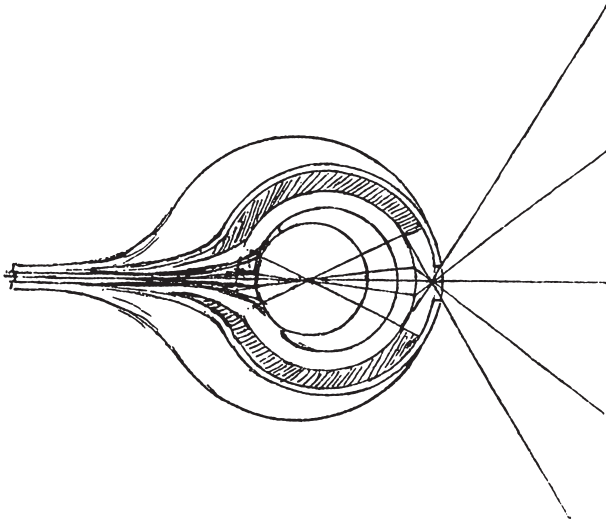


Fig. 14: Illustration of human vision after Leonardo da Vinci (1452 -1519), from *Codice Atlantico*, vol. 3, fol. 628.³⁸

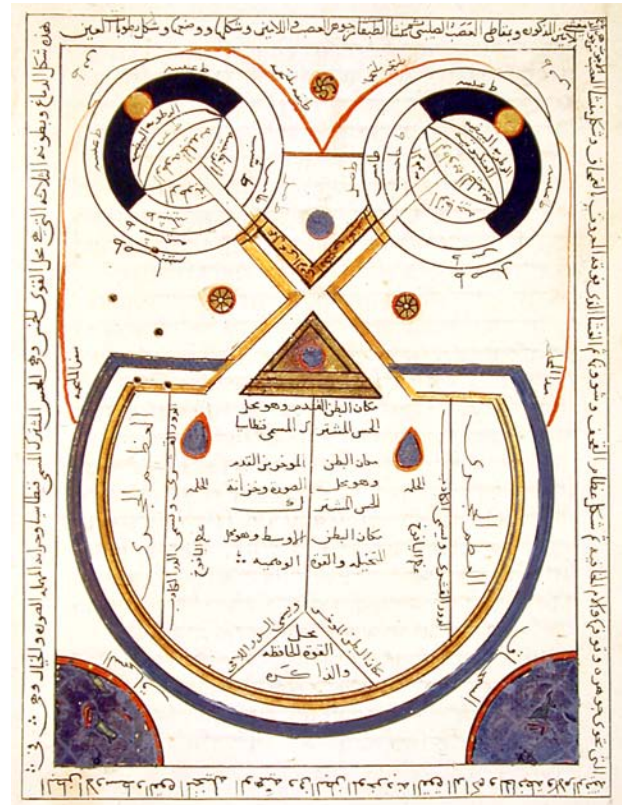


Fig. 15: Crossing of the optic nerves from the book on ophthalmology by Ḥalifa.³⁹

Julius Hirschberg, who copied and published this illustration⁴⁰ (see above, p. 5), after pointing out its deficiencies and merits,⁴¹ evaluates it in the following manner: «In any case we see in this venerable picture, which probably goes back to models at least from the time around 1000 A.D., a cautious attempt to represent what D. W. Soemmerring⁴² insightfully arranged in his classic illustration in 1827.»

³⁹ MS Istanbul, Süleymaniye Kütüphanesi, collection Yeni Cami No. 924, fol. 12a.

⁴⁰ 'Ammār b. 'Alī ..., op. cit., p. 34.

⁴¹ ibid, p. 164.

⁴² *De oculorum hominis animaliumque sectione horizontali commentatio*, Göttingen 1818, table 1; on this, v. S. Ry Andersen, Ole Munk and H. D. Scheepelers, *An Extract of Detmar Wilhelm Soemmerring's thesis: A Comment on the horizontal section of eyes in man and animals*, Copenhagen 1971.

³⁸ v. S. L. Polyak, *The Retina*, op. cit., fig. 24; K. Sudhoff, *Augenatomiebilder im 15. und 16. Jahrhundert*, op. cit., p. 26.

4.

Portraits of Famous Physicians



1. Dioscorides (2nd half of the 1st cent. B.C.), in a posture of teaching, from the Arabic translation of his *Materia Medica*, MS Istanbul, Topkapı Sarayı, collection Ahmet III, 2127 of 626/1229 (fol. 1b).¹



2. Dioscorides and a pupil, from the Arabic translation of his *Materia Medica*, MS Istanbul, Topkapı Sarayı, collection Ahmet III, 2127 of 626/1229 (fol. 2b).²

¹ v. Richard Ettinghausen, *Arabische Malerei*, Geneva 1962, p. 69.

² v. Richard Ettinghausen, *Arabische Malerei*, op. cit., p. 71.



3. Ishāq b. ‘Imrān, a physician from Baghdad, who died before 296/907 in Qairawān. In Schedel’s *World Chronicle*³ of 1493 he is portrayed as «the very famous physician Isaac benimiram» who, quite accurately, had «written of many things in medicine». His book on melancholy was plagiarized by Constantinus Africanus (see below).



4. An occidental portrait of Abū Bakr ar-Rāzī, Latinized Rhazes (physician, chemist and philosopher, d. 313/925), from the translation of his medical encyclopedia *al-Ḥāwī* (*Liber Continens*), printed frequently since 1486.⁴

³ Hartmann Schedel, *Buch der Cronicken*, Nuremberg 1493 (repr. under the title *Weltchronik*, ed. Stephan Füssel, Cologne, London etc. n.d.), folio 192 b.

It is remarkable that, on the one hand, this physician who is not well known in the West is at least mentioned by Schedel—who is otherwise not exactly receptive towards Islamic culture—, on the other hand, the same woodcut said to be his likeness, a few pages later is supposed to represent «Avicenna, a physician, the most famous of all doctors of medicine.» All the same, a detailed passage with praise for the latter is included there (folio 202).

⁴ v. Daniel M. Albert and Diane D. Edwards (eds.), *The History of Ophthalmology*, Cambridge MA 1996, p. 30.



5. Abū Bakr ar-Rāzī (Rhazes), after the portrayal in the Latin translation of his *Ḥāwī* in a manuscript of 1506.⁵



6. An occidental picture, dating probably from the 15th century, of Abu l-Qāsim az-Zahrāwī, Latinized Albucasis (4th/10th cent.). The chapter on surgery, which will be cited often below, of his *Kitāb at-Taṣrīf* had a deep influence on occidental medicine. The original of the picture is in the Biblioteca Apostolica Vaticana, MS Chigi F. VII. 158 (fol. 49a).⁶

⁵ v. *Europa und der Orient 800-1900* (exhibition catalogue), ed. G. Sievernich and H. Budde, Berlin 1989, p. 128.

⁶ v. Sami Kh. Hamarneh and Glenn Sonnedecker, *A Pharmaceutical View of Abulcasis al-Zahrāwī in Moorish Spain*, Leiden 1963, illustration after p. 22.



7. One more occidental picture of Abu l-Qāsim az-Zahrāwī (on the left in the picture). It is on the title page of *Liber Theoricae nec non Practicae*, the Latin translation of the first and second chapter of his *at-Taṣrif*, in the edition by Sigismund Grimm, Augsburg 1519.⁷



8. An occidental portrait of Abū 'Alī Ibn Sīnā (d. 428/1037), known in the Latin West as Avicenna. The portrait adorns the initial letter of the introduction to the Latin translation of his *al-Qānūn fi ṭ-ṭibb* (*Canon Medicinae*), Venice 1483.⁸



9. Ibn Sīnā (Avicenna), together with Hippocrates (d. 377 B.C.), Galen (2nd cent. A.D.) and Aetius (6th cent. A.D.), on the title page of the Latin translation of his *Qānūn* in the edition Venice 1608.⁹

⁷ v. S. Hamarneh, G. Sonnedeker, op. cit., ill. after p. 28.

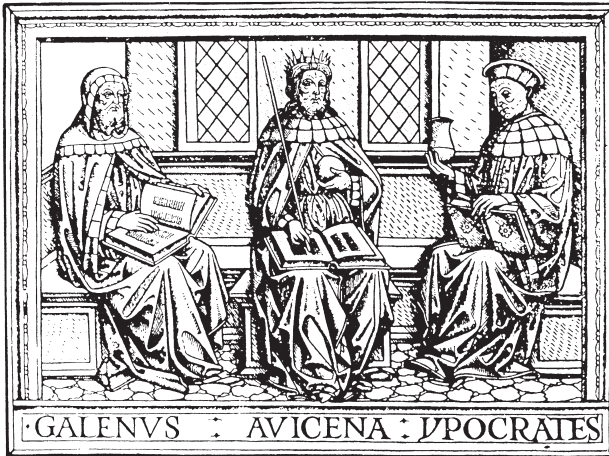
⁸ v. *Europa und der Orient 800-1900*, op. cit., p. 131.

⁹ v. H. Schipperges, *Arabische Medizin im lateinischen Mittelalter*, op. cit., p. 35.



10. Ibn Sīnā at the bed of a lovesick nephew of Qābūs
 b. Wušmgīr, a ruler from the Ziyāride dynasty in
 northern Persia, at whose court Ibn Sīnā spent some
 time. The illustration is to be found in the *Čahār*
maqāla by Nizāmī-i ‘Arūḍī, in a manuscript dating from
 835/1431 of the Museum for Turkish and Islamic Art in
 Istanbul¹⁰.

¹⁰ v. Arslan Terzioğlu, *Yeni araştırmalar ışığında büyük türk-islâm bilim adamı Ibn Sina (Avicenna) ve tababet*, İstanbul 1998, p. 97; *À l'ombre d'Avicenne. La médecine au temps des califes* (exhibition catalogue), Paris: IMA, 1996, p. 114.



11. Galen, Ibn Sīnā and Hippocrates as colleagues on the title page of the Latin translation of the *Qānūn* in the edition Pavia 1515.¹¹



12. Reading the Latin translation of Ibn Sīnā's *Qānūn*, from an illuminated parchment manuscript of the *Canon Medicinae* from the 15th century¹².



13. A scholar in Muslim dress, probably representing Ibn Sīnā (Avicenna), shown in the middle, standing out, quite literally, among the «three philosophers» in the thus entitled painting by the Italian painter Giorgione (d. 1510). The original of the picture hangs in the Kunsthistorisches Museum Vienna¹³.



14. Haly Abbas (ʿAlī b. al-ʿAbbās al-Mağūsī, d. ca. 400/1000) and Constantinus Africanus (d. 1087), together with Ysaac (Ishāq b. Sulaimān al-Isrāʾīlī, d. 320/932), the author of *Kitāb al-Ağdiya*. The illustration is taken from the title page of the Latin translation of his book, published in *Omnia opera ysaac*, Lyon 1515¹⁴.

¹¹ v. A. Terzioğlu, *Yeni araştırmalar ışığında...*, p. 84.

¹² v. *Europa und der Orient 800–1900*, p. 103.

¹³ v. A. Terzioğlu, *Yeni araştırmalar ışığında...*, p. 85.

¹⁴ v. H. Schipperges, *Arabische Medizin im lateinischen Mittelalter*, p. 170.



15. «Auenzoar a physician», illustration and reference in Schedel's World Chronicle (1493). The reference is to 'Abdalmalik Ibn Zuhr (d. 557/1162), who came to be known in the Occident as Auenzoar. Schedel also mentions his «Book of Medicine Theysir» that is *at-Taisir fi l-mudāwāt wa-t-tadbir*, which was translated into Latin¹⁵.

16. «Auerrois a physician and lover of wisdom», illustration and reference from Schedel's World Chronicle (1493). It is the versatile philosopher Muḥammad b. Aḥmad b. Muḥammad Ibn Ruṣd (d. 595/1198), Averroes of the Latins. Schedel has some historical and geographical knowledge about his life and achievements¹⁶.

¹⁵ Hartmann Schedel, *Buch der Cronicken*, fol. 202a.

¹⁶ Ibid., fol. 202a.

BLOODLETTING



Two Instruments

for Measuring the Quantity
of Blood after Bloodletting

In the third «category» of his *Kitāb al-Ġāmiʿ*, Ibn ar-Razzāz al-Ġazarī describes various instruments which function according to the principle that floating bodies transmit motion by rising up when a liquid enters a vessel and by causing a counterweight to sink down at the same time. The instrument described and illustrated here serves to measure the quantity of blood during bloodletting.¹ Al-Ġazarī's detailed description was already made accessible by Eilhard Wiedemann² through a German translation in 1918. An English translation was provided by Donald Hill³ when he translated the whole book (1974).

¹ Facs. editions, Ankara 1990, pp. 244-248; Frankfurt 2002, pp. 384-390.

² E. Wiedemann and Fritz Hauser: *Über Schalen, die beim Aderlaß verwendet werden, und Waschgefäße nach Gazarī*, in: *Archiv für Geschichte der Medizin* (Leipzig) 11/1918/22-43, esp. pp. 32-35 (reprint in: E. Wiedemann, *Gesammelte Schriften*, vol. 3, pp. 1607-1628, esp. pp. 1617-1620).



1. Our Model (on the left):
Figure: Pear tree wood, lacquered.
Column and measuring vessel of perspex,
partly lacquered.
Base plate of brass, gilded.
Round plate with engraving (a scale of 120 units)
and brass bowl, gilded.
Float and counterweight, inside brass.
Wooden table mahogany veneer (35 × 49 cm).
Aluminium feet and perspex cover.

2. Our Model (on the right):
Figures: Pear tree wood, lacquered.
Column and measuring vessel of perspex,
partly lacquered.
Float and counterweight, inside brass.
Total height: 53 cm.
(Inventory No. H 3.02)

³ *The Book of Knowledge of Ingenious Mechanical Devices*, pp. 137-139.

CAUTERISATION

Cauter
in the form of a fingernail
(*mikwāt mismārīya*)

From the *Kitāb at-Taṣrīf* of az-Zahrāwī¹
(4th/10th cent.).

Our model:
Brass and stainless steel.
Length: 118 mm.
(Inventory No. H 1.01)



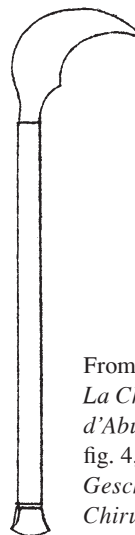
Kitāb at-Taṣrīf, facs.
ed., vol. 2,
p. 464.



Another
Cauter
in the form of a fingernail
(*mikwāt mismārīya*)

From the *Kitāb at-Taṣrīf* of az-Zahrāwī²
(4th/10th cent.).

Our model:
Brass and stainless steel.
Length: 129 mm.
(Inventory No. H 1.02).



From: Leclerc,
La Chirurgie
d'Abulcasis,
fig. 4, after Gurlt,
Geschichte der
Chirurgie.



¹ Abu l-Qāsim az-Zahrāwī, Ḥalaf b. 'Abbās, *at-Taṣrīf li-man 'ağīza 'an at-ta'līf*, facs. ed., Frankfurt 1986, vol. 2, p. 464; *La chirurgie d'Abulcasis... traduite par Lucien Leclerc*, Paris 1861 (reprint Frankfurt 1996, Islamic Medicine, vol. 36), p. 15, fig. no. 3; *Albucasis. On Surgery and Instruments. A Definitive Edition of the Arabic Text with English Translation and Commentary* by M.S. Spink and G.L. Lewis, London 1973, p. 25.

² Az-Zahrāwī, op. cit., vol. 2, p. 470; *La chirurgie d'Abulcasis*, p. 15, fig. no. 4; *Albucasis. On Surgery and Instruments*, p. 97.



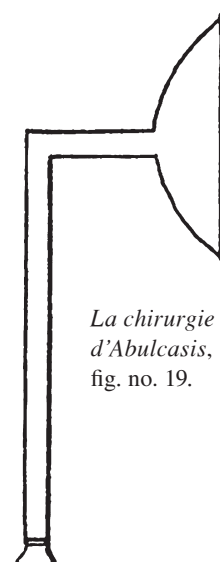
Instrument for cauterisation in the case of <cold liver> (*mikwāt fī kaiy al-kabid al-bārīda*)

Our model:
Brass and stainless steel.
Length: 113 mm.
(Inventory No. H 1.04)

from the *Kitāb at-Taṣrīf* by az-Zahrāwī.
Our model is based on the text and on the illustrations in one of the Paris manuscripts³ (v. fig. below) and in the manuscript Oxford, Bodleiana, Marsh⁴. The manuscripts also show the form of the track of the burn, from which it is apparent that the instrument ended in a flat tip, shaped like a lancet.

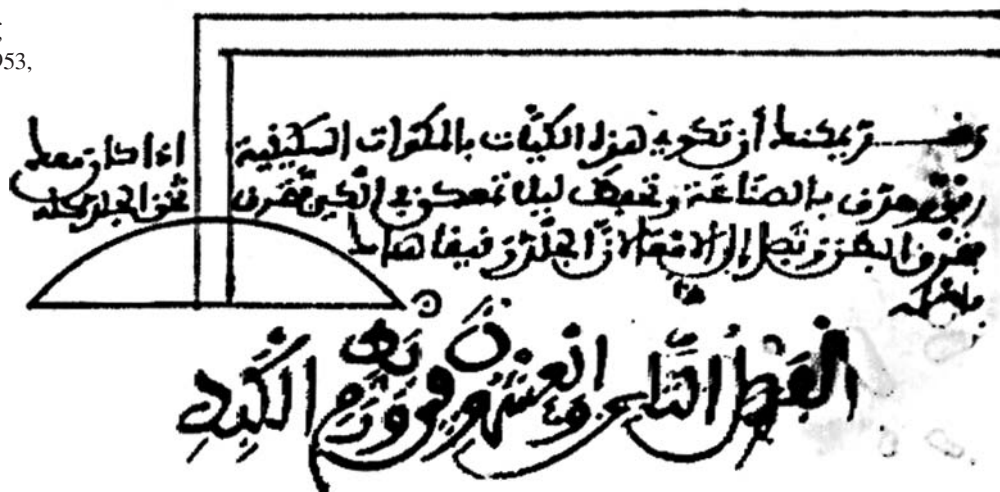


Fig from MS Marsh
after: Albucasis.
*On Surgery and
Instruments*, p. 87.



*La chirurgie
d'Abulcasis*,
fig. no. 19.

From: az-Zahrāwī, *Taṣrīf*,
MS Paris Bibl. nat., ar. 2953,
fol. 13.



³ *La chirurgie d'Abulcasis*, op. cit., pp. 32-33, fig. no. 19.

⁴ *Albucasis. On Surgery and Instruments*, op. cit., p. 87.

Cauter

for the treatment of the feet
and the thighs

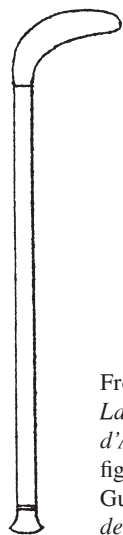
(*mikwāt fī kaiy al-qadamain
wa-s-sāqain*)

Our two models (a, b) reproduce the illustrations in
the manuscripts from Paris⁵ Istanbul⁶ and Oxford⁷
of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.).

Our models:

- a) Brass and stainless steel.
Length: 121 mm.
(Inventory No. H 1.06-1)

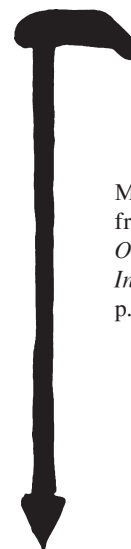
- b) Brass and stainless steel.
Length: 103 mm.
(Inventory No. H 1.06-2)



From: L. Leclerc,
*La chirurgie
d'Abulcasis*,
fig. 21; after
Gurlt, *Geschichte
der Chirurgie*.



At-Taṣrīf,
facsimile ed.,
vol. 2, p. 470.



MS Marsh,
from: *Albucasis.
On Surgery and
Instruments*,
p. 97.

⁵ L. Leclerc, *La chirurgie d'Abulcasis*, pp. 36–37, fig. no. 21;
E. Gurlt, *Geschichte der Chirurgie*, pl. IV, no. 21.

⁶ *At-Taṣrīf*, facsimile ed., vol. 2, p. 470.

⁷ *Albucasis. On Surgery and Instruments*, p. 97.

TREATMENTS OF THE HEAD AND THE FACE



«olive» Cauter

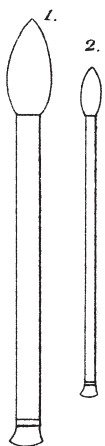
(*mikwāt zaitūniya*)

for a single cauterisation of the head

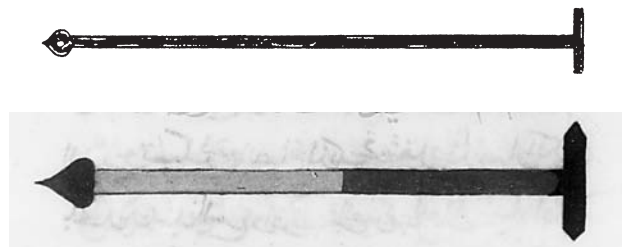
(*fī kaiy ar-ra's kaiyan wāḥidan*)

Our model:
Brass and stainless steel.
Length: 127 mm.
(Inventory No. H 1.03)

Kitāb at-Taṣrīf,
facsimile ed., vol. 2,



from the *Kitāb at-Taṣrīf* by az-Zahrāwī¹ (4th/10th cent.). Probably Leclerc (v. fig. below) allowed himself to be misled by the name of this important instrument and regarded the handle in the manuscripts available to him as the tip of the cauter. At the time of az-Zahrāwī, the real cauter (v. fig. on the right) probably had no likeness (any more) with an olive seed, which might have been decisive for the naming of the instrument that is known from Antiquity.



From: *Kitāb at-Taṣrīf*, MS İstanbul,
Ahmet III 1990 (8th/14th cent.), fol. 7b.

Leclerc, *La Chirurgie d'Abulcasis*, fig. 1 & 2;
after Gurlt, *Geschichte der Chirurgie*.

Our model:
Brass and stainless steel.
Length: 120 mm.
(Inventory No. H 1.07)



Another

Instrument for cauterisation
on the head, at the temples
and on the back of the skull

Constructed after an illustration from the *Kitāb at-Taṣrīf* by az-Zahrāwī as copied by L. Leclerc².



Albucasis.
On Surgery and Instruments,
p. 17 (MS Oxford,
Huntington 156).

¹ Az-Zahrāwī, op. cit., vol. 2, p. 463; *La chirurgie d'Abulcasis*, p. 12, fig. no. 1; cf. *Albucasis. On Surgery and Instruments*, p. 17.

Cauter

to be used in the case of
paralysis of the face
(*mikwāt al-laḡwa*)

Our model is based on a sketch drawn by L. Leclerc after an illustration in one of the Paris manuscripts of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.).³

Our model:
Brass and stainless steel.
Length: 120 mm.
(Inventory No. H 1.08)



L. Leclerc,
*La chirurgie
d'Abulcasis*,
fig. 6a.

Another

Cauter

to be used in the case of
paralysis of the face
(*mikwāt al-laḡwa*)

Our model reproduces an alternative sketch drawn by L. Leclerc after an illustration from one of the Paris manuscripts of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.).⁴

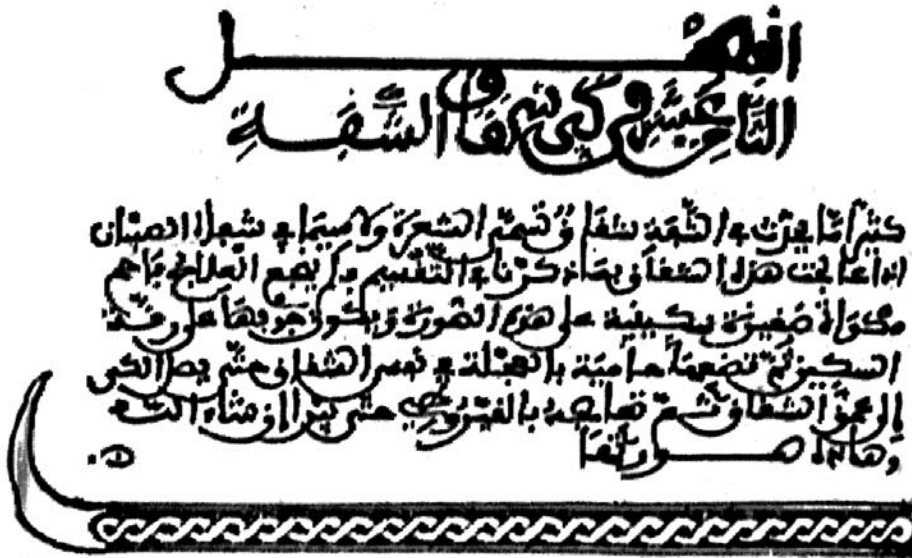
Our model:
Brass and stainless steel.
Length: 120 mm.
(Inventory No. H 1.09)



L. Leclerc,
*La chirurgie
d'Abulcasis*,
fig. 6.

³ *La chirurgie d'Abulcasis*, op. cit., pp. 17-18, fig. 6 bis; cf. MS İstanbul, Veliyeddin 2491, fol. 109a-b.

⁴ *La chirurgie d'Abulcasis*, op. cit., p. 17-18, fig. 6.



az-Zahrāwī, *Taṣrīf*,
MS Paris Bibl. nat.,
ar. 2953, fol. 10b.

Small

Cauter in the shape of a scalpel

for the treatment of fissures
on the lips

(*mikwāt ṣaḡīra sikkīniya*
li-kaiy šiqāq aš-šafa)

Our model was made after the illustration in a Paris
manuscript of the *Taṣrīf* by az-Zahrāwī (4th/10th
cent.) and its copy drawn by L. Leclerc⁵.

Our model:
Brass and stainless steel.
Length: 120 mm.
(Inventory No. H 1.10)



L. Leclerc,
La chirurgie
d'Abulcasis,
fig. 13.

⁵ *La chirurgie d'Abulcasis*, p. 27, fig. 13; E. Gurlt, *Geschichte der Chirurgie*, pl. IV, no. 13; cf. *Albucasis. On Surgery and Instruments*, p. 61.

TREATMENT OF THE EYES

Cauter

for the treatment of fistulas
in the tear gland

(*fī kaiy an-nāṣūr alladī*
fī maʿaq al-ʿain)

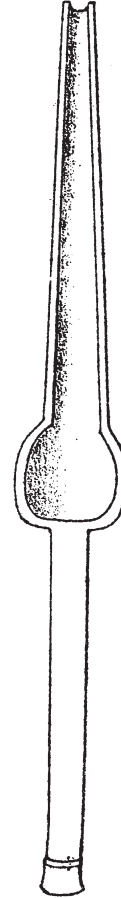
Our model was prepared according to the sketch drawn by L. Leclerc¹ after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.).

Our model:
Brass and stainless steel.
Length: 135 mm.
(Inventory No. H 2.01)

A second version of the same instrument was prepared after the illustration in manuscript Veliyeddin¹ (Istanbul).

Our model:
Brass and stainless steel.
Length: 132 mm.
(Inventory No. H 2.02)

La chirurgie
d'Abulcasis,
fig 11.



az-Zahrāwī, *Taṣrīf*,
MS Veliyeddin
no. 2491, fol. 112a.

az-Zahrāwī, *Taṣrīf*,
MS Paris Bibl. nat.,
ar. 2953, fol. 10b.

¹ *La chirurgie d'Abulcasis*, op. cit., pp. 25–26, fig. no. 11.

² *At-Taṣrīf*, MS Veliyeddin no. 2491, fol. 112a, cf. *Abulcasis. On Surgery and Instruments*, p. 57.

Cauter for the tear gland fistula (*mikwāt al-ġarab*)

»This is used to cauterise the tear gland fistula after its rupture» (Ḥalīfa al-Ḥalabī).
Our model was made after the illustration in the *al-Kāfi fī l-kuḥl*³ by Ḥalīfa b. Abi l-Maḥāsīn al-Ḥalabī⁴ (written before 674/1275) and after the sketch by J. Hirschberg.⁵



Drawing by
Hirschberg, p. 167,
No. 21.

Our model:
Brass and stainless steel.
Length: 113 mm.
(Inventory No. H 2.04)



Ḥalīfa, *al-Kāfi*, MS Yeni Cami
no. 924, fol. 95 b.

Cleaner for the tear gland fistula (*miḥsaf al-ġarab*)

«This is used to clean the entire corner of the eye – for those who do not like cauterisation near the fistula» (Ḥalīfa). (Ḥalīfa).
Our model was made after the illustration in the Paris⁶ manuscript of the *Kitāb al-Kāfi fī l-kuḥl* by Ḥalīfa al-Ḥalabī⁷.

Our model:
Stainless steel and wood.
Length: 122 mm.
(Inventory No. H 2.05)



MS Ḥalīfa, Paris Bibliothèque
nationale, ar. 2999, fol. 43 a.

³ MS Süleymaniye Kütüphanesi (İstanbul), collection Yeni Cami no. 924, fol. 95 b.

⁴ v. C. Brockelmann, *Geschichte der arabischen Litteratur*, suppl. vol. 1, p. 899.

⁵ 'Ammār b. 'Alī al-Maṣṣilī: *Das Buch der Auswahl von den Augenkrankheiten*. Ḥalīfa al-Ḥalabī: *Das Buch vom Genügen in der Augenheilkunde*. Ṣalāḥ ad-Dīn: *Licht der Augen*. Aus arabischen Handschriften übersetzt und erläutert von J. Hirschberg, J. Lippert and E. Mittwoch, Leipzig 1905 (repr. in: *Islamic Medicine*, vol. 45), p. 167, fig. no. 21, v. also p. 169.

⁶ Bibliothèque nationale, ar. 2999, fol. 43 a.

⁷ v. 'Ammār b. 'Alī..., p. 167, fig. no. 23, v. also p. 169.

Cataract needle

(*miqdaḥ*)

Constructed after the illustration in the *Taṣrīf* by az-Zahrāwī (4th/10th cent.)⁸.

Our model:
Brass and stainless steel.
Length: 122 mm.
(Inventory No. H 2.13)

az-Zahrāwī,
at-Taṣrīf,
facsimile ed.,
vol. 2, p. 488.

Cataract needle

(*barīd*)

Our model reproduces the sketch drawn by L. Leclerc⁹ after an illustration in the Paris manuscripts of az-Zahrāwī's book (4th/10th cent.).

Our model:
Brass and stainless steel.
Length: 130 mm.
(Inventory No. H 2.12)



Leclerc, *La chirurgie d'Abulcasis*, fig. no. 50.

⁸ *At-Taṣrīf*, facsimile ed., vol. 2, p. 488; Leclerc, *La chirurgie d'Abulcasis*, p. 92–93, fig. no. 51 et 52.

⁹ *La chirurgie d'Abulcasis*, p. 92, fig. no. 50; cf. 'Ammār b. 'Alī..., p. 173.

Spear

(*harba*)

«This one cleaves the sebaceous cyst and reaches under it and cuts it off. It is made dispensable by the myrtle leaf (*āsa*, see below),» says Ḥalīfa in his *al-Kāfī*¹⁰ (written before 674/1275). Our model was made after the illustration in Ḥalīfa's *al-Kāfī*.

Our model:
Brass and stainless steel.
Length: 121 mm.
(Inventory No. H 2.17)



Ḥalīfa, *al-Kāfī*, MS
Yeni Cami no. 924,
fol. 95b.

Rose leaf

(*warda*)

«For cutting off the mulberry (tumour) of the lid, also used for cutting off the sebaceous cyst and for some other operations» (Ḥalīfa).

Our model was prepared after the illustrations in the two manuscripts of the *Kitāb al-Kāfī* by Ḥalīfa (written before 674/1275) and the sketch by J. Hirschberg.¹¹

Our model:
Brass and stainless steel.
Length: 111 mm.
(Inventory No. H 2.18)



Ḥalīfa, *al-Kāfī*, MS
Yeni Cami no. 924,
fol. 95b.

¹⁰ MS Paris Bibliothèque nationale, ar. 2999, fol. 42b; İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95b; 'Ammār b. 'Alī, op. cit., p. 166, fig. no. 9, là-dessus p. 166.

¹¹ MS Paris Bibliothèque nationale, ar. 2999, fol. 42b; MS İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95b; 'Ammār b. 'Alī, op. cit., pp. 165–168 passim, fig. no. 7.



Our model:
Brass and stainless steel.
Length: 126 mm.
(Inventory No. H 2.07)

Crescent-shaped Cauter

(*mikwāt hilālīya*)



az-Zahrāwī, *Kitāb at-Taṣrīf*,
facsimile ed., vol. 2, p. 466.

It is used when the eyelids become limp. Our model reproduces the illustration in the Istanbul manuscript (Beşirağa) of az-Zahrāwī's book¹² (4th/10th cent.), chapter 15.

Scissors (*miqaṣṣ*) for the eyelids

A pair of scissors «with broad blades. Their length is set according to how much is cut off from the eyelid» (Ḥalifa).

Our model is based on the illustration in the *Kitāb al-Kāfī* by Ḥalifa al-Ḥalabī (written before 674/1275) in the manuscript *Yeni Cami*¹³ and the sketch by J. Hirschberg¹⁴.

Notre modèle:



Ḥalifa, *al-Kāfī*, MS Yeni Cami
no. 924, fol. 95a.



Ḥalifa, *al-Kāfī*, MS
Bibliothèque nationale,
ar. 2999, fol. 42b.



Our model:
Stainless steel,
polished.
Length: 119 mm.
(Inventory No. H
2.08)

¹² *at-Taṣrīf*, facsimile ed., vol. 2, p. 466; Leclerc, *La chirurgie d'Abulcasis*, op. cit., p. 23, fig. no. 9.

¹³ İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95a.

¹⁴ *ʿAmmār b. ʿAlī*, op. cit., p. 165, 166, fig. no. 1.

Myrtle leaf

(*āsa*)

«This is used to lift and skin the pterygium, while scissors are used for cutting it off. Adhesions of the eyelids can also be cleaved with it.» (Ḥalifa).

Our model was constructed after the illustrations in the manuscripts of the *Kitāb al-Kāfī* by Ḥalifa al-Ḥalabī (written before 674/1275) and the sketch by J. Hirschberg¹⁵.

Our model:
Brass and stainless steel.
Length: 110 mm.
(Inventory No. H 2.10))



Ḥalifa, *al-Kāfī*, MS
Yeni Cami no. 924,
fol. 95b.

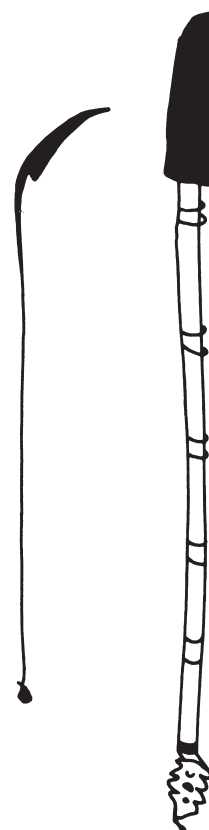
Scalpel

for cutting off the pterygium
and for removing adhesions in the
inner corner of the eye

(*mibḍa' li-qaṭ' az-ẓafra*
wa-nutūw laḥm al-āmāq)

Our model reproduces the sketch drawn by L. Leclerc¹⁶ after the Paris manuscripts of az-Zahrāwī's (4th/10th cent.) book. The three additional illustrations shown here are from manuscripts Beṣīraḡa¹⁷ in Istanbul, besides Marsh and Huntington in Oxford¹⁸.

Our model:
Brass and stainless steel.
Length: 141 mm.
(Inventory No. H 2.06)



Kitāb at-Taṣrīf, facsimile ed.,
vol. 2, p. 485.

Albucasis. *On Surgery and Instruments*, p. 231,
MS Hunt. (on the left),
MS Marsh (on the right).

¹⁵ MS Paris Bibliothèque nationale, ar. 2999, fol. 42b; MS İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95b; 'Ammār b. 'Alī, op. cit., p. 166, fig. no. 10, v. also p. 168.

¹⁶ *La chirurgie d'Abulcasis*, op. cit., pp. 82-83, fig. no. 43.

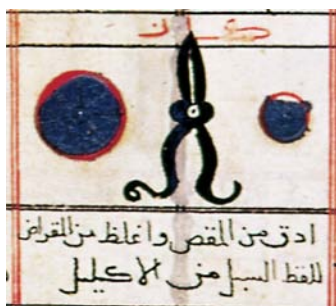
¹⁷ No. 502, v. facsimile ed., vol. 2, p. 485.

¹⁸ Bodleian Library, Huntington 156 and Marsh 55; cf. Albucasis. *On Surgery and Instruments*, op. cit., p. 231.

Scissors (*kāz*)

One of the scissors used in ophthalmology; «for gathering (cutting off) the pterygium of the cornea circumference,» according to Ḥalīfa (before 674/1275). It is said to be thinner than the *miqaṣṣ* and thicker than the scissors called *miqrāḍ* (see below).

Our model was made after the illustration in the manuscripts of the *Kitāb al-Kāfī* and the sketch by Hirschberg¹⁹.



Ḥalīfa, *al-Kāfī*,
MS Yeni Cami
no. 924, fol. 95a

Our model:
Stainless steel, riveted.
Length: 110 mm.
(Inventory No. H 2.14)



Scissors (*miqrāḍ*)

Another pair of scissors used in ophthalmology. It is «thinner than the *miqaṣṣ*» and «is used for cutting off the membrane (*sabal*) of the conjunctiva.»

Our model was prepared after the illustration in the manuscripts of the *Kitāb al-Kāfī* by Ḥalīfa al-Ḥalabī (before 674/1275) and the sketch by J. Hirschberg.²⁰



MS Yeni Cami 924,
fol. 95a.

Our model:
Stainless steel, riveted.
Length: 132 mm.
(Inventory No. H 2.15)



¹⁹ MS Paris Bibliothèque nationale, ar. 2999, fol. 42b; MS İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95a; *‘Ammār b. ‘Alī*..., p. 165, 166, fig. no. 3.

²⁰ MS Paris Bibliothèque nationale, ar. 2999, fol. 42b; MS Yeni Cami 924, fol. 95a; *‘Ammār b. ‘Alī*, op. cit., p. 165, 166, fig. no. 2.

Lancet

(*mibḍaʿ*)

The lancet «with a round top» (*mudauwar ar-raʿs*) is used, according to Ḥalifa, «for eradication of a blister (*širnāq*). The chalazion and the like are also cleaved with it.»

Our model was prepared after the illustration in the manuscripts of the *Kitāb al-Kāfī* by Ḥalifa al-Ḥalabī (before 674/1275) and the sketch by J. Hirschberg²¹.



MS Ḥalifa,
Bibliothèque nationale,
ar. 2999, fol. 42b.

Our model:
Brass and stainless steel.
Length: 128 mm.
(Inventory No. H 2.19)



Ḥalifa, *al-Kāfī*,
MS Yeni Cami no.
924, fol. 95b.

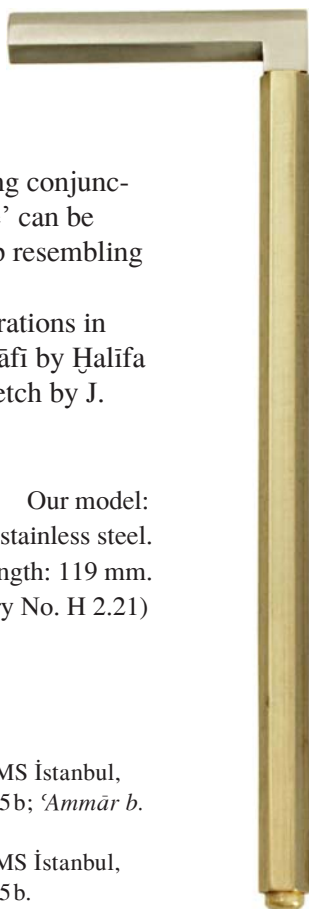
Scraper

(*miğrad*)

«For scratching scabies and for removing conjunctival concretions. For that the ‘half rose’ can be used,» which is an instrument with a tip resembling half a «rose leaf» (above).

Our model was prepared after the illustrations in the two manuscripts²² of the *Kitāb al-Kāfī* by Ḥalifa al-Ḥalabī (before 674/1275) and the sketch by J. Hirschberg²³.

Our model:
Brass and stainless steel.
Length: 119 mm.
(Inventory No. H 2.21)



Ḥalifa, *al-Kāfī*,
MS Yeni Cami no.
924, fol. 95b.

²¹ MS Paris Bibl. nationale, ar. 2999, fol. 42b; MS İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95b; ‘*Ammār b. ‘Alī*, op. cit., p. 166, fig. no. 15, v. also p. 168.

²² MS Paris Bibl. nationale, ar. 2999, fol. 42b; MS İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95b.

²³ ‘*Ammār b. ‘Alī*, op. cit., p. 166, fig. no. 14, v. also p. 168.

Axe (*ṭabar*)

A knife for bloodletting in the case of eye diseases, in particular «for opening the vein in the forehead (*li-faṣd al-ḡabha*): it is placed lengthwise on the vein (*yuda'u 'ala l-irq ṭulan*) and the severing is done with the middle finger of the right hand (*wa-yuṭqabu bi-l-wuṣṭā min al-yad al-yumnā*).»²⁴ Our model was prepared according to the sketch by J. Hirschberg, which he drew after the Paris manuscript²⁵ of the *Kitāb al-Kāfi* by Ḥalifa (before 674/1275).



Hirschberg,
'*Ammār b. 'Alī*...,
p. 166, fig. no. 11.

Our model:
Brass and stainless steel.
Length: 119 mm.
(Inventory No. H 2.22)

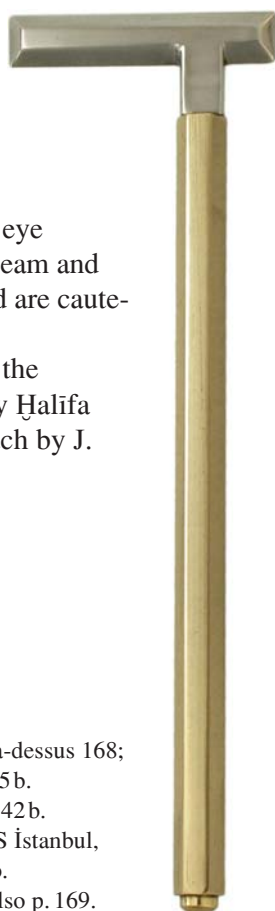


Ḥalifa, *al-Kāfi*, MS
Paris Bibl. nat., ar.
2999, fol. 42b.

Cauter for the vertex of the head (*mikwāt al-yāfūḥ*)

A branding iron used for the treatment of eye diseases. According to Ḥalifa «the head seam and the two veins on the two sides of the head are cauterised with this.»

Our model is based on the illustration in the two manuscripts²⁶ of the *Kitāb al-Kāfi* by Ḥalifa al-Ḥalabī (before 674/1275) and the sketch by J. Hirschberg²⁷.



Our model:
Brass and stainless steel.
Length: 120 mm.
(Inventory No. H 2.23)



Ḥalifa, *al-Kāfi*, MS
Yeni Cami no. 924,
fol. 95b.



Ḥalifa, *al-Kāfi*,
MS Paris Bibl. nat.,
ar. 2999, fol. 43.

²⁴ 'Ammār b. 'Alī, op. cit., p. 166, fig. no. 11, v. là-dessus 168; MS İstanbul, Süleymaniye, Yeni Cami 924, fol. 95b.

²⁵ MS Paris Bibliothèque nationale, ar. 2999, fol. 42b.

²⁶ MS Paris Bibl. nationale, ar. 2999, fol. 42b; MS İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95b.

²⁷ 'Ammār b. 'Alī, op. cit., p. 167, fig. no. 19, v. also p. 169.

Cauter

(*mikwāt*)

for cauterising the roots of the hair on the eyelid, when eyelashes grow into the eye (*fī kaiy ḡafn al-‘ain ida nqalabat aš‘āruhā ilā dāḥil al-‘ain*).

Our model was constructed according to the sketch by L. Leclerc²⁸, which he drew after the illustrations in the Paris manuscripts of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.). It differs slightly from the illustration in the facsimile of the Istanbul manuscript (Beşirağā)²⁹.

For an instrument with the same function, see the following.

Our model:
Brass and stainless steel.
Length: 113 mm.
(Inventory No. H 2.03)



az-Zahrāwī,
at-Taṣrīf,
facsimile ed.,
vol. 2, p. 467.

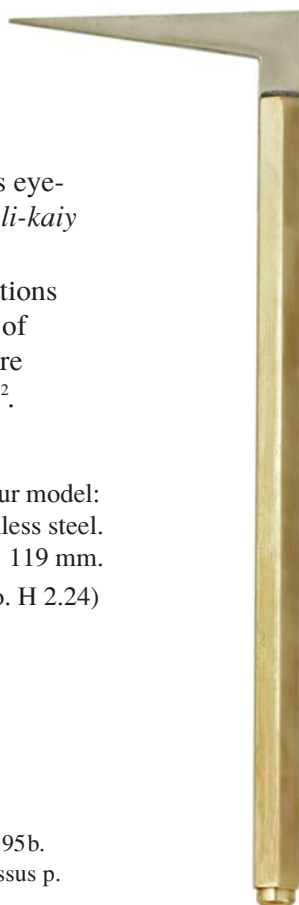
Cauter

(*mikwāt*)

«For cauterising the locations of superfluous eyelashes after the same have been pulled out (*li-kaiy mawāḍi‘ aš-ša‘r az-zā‘id ba‘d natfihī*).»

Our model was developed from the illustrations of the manuscripts in Paris³⁰ and Istanbul³¹ of the *Kitāb al-Kāfī* by Ḥalīfa al-Ḥalabī (before 674/1275) and the sketch by J. Hirschberg³².

Our model:
Brass and stainless steel.
Length: 119 mm.
(Inventory No. H 2.24)



Ḥalīfa, *al-Kāfī*, MS Yeni
Cami no. 924, fol. 95b.

²⁸ *La chirurgie d'Abulcasis*, p. 23*24 and fig. no. 10.

²⁹ *At-Taṣrīf*, facsimile ed. vol. 2, p. 467.

³⁰ Bibliothèque nationale, ar. 2999, fol. 43a.

³¹ Süleymaniye-Bibl., collection Yeni Cami 924, fol. 95b.

³² *‘Ammār b. ‘Alī*, op. cit., p. 167, fig. no. 22, v. là-dessus p. 169.

Sickle (*mingāl*)

«For separating adhesions between the two lids.

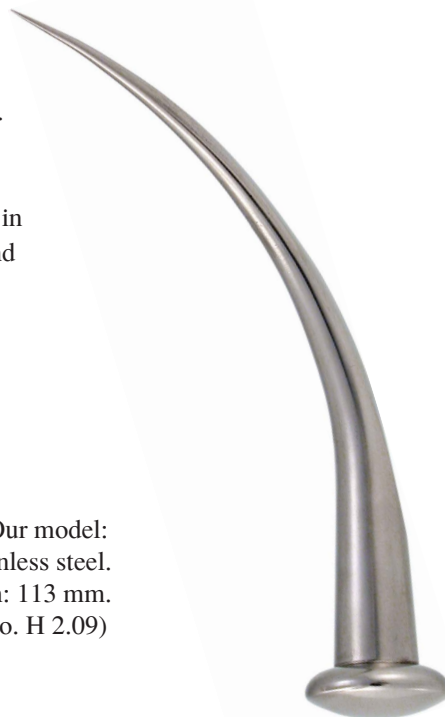
It is also used in the case of hare-eye (*šitra*)» (Ḥalifa).

Our model was developed from the illustration in the ³³ by Ḥalifa al-Ḥalabī (before 674/1275) and the sketch by J. Hirschberg³⁴.



Ḥalifa,
al-Kāfī,
MS Paris
Bibl. nat.,
ar. 2999, fol.
42b.

Our model:
Stainless steel.
Length: 113 mm.
(Inventory No. H 2.09)



Ḥalifa, *al-Kāfī*, MS
Yeni Cami no. 924,
fol. 95b.

Raven's Beak

(Arabic *šaft*, Persian *ğaft*, «courbé»)

«For removing whatever sticks to the eye or the inner side of the lid» (Ḥalifa).

Our model was developed from the illustration in the *Kitāb al-Kāfī*³⁵ by Ḥalifa al-Ḥalabī (before 674/1275) and the sketch by J. Hirschberg³⁶.



Ḥalifa,
al-Kāfī,
MS Paris
Bibl. nat.,
ar. 2999,
fol. 43.

Our model:
Stainless steel.
Length: 120 mm.
(Inventory No. H 2.11)



Ḥalifa, *al-Kāfī*, MS
Yeni Cami no. 924,
fol. 96.

³³ MS Paris Bibliothèque nationale, ar. 2999, fol. 42b; MS İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 95b.

³⁴ *‘Ammār b. ‘Alī*, op. cit., p. 167, fig. no. 16, v. also p. 168.

³⁵ MS Bibl. nat., ar. 2999, fol. 43a; MS Yeni Cami 924, fol. 96a.

³⁶ *‘Ammār b. ‘Alī*, op. cit., p. 167, fig. no. 24, v. also p. 169.

Awn-tongs

(*kalbatān nuṣūlīya*)

«It is used when an awn or a similar object falls into the eye» (Ḥalifa).

Our model was developed from the illustration in the two manuscripts of the *Kitāb al-Kāfī*³⁷ by Ḥalifa al-Ḥalabī (before 674/1275) and the sketch by J. Hirschberg³⁸.



Ḥalifa, *al-Kāfī*, MS
Paris Bibl. nat., ar.
2999, fol. 43 a.

Our model:
Stainless steel, riveted.
Length: 122 mm.
(Inventory No. H 2.20)



Ḥalifa, *al-Kāfī*, MS Yeni
Cami no. 924, fol. 96a.

Gatherer (*milqaṭ*)

«This is used to gather (pluck) superfluous hair. It also pulls out any ‘foreign body’ that has fallen into the eye» (Ḥalifa). Our model was developed from the illustration in the Paris manuscript³⁹ of the *Kitāb al-Kāfī* by Ḥalifa al-Ḥalabī (before 674/1275), which deviates in the depiction of the handle mechanism from that in the Istanbul manuscript.⁴⁰ J. Hirschberg⁴¹ follows the Paris manuscript in his sketch.



Ḥalifa, *al-Kāfī*, MS
Paris Bibl. nat., ar.
2999, fol. 42b.

Our model:
Stainless steel, polished.
Length: 121 mm.
(Inventory No. H 2.16)



Ḥalifa, *al-Kāfī*, MS Yeni
Cami no. 924, fol. 95b.

³⁷ MS Paris Bibliothèque nationale, ar. 2999, fol. 43a; MS İstanbul, Süleymaniye, collection Yeni Cami 924, fol. 96a.

³⁸ ‘Ammār b. ‘Alī, op. cit., p. 167, fig. no. 35, v. also p. 170.

³⁹ Bibliothèque nationale, ar. 2999, fol. 42b.

⁴⁰ Süleymaniye Kütüphanesi, coll. Yeni Cami 924, fol. 95b.

⁴¹ ‘Ammār b. ‘Alī, op. cit., p. 166, fig. no. 18, v. also p. 168.

TREATMENT OF THE EARS, NOSE, AND RESPIRATORY PASSAGES

Cauter

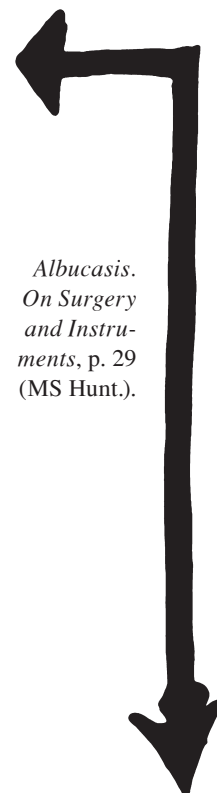
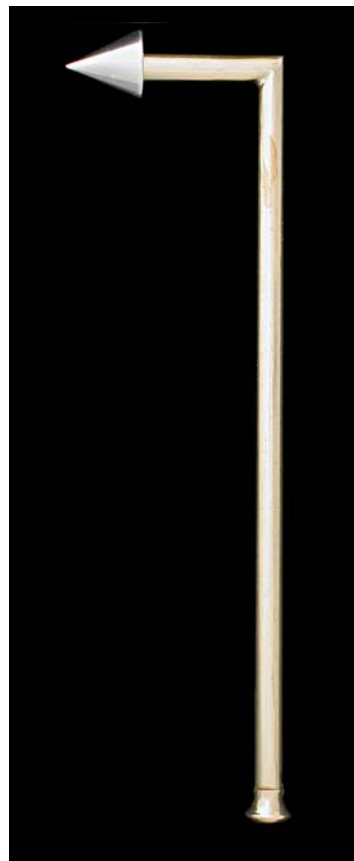
called ‹point›

(*al-mikwāt allatī tusammā an-nuqṭa*)

It serves the treatment of earache by cauterising various points on the auricle

This instrument is depicted in two versions, one pointed and the other blunt. We have designed the pointed form after the illustrations in manuscript Huntington (Oxford)¹ and one of the Paris manuscripts² of az-Zahrāwī's (4th/10th cent.) book.

Our model:
Brass and stainless steel.
Length: 108 mm.
(Inventory No. H 4.08))



*Albucasis.
On Surgery
and Instru-
ments, p. 29
(MS Hunt.).*

Cauter

called ‹point›

(*al-mikwāt allatī tusammā an-nuqṭa*)

It serves the treatment of earache.

The second, blunt version of this instrument was fashioned after the illustration in manuscript Marsh (Oxford),³ one of the Paris manuscripts⁴ and the facsimile edition⁵ of az-Zahrāwī's (4th/10th cent.).

Our models:
Brass and stainless steel.
Length: 119 mm each.
(Inventory No. H 4.07 and H 4.01)



Kitāb at-Taṣrīf,
facsimile ed.,
vol. 2, p. 467.

*Albucasis. On
Surgery and
Instruments, p.
29 (MS Marsh).*

¹ *Albucasis. On Surgery and Instruments*, p. 29.

² *La chirurgie d'Abulcasis*, pp. 16–17, fig. 5.

³ *Albucasis. On Surgery and Instruments*, p. 29.

⁴ *La chirurgie d'Abulcasis*, pp. 16–17, fig. 5 bis; cf. E. Gurlt, *Geschichte der Chirurgie und ihrer Ausübung*, vol. 1, Berlin 1898 (reprint Hildesheim 1964), p. 648.

⁵ *At-Taṣrīf*, vol. 2, p. 464.

A fine Scalpel

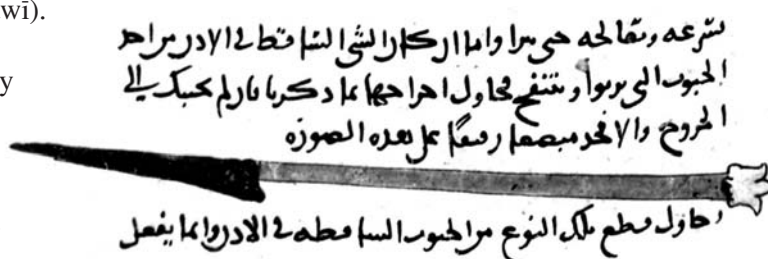
(*mibḍaʿ raqīq*)



Our model:
Brass and stainless steel.
Length: 121 mm.
(Inventory No. H 4.09)

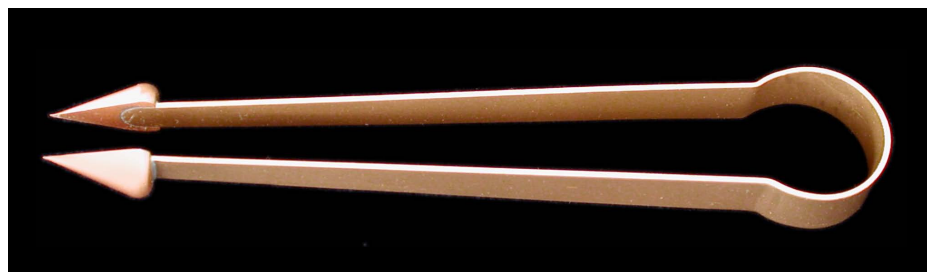
It serves «to disintegrate corns or seeds that have fallen into the ear (*qaṭʿ al-ḥubūb as-sāqiṭa fī l-uḍn*) and have swollen up due to the moisture inside the ear (*qad taraṭṭabat bi-buḥār al-uḍn*)» (az-Zahrāwī). Our model is constructed after the illustrations in the Paris manuscripts of the *Kitāb at-Taṣrif* by az-Zahrāwī (4th/10th cent.) in the reproduction by L. Leclerc,⁶ which correspond with the illustrations in one of the two Oxford manuscripts⁷ and in MS Veliyeddin⁸ at Istanbul.

az-Zahrāwī, *Taṣrif*, MS
Veliyeddin no. 2491, fol. 128a.

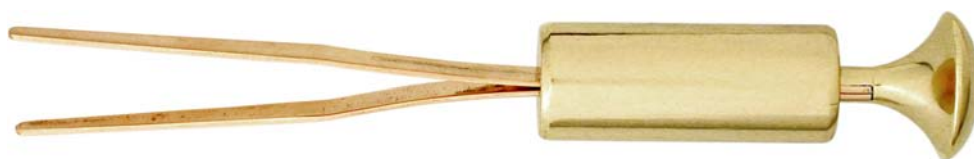


Tweezers (*ḡift*)

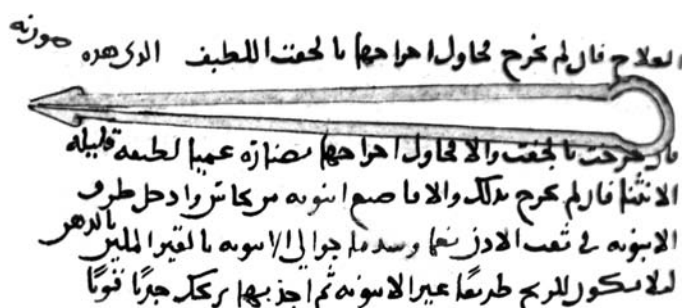
Our model (a):
Copper.
Length: 118 mm.
(Inventory No. H 4.02a)



Our model (b):
Brass.
Length: 130 mm.
(Inventory No. H 4.02b)



for removing foreign bodies from the auditory canal. Our model was constructed after the illustrations in the two Oxford manuscripts⁹ of the *Taṣrif* by az-Zahrāwī (4th/10th cent.) and after the illustration in MS Veliyeddin¹⁰ in Istanbul.



az-Zahrāwī, *Taṣrif*, MS
Veliyeddin no. 2491, fol. 112a.

⁶ *La chirurgie d'Abulcasis*, p. 69, fig. no. 36; E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 649, no. 33.

⁷ Bodleian, Marsh 54, v. *Abulcasis. On Surgery and Instruments*, p. 195.

⁸ No. 2491, fol. 128a.

⁹ Bodleian, Marsh 54, v. *Abulcasis. On Surgery and Instruments*, p. 195.

¹⁰ No. 2491, fol. 128a.



az-Zahrāwī, *Taṣrīf*, MS Paris
Bibl. nat. ar. 2953, fol. 8b.

*Kitāb at-
Taṣrīf*, facsi-
mile ed.,
vol. 2, p. 466.

Cauter (*mikwāt*)

to be used in the case of nasal putrefaction (*natn al-anf*). Our model reproduces the illustration of one of the Paris manuscripts of az-Zahrāwī's (4th/10th cent.) book¹¹ (see above). The depiction of how to use it in the Turkish version by Šerefeddīn (see below) corresponds to the instruction given in the text; according to that, the nose itself is not cauterised, but cauterisation is done twice between the eyebrows and the hairline with an instrument «shaped like a nail» or «shaped like a pin».

Our model:
Brass and stainless steel.
Length: 118 mm.
(Inventory No. H 4.03)



¹¹ *At-Taṣrīf*, MS Paris Bibl. nat., ar. 2953, fol. 8b, cf. facsimile ed., vol. 2, p. 466; MS İstanbul, Bibl. de Beyazıt, collection Veliyeddin no. 2491, fol. 111a; Leclerc, *La chirurgie d'Abulcasis*, pp. 22–23, fig. no. 8.

Illustration from the Turkish version of the *Taṣrīf* de Šerefeddīn, MS İstanbul, Millet, Ali Emiri no. 79, fol. 24b.



Kitāb at-Taṣrīf, facsimile ed., vol. 2, p. 493.

«Scissor-like Instrument»

(*āla tušbihu l-miqaṣṣ*)

«for removing tonsils and other tumours of the pharynx.»

(*li-qaṭ' waram al-lauzatain wa-mā yanbutu fi l-ḥalq min sā'ir al-aurām*).

Our model:
Stainless steel, riveted.
Length: 168 mm.
(Inventory No. H 4.05)



Our model is based on the sketch drawn by L. Leclerc¹² after the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.) and on the illustration in the manuscript Beṣirağa¹³.



Scalpel (*mibḍa'*) for removing tonsils (tonsillectomy)

To be used as an alternative to the previous instrument.

Our model is based on the description of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.), on the sketch by Leclerc,¹⁴ as well as the depiction in the facsimile edition¹⁵ of the manuscript Beṣirağa (İstanbul).

Our model:
Brass and stainless steel.
Length: 130 mm.
(Inventory No. H 4.04)

Kitāb at-Taṣrīf,
facsimile ed.,
vol. 2, p. 493.

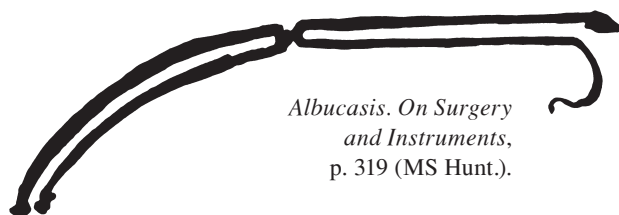


¹² *La chirurgie d'Abulcasis*, p. 106, fig. no. 67.

¹³ Facsimile ed., vol. 2, p. 493; v. also *Abulcasis. On Surgery and Instruments*, p. 303.

¹⁴ *La chirurgie d'Abulcasis*, p. 106, fig. no. 68; v. also *Abulcasis. On Surgery and Instruments*, p. 303.

¹⁵ *At-Taṣrīf*, vol. 2, p. 493.



*Albucasis. On Surgery
and Instruments,
p. 319 (MS Hunt.).*

«Instrument shaped like a hook

(*āla tušbiḥu l-kalālīb*)

A pair of tongs «for the extraction of foreign bodies from the pharyngeal cavity» (*fī iḥrāğ al-ʿalaq an-nāšib fi l-ḥalaq*).

Of our two models, (a) was made according to the sketch drawn by L. Leclerc¹⁶ after the diagram of the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th century), and after the illustration in the MS Huntington at Oxford¹⁷.

Model (b) was developed after the variant depictions in the Istanbul manuscripts at Beşirağa¹⁸ and Veliyeddin¹⁹ as well as Marsh²⁰ in Oxford.

K. Sudhoff established as early as in 1918 that the illustrations of this pair of tongs differ considerably also in the manuscripts of the Latin translation of az-Zahrāwī's book²¹.

Our model (a):
Stainless steel, riveted.
Length: 320 mm.
(Inventory No. H 4.13)



¹⁶ *La chirurgie d'Abulcasis*, pp. 112–113, fig. no. 72.

¹⁷ *Albucasis. On Surgery and Instruments*, p. 319.

¹⁸ No. 502, v. *at-Taṣrīf*, vol. 2, p. 495.

¹⁹ No. 2491, fol. 145a.

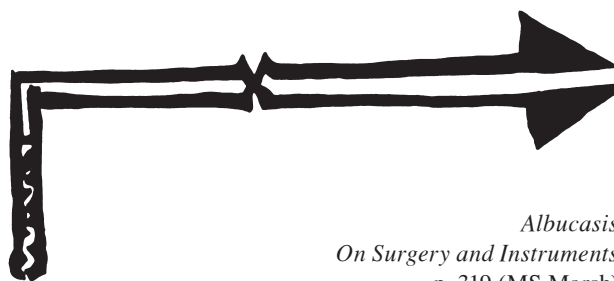
²⁰ *Albucasis. On Surgery and Instruments*, p. 319.

²¹ K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, Leipzig 1918, pp. 30–31 (reprint in: *Islamic Medicine*, vol. 37, pp. 180–181).



(Inventaire no. H 4.13)

Our model (b):
Stainless steel, riveted.
Length: 273 mm.
(Inventory No. H 4.14)



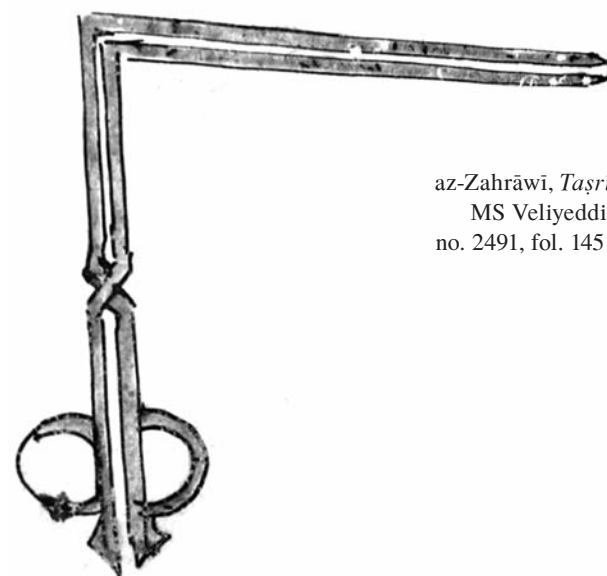
Albucasis.
On Surgery and Instruments,
p. 319 (MS Marsh).



az-Zahrāwī, *Taṣrīf*,
MS Paris Bibl. nat., ar.
2953, fol. 42 b.



Kitāb at-Taṣrīf,
facsimile ed.,
vol. 2, p. 495.



az-Zahrāwī, *Taṣrīf*,
MS Veliyeddin
no. 2491, fol. 145 a.

Cauter

(*mikwāt*)

For use «in the case of diseases of the lungs and coughing» (*fī kaiy maraḍ ar-ri'a wa-s-su'āl*) from the *Kitāb at-Taṣrīf* by az-Zahrāwī.

The instrument with three pin-shaped projections at one end replaces the cauter called «point» (see above) when numerous, closely spaced applications are required.

Our model was developed according to the sketch drawn by L. Leclerc²² after a manuscript of the *Taṣrīf* preserved in Paris. The illustrations reproduced here after our facsimile edition seem to be incorrect.²³ The instrument is completely omitted in manuscripts Paris Bibl. nat. ar. 2953 and Veliyeddin No. 2491.

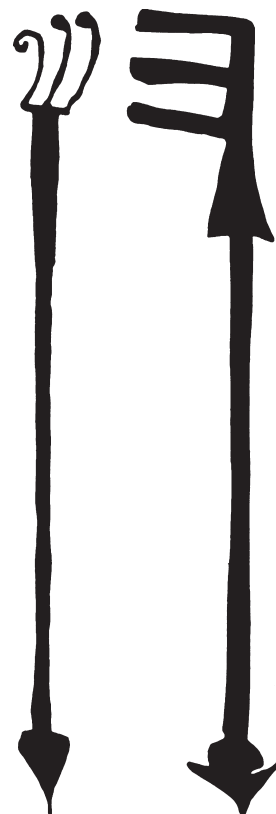


La chirurgie d'Abulcasis, fig. 17a.



Kitāb at-Taṣrīf, facsimile ed., t. 2, p. 468.

Our model:
Brass and stainless steel.
Length: 120 mm.
(Inventory No. H 4.06)



Albucasis. On Surgery and Instruments, p. 319 (MS Marsh, on the left, and MS Hunt., on the right).



az-Zahrāwī, *Taṣrīf*,
MS Vienne, Österreichische
Nationalbibliothek, Cod. N. F. 476a
(Morocco 11th/17th century), fol. 14a.

²² *La chirurgie d'Abulcasis*, pp. 30–31, fig. no. 17.

²³ MS İstanbul, Bibliothèque de la Süleymaniye, collection Beşirağa 502, cf. facsimile ed., vol. 2, p. 468; v. also Albucasis. *On Surgery and Instruments*, p. 75; K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, pp. 16–74, 22 pl., esp. pl. 2 (reprint. pp. 166–247, esp. p. 226, figs. 7–8).

DENTAL TREATMENT

14 Raspatories for the Removal of Tartar

Our models:
Brass and stainless steel.
Length ca. 110 mm each.
(H 9.01 to H 9.14)

Among the dental instruments which az-Zahrāwī (4th/10th cent.) discusses and illustrates in sections 29 to 32 of the first chapter of his 30th treatise on medical treatment, the fourteen small instruments for removing tartar form a compact group. They appear, in various forms that differ considerably from one another, in Arabic and Latin manuscripts and in incunabula of the translation of the chapter on «surgery» (*al-ʿamal bi-l-yad*, «treatment») of az-Zahrāwī's book. The most striking feature is that in the European Zahrāwī-tradition the dental instruments often display an option for using them from both ends.¹

Our models were made according to the drawings by L. Leclerc² after the illustrations in the manuscripts in az-Zahrāwī's book preserved in Paris as well as after the illustrations in the manuscript Beşirağa (Istanbul)³ and the two manuscripts at Oxford.⁴ In addition, the illustrations which K. Sudhoff⁵ compiled from Latin manuscripts and incunabula were also consulted.



¹ Vincenzo Guerini, *A history of dentistry from the most ancient times until the end of the eighteenth century*, New York 1909, repr. Amsterdam 1967, pp. 125–138; K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, pp. 68–74 (repr. pp. 218–224); Ch. Niel, *La chirurgie dentaire d'Abulcasis comparée à celle des Maures du Trarza*, in: *La revue de stomatologie* (Paris) 18/1911/169–180, 222–229 (repr. in: *Islamic Medicine*, vol. 37, pp. 145–156); Hans Zimmer, *Das zahnärztliche Instrumentarium des Albucasis*, in: *Zahnärztliche Rundschau* (Berlin) 48/1939/col. 69–71 (repr. in: *Islamic Medicine*, vol. 38, pp. 364–365).

² *La chirurgie d'Abulcasis*, 97–98, fig. no. 54 (14 figs.).

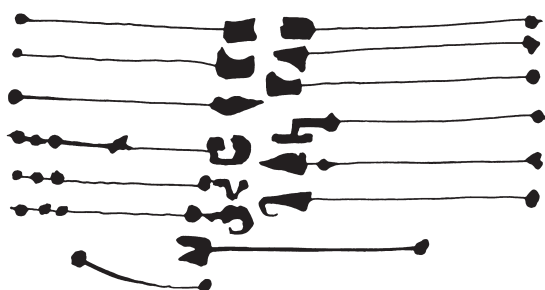
³ No. 502, v. facsimile ed., op. cit., vol. 2, p. 490.

⁴ Bodleian, Marsh 54 and Huntington 156, v. *Albucasis. On Surgery and Instruments*, p. 275.

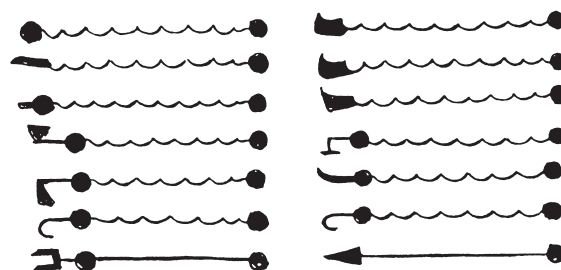
⁵ *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, pp. 68–70 (repr. pp. 218–220).



az-Zahrāwī, *Taṣrif*, MS Veliyeddin no. 2491, fol. 139a.



Albucasis. *On Surgery and Instruments*, p. 275 (MS Hunt.).

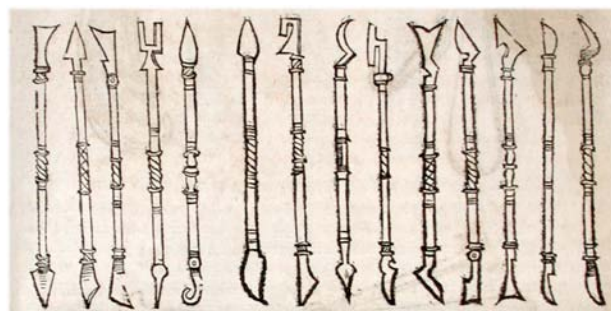


Kitāb at-Taṣrif, facsimile ed., vol. 2, p. 490.



Albucasis. *On Surgery and Instruments*, p. 275 (MS Marsh).

In the «Groß Chirurgen» by Walter Ryff (1559), this group of 14 instruments is shown as follows⁶:



⁶ *Groß Chirurgen / oder Vollkommene Wundartznei*, Franckfurt am Meyn, 1559, fol. 38.



Instrument

⟨like a small chisel⟩

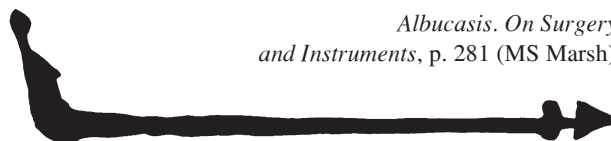
(*āla tušbiḥu ʿatala ṣaḡīra*)

For levering out broken teeth that cannot be extracted with a pair of tongs.

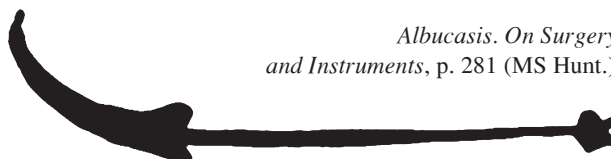
Our model was prepared according to the sketch drawn by L. Leclerc⁷ after the illustrations in the manuscripts preserved in Paris of az-Zahrāwī's book, as well as after the illustrations in the manuscript Beṣiraḡa⁸ and in the Oxford manuscripts Huntington⁹ and Marsh¹⁰.

Our model:
Brass and stainless steel.
Length: 117 mm.
(Inventory No. H 9.15)

Albucasis. On Surgery and Instruments, p. 281 (MS Marsh).



Albucasis. On Surgery and Instruments, p. 281 (MS Hunt.).



Instrument

for levering out broken teeth

Serves the same purpose as the preceding instrument. Our model was prepared according to the sketch drawn by L. Leclerc¹¹ after the illustrations of the manuscripts of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.) which are preserved in Paris as well as after the illustrations of the Istanbul manuscript Beṣiraḡa¹² and the Oxford manuscripts Huntington¹³ and Marsh.¹⁴

Our model:
Brass and stainless steel.
Length: 122 mm.
(Inventory No. H 9.16)

Albucasis. On Surgery and Instruments, p. 283 (MS Marsh).



Albucasis. On Surgery and Instruments, p. 283 (MS Hunt.).



az-Zahrāwī, *Kitāb at-Taṣrīf*, facsimile ed., vol. 2, p. 491.

⁷ *La chirurgie d'Abulcasis*, 101, fig. no. 57.

⁸ No. 502, cf. facsimile ed., op. cit., vol. 2, p. 491.

⁹ No. 156.

¹⁰ No. 54, v. *Albucasis. On Surgery and Instruments*, p. 281, cf. K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 72 (repr., p. 222).

¹¹ *La chirurgie d'Abulcasis*, p. 101, fig. no. 58.

¹² No. 502, v. facsimile ed., op. cit. vol. 2, p. 491.

¹³ No. 156.

¹⁴ No. 54, v. *Albucasis. On Surgery and Instruments*, p. 283, cf. K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 72 (repr., p. 222).

The ‹Instrument with a fork›

(*āla dāt aš-šu‘batain*)



Likewise for levering out broken teeth that cannot be extracted with tongs any more. Our model was prepared according to the sketch drawn by L. Leclerc¹⁵ after the illustration in a Paris manuscript of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.), and after the illustration in the manuscript Huntington¹⁶ in Oxford. This shape is confirmed by the Latin Zahrāwī-tradition.¹⁷ The instrument is depicted neither in the Istanbul manuscripts Veliyeddin and Beṣirağa nor in the Oxford copy Marsh.

Notre modèle:
Laiton et acier inoxydable.
Longueur: 116 mm.
(Inventaire no. H 9.17)



Albucasis. *On Surgery and Instruments*, p. 283 (MS Hunt.).

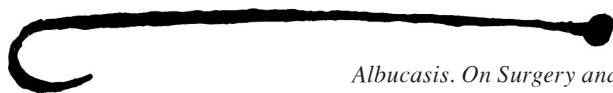
Instrument ‹like a large fish hook›

(*āla tušbiḥu ṣ-ṣinnāra al-kabīra*)

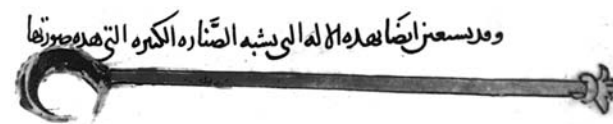


Our model: Brass and stainless steel.
Length: 115 mm. (Inventory No. H 9.18).

Serves the same purpose as the preceding instruments, for exposing and levering out broken teeth. Our model was prepared according to the sketch drawn by L. Leclerc¹⁸ after the illustrations in the manuscripts of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.) preserved in Paris as well as the illustrations in the Istanbul manuscript Beṣirağa¹⁹ and the Oxford manuscripts Marsh²⁰ and Huntington,²¹ taking into account the Latin Zahrāwī-tradition²².



Albucasis. *On Surgery and Instruments*, p. 285 (MS Hunt.).



az-Zahrāwī, *Taṣrīf*,
MS Veliyeddin no. 2491, fol. 139a.



az-Zahrāwī, *Kitāb at-Taṣrīf*, facsimile ed., vol. 2, p. 491.

¹⁵ *La chirurgie d'Abulcasis*, p. 101, fig. no. 60.

¹⁶ No. 156, v. *Albucasis. On Surgery*..., p. 285.

¹⁷ Ch. Niel, *La chirurgie dentaire d'Abulcasis*, p. 178. (repr., p. 154); K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 72 (repr., op. cit., p. 222).

¹⁸ *La chirurgie d'Abulcasis*, p. 101, fig. no. 61.

¹⁹ No. 502, v. facsimile ed., op. cit., vol. 2, p. 491.

²⁰ No. 54.

²¹ No. 156, v. *Albucasis. On Surgery*..., p. 283, 285.

²² v. V. Guerini, *A history of dentistry*, p. 134; Ch. Niel, *La chirurgie dentaire d'Abulcasis*, p. 178 (repr., op. cit., p. 154); K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 72 (repr., op. cit., p. 222).



Model (a):
Stainless steel, riveted.
Length: 121 mm.
(Inventory No. H 9.21))

*Albucasis. On
Surgery and Instru-
ments*, p. 281 (MS
Marsh und Hunt.).



Model (b):
Stainless steel, riveted.
Length: 144 mm.
(Inventory No. H 9.19)



Model (c):
Stainless steel, pivoted.
Length 144 mm.
(Inventory No. H 9.20)



Tongs

(*kalālīb*)

For the extraction of teeth and the removal of tooth fragments.

Our models (a, b, c) were prepared according to the sketches drawn by L. Leclerc²³ after the illustrations in the Paris manuscripts of az-Zahrāwī's *Taṣrīf*, also taking into account the illustrations in the Istanbul manuscript Beṣīrağā²⁴ and the Oxford manuscripts²⁵ as well as the Latin Zahrāwī-tradition²⁶.

الْقَطْلُ الْوَاجِبُ وَاللَّاتُورِيَّةُ قَلْبُ
أَصُولِ الْأَصْلِيَّةِ وَأَخْرَاجُ الْقَطْلِ الْمَكِينَةُ

إِنَّمَا يَفْعَلُ عَنْ قَلْبِ الصَّغِيرِ أَيْ فِي أَنْفِ الْبُحْبُوحِ أَوْ فِي بَيْتِ الْأُذُنِ عَلَى الْمَوْضِعِ
فَصْنَةُ بِالْمَقْرُونَةِ أَوْ بِوَسْطِ مَقْرُونَةٍ يَسْتَرْخِي الْمَوْضِعَ ثُمَّ يَنْزِلُ إِلَيْهِ الْجَبِثُ
أَوْ الْكَلَالِيبُ أَيْ تَشْبِيهِهُ هَذَا بِأَخْرَاجِ الْعَاقِرِ الْبَيْتِ تَشْمِي السَّرِيحَةِ
هَذَا صَوْرَةُ الْكَلَالِيبِ



تَدْرُجُ الْبُحْبُوحَ مَا تَوْصَفَتْ خَالِصَةً مِنْهُ الْبُحْبُوحُ كَمَا فِي كِتَابِ الْبُحْبُوحِ بِأَنْزِلِ الْبُحْبُوحَ بِأَنْزِلِ الْبُحْبُوحَ

az-Zahrāwī, *Taṣrīf*,
MS Paris Bibl. nat., ar. 2953.

²³ *La chirurgie d'Abulcasis*, p. 100, fig. nos. 55 and 56.

²⁴ No. 502, v. facsimile ed., op. cit. vol. 2, p. 491.

²⁵ Huntington 156 and Marsh 54, v. *Albucasis. On Surgery and Instruments*, p. 281.

²⁶ V. Guerini, *A history of dentistry*, p. 133; K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 70 (repr., op. cit., p. 220).

Tongs or Tweezers (*ğift*)



Our model:
Brass and Stainless Steel.
Length: 96 mm.
(Inventory No. H 9.22)

For the extraction of the roots of teeth and for the removal of jawbone fragments.

Our model was prepared according to the sketches drawn by L. Leclerc²⁷ after the illustrations of the Paris manuscripts of az-Zahrāwī's (4th/10th cent.) *Taṣrīf*, taking into account the illustrations in the Istanbul manuscript Beṣīrağa²⁸ and the two Oxford manuscripts Huntington and Marsh²⁹.



Albucasis. On Surgery and Instruments, p. 287 (MS Marsh).



az-Zahrāwī, *Kitāb at-Taṣrīf*, facsimile ed., vol. 2, p. 491.



Albucasis. On Surgery and Instruments, p. 287 (MS Hunt.).



az-Zahrāwī, *Taṣrīf*, MS Paris Bibl. nat., ar. 2953, fol. 38a.

²⁷ *La chirurgie d'Abulcasis*, p. 101, fig. no. 62.

²⁸ No. 502, v. facsimile ed., op. cit. vol. 2, p. 491.

²⁹ No. 156 and no. 54, v. *Albucasis. On Surgery and Instruments*, p. 287.

TREATMENT OF NERVOUS DISORDERS

Cauter with ring-shaped branding area

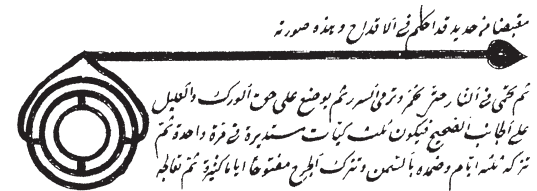
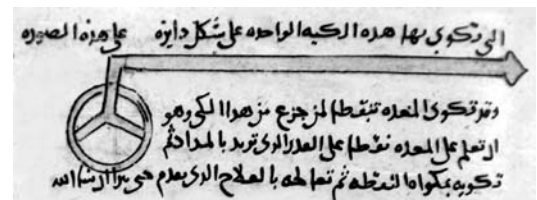


Our model:
Brass and stainless steel.
Length: 117 mm.
(Inventory No. H 7.01)

az-Zahrāwī, *Taṣrīf*,
MS Veliyeddin
no. 2491, fol. 115a.

for the treatment of the lower area of the back «in the case of children with painful diseases of the spinal column.»¹

Our model is based on the drawing made by L. Leclerc² after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.), and after the illustrations in the manuscript Veliyeddin and those in the two copies at Oxford³.



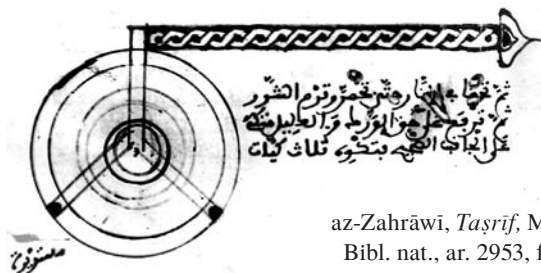
az-Zahrāwī, *Kitāb at-Taṣrīf*,
facsimile ed., vol. 2, p. 472.



Our model:
Brass and
stainless steel.
Length: 117 mm.
(Inventory No.H 7.02)

Cauter for use in lumbar sciatica (*āla li-kaiy ḥuqq al-wark*)

The round head of this instrument that is used in the case of pain in the lumbar region (sciatica) has a diameter of roughly half a span. Our model reproduces the illustration of the Istanbul manuscript Beṣīrağā⁴ of az-Zahrāwī's (4th/10th cent.) *Kitāb at-Taṣrīf*. The illustrations of the Paris manuscripts as copied by L. Leclerc were also consulted.⁵



az-Zahrāwī, *Taṣrīf*, MS Paris
Bibl. nat., ar. 2953, fol. 16b.

¹ K. Sudhoff, *Beiträge zur Geschichte ...*, 2nd part, p. 22 and pl. II, fig. 13 (repr., op. cit., p. 172, 226).

² *La chirurgie d'Abulcasis*, p. 46, fig. no. 25.

³ *Abulcasis. On Surgery and Instruments*, p. 129.

⁴ No. 502, v. facsimile ed., op. cit., vol. 2, p. 472.

⁵ *La chirurgie d'Abulcasis*, p. 43, fig. no. 23; E. Gurlt, *Geschichte der Chirurgie*, pl. IV, no. 23; v. also *Abulcasis. On Surgery ...*, p. 119; K. Sudhoff, *Beiträge ...*, 2nd part., p. 22 and pl. II, fig. 14 (repr., op. cit., p. 172, 226).



Our model:
Brass and stainless steel.
Length: 116 mm.
(Inventory No. H 7.05)

Cauter

for the treatment of epilepsy

(*mikwāt fī kaiy aṣ-ṣarʿ*)



az-Zahrāwī, *Taṣrīf*, MS Paris Bibl.
nat., ar. 2953, fol. 38 a.

Our model was constructed after the illustrations in the Paris manuscripts of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.) as sketched by L. Leclerc⁶ and after the illustration of the manuscript Veliyeddin.⁷ In the facsimile edition of az-Zahrāwī's book the illustration is missing. The illustration in the manuscript Huntington,⁸ at variance with the other manuscripts, shows an instrument bent at an angle which is meant for a similar purpose.

According to az-Zahrāwī, the common 'olive-cauter' (*mikwāt zaitūniya*, see above, p. 39) is used for cauterisation of adult patients; the smaller instrument, shown here, is meant for boys.

az-Zahrāwī, *Taṣrīf*,
MS Veliyeddin no. 2491,
fol. 110 a.



⁶ *La chirurgie d'Abulcasis*, op. cit., p. 19–20, fig. 7.

⁷ No. 2491, fol. 110a.

⁸ *Albucasis. On Surgery and Instruments*, op. cit., p. 39.

TREATMENT OF THE URINARY TRACT

Catheter

(*qātātīr*)

«for relief when urine is retained in the bladder» (*fī ‘ilāğ al-bawl al-muḥtabas fī l-matāna*). It is a very fine, smooth, silver tube of about one and a half spans in length which terminates in a beaker-like projection. With the help of a piece of cotton or wool which is inserted like a plug at the end of the tube and which is held by a thread laid out in double, the physician can let the accumulated urine flow off from the bladder. After applying some lubricating substance to it, he inserts the instrument into the male urinary tract and moves it, while pushing it forward, first with a downward movement and then upwards until the bladder is reached. Then he pulls the wool or cotton plug out through the narrow silver tube in order to let the urine, which has become free, flow off. The procedure is repeated until the bladder is emptied.

Our model is based on the illustrations in the manuscripts of the *Taṣrif* by az-Zahrāwī (4th/10th cent.) in Istanbul⁹ and Oxford¹⁰ and on the drawing made by L. Leclerc¹¹ after the manuscripts preserved in Paris.

Reproduced here are the illustrations of two extant catheters made by the successors of this tradition: the first (a) by Cornelius Solingen (1706) and the second (b) by Whicker & Blaise (London, circa 1856).¹²

⁹ Veliyeddin 2491, fol. 157b.

¹⁰ Bodleiana, Marsh 54, v. *Albucasis. On Surgery and Instruments*, p. 403.

¹¹ *La chirurgie d'Abulcasis*, p. 147, fig. no. 95; v. also O. Spies and H. Müller-Bütow, *Drei urologische Kapitel aus der arabischen Medizin*, in: *Sudhoffs Archiv* (Wiesbaden) 48/1964/248-259, esp. pp. 250-251; Abdul Salam Schahien, *Die geburtshilflich-gynäkologischen Kapitel aus der Chirurgie des Abulkasim. Ins Deutsche übersetzt und kommentiert*, doctoral thesis, Berlin 1937, pp. 11-12 (repr. in: *Islamic Medicine*, vol. 38, pp. 321-359, esp. pp. 331-332); M.S. Spink,

Our models:

Silver, length 23 (illustration) and 34 cm.
(Inventory No. H 5.01)



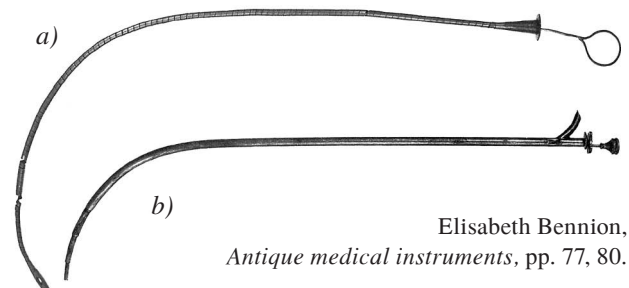
La chirurgie d'Abulcasis, fig. 69.



Albucasis. On Surgery and Instruments, p. 407 (MS Marsh).



az-Zahrāwī, *Taṣrif*,
MS Veliyeddin no. 2491, fol. 107b.



Elisabeth Bennion,
Antique medical instruments, pp. 77, 80.

Arabian gynaecological, obstetrical and genito-urinary practice illustrated from Albucasis, in: *Proceedings of the Royal Society of Medicine* (London) 30/1937/653-670, esp. p. 666 (repr. *Islamic Medicine*, vol. 38, pp. 303-320, esp. p. 316).

¹² Both in the Royal College of Surgeons of England, cf. Elisabeth Bennion, *Antique medical instruments*, London (Sotheby's) 1979, pp. 77, 80.

Stamp Syringe

(*zarrāqa* or *miḥqan*)

for instillation (*ḥaqn*) of the bladder. This apparatus is used for instilling medicines in liquid form through the urethra into the bladder. This is done for the treatment of ulcers, blood clots or pus in the bladder. The syringe is made of silver or ivory. The diameter of the cannula corresponds to the width of the urethra. As in the case of a modern syringe, a piston is passed through the broader part at the back, which is «used for drawing liquids as well as for giving injections» (Sudhoff). Towards the end of the cannula there are three holes on opposite sides, two on one side and one on the opposite side. Through these holes the liquid reaches the bladder while the injection is done.

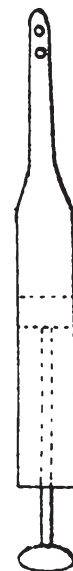
Our model was constructed after the description in the *Taṣrīf* by az-Zahrāwī (4th/10th cent.) and after the illustrations in the manuscripts at Oxford¹³ and Istanbul,¹⁴ and also after the drawing made by L. Leclerc¹⁵ after the illustrations in the Paris manuscripts.



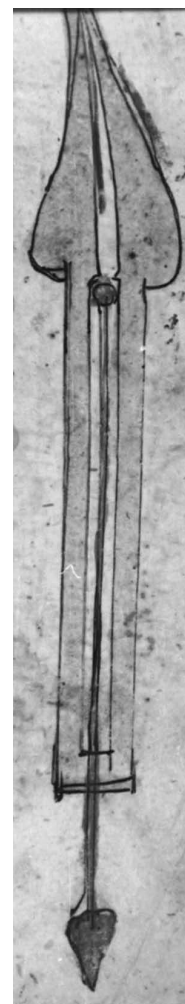
Kitāb at-Taṣrīf,
facsimile ed.,
vol. 2, p. 506.



Our model:
Brass, synthetic material
Length: 133 mm
(Inventory No. H 5.06)

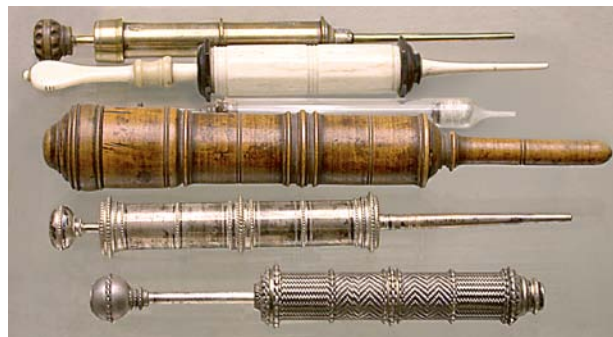


*La chirurgie
d'Abulcasis*,
fig. 70.



az-Zahrāwī,
at-Taṣrīf,
MS Veliyeddin

Fig. on the right: The form of the apparatus described by az-Zahrāwī continued through the centuries in different sizes and with differing functions and survives in the modern injection syringe. Some specimens of the 17th century made of silver, ivory, brass or wood can be found in the Germanisches Nationalmuseum at Nuremberg.



¹³ Bodleian Library, Marsh 54 and Huntington 156, v. *Abulcasis. On Surgery and Instruments*, op. cit., p. 407.

¹⁴ Beṣīrağa no. 502, v. facsimile ed., vol. 2, p. 506; Veliyeddin no. 2491, fol. 108a.

¹⁵ *La chirurgie d'Abulcasis*, op. cit., pp. 148–149, fig. no. 96; v. also K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, op. cit., 2nd part, pp. 39–41 (repr., op. cit.,

pp. 189–191); Sami Hamarneh, *Drawings and pharmacy in al-Zahrāwī's 10th-century surgical treatise*, in: *Contributions from the Museum of History and Technology* (Washington, D.C.) 22/1961/81–94, esp. pp. 90–91.

Balloon Syringe

(*miḥqan*)

for bladder irrigation. In continuation of the preceding instrument for instillation of the bladder, az-Zahrāwī describes another type where the function of the piston is performed by a balloon-like hose. A ram-bladder, filled with the liquid medication, is tied to the cannula which is provided at the end with a groove for the piece of cord with which the bladder is fastened. If no ram-bladder is at hand, az-Zahrāwī recommends that a round piece be cut out of parchment (*qiṭ'at raqq*), that holes be made closely to each other near the edge and a strong piece of cord be drawn through the holes and, while pulling the cord together, the parchment be given the form of a moneybag (read *ṣurra* instead of *ṣufra*). Then this bag, filled with the liquid medication, is tied to the cannula.

Model (a) was made after the description of the Arabic text¹⁶ of the *Taṣrif* by az-Zahrāwī (4th/10th cent.); model (b) after the illustrations known to us in its Latin translation.¹⁷

Model (a):

Brass.

Length: 170 mm.

(Inventory No. H 5.02 a)



Model (b):

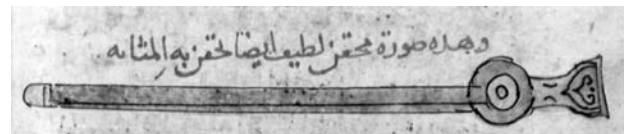
Brass and leather.

Length: 157 mm.

(Inventory No. H 5.02b)



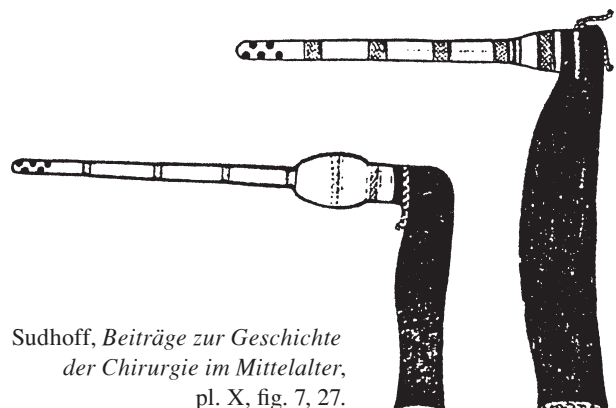
az-Zahrāwī, *Kitāb at-Taṣrif*, facsimile ed., vol. 2, p. 506.



az-Zahrāwī, *Taṣrif*,
MS Veliyeddin no. 2491,
fol. 108b.

¹⁶ v. facsimile ed. of MS Beṣirağa, vol. 2, p. 506; v. also *La chirurgie d'Abulcasis*, op. cit., p. 149; *Abulcasis. On Surgery and Instruments*, op. cit., p. 409; E. Gurlt, *Geschichte der Chirurgie*, vol. 1, pp. 632–633, fig. no. 71.

¹⁷ V. K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, pp. 43–44 and pl. X, figs. 7, 27 (repr., op. cit., pp. 193–194, 234). Sudhoff understands the instrument as an apparatus for the irrigation of the intestines, but not of the bladder.



Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*,
pl. X, fig. 7, 27.

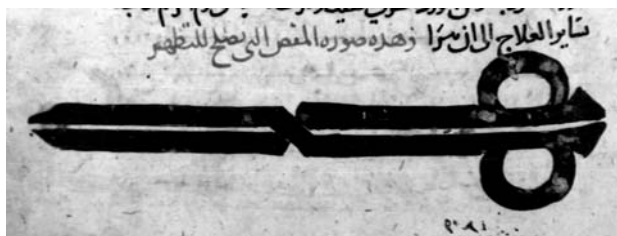


Scissors

(*miqaş*)

Our model:
Stainless steel.
Length: 168 mm.
(Inventory No. H 5.07)

for the circumcision of boys. Our model was prepared after the illustration in one of the Paris manuscripts¹⁸ of the *Taşrîf* by az-Zahrâwî (4th/10th cent.) and after the drawing by L. Leclerc.¹⁹ For comparison, the illustrations from the manuscripts Istanbul (Beşirağa²⁰ and Veliyeddin)²¹ as well as Oxford (Hunt. and Marsh) are shown here.



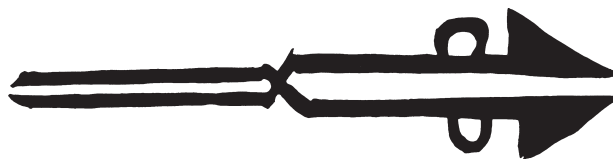
az-Zahrâwî, *Taşrîf*, MS
Veliyeddin no. 2491, fol. 107.



az-Zahrâwî, *Kitâb at-Taşrîf*, facsimile ed., vol. 2, p. 505.



Albucasis. *On Surgery
and Instruments*, p. 401 (MS Hunt.).



Albucasis. *On Surgery
and Instruments*, p. 401 (MS Marsh).

¹⁸ Bibliothèque nationale, ar. 2953, fol. 54a.

¹⁹ *La chirurgie d'Abulcasis*, pp. 143–146, fig. no. 94.

²⁰ No. 502, v. facsimile ed., vol. 2, p. 505.

²¹ No. 2491, fol. 107.

GYNAECOLOGICAL INSTRUMENTS

In connection with the extraction of the fetus, az-Zahrāwī (4th/10th cent.) briefly describes three instruments in his *Taṣrīf*. We are indebted to K. Sudhoff¹ for a helpful interpretation of the illustrations belonging to this subject, which are difficult to understand and in parts unclear in the manuscripts and incunabula of the Latin and French translations.

The first of the instruments mentioned and depicted by az-Zahrāwī under the heading *Ṣuwar al-ālāt allatī yuḥtāḡu ilaiḥā fī iḥrāḡ al-ḡanīn*² («Depiction



Various gynaecological instruments from *Taṣrīf* d'az-Zahrāwī, MS Paris Bibl. nat., ar. 2953, fol. 68.

of the implements needed for the extraction of the fetus») is called *laulab yuḥtāḡu biḥī fam ar-raḥīm* («device in the form of a screw for opening the neck of the cervix»). In modern technical literature, this apparatus is known as a «two-leaved speculum uteri»³.

The second instrument is called «tongs-shaped» (*alā šakl al-kalālib*) by az-Zahrāwī. According to him, the third is another screw-like device «mentioned by the ancients» (*laulab āḡar dakarathu l-awā'il*). About the material of which the first two instruments were made, az-Zahrāwī states that it was ebony (*ābanūs*) or box-tree wood (*ḥašab al-baqs*),⁴ but he does not make any comment on the material of the instruments of «the ancients.» We know from archaeological finds from Pompeii that this was made of metal in Antiquity.⁵



az-Zahrāwī, *Taṣrīf*, MS Veliyeddin no. 2491, fol. 172 a.

¹ *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, pp. 45–52 (repr., op. cit., pp. 195–202).

² *at-Taṣrīf*, facsimile ed., vol. 2, p. 515; *Albucasis. On Surgery and Instruments*, p. 485.

³ E. Gurlt, *Geschichte der Chirurgie*, vol. 1, plate III, after p. 519, no. 99.

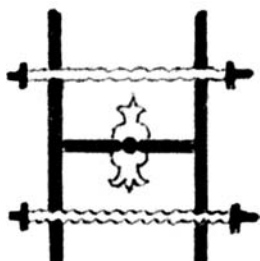
⁴ A. Schahien, *Die geburtshilflich-gynäkologischen Kapitel aus der Chirurgie des Abulkasim*, p. 31 (repr., op. cit., p. 351).

⁵ V. E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 506, with further literature; J. S. Milne, *Surgical instruments in Greek and Roman times*, Oxford 1907, pl. 47–49; *Pompéi. Nature, sciences et techniques*, sous la direction de Annamaria Ciarallo, Ernesto de Carolis, ... Alix Barbet, Milan 2001 (exhibition catalogue, Paris: Palais de la découverte), p. 256.

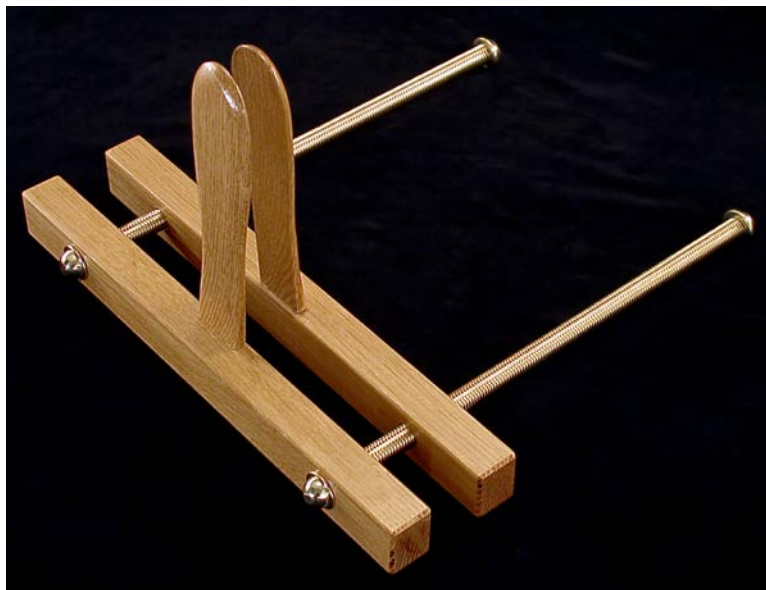
I. The Two-leaves Speculum

About the illustration az-Zahrāwī says: «This is [like] the drawing of a press with which books are prepared. It consists of two screws at the end of two pieces of wood. But the two screws must be finer than the screws of the press and must be of ivory or box-tree wood, and the width of each of the two pieces of wood must be about two fingers, its thickness about one finger and their length must be one and a half spans, and at the middle of [each of] the two wooden pieces there should be two insets of the same type of wood, fixed firmly to them. Their length should be half a span or a little more, their width about two fingers or a little more. These are the two pieces of wood which are inserted into the cervix so that it is opened by them when you turn the two screws.»⁶

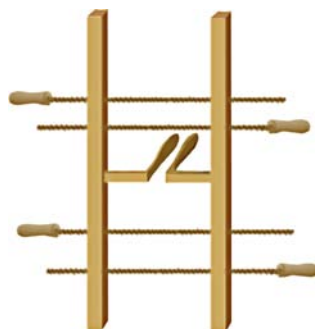
Our model was prepared according to the sketch drawn by L. Leclerc⁷ after the illustrations in the Paris manuscripts of az-Zahrāwī's book, and after the illustrations in the manuscripts Beşirağa⁸ at Istanbul and Huntington⁹ at Oxford. Moreover, we consulted the illustration in the Istanbul manuscript Veliyeddin¹⁰ which is not reproduced here. In this illustration the grooves of the screw-spindle are not depicted, but the broad, spoon-like shape of the gliding strips of wood are clearly discernable, which serve for widening the genital tract.



Kitāb at-Taşrif,
facsimile ed.,
vol. 2, p. 515.



Our model:
Oak (for want of true box-tree wood)
and brass, 30 × 30 cm.
(Inventory No. 6.04)



A variant with four threads is depicted in the Turkish adaptation by Şerefeddin (1465) (see below; left: reconstruction sketch).



Şerefeddin, MS İstanbul, Millet, Ali Emiri no. 79, fol. 113a.

⁶ *At-Taşrif*, facsimile ed., vol. 2, p. 515; *Albucasis. On Surgery and Instruments*, p. 485; German translation. A. Schahien, op. cit., pp. 31–32 (repr., op. cit., pp. 351–352); for the French translation v. L. Leclerc, *La chirurgie d'Abulcasis*, p. 183.

⁷ *La chirurgie d'Abulcasis*, fig. no. 102 to p. 183.

⁸ No. 502, v. facsimile ed., vol. 2, p. 515.

⁹ No. 156, v. *Albucasis. On Surgery and Instruments*, p. 485.

¹⁰ No. 2491, fol. 171a.

2. The second instrument used in connection with the extraction of the fetus as described by az-Zahrāwī is called

«Scissor-Speculum»



by K. Sudhoff, who describes it in the following words after the Latin translation: «It is a wooden instrument, shaped like a pair of tongs, which has appendages (additamenta), as long as one's hand and as broad as two fingers, that is to say quite large spoon-shaped branches of the speculum. These spoons (additamenta), in a closed state, are to be pushed into the vagina of the woman who is sitting on the bed with her legs hanging down. Then one should take hold of the other end of the scissor-speculum and open it with the hand, as one does while opening a pair of scissors; indeed open it as far as necessary to open the vulva and the vagina in order to see the portio. The physician and the midwife probably used to content themselves even with a thorough opening of the introitus vaginae. Particularly since even this is unnecessary, as a rule, when gynaecological operations are carried out.»¹¹

Our model was made after the description in the text of the *Taṣrīf* by az-Zahrāwī¹² and after the figure in manuscript Marsh¹³ (Oxford).

Our model:
Stainless steel, riveted.
Length: 194 mm.
(Inventory No. H 6.01)



Albucasis. On Surgery and Instruments, p. 487 (MS Marsh).

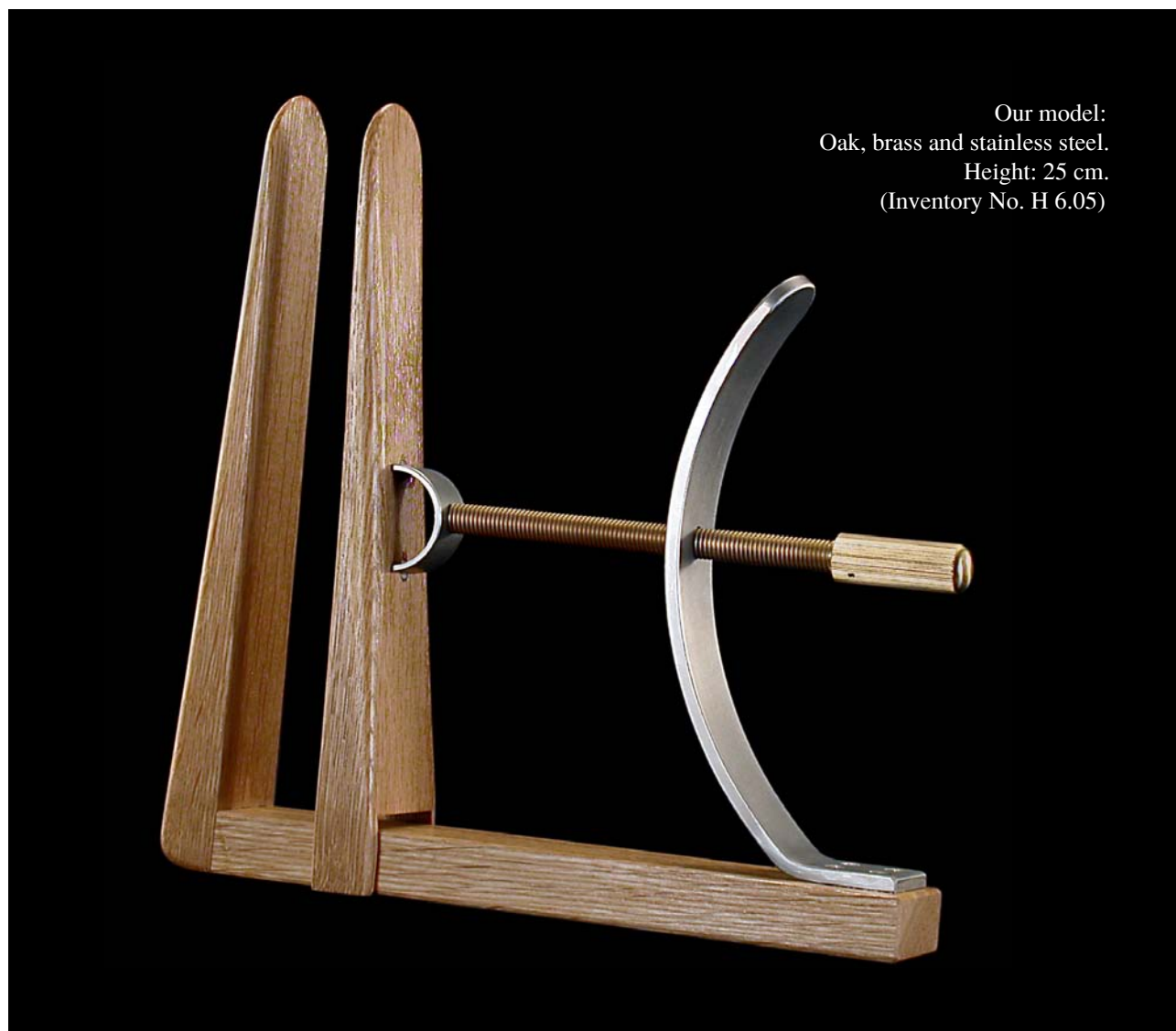


Cod. lat. Monacensis 161 (XIII^e s.) fol. 18a.
D'après Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 51.

¹¹ *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 51 (repr., op. cit., p. 201); v. also A. Schahien, op. cit., p. 32 (repr., op. cit., p. 352).

¹² v. facsimile ed., vol. 2, p. 515; v. also Leclerc, *La chirurgie d'Albucasis*, pp. 183–184, fig. no. 103.

¹³ No. 56, v. *Albucasis. On Surgery...*, op. cit., p. 487.



3. The third instrument which az-Zahrāwī mentions in connection with the extraction of the fetus and calls the

Instrument «of the Ancients» (*ālāt al-awā'il*)¹⁴

without, however, describing it. Even the illustrations in the available manuscripts do not offer a clear idea about this apparatus. K. Sudhoff¹⁵ made every effort and succeeded in finding an explana-

tion for the illustrations preserved in manuscripts and incunabula. He found that the drawing which is difficult to interpret even in some of the Arabic manuscripts and which in the Latin copies resembles a street-lantern, must originally have represented «a spoon-speculum with a screw arrangement for unscrewing its spoon-branches as they are preserved from Pompeii as speculum trivalve.»¹⁶ Only in the manuscript Marsh 54, which he knew through the Latin translation by Channing¹⁷, did he find [77] «a screw arrangement of a similar nature where one could, if so inclined, really find what is essential.»¹⁸ Among the Arabic manuscripts of the

¹⁴ *At-Taṣrīf*, facsimile ed., vol. 2, p. 515.

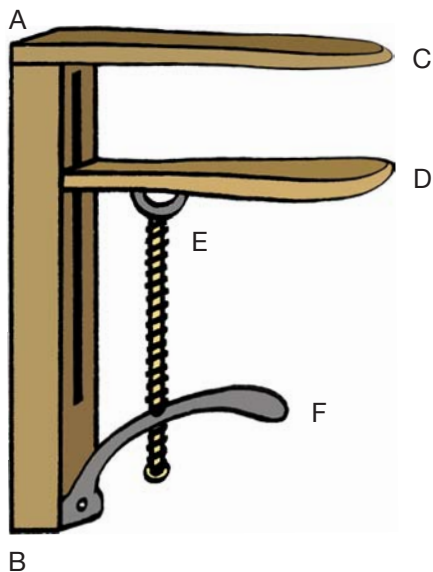
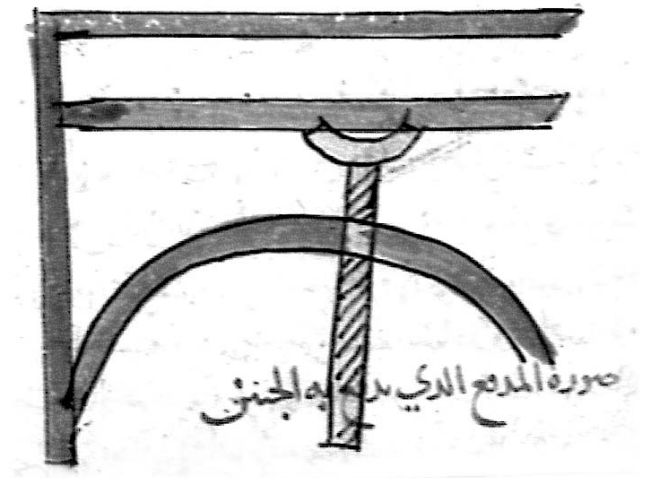
¹⁵ *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, pp. 51–52 (repr., op. cit., p. 201–202).

¹⁶ *Ibid.*, p. 52 (repr., p. 202).

¹⁷ *Albucasis de Chirurgia Arabice et Latine Cura Johannes Channing*, 2 vols, London 1778.

30th chapter of az-Zahrāwī's *Taṣrīf* which are accessible to me at present, I believe that the illustration of the Istanbul manuscript Veliyeddin comes the closest to reality:

az-Zahrāwī, *Taṣrīf*, MS
Veliyeddin no. 2491, fol. 171 b.



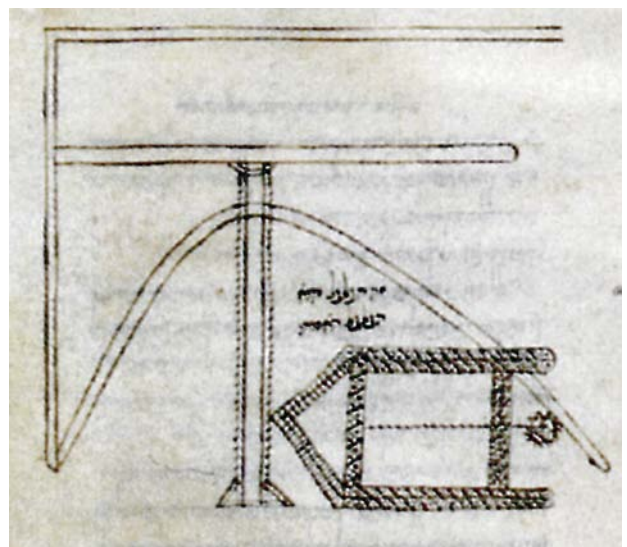
With this it is possible to reconstruct the instrument as follows:

The two arcs E and F have the function of securing the screw with which the lower and movable of the two spoon-branches is screwed upwards and downwards. This branch must have acquired its ability to slide up or down through a slot in the beam AB or through a ring surrounding the beam.

After these deliberations it should not be difficult to realise the connection between the distorted illustrations in a few Arabic and in almost all Latin manuscripts, on the one hand, and the original illustration, on the other.

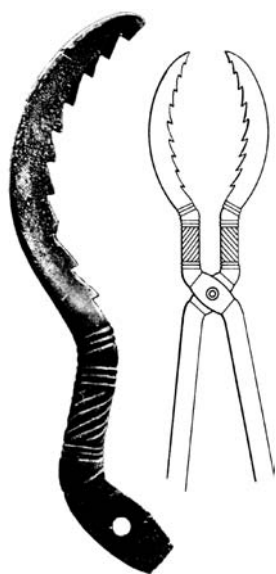
An example of the later «lantern» pictures where the «lantern» had obviously been installed erroneously from an independent illustration (of another speculum ?):

Fig. from the *Taṣrīf*'s Hebrew translation by Shemtov b. Isaac of Tortosa (1258), copy from the early 15th century¹⁹.

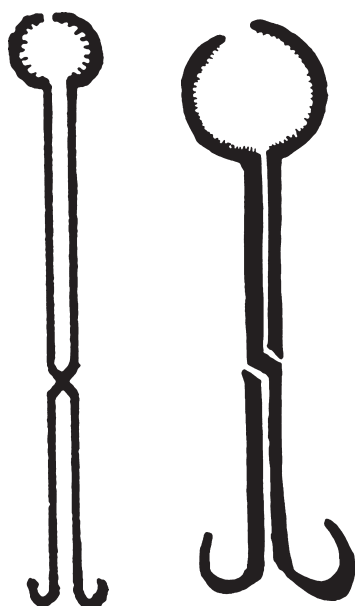


¹⁸ K. Sudhoff, op. cit., p. 52 (repr., p. 202).

¹⁹ MS Paris Bibl. nat., heb. 1163, fol. 222a.



Part of a comparable instrument from the alleged «physician's grave of Ephesus», Byzantine (?). Copper alloy. After S. Zimmermann, E. Künzl: *Die Antiken der Sammlung Mayer-Steinegg in Jena I*, Jahrbuch des Röm.-Germ. Zentralmuseums Mainz, 38/2, 1991 (Mainz 1995).



Kitāb at-Taṣrīf, facsimile ed., vol. 2, p. 515.

Albucasis. On Surgery and Instruments, p. 491 (MS Hunt.).



Our model:
Stainless steel, riveted.
Length: 214 mm.
(Inventory No. H 6.02)

Cephalotribe

(*mišdāḥ*)

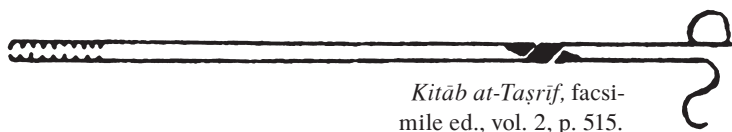
An instrument resembling obstetric forceps «for crushing the head of a fetus» (*yušdah bihī raʿs al-ḡanīn*) in case of miscarriages.

Our model is based on the sketch by L. Leclerc²⁰ which he drew after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.) and on the illustration in the Istanbul manuscript *Beṣiraḡa*²¹ (see above). By way of comparison, the illustration of the Oxford manuscript *Huntington*²² is reproduced here.

²⁰ *La chirurgie d'Abulcasis*, p. 184, fig. no. 106.

²¹ No. 502, v. facsimile ed., vol. 2, p. 515.

²² v. *Albucasis. On Surgery and Instruments*, p. 491; v. also A. Schahien, *Die geburtshilflich-gynäkologischen Kapitel aus der Chirurgie des Abulkasim*, pp. 33–34 (repr., op. cit., pp. 353–354); K. Sudhoff, *Beiträge zur Geschichte der Chirurgie ...*, 2nd part, p. 53 (repr., op. cit., p. 203).



Kitāb at-Taṣrīf, facsimile ed., vol. 2, p. 515.

Model (a):
Stainless steel, riveted.
Length: 254 mm.
(Inventory No. H 6.03)

Cephalotribe

(*mišdāḥ*)

Another pair of tongs with the same function, which az-Zahrāwī describes in the following manner: «It is similar to a pair of scissors. As you see, it has teeth at the end, and sometimes it is made long like tongs. In this illustration it has, as you see, teeth like the teeth of a saw. With this you cut and crush (the head).»²³

Our models (a, b) are based on the Istanbul manuscript Beṣirağā²⁴ of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.) and on a sketch drawn by L. Leclerc²⁵ after one of the Paris manuscripts of that book. For comparison, the illustration from the Paris manuscript ar. 2953²⁶ is reproduced here.



Model (b):
Stainless steel, riveted.
Length: 198 mm.
(Inventory No. H 6.06)



²³ A. Schahien, *Die geburtshilflich-gynäkologischen Kapitel aus der Chirurgie des Abulkasim*, p. 34 (repr., op. cit., p. 354).

²⁴ No. 502, v. facsimile ed., vol. 2, p. 515.

²⁵ *La chirurgie d'Abulcasis*, op. cit., p. 183, fig. no. 107.

²⁶ Bibliothèque nationale, ar. 2953, fol. 67b.

az-Zahrāwī, *Taṣrīf*,
MS Paris Bibl. nat., ar.
2953, fol. 67b.

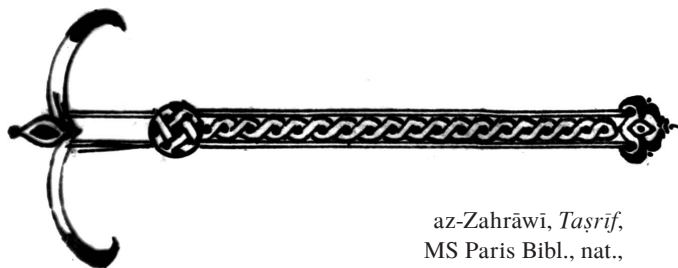
«Hook with two horns»

(*ṣinnāra dāt aš-šaukatain*)

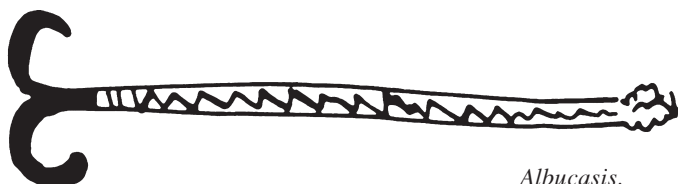
An instrument for the extirpation of dead fetuses from the uterus.

Our model is based on the illustrations, one from each, of the Paris²⁷ Istanbul²⁸ and Oxford²⁹ manuscripts and the drawing by L. Leclerc.³⁰

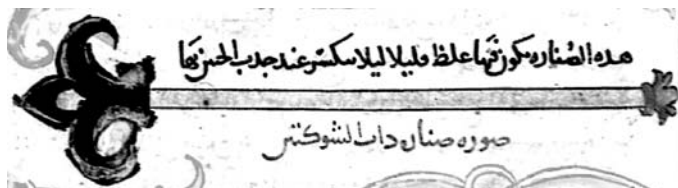
Our model:
Brass and stainless steel.
Length: 196 mm.
(Inventory No. H 6.07)



az-Zahrāwī, *Taṣrīf*,
MS Paris Bibl., nat.,
ar. 2953, fol. 68 a.



Albucasis.
On Surgery and Instruments,
p. 495 (MS Marsh).



az-Zahrāwī, *Taṣrīf*, MS
Veliyeddin no.2491, fol. 172 b.



²⁷ Bibliothèque nationale, ar. 2953, fol. 68a.

²⁸ Süleymaniye Kütüphanesi, collection Beşirağa 502, v. facsimile ed., vol. 2, p. 516.

²⁹ Bodleian Library, Marsh 54, v. Albucasis. *On Surgery and Instruments*, p. 495.

³⁰ *La chirurgie d'Abulcasis*, p. 184, fig. no. 110; v. also K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, pp. 54–55 (repr., op. cit., p. 204–205); A. Schahien, *Die geburtshilflich-gynäkologischen Kapitel aus der Chirurgie des Abulkasim*, p. 34 (repr., op. cit., p. 354).

ORTHOPAEDICS

Cauter

with <two spits>

(mikwāt dāt as-saffūdain)



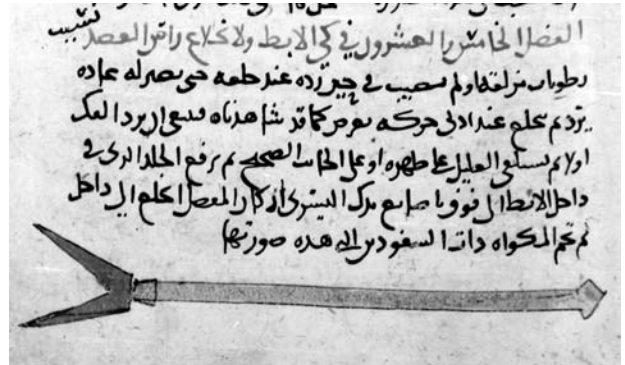
Our model:
Brass and stainless steel.
Length: 120 mm.
(Inventory No. H 3.03)



Kitāb at-Taṣrīf,
facsimile ed.,
vol. 2, p. 479
(on the margin).

for branding the armpit (*li-kaiy al-ibt*) in case of luxations (dislocations).

Our model reproduces one of the illustrations in the Istanbul manuscript Beṣirağā¹ of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.) and corresponds with the sketch drawn by L. Leclerc² after the manuscripts of the book preserved in Paris.



az-Zahrāwī, *Taṣrīf*, MS Veliyeddin
no. 2491, fol. 114a.

Cauter

with <three spits>

(mikwāt dāt talāt safāfid)



Our model:

Likewise for branding the armpit (*li-kaiy al-ibt*) in case of luxations (dislocations).

Our model corresponds with the drawing made by L. Leclerc³ after the manuscripts of the *Kitāb at-Taṣrīf* by az-Zahrāwī (4th/10th cent.) preserved in Paris and takes into account the illustrations in the Latin translations of the book. The illustrations reproduced here are taken from the Arabic copies of the work in the collections Beṣirağā⁴ (a) and Veliyeddin⁵ (b) at Istanbul as well as from the copy of the Bodleian at Oxford⁶ (c).

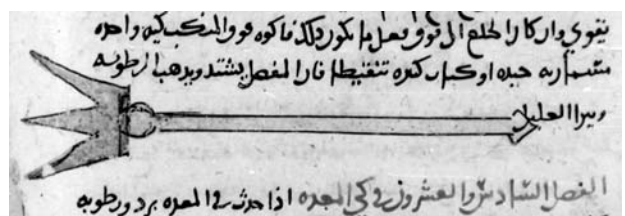


Fig.
(a)



Fig.
(c)

Fig. (b)



¹ No. 502, v. facsimile ed., vol. 2, p. 469.

² *La chirurgie d'Abulcasis*, p. 31, fig. no. 17'.

³ *La chirurgie d'Abulcasis*, p. 31–32, fig. no. 17".

⁴ No. 502, v. facsimile ed., vol. 2, p. 469 in the margin.

⁵ No. 2491, fol. 114b.

⁶ Huntington no. 156, v. *Albucasis. On Surgery and Instruments*, p. 79; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, pp. 623, 648, plate IV, no. 17b; K. Sudhoff, *Beiträge zur*

Geschichte der Chirurgie im Mittelalter, 2nd part, p. 22 and plate II, fig. 12 (repr., op. cit. p. 172, 226).

Orthopaedic bench

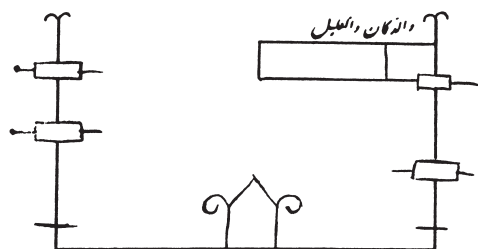
‹for the treatment of
luxations (dislocations)
of the dorsal vertebrae›

(fī ‘ilāğ fakk
ḥaraz az-ẓahr)

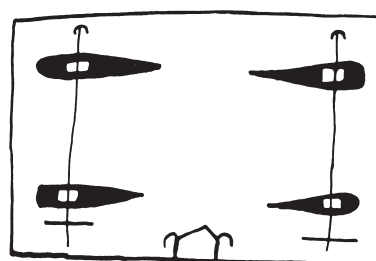
Our model:
Wood, carved figure.
(Inventory No. H 3.05)



Our model was constructed according to the drawing made by L. Leclerc⁷ after the illustrations in the Paris manuscripts of the *Taṣrif* and after the description in az-Zahrāwī's book⁸.



Kitāb at-Taṣrif, facsimile ed., vol. 2, p. 464.



Albucasis.
On Surgery and Instruments,
p. 817 (MS Hunt.).



Miniature with orthopaedic bench from the Latin translation of the *Taṣrif* (MS 14th cent.) in the Austrian National Library.⁹



Miniature with orthopaedic bench from the Turkish version of the text by az-Zahrāwī through Šerefeddīn (MS Paris).¹⁰

⁷ *La chirurgie d'Abulcasis*, pp. 131–133, fig. no. 151.

⁸ *At-Taṣrif*, facsimile ed., vol. 2, pp. 563–564; v. also K. Sudhoff, *Beiträge ...*, 2nd part, p. 67 (repr., op. cit., p. 217).

⁹ Codex S.N. 2641, facsimile ed., Graz 1979, fol. 76b.

¹⁰ P. Huard, M.D. Grmek, *Le premier manuscrit chirurgical turc rédigé par Charaf ed-Din (1465) et illustré de 140 miniatures*. Présentation française. Paris 1960, fig. 127.

GENERAL SURGERY



Scarificator

(*mišraṭ*)

Our model:
Brass and stainless steel.
Length: 147 mm.
(Inventory No. H 3.06)

for cutting off and removing cysts, sebaceous cysts and tumours (*yušraṭ bihī as-silā' wa-l-aurām*). az-Zahrāwī (4th/10th cent.) knows three different sizes (v. fig. on the right). Our model representing the largest of the three forms according to the *Kitāb at-Taṣrif*, was made on the basis of the sketch drawn by L. Leclerc¹ after the illustrations in the Parisian manuscripts. For comparison, the illustration from one of the Oxford manuscripts² is added here (on the left).

Albucasis.
On Surgery and Instruments,
p. 355 (MS Marsh).



az-Zahrāwī, *Taṣrif*, MS
Veliyeddin no. 2491, fol. 150b.

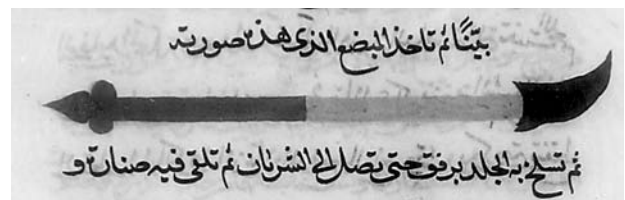
Scalpel

(*mibḍa'*)



Our model: Brass and stainless steel.
Length: 118 mm. (Inventory No. H 3.07)

for the extraction of arteries at the temples (*fī sall aš-širyānain alladain fī l-aṣḍāğ*). Our model is based on the drawing made by L. Leclerc³ after the illustrations in the Paris manuscripts of the *Taṣrif* by az-Zahrāwī (4th/ 10th cent.). For comparison, the depictions from the Istanbul manuscripts Beṣirağā⁴ and Ahmet III are added here



az-Zahrāwī, *Taṣrif*, MS Ahmet III, 1990, fol. 35a.



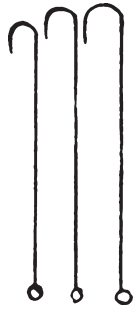
az-Zahrāwī, *Taṣrif*, facsimile ed., vol. 2, p. 479.

¹ *La chirurgie d'Abulcasis*, p. 126, fig. no. 83; cf. K. Sudhoff, *Beiträge ...*, 2nd part, p. 35 (repr., op. cit. p. 185).

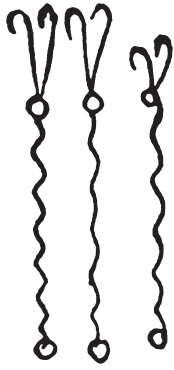
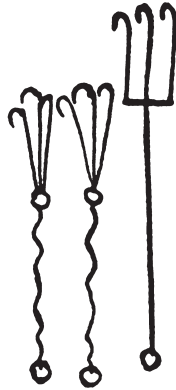
² Bodleian Library, Marsh 54, v. *Albucasis. On Surgery and Instruments*, p. 355.

³ *La chirurgie d'Abulcasis*, p. 62, fig. no. 31; cf. *Albucasis. On Surgery and Instruments*, p. 179; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 625.

⁴ No. 502, v. facsimile ed., vol. 2, p. 478–479.



Kitāb at-Taṣrīf,
facsimile ed., vol.
2, pp. 499–500.



Our model (single hook):
Brass and stainless steel.
Length: 106 mm.
(Inventory No. H 3.08)



Our model (double hook):
Brass and stainless steel.
Length: 133 mm.
(Inventory No. H. 309)



Our model (triple hook):
Brass and stainless steel.
Length: 153 mm.
(Inventory No. H 3.10)

Hook

(*ṣinnāra*)

for lifting vessels. Az-Zahrāwī (4th/10th cent.) describes in his *Taṣrīf* three types of hooks: a simple one with a single prong, one with two prongs and one with three prongs. Of each type, he mentions three sizes: small, medium and large (*ṣinnāra ṣaḡīra*, *ṣinnāra «wasat»*, *ṣinnāra kabīra*). Our models represent the «large» size in each case. They are based on the drawings made by L. Leclerc⁵ after the manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.) available in his time at Paris and on the illustrations in other manuscripts in Istanbul⁶ and Oxford⁷.

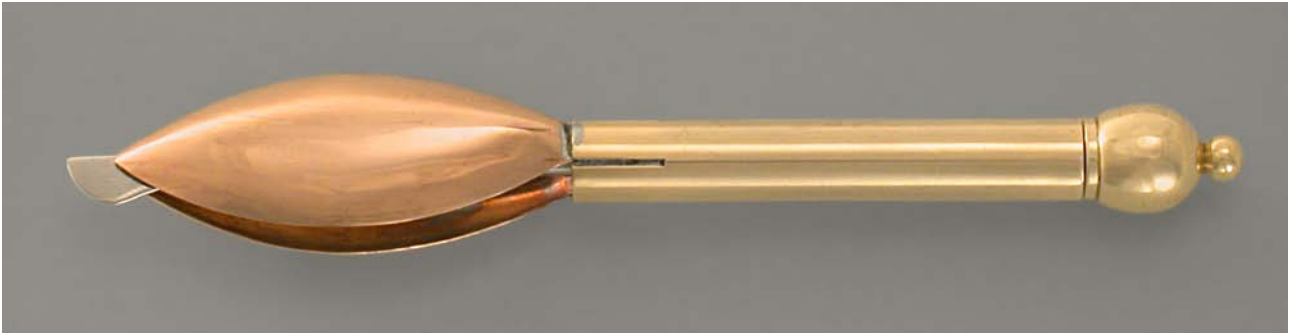


az-Zahrāwī, *Taṣrīf*, MS
Veliyeddin no. 2491, fol. 150b.

⁵ *La chirurgie d'Abulcasis*, p. 126, fig. no. 78, 80, 81.

⁶ Süleymaniye Kütüphanesi, collection Beşirağa 502, v. facsimile ed., vol. 2, p. 499–500.

⁷ Bodleian Library, Huntington 156 and Marsh 54, v. *Albucasis. On Surgery ...*, pp. 351–355; v. also K. Sudhoff, *Beiträge ...*, 2nd part, pp. 34–35 (repr., op. cit., pp. 184–185).



Covered Scalpel

«secret chamber» (*miḥdaʿ*)

Our model:
Copper, brass and steel,
length: 125 mm.
(Inventory No. H 3.11)

According to the description by az-Zahrāwī⁸ (4th/10th cent.) and his illustrations in the *Kitāb at-Taṣrīf*, this instrument consists of a blade hidden inside an ellipsoid shell. It can be pushed out of the shell up to the desired length and pulled back again into the shell so that the patient does not notice it. Our model was constructed after the description by az-Zahrāwī, following the illustrations in the Istanbul manuscript Veliyeddin⁹ and the Oxford manuscript Marsh¹⁰, and after the sketch drawn by



Albucasis. *On Surgery and Instruments*, p. 357 (MS Marsh).

L. Leclerc¹¹ after the illustrations in the manuscripts of the *Taṣrīf* available in his time at Paris. This instrument was also in use in three sizes (v. fig. below, on the left).



az-Zahrāwī, *Taṣrīf*, MS Veliyeddin no. 2491, fol. 151a.



az-Zahrāwī, *Taṣrīf*, MS Paris Bibl. nat., ar. 2953, fol. 68a.

⁸ *At-Taṣrīf*, facsimile ed., vol. 2, p. 500.

⁹ Veliyeddin 2491, fol. 151a.

¹⁰ Bodleian Library, Marsh 54, v. Albucasis. *On Surgery and Instruments*, p. 357.

¹¹ *La chirurgie d'Abulcasis*, p. 127, fig. no. 84; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 630, plate IV, no. 62; K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, pp. 35–36 (repr., op. cit. pp. 185–186).

TRAUMA SURGERY



a)

«Peeler»

or «Scraper» (Raspatorium)

(miğrad)

for the incision of bones (*li-qaṭ' al-'izām*).

Our model was prepared according to the sketch drawn by L. Leclerc¹ after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.). The illustration added here goes back to one of the Oxford manuscripts.²

Our model:
Brass and stainless steel. Length: 174 mm.
(Inventory No. H 3.12)



Albucasis. On Surgery and Instruments,
p. 573 (MS Marsh).

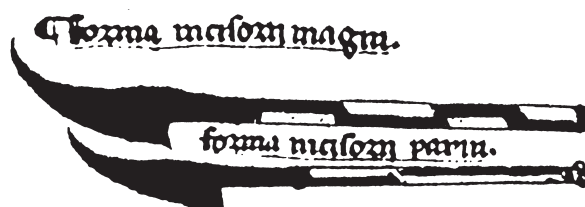
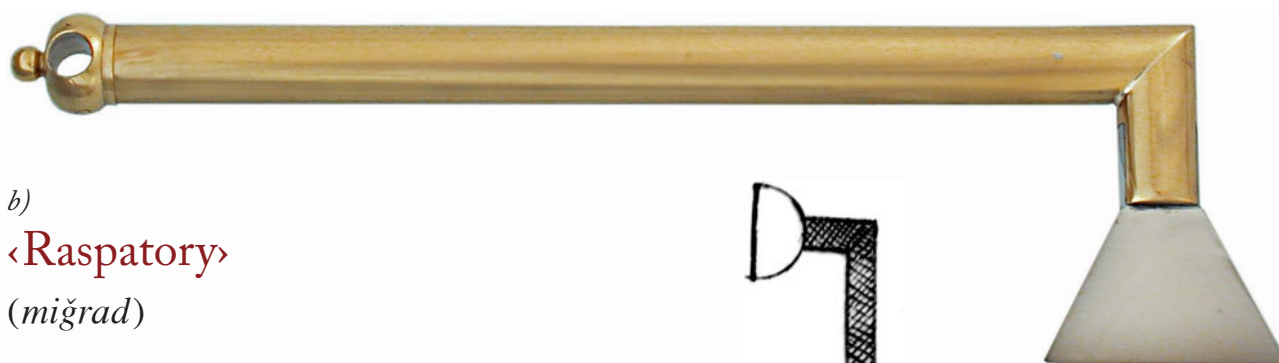


Fig. from the Latin MS, Munich, cod. lat. 161, after
K. Sudhoff, *Beiträge ...*, 2nd part, plate XVII, 8-9.



b)

«Raspatory»

(miğrad)

»bent at an angle at the end» (*mu'aqqaf at-ṭaraf*).

Our model was prepared according to the sketch drawn by L. Leclerc³ after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.). The illustration reproduced here is taken from such a source.⁴ The rounded shape of the blade probably did not affect its function.

Our model:
Brass and stainless steel.
Length: 174 mm.
(Inventory No. H. 3.13)



az-Zahrāwī, *Taṣrīf*,
MS Paris Bibl. nat.,
ar. 2953, fol. 80b.

¹ *La chirurgie d'Abulcasis*, p. 219, fig. no. 130.

² Bodleian Library, Marsh 54, v. *Albucasis. On Surgery and Instruments*, p. 573.

³ *La chirurgie d'Abulcasis*, p. 219, fig. no. 125.

⁴ Bibliothèque nationale, ar. 2953, fol. 80b; cf. *Albucasis. On Surgery and Instruments*, p. 573; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 642 and plate V, no. 85; K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 58 (repr., op. cit., p. 208).



c)

«Raspatory»

(*miğrad*)

«with indentation» (*fihi tağwif*), i.e. with a concave blade.

Our model is based on the sketch drawn by L. Leclerc⁵ after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.). The illustrations reproduced here are from the copies Huntington (a) and Marsh (b) in Oxford⁷.



(b)



(a)



d)

«Broad Raspatory»

(*miğrad ‘arīd*)

Our model is based on the sketch drawn by L. Leclerc⁸ after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.). The illustrations reproduced here⁹ come from the manuscripts Veliyeddin¹⁰ (a) at Istanbul and Marsh¹¹ (b) at Oxford.



(a)



(b)

⁵ *La chirurgie d'Abulcasis*, p. 219, fig. no. 124.

⁶ No. 502, v. facsimile ed., vol. 2, p. 528.

⁷ Bodleian Library, Huntington 156 et Marsh 54, v. *Albucasis. On Surgery and Instruments*, p. 571; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 642 and plate V, no. 84; K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 58 (repr., op. cit., p. 208).

⁸ *La chirurgie d'Abulcasis*, p. 219, fig. no. 126.

⁹ No. 2491, fol. 185b; cf. facsimile ed., vol. 2, p. 528.

¹⁰ Marsh 54, v. *Albucasis. On Surgery and Instruments*, p. 571; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 642 and plate V, no. 86.



e) **«Compact Hacksaw»**
(*minšār muḥkam*)

Our model:
Brass and stainless steel.
Length: 245 mm.
(Inventory No. H 3.16)

Our model is based on the sketch drawn by L. Leclerc¹¹ after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.) and following the illustration in the Istanbul manuscript Veliyeddin.¹² According to az-Zahrāwī, the bow and the blade are of «iron» (*ḥadīd*), the handle of box-tree wood (*baqs*), «turned and fastened well».



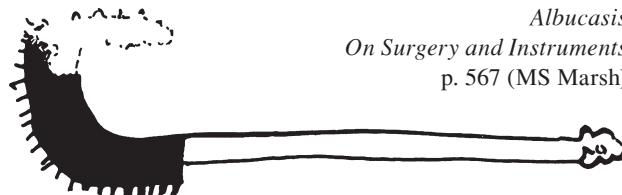
az-Zahrāwī, *Taṣrīf*, MS Veliyeddin
no. 2491, fol. 185b.

f) **Padsaw**
(*minšār*)

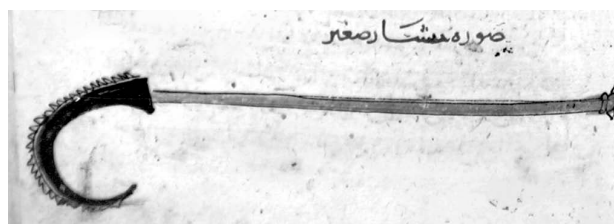
Notre modèle:
Laiton et acier inoxydable.
Longueur: 145 mm.
(Inventaire no. H 3.17)



Our model is based on the sketch drawn by L. Leclerc¹³ after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.). It corresponds to the drawing in the Oxford manuscript Marsh¹⁴.



Albucasis.
On Surgery and Instruments,
p. 567 (MS Marsh).



az-Zahrāwī, *Taṣrīf*, MS Veliyeddin
no. 2491, fol. 185a.

¹¹ *La chirurgie d'Abulcasis*, p. 219, fig. no. 128.

¹² No. 2491, fol. 185b.; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 642 and plate V, no. 81; K. Sudhoff, *Beiträge zur Geschichte der Chirurgie im Mittelalter*, 2nd part, p. 58 (repr., op. cit. p. 208).

¹³ *La chirurgie d'Abulcasis*, p. 218, fig. no. 119.

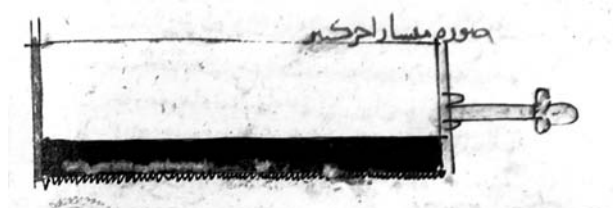
¹⁴ Bodleian Library, Marsh 54, v. Albucasis. *On Surgery and Instruments*, p. 567; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 642 and plate V, no. 79.



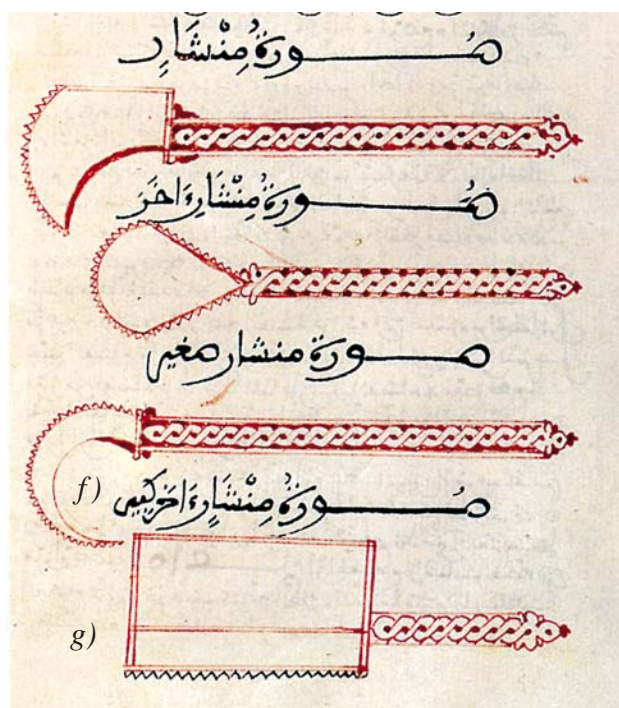
g)
 «Large hacksaw»
 (minšār kabīr)

Our model:
 Brass and stainless steel.
 Length: 255 mm.
 (Inventory No. H 3.18)

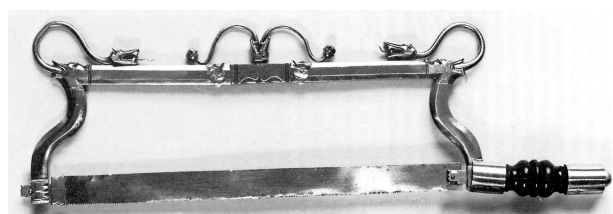
Our model is based on the sketch drawn by L. Leclerc¹⁵ after the illustrations in the Paris manuscripts of the *Taṣrīf* by az-Zahrāwī (4th/10th cent.). Additionally, the illustrations from the manuscript Veliyeddin¹⁶ at Istanbul and from one of the Paris manuscripts are reproduced here.¹⁷



az-Zahrāwī, *Taṣrīf*,
 MS Veliyeddin no. 2491, fol. 145b.



az-Zahrāwī, *Taṣrīf*,
 MS Paris Bibl. nat., 2953, fol. 79b.

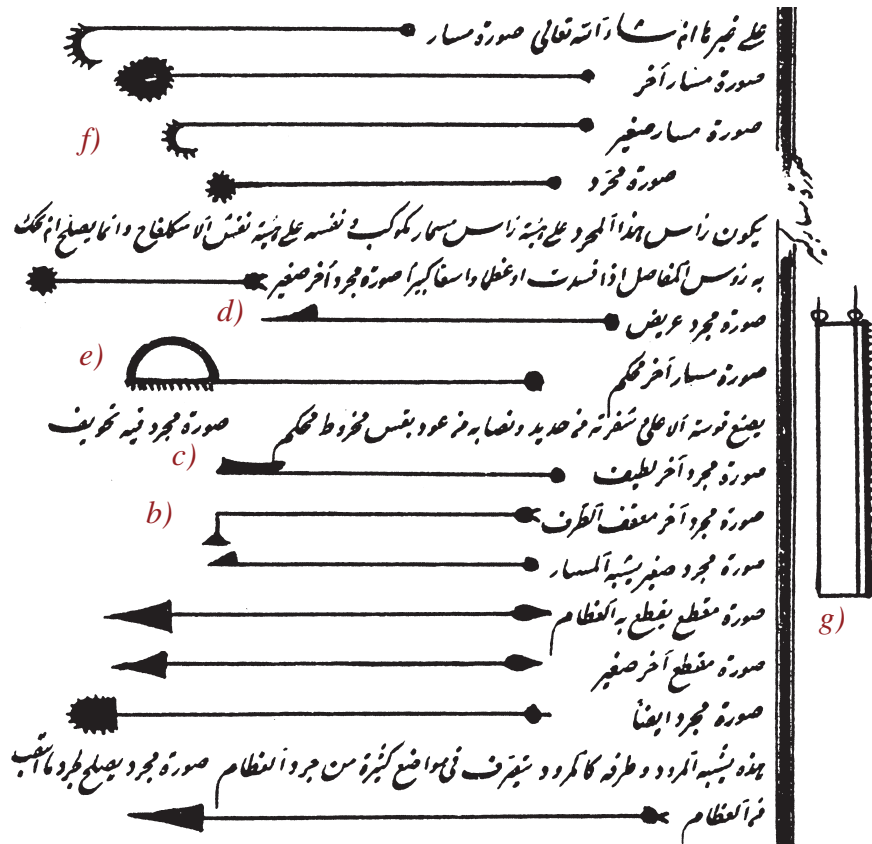


Early European saw for cutting bones (ca. 1550),
 Nuremberg, «Germanisches Nationalmuseum».

¹⁵ *La chirurgie d'Abulcasis*, p. 218, fig. no. 122; v. also E. Gurlt, *Geschichte der Chirurgie*, vol. 1, p. 642 and plate V, no. 80.

¹⁶ No. 2491, fol. 145b.

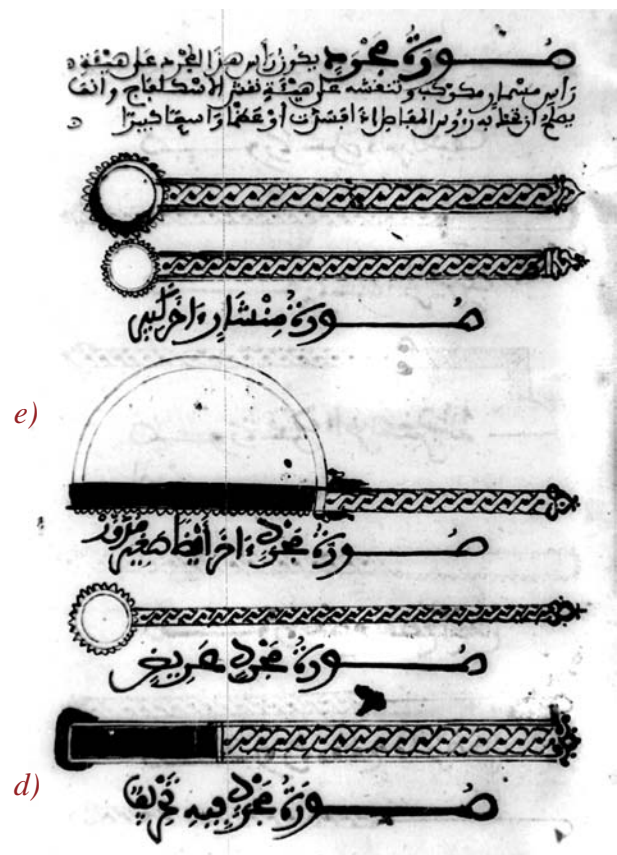
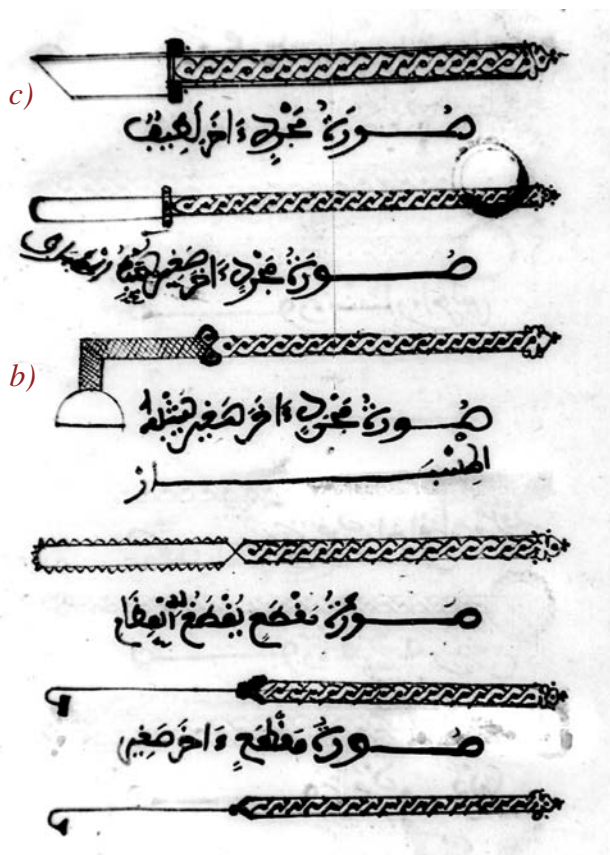
¹⁷ Bibl. nat., ar. 2953, fol. 79b.



In view of the fact that the following surgical instruments are depicted variously in different manuscripts, it seemed advisable to collect the relevant pages of the manuscripts here and to indicate with the letters of the alphabet those instruments which we reconstructed.

az-Zahrāwī, *Taṣrīf*, Süleymaniye Kütüphanesi, collection Beşirağa 502, facsimile ed., vol. 2, p. 528.

az-Zahrāwī, *Taṣrīf*, MS Paris Bibl. nat., ar. 2953, fol. 80.

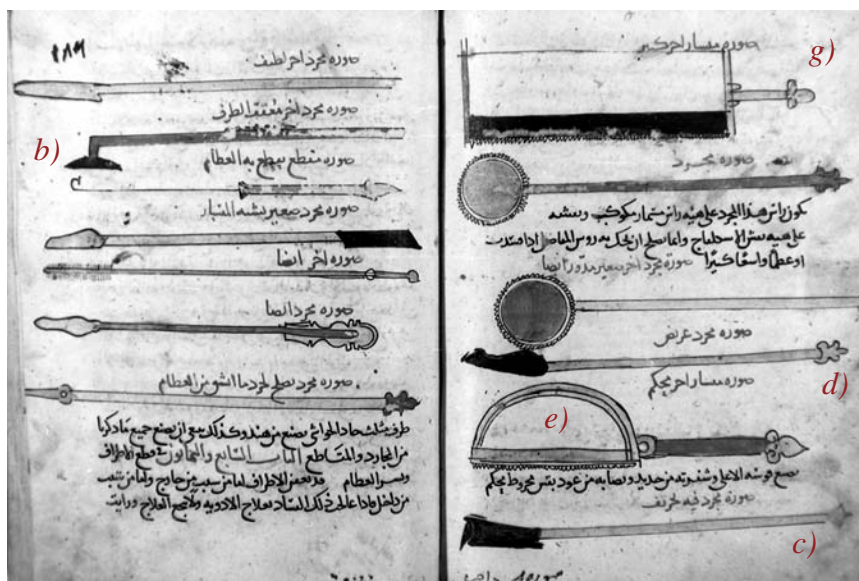




From the Turkish version of az-Zahrāwī's text by Şerefeddin
(9th/15th cent.). MS Paris suppl. turc 693, fol. 138a.



az-Zahrāwī, *Taṣrīf*,
MS Berlin, Staatsbibl., MS or. 91, f. 154 a.



az-Zahrāwī, *Taṣrīf*,
MS Veliyeddin no. 2491, fol. 185-186a.



VARIOUS INSTRUMENTS

from al-Fuṣṭāṭ (Egypt)

ca. 3rd/9th cent.?

(Originals in the Islamic Museum, Cairo)

Our models (figs. 1-5)
Brass, partly silver-plated
(Originals of copper alloys)
Length: 44-137 mm.
(Inventory nos. H 8.01-43)

The few publications¹ to have appeared so far on these uncertain archaeological finds do not, unfortunately, offer the detailed comparison needed for their identification with instruments known from literature; in some cases, the function is obvious, e.g. tweezers (fig. 1, on the right); others are unusu-

al but can be identified quite correctly with the help of the descriptions and illustrations in the *Kitāb at-Taṣrīf*; e.g. fig. 1, 2 from the left is probably a multiple cauter (see above, pp. 60, 81) which would be useful for eyelids; a few more common cauters of the kind described in az-Zahrāwī's book (see above, p. 36 ff.) are collected in fig. 5; fig. 4 shows two classical forms of the scalpel.

¹ Sami K. Hamarneh, *Excavated Surgical Instruments from old Cairo, Egypt*, in: *Annali Dell'Istituto e Museo di Storia della Scienza di Firenze*, 2/1977/1-14, 6 fig.



2



3



Chapter 8

Chemistry and Alchemy





An occidental idealised portrait of Geber, the Latinised name of Ġābir b. Ḥayyān (2nd/8th cent.), the father of Arab chemistry. The picture is from Codex lat. Ashburnham 1166 of the Biblioteca Laurenziana at Florence¹; the scroll on the side reads: «Deus et natura non faciunt frustra».

¹ v. G.B. Hartlaub, *Der Stein der Weisen*, Munich 1959, pl. 15; E.E. Ploss, H. Roosen-Runge, H. Schipperges and H. Buntz, *Alchimia. Ideologie und Technologie*, Munich 1970, p. 84; H. Schipperges, *Arabische Medizin im lateinischen Mittelalter*, p. 135.

Introduction

WHEN we trace the origin of the words chemistry and alchemy back a long way through the occidental cultural sphere, we encounter in about the 12th century the Arabic loanword *kīmiyā*¹ or, with its article, *al-kīmiyā*². Probably we strike here on the word *χημεία*, *χημεία* or *χημία* that had been used by the Greeks since an unknown time, a word whose origin the philologists and historians of chemistry have not yet agreed on.¹ Chemistry or alchemy in the sense of the transmutation or imitation of metals, or the art of making gold, under the name of *al-kīmiyā*², reached the Arabic-Islamic culture area rather early, in any case earlier than the *ʿilm aṣ-ṣanʿa*, which we encounter since the middle of the 2nd/8th century in the works of the most important figure of Arab alchemy, Ḡābir b. Ḥaiyān, in the sense of the art of the quantitative transformation of materials on a qualitative basis.² That the inhabitants of the Arabian peninsula possessed a rather sound knowledge of metallurgy and of the manufacture of glass before Islam has been attested by the rich finds unearthed since 1971 at the excavations of Qaryat al-Fau.³ The answer to the question of how far this knowledge had spread in Arabia will be one of the tasks which future historians of science will have to solve. We shall not indulge in any guesswork about the question of whether this knowledge was accompanied by some type of written documents.

The earliest preoccupation by Muslims with chemistry-alchemy as a scientific discipline is connected in Arabic literature with the names of scholars from the conquered territories. According to several early Arabic sources, Prince Ḥālid b. Yazīd, a son of the second Umayyad ruler (d. probably after 102/720), was the first among the Arabs to preoccupy himself with this art. He himself

states that having missed the caliphate he turned to scientific studies, particularly to alchemy.⁴ He is said to have been the first to suggest the translation of books on astronomy, medicine and alchemy.⁵ Among his teachers in alchemy are named a Stephanos and a Marianus of Alexandria.⁶ The grounds for his position in the history of Arab alchemy agree with one another in the treatises preserved under his name, in the statements of several Arabic sources and in the relevant citations and references in alchemical literature.

Moreover, there is the evidence of several extant manuscripts on books that were translated from the Greek into Arabic on his orders. Of course, not all scholars share the conviction expressed here. The doubts concerning the role assigned to Ḥālid b. Yazīd in the history of alchemy go back to a scholar who otherwise made a significant contribution to the study of Arabic-Islamic science, namely to Julius Ruska,⁷ who, however, almost categorically denied the beginning of the study of this and other scientific [98] disciplines in Islamic times

⁴ v. Ibn an-Nadīm, *Fihrist*, p. 354; F. Sezgin, op. cit., vol. 4, p. 121.

⁵ F. Sezgin, op. cit., vol. 4, p. 121.

⁶ *ibid*, p. 122.

⁷ I do not wish to miss the opportunity to make available to future research a note I made (in the margin of p. 124) in my own copy of the 4th volume of the *Geschichte des arabischen Schrifttums* about one of the objections raised by Ruska. It is a response to H. E. Stapleton and R. F. Azo, *An Alchemical Compilation of the Thirteenth Century, A. D.*, in: *Memoirs of the Asiatic Society of Bengal (Calcutta)* 3/1910-1914/57-94, especially p. 60 (repr. in: *Natural Sciences in Islam*, vol. 61, Frankfurt 2001, pp. 27-64, esp. p. 30). This involves the statement made by Ḥālid b. Yazīd in his *Risāla fi ṣ-ṣanʿa aṣ-ṣarifa wa-ḥawāṣṣihā*, where in connection with some medicine he says that he had treated Ṭalḥa b. ʿUbaidallāh with it. Stapleton and Azo take this name to be that of the war-hero of the same name who fell in 656 A.D. in the so-called camel battle, before Ḥālid b. Yazīd was born, and conclude from this that the treatise is a fake. Ruska seized the opportunity to agree with this. (*Arabische Alchemisten. I. Ḥālid ibn Jazīd ibn Muʿāwiya*, Heidelberg 1924, p. 29; repr. in: *Natural Sciences in Islam*, vol. 59, Frankfurt 2001, p. 29). Apart from my response that other persons by the name Ṭalḥa b. ʿAbdallāh (or ʿUbaidallāh) known to the sources could come into question here, I find the note that in the manuscript Nuruosmaniye 3633 (fol. 172 b) the statement of Ḥālid runs like this: *ʿālaḡtu Ibn Abi ʿUbaidallāh* («I have treated Ibn Abi ʿUbaidallāh»).

¹ v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 4, Leiden 1971, p. 3; see also E. E. Ploss, H. Roosen-Runge, H. Schipperges, H. Buntz, *Alchimia. Ideologie und Technologie*, Munich 1970, p. 15.

² v. F. Sezgin, op. cit., vol. 4, pp. 4-10.

³ The place lies 700 km south-west of ar-Riyāḍ in today's Saudi Arabia. At present I have only the first of the volumes on the excavations to have appeared so far: *Qaryat al-Fau. A Portrait of Pre-Islamic Civilisation in Saudi Arabia* by A. R. al-Ansary, Riyadh 1982.

before the 3rd/9th century. Ruska did not, as far as I know, deal with the pseudepigrapha—which appear in Arabic literature as titles, in quotations or as extant works, and the question of whose historicity is of great importance not only for the history of Arab chemistry-alchemy, but for the history of chemistry-alchemy as such—as one of the fundamental problems in the emergence of Arabic-Islamic knowledge, but discussed them from case to case and almost always considered them as writings authored by the «Arabs» themselves. However, if that were so, then in the field of alchemy—and not only there—the «Arabs» would be in an unusual situation of having authored their sources under pseudonyms in order to be able to quote them later as such in their own works. The question that logically follows from this, namely, whether in terms of content the Arabs could actually have been the authors of these pseudepigraphical sources at all has not, as far as I know, been seriously asked yet. Many share Ruska's attitude.

In most of the volumes of my *Geschichte des arabischen Schrifttums*, published since 1967, I have clearly stated the ideas about this problem that occurred to me in the course of my work on the history of Arabic-Islamic sciences. Naturally, I am not happy that my ideas have not found the acceptance which I expected from most of the colleagues in the field. However, nowhere do I find my views refuted with well-founded arguments.

Within the narrow confines of this introduction I wish to say just this: the writings on alchemy preserved in Arabic literature which pretend to be works by the authorities of Antiquity or which are in circulation as translations under unknown names are, in my view, important documents for a period that is still too little known in the history of the subject. By this is meant the period of Late Antiquity when pseudepigraphy enjoyed great popularity. Its beginnings among the Greeks extend back to the second century B.C. The pseudepigrapha bring us into contact with an aspect of science that was cultivated originally by the ancient Egyptians and the Greeks, and which was later cultivated in the cultural centres along the Mediterranean in Late Antiquity until the time of Early Islam, and was enriched with new elements and ideas; these were not necessarily correct in all cases, but through these the disciplines concerned seem to have reached quite a high standard.

Not all treatises on alchemy preserved in Arabic translation belong to the realm of pseudepigrapha. Among the true original which are extant only in Arabic translation, we must count, e.g. several works by Zosimus from Upper Egypt (flourished probably between 350 and 420 A.D.). His main work, *Muṣḥaf aṣ-ṣuwar*,⁸ which was discovered by the author of these lines, is probably the most important extant document of the alchemy of Late Antiquity.⁹

Incidentally, not all the originals of the pseudepigrapha preserved in Arabic translation are lost. The extant corpus of original texts in the field of alchemy and beyond, consisting both of independent books and also of fragments in Arabic literature, should in fact suffice for ruling the «Arabs» out as the authors of the pseudepigrapha. The conventional manner of looking at things stems from a period of research in the history of chemistry and alchemy, when practically nothing was known about the relevant Arabic material, and should therefore be reconsidered critically. The materials [99] put together in the fourth volume of the *Geschichte des arabischen Schrifttums* could provide impetus for such a reconsideration in accordance with the present state of knowledge.

Alchemical pseudepigrapha began reaching the Arab-Islamic world in the first century of Islam (7th cent. A.D), perhaps already together with some works which carried the names of their true authors. Persons who were acquainted with these writings and could communicate and translate their contents were as a rule members of the cultural elite of the conquered countries which, along with their cultural centres, were now part of the Islamic territory. With the translation of those works and the supported continuation of practical alchemical art by the old representatives and their newly found pupils the period of the reception of the subject in the

⁸ F. Sezgin, op. cit., vol. 4, p. 75.

⁹ Regrettably, an Arabist, displaying much destructive energy, took the liberty, in his handbook, which appeared soon after the fourth volume of the *Geschichte des arabischen Schrifttums*, of referring to the book *Muṣḥaf aṣ-ṣuwar* as «Letters from Zosimus to Theosebeia», parts of which consisted of fragments which I had listed as independent writings by Zosimus. He pronounced this judgment from his desk, without having seen any of the works mentioned.

Arabic-Islamic culture area began. The content of these writings originating in these new circles could, understandably enough, consist for quite some time of nothing but imitations and adaptations of the earliest translated works which had been authored by the youngest representatives of the discipline from the old cultural centres. The intensity of the continuation of chemistry-alchemy, the greatly enhanced interest in the subject and the helpful support on behalf of the neighboring disciplines which had found their way into the new cultural sphere at about the same time made possible a rapid transition to the phase of assimilation and shortly afterwards even to creativity. The content of those earliest translations and the quotations of Arab alchemists from them create the impression that the art of alchemy must have reached by and large a remarkable level among the people living along the Eastern Mediterranean shortly before the advent of Islam. The main thing that was lacking was exchange and interaction between the traditional cultural centres. That situation changed in the early Islamic period. Especially, Iraq with all its favourable conditions became the focal point. A phenomenon like Ġābir b. Ḥayyān, who combined in his work, appearing since about the middle of the 2nd/8th century, the two phases of the assimilation and creativity of Arabic alchemy which we have mentioned, can be explained only through this historic constellation. The chronological sequence of the progress of his thought which can be deduced from his works, the method of his citations and his attitude towards the sources help us to follow his development as clearly as with nearly no other comparable figure in intellectual history. The period of the history of alchemy which began with him, which was moulded by him and which enjoyed a comparatively high standard, was to extend up to the emergence of scholars like Boyle, Priestley and Lavoisier. His persona and his work embody almost singly the following period of the subject until the 11th/17th century in the Arabic-Islamic culture area and in the Occident. Therefore we wish to pay special attention to him at this point.

Ġābir b. Ḥayyān

In the fourth volume of my *Geschichte des arabischen Schrifttums* (pp. 132-269) which appeared in 1971, I treated the life and work of Ġābir b. Ḥayyān extensively and defended the authenticity of his lifespan and the corpus of his writings against the views of Paul Kraus, who from 1931 onwards upheld the view that Ġābir was a legendary person and that the writings attributed to him were authored by representatives of the Ismaili school of alchemy in the period between circa 250/860 and 350/960. Leaving aside the strange dating, which is untenable in my view, Kraus showed in his book *Jābir ibn Ḥayyān. Contribution à l'histoire des idées scientifiques dans l'Islam*¹⁰ in which he defends his idea of the origin of the corpus that the importance of the writings was unexpectedly great. The passage of time did not change my view of Ġābir's lifespan and his authorship. Moreover, with the more comprehensive overview which I have gained through my work on other Arabic-Islamic sciences since 1971, I can relate the appearance of Ġābir's writings only to his early date, in accordance with the Arabic sources. The author of those writings cannot have lived earlier or later than the second half of the 2nd/8th century.

Ġābir was primarily an alchemist or rather a chemist. In the course of time and as a consequence of his becoming acquainted with translated works, his interest widened to include medicine, physics, astronomy, mathematics [100] and almost all other branches of knowledge of his time.

On the question of the historicity of Ġābir and the authenticity of his work, Kraus himself provided us with important clues. Among these is the fact that many of the titles of Ġābir's works mentioned by the historian of science Ibn an-Nadīm (4th/10th cent.) are corroborated by extant writings¹¹ and that there are cross-references between the titles,¹² thus confirming the chronological sequence of the works given by Ibn an-Nadīm after Ġābir's own lists.¹³ The remarkable uniformity and consistency of the

¹⁰ Vol. I: *Le corpus des écrits jābiriens*, vol. II: *Jābir et la science grecque*, Cairo 1942-1943 (repr. in: *Natural Sciences in Islam*, vol. 67-68, Frankfurt 2002).

¹¹ P. Kraus, *Jābir ibn Ḥayyān*, vol. 1, Introduction, p. 21; F. Sezgin, op. cit., vol. 4, p. 136.

¹² P. Kraus, op. cit., vol. 1, Introduction, pp. 24-25.

¹³ *ibid.*, vol. 1, p. 23.

ideas spread over various books and the bibliographical references, together with the frequent repetitions, help the dominant ideas in Ġābir's system to stand out again and again.¹⁴ In his first study on Ġābir, Kraus¹⁵ already noticed that Ġābir's writings were characterised by certain common features of style and language. One could «therefore not take out an individual work from this corpus and declare it as unauthentic without endangering the authenticity of the entire collection.»¹⁶ And: «All the individual features of the natural sciences are built into a larger context and receive their significance and justification only from this context. We are dealing here with a philosophical train of thought which is the actual starting point of the author and his strength throughout. Again and again he emphasises that the use of the equipment and the practice of science (*'amal*) leads nowhere if theory (*'ilm*, *qijās*, *burhān*) is not given its proper place.»¹⁷

One of the characteristics of Ġābir's alchemy is his notion that the elixir can be gained not only from mineral substances but also from animals and plants. He even favours the elixir from animal substances since these are more highly developed than the others.¹⁸

The extraction of the true elixir must rest on secure principles and must fulfil all the conditions of exactitude. For this Ġābir relies on the idea that in the material world all things are composed of four elements which, for their part, are built up on four elementary qualities. Through the method of the proportions of equilibrium it is possible to define the shares of the four natures occurring in each body and to specify thus exactly its composition. The chemist will be able to control all changes that occur in the body as soon as he is able to produce separately each of the elements and elementary qualities through which nature operates. He will also be in a position to create on his own new bod-

ies and, above all, various elixirs which are capable of acting upon the metals.¹⁹

Ġābir describes the function of an elixir in the following manner: «The four principles which have an effect on the bodies from the three realms of nature, which influence them and determine their colour, are fire, water, air and earth. In fact there is no action in the three realms of nature which is not the result of these four elements. That is the reason why we rely in this art (of alchemy) on the treatment of these elements by strengthening those among them which are too weak and making weaker those which are too strong, in short, by upgrading that which is inadequate. He who succeeds in handling those four elements in the three realms of nature will thus achieve all that is to be known and will have a grasp of the knowledge of creation and of the art of nature.»²⁰

For the distillation of organic substances, Ġābir reserves an important place the kind of which cannot be found in the same measure in the earlier development of [101] this science. What is remarkable about it is, above all, the use of sal ammoniac not only of inorganic substances but also of organic ones. Because of their volatility, he counts sal ammoniac together with sulphur, mercury and arsenic among the so-called «spirits».²¹

The characteristic features of his chemistry also include the clear description of procedures and apparatuses, the methodological classification of substances, emphasis on the experiment as an important component, and a theory which is conclusive in itself.²²

Guided by his trust in human reason and natural law, Ġābir poses the question of artificial procreation (*taulīd*). «For him any living creature, in fact even humanity itself, is the result of the forces of nature working together. For, nature, in its crea-

¹⁴ P. Kraus, op. cit., vol. 2, p. 135; F. Sezgin, op. cit., vol. 4, p. 137.

¹⁵ *Dschābir ibn Ḥajjān und die Ismā'īlija*, in: Forschungsinstitut für Geschichte der Naturwissenschaften in Berlin. Dritter Jahresbericht. Mit einer wissenschaftlichen Beilage: *Der Zusammenbruch der Dschābir-Legende*. Berlin 1930, pp. 23-42, esp. p. 24 (repr. in: *Natural Sciences in Islam*, vol. 70, Frankfurt 2002, pp. 97-116, esp. p. 98).

¹⁶ *ibid.*, p. 24 (repr., p. 98).

¹⁷ *ibid.*, p. 25 (repr., p. 99); F. Sezgin, op. cit., vol. 4, p. 137.

¹⁸ P. Kraus, *Jābir ibn Ḥayyān*, op. cit., vol. 2, p. 3.

¹⁹ P. Kraus, op. cit., vol. 2, pp. 4-5; F. Sezgin, op. cit., vol. 4, p. 138.

²⁰ Ġābir, *Kitāb as-Sab'īn*, facsimile ed. under the title *The Book of Seventy*, Frankfurt, Institut für Geschichte der Arabisch-Islamischen Wissenschaften 1986, pp. 266-267; *Muḥtār rasā'il Ġābir b. Ḥayyān*, ed. by P. Kraus, Cairo 1935 (repr. *Natural Sciences in Islam*, vol. 66, Frankfurt 2002), p. 481; transl. by P. Kraus, *Jābir ibn Ḥayyān*, op. cit., vol. 2, p. 7; F. Sezgin, op. cit., vol. 4, pp. 138-139.

²¹ F. Sezgin, op. cit., vol. 4, p. 140; cf. P. Krause, *Jābir ibn Ḥayyān*, op. cit., vol. 2, p. 41.

²² cf. P. Kraus, op. cit., vol. 2, p. 32; F. Sezgin, op. cit., vol. 4, p. 140.

tions, obeys a law of quantity and numbers, the secret of which is unveiled through the theory of the proportions of equilibrium. The imitation of the procedure of nature, indeed its improvement when necessary, is possible—at least theoretically.»²³ The idea of human automatons (homunculus) occupied the Middle Ages and the Renaissance, but rarely does the problem get such scientific treatment and rarely is it discussed in such detail as done by Ġābir.

The essential features of Ġābir's system include measuring the four natures and establishing the quantity with which they are represented in each individual body. If the proportions can be defined exactly, it will also be possible to alter the composition of bodies through additions to or subtractions of their natures and to thus create new bodies.²⁴ Within the framework of his theory, Ġābir compares the non-material natures with dots or zeroes. The four natures that constitute the principle of the elements can be grasped only through intellect. Their warmth and dryness are not perceivable; that is why they act as the zero does to numbers. Zero does not possess any numerical value just as natures can neither be felt nor seen.²⁵ His belief in the mathematical order of the material world and in the possibility of explaining the qualitative change of substances on a quantitative basis is most clearly expressed in his theory of the proportions of equilibrium which he calls *‘ilm al-mizān*. This, in Ġābir's view, is «the fact that the specific characteristics (*ḥawāṣṣ*) of substances, particularly in the field of chemistry, can be measured and are based on numerically ascertainable proportions. If, e.g., vinegar loses its acidic taste when litharge is added, it means that vinegar had at first a specific composition which can be expressed in numbers and that this was altered through the addition of litharge which can likewise be expressed numerically. The appearance of the specific characteristic, in this case the capability of litharge to alter vinegar, is therefore not accidental but depends on the inner composition of the matter, and to

alter this at will is the task of the chemical procedure (*tadbīr*). If the specific characteristics have a mathematical rationale, then the procedure also has its justification and its correctness is—according to Dschābir—established.»

«Thus the principle of the measurability of bodies (*mizān*) implies that everything in the cosmos conforms to mathematical laws. It indicates the rational order of things, their harmony. On the one hand, it is manifest in each and every thing, even in the smallest, on the other, it is the broad abstract concept of our world. *Mizān* is the symbol for world order. Provided that there can be only one mathematical rationale of the specific characteristics, provided that it is clear in itself and cannot be described now in one way and now in another, in short, that there is only one type of *mizān*, only one highest world principle.»²⁶

From his basic chemical-physical notions, Ġābir is led to the formulation of [102] another system which he calls *‘ilm al-ḥawāṣṣ* («science of the specific characteristics»). Here he deals with the peculiarities of minerals, plants and animals, their «sympathies» and «antipathies» and with the significance of their characteristics for the technical and medical field.²⁷ With his immense material «Ġābir is not satisfied with a simple order or classification of the characteristics. As strange as they might seem, they must be submitted to a rational explanation, otherwise they cannot be the subject of an exact science. Beyond empirical observation, which itself aims to establish even unusual characteristics of natural things, one must define the causes on which they depend.»

«In his *Kitāb al-Ḥawāṣṣ*, Ġābir frequently connects the concept of the characteristics with that of the cause (*‘illa*, *sabab*). He criticises not only those theologians (*ahl aš-šar‘*) who deny the existence of the characteristics, but also the philosophers—among them Aristotle in particular—who maintain that the cause of the characteristics is beyond human understanding.»²⁸

²³ cf. P. Kraus, op. cit., vol. 2, p. 32; F. Sezgin, op. cit., vol. 4, p. 141.

²⁴ cf. P. Kraus, op. cit., vol. 2, p. 32; F. Sezgin, op. cit., vol. 4, p. 145.

²⁵ P. Kraus, op. cit., vol. 2, pp. 179-181; F. Sezgin, op. cit., vol. 4, p. 145.

²⁶ P. Kraus, *Dschābir ibn Ḥajjān und die Ismā‘ilijja*, op. cit., pp. 25-26 (repr., op. cit., pp. 99-100); F. Sezgin, op. cit., vol. 4, pp. 145-146.

²⁷ P. Kraus, *Jābir ibn Ḥayyān*, op. cit., vol. 2, p. 91; F. Sezgin, op. cit., vol. 4, p. 140.

²⁸ P. Kraus, *Jābir ibn Ḥayyān*, op. cit., vol. 2, p. 94; F. Sezgin, op. cit., vol. 4, p. 140.

«... Ġābir attempts to find a causal explanation of the causes.»²⁹ «Convinced that he developed natural sciences on the basis of strict exactitude, Ġābir is bold enough to believe that he has wrested the very last secret from nature. The characteristic feature of his science consists in no admitting any limit for human thought.»³⁰

These are just a few of the concepts of chemistry-alchemy and the natural sciences excerpted from Ġābir's writings by Paul Kraus, which I selected and cited in order to give the reader a general impression. Ġābir left behind a very extensive corpus of writings as can be judged from the self-citations and the cross-references, from the lists of titles preserved in literature and from his extant works. Kraus attempted to record as completely as possible the manuscripts available in the libraries at his time. Today the extent of the preserved writings known to us is considerably larger than the titles recorded by Kraus.³¹ Moreover, Kraus was not able to study all the writings of Ġābir, but did manage a relatively large part. All the same, his remarks on the ideas hidden in those manuscripts are enough to show that we are dealing with one of the most interesting and most original figures in the history of science and that those treatises reflect individual steps in the rapid and continuous development of a scientist who wishes to learn everything, who advances what he has learnt and who incorporates it continuously anew into a scientific system of natural philosophy. The vast body of knowledge that Ġābir was able to acquire and assimilate in the course of more than fifty years in that 2nd/8th century when various works from foreign cultures, particularly from the Greeks, became accessible to Muslims through translations led Kraus, unfortunately, to an erroneous conclusion. He thought that being convinced of the authenticity of Ġābir's corpus would mean setting up at the beginning of Arabic science a personality who would have anticipated the entire achievements of the following generations and

made them superfluous.³² Here we must contradict Kraus unreservedly. As wide as the framework of Ġābir's universal knowledge might have been, as masterly and as original the ideas expressed in his works may appear, we still miss in his writings the distinctive achievements known to us at this period of Arabic-Islamic science of the 3rd/9th century and the following centuries. Perhaps we can come closer to a true assessment of his actual position in the history of science [103] when we imagine that he created a synthesis on the basis of the individual pieces of knowledge that had become known to him through the pseudepigrapha and the original writings of preceding generations and through the notions which he developed on the basis of his own experiences—a synthesis which we may call the foundation of chemistry-alchemy as a science based on experiment and theory. The development achieved by him was so enormous that it slowed down afterwards in the Islamic world, but without coming to a full stop. Its direct and indirect influence on the origin and development of the subject in the Occident extends, according to the present state of our knowledge, from the 13th up to the 17th century, when efforts began to be made in the West to place the subject on a new basis. The art of alchemy-chemistry was extensively cultivated among Ġābir's contemporaries and in the first two generations following him. Of the importance of the titles known to us through citations and of the few extant treatises, no evaluation is available which rests on an examination of this material. The natural philosopher Ya'qūb b. Ishāq al-Kindī³³ (d. soon after 256/870) seems to have taken a rather negative attitude towards *al-kīmīyā'*. Of course, today, we are not yet in a position to determine what exactly he rejected³⁴ in chemistry-alchemy, which gave his younger contemporary Abū Bakr ar-Rāzī a cause for refutation (*Kitāb ar-Radd 'ala l-Kindī fī raddihī 'ala ṣ-ṣinā'a*). Al-Kindī's extant *Kitāb fī Kīmīyā' al-ʿiṭr wa-t-taṣʿidāt*³⁵ («Book on the chemistry of perfumes and distillations») allows us to suppose that he rejected the notion of transmu-

²⁹ P. Kraus, *Jābir ibn Ḥayyān*, op. cit., vol. 2, p. 95; F. Sezgin, op. cit., vol. 4, p. 141.

³⁰ P. Kraus, *Jābir ibn Ḥayyān* op. cit., vol. 2, pp. 98-99; F. Sezgin, op. cit., vol. 4, p. 141.

³¹ v. F. Sezgin, op. cit., vol. 4, pp. 231-269. In Tripoli (Libya) in 1980 I happened to come across an important anthology with about forty until then mostly unknown treatises by Ġābir. I have a low-quality Xerox-copy of the manuscript which is mislaid at present.

³² P. Kraus, *Jābir ibn Ḥayyān*, vol. 1, Preface, p. 48; F. Sezgin, op. cit., vol. 4, pp. 184, 189.

³³ v. F. Sezgin, op. cit., vol. 3, pp. 244-247.

³⁴ v. ibid, vol. 4, p. 6.

³⁵ ed. and transl. into German by Karl Garbers, Leipzig 1948 (repr. Natural Sciences in Islam, vol. 72, Frankfurt 2002).

tation and the corresponding imitations. This book consists of a collection of more than one hundred recipes «for the manufacture of fragrant oils and ointments as well as aromatic waters, and for the substitution or rather the counterfeiting of precious drugs, which give an interesting insight into the perfumery and also the trade in drugs and perfumes of those times».³⁶ The eminent physician and philosopher Abū Bakr Muḥammad b. Zakariyā‘ ar-Rāzī³⁷ (b. ca. 251/865, d. 313/925) was seriously engaged in the art of chemistry-alchemy. Apart from the fact that he refers to Ġābir in his fundamental work on alchemy, the *Kitāb al-Asrār*,³⁸ ar-Rāzī is highly dependent on Ġābir as shown clearly by H. E. Stapleton,³⁹ R. F. Azo and M. Hidāyat Ḥusain in 1927 through a comparison between the works of Ġābir and ar-Rāzī which were available to them. Our knowledge of ar-Rāzī’s chemistry-alchemy is due for the most part to Julius Ruska, whose investigations, translations and editions of ar-Rāzī’s texts between 1928 and 1939 filled a considerable lacuna in the history of chemistry. He calls ar-Rāzī «the pioneer of chemistry» or even «the founder of a new chemistry». He came, however, to this conclusion because he accepted P. Kraus’s view that Ġābir was a fictitious figure.

From ar-Rāzī’s propaedeutic introduction (*Kitāb al-Mudḥal at-ta‘līmī*), Ruska⁴⁰ communicates the manner in which he introduces instruments: «According to Rāzī, each art has its special instruments ... Thus alchemy also uses instruments and substances that must be known very thoroughly when wanting to deal with this art. First, the ‘bodies’ [*aḡsād*] and the ‘spirits’ [*arwāḥ*], i.e. the metals and the volatile substances, sulphur, mercury, zarnīch and sal ammoniac must be known, then the different kinds of salts, borax, vitriol and alum, then certain ores and rocks and some substances which

are produced artificially. Again, the construction and function of the apparatuses used for melting the metals and the treatment of other substances must be known, that is to say, the kilns, hearths, crucibles, distillation fiasks and other utensils. An apparatus for sublimation is already discussed in great detail here, which is called *al-uṭāl* in Arabic [104] and which is known even now under that name ‘aludel’. After studying the substances and the apparatuses, the pupil should then proceed to the study of the behaviour of the substances under different procedures.»

Since Ruska⁴¹ failed to recognise Ġābir’s historicity, he was convinced that ar-Rāzī should get the credit «for having brought alchemy into a strictly scientific form for the first time.» For the sake of comparison between the two great figures in the history of alchemy-chemistry, Ġābir and ar-Rāzī, I reiterate here my conviction which I voiced 31 years ago: while Ġābir, in his purely alchemical treatises, draws upon a manifold system of ideas for the experiments and observations and while he again and again stands out as a great and independent natural philosopher, it is characteristic of ar-Rāzī to create with short instructions and brief descriptions of the materials, apparatuses and procedures an alchemy-chemistry which has to serve more practical purposes.⁴² As I see it, the chemistry-alchemy we know from the works of ar-Rāzī would be unthinkable without the great opus of Ġābir which preceded it.

Like Ġābir’s writings, ar-Rāzī’s also exercised a great influence on the process of dealing with chemistry and its progress up to a new stage of development in the 17th century in the Occident (see below, p. 105 ff.). It is one of the conspicuous phenomena of the history of alchemy that a contemporary of ar-Rāzī named Abū ‘Abdallāh Muḥammad Ibn Umail,⁴³ ignoring the progress made by the experimental scientific method of the subject, continued on a path of alchemy that operated with allegories. J. Ruska thought that he had found the home of this allegorical orientation in Egypt. Without thinking of a specific home, we believe that the origin of this orientation of alchemy is to be sought in

³⁶ Karl Garbers, op. cit., p. 2.

³⁷ v. F. Sezgin, op. cit., vol. 3, pp. 274-294; vol. 4, pp. 275-282.

³⁸ v. ibid, vol. 4, pp. 216-217.

³⁹ *Chemistry in Iraq and Persia in the tenth century A. D.*, in: *Memoirs of the Asiatic Society of Bengal* 8/1922-29/317-418, esp. pp. 335-340 (repr. in: *Natural Sciences in Islam*, vol. 73, Frankfurt 2002, pp. 9-114, esp. pp. 27-32).

⁴⁰ *Al-Rāzī’s Buch Geheimnis der Geheimnisse. Mit Einleitung und Erläuterungen in deutscher Übersetzung*, in: *Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin*, vol. 6, Berlin 1937, p. 10 (repr. in: *Natural Sciences in Islam*, vol. 74, Frankfurt 2002, pp. 1-260, esp. p. 24).

⁴¹ *Al-Rāzī’s Buch Geheimnis der Geheimnisse*, op. cit., p. 13 (repr., op. cit., p. 27).

⁴² F. Sezgin, op. cit., vol. 4, p. 277.

⁴³ ibid, vol. 4, pp. 283-288.

the pre-Islamic pseudepigrapha, which include the *Turba Philosophorum*⁴⁴ (before the 4th cent. A.D.).⁴⁵ Ibn Umail seems to have found a rather wide popularity in the Occident. The Latin allegorists called him Senior Zadith filius Hamuelis.

Chemistry-alchemy, widely propagated by Ġābir and ar-Rāzī, continued to be cultivated for centuries in the Arabic-Islamic culture area. However, we do not know of any scholar among their successors who had made his mark by developing the field further on a new creative basis, a field which had been shaped by Ġābir and ar-Rāzī. The work done by the following generations consists of relatively modest contributions in which the progress achieved was not so much in the realm of theory but in practical application, such as, e.g., the widespread use of saltpeter or the quite advanced development of inks. Thus H. E. Stapleton and R. F. Azo found in the small treatise by Abu l-Ḥakīm Muḥammad b. ‘Abdalmalik al-Kāṭi⁴⁶ (written 426/1035) chemical procedures, as one would find again only 700 years later in the writings of J. Black and A.-L. Lavoisier.⁴⁷ Unfortunately, research is in rather poor shape, especially in this area of Arabic-Islamic chemistry-alchemy.

After this overview I would like to discuss briefly the question of the continuation of Arabic-Islamic alchemy in the Occident. The beginnings of the knowledge of Arabic chemistry-alchemy in the Latin world continue to remain a mystery. At this point we have no reason for believing that in this field, too, Arabic treatises came to the knowledge of Europeans through translations as early as in the 4th/10th century. But on the other hand, we know for certain that Arabs in Spain could already author books on this subject in the first half of the 5th/11th century.⁴⁸ In this connection it is worth noting that the historian of chemistry, Marcelin Berthelot, could ascertain towards the end of the 19th century that in the second edition of the famous treatise *Mappae clavicula* (on the production of colours and dyeing) some Arabic alchemistic [105] terms

occur.⁴⁹ These and other elements, missing in the older of the two extant manuscripts of the treatise, which probably dates from the 10th century, led to the assumption that they were interpolated in the first half of the 12th century. This edition, which also contains some English words, is even associated with the name of the famous English scholar and translator Adelard of Bath.⁵⁰ Based on this fact, the historian of chemistry, John Maxson Stillman⁵¹ opined: «It is during the twelfth century that Christian Europe first seems to have assimilated the results of Arabian chemistry and it is probable that these manuscripts had their origin either in Italy or in the south of France.» Once sufficient insight into the translated material from Arabic alchemical-chemical books, their adaptations, imitations and forgeries in Latin literature, has been gained it is possible to reach the supposition that the beginnings of the translation activity in this area can be placed in the first half of the 12th century. Julius Ruska⁵² asked himself in 1935 how the Occident got to know these books. His answer which, as I believe, is still valid even now is as follows: «For the time being it is difficult to say what the circumstances were on which the selection of the translated authors depended. We can hardly credit the oldest translators with a special knowledge of the field and critical acumen. Thus they would have been dependent on the judgment of the Muslims to whom they owe the Arabic material; in other words, the oldest stock of Latin alchemy must have been a reflection of the literature which enjoyed wider popularity and special esteem in the Islamic west in the 11th/12th century.»

Even now we are far removed from even an approximate idea as to which and how many treatises altogether of Arabic-Islamic alchemy reached the Occident in translations. Several treatises under the

⁴⁴ F. Sezgin, op. cit., vol. 4, pp. 60-66.

⁴⁵ ibid, p. 286.

⁴⁶ ibid, p. 291-292.

⁴⁷ H. E. Stapleton, R. F. Azo, *Alchemical equipment in the eleventh century A. D.*, in: *Memoirs of the Asiatic Society of Bengal* 1/1905/47-70, part. p. 48 (repr. in: *Natural Sciences in Islam*, vol. 61, Frankfurt 2001, p. 2).

⁴⁸ F. Sezgin, op. cit., vol. 4, pp. 294-298.

⁴⁹ *La chimie au moyen âge*, vol. 1, Paris 1893 (repr. Osnabrück, Amsterdam 1967), p. 59.

⁵⁰ G. Sarton, *Introduction to the History of Science*, vol. 1, pp. 533-534; E. E. Ploss, H. Roosen-Runge, H. Schipperges, H. Buntz, *Alchimia*, op. cit., p. 52 ff.

⁵¹ *The Story of Alchemy and Early Chemistry*, New York 1960 (repr. of *The Story of Early Chemistry*, New York 1924), p. 188.

⁵² *Übersetzung und Bearbeitungen von al-Rāzīs Buch Geheimnis der Geheimnisse*, in: *Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin*, vol. 4, Berlin 1935, pp. 153-239, esp. p. 154 (repr. in: *Natural Sciences in Islam*, vol. 74, Frankfurt 2002, pp. 261-347, esp. p. 262).

authorship of Geber and Rhazes (ar-Rāzī) had been widely circulated since at least the 13th century. Historians of chemistry of the 18th and 19th centuries identified the former with Ġābir b. Ḥaiyān. The most vehement objection to this identification came in 1893 from the French historian of chemistry M. Berthelot.⁵³ In his opinion «the Arabic works of Dschābir, judged by the accuracy in the presentation of facts, as also by the clarity of the teachings and the literary structure, are infinitely far removed from the Latin treatises of the pseudo-Geber. Not only is any knowledge of the new and original facts contained in these Latin treatises missing in the writings of the Arabic author, but it is not even possible to find in them even a single page or paragraph that could be considered a translation from the Arabic works.» Here Berthelot refers to the following Geber-treatises 1. *Summa perfectionis magisterii*; 2. *De investigatione perfectionis*; 3. *De inventione veritatis*; 4. *Testamentum Geberi*. Julius Ruska⁵⁴ was perhaps the first Arabist to deal with the Geber question, even though at a time (1929) when just very few Arabic manuscripts of Ġābir's were known. On the content of the treatises, Ruska says:⁵⁵ «In order to move one step ahead with the Geber problem we must take note of three things: the general dependence of the Geber treatises on Arabic alchemy, the special dependence on Dschābir, and the new experiences and observations [106] which are set down in these treatises. That the author is dependent on Arabic alchemy in all the essentials is obvious. I consider it totally impossible that his work could be the translation of a work by the old Dschābir ibn Ḥajjān. In which respect the author already goes beyond the Arabs cannot be ascertained today when we consider that we still have only an unsatisfactory grasp of Arabic

alchemy today.» About the author Ruska says:⁵⁶ «That the author of the Geber treatises was a person who knew Arabic alchemy very well is obvious at every step. Certain sentences and expressions, even complete chapters, can perhaps be shown to have been used in Arabic alchemical treatises as well [here he refers to the Arabic proverb 'haste is of the devil' which appears in *De investigatione perfectionis*]. But I do not believe that the 'Pseudo-Geber' had Arabic originals in front of him and that he translated from them ...».

«So far all attempts to throw light on the darkness surrounding the personality of the author of the Geber treatises have been in vain. His Latin schooling points to his being a cleric familiar with matters related to the natural sciences.»

During his intensive study of Abū Bakr ar-Rāzī's chemistry-alchemy, Ruska was led, in the fourth decade of the 20th century, to an explanation of the authorship of *The Summa Perfectionis magisterii* which he then considered as basically settled.⁵⁷ The crucial factor was a piece of information in the manuscript of the Latin version of ar-Rāzī's «Mystery of Mysteries» which is preserved in the Riccardiana library in Florence.⁵⁸ There Ruska found the author's indication that he wanted to write another book entitled *Summa* on all questions of alchemy.⁵⁹ Of course, it is not at all safe to equate this *Summa* with *The Summa Perfectionis magisterii*, for the Latin translator could have rendered any one of the three Arabic terms *ġāmi'*, *ḥāwī* or *maġmū'* with the word *summa*, assuming that the adaptation was done by a person who wrote in Arabic. Ruska noticed further that in this codex ar-Rāzī's book shows signs of an adaptation. He wondered whether it was an Arabic adaptation of the *Kitāb Sirr al-asrār*, which could have been done for instance in Spain or whether it was a late Latin adaptation. «The occasional use of the Arabic formulas, cum Deo, nutu Dei, Deo volente etc., in any case no longer suffices for the assumption of a translation after an Arabic original. The consistently better form of the Latin sentence structure and the entire

⁵³ *La chimie au moyen âge*, vol. 3, Paris 1893 (repr. in: *Natural Sciences in Islam*, vol. 64, Frankfurt 2002), p. 23; J. Ruska, *Die bisherigen Versuche, das Dschābir-Problem zu lösen*, in: *Forschungs-Institut für Geschichte der Naturwissenschaften in Berlin. Dritter Jahresbericht*, Berlin 1930, p. 14 (repr. in: *Natural Sciences in Islam*, vol. 70, Frankfurt 2002, pp. 89-102, esp. p. 94); F. Sezgin, op. cit., vol. 4, p. 175.

⁵⁴ *Pseudo-Geber*, in: *Das Buch der großen Chemiker*, ed. Günther Bugge, vol. 1, Berlin 1929, pp. 32-41 (repr. in: *Natural Sciences in Islam*, vol. 70, Frankfurt 2002, pp. 72-81). Here Ruska depends on the German translation of the Geber treatises by Ernst Darmstaedter, *Die Alchemie des Geber*, Berlin 1922.

⁵⁵ *Pseudo-Geber*, op. cit., p. 66 (repr., op. cit., p. 78).

⁵⁶ *Pseudo-Geber*, op. cit., pp. 40-41 (repr., op. cit., pp. 80-81).

⁵⁷ *Al-Rāzī's Buch Geheimnis der Geheimnisse ... in deutscher Übersetzung*, op. cit., p. 33 (repr., op. cit., p. 47).

⁵⁸ J. Ruska, *Übersetzung und Bearbeitung von al-Rāzīs Buch Geheimnis der Geheimnisse*, op. cit., p. 178 ff. (repr., op. cit., p. 286 ff).

⁵⁹ *ibid.*, p. 238 (repr., op. cit., p. 346).

construction of the chapters seem to indicate an original Latin composition. But in particular ... the references to later paragraphs in the large overall plan of the work, which are not contained in the *k. sirr al-asrār*, testify to the achievement of a Christian alchemist, an achievement that was independent in form and presentation, though dependent on Arabic sources.»⁶⁰

I find it difficult to understand how Ruska, to whom the history of Arabic chemistry-alchemy owes so much, could reach an explanation in which he declared «the references to later paragraphs» occurring in a 13th century manuscript⁶¹ of the Latin version of the *Sirr al-asrār* by ar-Rāzī as the achievement of a Latin alchemist, which this person was supposed to have achieved in dependence on Arabic sources. Ruska does not state whether this (Christian) alchemist who wrote in Latin was also supposed to have been the translator of the original work, or whether he, on the basis of some knowledge of Arabic sources, merely «revised»⁶² the book that had been translated by somebody else. However, it is especially remarkable that Ruska noticed that, among the Arabic sources of the book, the 38th chapter of the «Seventy Books» (*al-Kutub as-sabʿūn*) by Ġābir bears the title «Book of Games» (*Kitāb al-Laʿba*⁶³), Latin *Liber ludorum*.⁶⁴ Here it is important for us to see that, judging from the quality of the excerpts, [107] these go back directly to the Arabic original and are not borrowed from the highly corrupt Latin translation *Liber de septuaginta*⁶⁵, which had been in circulation in Europe possibly since the 12th century. This is supported by the fact that the additions also include the plate with the chemical instruments (see below, p. 110), whose Arabic names the translator had to accept frequently because of the absence of Latin equivalents.

On another occasion, Ruska⁶⁶ offers a substantially different but rather helpful explanation for the origin of this Latin adaptation of Rāzī's *Sirr al-asrār*: «The evidence which I produced to show that a complete Latin translation of this work [*Sirr al-asrār*] is available in an old manuscript in Palermo permits the conclusion that it was translated for the first time in Sicily. But it also reached Spain and underwent numerous adaptations in which the descriptions of the materials and the instruments were increasingly expanded. An excellent example of such treatises derived from al Rāzī is the work *De Alumnibus et Salibus*, edited here, which was authored by a Spanish alchemist of the 11th/12th century and was already available in a Latin translation at the beginning of the 13th century.»

It becomes clear, not only⁶⁷ from this statement, that Ruska presupposes an activity of Spanish-Arabic alchemists in the 5th/11th to 6th/12th centuries, thus showing the historian the way to a solution in his endeavour to explain the origin of the Geber treatises and also of other Latin alchemical texts of the 13th and 14th century.

Without intending to dwell any longer on the discussion of this question, I would like to say that I consider not only the *Secretum Bubacaris* (*Sirr al-asrār* by ar-Rāzī) but also the Latin Geber treatises as translations of adaptations which had originated for their part in the Arabic-Islamic world (such as in Spain or Northern Africa), incorporating the latest developments. This type of adaptation, while retaining the original author's name, is known to us from almost all fields of Arabic-Islamic sciences. If those treatises show, for instance, the knowledge of saltpetre, then this goes back to the fact that, besides the earlier knowledge, saltpetre was widely known in the 12th century. It may also be mentioned that Geber's *Summa perfectionis* contains long passages from Ġābir's *Kitāb as-Sabʿīn*, which turn out to be

⁶⁰ J. Ruska, op. cit., pp. 205-206 (repr., op. cit., p. 313 ff).

⁶¹ ibid, op. cit., p. 178 (repr., op. cit., p. 286).

⁶² ibid, op. cit., 212 (repr., op. cit., p. 320).

⁶³ F. Sezgin, op. cit., vol. 4, p. 242.

⁶⁴ J. Ruska, *Übersetzung und Bearbeitungen von al-Rāzīs Buch Geheimnis der Geheimnisse*, op. cit., p. 212 ff. (repr., op. cit., p. 320 ff.).

⁶⁵ cf. ibid, p. 215 (repr., op. cit., p. 323).

⁶⁶ *Das Buch der Alaune und Salze. Ein Grundwerk der spätleinischen Alchemie*, edited, translated and explained, Berlin 1935, p. 12 (repr. in: *Natural Sciences in Islam*, vol. 73, Frankfurt 2002, pp. 227-351, esp. p. 236).

⁶⁷ cf. also J. Ruska, *Über die Quellen des Liber Claritatis*, in: *Archeion* (Rome) 16/1934/145-167, esp. p. 166 (repr. in: *Natural Sciences in Islam*, vol. 71, pp. 431-453, esp. p. 452) where he says: «In a still unpublished book I have furnished proof that this treatise does not belong to Rāzī but must have been authored by a Spanish Moor in the 11th/12th century.»

independent of its Latin translation *Liber de septuaginta*.

Starting out from Ruska's work, W. R. Newman has dealt, repeatedly since 1985, with the question of the identity of the Latin writings of Geber.⁶⁸ For their explanation he consulted the treatise *Theorica et practica* of an almost unknown Paulus de Tarento, who was probably a Franciscan from the Assisi cloister. Newman established that the *Theorica et practica* contains, in parts verbatim, some passages from the adaptation of ar-Rāzī's *Secretum* as available in the Riccardiana manuscript at Florence (which he calls *De investigatione perfectionis*). In view of Ruska's remark that the author of the adaptation of the *Secretum* announces that he himself intends to write a *Summa*, Newman concludes that Paulus de Tarento is the author of *The Summa Perfectionis magisterii*.⁶⁹ Newman attempts to support his theory with many reasons and arguments. At least he tries, in one passage as far as I see, to point out that such a theory by the very nature cannot claim absolute [108] certainty.⁷⁰ Even though we cannot say that we agree with his conclusion, yet we must acknowledge with gratitude that he gave us access to rich alchemical materials in the Latin language. Moreover, he was the first to show that the author of *The Summa Perfectionis* bases his work, to a large extent, upon Ġābir's «Seventy Books».⁷¹ He has shown that Ġābir's *Kitāb al-Uṣūl* is preserved in Latin translation under the name of *Liber radicum Rasis de alkimia*.⁷²

In his main work and also in several articles, Newman treats the question of the impact of *The Summa Perfectionis*. Since, in his opinion, the book was written by Paulus de Tarento between the last quarter of the 13th century and the beginnings of the 14th century⁷³, he comes to the conclusion that the

alchemical works of the 13th century which used the *Summa* as a source are pseudo-treatises. These include books like the *Semita recta* by Albertus Magnus,⁷⁴ the *Tres epistolae* by Roger Bacon⁷⁵ and also the *Rosarium* by Arnaldus Villanovanus.⁷⁶ In order not to stretch the framework of this introduction too far, I shall just mention the question of the dissemination of the true or false writings of Rhazes (Abū Bakr ar-Rāzī),⁷⁷ Avicenna (Ibn Sīnā),⁷⁸ Senior Zadith (Ibn Umail),⁷⁹ and the writings that came into circulation as early as in the 13th century under the name of Raimundus Lullus⁸⁰ (ca. 1232-ca. 1316) to whom many texts of Arabic provenance or later forgeries were attributed.

Latin alchemical literature provides us with an instructive example of the entire process of the period of reception and assimilation of the Arabic-Islamic sciences. Individual questions like the Geber problem can, I believe, be solved more easily when they are treated within this broad framework of the period of adaptation that lasted, with certain deviations, from the 10th until the 15th and in some areas also up to the 16th century.

Let this introduction be concluded with a clarification by Julius Ruska⁸¹ regarding the sources of Latin alchemy, which he voiced 67 years ago and

⁷⁴ W. Newman, *The Genesis of The Summa Perfectionis*, op. cit., pp. 246-259; idem, *The Summa Perfectionis*, op. cit., pp. 193-194.

⁷⁵ W. Newman, *The Alchemy of Roger Bacon and the Tres Epistolae Attributed to him*, in: *Comprendre et maîtriser la nature au Moyen Âge. Mélanges d'histoire des sciences offerts à Guy Beaujouan*, Paris 1994, pp. 461-479.

⁷⁶ *The Summa Perfectionis*, op. cit., pp. 193-208.

⁷⁷ J. Ruska, *Pseudepigraphie Rasis-Schriften*, in: *Osiris* (Bruges) 7/1939/31-94 (repr. in: *Natural Sciences in Islam*, vol. 73, Frankfurt 2002, pp. 353-416).

⁷⁸ J. Ruska, *Die Alchemie des Avicenna*, in: *Isis* (Bruges) 21/1934/14-51 (repr. in: *Natural Sciences in Islam*, vol. 60, Frankfurt 2001, pp. 244-281); idem, *Avicennas Verhältnis zur Alchemie*, in: *Fortschritte der Medizin* (Berlin) 52/1934/836-837 (repr. in: *Natural Sciences in Islam*, vol. 60, pp. 242-243); G. C. Anawati, *Avicenne et l'alchimie*, in: *Convegno Internazionale, 9-15 Aprile 1969. Tema: Oriente e Occidente nel medioevo: Filosofia e scienze*, Roma 1971, pp. 285-346; F. Sezgin, op. cit., vol. 4, pp. 8-9.

⁷⁹ Studies on Ibn Umail and his impact are collected in *Natural Sciences in Islam*, vol. 75, Frankfurt 2002.

⁸⁰ *Alchimia. Ideologie und Technologie*, op. cit., p. 72; M. Pereira, *The Alchemical Corpus attributed to Raymund Lull*, London: The Warburg Institute 1989.

⁸¹ *Übersetzung und Bearbeitungen von al-Rāzī's Buch*, op. cit., p. 153 (repr., op. cit., p. 261).

⁶⁸ *New Light on the Identity of «Geber»*, in: *Sudhoffs Archiv*

⁶⁹ 1985/76-90; idem, *The Genesis of The Summa Perfectionis*, in: *Archives internationales d'histoire des sciences* (Paris) 35/1985/240-302; idem, *The Summa Perfectionis of Pseudo-Geber. A Critical Edition, Translation and Study*, Leiden 1991; idem, *L'influence de la Summa perfectionis du Pseudo-Geber*, in: J.-C. Margolin, S. Matton (Eds.), *Alchimie et philosophie à la Renaissance*, Paris 1993, pp. 65-77.

⁷⁰ W. R. Newman, *The Summa Perfectionis*, op. cit., p. 64 ff.

⁷¹ W. R. Newman, *The Summa Perfectionis*, op. cit., p. 102.

⁷² However, in my opinion, not on the Latin translation.

⁷³ W. Newman, *An unknown Latin translation of Jābir*, in: *Archives internationales d'histoire des sciences* 35/1985/301-302.

⁷⁴ *The Summa Perfectionis*, op. cit., p. 208.

which, in my opinion, is still fully justified: «It cannot be emphasised strongly enough that the alchemy of the Latin West owes practically nothing to the Greeks and nearly everything to the Arabs. For decades we stared at the fragments of the works of the Greek alchemists as if we could explain from these the content and the nature of Latin alchemy; and meanwhile we neglected the most obvious task

of tracing the occidental literature first of all to its direct and immediate sources. It is not the Greek alchemists but the translations of Arabic original works that constitute the basis of Latin alchemy, and again and again it is the translations and adaptations of Arabic authors that determined the course of developments in the Occident.»



Chemical Laboratory Equipment

The science-historical fact that the art of chemistry cultivated before the advent of Islam in Mediterranean and neighbouring cultures was not limited merely to theoretical knowledge but also included apparatuses for practical use is, for me, beyond any doubt. However, the question of since when the members of the new cultural sphere, Muslims and non-Muslims, had begun working with those apparatuses is still uncertain. Unlike most specialists in this field, the writer of these lines believes that the beginning of the use of laboratory equipment in the field of chemistry-alchemy can be traced back to as early as the first century of Islam (7th century A.D.).

Unfortunately, very little has been preserved of such tools and apparatuses that were prepared in the new culture area of Islam, at first as imitations of those of the preceding cultures, which then were advanced or invented afresh. Leaving aside smaller accessories like spatulas and tongs (see below, vol. V, 141 ff.), the archaeological finds unearthed so far are merely the fragments of larger apparatuses. But a study that aims to assess the relevant material in the museums of the world still awaits to be seen. The extant equipment known to us includes propulsion hammers (*māšiq*), plate shears (*miqṭaʿ*), tongs or tweezers (*māsik*), mortars (*hāwūn*), casting spoons (*miḡrafa*), casting moulds (*rāṭ* or *misbaka*), bottles (*qārūra*, pl. *qawārīr*), phials (*qinnīna*, pl. *qanānī*), jugs (*kūz*, pl. *kizān*), distillation caps (*inbiq*, *anbiq*, pl. *anābīq*), «gourds», i.e. retorts (*qarʿa*, pl. *qaraʿ*, Latin *cucurbita*) and receptacles (*qābila*, pl. *qawābil*).

Of the studies on the chemical apparatuses in the Arabic-Islamic culture area, we may mention the following:

Rubens Duval, *Traité d'alchimie syriaque et arabe*. II. *Traduction du texte arabe*, in: M. Berthelot, *La chimie au moyen âge*, vol. 2, Paris 1893 (repr. Osnabrück 1967), pp. 141-165.

H. E. Stapleton, R. F. Azo, *Alchemical equipment in the eleventh century, A. D.*, in: *Memoirs of the Asiatic Society of Bengal* 1/1905/47-71. Here the relevant sections from the *ʿAin aṣ-ṣanʿa wa-ʿaun aṣ-ṣanaʿa* by Abu l-Ḥakīm Muḥammad b. ʿAbdalmalik al-Ḥwārizmī al-Kāṭī¹ have been edited and translated into English.

Eilhard Wiedemann, *Über chemische Apparate bei den Arabern*, in: *Beiträge aus der Geschichte der Chemie, dem Gedächtnis von Georg W. A. Kahlbaum*, ed. by Paul Diergart, Leipzig and Vienna 1909, pp. 234-252 (repr. in: Wiedemann, *Gesammelte Schriften*, vol. 1, pp. 291-309): German translation of the relevant chapters from the *Kitāb al-Asrār* by Abū Bakr ar-Rāzī, *Mafātīḥ al-ʿulūm* by Abū ʿAbdallāh al-Ḥwārizmī, the list from *Kitāb al-Muḥtār fī kaṣf al-asrār* by ʿAbdarrahmān b. ʿUmar al-Ḡaubarī and the explanations by Abū ʿAbdallāh Šamsaddīn ad-Dimašqī.

H. E. Stapleton, R. F. Azo, M. Hidāyat Ḥusain, *Chemistry in ʿIrāq and Persia in the tenth century A. D.*, in: *Memoirs of the Asiatic Society of Bengal* 8/1928/318-417.

J. Ruska, *Übersetzung und Bearbeitungen von al-Rāzī's Buch Geheimnis der Geheimnisse*, in: *Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin* (Berlin) 4/1935/153-239, esp. pp. 230-237.

J. Ruska, *al-Rāzī's Buch Geheimnis der Geheimnisse mit Einleitung und Erläuterungen in deutscher Übersetzung*, in: *Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin* (Berlin) 6/1937/1-246, esp. pp. 54-63, 92-99.

Ahmad Y. al-Hassan, Donald R. Hill, *Islamic technology. An illustrated history*. Cambridge etc. 1986, p. 193 ff.

Unfortunately, the extant Arabic manuscripts on chemistry and alchemy very rarely include illustrations of the apparatus. The oldest known drawings are to be found in the *Kitāb Kīmīyāʾ al-ʿiṭr wa-t-tasʿīdāt* by Yaʿqūb b. Ishāq al-Kindī (d. soon after 256/870), in a manuscript dating from 405/1014.² Illustrations are also occasionally found in medical or cosmographical works or in books on

¹ v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 4, Leiden 1971, pp. 291-292.

² v. *ibid.*, vol. 3, Leiden 1970, p. 246; translated by Karl Garbers, Leipzig 1948, pp. 93-95, Arabic text pp. 49-51.

military technology. [110] The situation regarding the description and classification of apparatuses is much more favourable. Thus, for instance, the physician and chemist Abū Bakr ar-Rāzī³ (d. 313/925) describes in his *Sirr al-asrār*, 25 apparatuses,⁴ divided according to the two functions of «melting of metals» and «treatment of non-metals». It is a stroke of good luck for the history of chemistry that a Latin manuscript, which through its title *Secretum Bubacaris* proclaims the authorship of Abū Bakr ar-Rāzī,⁵ contains illustrations of 42 apparatuses. The deviations, errors and additions which occur in the Latin version when compared with the Arabic text led Julius Ruska to the assumption that the Latin version, despite much agreement with the Arabic text, was in fact an adaptation that may have originated in Spain. Be that as it may, the descriptions and names of the apparatuses we know from the Arabic original allow us to conclude that the illustrations in the Latin Riccardiana manuscript (Florence) are related to those in ar-Rāzī's original text. Another, less substantial, depiction of chemical apparatus from ar-Rāzī's book is contained in a manuscript of the Latin version in Bologna (university library 184, fol. 234) which was made known by Giovanni Carbonelli⁶ in 1925. An important compilation of illustrations of chemical furnaces, as we encounter occasionally in Arabic sources or in the Latin tradition of Arabic chemistry-alchemy such as in the Geber treatises, is contained in a manuscript of the *Liber florum Geberti*. This treatise was published by W. Ganzenmüller⁷ in 1942. Nothing is known so far about any Gebert; most likely it is a misspelling of Geber. Ganzenmüller considers it «a rather clumsily chosen pseudonym».⁸ Of Arabic authors, Gebert mentions ar-Rāzī (Albuchasir) and Ibn Sinā (Avicenna). «As far as the content of

the alchemical observations is concerned, the procedures mentioned in the foreword come, in the final analysis, from Rāzī's *Secretum Secretorum* ...»⁹ Ganzenmüller points out one special feature of the *Liber florum*, namely that «the numerous illustrations and their designations» are marked «not with words, numbers or letters, but with strange symbols which are not met with otherwise in alchemical writings.»¹⁰ This reminds us of the symbols used by Abu l-ʿIzz Ismāʿīl b. ar-Razzāz al-Ġazarī (ca. 600/1200) in his *al-Ġāmiʿ bain al-ʿilm wa-l-ʿamal* for labelling the parts of the depicted apparatuses, and these may lead us to traces of a possible Arabic prototype. In any case, Ganzenmüller recognises in many of the illustrations «quite clearly a Moorish style».¹¹ We are therefore justified in introducing to the public, within the scope of the apparatuses and devices of Arabic-Islamic chemistry-alchemy known to us, models of a selection of the furnaces illustrated in the *Liber florum Geberti* as well.



³ v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 3, p. 274 ff., vol. 4, p. 275 ff.

⁴ v. J. Ruska, *Al-Rāzī's Buch Geheimnis der Geheimnisse*, op. cit., pp. 92-99 (repr., op. cit., pp. 106-113).

⁵ v. J. Ruska, *Übersetzung und Bearbeitungen von al-Rāzī's Buch*, op. cit., p. 83 (repr., op. cit., p. 343).

⁶ *Sulle fonti storiche della chimica e dell'alchimia in Italia*, Rome 1925, p. 110.

⁷ *Liber Florum Geberti. Alchemistische Öfen und Geräte in einer Handschrift des 15. Jahrhunderts*, in: *Quellen und Studien zur Geschichte der Naturwissenschaften und der Technik* (Berlin) 8/1942/273-304 (repr. in: *Natural Sciences in Islam*, vol. 63).

⁸ *ibid*, p. 288.

⁹ *ibid*, p. 291.

¹⁰ *ibid*, p. 294.

¹¹ *ibid*, p. 295.

[111] Apparatus for the Distillation of Rose-water

described by az-Zahrāwī

The Andalusian physician Abu l-Qāsim Ḥalaf b. ‘Abbās az-Zahrāwī¹ (late 4th/10th cent.) deals rather extensively with the distillation of rose-water in the third paragraph of the 28th chapter of his *Kitāb at-Taṣrīf li-man ‘aḡiza ‘an at-taṣnīf*.² He says that the procedure for the distillation of rose-water was known to many people. He mentions it here, as he says, for two reasons. First, because it is relevant to the topic of the paragraph in question (on medicines made from animal substances) and second, to teach those who otherwise do not find a teacher. He knows four processes: 1. with water and wood fire, 2. with water and coal fire, 3. with wood fire and without water, 4. with coal fire and without water. The first is the most commonly used. After pointing out the differences in the quality of products made by the four processes, he describes first an apparatus used in Iraq for the extraction of rose-water for the rulers, and then the process common in Andalusia. While describing this, he omits certain details which he obviously expects his readers to know. For instance, we are not told how the receptacles were fastened or suspended.

The Iraqi method places a large vessel (*ṣihrīḡ*) in an expansive room. The base and sides of this vessel are made of lead and are watertight. It should be closed with a firm lid. Into the lid should be cut as many holes as required by the number and size of the intended retorts (*buṭūn*): fifty, one hundred or two hundred. Then a large copper cauldron in the form of a boiler for bath water should be taken. It [as the water reservoir] should be fastened behind the wall, above the vessel which is on the stove. It must be assured that the smoke of the stove is directed to the outside so that the rose-water is not affected by it. Then the water [from the cauldron]



Our model:
Copper and wood, laminated.
6 alembics of glass.
Total height 1.2 m.
(Inventory No. K 1.63)

should be allowed to run into the vessel on the stove ... The retorts should be placed in the holes and the spaces in between should be sealed well by using strips of linen. If the retorts are not of glass, they can be of glazed earthenware. This also applies to the receptacles into which the distilled rose-water drips.

After this, az-Zahrāwī briefly describes the process common in Andalusia which, as a matter of fact, hardly differs from the method used in Iraq. az-Zahrāwī's description, which seems to be incomplete, at least in the manuscript available to me, reached the Occident at the latest in a separate Latin translation of the 28th chapter. This translation called *Liber servitoris de praeparatione medicinarum* [112] *simplicium* appears to have been made

¹ F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 3, Leiden 1970, pp. 323-325.

² Facsimile edition, Frankfurt, Institute for the History of Arabic-Islamic Sciences, 1986, 2 vols., esp. vol. 2, pp. 399-400.

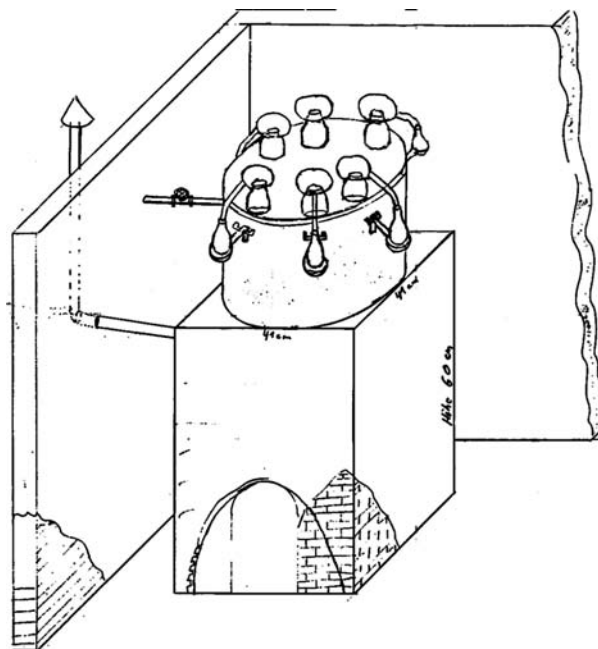
through an intermediary Hebrew translation.³ It is uncertain whether az-Zahrāwī also added illustrations to the description of the distillation vessels, as he did for surgical instruments. The explanation for the term *Berchile* appearing in the Latin translation has frequently occupied the attention of the experts.⁴ It tended quite often to be regarded as the name of the apparatus itself. The term appears in the Arabic original in the sense of a «kettle of copper» (*qidr min nuhās*). We encounter it in the *Kitāb al-Asrār* by Abū Bakr ar-Rāzī as a kettle with feet (*qidr .. ‘alā hai‘at al-mirḡal*).

Az-Zahrāwī's depiction of the distillation apparatus seems to have strongly influenced the professional circles in Europe, either through his description or through a possible illustration. In 1787 the Swedish scientist Torbern Bergman⁵ called this description «one of the first and the best».

The innovations connected in the historiography of chemistry with az-Zahrāwī's description include the use of distillation retorts of glazed earthenware, apart from those of glass.⁶ It is also possible that the shape of the retort with an enlarged head,⁷ which was called «Moore's head» by European chemists of the 16th century, is connected with az-Zahrāwī's description. For, in the course of time, the shape of the retorts placed upon the holes in the lid of the distillation vessel, as az-Zahrāwī describes

them, takes on a hybrid dimension.⁸ The fact that az-Zahrāwī speaks in the same context also of the distillation of ethanol (ethyl alcohol) attracted the attention of some historians of chemistry.⁹

Our model was constructed after the description of the Arabic text, with the exception of the manner in which the receptacles are fastened. We kept the number of alembics at a relatively small number of six, which was chosen at random. According to az-Zahrāwī it can go up to 250.



Preliminary sketch of our model.

³ M. Steinschneider, *Die hebräischen Übersetzungen des Mittelalters und die Juden als Dolmetscher*, Berlin 1893 (repr. Graz 1956), p. 740; F. Sezgin, Introduction to the facsimile edition of the *Kitāb at-Taṣrīf*, op. cit., pp. 5-6.

⁴ M. Berthelot, *La chimie au moyen âge*, Paris 1893 (repr. Osnabrück 1967), vol. 1, pp. 139-141; H. Schelenz, *Zur Geschichte der pharmazeutisch-chemischen Destilliergeräte*, Miltitz 1911 (repr. Hildesheim 1964), pp. 34-35; E. O. von Lippmann, *Beiträge zur Geschichte der Naturwissenschaften und der Technik*, Berlin 1923, p. 78, note 2; M. Speter, *Zur Geschichte der Wasserbad-Destillation: Das «Berchile» Albukasims*, in: *Pharmaceutica Acta Helvetica* (Amsterdam) 5/1930/116-120 (repr. *Natural Sciences in Islam*, vol. 62, pp. 294-298); J. Ruska, *Über die von Abulqāsim az-Zuhrāwī (read Zahrāwī) beschriebene Apparatur zur Destillation des Rosenwassers*, in: *Chemische Apparatur* (Berlin) 24/1937/313-315 (repr. *Natural Sciences in Islam*, vol. 62, pp. 299-301).

⁵ *Historiae chemiae medium seu obscurum aevum*, Leipzig 1787, p. 7; see E. Gildemeister, Fr. Hoffmann, *Die ätherischen Öle*, 2nd ed., Miltitz 1910, vol. 1, pp. 27-28.

⁶ E. Gildemeister, Fr. Hoffmann, *Die ätherischen Öle*, op. cit., vol. 1, p. 218.

⁷ v. ibid, p. 220; R. J. Forbes, *Short History of the Art of Distillation*, op. cit., pp. 83, 116, 140, 217.

⁸ v. e.g. H. Brunschwig, *Das buch der waren kunst*, op. cit., fol. 41 b, 51 a, 134 a, 142 a, 217 a.

⁹ H. Schelenz, *Zur Geschichte der pharmazeutisch-chemischen Destilliergeräte*, op. cit., p. 34; E. Gildemeister, Fr. Hoffmann, *Die ätherischen Öle*, op. cit., vol. 1, p. 220; E. O. von Lippmann, *Beiträge zur Geschichte der Naturwissenschaften und der Technik*, op. cit., p. 190; R. J. Forbes, *Short History of the Art of Distillation*, op. cit., p. 41.

Apparatus for distillation from al-Mizza for extracting Rose-water

Our model (a)
Brass, acrylic and glass.
Height: 135 cm, diameter: 50 cm.
(Inventory No. K 1.01-2)

A large apparatus for extracting rose-water is described by the cosmographer Abū ‘Abdallāh Šamsaddīn Muḥammad b. Ibrāhīm b. Abī Ṭālib al-Anṣārī Šaiḥ ar-Rabwa (d. 727/1327), who is known to Arabists as ad-Dimašqī.¹ In the context of the topography of al-Mizza, a village near Damascus,² he describes this apparatus which appears to have been quite well known in the vicinity. The relevant text³ was made accessible to the scholars by Eilhard Wiedemann through his essay *Über chemische Apparate bei den Arabern*, which appeared in 1909.⁴ According to the description by «Dimasqi», the total height of the apparatus amounted to 1 1/2 times the height of a man. Even at the beginning of the 20th century a similar apparatus called *karaka* was in use in Syria.⁵ The apparatuses at al-Mizza consisted of [114] several layers of retorts

¹ v. C. Brockelmann, *Geschichte der arabischen Litteratur*, vol. 2, p. 130; suppl.-vol. 2, p. 161.

² v. Yāqūt, *Mu‘ğam al-buldān*, vol. 4, Leipzig 1869 (repr. Frankfurt 1994), p. 522.

³ *Nuḥbat ad-dahr fī ‘ağā’ib al-barr wa-l-baḥr*, ed. A. F. Mehren, St. Petersburg 1866 (repr. Frankfurt, Islamic Geography, vol. 203), pp. 194-195; French transl., idem, *Manuel de la cosmographie du moyen âge*, Copenhagen 1874 (repr. Frankfurt, Islamic Geography, vol. 204), p. 264.

⁴ in: *Beiträge aus der Geschichte der Chemie*, dem Gedächtnis von Georg W. A. Kahlbaum, ed. by Paul Diergart, Leipzig and Vienna 1909, pp. 234-252, esp. pp. 245-249 (repr. in: Wiedemann, *Gesammelte Schriften*, vol. 1, pp. 291-309, esp. pp. 302-306); idem, *Zur Chemie bei den Arabern* (= Beiträge zur Geschichte der Naturwissenschaften XXIV), in: *Sitzungsberichte der Physikalisch-medizinischen Sozietät (Erlangen)* 43/1911/72-113, esp. pp. 107-112 (repr. in: Wiedemann, *Aufsätze*, vol. 1, pp. 689-730, esp. pp. 724-729).

⁵ Wiedemann, *Über chemische Apparate*, op. cit., p. 245 (repr., p. 302); R. J. Forbes, *Short History of the Art of Distillation*, op. cit., pp. 48-52.



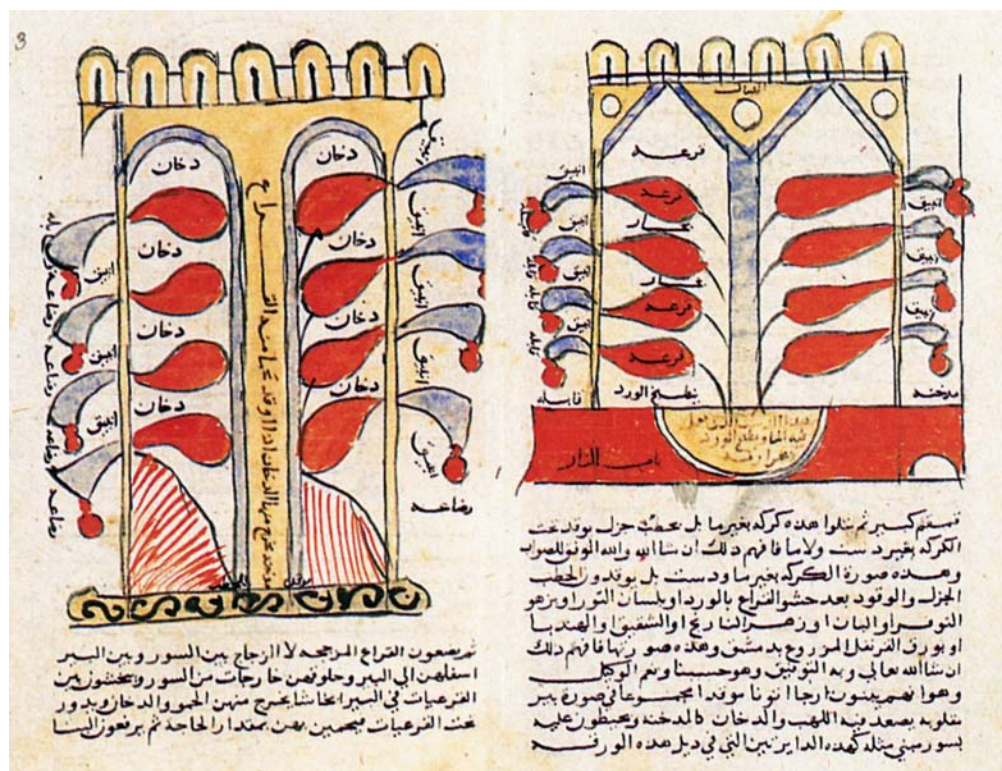


Fig. from <ad-Dimašqī>, *Nuḥbat ad-dahr*, MS Ayasofya 2945.

arranged in a radical manner with the openings to the outside. These retorts were filled with the petals to be distilled and were suspended in the smoke which started from a combustion chamber installed below and went up through a pervious shaft in the middle of the apparatus. The receptacles for the distilled liquid, which were joined to the retorts through «cap» and «beak», were fastened to the outer wall of the apparatus, which was completely covered at the top.

There seems to be a connection between this large distillation apparatus and the fornax rotunda of the Italian Pietro Andrea Mattioli⁶ (1565), which looks like a beehive made of straw (fig. on the right).

This invalidates the judgment pronounced by Franz Maria Feldhaus⁷ in 1914 to the effect that the Arabs did not know the distillation of rose oil.



Fig. from Gildemeister/Hoffmann, *Ätherische Öle* (2nd ed., 1910), vol. 1, p. 232.

⁶ *Opera quae extant omnia. Supplementum: De ratione destillandi aquas ex omnibus plantis et quomodo genuine odores in ipsis aquis conservari possint*. Basel 1565, p. 55 (not seen), see E. Gildemeister and Fr. Hoffmann, op. cit., vol. 1, pp. 231-232.

⁷ *Die Technik. Ein Lexikon der Vorzeit ...*, op. cit., p. 194.



Our model (b):
 Brass and glass.
 Total height 1.13 m.
 (Inventory No. K 1.01-1)

The distillation apparatus from al-Mizza is represented in our museum by two reconstructed models. The smaller model, built in 1987 (above), displays a simpler representation which does not fully correspond with reality. The bottom right-hand corner

has the opening for the fire; the combustion gases escape through the chimney. There is water in the inner basin, that evaporates as it is heated. The steam heats the rose petals in the retorts. Their distillate is collected in the outside receptacles.

Alembic

(latin *alembic*, Arabic *al-anbīq*)
with beak and receptacle

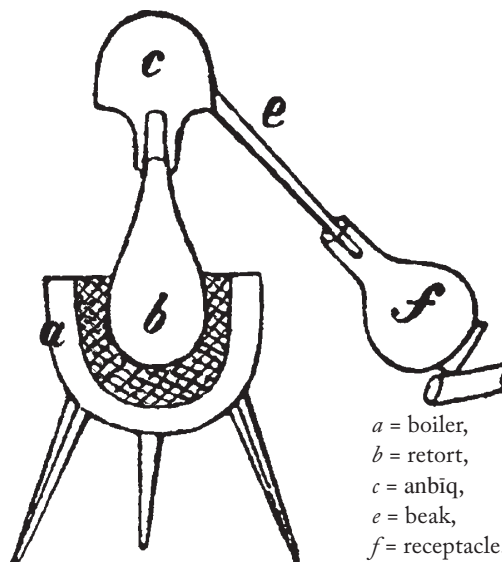
Our model:
Clay, glass, stand
and copper boiler.
Total height: 77 cm.
(Inventory No. K 1.64)

Abū Bakr ar-Rāzī describes an advanced alembic: «The anbīq with a beak and its model are suitable for the distillation of liquids. The secret here is that the retort must be large and have thick walls, without any cracks at the bottom and without any bubbles in its wall, and that the anbīq must fit tightly and sit well. The boiler in which the anbīq is placed must have the shape of a cooking pot and the retort must be submerged in the water (of the boiler) up to the highest level of the substance contained in it. Moreover, near the furnace a large boiler with boiling water must stand so that water from it can be added to the boiler (of the water bath) when the water in the latter decreases. And care must be taken that the retort is not affected by cold water, and secure the retort so that it cannot move, its bottom does not touch the bottom of the boiler, lest it should burst.»¹

Here we have the oldest description known to us of a distillation apparatus where the vapour condenses outside the cap in the receptacle. In 1909 E. Wiedemann² drew the following sketch (fig. on the right) after ar-Rāzī's description:



Fig. from Wiedemann,
Gesammelte Schriften,
vol. 1, p. 294.



a = boiler,
b = retort,
c = anbīq,
e = beak,
f = receptacle.

¹ *Kitāb al-Asrār wa-Sirr al-asrār*, ed. M. Taqī Dānīšpažūh, Teheran 1964, p. 9; German translation J. Ruska, *Al-Rāzī's Buch Geheimnis der Geheimnisse*, Berlin 1937, p. 94.

² *Über chemische Apparate bei den Arabern*, op. cit., p. 237 (repr., p. 294).



Distillation Apparatus

whose retort is surrounded by steam

The cosmographer Šamsaddīn ad-Dimašqī (d. 727/1327) describes among the «apparatuses used by Greek and Arab chemists,» (*ālāt al-Yūnān wa-ahl al-ḥikma*) a distillation apparatus for rose-water called *az-zuḡāḡ al-ḥikmī*.¹ From this description it is evident that the retort in this device is surrounded by steam, i.e., there must be some distance between the inner base of the pot and the lower tip of the retort suspended in it.²

¹ v. his *Kitāb Nuḥbat ad-dahr fī ‘aḡā’ib al-barr wa-l-baḥr*, op. cit., pp. 197-198, French transl., op. cit., p. 266.

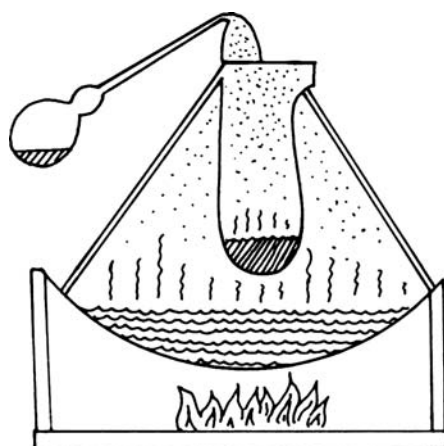


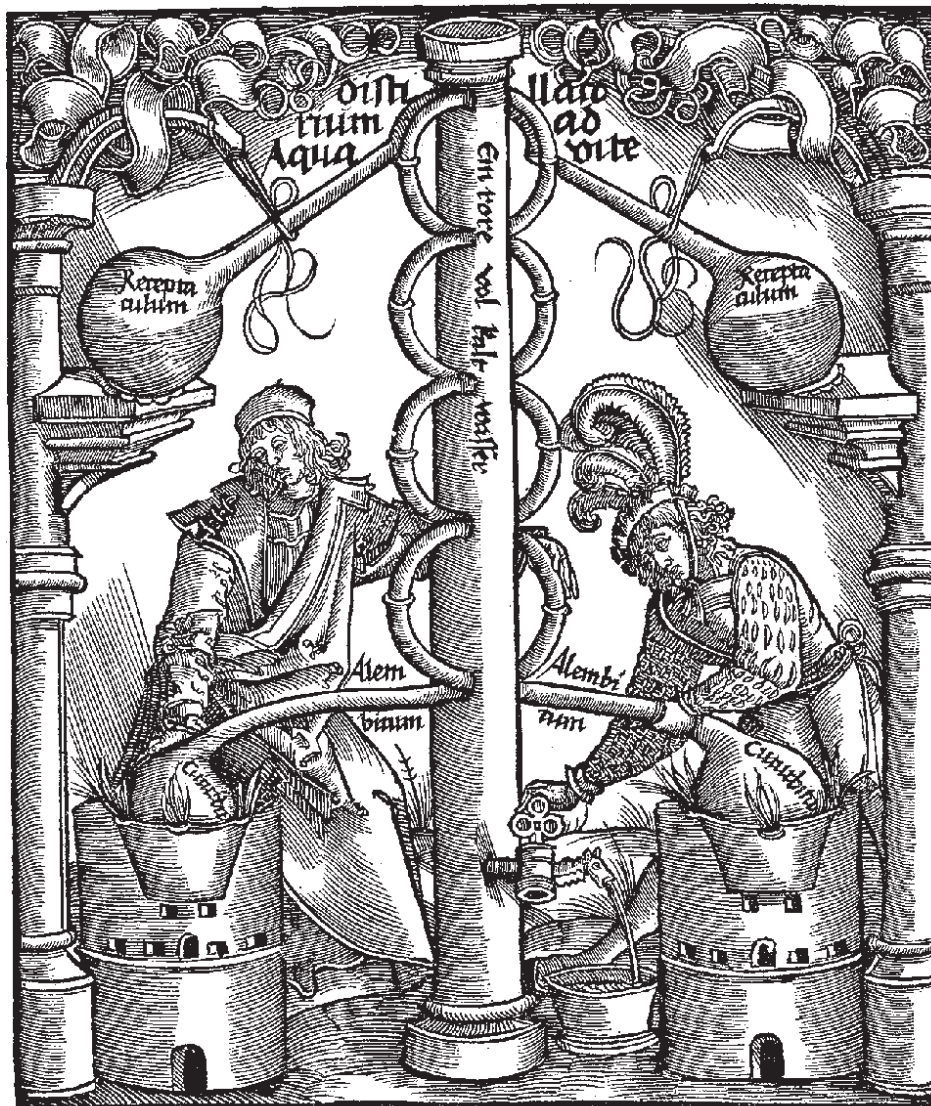
Fig. after <Dimašqī, *Nuḥbat ad-dahr*.

² v. E. Wiedemann, *Über chemische Apparate*, op. cit., p. 248 (repr. in: *Gesammelte Schriften*, op. cit., vol. 1, p. 305)



Apparatus
for the distillation of ethyl alcohol

Our model:
Brass and glass. Height: 160 cm.
Cooling tower with two retorts,
placed upon two furnaces.
Two glass containers on brass stands
at the end of the exchange pipe.
(Inventory No. K 1.02)



Gildemeister/
Hoffmann,
*Die ätherischen
Öle*, 2nd ed.,
vol. 1, p. 45.

At the beginning of the 16th century¹ a distillation apparatus of enormous dimensions for the extraction of ethyl alcohol appeared in Central Europe. An illustration of it can be seen on the frontispiece of the *Liber de arte Distillandi de Compositis* by Hieronymus Brunschwig (ca. 1450- ca. 1512), which appeared in 1507. In its size and the purpose of construction, this apparatus combines in itself the characteristics of the large rose oil distillatory apparatus from al-Mizza (see above, p. 113) and of the ethyl alcohol distillatory apparatus by Abu l-Qāsim az-Zahrāwī (see above, p. 111). On the mutual relationship of these apparatuses, F. Gildemeister and Fr. Hoffmann state: «In the distilla-

tion of ethyl alcohol (*aqua vitae*), the method of cooling borrowed from the Arabs was considered the most perfect procedure and was chosen by Brunschwig as the cover picture for the second volume of his book on distillation which appeared in 1507, and this is reproduced on p. 45.»² (Illustration above).

«The connecting pipes (*serpentinae*) that proceed upwards in wavy curves between the two retorts (*curcubitae*) and receptacles (*receptacula*) pass, at their intersections, through a pipe filled with cold water.»³

¹ E. Gildemeister, Fr. Hoffmann, *Die ätherischen Öle*, 2nd ed., Leipzig 1910, vol. 1, pp. 42-47; R. J. Forbes, *Short History of the Art of Distillation*, Leiden 1948, pp. 117-120, 128-129.

² Gildemeister and Hoffmann, op. cit., p. 220.

³ *ibid*, p. 220.



Alembic

for the extraction
of ethereal oils and alcohol

Our Museum at the Institute possesses a specimen of the alembic made of copper; its shape goes back to the 6th/12th or the 7th/13th century. This apparatus is from Anatolia and comes from the collection of the pharmacologist Turhan Baytop (Istanbul). In this version the cooler lies directly above the pot which is heated.¹

¹ Turhan Baytop, *Selçuklular devrinde Anadolu'da eczacılık*, in: 1. Uluslararası Türk-Islâm bilim ve teknoloji tarihi kongresi 14-18 eylül 1981 (Istanbul), Proceedings, vol. 1, pp. 183-192; idem, *Türk eczacılık tarihi*, Istanbul 1985, pp. 59-62.



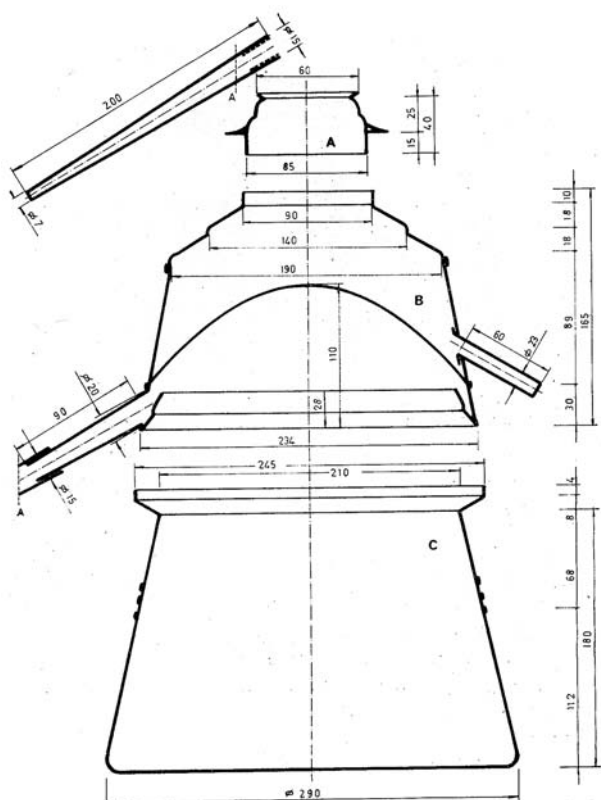


Fig. from T. Baytop,
Türk eczacılık tarihi, op. cit., p. 62.

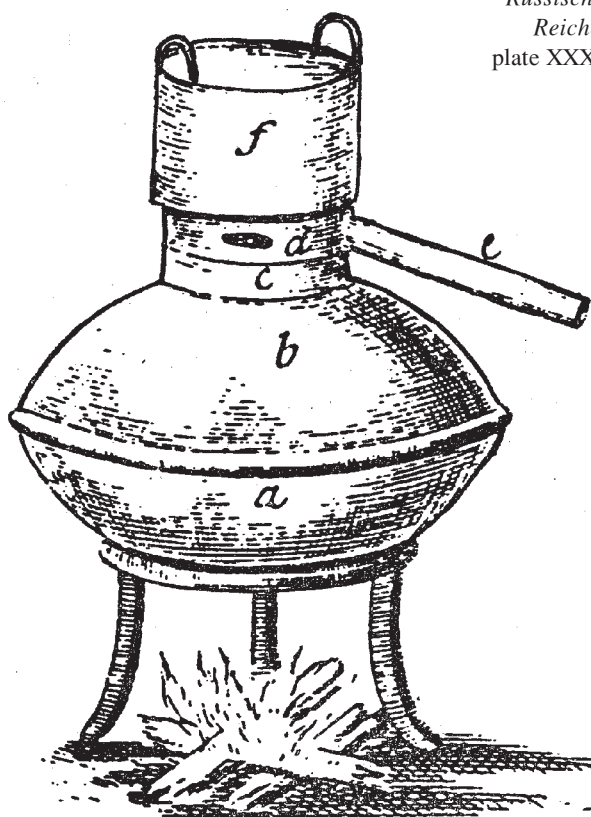
A: lead.
B: cooler.
C: pot.

The previous owner, T. Baytop, is of the opinion that this type of alembic was commonly used by the Turks in Central Asia and Anatolia. Peter Simon Pallas,² the German explorer of Asia, noticed the use of a similar apparatus for the extraction of milk brandy in Central Asia between 1768 and 1774. He reproduced the apparatus in one of his plates of illustrations.³

² *Reisen durch verschiedene Provinzen des Russischen Reiches in den Jahren 1768-1774*, 3 vols.; St. Petersburg 1771-1774 (repr. Graz 1967), esp. vol. 3, p. 404; see T. Baytop, *Türk eczacılık tarihi*, op. cit., pp. 53-54.

³ Plate XXXII

Fig. from P.S. Pallas,
*Reise durch verschiedene
Provinzen des
Russischen
Reiches*,
plate XXXII.





Two alembics from the Munich manuscript of the *Liber florum Geberti* (cod. lat. 25110, nos. 37 and 52)

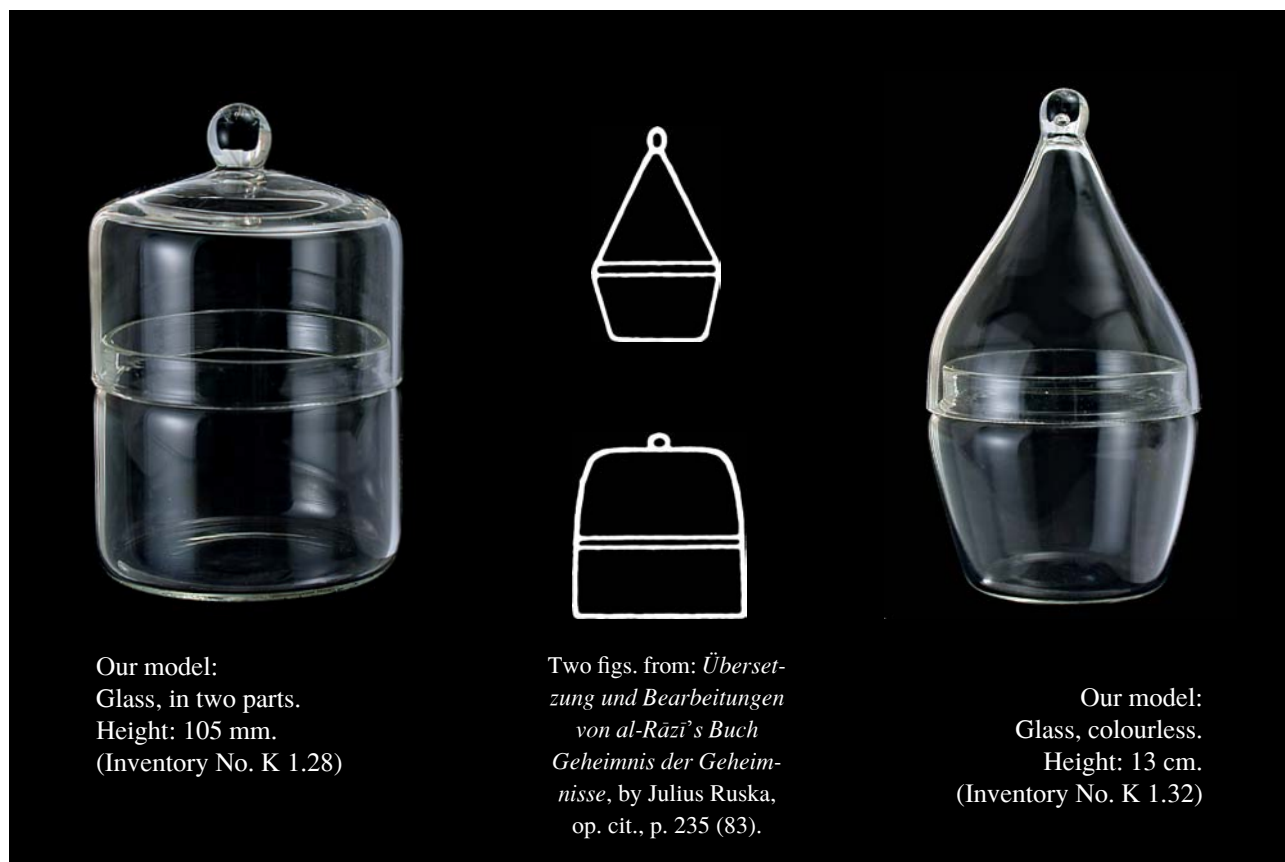


Another historical Alembic

in a simpler form, without cooling. Likewise from the collection of Turhan Baytop (Istanbul), now in the possession of the Institute.



Our model:
Copper, tin-plated.
Cap, removable
Height: 32 cm.
(Inventory No. K 1.67)



Apparatus

for the sublimation of dry substances

(Arabic *al-utāl*, Latin *alutel*, *aludel*)

According to Abū Bakr ar-Rāzī,¹ the *utāl* is used for the <sublimation> (*taṣʿīd*) of dry substances. Abū ʿAbdallāh Muḥammad b. Aḥmad al-Ḥwārizmī (2nd half of the 4th/10th cent.)² describes it as an apparatus made either of glass or clay.³ Our model was made after the Latin translation⁴ in which the name of the apparatus is given as *alutel*.

¹ *Kitāb al-Asrār wa-Sirr al-asrār*, op. cit., p. 10; J. Ruska, *Al-Rāzī's Buch*, op. cit., p. 97.

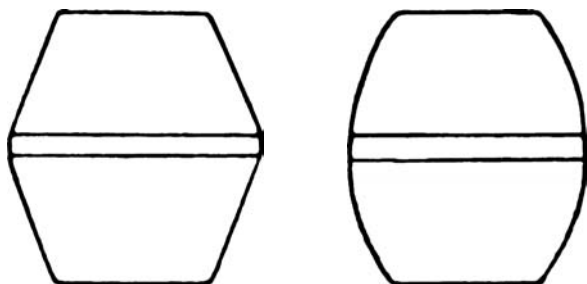
² v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 4, Leiden 1971, pp. 289-290.

³ *Mafātīḥ al-ʿulūm*, ed. G. van Vloten, Leiden 1895 (repr. Leiden 1968), p. 257; German translation of the relevant chapter by E. Wiedemann, *Zur Chemie bei den Arabern*, op. cit., p. 78 (repr., p. 695).

⁴ *Übersetzung und Bearbeitungen von al-Rāzī's Buch Geheimnis der Geheimnisse* by Julius Ruska, in: *Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin* (Berlin) 4/1935/153-239, esp. p. 235 (83).

¹ *Übersetzung und Bearbeitungen von al-Rāzī's Buch*, p. 234 (82).

² G. Carbonelli, *Sulle fonti storiche della Chimica e dell'Alchimia in Italia*, Rome 1925, p. 110.



Illustr. extraites de: *Übersetzung und Bearbeitungen von al-Rāzī's Buch Geheimnis der Geheimnisse* par Julius Ruska, p. 235 (83).

Vessels

made of two

similar glass components

On the plate of instruments of the Latin version of ar-Rāzī's *Sirr al-asrār* in the Riccardiana manuscript, two apparatuses are shown each of which is made up of two similar vessels. The first (no. 2) bears the legend *Cauchil* and is said to have been used for «the sublimation of spirits», the second (no. 13) is called *Scutellæ* and is meant for «the dissolution of spirits». ¹ A third illustration of this type of apparatus can be seen in the manuscript of the book preserved in Bologna (University, No. 184). ² Al-Kindi describes the use of such a vessel in the 73rd recipe of his *K. Kīmiyā' al-ʿitr wa-t-taṣʿidāt*. ³

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

² G. Carbonelli, *Sulle fonti storiche della Chimica*, op. cit., p. 110.

³ K. Garbers, *K. Kīmiyā' al-ʿitr wa-t-taṣʿidāt*, Leipzig 1948 (repr. *Natural Sciences in Islam*, vol. 72, Frankfurt 2002), pp. 89-90.



Our model (*Scutellæ*):

Glass, colourless.

Made up of two parts.

Height: 14.5 cm.

(Inventory No. K 1.40)



Our model (*Cauchil*):

Glass, colourless.

In two parts.

Height: 10 cm.

(Inventory No. K 1.29)



Our model (*Alembic* No. 6):
Glass, colourless.
Made up of two parts.
Height: 19 cm.
(Inventory No. K 1.33)

Our model (*Caecum*):
Glass, colourless.
Made up of two parts.
Height: 13 cm.
(Inventory No. K 1.51)

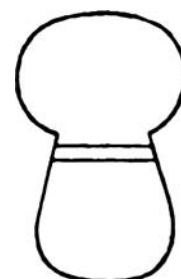
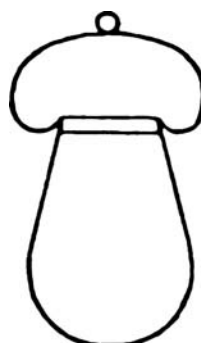
Our model (*Alembic caecum*):
Glass, colourless.
Made up of two parts.
Height: 19 cm.
(Inventory No. K 1.53)

⟨blind⟩

Alembics

(*inbīq a'mā*)

On the plate of instruments in the Latin version of ar-Rāzī's book, an apparently beakless *alembic* is depicted as no. 6.¹ It displays certain deviations when compared to the instruments shown as nos. 14, 24, and 28. These are known under the name *Alembic caecum*, derived from the Arabic, and belong to the apparatuses for the sublimation of spirits. This instrument is called *qar'a* and *anbīq* (*inbīq*) in Arabic.² The product (sublimate) is collected in the groove of the «blind» cap.



figs. from:
*Übersetzung und Bearbeitungen
von al-Rāzī's Buch Geheimnis
der Geheimnisse* by Julius Ruska,
p. 235 (83).

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

² Abū Bakr ar-Rāzī, *Kitāb al-Asrār wa-Sirr al-asrār*, op. cit., p. 9.



Distillation cap,
Iran, 3rd-4th/9th-10th cent.
Khalili Collection
No. GLS 199.



Retort, Islamic,
4th-6th/10th-12th cent.,
Science Museum,
London,
after A. Y. al-Hassan,
D. R. Hill,
Islamic Technology,
op. cit. p. 136.



Alembic with beak

Abū Bakr ar-Rāzī¹ mentions the *qar'* («gourd», i.e. retort) *wa-l-inbīq dāt al-ḥatm* (and cap with a beak) as an apparatus made up of two parts for the distillation of water. A translation of his description on the construction of the retort that should be used for this distillation is given above (p. 116).² This type of alembic is simply called *Alanbic* in the Latin version (or adaptation) of ar-Rāzī's book, whereas the name of another alembic, which ar-Rāzī³ calls *inbīq a'mā* («blind»), is rendered literally into Latin⁴ as *Caecum alembic* or *Alembic caecum*, or simply as *Caecum*.

Our model (*Alanbic*):
Glass, colourless.
Made up of two parts, a retort
and a cap with a beak.
Height: 25 cm.

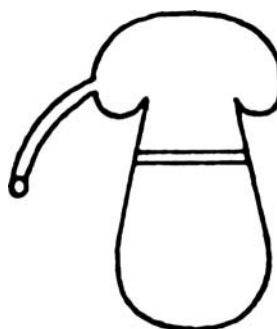


Fig. from:
Übersetzung und Bearbeitungen von al-Rāzī's Buch Geheimnis der Geheimnisse
by Julius Ruska, p. 235 (83).

¹ *Kitāb al-Asrār wa-Sirr al-Asrār*, op. cit., p. 9.

² J. Ruska, *Al-Rāzī's Buch*, op. cit., p. 94.

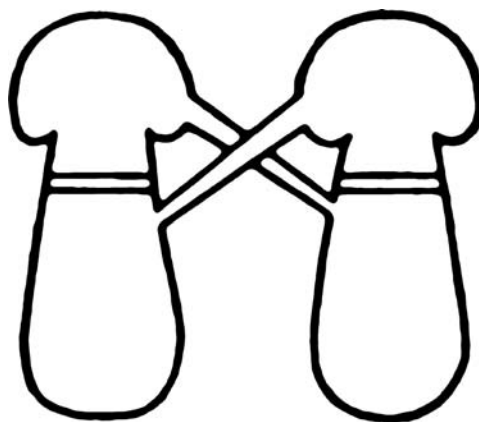
³ *Kitāb al-Asrār wa-Sirr al-asrār*, op. cit., p. 9.

⁴ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.



Double Alembic

The instruments depicted in the Latin version of ar-Rāzī's book in the Riccardiana manuscript¹ also include a pair of «double alembics» (*Alembic duplicati*, no. 31) among the devices that are made up of identical vessels. This combination seems to have been widespread in Europe.² Our model was reconstructed after the illustration in the Riccardiana manuscript.



Alembic duplicati, fig. from:
Übersetzung und Bearbeitungen von al-Rāzī's Buch...
by Julius Ruska, op. cit., p. 235 (83).

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

² v. e.g. Hieronymus Brunschwig, *Das buch der waren kunst zu destillieren*, Leipzig 1972 (repr. of the edition 1512), fol. 16a, 37a.



Two more forms of
Alembic with beak

In the Bologna manuscript (University, No. 184) of the Latin version of ar-Rāzī's book¹ two more forms of the alembic are preserved that differ from one another in the width and in the shape of the beak. In the second type the beak appears to have been extended as a coil for cooling.

Fig. from:
G. Carbonelli,
*Sulle fonti storiche
della Chimica*, p. 110.

al'ābic

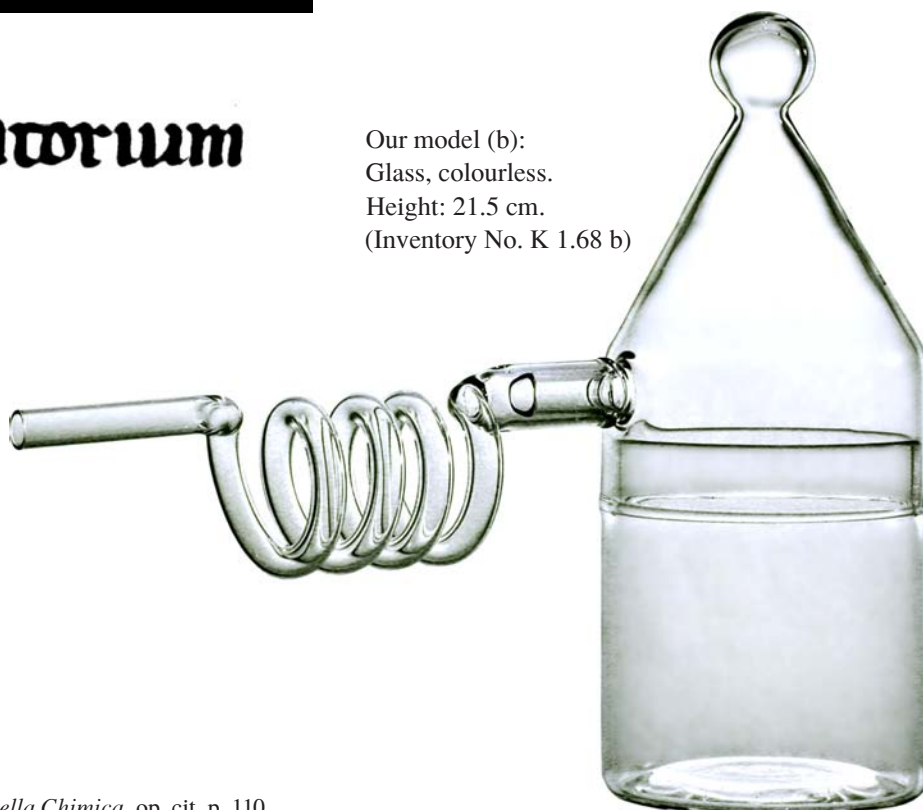


Our model (a):
Glass, colourless.
Height: 21.5 cm.
(Inventory No. K 1.68)



Fig. from:
G. Carbonelli, *Sulle fonti
storiche della Chimica*,
p. 110.

Our model (b):
Glass, colourless.
Height: 21.5 cm.
(Inventory No. K 1.68 b)



¹ G. Carbonelli, *Sulle fonti storiche della Chimica*, op. cit. p. 110.

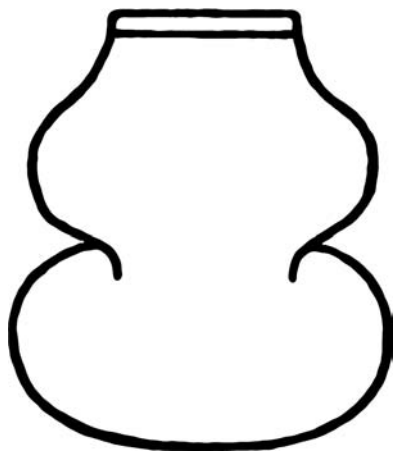


Fig. from: *Übersetzung und Bearbeitungen von al-Rāzī's Buch ...*
by Julius Ruska, p. 235 (83).

Our model:
Glass, colourless.
Height: 20 cm.
(Inventory No. K 1.52)



The «doubled gourd»

A glass vessel in the shape of a «double gourd» (*Cucurbita duplicata*; Arabic probably *qarʿa muṭannā*) is also depicted on the plate of instruments in the Latin version of ar-Rāzī's book¹ in the Riccardiana manuscript (No. 27). We find a similar picture in Hieronymus Brunschwig's book.²

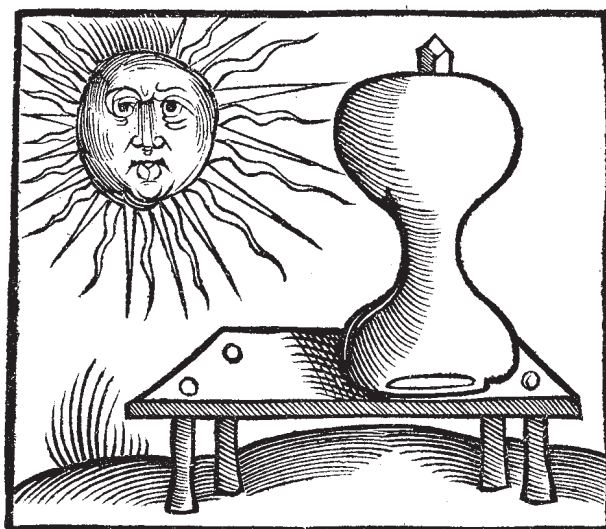


Fig. from Brunschwig, *Das buch der waren kunst zu distillieren*, reprint., fol. 14b.

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

² *Das buch der waren kunst zu distillieren*, op. cit., fol. 14b.



Our model:
Glass, colourless.
Height: 14.5 cm.
(Inventory No. K 1.57)

Retort

with a strongly bent beak

The plate of instruments in the Riccardiana manuscript of the Latin version of ar-Rāzī's book depicts another vessel (no. 32) which has a bent beak and bears the caption *Canna retroversa*. It is classified among *vasae congelationis*, the apparatuses for solidification. J. Ruska identifies it as the vessel which «is called pelican in more recent works».¹

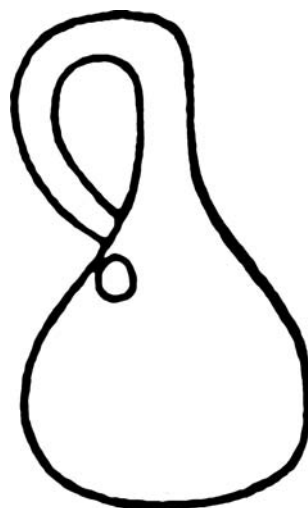


Fig. from:
Übersetzung und Bearbeitungen von al-Rāzī's Buch Geheimnis der Geheimnisse
by Julius Ruska,
p. 235 (83).

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., pp. 82, 83.



Phials/Round-bottomed Retorts

With a curved neck
or a neck bent at right angles

The plate of instruments in the Latin version of ar-Rāzī's *Sirr al-asrār* in the Riccardiana manuscript depicts two vessels for condensation under the numbers 8 (*Ampulla*) and 10 (*Canna*). One of the vessels is equipped with a curved neck, the other with a neck bent at right angles.¹

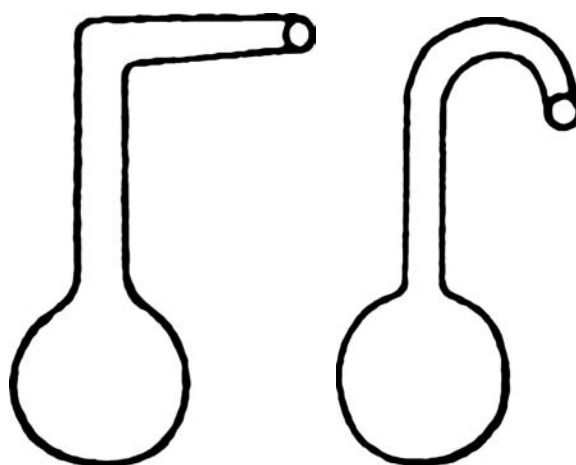


Fig. from: *Übersetzung und Bearbeitungen von al-Rāzī's Buch Geheimnis der Geheimnisse* by Julius Ruska, p. 235 (83).

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., 83.



Our model (no. 7):
Glass, colourless.
Height: 14 cm.
(Inventory no. K 1.34)

Our model (no. 15):
Glass, colourless.
Height: 13.5 cm.
(Inventory no. K 1.42)

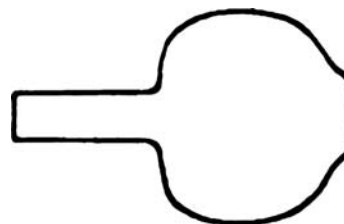
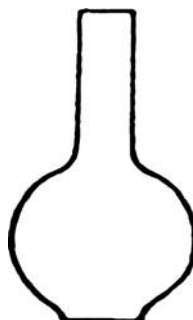
Our model (no. 29):
Glass, colourless.
Height: 23 cm.
(Inventory No. K 1.54)

Phials/flat-bottom Retorts

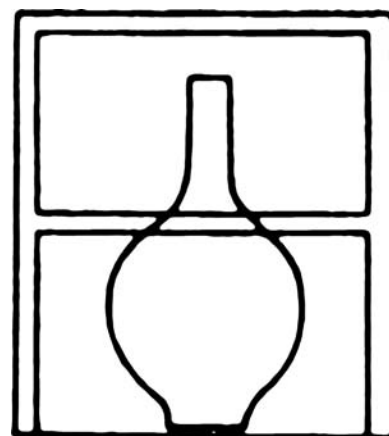
The plate of instruments of the Latin version of ar-Rāzī's book¹ contains three pictures of retorts for different operations (nos. 7, 15, 29) in the following shapes:



Glass retort, Iran, 4th/
10th cent., Museum für
Angewandte Kunst,
Frankfurt, V 204/5076.



Three figures of
Ampullae from:
*Übersetzung und
Bearbeitungen von
al-Rāzī's Buch
Geheimnis der
Geheimnisse* by
Julius Ruska, op.
cit., p. 235 (83).



¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.



Our model
(Ampulla, no.16):
Glass, colourless.
Height: 11.5 cm.
(Inventory No. K 1.55)

Our model
(Ampulla no. 30):
Glass, colourless.
Height: 12.5 cm.
(Inventory No. K 1.58)

Our model
(*Vas diss. sub fimo*, no. 33):
Glass, colourless.
Height: 11 cm.
(Inventory No. K 1.47)



Phials/Retorts with a round base

Long-necked or short-necked phials or retorts (Arabic *qinnīna* or *qār'ra*) with round bases are depicted on the plate of instruments in the Latin version of ar-Rāzī's book¹ in the Riccardiana manuscript. There they bear the numbers 16, 30 and 33.

A similar vessel is also depicted in the Bologna manuscript of the Latin translation of ar-Rāzī's *Sirr al-asrār*.²



Three figs. of Ampullae
(above) from:
Übersetzung und Bearbeitungen von al-Razi's Buch ...
by Julius Ruska, op. cit.
p. 235 (83).

Fig. from G. Carbonelli,
*Sulle fonti storiche della Chimica
e dell' Alchimia in Italia*, Rome
1925, p. 110.



Glass retort, Iran,
3rd-5th/9th-11th cent., Mu-
seum für Islamische Kunst,
Berlin, I 2312.

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

² G. Carbonelli, op. cit., p. 110, cf. p. 70.

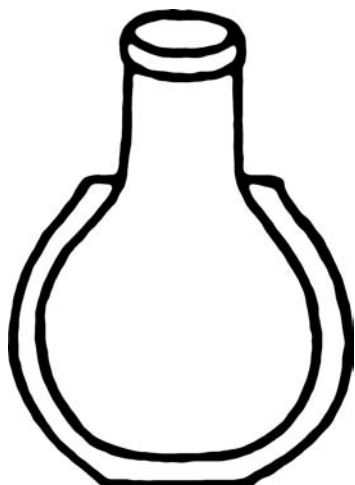


Fig. of an *Ampulla lutata* from:
Übersetzung und Bearbeitungen von al-Rāzī's Buch ...
by Julius Ruska, op. cit., p. 235 (83).

Round Retort sheathed in clay



Our model:
Glass, colourless.
Coating of unfired clay.
Height: 16 cm.
(Inventory No. K 1.49)

In connection with the «roasting of substances», Abū Bakr ar-Rāzī¹ speaks of two «beakers coated with clay» (*qadaḥān muṭaiyanān*). Abū ‘Abdallāh al-Ḥwārizmī² knows of «a pitcher coated with clay» (*kūz muṭaiyan*). As a rule, glass vessels were covered with clay to protect them from cracking under strong heating or cooling, or to seal the joints. In the Latin translation of ar-Rāzī's book,³ the retort coated with clay is called *Ampulla lutata* (no. 22).

This is the retort reconstructed by us. The ‘artificial clay’ (*ṭīn al-ḥikma*) which has the necessary properties (resistance against moisture and heat) and is very expensive to produce was described by al-Kindī,⁴ ar-Rāzī,⁵ al-Ḥwārizmī⁶ and in the Latin Riccardiana manuscript.⁷ Known as *lutum* (English *lute*), it remained an indispensable laboratory cement until recent times.

¹ *Kitāb al-Asrār wa-Sirr al-asrār*, op. cit., p. 12; Ruska, *Al-Rāzī's Buch Geheimnis der Geheimnisse*, op. cit., pp. 61, 98.

² *Mafātīḥ al-‘ulūm*, op. cit., p. 258; E. Wiedemann, *Zur Chemie bei den Arabern*, op. cit., p. 78 (repr., op. cit., p. 695).

³ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

⁴ K. Garbers, *K. Kimiyā' al-‘īṭr wa-t-taṣ‘idāt*, Leipzig 1948 (repr. *Natural Sciences in Islam*, vol. 72, Frankfurt 2002), p. 94.

⁵ J. Ruska, *Al-Rāzī's Buch Geheimnis der Geheimnisse*, op. cit., p. 96, § 14.

⁶ E. Wiedemann, *Über chemische Apparate bei den Arabern*, op. cit., p. 244 (repr., op. cit., p. 70).

⁷ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 81.



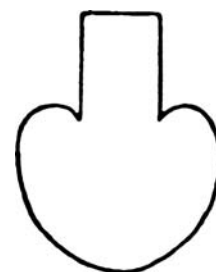
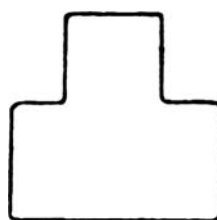
Our model (... esgen):
Glass, colourless.
Height: 10 cm.
(Inventory No. K 1.30)



Our model (Cannina):
Glass, colourless.
Height: 15 cm.
(Inventory No. K 1.31)

Two vessels with wide necks (carafes)

On the plate of instruments in the Latin version of ar-Rāzī's *Kitāb Sirr al-asrār*¹ two wide-necked vessels for sublimation are depicted under the names ...*esgen* and *Cannina* (nos. 3 and 4). While *cannina* reproduces the Arabic term *qinnīna*, the identification of the first name is beyond my knowledge.



Two figs. from: *Übersetzung und Bearbeitungen von al-Rāzī's Buch Geheimnis der Geheimnisse* by Julius Ruska, op. cit., p. 235 (83).

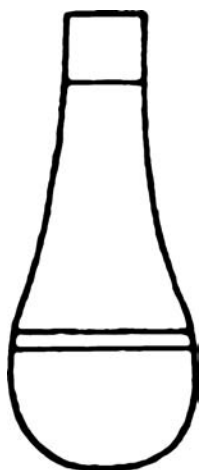


Glass vessel,
Egypt, Early Islamic,
Athens, Benaki Museum
No. 360 (43/48).

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

Mace-shaped Glass vessel

The plate of instruments in the Latin version of ar-Rāzī's *Sirr al-asrār* (Riccardiana manuscript), includes instruments that serve the purpose of «fixing the spirits,» and depicts a glass vessel, obviously in several parts, with the designation Tuba (no. 9).¹

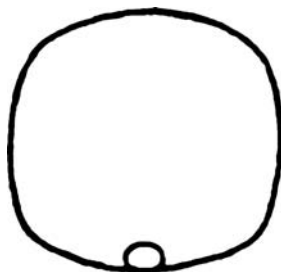


Tuba, fig. from:
*Übersetzung und Bearbeitungen von
al-Rāzī's Buch Geheimnis der Geheim-
nisse*, by Julius Ruska, p. 235 (83).

Sphere-shaped Vessel

The plate of instruments in the Latin version of ar-Rāzī's *Sirr al-asrār* (Riccardiana manuscript) includes instruments that serve the purpose of the «calcination of spirits», and depicts a spherical vessel without a neck («Phiala») (no. 17).²

Phiala, fig from:
*Übersetzung und Bearbei-
tungen von al-Rāzī's Buch
Geheimnis der Geheimnisse*,
by Julius Ruska, p. 235 (83).



¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

² Ibid., p. 83.

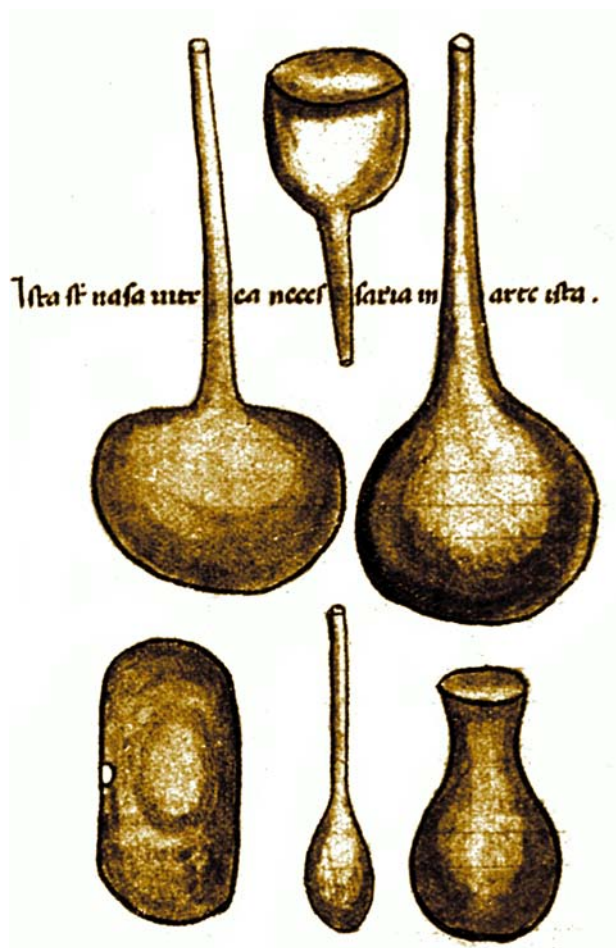


Fig. from: G. Carbonelli, *Sulle fonti storiche della Chimica e dell'Alchimia in Italia*, Rome 1925, p. 138, fig. 161 (bottom left).

Another

Vessel

«for the dissolution of spirits»

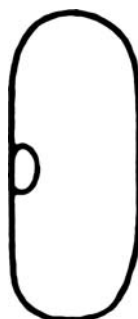
Under the caption *Cannutum* (probably from Arabic *qinnīna*) another device for the «dissolution of spirits» (*fusio spiritum*; *ḥall al-arwāḥ*) appears on the plate of instruments¹ in the Latin version of ar-Rāzī's book in the Riccardiana manuscript. A similar figure is also to be found in the anonymous Latin copy, the illustrations of which were published by G. Carbonelli.²

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

² Carbonelli, op. cit., p. 138, no. 161.



Our model:
Glass, colourless.
Length: 10.5 cm.
(Inventory No. K 1.38)



Cannutum, fig from: *Übersetzung und Bearbeitungen von al-Rāzī's Buch...* by Julius Ruska, p. 235 (83).

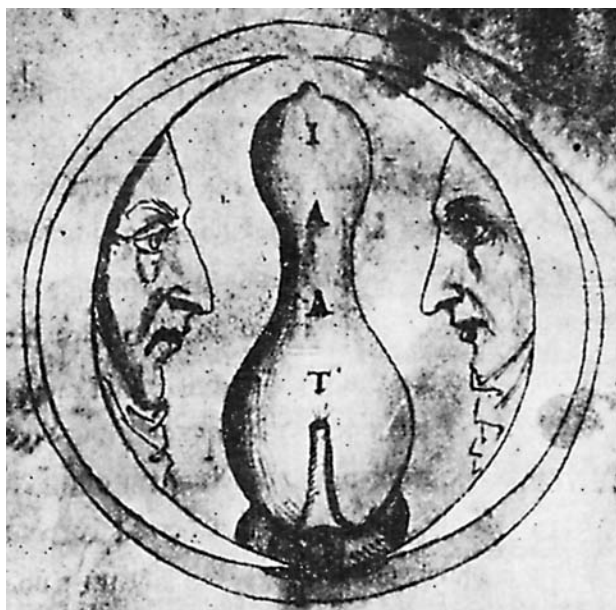


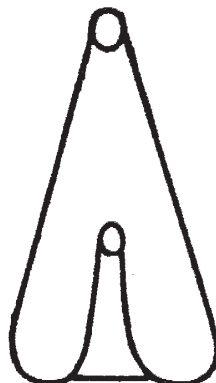
Fig from: G. Carbonelli, *Sulle fonti storiche della Chimica e dell'Alchimia in Italia*, Rome 1925, p. 57.

An Apparatus for the «dissolution of spirits»

The plate of instruments in the Latin version of ar-Rāzī's book in the Riccardiana manuscript¹ depicts among the *vasae fusionis spiritum* (*qawārīr li-ḥall al-arwāḥ*) an apparatus that bears the caption Caxa (no. 12). It recalls an illustration included in his book by G. Carbonelli.²



Our model:
Glass, colourless.
Height: 14.5 cm.
(Inventory No. K 1.39)



Caxa, Fig. from: *Übersetzung und Bearbeitungen von al-Rāzī's Buch* by Julius Ruska, p. 235 (83).

¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

² Carbonelli, op. cit., p. 57.

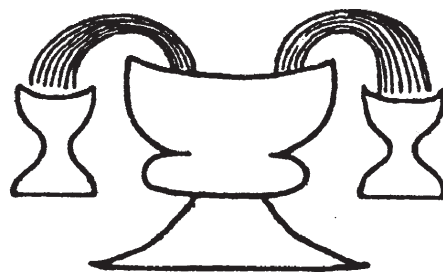


Our model:
Glass, colourless and wick.
Height: 13 or 5.3 cm.
(Inventory No. K 1.69)

Capillary filter

Beaker

In the chapter on the washing of chemical substances, Abū Bakr ar-Rāzī speaks, inter alia, of the procedure of washing by means of a *rāwūq fī ġām* (a filter in a «goblet»),¹ but unfortunately does not describe the device in the chapter on apparatuses. As J. Ruska noted, in the «Book of Secrets,» at one time «the instruction is given to soak up the moisture by means of a wick that passes through a hole in the lid of the Uṭāl and to let the moisture drip into a sugar bowl. In half a dozen passages the instruction is found to wash or to clean something with or on the *rāwūq*».² We learn about the shape of the apparatus from the illustrations in the Latin version of the text, both in the Riccardiana manuscript in Florence (No. 26) and from the manuscript in the University Library in Bologna.³



Destillatio per filtrum, fig. from: *Übersetzung und Bearbeitungen von al-Rāzī's Buch...* by Julius Ruska, op. cit., p. 235 (83).



Fig. from: G. Carbonelli, *Sulle fonti storiche...*, op. cit., p. 110.

¹ *Kitāb al-Asrār wa-Sirr al-asrār*, op. cit., p. 25.

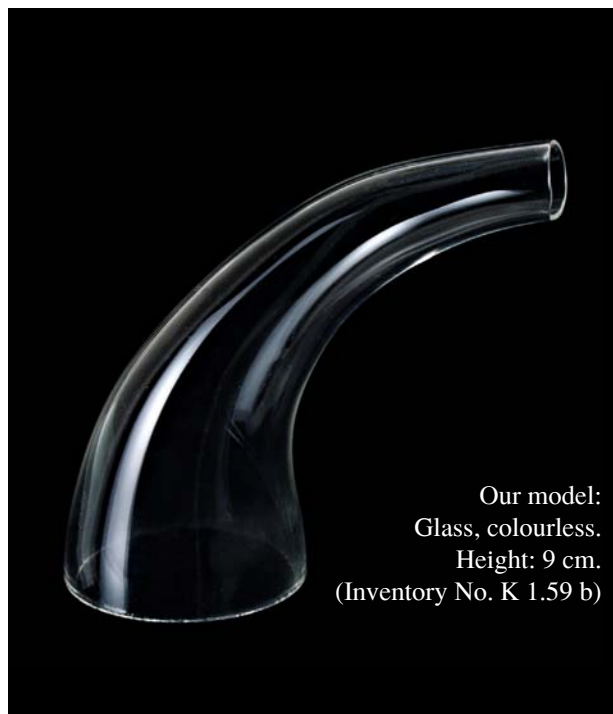
² *Al-Rāzī's Buch Geheimnis der Geheimnisse*, op. cit., pp. 62-63.

³ G. Carbonelli, op. cit., p. 110.

Cornu

The plate of instruments of the Riccardiana manuscript of the Latin version of ar-Rāzī's book depicts, among the devices for the dissolution of chemical substances, a horn-like object with the caption Cornu (no. 37). Perhaps it has to do here with a funnel.¹

Cornu, fig. from: *Übersetzung und Bearbeitungen von al-Rāzī's Buch...* by Julius Ruska, op. cit., p. 235 (83).



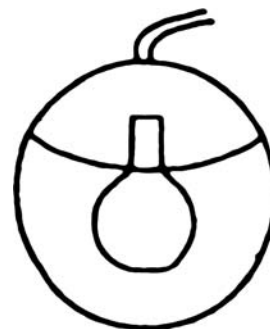
Our model:
Glass, colourless.
Height: 9 cm.
(Inventory No. K 1.59 b)

A spherical Device for dissolution

The plate of instruments in the Riccardiana manuscript of the Latin version of ar-Rāzī's book depicts, among the apparatuses for the dissolution of substances, a spherical vessel with an attachment of a right-angled pipe at the top and a small retort inside (no. 42). The meaning of the caption *Dissolutio cum apiis* is not quite clear.²

Our model:
Glass, yellowish-brown, made up of two parts.
Retort with a short neck of clear glass, 10 cm high.
(Inventory No. K 1.60)

Dissolutio cum apiis,
fig. from: *Übersetzung
und Bearbeitungen
von al-Rāzī's Buch...*
by Julius Ruska,
p. 235 (83).



¹ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 82, 83.

² Ibid., p. 83.

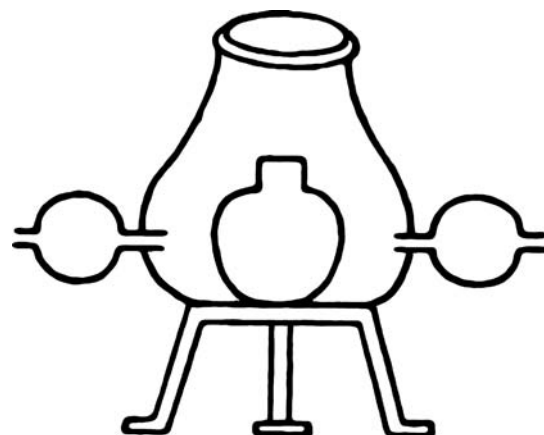


Fig. from: *Übersetzung und Bearbeitungen von al-Rāzī's Buch...*
by Julius Ruska, op.cit., p. 235 (83).

Our model:
Clay, fired.
Tripod of steel.
Total height: 38 cm.
(Inventory No. K 1.62)

The Kiln «that fans itself»

Among the «instruments for the treatment of non-metals,» Abū Bakr ar-Rāzī¹ mentions a kiln that «fans itself» (*nāfilḥ nafsaḥū*): «The self-ventilating device is a kiln (*tannūr*) whose lower part is narrower than the upper part. It stands on three feet and is placed upon a stand whose walls are perforated. In the middle of its base there is a hole through which the ashes fall out. Into its lowest part coals are shuffled and that which is to be calcinated is placed on it and is buried in the coal and covered with coal. It should be placed in a windy location. Its fire is extremely strong, it calcinates the metals and amalgamates them and

melts them.»² The text from al-Ḥwārizmī's *Mafātīḥ al-ʿulūm* amplifies ar-Rāzī's text in an important respect, in the sense that there the substance to be treated is put on the fire in a pitcher coated with clay.³ This corresponds with the figure with the caption *Nafis* (no. 42), which has become accessible through the Latin version of ar-Rāzī's book.⁴

² J. Ruska, *Al-Rāzī's Buch Geheimnis der Geheimnisse*, p. 99.

³ v. E. Wiedemann, *Zur Chemie bei den Arabern*, op. cit., p. 78 (repr., p. 695).

⁴ J. Ruska, *Übersetzung und Bearbeitungen*, op. cit., p. 83.

¹ *Kitāb al-Asrār wa-Sirr al-asrār*, op. cit., p. 12; v. also Abū ʿAbdallāh al-Ḥwārizmī, *Mafātīḥ al-ʿulūm*, pp. 257-258.

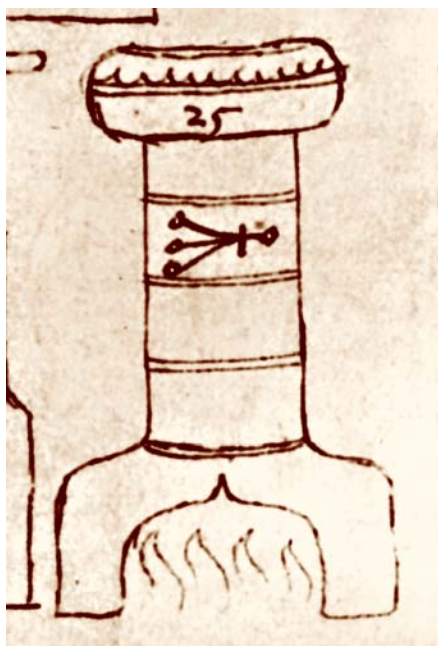
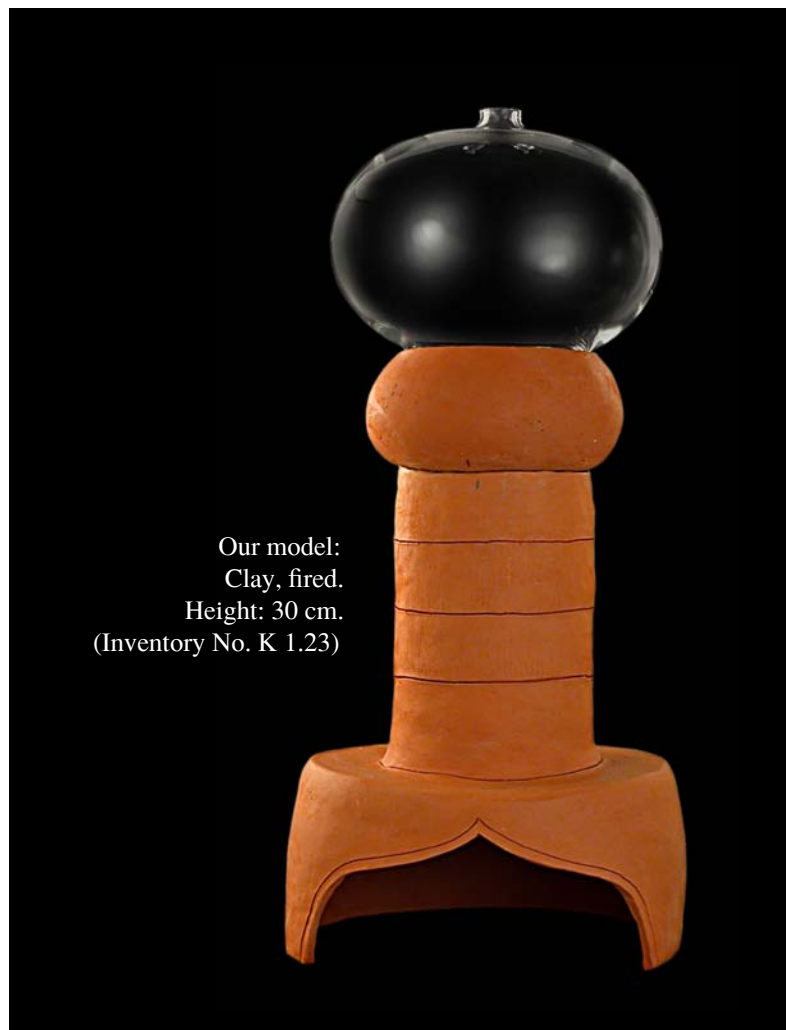


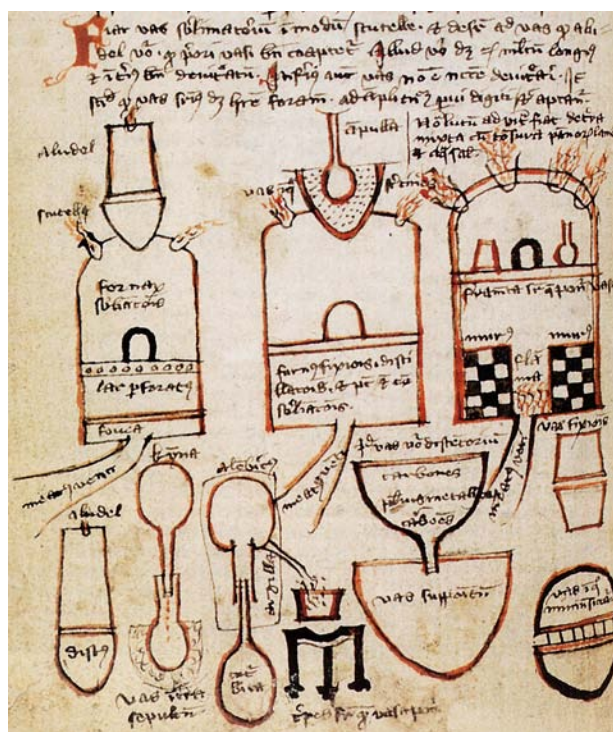
Fig. from W. Ganzenmüller,
op. cit., p. 297, no. 25



Vas decoctionis mercuris

Among the kilns characterised by «Moorish style», as depicted in the Munich manuscript of the *Liber florum Geberti* (Cod. Lat. 25110), the following specimen appears for heating mercury with a process that is prescribed in Gebert's «fourth flower».¹ In the illustration it is very clear to see the manner in which the kiln was constructed with ring-shaped components.

Plate from *De operationibus alchymiae*,
14th/15th cent. MS Munich, Bayer. Staats-
bibl. CLM 405, fol. 171 b.



¹ W. Ganzenmüller, *Liber florum Geberti. Alchemistische Öfen und Geräte in einer Handschrift des 15. Jahrhunderts*, in: *Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin* (Berlin), 8/1942/273-303, esp. pp. 288, 299 and 297, fig. 4, no. 25.



Fig. from the Paris Geber manuscript (Bibl. Nat. MS lat. 6514), after A.Y. al-Hassan, D. R. Hill, *Islamic Technology*, op. cit., p. 136.



Aludel

For the process of sublimation, i.e. the transition of a solid substance to the gaseous stage, illustrations are provided in the treatise *ʿAin aṣ-ṣanʿa wa-ʿaun aṣ-ṣanaʿa* by Abu l-Ḥakīm Muḥammad b. ʿAbdalmalik al-Ḥwārizmī al-Kāfī (writing in 426/1034) of Baghdad¹ and in the *Summa collectionis complementi occulte secretorum nature* of Geber (Latinised edition of the Arabic works by Ḡābir b. Ḥaiyān) in the Paris manuscript² (Bibl. Nat. MS lat. 6514). With the help of these illustrations, we were able to reconstruct our model of the relevant with just a little bit of imagination on our part.

¹ F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 4, Leiden 1971, pp. 291-292; H. E. Stapleton, R. F. Azo, *Alchemical equipment in the eleventh century, A. D.*, in: *Memoirs of the Asiatic Society of Bengal* 1/1905/47-71.

² M. Berthelot, *La chimie du moyen âge*, op. cit., vol. 1, p. 149 ff.; A. Y. al-Hassan, D. R. Hill, *Islamic Technology*, op. cit., p. 136.

Our model:
Clay, fired.
Aludel of glass.
Height: 51 cm.
(Inventory No. K 1.70)

The upper part, made of glass, is called *utāl* in the Arabic text and the kiln itself *mustauqad*. In Latin the terms are *alutel* and *furnus*. From the Latin text we also learn that the hole at the upper tip (*foramen*) is meant for the escape of the gases formed during the sublimation.



Our model:
Clay, fired.
Height: 48 cm.
(Inventory No. K 1.07)

Fig. from:
W. Ganzenmüller,
op. cit., p. 296, no.
10.

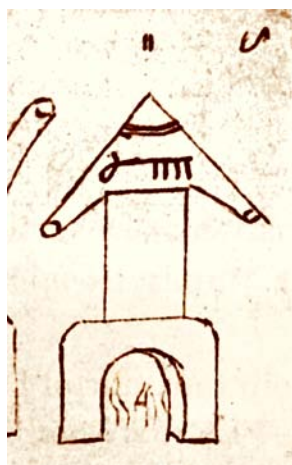


Kiln for chemical operations

Our model was built after an illustration in the
Liber florum Geberti (no. 10).¹

Kiln with a cap and two beaks

Reconstructed after an illustration in the *Liber flo-
rum Geberti* Geberti (no. 11).²



Our model:
Clay, fired.
Height: 30 cm.
(Inventory No. K 1.08)

Fig. from:
W. Ganzenmüller, op.
cit., p. 296, no. 11.



¹ v. W. Ganzenmüller, op. cit., p. 296, 297, no. 10.

² Ibid., p. 296, 299, no. 11.



Fig. from:
W. Ganzenmüller, op. cit.,
p. 302, no. 74.

Kiln

reconstructed after an illustration
in the *Liber florum Geberti* (no.
74).¹



Fig. from:
W. Ganzenmüller,
op. cit., p. 302, no. 76.

Another kiln

A kiln for heating solid
substances, modelled after an il-
lustration in *Liber florum Geberti*
(no. 76).²



Our model:
Clay, fired.
Height: 19.50 cm.
(without retorts).
(Inventory No.
K 1.09)

Our model:
Clay, fired.
Made of two parts.
Height: 29.50 cm.
(Inventory No. K 1.10)

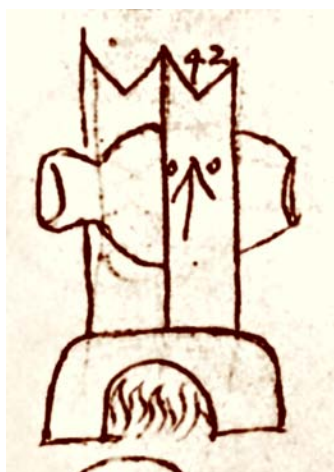
¹ W. Ganzenmüller, op. cit., p. 296, no. 74.

² Ibid., p. 302, no. 76.

Kiln

for heating a retort
suspended above it

Reconstructed after an illustration in the *Liber
florum Geberti* (no. 42).¹



Our model:
Clay, fired.
Height: 21.5 cm.
Retort (height = 11.5 cm)
of clear glass, hung in a
wire-frame
(Inventory No. K 1.12)

Fig. from:
W. Ganzenmüller, op.
cit., p. 299, no. 42.



Kiln

with alembic

In this model two apparatuses depicted in the *Liber
florum Geberti*,² a kiln (no. 44) and an alembic (no.
37), were combined with one another.



Our model:
Kiln of clay, fired.
Height: 21 cm.
(Inventory No. K 1.13)
Alembic: Glass, colourless.
Made of two parts.
Height: 48 cm.
(Inventory No. K 1.14)

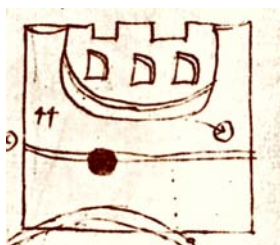


Fig from:
W. Ganzenmüller,
op. cit., p. 299, no. 37
(sic!) and 44.



¹ W. Ganzenmüller, op. cit., p. 299, no. 42.

² Ibid., p. 296, 299, no. 37, 44.

Kiln

with a glass lead attachment

A kiln for heating chemical substances, reconstructed after an illustration in the *Liber florum Geberti* (no. 4).¹



Our model:
Clay, fired.
Height: 51 cm
with a glass lid attachment.
(Inventory No. K 1.15)

Fig. from:
W. Ganzenmüller,
op. cit., p. 295, no. 4.



Vas

decoctionis elixir

Construction for boiling the elixir, after an illustration in the *Liber florum Geberti* (no. 40).²



Our model:
Clay, fired.
Height: 52 cm.
(Inventory No. K 1.16)

Fig. from:
W. Ganzenmüller, op.
cit., p. 299, no. 40.

¹ W. Ganzenmüller, op. cit., p. 295, no. 4.

² Ibid., p. 299, no. 40, cf. p. 300.

Cauldron with lion paws

Reconstructed after an illustration in the *Liber florum Geberti* (no. 48).¹



Fig. from:
W. Ganzenmüller,
op. cit., p. 299, no. 48.

Our model:
Clay, fired.
Made of two parts.
Height: 25 cm.
(Inventory No. K 1.17)



Kiln with a retort in the form of a cap

Reconstructed after an illustration in *Liber florum Geberti* (no. 29).²

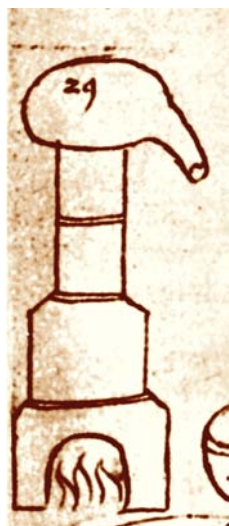


Fig. from:
W. Ganzenmüller, op.
cit., p. 298, no. 29.

Our model:
Clay, fired.
Height: 27.5 cm.
Alembic of clear glass.
Total height: 34.5 cm.
(Inventory No. K 1.20)



¹ W. Ganzenmüller, op. cit., p. 296, 299, no. 48.

² Ibid., p. 298, 296, no. 29.

Kiln

in the form of an elephant's trunk

Reconstructed after an illustration in the *Liber florum Geberti* (no. 17).¹



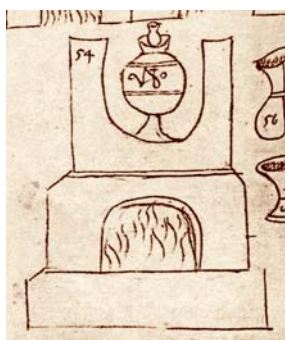
Our model:
Clay, fired.
Height: 36 cm.
(Inventory No. K 1.19)

Fig. from:
W. Ganzenmüller,
op. cit., p. 297, no. 17.



Kiln

Due to the symbol, declared by Ganzenmüller as *furnellus lune et veneris*, a small silver and copper kiln. Reconstructed after the illustration in the *Liber florum Geberti* (no. 54).²



Our model:
Clay, fired.
Height: 38 cm,
including the retort.
(Inventory No. K 1.71)

Fig. from:
W. Ganzenmüller,
op. cit., p. 300, no. 54.

¹ W. Ganzenmüller, op. cit., p. 297, no. 17, cf. p. 302.

² Ibid., p. 300, no. 54, cf. p. 296.



Fig. from:
W. Ganzenmüller, op.
cit., p. 295, no. 2.

Apparatus of unknown function

Reconstructed after a sketch in the *Liber florum Geberti* (no. 2).¹ The two openings of the glass could have served for producing a stream of air.

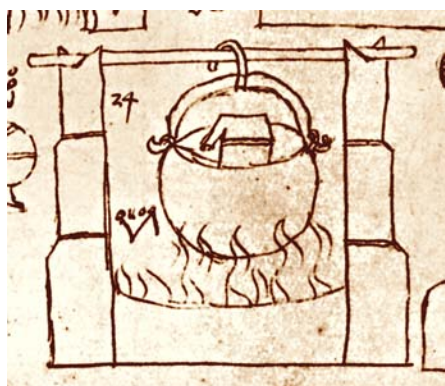


Fig. from:
W. Ganzenmüller, op.
cit., p. 297, no. 24.

Hearth with «a kettle full of vinegar»

Reconstructed after an illustration in the *Liber florum Geberti* (no. 24).²

¹ W. Ganzenmüller, op. cit., p. 295, no. 2, cf. p. 296.

² Ibid., p. 297, no. 24, cf. p. 298.



Our model: Clay, fired.
Height: 23 cm, including the glass.
(Inventory No. K 1.11)



Our model:
Hearth: clay, fired, Height: 38 cm.
Kettle: copper, engraved,
diameter 22 cm.
Alembic inside the kettle.
(Inventory No. K 1.22)

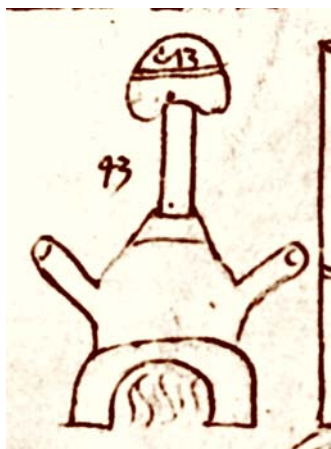


Fig. from:
W. Ganzenmüller,
op. cit., p. 299, no. 43.

Kiln with Alembic

Reconstructed after an illustration in the *Liber
florum Geberti* (no. 43).¹

Our model:
Clay, fired.
Height: 64 cm,
including the alembic.
(Inventory No. K 1.25)

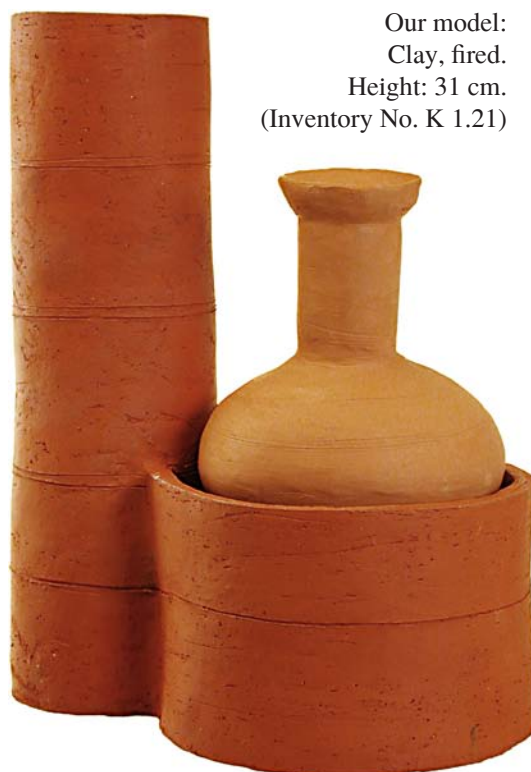


Fig. from: W. Ganzenmüller,
op. cit., p. 300, no. 52.

Kiln

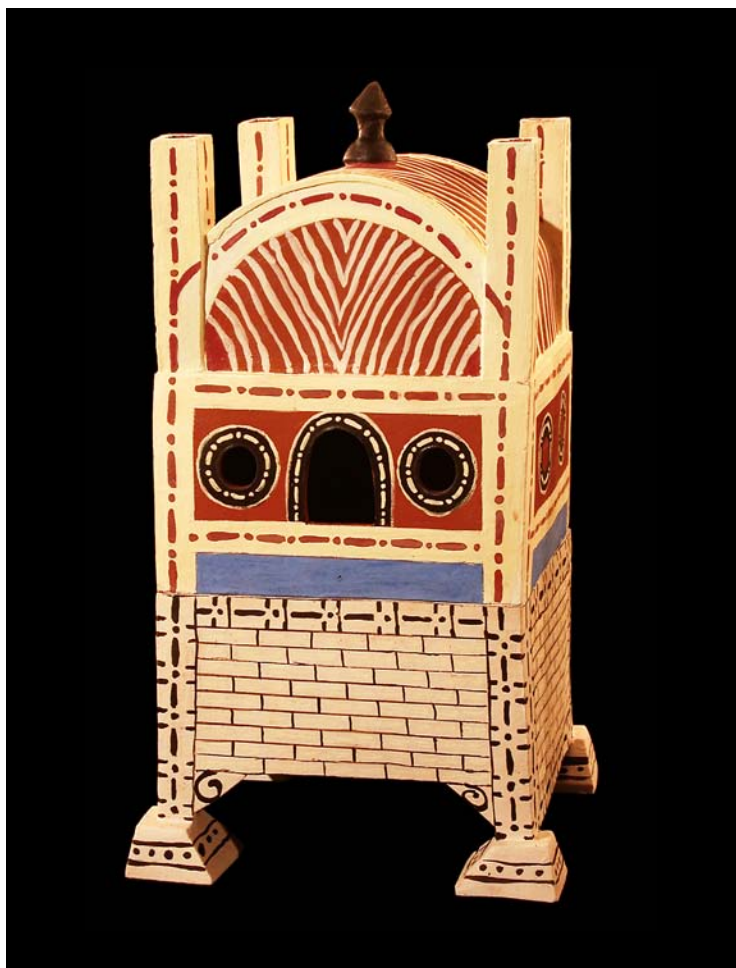
Reconstructed after an illustration in the *Liber flo-
rum Geberti* (no. 52).²

Our model:
Clay, fired.
Height: 31 cm.
(Inventory No. K 1.21)



¹ W. Ganzenmüller, op. cit., p. 299, no. 43.

² Ibid., p. 300, no. 52, cf. pp. 296, 297, 298-299.



A Kiln for the production of artificial gems

Our model:
Clay, fired, cold painted.
Height: 53 cm.
(Inventory No. K 1.06)

Fig from MS
Gotha 1347,
after Hassan/Hill,
Islamic Technology,
op. cit., p. 167.

The partly preserved manuscript of the *Ġawāhir al-funūn wa-ṣ-ṣanāʾiʿ fī ḡarīb al-ʿulūm wa-l-badāʾiʿ* (Gotha 1347, fol. 55a, 57a) depicts, inter alia, two «carefully executed ink drawings of kiln constructions.» The author, Muḥammad b. Muḥammad Aflātūn al-Harmasī al-ʿAbbāsī al-Biṣṭāmī, is unknown so far.¹ The extant manuscript contains excerpts from 6 of the original 28 chapters of a large book on mineralogy.² E. Wiedemann³ was the

first to draw attention to the two kilns through his short descriptions and he was the first to publish the drawings.

¹ v. C. Brockelmann, *Geschichte der arabischen Litteratur*, suppl., volume 2, p. 1033.

² v. Alfred Siggel, *Katalog der arabischen alchemistischen Handschriften Deutschlands*, Part 2, Berlin 1950, pp. 83–86, cf. Wilhelm Pertsch, *Die arabischen Handschriften der Herzoglichen Bibliothek zu Gotha*, vol. 3, Gotha 1881 (repr. Frankfurt 1987), pp. 17–18.

³ *Zur Geschichte der Alchemie. IV. Über chemische Apparate bei den Arabern*, in: *Zeitschrift für angewandte Chemie* (Leipzig and Berlin) 34/1921/528–530, esp. pp. 528–529 (repr. in: Wiedemann, *Gesammelte Schriften*, vol. 2, esp. pp. 957–960); idem, *Beiträge zur Mineralogie etc. bei den Arabern*, in: *Studien zur Geschichte der Chemie*, Festgabe für O. v. Lippmann, Berlin 1927, pp. 48–54, esp. pp. 51–54 (repr. in: *Gesammelte Schriften*, vol. 2, esp. pp. 1207–1210); see also A. Y. al-Hassan, D. R. Hill, *Islamic Technology*, op. cit., p. 167.



Kiln of Zosimus

Our model:
Clay, fired and glazed.
Height: 43 cm.
(Inventory No. K 1.05)

Fig from MS
Gotha 1347
after Hassan/Hill,
op. cit. p. 154.

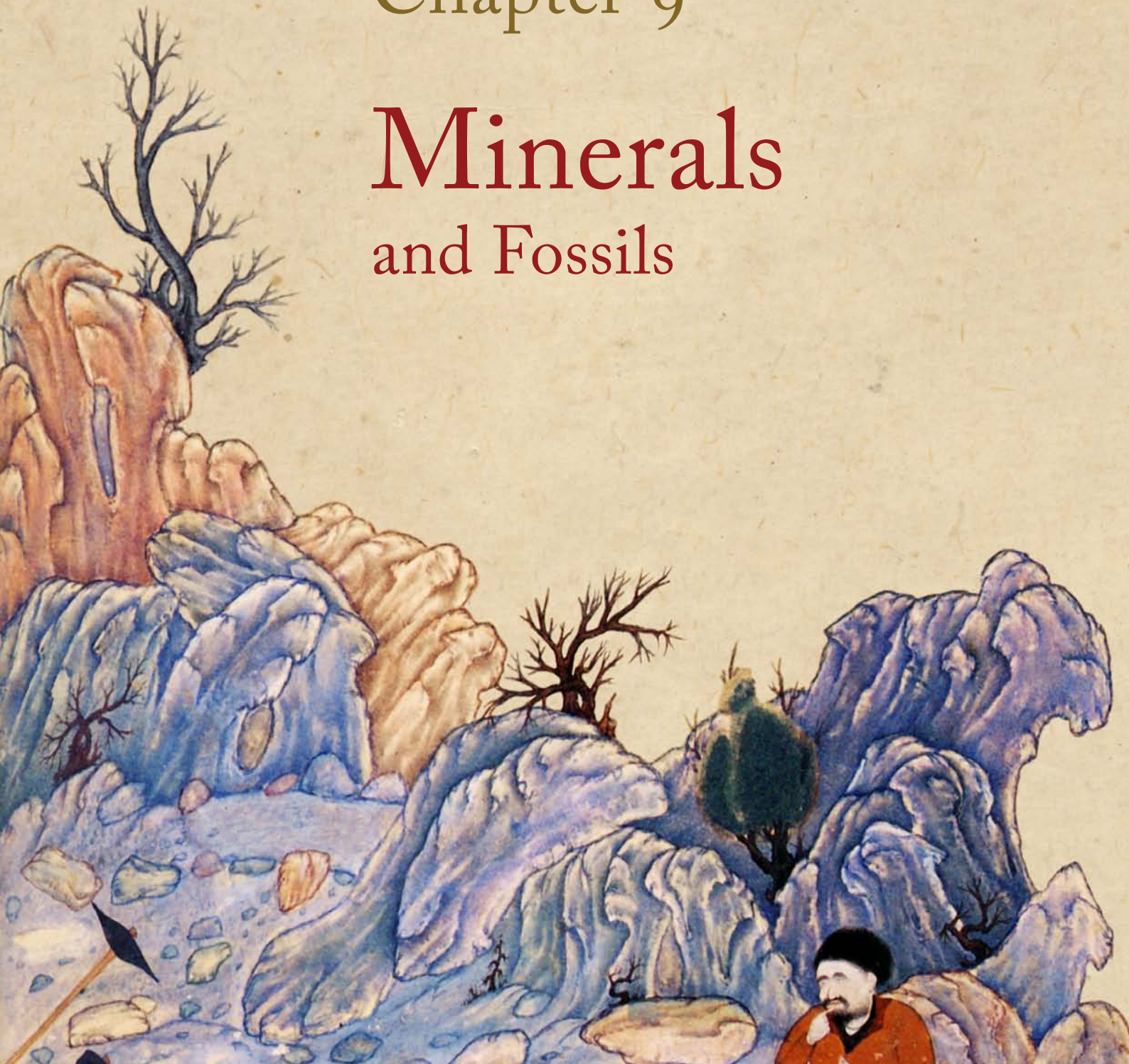
This kiln ascribed to Zosimus¹ (4th or 5th cent. A.D.) appears in the Gotha manuscript mentioned above (p. 152) in a carefully executed drawing but without any explanation whatsoever. This drawing was also published by E. Wiedemann. There is no

doubt that Zosimos worked with a kiln. But the apparatus connected with his name seems to be the result of a development in the construction of chemical apparatuses that took place only after the 5th/11th century in the Arab-Islamic culture area.

¹ v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 4, Leiden 1971, pp. 73-77.

Chapter 9

Minerals and Fossils



Introduction

IN one of the few studies on the history of mineralogy where the role of the Arabic-Islamic cultural sphere in this field is discussed, Julius Ruska¹ stated in 1912: “History of science has to deal with Arabic literature in three ways. History of science encounters the Muslims first as pupils of the Greeks, endeavouring, with the help of the Syrians and Persians, who knew the subject and the language, to transfer the treasures of Greek wisdom within reach into their own language and to utilise them. Studying the Greeks aroused the urge towards independent research and discovery, and as a fruit of this scientific enthusiasm we encounter an enormous corpus of treatises on matters dealing with mathematics and astronomy, natural sciences and medicine. After a few generations we find the Arabs as the teachers of the scientifically impoverished Latin West and we find their works translated, commented upon, published and recognised as authoritative works down to the 16th century and further.” J. Ruska penned these lines almost one hundred years after the appearance of the first orientalist studies on this subject. These were an Italian translation² of the book on mineralogy, the *Azhār al-afkār fī ḡawāhir al-aḡḡār* by Aḥmad b. Yūsuf at-Tifāṣī (d. 651/1253) and, at about the same time, a German translation³ of excerpts from the Persian *Ġawāhirnāma* by Muḥammad b. Maṣṣūr ad-Daštakī (early 8th/14th cent.). In the course of time, both before and after J. Ruska, a few Arabic books on mineralogy were edited and translated into European languages. Moreover, a large number of studies and bibliographical works appeared

without which the compilation of our selection⁴ of minerals would have been inconceivable. In spite of all the commendable attempts so far, the following questions seem to have been rarely asked: Which new minerals were discussed by the Arabic-Islamic scholars as compared to their Greek masters? Which new sites were discovered in Islamic times? What were their own experiences, observations, classifications and theories of their origin? Likewise there are hardly any studies on the impact of Arabic mineralogy on the advances made in the Occident. We can safely follow J. Ruska in his chronological overview of the participating cultures which played a decisive role in the history of science.⁵ And his observations are not restricted to the field of mineralogy alone: “In this connection, we have to distinguish basically between four large culture areas: the Egyptian-Babylonian, the Graeco-Roman, the Islamic, and the Christian-Occidental, which leads into the modern era. Basically, there is a significant connection between these cultures; the Far East also follows them.” Unfortunately the Greeks, with all their astonishingly vast knowledge of mineralogy, provide us with hardly any clues as to which of the minerals mentioned by them and which part of information about those minerals are their own in origin and what knowledge they borrowed from other cultures. In this connection the Arabic-Islamic successors differ greatly from their teachers. Not only do they cite their Greek sources with amazing precision and [158] mention with regard to each individual mineral what information they had adopted; frequently they give, beside the author’s name, also the title of the work, sometimes even the relevant chapter.

¹ *Das Steinbuch des Aristoteles mit literargeschichtlichen Untersuchungen nach der arabischen Handschrift der Bibliothèque nationale herausgegeben und übersetzt*, Heidelberg 1912, pp. 1 (reprint in: *Natural Sciences in Islam*, vol. 27, Frankfurt 2001, pp. 1-216, esp. pp. 9).

² *Fior di pensieri sulle pietre preziose di Ahmed Teifascite*, ed. and transl. Antonio Raineri, Florence 1818 (reprint in: *Natural Sciences in Islam*, vol. 31, Frankfurt 2001, pp. 1-178).

³ Josef von Hammer, *Auszüge aus dem persischen Werke Ġawāhirnāma* [orig. Arabic] i.e. *das Buch der Edelsteine*, von Mohammed Ben Manssur, in: *Fundgruben des Orients*, vol. 6, Vienna 1818, pp. 126-142 (v. *Das Steinbuch des Aristoteles*, pp. 31); Āḡābuzurg at-Ṭahrānī, *ad-Darī‘a ilā taṣānīf aš-šī‘a*, vol. 5, Teheran 1363/1944, pp. 283.

⁴ Our selection stems from the large collection of minerals of the Institut für Mineralogische Rohstoffe of the Technical University, Clausthal. For this we wish to express our thanks here. We also thank Dr. Armin Schopen for his manifold support in this connection.

⁵ *Die Mineralogie in der arabischen Literatur*, in: *Isis* (Brussels) 1/1913-14/341-350, esp. pp. 342 (reprint in: *Natural Sciences in Islam*, vol. 28, Frankfurt 2001, pp. 255-264, esp. pp. 256).

Their main sources included the Arabic translation of Dioscorides's (2nd half of the 1st cent. B.C.) *Περὶ ὕλης ἰατρικῆς* and Galen's (2nd half of the 2nd cent. A.D.) *Περὶ κράσεως καὶ δυνάμεως τῶν ἀπλῶν φαρμάκων*. Apart from several authentic and not authentic Greek pharmaceutical and mineralogical treatises, a pseudo-Aristotelian book of stones also reached the Arabic-Islamic culture area. It was translated into Arabic by a certain Lūqā b. Isrāfiyūn, as he himself states. This work in which 72 stones are described holds the foremost position among the sources of Arabic mineralogy. According to J. Ruska,⁶ it is likely that "a Syrian who was familiar with the Greek and also with the Persian sources and traditions authored the book in the period of translations, before the middle of the 9th century." According to the author of these lines, however, this work had its origin in Late Antiquity (ca. 5th-6th cent. A.D.) and was translated into Arabic in the 2nd/8th or the 3rd/9th century.⁷ This and other pseudo-texts and Hermetic treatises circulated in the Mediterranean region during Pre-Islamic and Early Islamic times. The importance of their contents was realised quite early, they were translated, treated as authentic works and cited under their pseudonyms.

We must also mention that, together with the authentic and pseudo Greek texts on mineralogy, pharmaceuticals, and medicine, not only sober matter-of-fact descriptions of minerals reached the Arabic-Islamic world, but also, for instance, beliefs related to the magical effects of stones and their use as amulets. When we find such elements even in the works of Dioscorides and Galen, we must not fall into the error of thinking that the cultural importance of these works or their importance for the history of science becomes diluted because of this. Arabic-Islamic mineralogy also contains some traces of Indian⁸ and Middle-Persian⁹ sources, but

these are of minimal consequence because of the dominant position of the Greek sources.

In view of the modest status of the contemporary research on Arabic mineralogy, we make here the bold attempt to communicate some of the discoveries and interpretations of Arabic mineralogy which are of interest for the history of mineralogy and geology. J. Ruska¹⁰ gave some broad outlines of the knowledge he gained from his intensive study of the material in the first half of last century. Thus he finds in Arabic cosmological and nature-philosophical treatises a "stronger emphasis on the general issues of the origin of minerals and their chemical properties," and also of issues concerning geology—as compared to their pharmacological treatises. In this connection, what he finds particularly interesting are the observations of the fifth treatise of the Encyclopedia of the Brethren of Purity (Iḥwān aṣ-Ṣafā', 4th/10th cent.) on the origin of minerals, which "contains much on geology that has not been noticed so far. Thus, e.g. the minerals are divided into three classes according to the time required for their formation. The first group is formed in dust, loam and salt steppes and needs just one year for maturing; here the rapid formation of steppe salt, gypsum and such salts in the dry climate of the Near East can be recognised. The second group is of the stones that form slowly at the bottom of the sea, such as corals and pearls. The last group consists of metals and gems which originate in the interior of stones, in mountain caves; some of these only reach maturity after centuries. The fixed stars in the sky make one full revolution in 36,000 [159] years,¹¹ the conditions on earth change correspondingly, cultivable land becomes desert, deserts become cultivable, steppes and mountain ranges emerge from the oceans, deserts and mountain ranges sink into the sea. The mountain ranges heat up under the rays of the sun, they dry up, burst and crumble, become gravel and sand; heavy showers of rain turn them into sludge in the beds of mountain rivulets, rivers and streams; these lead them to the oceans, the lakes and the marshes;

⁶ *Das Steinbuch des Aristoteles*, op. cit., pp. 44-45 (reprint pp. 44-45).

⁷ v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 4, pp. 103.

⁸ v. Muḥammad Yaḥyā al-Hāsimī, *al-Maṣādir al-hindīya li-kutub al-aḡḡār al-ʿarabiya*, in: *Taqāfat al-Hind* (New Delhi) 12,3/1961/100-115 (reprint in: *Natural Sciences in Islam*, vol. 30, Frankfurt 2001, pp. 227-242).

⁹ Jean Pierre de Menasce, *Un lapidaire pehlevi*, in: *Anthropos* 37-40/1942-45/180-185; M. Yaḥyā al-Hāsimī, *al-Maṣādir al-fārisīya li-Kitāb al-Ġamāhir fī maʿrifat al-ġawāhir li-l-Bīrūnī*, in: *ad-Dirāsāt al-adabiya* (Beirut) 1959, issues 2-3,

pp. 58-65 (reprint in: *Natural Sciences in Islam*, vol. 30, pp. 219-226).

¹⁰ *Die Mineralogie in der arabischen Literatur*, op. cit., pp. 345-346 (reprint op. cit., pp. 259-260).

¹¹ The Iḥwān aṣ-Ṣafā' obviously did not know the much improved value for the precession (v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 6, pp. 26).

the oceans act on them through the surf and the pounding of the waves, and spread them in layers at their bottom; they are deposited one above the other; they adhere to one another, form mountains and hills under water; like the sand in the steppes and deserts, they rise gradually and become firm land on which plants take over, while, to compensate for it at other places, the ocean overflows its coasts and spreads across firm country. Here it is possible to see the main features of Joh. Walther's¹² theory of deserts and Ch. Lyell's¹³ principle of geology, and it would be an interesting task to examine how far these geological views rest on independent observations and ideas and how far they must be traced back to those of the Greek geographers, for example."

"The enumeration of stones and the extensive subdivision of salt-like substances" which occur in the "Book of Secrets" (*Kitāb al-Asrār*) by Abū Bakr ar-Rāzī (d. 313/925) were regarded by J. Ruska as "an innovation introduced by Rāzī".¹⁴ Ruska also made the observation that some books are very precise in their information about the places of the occurrence of minerals.¹⁵ This is confirmed by other sources which were not accessible to him or were not known in his times.

"Greater attention is paid to the physical properties which can be ascertained directly or with the simplest tools. Whether the mineral is heavy or light, hard or soft, smooth or rough, brittle, whether it can be split or hammered, whether it is soluble or not, whether it is lustrous or dull, transparent or opaque, and what colours it has—all this is listed, though not systematically, but in many cases with good powers of observation, likewise the behaviour of the mineral in fire or against acids, its taste and odour."¹⁶

On the question of the advances made by the Arab authors as against their Greek sources in the descriptions of the minerals, Ruska again provides an example. On the book of stones by Aḥmad at-Tifāṣī

(d. 651/1253) he remarks as follows: "The description of each stone is given in five chapters, the first of which deals with the cause of the formation of the stone in its mine, the second deals with the localities where it occurs, the third with its good and bad properties, the fourth with its specific powers and effects, the fifth with its commercial value." "In describing the medicinal and chemical properties, at-Tifāṣī depends greatly on the work by [pseudo-]Aristotle, yet he offers much new information on the places of occurrence, on the method of differentiating between different varieties, on the defects and flaws, on the price and the use of gems."¹⁷

J. Ruska cites likewise an instructive example of the description of the places of occurrence according to at-Tifāṣī: "On the quarrying of emeralds in Upper Egypt highly interesting information is provided by our author. According to Bauer's *Edelsteinkunde*,¹⁸ the old Egyptian emerald mines were rediscovered only under Meḥemmed 'Alī by the Frenchman Fr. Cailliaud in 1816, but the operations were stopped again after a short time, and no information was available about the operation of the mines from the period after the Roman occupation.[160] But this is not correct in so far as the mines are mentioned by al-Iṣṭaḥrī in the 4th/10th century as well as by al-Idrīsī about 545/1150. Al-Mas'ūdī already reports at length about the mining of emeralds and their varieties in the *Murūḡ ad-dahab* (ed. Barbier de Meynard, vol. 3, pp. 43 ff.). The information given by at-Tifāṣī can be summarised as follows: Emeralds are found on the border between Egypt and Ethiopia in a mountain range that stretches to the sea near Aswan. The senior inspector of mines, who was appointed by the sultan, informs that the first thing to be encountered in the emerald mines is black talc which, when exposed to fire, appears like golden marcasite. Through further digging the soft red sand in which emeralds occur is reached. Only small stones which are used for rings are found in the sand; the large ones and the complete emeralds are to be found in galleries and veins."¹⁹

¹² On him, v. Ilse Seibold, *Der Weg zur Biogeologie. Johannes Walther (1860-1937)*, Berlin etc. 1992.

¹³ Born 1797 in Kinnordy (Scotland), died 1875 in London.

¹⁴ *Al-Rāzī's Buch Geheimnis der Geheimnisse mit Einleitung und Erläuterungen in deutscher Übersetzung* by Julius Ruska, Berlin 1937 (Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin, vol. 6), pp. 37.

¹⁵ *Die Mineralogie in der arabischen Literatur*, op. cit. pp. 343 (reprint op. cit. pp. 257).

¹⁶ *ibid.*, pp. 343 (reprint pp. 257).

¹⁷ *ibid.*, pp. 348 (reprint pp. 262).

¹⁸ Max Bauer, *Edelsteinkunde. Eine allgemein verständliche Darstellung der Eigenschaften, des Vorkommens und der Verwendung der Edelsteine, nebst einer Anleitung zur Bestimmung derselben, für Mineralogen, Edelsteinliebhaber, Steinschleifer, Juweliere*, Leipzig 1909, pp. 390.

¹⁹ *Die Mineralogie in der arabischen Literatur*, op. cit., pp. 349

It was without doubt a great advance when the Arab-Islamic mineralogists discovered a procedure to evaluate minerals²⁰ and ores according to their specific weight.²¹ The pycnometer invented by al-Bīrūnī (1st half of the 5th/11th cent.) made it possible for him and his successors to determine the specific weight with amazing accuracy (see below, V.9).

It may also be mentioned that al-Bīrūnī²² refuted the popular notion that all salt water everywhere on earth was transformed into fresh water at a specific hour on the 6th day of January every year and that he contradicted a method which had come down from Aristotle for the desalination of sea water. This has to do with the attempt to extract fresh water out of sea water with the help of a waxen vessel, as described in Aristotle's meteorology: "Actually, if a waxen vessel with the neck closed tightly is submerged into the sea, after 24 hours it would contain some amount of water which had seeped into it through the waxen walls and this water would be drinkable because the earthy and salty parts had been 'filtered out'."²³ Abū 'Alī Ibn Sīnā (d. 428/1037) also deals with the origin of rocks in the section on meteorology of his *Kitāb*

aṣ-Ṣifā'. Until the 19th century this section, available in Latin under the title *Liber de mineralibus Aristotelis*, was thought to be the work of the Greek philosopher Aristotle (see below, pp. 163). On the topic that interests us, M. Y. Haschmi of Aleppo has published several studies. From his work *Die geologischen und mineralogischen Kenntnisse bei Ibn Sīnā*²⁴ we cite the following passages on the origin of minerals:²⁵ "Stones are formed in two ways, either through drying up as with the formation of loam, or through ossification. Loam dries up and turns gradually into stone. If it is not [161] fatty, it will decompose before it becomes stone. Ibn Sīnā recounts that in his youth he saw on the banks of the River Ġaiḥūn [Amu-Darya] a type of loam which turned into stone within 23 years. Stones originate in running water in two ways, firstly through evaporation and secondly through gradual precipitation. Ibn Sīnā also observed that some waters condense to stones and pebbles with different colours when they drip upon a certain spot. Some waters ossify, but only when they come into contact with certain types of stone. From this he concluded that there were some types of earth which had mineralogical properties to bring about the ossification of water. The beginning of stone formation occurs either through loam-like substances or through other substances that contain much water. In the latter case, the rock is formed either through a mineral force that causes the solidification or through the predominance of the earthy parts as in the case of salt formation ... Water turns into loam and loam also turns into water. Thus the stones are either dried in the sun as in loam formation or through the hardening of water and through drying up."²⁶ After this Ibn Sīnā discusses the reason for the fossilisation of plants and animals. In conjunction with this, he also mentions his own observations made in Central Asia. One of these is connected with the so-called "lightning tube": "Sometimes stone-like or iron bodies form through lightning. In the land of the Turks (Turkistān), after thunder and lightning, copper-like bodies [in the form of lances, *aḡsām*

(reprint op. cit., pp. 263).

²⁰ Al-Bīrūnī reports in his *Kitāb al-Ġamāhīr fī ma'rīfat al-ḡawāhīr* (ed. F. Krenkow, Hyderabad 1355/1936, pp. 50) on the existence of a book on the prices of precious stones, written in Damascus during the reign of Marwān b. 'Abdalmalik (65/685-86/705) which he had come across. E. Wiedemann (*Über den Wert von Edelsteinen bei den Muslimen*, pp. 353, reprint in: *Natural Sciences in Islam*, vol. 28, pp. 237) earns the credit for having been the first to draw attention to this early source. The manuscript of the book by al-Bīrūnī, which Wiedemann used, seems to have contained a more detailed description of the old book (to be more precise, the booklet) than the printed edition which is at our disposal.

²¹ E. Wiedemann, *Über den Wert von Edelsteinen bei den Muslimen*, in: *Der Islam* (Strasburg) 2/1911/345-358 (reprint in: *Natural Sciences in Islam*, vol. 28, Frankfurt 2001, pp. 229-242).

²² *al-Ātār al-bāqīya 'an al-qurūn al-ḥāliya*, ed. by Eduard Sachau, Leipzig 1878 (repr. *Islamic Mathematics and Astronomy*, vol. 30, Frankfurt 1998), pp. 250; Engl. transl. idem, *The Chronology of Ancient Nations*, London 1879 (repr. *Islamic Mathematics and Astronomy*, vol. 31, Frankfurt 1998), pp. 240; v. also E. Wiedemann, *Entsalzung des Meerwassers bei Bīrūnī*, in: *Chemiker-Zeitung* (Heidelberg) 46/1922/230 (reprint in: *Gesammelte Schriften* vol. 2, Frankfurt 1984, pp. 1019).

²³ Edmund O. von Lippmann, *Die "Entsalzung des Meerwassers" bei Aristoteles*, in: *Chemiker-Zeitung* (Heidelberg) 1911, pp. 629 ff., 1189 ff., and in: *Abhandlungen und Vorträge zur Geschichte der Naturwissenschaften von E. O. von Lippmann*, vol. 2, Leipzig 1913, pp. 157-167, esp. pp. 167.

²⁴ In: *Zeitschrift der Deutschen Morgenländischen Gesellschaft* (Wiesbaden) 116/1966/44-59.

²⁵ *Kitāb aṣ-Ṣifā' Ṭabī'iyāt*, part 5: *al-Ma'ādīn wa-l-ātār al-'ulwiya*, ed. by Ibrāhīm Madkūr, 'Abdalḥalīm Muntaṣir, Sa'id Zāyid, 'Abdallāh Ismā'il, Cairo 1965, pp. 3 ff.; M. Y. Haschmi, op. cit., pp. 44 ff.

²⁶ Ibn Sīnā, *Ṣifā'* op. cit., pp. 3-4; Haschmi, op. cit., pp. 44-45.

nuḥāsīya ‘*alā hai‘at as-sihām*] were formed. Ibn Sinā tried to melt a piece, but it burned with green smoke and left an ash-like substance behind. He also heard about iron that had fallen from the air.”²⁷ No doubt, the “copper-like body in the form of a lance” was a lightning tube or a fulgurite; these are sand grains fused together in the form of a tube which form in sand through flashes of lightning. A first description of this phenomenon was given by Karl Gustav Friedler in 1817.²⁸

According to Eric J. Holmyard, in his discussion of the formation of mountain ranges and stones, Ibn Sinā had anticipated quite early the conclusions of Leonardo da Vinci (1452-1519) and Nicolas Steno (1631-1686).²⁹

In the history of mineralogy, reference is made particularly to Ibn Sinā’s classification of minerals. He divides them into four classes: 1. stones (*aḥḡār*), 2. ores (*dā‘ibāt*, i.e. substances that can be melted), 3. substances that can be burnt (*kabārīt*, sulphura = varieties of sulphur), 4. salts (*amlāḥ*, substances that are soluble in water). However, I do not believe that this is in fact the “only thing” which “really survived the Middle Ages” as Karl Mieleitner³⁰ opined in 1922. At the end of this introduction, when we now raise the question of the continuation of Arabic-Islamic mineralogy in the Occident, we must be aware of the fact that we are not dealing with one of the fundamental areas of Arabic science, such as mathematics, astronomy, medicine and geography which exceptionally many scholars dealt with and left numerous works. Therefore the process of the reception and assimilation in the Oc-

cident of this peripheral subject looks different to that of the core subjects. Thus, there is hardly any influence worth mentioning, e.g., on the encyclopaedist Alexander Neckam (1157-1227), one of the most eminent figures in the phase of reception.

[162] In his book entitled *De naturis rerum liber* he does mention plenty of stones, but he does not give any descriptions.³¹

In my view, this explains why there are no more than isolated references to mineralogy in the works of Roger Bacon, the great European nature philosopher of the 13th century.³²

It is the book on minerals by Albertus Magnus (1193-1280), said to be the “best mineralogical work of the Occidental Middle Ages,” which shows for the first time noticeable traces of texts translated from the Arabic. These Arabic texts include Ibn Sinā’s book of stones, the pseudo-Aristotelean book of stones and a few other materials that were made available in Latin translation from the Arabic originals by the convert, Constantinus Africanus (d. 1085 in Salerno). It is striking that in his *Libri V de mineralibus* he adopts Ibn Sinā’s classification of stones, which we mentioned above, placing, however, the salts and the substances that can be burnt (sulphura) between stones and metals.³³ In a manner that is instructive for our question, K. Mieleitner³⁴ explains the nature of the special knowledge and the capacities of a personality as important for the assimilation process as Albertus Magnus is: “All in all, the mineralogical knowledge of Albertus is very meager, and in this field he excels his contemporaries only slightly. He relies mainly on the statements of his sources, but at least in his case there are the beginnings, though only in modest form, of making observations of his own. He was not familiar with the best writings of the Mohammedans, their works on the specific weight were completely unknown to him—as also to all other mineralogists of the Occidental Middle Ages—since he had at his disposal only imperfect Latin extracts of Arabic texts. Of course, Albertus also laboured under the opinions of his times, particularly the alchemical beliefs. His chemical knowledge was very meagre, although according to his own words he had read and stud-

²⁷ Šifā‘, op. cit., pp. 5; Haschmi, op. cit., pp. 45; idem, *Geologische Beobachtungen bei Avicenna*, in: Der Aufschluß. Zeitschrift für die Freunde der Mineralogie und Geologie (Heidelberg, Göttingen) 7/1956/15-16.

²⁸ v. Rudolph Zaunick, *Kurze Notiz*, in: Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften 41/1961/163. In F. M. Feldhaus, *Die Technik. Ein Lexikon der Vorzeit, der geschichtlichen Zeit und der Naturvölker*, Wiesbaden 1914 (repr. Munich 1970), column 110 one can read: “The clergyman Leonhard David Hermann found at Massel in Silesia one such [a lightning tube] first in 1706, but he explained it as ‘a fruit of a subterranean fire’ (...). The tube is preserved in the Mineralogisches Kabinett in Dresden. Around 1796 one farmer Hentzen found such a tube in the Senne near Paderborn and correctly called it a ‘lightning tube’.”

²⁹ *Makers of Chemistry*, Oxford 1931, pp. 72.

³⁰ *Zur Geschichte der Mineralogie. Geschichte der Mineralogie im Altertum und im Mittelalter*, in: Fortschritte der Mineralogie, Kristallographie und Petrographie (Jena) 7/1922/427-480, esp. pp. 480, cf. ibid., pp. 461.

³¹ v. K. Mieleitner, *Zur Geschichte der Mineralogie*, op. cit., pp. 466.

³² ibid., pp. 477.

³³ ibid., pp. 466, 468.

³⁴ ibid., pp. 473, 474.

ied much and had undertaken journeys to find out about the nature of metals. In the explanation of the physical and chemical properties, he finds in fact very few difficulties; as a rule he has at once a completely adequate explanation for everything, in the manner of scholastic philosophy. He modified Avicenna's excellent division of the minerals into four classes, which was not very fortunate, but at the same time very necessary because he knew so few salts and combustible bodies among the minerals that he could not put them as an equally important class next to stones and minerals. His book on precious stones differs from the numerous others of the Middle Ages only in the sense that he at least includes a few of his own observations, even if those are for the most part incorrect." The first Arabic book with mineralogical content that reached the Occident in Latin translation was apparently *al-ʿItimād fi l-adwiya al-mufrada* by Aḥmad b. Ibrāhīm Ibn al-Ġazzār (d. 369/979).³⁵ It is a book of drugs in four parts, the fourth of which is devoted to minerals and mineral medicaments.³⁶ It saw the light of the day in Salerno under the title *Liber de gradibus* as a work of the above-mentioned north-African convert Constantinus Africanus, who translated several books from the Arabic, reworked them arbitrarily, and attributed them to himself or to a Greek authority.³⁷

This adaptation circulated for seven hundred years as the work of Constantinus Africanus, parallel to the Latin translation of a certain Stephanus de Caesaraugusta (Zaragoza, written 1233) which bears the name of the actual author and the title *Liber fiducia de simplicibus medicinis*.

[163] The mineralogical knowledge of the Arabic-Islamic culture area also reached the Occident through Latin and Hebrew translations of the chemical-alchemical books by Ġābir b. Ḥaiyān and Abū Bakr ar-Rāzī. In his study *Übersetzung und Bearbeitungen von al-Rāzīs Buch Geheimnis der Geheimnisse*³⁸, which appeared in 1935, Julius Ruska could show what kind of elaborations and adaptations were done to this book that contains an important chapter on minerals.

Wide popularity in the Occident was also enjoyed by the above-mentioned pseudo-Aristotelean book of stones which was obviously translated into Latin from the Arabic in the 6th/12th century. Of course, it was considered for centuries a book by Aristotle, not only in the Occident, but also in the Islamic world. For the author of these lines it is, however, a Greek pseudo-epigraph from Late Antiquity that was first translated into Arabic and from there into Latin.

In conclusion, we may mention another work which too was translated at first from the Arabic and was circulated as the work by Aristotle. It is the *Liber de mineralibus Aristoteles*, which was known for centuries, besides the *Tria vero ultima Avicennae capitula transtulit Aurelius de arabico in latinum*, until E. J. Holmyard and D. C. Mandeville³⁹ demonstrated that both the texts are a part of the section on natural sciences (*ṭabīʿiyyāt*) in Ibn Sīnā's *Kitāb aš-Šifāʿ*.

³⁵ v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 3, pp. 304-307.

³⁶ Facsimile ed., Frankfurt 1985.

³⁷ v. Moritz Steinschneider, *Constantinus Africanus und seine arabischen Quellen*, in: *Archiv für pathologische Anatomie und Physiologie und für klinische Medizin* (Berlin) 37/1866/351-410, esp. pp. 361-363 (reprint in: *Islamic Medicine*, vol. 43, pp. 1-60, esp. pp. 11-13; idem, *Constantin's lib. de gradibus und Ibn al-Ġazzār's Adminiculum*, in: *Deutsches Archiv für Geschichte der Medizin und medicinischen Geographie* (Leipzig) 2/1879/1-19 (reprint in: *Islamic Medicine* vol. 94, pp. 320-338).

³⁸ In: *Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin*, vol. 6, Berlin 1935, pp. 153-239.

³⁹ *Avicennae De congelatione et conglutinatione lapidum being sections of the Kitāb al-Shifāʿ*. The Latin and Arabic texts edited with an English translation of the latter and with critical notes by E. J. Holmyard and D. C. Mandeville, Paris 1927 (reprint in: *Natural Sciences in Islam*, vol. 60, Frankfurt 2001, pp. 147-240).



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Clément-Mullet, see Tifāṣī

A. Dietrich, *Dioscurides triumphans* = *Dioscurides triumphans. Ein anonym arabischer Kommentar (Ende 12. Jahrh. n. Chr.) zur Materia medica. Arabischer Text nebst kommentierter deutscher Übersetzung*, 2 vols., Göttingen 1988.

EI = *Enzyklopaedie des Islām. Geographisches, ethnographisches und biographisches Wörterbuch der muhammedanischen Völker*. Ed. M.Th. Houtsma et al., 4 vols. and supplement, Leiden and Leipzig 1913–1938.

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Lat. transl. *Liber fiducia* = Lothar Volger, *Der Liber fiducia de simplicibus medicinis des Ibn al-Jazzār in der Übersetzung von Stephanus de Saragossa. Übertragung aus der Handschrift München, Cod. Lat. 253, Würzburg 1941 (Texte und Untersuchungen zur Geschichte der Naturwissenschaften. Heft 1) (repr. Islamic Medicine, vol. 39, Frankfurt 1996, pp. 225–334).*

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Schönfeld, see Tamimī

Sontheimer, see Ibn al-Baiṭār

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Tamimī, *Muršid* = Jutta Schönfeld, *Über die Steine. Das 14. Kapitel aus dem "Kitāb al-Muršid" des Muḥammad ibn Aḥmad at-Tamimī, nach dem Pariser Manuskript herausgegeben, übersetzt und kommentiert*, Freiburg 1976 (Islamkundliche Untersuchungen, vol. 38). Tifāšī, *Azhār al-afkār* = *Fior di pensieri sulle pietre preziose* di Ahmed Teifascite. Opera stampata nel suo originale arabo, colla traduzione italiana appresso, e diverse note di Antonio Raineri, Florence 1818 (repr. Natural Sciences in Islam, vol. 31, Frankfurt 2001, pp. 1–178).

Clément-Mullet = Jean-Jacques Clément-Mullet, *Essai sur la minéralogie arabe*, in: *Journal asiatique* (Paris), série 6, 11/1868/5–81, 109–253, 502–522 (repr. Natural Sciences in Islam, vol. 31, Frankfurt 2001, pp. 179–422).

Wiedemann, *Aufsätze* = Eilhard Wiedemann, *Aufsätze zur arabischen Wissenschaftsgeschichte*, ed. Wolf Dietrich Fischer, 2 vols., Hildesheim and New York 1970 (Collectanea VI/1–2).

Wiedemann, *Gesammelte Schriften* = Eilhard Wiedemann, *Gesammelte Schriften zur arabisch-islamischen Wissenschaftsgeschichte*, collected by Dorothea Girke and Dieter Bischoff, ed. Fuat Sezgin, 3 vols., Frankfurt 1984 (Veröffentlichungen des Institutes für Geschichte der Arabisch-Islamischen Wissenschaften, Reihe B: Nachdrucke, vol. 1,1–1,3).

E. Wiedemann, *Zur Mineralogie im Islam* = Eilhard Wiedemann, *Zur Mineralogie im Islam (Beiträge zur Geschichte der Naturwissenschaften 30)*, in: *Sitzungsberichte der Physikalisch-medizinischen Sozietät zu Erlangen* 44/1912/205–256 (repr. Natural Sciences in Islam, vol. 28, Frankfurt 2001, pp. 177–228).

Yāqūt, *Mu'ğam al-buldān* = *Kitāb Mu'ğam al-buldān ta'līf... Yāqūt b. 'Abdallāh al-Ḥamawī*, *Jacut's Geographisches Wörterbuch* aus den Handschriften... herausgegeben von Ferdinand Wüstenfeld, 6 vols., Leipzig 1866–1870 (repr. Islamic Geography vol. 210–220, Frankfurt 1994).





almās

Diamant

11 pieces, white and tinted.

Diameter: ca. 1.5-5 mm. Total weight: ca. 5 ct. (5 carats = 1 g).

(Inventory No. K 3.14)

Diamond is referred to as the hardest of all stones which, unbreakable in itself, can reduce to small pieces all other stones (and metal, with the exception of black lead). Arabic sources mention only India as the deposit site.

Steinbuch des Aristoteles, pp. 105–106, 149–150 (reprint op. cit., pp. 113–114, 157–158); Tamīmī, *Muršid*, pp. 111–113, 191–193; Bīrūnī, *Ġamāhir*, pp. 92–102; Ibn al-Ġazzār, *Iʿtimād*, facsimile ed., pp. 157–158; Qazwīnī, *ʿAġāʾib al-maḥlūqāt*, pp. 236–237; Ibn al-Baiṭār, *Ġāmiʿ*, vol. 4, pp. 126–127 (French transl. Leclerc, vol. 3, pp. 272; German transl. Sontheimer, vol. 2, pp. 466–467); Tifāšī, *Azhār al-afkār*, pp. 24–25 (reprint op. cit. pp. 36–37); J. Ruska, *Der Diamant in der Medizin*, in: *Zwanzig Abhandlungen zur Geschichte der Medizin. Festschrift Hermann Baas...*, Hambourg and Leipzig 1908, pp. 121–130 (reprint in: *Natural Sciences in Islam*, vol. 27, Frankfurt 2001, pp. 239–248).

sunbādağ
Corundum
(Emery)



(1) Var. ruby in gneiss.
115 x 85 mm, 0.79 kg.
(Inventory No. K 3.27a)



(2) Var. emery.
85 x 85 mm, 0.206 kg.
(Inventory No. K 3.27b)

Sunbādağ is a Persian term; in Greek the stone is called σμύδιος. It is a hard stone which has the property of being able to grind metal and stone (corundum is still used today in the production of emery paper). Because of its hardness it is considered a “deputy” (*nā’ib*) of diamond (see Bīrūnī, *Ġamāhir*, p. 102). It is also called *yāqūt aḥmar* (ibid, p. 103).

Sudan, Sri Lanka and Isfahan in Persia are mentioned in Arabic sources as the locations of deposits.

Dioscorides, book 5, chapter 165; v. J. Berendes p. 553; *Steinbuch des Aristoteles*, op. cit., pp. 106, 150-151 (reprint op. cit., pp. 114, 158-159); Ibn al-Baitār, *Ġāmi’*, vol. 3, p. 40 (French transl. Leclerc, vol. 2, pp. 299-300; German transl. Sontheimer, vol. 2, pp. 63-64); Qazwīnī, *‘Ağā’ib al-maḥlūqāt*, p. 228; Tifāšī, *Azhār al-afkār*, p. 40 (reprint op. cit., p. 21).

biğādī
Garnet



(1) On muscovite and quartz.
55 x 450 mm, 148 g.
(Inventory No. K 3.19a)



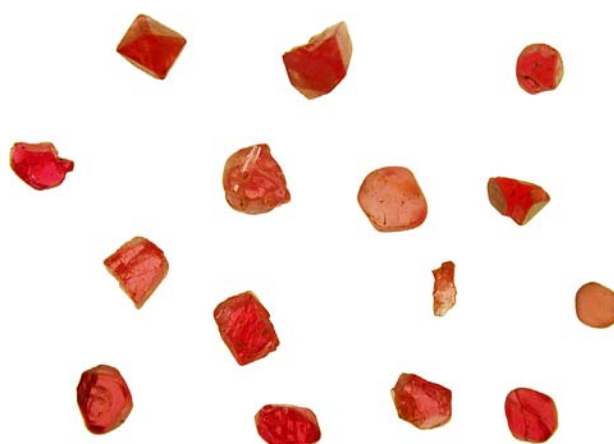
(2)
Diameter: 50 mm, 96 g.
(Inventory No. K 3. 19b)

v. *Steinbuch des Aristoteles*, op. cit., pp. 102, 143-144 (reprint op. cit., pp. 110, 151-152); Tifāṣī, *Azhār al-afkār*, pp. 22-23 (reprint op. cit., pp. 38-39).



balḥaš (from Persian *balahš*)
Spinel, Ruby Spinel

Described by at-Tifāšī (*Azhār al-afkār*, p. 19, reprint p. 42) as related to the ruby (*yāqūt*), this stone is identified with the term *laʿl* (likewise “ruby” etc.) by Ibn al-Akfānī (*Nuḥab ad-daḥāʿir*, pp. 755-756): “*Balahš* is called *laʿl* in Persian. It is a red transparent stone and it is in fact the red that is called *musfir*, it is also pure. In colour and lustre, it has a striking resemblance to a beautiful *yāqūt*. It differs from it in hardness so that it is cut when the two minerals collide with one another. That is why it must be polished with gold-coloured marcasite, which is the most excellent polishing material for this precious stone. There is one type that resembles the *bahramānī* and is known under the name *al-yāzakī*; it ranks the highest and is the most precious.” “At the time of the Buyids (321/933-448/1056), it was sold for the same price as *yāqūt*, until it came to be better known; then its price sank and it was decided that it should be sold by *dirhams* and not by *miṭqāls*, in order to differentiate it from the *yāqūt*. There are specimens tending to white and there are some which tend to the colour of violets (*banafsaḡīya*); these two are less valuable than the first mentioned.” “It is found in the East, three days journey from Baḍaḥšān. This is the gate for it, so to speak, [through which it comes to other countries]. Some spinels occur with transparent coatings and some without. Pieces weighing more than 100



(1) dark, 10 pieces,
diameter: 3-5 mm.
Total weight: 10 ct.
(Inventory No. K 3.49a)

(2) light, 15 pieces,
diameter: 1.5-3 mm.
Total weight: 8 ct.
(Inventory No. K 3.49b)

dirham have been noticed. In earlier times the price of each dirham was 20 dinar and sometimes more.”¹ Al-Bīrūnī (*Ġamāhir* pp. 81-88) lists the stone under the name *al-laʿl al-badaḥšī*, and the same term is used also by al-Ḥāzinī (*Mizān al-ḥikma*, p. 138, reprint op. cit., p. 295).

In 1818 J. Hammer-Purgstall² identified *balḥaš* listed by at-Tifāšī as spinel. A generation later, E. Quatremère compiled a series of statements on the stone from Arabic and Persian sources in his *Histoire des Sultans Mamlouks de l'Égypte*, écrite en arabe par Taki-Eddin-Ahmed-Makrizi, traduite en français ..., vol. 2, Paris 1845, p. 71.³

¹ With slight changes adapted from E. Wiedemann, *Zur Mineralogie im Islam*, op. cit., pp. 216-217 (reprint op. cit., pp. 188-189).

² cf. *Steinbuch des Aristoteles*, op. cit., p. 32 (reprint op. cit., p. 40).

³ Quatremère's statements were translated by E. Wiedemann, *Zur Mineralogie im Islam*, op. cit., pp. 235-236 (reprint op. cit., pp. 207-208).



banfaš (from Persian *banafš*)
Zircon (hyacinth)

Diameter: 17 mm, 50 ct.
(Inventory No. K 3.58)

According to at-Tifāṣī (*Azhār al-afkār*, p. 19, repr. p. 42), *banfaš* as well as *balḥaš* (spinel) and *biḡādī* (garnet) belong to the types (*anwāʿ*) and varieties (*ašbāh*) of *yāqūt* (ruby): “The wise man (ḥakīm) says that these three were originally meant to become ruby, but this had been prevented by external influences like too high or too low moisture, lack of warmth or rest. That is why they turned into stones which do not resist fire.”

There are said to be four classes (*aṣnāf*) of *banfaš*. The first is called *mādinī*. It is of a clear light-red colour. The second is called *asādast* and is black. The third (without a name) is yellow. The fourth remains without any description (*Azhār al-afkār*, p. 21, reprint p. 40). J. J. Clément-Mullet¹ identified *banfaš* as zircon.²

¹ *Essai sur la minéralogie arabe*, in: *Journal Asiatique*, sér. 6, 11/1868/5-81, 109-253, 502-522, esp. p. 117 (repr. in *Natural Sciences in Islam*, vol. 31, Frankfurt 2001, pp. 179-422, esp. p. 265).

² On this, v. Oken, *Allgemeine Naturgeschichte*, vol. 1, pp. 150-152; Bauer, *Edelsteinkunde*, pp. 426-432.



ğamast
Amethyst

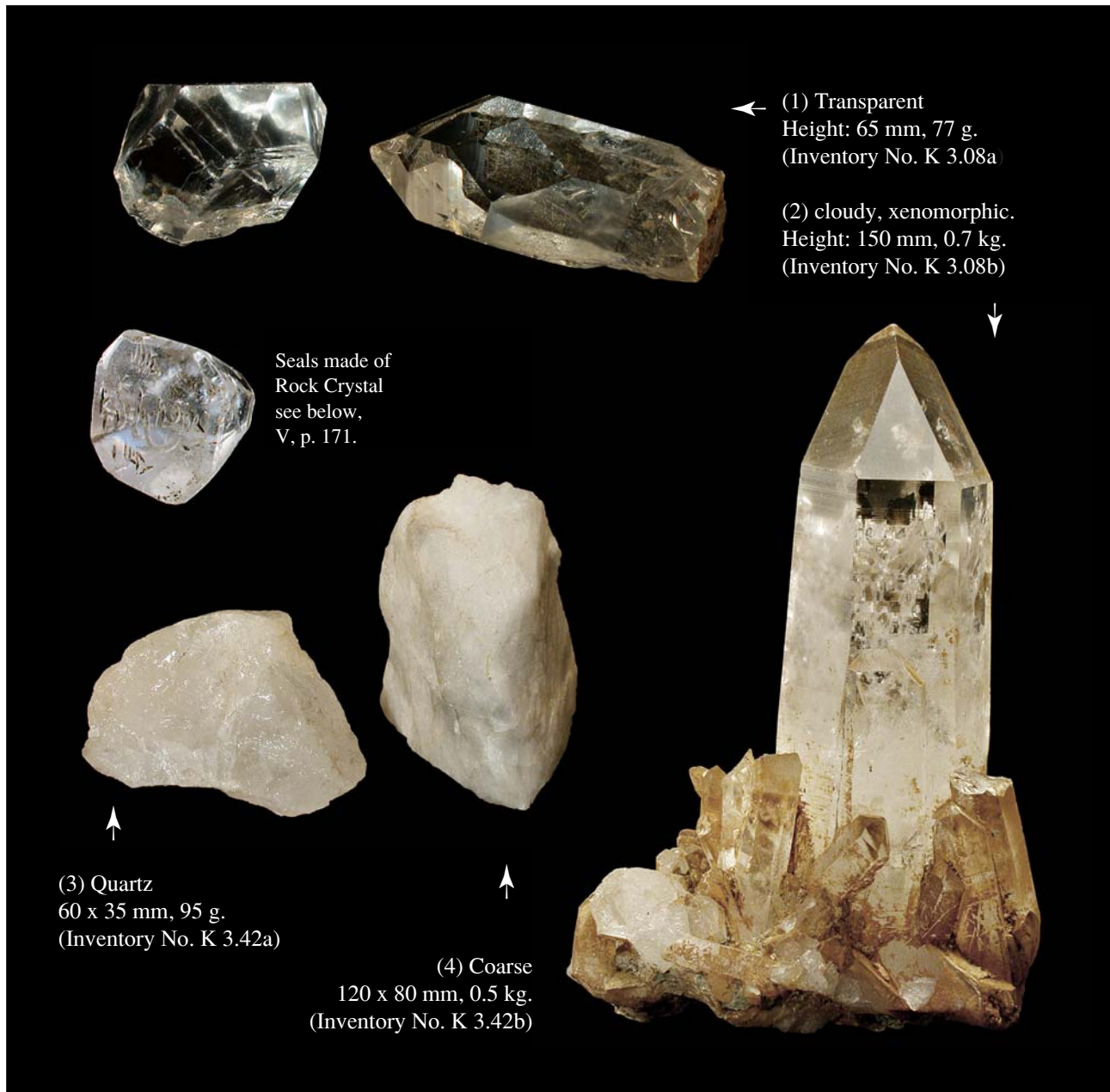
(1) Diameter: ca. 95 mm, 0.49 kg.
(Inventory No. K 3.04a)

(2) 180 x 70 mm, 0.77 kg.
(Inventory No. K 3.04b)

About the stone al-ğamast, also called al-ğamaz, Ibn al-Akfānī (d. 749/1348) says in his book *Nuḥab ad-daḥā'ir fī aḥwāl al-ğawāhir*:¹ "It is a stone that resembles the violet-coloured *yāqūt* (*al-yāqūt al-banaḥsaḡī*). The most precious variety sold for the highest price is the rose-coloured variety (*wardī*). It is found near aṣ-Ṣafrā' in the Ḥiğāz. Some specimens are found which are covered with a white coating; they resemble the snow on the surface of which there is some reddishness." The deposit sites are Waṣḡird in Persia and the region around the city of aṣ-Ṣafrā' in the Ḥiğāz. In medicine it was believed that the stone strengthened the brain and the stomach.

Birūnī, *Ğamāhir*, p. 194; Tifāṣī, *Azhār al-afkār*, p. 49 (reprint op. cit., p. 12, v. also Clément-Mullet, op. cit., pp. 211-216, reprint op. cit., pp. 359-364); Ibn al-Baiṭār, *Ğami'*, vol. 1, p. 168 (French transl. Leclerc, vol. 1, pp. 366-367; German transl. Sontheimer, vol. 1, p. 258)

¹ Ed. Cheikho, in: al-Maṣriq (Beirut) 11/1908/763, translation on E. Wiedemann, *Zur Mineralogie im Islam (Beiträge zur Geschichte der Naturwissenschaften XXX)*, in: Sitzungsberichte der Physikalisch-medizinischen Sozietät (Erlangen) 44/1912/205-256, esp. pp. 226-227 (reprint in: *Natural Sciences in Islam*, vol. 28, Frankfurt 2001, pp. 177-228, esp. pp. 198-199)..



billaur, ballūr, mahā

Rock Cristal

In the pseudo-Aristotelian book of stones (see above, p. 117) rock crystal is called a stone that resembles glass. This view was also generally held by Arab scholars.

Upper Egypt, Indian Ocean (al-Baḥr al-aḥḍar), Armenia and Sri Lanka are mentioned as the deposit sites.

Rāzī, *Asrār wa-sirr al-asrār*, p. 4; *al-Rāzī's Buch Geheimnis der Geheimnisse*, p. 87; Tamīmī, *Muršid*, pp. 97, 184; Ibn al-Baiṭār, *Ḡāmi'*, vol. 4, pp. 167–168 (French transl. Leclerc, vol. 3, pp. 342–343; German transl. Sontheimer, vol. 2, p. 534); Bīrūnī, *Ḡamāhir*, pp. 181–186; Tifāšī, *Azhār al-afkār*, p. 53 (reprint op. cit., p. 8).



zumurrud

Emerald

Diameter: 12 mm, enclosed in rock: 85 x 50 mm.
Total weight: 120 g.
(Inventory No. K 3.48)

Zumurrud and *zabarġad* (v. the following) are generally considered in Arabic sources to be one and the same stone. Some mineralogists are of the view that both are found in the same mines and that *zabarġad* is the less valuable variety.

Upper Egypt, the localities of Sindān and Kambāyāt in India and a region called Buga in the Far East are mentioned as deposit sites.¹

Steinbuch des Aristoteles, op. cit., pp. 98-99, 134-135 (reprint op. cit., pp. 106-107, 142-143); Tamīmī, Muršid, pp. 43-48, 146-150; Birūnī, *Ġamāhir*, pp. 160-169; Qazwīnī, *ʿAġāʿib al-maḥlūqāt*, p. 227; Ibn al-Baiṭār, *Ġāmiʿ*, vol. 2, pp. 166-167 (French transl. Leclerc, vol. 2, pp. 216-217; German transl. Sontheimer, vol. 1, p. 537); Tifāšī, *Azhār al-afkār*, pp. 13-16 (reprint op. cit., pp. 45-48); Ibn al-Akfānī, *Nuḥab ad-ḍaḥāʿir*, op. cit., pp. 760-761.

¹ On the deposit sites, v. E. Wiedemann, *Zur Mineralogie im Islam*, op. cit., pp. 239-242 (reprint op. cit., pp. 211-214).

zabarġad

Beryl is related in mineralogy to emerald. Arabic mineralogists could not agree whether *zabarġad* and *zumurrud* were the same kind of stones or different ones. On the sources, see above under emerald.

(2) Greenish
Diameter: 18 mm, 35 ct.
(Inventory No. K 3. 10b)

(1) Greenish-yellow
Diameter: 22 mm, 55 ct.
(Inventory No. K 3.10a)

‘ain al-hirr

Cat's Eye

Diameter: 34 mm, 30 g.
(Inventory No. K 3.24)



Jean-Jacques Clément-Mullet¹ translates the Arabic name into French as *œil-de-chat* and identifies the stone as quartz chatoyant.

At-Tifāṣī (*Azhār al-afkār*, pp. 28-29, reprint pp. 35-36) considers the stone to be an insufficiently developed ruby which is mined together with the ruby as an inferior variety. He complains that none of the books of stones known to him mentioned this stone.

¹ *Essai sur la minéralogie arabe*, in: *Journal Asiatique*, sér. 6, 11/1868/5-81, 109-253, 502-522, esp. pp. 139-143 (reprint in: *Natural Sciences in Islam*, vol. 31, Frankfurt 2001, pp. 179-422, esp. pp. 287-291).



yašb, yašm, yast

Jasper

10 pieces in various colours
Average diameter: 25 mm. Total weight: 68 g.
(Inventory No. K 3.22)

This is the stone called *ῥαυσις λίθος* by the Greeks (Dioscorides, book 5, chapter 159, v. J. Berendes p. 551). Ibn al-Baitār mentions the stone in his *Ġāmiʿ* (vol. 4, p. 209) and quotes from Dioscorides, Galen and al-Ġāfiqī. At the beginning he says, following Dioscorides: “Some claim that jasper is a kind of emerald. There is one variety whose colour comes close to that of smoke and represents as it were something covered by smoke. Another variety of jasper has white lustrous veins and is called *Astrius* (*kaukabī*). Another type is called *Terebinthinum* (*ṭarmīnūn*) because it has a colour similar to that of

the fruit of the terpentine tree ...” (transl. Sontheimer, vol. 2, p. 602, cf. transl. Leclerc, vol. 3, p. 427). Al-Bīrūnī mentions China (*Ḥutan*) as the deposit site; there since Antiquity various jasper varieties that were as pale as milk were preferred to diamonds, rubies or emeralds.

v. also Bīrūnī, *Ġamāhir*, pp. 198-199; Muwaffaqaddin al-Harawī, *Abniya*, pp. 120, 346 (transl. Achundow, pp. 190, 284, 318; reprint pp. 62, 156, 190).

ğins min al-‘aqiq

Agate

(1) Broken.

Diameter: ca. 135 mm, 0.69 kg.
(Inventory No. K 3.02 a)

(2) Sawed and polished.

Diameter: ca. 130 mm, 0.75 kg.
(Inventory No. K 3.02 b)

(3) Water Agate.

Diameter: 50 mm, 95 g.
(Inventory No. K 3.02 c)

This variety of carnelian is described in the pseudo-Aristotelian Book of Stones as follows: “Among the carnelians there are also those which are less beautiful, whose colour is that of meat water and in which there are fine white lines. Whosoever uses this variety as the stone for his seal, his anger will subside. It staunches haemorrhages and actually has its special effect on women whose menstrual period lasts too long. Its powder smoothens the teeth, removes dental caries and draws out the rotten blood from the roots of the teeth.” (*Steinbuch des Aristoteles*, pp. 103, 144, reprint op. cit., pp. 111, 152).

This variety seems to be identical with that which al-Bīrūnī mentions in the *Kitāb al-Ġamāhir* (p. 174), following Naṣr b. Ya‘qūb al-Kindī (4th/10th cent.). It is said to have been called ‘*aqiq ḥalanğ*’ and to have been less valuable than carnelian. He mentions India as the deposit site.





2 Seals made of
Carnelian, see below, vol. V, 168
Iran, Zand/Qajar
(13th/18th-19th cent.)
Breadth: 17 and 20 mm.
(Inventory No. J 72 and 73)

‘aqīq

(1) Yellow.
Diameter: 45 mm, 68 g.
(Inventory No. K 3.23a)

(2) Red.
90 x 60 mm, 340 g.
(Inventory No. K 3.23b)

This stone, which was especially popular in Arabia, occurs in various colours, but preference was given to that having a certain red shade which is called in Arabic *laun mā‘ al-laḥm* (“meat-water colour”). This designation is explained by Ibn al-Baiṭār (*Ġāmi‘*, vol. 3, p. 128) as “the colour of the water that oozes when salt is sprinkled on meat”. The Latin name carnelian goes back to this fact. Pliny calls the stone sardonyx. *‘Aqīq* was (and still is) used for necklaces, signet rings and inlaid work at prayer niches (*miḥrāb*) at mosques. It was also used as a powder for dental care. Arabic sources mention, among others, Yemen, the vicinity of Basra and the banks of river Jordan as the deposit sites.

Steinbuch des Aristoteles, pp. 103, 144–145 (reprint op. cit., pp. 111, 152–153); Tamīmī, *Muršid*, pp. 47–48, 151–152; Birūnī, *Ġamāhir*, pp. 172–174; Qazwīnī, *‘Ağā’ib al-maḥlūqāt*, pp. 230; J. Hell, in: *EI*¹, vol. 1, pp. 251.



ğaz'

Onyx

40 x 25 mm, 33 g.
(Inventory No. K 3.37)

This stone, quite well known in Arabia, is often mentioned together with the carnelian because of the deposit sites. Ibn al-Faḥīh al-Hamaḍānī, the geographer who was active in the first half of the 4th/10th century (*Kitāb al-Bulḍān*, Leiden 1885, p. 36), after mentioning its source, goes on to say: "In the mountains of al-Yaman there are deposits of onyx (ğaz'); it has different varieties. All of them appear in the same places that carnelian occurs. The best and most valuable variety is *al-baqarānī*, others are *al-ʿarwānī*, *al-fārisī* (from Fars), *al-ḥabašī* (from Ethiopia), *al-muʿassal* (looking like honey), *al-muʿarraḡ* (having veins)."¹ Ibn al-Baiṭār (*Ğāmiʿ*, vol. 1, p. 163) also knows a variety from China. Valuable information on this stone is to be found in the *Kitāb al-Išāra ilā maḥāsīn at-tiğāra* by Abū l-Faḍl ad-Dimašqī (p. 18): "Artists fashion large impeccable pieces of jewellery from it. Often they get high prices because of the skill they had to employ, since it is a stone that is difficult to work with. One of its varieties is the *bāqarānī* onyx. Signet rings are made out of it with the names of the kings

and nobles. It fetches high prices." "Onyx consists of successive parallel layers, each having a clear white, black and red colour. With the help of these the artist carves out letters whose colour is different from that of the background. Sometimes three colours are also found, be it in writing or in a picture. Generally they can show three colours only in a picture because the picture is of the human body and can be carved through three layers; in the case of writing they can achieve that only when the surface of the signet ring is not flat (i.e. several colours are only possible when depictions are in relief)".²

v. also *Steinbuch des Aristoteles*, pp. 103, 145 (reprint op. cit. pp. 111, 153); Tifāšī, *Azhār al-afkār*, pp. 35 (reprint op. cit. pp. 26); J.-J. Clément-Mullet, op. cit., pp. 162–170 (reprint in: *Natural Sciences in Islam*, vol. 31, Frankfurt 2001, pp. 310–318).

¹ E. Wiedemann, *Zur Mineralogie im Islam*, op. cit., p. 245 (reprint op. cit., p. 217).

² Translated by E. Wiedemann, op. cit., p. 235 (reprint op. cit., p. 207)



marqašitā (dahabīya)

Marcasite (golden)

85 x 65 mm, 482 g.
(Inventory No. K 3.32)

According to Šamsaddīn ad-Dimašqī (*Nuḥbat ad-dahr*, p. 84), there are seven varieties of marcasite of which he enumerates “the golden one” (*dahabī*), “the silver one” (*fiḍḍī*), “the copper one” (*nuḥāsī*), “the iron one” (*ḥadīdī*) and “the mercury one” (*zaibaqī*). The last two are said to be the lowest in quality. On the fundamental concept, most of the relevant Arabic sources refer to Dioscorides, who treats the πυρίτος λίθος in his fifth book (chapter 142). In his description from the point of view of medicine he does not mention the differences between the varieties. According to Julius Berendes (p. 545), Dioscorides confuses “two minerals, namely copper pyrite and sulphur pyrite”.

Of the varieties of marcasite mentioned by Šamsaddīn ad-Dimašqī, we may also show here “the copper marcasite”:



marqašitā nuḥāsīya

65 x 45, 185 g.
(Inventory No. K 3.28)

Copper Pyrite

Steinbuch des Aristoteles, pp. 112 (reprint op. cit. pp. 120); Rāzī, *al-Mudḥal at-taʿlīmī*, pp. 412 (reprint pp. 108); Ibn al-Baiṭār, *Ḡāmiʿ*, vol. 4, pp. 152–153 (French transl. Leclerc, vol. 3, pp. 312; German transl. Sontheimer, vol. 2, pp. 508–509); E. Wiedemann, *Zur Chemie bei den Arabern* (= Beiträge zur Geschichte der Naturwissenschaften XXIV), in: *Sitzungsberichte der Physikalisch-medizinischen Sozietät (Erlangen)* 43/1911/72–113, esp. pp. 97–98 (reprint in: Wiedemann, *Aufsätze*, vol. 1, pp. 689–730, esp. pp. 714–715).

As deposit sites of marcasite, ad-Dimašqī mentions Ḥadaṭ in Lebanon, Ġūsīya near Karak, and Yaʿfūr, a village near Damascus.



šādanağ, amāṭītīs

Hematite

(1) Var. haematite
Diameter: 60 mm, 0.3 kg.
(Inventory No. K 3.21a)

(2) Var. kidney ore
200 x 100 mm, 1.96 kg.
(Inventory No. K 3.21b)

This stone, called αἱματίτης by the Greek predecessors, appears in Arabic writings in the Arabic form *amāṭītīs* as well as under the Persian equivalent *šādanağ* and also under the names *hağar ad-dam* (“blood stone”) and *hağar aṭ-ṭūr* (“mountain stone”). at-Tamīmī (*Muršid*, pp. 65-69), to whom, as far as I know, we owe the most detailed treatment of the subject, says: “There are two varieties, one of them is masculine and the other feminine. The masculine haematite is the hard, smooth, externally very red variety that serves people (?) when it is rubbed on a red spot or a boil that is caused by a congestion in the face and in the head and in the other limbs; then it distributes the blood, removes the boil and is beneficial to the person; and that is why it is called blood stone. As for the feminine one, it is formed like a lentil, deep red and nice to the touch and (it looks) as if there are red lines in the form of a lentil on its surface. It is collected and melted (together) and glued one on the top of the other. It can be of different shades of deep red, and can be (differently) brittle when crushed. Those which are deep red and shine on the inside, when it breaks are chosen, which is clear from (other) rocks and

which is easy to pulverise ...” “Another variety is called blood stone from Yemen (*yamani*); its colour comes close to black and it is not very hard. This is more useful to the eyes than the Nubian variety (*nūbī*). Another variety of *Šādanağ* is called that of Malaṭiya (*malaṭī*); yet another variety is imported from Libya, it is close to the Nubian variety in colour when heaped on top of each other ...” (after the transl. by Jutta Schönfeld, *ibid.*, pp. 66-68).

According to Arabic sources, the deposit sites are Malatya in Anatolia, the mountain of Tabor and al-Karak in Palestine and certain regions in Yemen, in Egypt, in Sudan and North Africa.

v. also Rāzī, *Asrār wa-sirr al-asrār*, pp. 4; *al-Rāzī's Buch Geheimnis der Geheimnisse*, pp. 45; Bīrūnī, *Ġamāhir*, pp. 217; Ibn al-Baiṭār, *Ġāmi'*, vol. 3, pp. 49–50 (French transl. Leclerc, t. 2, pp. 315; German transl. Sontheimer, vol. 2, pp. 77–78); Qazwīnī, *ʿAğā'ib al-maḥlūqāt*, pp. 228; Tifāšī, *Azhār al-afkār*, pp. 50 (reprint op. cit. pp. 11).



magnētis

Loadstone

70 x 55 mm, 0.35 kg.
(Inventory No. K 3.30)

The loadstone is also called *ḥaḡar al-bāhit* in Arabic. Knowledge of this mineral, which reached the Arabs from the Greek and other neighbouring cultures, was widespread in the Islamic world. The use of the loadstone in the ship's compass, which was at first rather primitive, reached the Arabic-Islamic culture area possibly from China. However, the further development of the compass and its systematic use as a means of orientation seems to have been an achievement of the nautical science which developed in the Indian Ocean region.¹

¹ On this, v. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 11, pp. 232-268.

On the loadstone v. *Steinbuch des Aristoteles*, pp. 109, 154–155 (reprint op. cit., pp. 117, 162–163); Tamimī, *Muršid*, pp. 123–128, 200–203; Bīrūnī, *Ġamāhir*, pp. 212–215; Qazwīnī, *ʿAḡāʾib al-maḥlūqāt*, pp. 211–212, 239–240; Ibn al-Baitār, *Ġāmiʿ*, vol. 4, pp. 161 (French transl. Leclerc, vol. 3, p. 329–330; German transl. Sontheimer, vol. 2, pp. 523); Tifāšī, *Azhār al-afkār*, pp. 37–39 (reprint op. cit., pp. 22–24); J.-J. Clément-Mullet, op. cit., pp. 170–178 (reprint in: *Natural Sciences in Islam*, vol. 31, pp. 318–326).



lāzuward

Lapis Lazuli, Lazurite

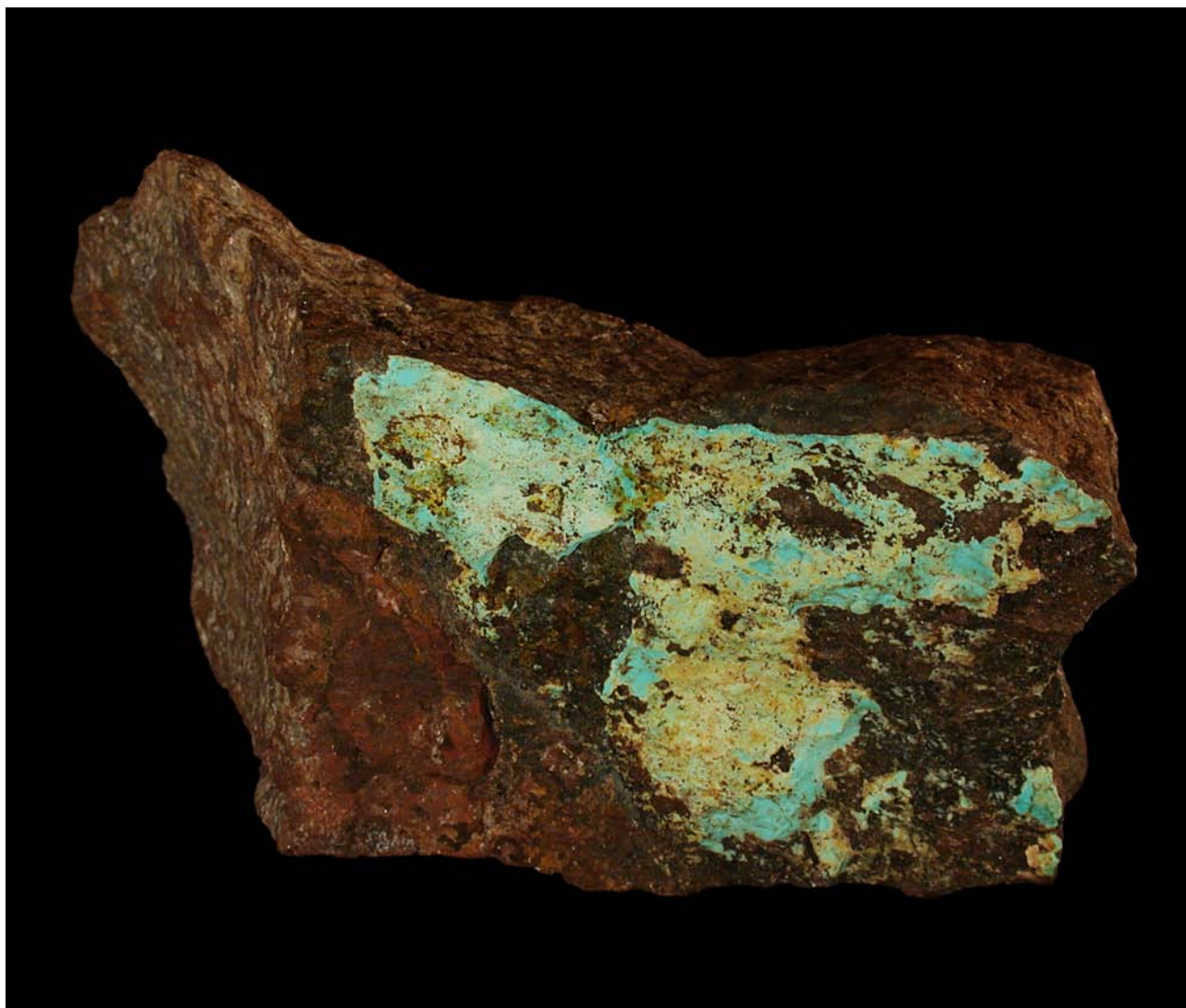
53 x 30 mm, 42 g.
(Inventory No. K 3.29)

According to ar-Rāzī, there is only one variety of lazurite. It is dark blue with a little red and has shining gold-coloured eyes (*al-Rāzī's Buch Geheimnis der Geheimnisse*, p. 86). Ar-Rāzī, who displays a sound knowledge of the subject here, describes the stone as one of four “oily” stones which have an oily lustre or which achieve special lustre when rubbed with oil (*ibid*, p. 44).

As a medicinal remedy lapis lazuli is used for diseases caused by black bile such as the symptoms of melancholy. About its function as a laxative at-Tamīmī (*Muršid*, pp. 77-78) says that he had tried it but “found no truth in it”. In powder form

the stone is one of the most important and most cherished pigments (true ultramarine) even today. Among the deposit sites, al-Bīrūnī (*Ġamāhir*, p. 195) mentions a mine in the vicinity of the mountain Bīḡaḍī in Badaḡšān, in the extreme north-east of Afghanistan.

Steinbuch des Aristoteles, pp. 107, 153 (reprint op. cit., pp. 115, 161); Tamīmī, *Muršid*, pp. 75–78, 167–169; Qazwīnī, *‘Aḡā’ib al-maḥlūqāt*, pp. 234; Ibn al-Baiṭār, *Ġāmi’*, vol. 4, pp. 91 (French transl. Leclerc, vol. 3, pp. 215–216; German transl. Sontheimer, vol. 2, pp. 410–411); J.-J. Clément-Mullet, op. cit., pp. 191–201 (reprint in: *Natural Sciences in Islam*, vol. 31, pp. 339–349).



fīrūzaġ
Turquoise

108 x 56 mm, 376 g.
(Inventory No. K 3.53)

Turquoise is also called *ḥaġar al-ġalaba* (“victory stone”) and *ḥaġar al-‘ain* (“eye stone”). In Arabic sources Nishapur and Gundishapur (South-East Iraq) are mentioned as the deposit sites.

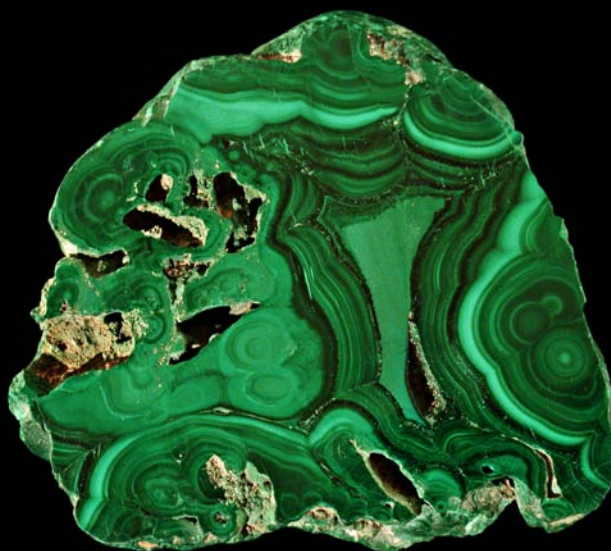
Steinbuch des Aristoteles, pp. 106–107, 151–152 (reprint op. cit., pp. 114–115, 159–160); Rāzī, *Asrār wa-sirr al-asrār*, pp. 4; *al-Rāzī’s Buch Geheimnis der Geheimnisse*, pp. 86; Tamīmī, *Muršid*, pp. 81–82, 173–174; Bīrūnī, *Ġamāhīr*, pp. 169–172; Ibn al-Baiṭār, *Ġāmī‘*, vol. 3, pp. 172 (French transl. Leclerc, vol. 3, S. 50–51; German transl. Sontheimer, vol. 2, pp. 270–271); Tifāšī, *Azhār al-afkār*, pp. 32–33 (reprint op. cit., pp. 28–29); French transl., J.-J. Clément-Mullet, op. cit., pp. 150–157 (reprint in: *Natural Sciences in Islam*, vol. 31, pp. 298–305); Šamsaddīn ad-Dimašqī, *Tuḥfat ad-dahr*, pp. 68–69 (trad. franç., A.F. Mehren, pp. 78); Ibn al-Akfānī, *Nuḥab ad-daḥā’ir*, pp. 761–762, cf. E. Wiedemann, *Zur Mineralogie im Islam*, pp. 225 (reprint op. cit., pp. 197–198).

dahnağ
Malachite

(1) Banded.
Diameter: 80 mm, 225 g.
(Inventory No. K 3.31b)

(2) Dark Green.
80 x 70 mm, 555 g.
(Inventory No. K 3.31a)

(3) Light Green.
70 x 50 mm, 200 g.
(Inventory No. K 3.31c)



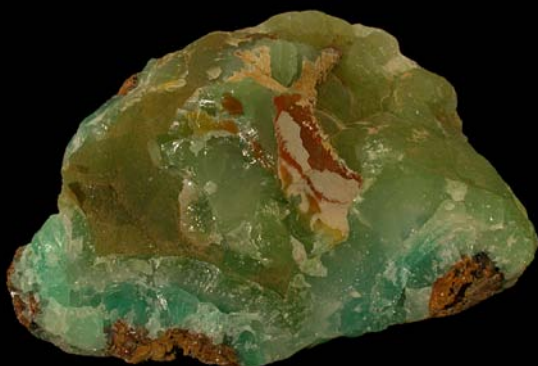
According to the description by Arabic mineralogists, this green stone belongs to the minerals containing copper. Ar-Rāzī (*al-Rāzī's Buch Geheimnis der Geheimnisse*, p. 86) describes it as a green stone with veins out of which seals and amulets are carved. He knows of new and old malachites from Egypt, from Kirmān and from Ḥurāsān (Khorasan in north-eastern Persia). The old malachite from Kirmān was the best. Al-Bīrūnī (*Ġamāhir* pp. 196-197) also mentions the high quality of malachite from Kirmān and refers to the mountain range Ḥarrat Banī Sulaim in the vicinity of Mecca as another deposit site.

In medicine the stone was credited with a certain antidotal effect. It was also used against leprosy and as a medicine for the eyes (Qazwīnī, *ʿAğā'ib al-maḥlūqāt*, p. 225).

Steinbuch des Aristoteles, pp. 103–104, 145–147 (reprint op. cit., pp. 111–112, 153–155); Tamīmī, *Muršid*, pp. 117–122, 197–199; Ibn al-Baiṭār, *Ġāmiʿ*, vol. 2, pp. 117–118 (French transl. Leclerc, vol. 2, pp. 132–133; German transl. Sontheimer, vol. 1, pp. 460–461); Tifāšī, *Azhār al-afkār*, pp. 41–43 (reprint op. cit. pp. 18–20); French transl., J.-J. Clément-Mullet, op. cit., pp. 185–191 (reprint in: *Natural Sciences in Islam*, vol. 31, pp. 333–339).



Yellow.
Diameter: 65 mm, 195 g.
(Inventory No. K 3.25)



(1) Green.
70 x 45 mm, 160 g.
(Inventory No. K 3.56a)



(2) White.
Diameter: 65 mm, 219 g.
(Inventory No. K 3.56b)

tūtiyā'

Hemimorphite

The origin of the word is uncertain. It is assumed it could have derived either from the Persian or the Sanskrit. *Tūtiyā'* is counted among the stones. Arabic mineralogists knew it in white, yellow, green, brown and grey hues. In medicine it was used as a remedy for the eyes and against ulcers. The deposit sites mentioned are the coasts of the Indian Ocean, India (Sind), Persia (Kirmān), Mesopotamia (Baṣra), Eastern Anatolia (Armenia), Byzantium, Syria (Ḥimṣ), localities on the eastern coast of the Mediterranean (Beirut), in Northern Africa (Tūnis) and in Moorish Spain (al-Andalus).

Zinc Spar

Hemimorphite is usually “accompanied by another zinc-containing mineral, viz. zinc carbonate, which as a mineral is named zinc spar or calamine and plays an important role as zinc ore. It is to be found at times also in bright green, blue and probably also in violet-coloured aggregates just like hemimorphite ...” (Bauer, *Edelsteinkunde*, p. 524).

v. Rāzī, *Asrār wa-sirr al-asrār*, p. 2 (*al-Rāzī's Buch Geheimnis der Geheimnisse*, pp. 44, 86); idem, *al-Mudḥal at-ta'limī*, pp. 413–414 (reprint pp. 109–110; Rāzī states here that he discussed the origin of this material in his book *ʿIlal al-ma'ādin*); *Steinbuch des Aristoteles*, pp. 175–176 (reprint op. cit. pp. 183–184); Tamīmī, *Muršid*, pp. 53–66, 158–162; Qazwīnī, *ʿAğā'ib al-maḥlūqāt* pp. 214; Ibn al-Baiṭār, *Ġāmi'*, vol. 1, pp. 143–145 (French transl. Leclerc, vol. 1, pp. 322–325; German transl. Sontheimer, vol. 1, pp. 217–220).

bādzahr

Bezoar Stone,

or perhaps:

ḥaġar al-ḥaiya

(«Snake Stone»)

Serpentine

(1) Green.

120 x 90 mm, 478 g.

(Inventory No. K. 3.47a)

(2) Grey.

100 x 45 mm, 242 g.

(Inventory No. K. 3.47b)

(3) Black.

100 x 70 mm, 375 g.

(Inventory No. K. 3.47c)

According to al-Qazwīnī (*‘Aġā’ib al-maḥlūqāt*, p. 217), the two stones are confused with one another. The name of the first is derived from the Persian (*zahr* = poison).¹ Both were used as antidotes. They are also said to be useful against leprosy and the diseases of the heart, the kidneys and the stomach.

Persia, especially Ḥurāsān (Khorasan) and India are mentioned as deposit sites.

Dioscoride, Livre 5, chap. 161 (v. J. Berendes, p. 55); *Steinbuch des Aristoteles*, pp. 104–105, 147–149 (reprint op. cit., pp. 112–113, 155–157); Tamīmī, *Muršid*, pp. 115–118, 194–197; Birūnī, *Ġamāhir*, pp. 200–202, 207–208; Qazwīnī, *‘Aġā’ib al-maḥlūqāt*, pp. 217–218, 231; Ibn al-Baiṭār, *Ġāmi’*, vol. 2, p. 10 (trad. franç., Leclerc, vol. 1, p. 412; German transl. Sontheimer, vol. 1, p. 289).

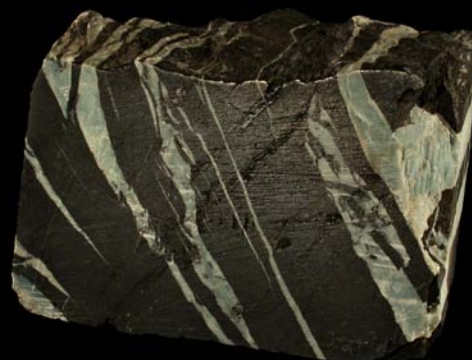
1 v. J. Ruska, *Das Steinbuch aus der Kosmographie des ... al-Qazwīnī*, op. cit. p. 29 (reprint op. cit. p. 249).



ruhām
Marble



(1) Red.
110 x 40 mm, 310 g.
(Inventory No. K 3.33a)



(2) Black.
85 x 60 mm, 320 g.
(Inventory No. K 3.33b)



(3) Grey (ash-coloured)
170 x 90 mm, 450 g.
(Inventory No. K 3.33c)

(4) Yellowish-white.
95 x 80 mm, 398 g.
(Inventory No. K 3.33d)

(5) White.
120 x 90 mm, 580 g.
(Inventory No. 3.33e)



In Persian and Turkish the stone is called mermer. The Arabic sources in which it is described know it in various shades and mention that it is used for building and as a tombstone. In Arabic medicine it was used as styptic in pulverised form.

Idrisī, *al-Ġāmiʿ li-ṣifāt aṣṭāt an-nabāt*, vol. 2, 2nd part, p. 452; Ibn al-Baiṭār, *Ġāmiʿ*, vol. 2, p. 138 (French transl. Leclerc, vol. 2, p. 1040; German transl. Sontheimer, vol. 1, p. 493); Qazwīnī, *ʿAğāʾib al-maḥlūqāt*, p. 225.



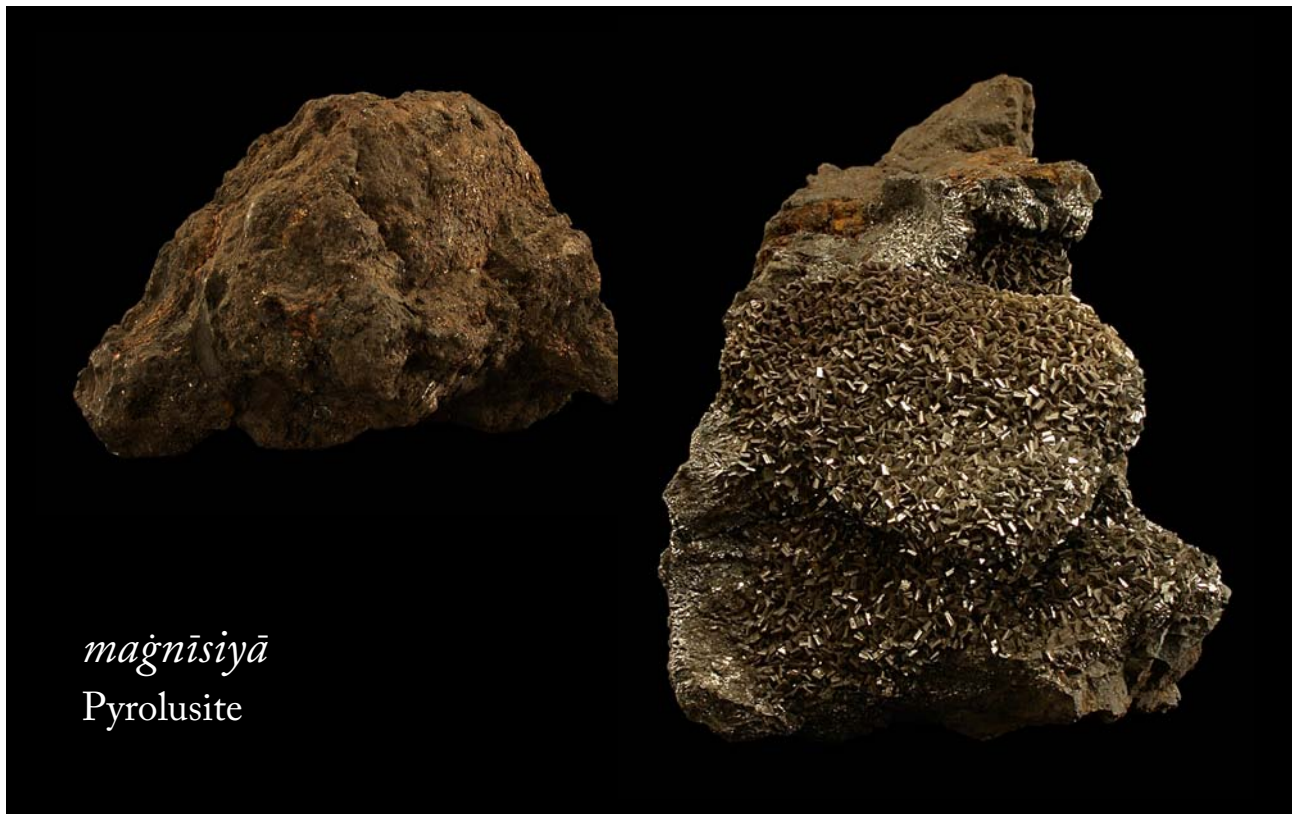
artakān

Yellow Iron Ore, Ochre

75 x 55 mm, 215 g.
(Inventory No. K 3.15)

A yellow brittle stone which has been used as a pigment since the Palaeolithic period and which serves in the medical field for the treatment of skin diseases.

Ibn al-Baiṭār, *Ḥāmiʿ*, vol. 1, pp. 20–21 (French transl. Leclerc, vol. 1, p. 49–50; German transl. Sontheimer, vol. 1, p. 28).



The stone *maġnīsiyā*, which was known in numerous colours, is often mentioned in Arabic sources together with *marqašīṭa*, the marcasite, which was likewise known in many colours. That is why they were quite frequently mistaken for one another.¹ About *maġnīsiyā*, Abū Bakr ar-Rāzī states as follows: “There are different varieties (colours). There is one earthy black variety in which there are shining eyes. Then there are also hard iron-like pieces of it; that is the masculine variety. Then there is a red variety with crust; that is the feminine variety; in it there are flashing eyes and it is the best of its kind.”² J. Ruska says in explanation: “The word *maġnīsiyā* refers in Rāzī’s work on the manganese oxides which even now are differentiated for practical purposes as soft and hard manganese ores. With ‘flashing eyes’ he probably means small areas of crystal which flash in the sun while they moved to and fro and perhaps he also means areas shining like metal against a dull background. The red variety which appears in the form of a crust is obvi-

(1) diameter: 55 mm, 142 g.
(Inventory No. K 3.41 a)

(2) diameter: 70 mm, 210 g.
(Inventory No. K 3.41 b)

ously manganese spar which is to be found often at manganese sites as a product of transformation. The differentiation of the various varieties leads us to assume that Rāzī was familiar with a natural site in Persia.”³

With great probability *maġnīsiyā* is identical with the mineral which in our times is called pyrolusite. It was used for the manufacture of glass. Deposit site is Persia.

See also *Steinbuch des Aristoteles*, op. cit., p. 112, 160-161 (reprint op. cit., p. 120, 160-161); Abū ‘Abdallāh al-Ĥwārizmī, *Mafātīḥ al-‘ulūm*, p. 261; Ibn al-Baiṭār, *Ġāmi‘*, vol. 4, p. 161 (French transl. Leclerc, vol. 3, p. 329; German transl. Sontheimer, vol. 2, p. 523).

¹ v. E. Wiedemann, *Zur Chemie bei den Arabern* (= Beiträge zur Geschichte der Naturwissenschaften XXIV), in: *Sitzungsberichte der Physikalisch-medizinischen Sozietät (Erlangen)* 43/1911/72-113, esp. p. 98 (reprint in: Wiedemann, *Aufsätze*, vol. 1, pp. 689-730, esp. p. 715).

² Translated by J. Ruska, *Al-Rāzī’s Buch Geheimnis der Geheimnisse*, op. cit., p. 86.

³ *ibid*, p. 43; v. also p. 146 about the two methods of calcination of *maġnīsiyā*.



ḥağar al-ʿuqāb

Eagle Stone, Rattle Stone

(1) Closed.

Diameter: 50 mm, 74 g.
(Inventory No. K 3.01a)

(2) Broken.

Diameter: 50 mm, 66 g.
(Inventory No. K 3.01b)

“A stone that resembles the Tamarind seed; when it is shaken a sound is heard from inside, (but) when it is broken, nothing is seen in it. It is found in the nest of the eagle that brings it from India. When somebody goes towards the nest, it [the eagle] takes it [the stone] and throws it towards him so that he may take it and turn back, as if the eagle knew that he came in search of this stone.”¹ The stone is also called *ḥağar an-nasr* (“eagle stone”) and *ḥağar iktamakt*.

Four deposit sites are mentioned: Yemen, Antioch, Cyprus and Northern Africa.

Ibn al-Baiṭār, *Ğāmiʿ*, vol. 1, pp. 51–52, vol. 2, p. 12 (French transl. Leclerc, vol. 1, pp. 121–122, 412, 420–421; German transl. Sontheimer, vol. 1, pp. 73–74, 294); v. also Bīrūnī, *Ğamāhir*, p. 102.

¹ Qazwīnī, *ʿAğāʿib al-mahlūqāt*, p. 220, transl. J. Ruska, *Das Steinbuch aus der Kosmographie des ... al-Ğazwīnī*, op. cit. p. 218 (reprint op. cit., p. 238).



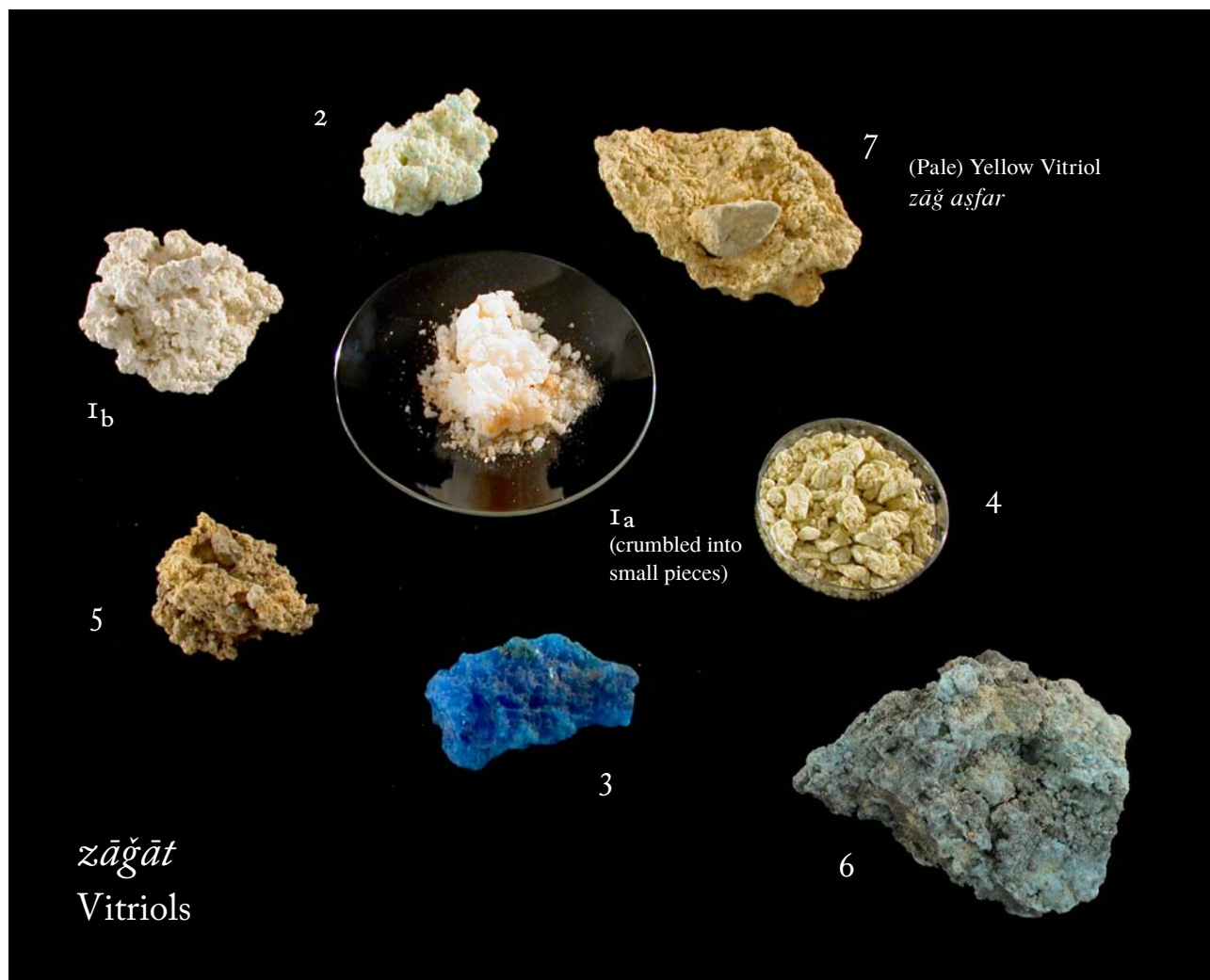
šabb

Alum

2 specimens.
Diameter: 24 mm.
Total weight: 60 ct.
(Inventory No. K 3.03)

According to ar-Rāzī, alum belongs to the group of vitriols. These are used in dyeing and tanning, as additives to coloured inks and for clarifying turbid liquids. In the field of medicine, they have their use as styptics, as ingredients of eye medicines and of collyria, in skin diseases, as gargling water for toothaches and for fortifying the gums. Deposit sites are Egypt, Libya, Yemen and Eastern Turkistan.

Steinbuch des Aristoteles, pp. 119, 174 (reprint op. cit., pp. 127, 182); Rāzī, *Asrār wa-sirr al-asrār*, pp. 2, 4; *al-Rāzī's Buch Geheimnis der Geheimnisse*, p. 87; J. Ruska, *Das Buch der Alaune und Salze*, Berlin 1935, pp. 79–80, 121.



Ar-Rāzī speaks of seven types of vitriols, among them *qalqadis*, *qalqaṭār*, *qalqand* and *sūrīn*. Other scholars like Ibn Sīnā and Ibn al-Baiṭār mention the colours white, yellow, red and green; blue is missing. Ar-Rāzī also deals with procedures for the artificial production of vitriols (v. *Al-Rāzī's Buch Geheimnis der Geheimnisse*, op. cit., pp. 47, 87-88; Ibn al-Baiṭār, *Ġāmi'*, vol. 2, pp. 148-152).

According to Arabic sources, the deposit sites are Syria, Egypt, Yemen, Cyprus, Spain as well as Ġurġān und Ṭabaristān in Northern Persia and Bāmiyān in present-day Afghanistan.

The medicinal use of the stone is mentioned in the case of ulcers, accumulation of earwax, ranula and decay in the mouth and nose, against scabies and for staunching blood (Ibn al-Baiṭār, *Ġāmi'*, vol. 2, p. 152; French transl. Leclerc, vol. 2, p. 194; German transl. Sontheimer, vol. 1, p. 515).

(1) White.
2 pieces, Ø: 30 mm, 13 g.
1 piece, Ø: 50 mm, 34 g.
(Inventory No. K 3.54a)

(2) Coloured Vitriol
96 x 63 mm, 55 g.
(Inventory No. K 3.54c)

(3) Blue.
Length: 58 mm, 28 g.
(Inventory No. 3.54b)

(4) Green.
Ground. 13 g.
(Inventory No. 3.54d)

(5) Golden Eyes.
Ø: 42 mm, 18 g.
(Inventory No. K 3.54e)

(6) Chalcantite
(copper vitriol).
Ø: 46 mm, 51 g.
(Inventory No. K 3.59)

v. also *Steinbuch des Aristoteles*, op. cit., pp. 119, 173-174 (reprint op. cit., pp. 127, 181-182); Bīrūnī, *Ġamāhir*, pp. 253; Idrisi, *al-Ġāmi' li-ṣifāt aštāt an-nabāt*, vol. 1, p. 152, vol. 1, part 2, pp. 209-211; Qazwīnī, *ʿAğā'ib al-maḥlūqāt*, pp. 225-226, cf. J. Ruska, *Das Steinbuch aus der Kosmographie des... al-Ḳazwīnī*, op. cit., pp. 23-24 (reprint op. cit. pp. 243-244).



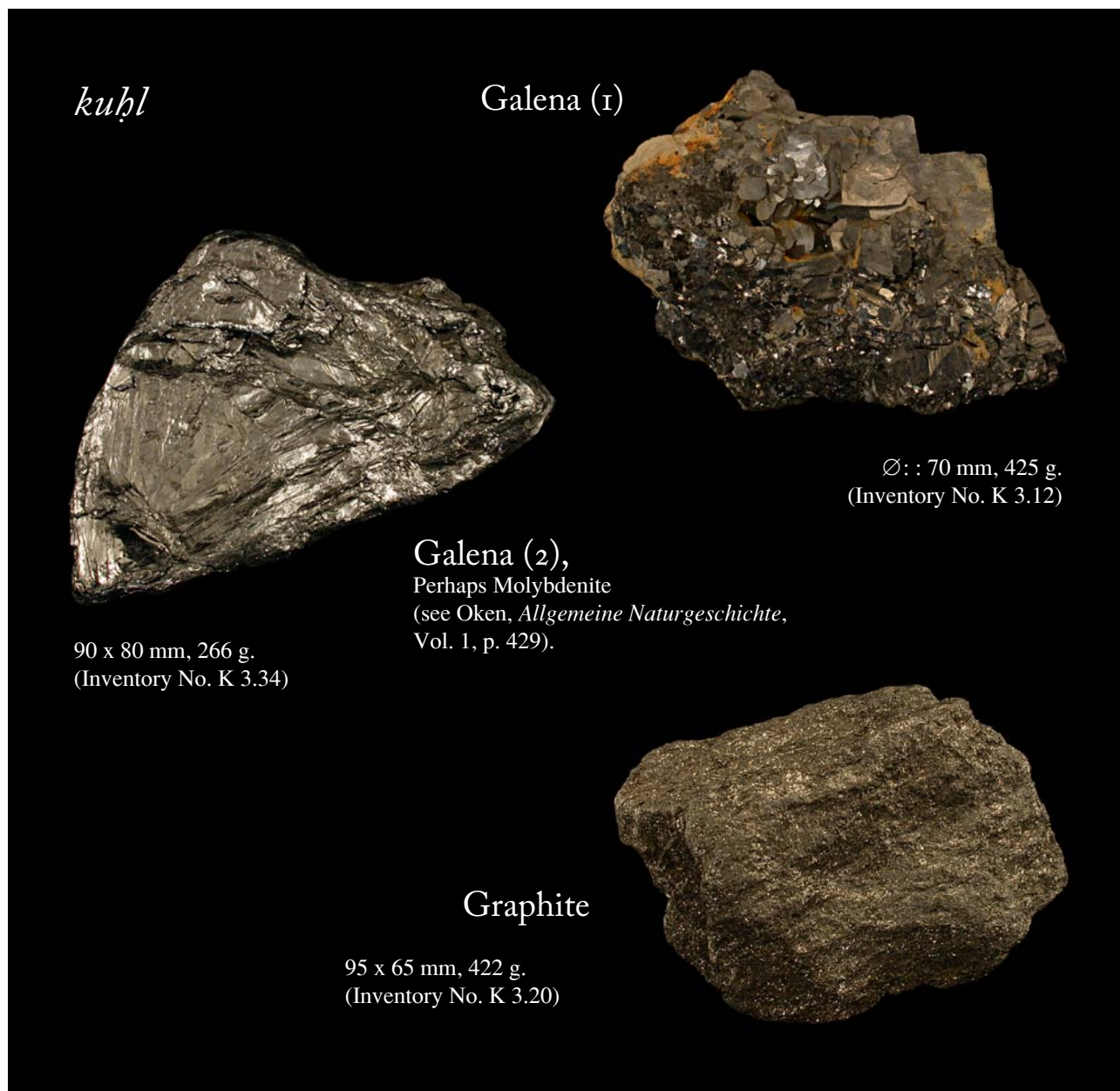
iṭmid

Antimony

Ø: ca. 45 mm, 122 g.
(Inventory No. K 3.05)

According to Muḥammad b. Aḥmad at-Tamīmī (4th/10th cent.), there are two kinds of antimony. One comes from the region of Isfahan, the other from the Maḡrib. Of the latter he knows again two kinds (*Kitāb al-Muršid*, pp. 31–35).

Steinbuch des Aristoteles, pp. 119, 175 (reprint pp. 127, 183); Ibn al-Ġazzār, *Iʿtimād*, facsimile ed., pp. 177–178, trad. Lat. *Liber fiduciæ*, pp. 89 (reprint op. cit., pp. 331); Ibn al-Baiṭār, *Ġāmiʿ*, vol. 1, pp. 12 (French transl. Leclerc, vol. 1, pp. 27–28; German transl. Sontheimer, vol. 1, pp. 15–16).



In Arabic literature galena is not clearly differentiated from antimony (*itmid*), which is listed above (p. 193). Frequently both terms are used as synonyms. The most detailed and best treatment of the subject can be attributed to the *Kitāb al-Muršid* by Muḥammad b. Aḥmad at-Tamīmī (pp. 31-36). A valuable commentary on it with additional references to further sources is published by Jutta Schönfeld (ibid., pp. 132-137). Among the characteristics of galena, Lorenz Oken¹ mentions its metallic sheen and its funnel-shaped cavities which at-Tamīmī obviously refers to as “*mu‘ayyan* (endowed with

eyes); the flatter these ‘eyes’ are, that is to say the smoother the surface, the better the quality of Galena” (ibid., p. 133).

As deposit sites, Arabic sources mention Moorish Spain (al-Andalus), North Africa (Tunisia) and Persia. In this connection, the two mountains Ġabal Zaġwān near Tunis (v. Yāqūt, *Mu‘ğam al-buldān*, vol. 2, p. 935) and Ġabal al-Kuḥl near the Spanish town of Baza (Qazwīnī, *Ağā’ib al-maḥlūqāt*, p. 171) are mentioned by name (v. ibid., p. 134). Furthermore, the eye make-up, or rather the fine powder used in its production which is made from, graphite for example, is called kuhl in its generic sense.

¹ *Allgemeine Naturgeschichte für alle Stände*, vol. 1: *Mineralogie und Geognosie*, Stuttgart 1839, pp. 426, 435.



zaibaq

Mercury

ca. 15 g. in a welded ampoule
(Liquid at room temperature)
(Inventory No. K 3.43)

Ğābir b. Ḥaiyān, ar-Rāzī and most Arabic chemist-alchemists count mercury among the “spirits” (*arwāḥ*). The word *zaibaq* goes back to a Middle Persian word which reached the Syriac and the Arabic language.¹ As deposit sites, Arabic sources mention Iṣṭaḥr near Persepolis, another site in Azerbaijan, south-east of Lake Urmia and a region in the mountains of Bāmiyān in the west of the Hindukush.²

Steinbuch des Aristoteles, op. cit., pp. 123, 180 (reprint op. cit., pp. 131, 188); Rāzī, *Asrār wa-sirr al-asrār*, pp. 13–20; Bīrūnī, *Ġamāhir*, pp. 229–232; Qazwīnī, *Āṭār al-bilād*, p. 126 (v. Dārābğird); Ibn al-Baiṭār, *Ğāmiʿ*, vol. 2, pp. 177–178 (French transl. Leclerc, vol. 2, pp. 228–230; German transl. Sontheimer, vol. 1, pp. 553–555).



zunğufr

Cinnabarite (Cinnabar)

Dimension: 120 x 180 mm.
Weight: 160 g.
Poisonous!
(Inventory No. K 3.57)

Apart from the cinnabar (*zunğufr maḥlūq*) extracted from mines, artificially produced cinnabar (*zunğufr maṣnūʿ*) was also known in the 4th/10th century. The most famous deposit site was Spain (v. Ibn al-Baiṭār, *Ğāmiʿ*, vol. 2, p. 170; J. Ruska, *al-Rāzī's*

Buch Geheimnis der Geheimnisse, op. cit., pp. 38–51).

In medicine, cinnabar was one of the ingredients in ointments for injuries and was used as a powder in the treatment of ulcers.

¹ v. J. Ruska, *al-Rāzī's Buch Geheimnis der Geheimnisse*, op. cit., p. 37.

² Ibid., pp. 38.

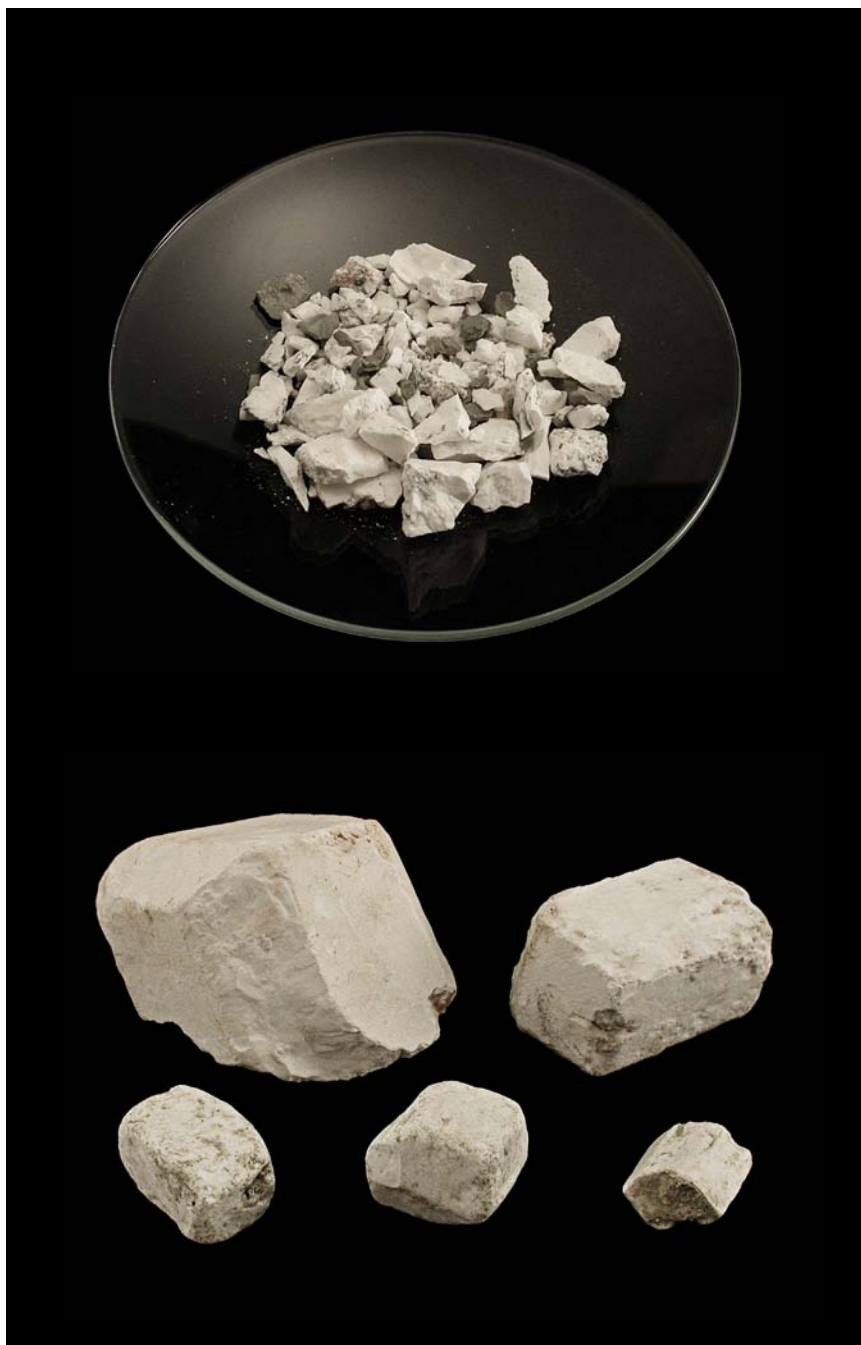
Steinbuch des Aristoteles, pp. 124–125, 182 (reprint op. cit., pp. 132–133, 190); Qazwīnī, *ʿAğāʾib al-maḥlūqāt*, p. 228; French transl. Leclerc, vol. 2, pp. 221–222.

būraq

Borax

(1) Coarse, broken.
Weight: 11 g.
(Inventory No. K 3.13a)

(2) Idiomorphic
50 x 40 mm, 65 g.
(Inventory No. K 3.13b)



Arabic mineralogists and chemists sometimes treat *būraq* (borax) and *tinkār* (tinkal) as two separate substances and at other times as a single one. Abū Bakr ar-Rāzī seems to be of the opinion that tinkal is produced artificially from borax and that borax was known in five colours. The “borax of the bread” (*būraq al-ḥubz*) and the “borax of the goldsmiths” (*būraq aṣ-ṣināʿa*) was white. The best variety he continues, was the “borax from Zarāwand” in Persia. Al-Qazwīnī (*ʿAğāʾib al-maḥlūqāt* p. 212) mentions India and Kerman in Persia as the deposit sites.

v. also Rāzī, *Asrār wa-sirr al-asrār*, p. 6; *al-Rāzī's Buch Geheimnis der Geheimnisse*, op. cit., pp. 88-89; *Steinbuch des Aristoteles*, op. cit., pp. 118, 173 (repr. pp. 126, 181); Tamīmī, *Muršid*, pp. 51-53, 155-157; Ibn al-Baiṭār, *Ḍāmiʿ*, vol. 1, pp. 125-127, 141 (French transl. Leclerc, vol. 1, pp. 288-290; German transl. Sontheimer, vol. 1, pp. 187-190).

*ṭalq*Muscovite
(Mica)

The German word 'Talk', which designates a variety of gypsum, is derived from the Arabic term *ṭalq*.

In medical science *ṭalq* was used against ulcers and as a styptic.

As deposit sites, Arabic sources mention India, Yemen, Spain and Cyprus.

175 x 135 mm, 0.69 kg.
(Inventory No. K 3.35)

Steinbuch des Aristoteles, pp. 119, 174–175 (reprint op. cit., pp. 127, 182–183); Rāzī, *al-Mudḥal at-ta'limī*, p. 413 (reprint p. 109); Idrīsī, *al-Ġāmi' li-ṣifāt aṣṭāt an-nabāt*, vol. 2, part 1, p. 243; Qazwīnī, *ʿAğā'ib al-maḥlūqāt*, p. 230; Tifāṣī, *Azhār al-afkār*, pp. 54–55 (reprint op. cit., pp. 6–7); J.-J. Clément-Mullet, op. cit., pp. 237–250 (reprint in: *Natural Sciences in Islam*, vol. 31, pp. 385–398).





milḥ
Rock Salt

(1) Idiomorphic.
Diameter: 75 mm, 185 g.
(Inventory No. K 3.51)

(2) Coarse.
120 x 80 mm, 0.5 kg.
(Inventory No. K 3.51a)



‘Alī b. Rabban aṭ-Ṭabarī, *Firdaus al-ḥikma*, p. 395; Rāzī, *Asrār wa-sirr al-asrār*, pp. 6–7; idem, *Ḥawī*, vol. 21, part 2, Hyderabad 1968, pp. 554–561; Muwaffaqaddin al-Harawī, *Abniya*, pp. 314–315 (Transl. Achundow, p. 272; repr. p. 144); Abū ‘Abdallāh al-Ḥwārizmī, *Mafātīḥ al-‘ulūm*, p. 259; Ibn al-Baiṭār, *Ḥāmī*, vol. 4, p. 163–166 (French transl., Leclerc, vol. 3, pp. 334–337; German

transl. Sontheimer, vol. 2, pp. 527–531); Qazwīnī, *‘Ağā’ib al-maḥlūqāt*, p. 240.

E. Wiedemann, *Entsalzung des Meerwassers bei Bīrūnī*, in: *Chemiker-Zeitung* 46/1922/230 (reprint in: *Gesammelte Schriften*, vol. 2, Frankfurt 1984, p. 1019); J. Ruska, *Das Buch der Alaune und Salze*, Berlin 1935..

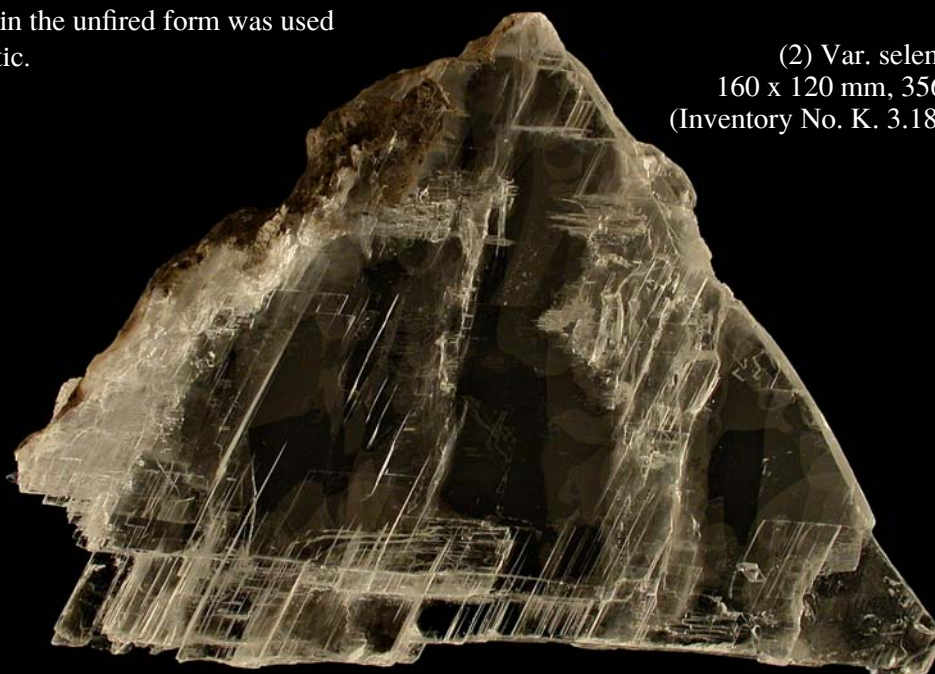


ğibsīn, ġaṣṣ
Gypsum



(1) Var. alabaster
90 x 70 mm, 341 g.
(Inventory no. K 3.18 a)

Gypsum in the unfired form was used
as a styptic.



(2) Var. selenite
160 x 120 mm, 356 g.
(Inventory No. K. 3.18 b)

Rāzī, *Asrār wa-sirr al-asrār*, p. 4; *al-Rāzī's Buch Geheimnis der Geheimnisse*, p. 87; Ibn al-Baitār, *Ġāmi'*, vol. 1, p. 159 (French transl., Leclerc, vol. 1, pp. 346–347; German transl. Sontheimer, vol. 1, pp. 242–243).

kibrīt

Sulphur

(1) Fine crystalline.
65 x 55 mm, 9 g.
(Inventory No. K 3.45a)

(2) Coarse crystalline.
55 x 50 mm, 88 g.
(Inventory No. K 3.45b)



Arab chemist-alchemists enumerate sulphur among the “spirits” (*arwāḥ*) as against metals, which they call “bodies” (*ağsād*). In contrast to the bodies, the spirits are “colouring” and “volatile”. Arab chemists and mineralogists know sulphur in various colours, among them yellow, red, white and black hues. They considered red sulphur to be the most valuable. Sulphur was an indispensable element in chemical and industrial processes. According to ar-Rāzī, the substances with which sulphur and *zarniḥ* (see below) were treated included “chrysolilla, nūra, limes, the filings of iron, of copper, of tin and of black lead, vitriol, salt, white lead, litharge, glass, potash, talcum ...”¹ In a joint study Eilhard Wiedemann and Julius Ruska found twenty names for sulphur when they attempted to compile the code names commonly used by Arabic alchemists. These names were predominantly Arabic, rarely Persian or Syrian and hardly ever Greek.² In the medical field the use of sulphur was very

widespread, for instance, for the treatment of scabies, jaundice, asthma and coughs, in the case of maculae or scorpion stings.

Steinbuch des Aristoteles, pp. 112–113, 161–162 (reprint op. cit., pp. 120–121, 169–170); Ibn al-Baitār, *Čāmi*^c, vol. 4, pp. 49–50 (French transl., Leclerc, vol. 3, pp. 139–141; German transl. Sontheimer, vol. 2, pp. 344–347); Qazwini, *‘Ağā’ib al-maḥlūqāt*, pp. 243–244; Šamsaddīn ad-Dimašqī, *Tuḥfat ad-dahr*, p. 58 (trad. A.F. Mehren, pp. 62–63).

¹ J. Ruska, *al-Rāzī’s Buch Geheimnis der Geheimnisse*, op. cit., p. 111.

² *Alchemistische Decknamen*, in: *Sitzungsberichte der Physikalisch-medizinischen Sozietät (Erlangen)* 56–57/1924–25/17–36, esp. pp. 35–36 (reprint in: Wiedemann, *Aufsätze*, vol. 2, pp. 596–615, esp. pp. 614–615).



zarnīḥ

Arsenic

Diameter: ca. 45 mm, 122g.
Poisonous!
(Inventory No. K 3.06)

zarnīḥ asfar
Orpiment

Diameter: 65 mm, 270 g.
Poisonous!
(Inventory No. K 3.07)



zarnīḥ aḥmar

Realgar

95 x 45 mm, 147 g.
Poisonous!
(Inventory No. K 3.44)

Arab mineralogists knew arsenic in several colours. They also knew its use as a poison. They mention Iṣfahān as the deposit site.

Steinbuch des Aristoteles, op. cit., p. 113; Rāzī, *Asrār wa-sirr al-asrār*, p. 3; Bīrūnī, *Ġamāhir*, p. 103; Ibn al-Baitār, *Ġāmiʿ*, vol. 2, pp. 160-161 (he cites, among others, ar-Rāzī's *Kitāb ʿIlal al-maʿādin*, which is not extant) (French transl. Leclerc, vol. 2, pp. 205-207; German transl. Sontheimer, vol. 1, pp.



ḥaġar al-birām

Steatite

105 x 60 mm, 225 g.
(Inventory No. K 3.50)

Arab philologists refer to this mineral extracted from mines as “the quintessential pot” (*al-qidr muṭlaqan*), since it is especially suitable for the production of vessels, coal basins, lamps etc. Ḥiġāz (Western Arabia) and Yemen were the most well-known deposit sites.¹ The geographer aš-Šarīf al-Idrīsī² calls the locality al-Ḥaurā’ on the east coast of the Red Sea the most important deposit site from where it was exported to many countries. A mine for this mineral (*ma’din al-burm*)

located near a village of the same name situated between aṭ-Ṭā’if and Mecca was already known in Umayyad times.³ Al-Qazwīnī⁴ also mentions Ṭūs in north-eastern Persia as a well-known deposit site. According to Ibn al-Baiṭār (*Ğāmi’*, vol. 2, p. 10), the pulverized stone was used for dental care, and also—according to ar-Rāzī—as an ingredient of ‘artificial loam’, which was indispensable in the chemical laboratories of those times (see above, p. 134).⁵

¹ Ibn Manẓūr, Muḥammad b. Mukarram, *Lisān al-‘arab*, vol. 14, Cairo 1302 (1885), p. 311.

² *Nuzhat al-muštāq fi ḥtirāq al-āfāq*, Naples and Rome 1970, p. 350.

³ Cf. Yāqūt, *Muġam al-buldān*, vol. 4, p. 572.

⁴ *Āṭār al-bilād*, p. 275.

⁵ *Al-Rāzī’s Buch Geheimnis der Geheimnisse*, pp. 61, 96, 195; E. Wiedemann, *Zur Mineralogie im Islam*, p. 251 (reprint op. cit., p. 223).



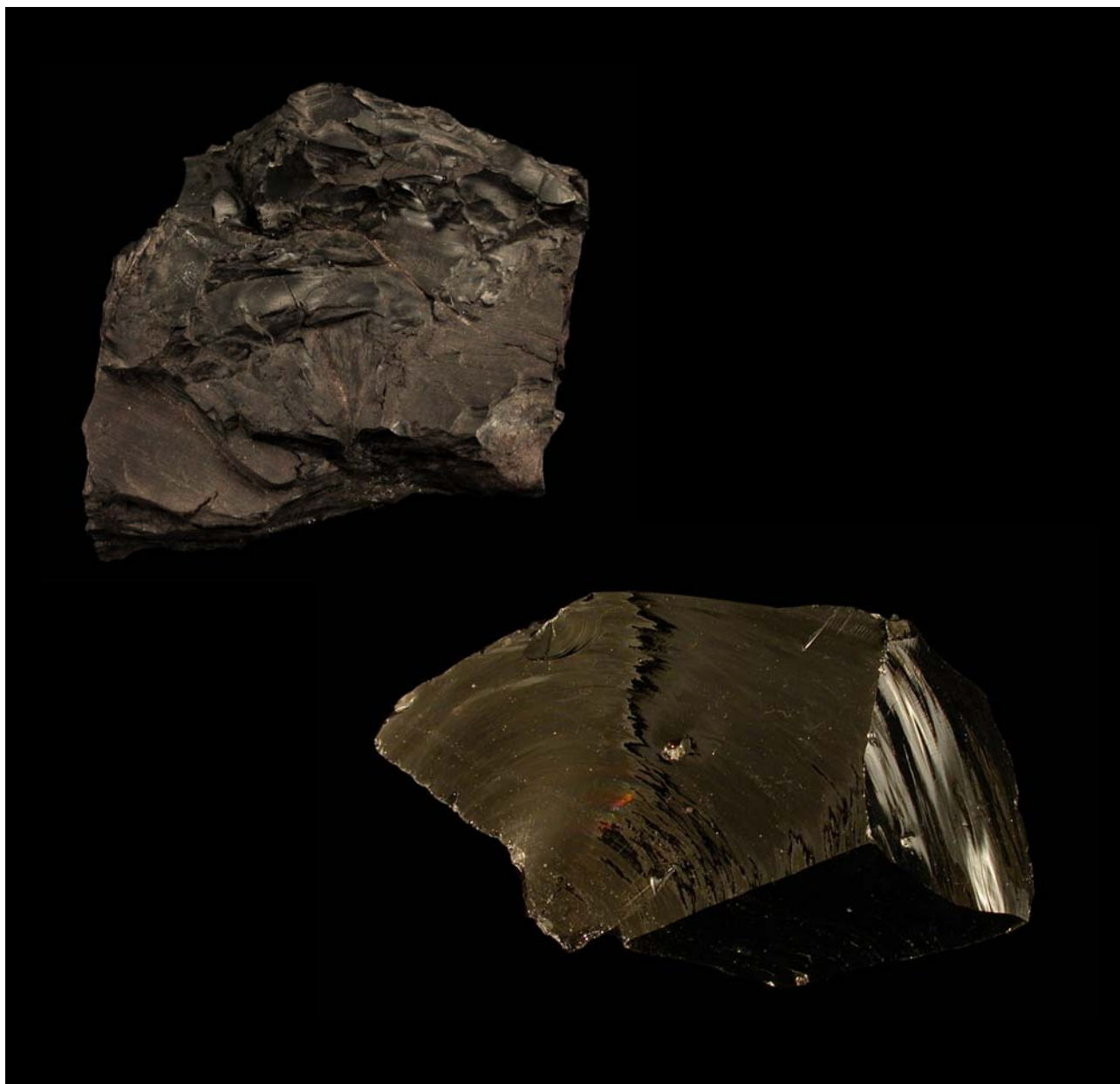
qaišūr, qaisūr

Pumice

In the pseudo-Aristotelian book of stones (p. 120, reprint p. 128) pumice is described as follows: “This is a stone of the ocean, light, of loose substance; it swims on water. It is found in Sicily, it is mostly white and is called sea-butter. When animal hides are rubbed with it, they become rough. It cleanses the teeth and is included in powders for the eyes. With pumice it is also possible to remove colour and ink from paper. — It removes the leucoma from the eye, particularly from the eyes of animals, when (the veterinarian) mixes it with honey. But he does not apply it in pure form, because it would hurt the animal due to its causticity” (after the transl. by J. Ruska, p. 176, reprint p.

184). Arabic sources mention Armenia and Alexandria, besides Sicily, as the deposit sites. Tamīmī (*Muršīd*, pp. 91-95) says: ” As for its true composition, it is one of the burnt ashes; because the fire that occurs in Sicily on the mountain which lies on the sea and which is called volcano, spits this stone out, big rocks and small ones, and that stone is of the nature of fire. When it falls into the water of the sea, it swims on the surface of the water, because in its body there is porosity and brittleness” (after the transl. by Jutta Schönhofeld, op. cit., p. 92).

v. also Qazwīnī, *‘Ağā’ib al-maḥlūqāt*, p. 233; Ibn al-Baiṭār, *Ḡāmi‘*, vol. 4, p. 42 (French transl., Leclerc, vol. 3, p. 126; German transl. Sontheimer, vol. 2, pp. 332–333).



sabağ

Jet

(1) Diameter: 90 mm, 188 g.
(Inventory No. K 3.17)

(2) 64 x 116 mm.
(Inventory No. K 3.38)

Pitch coal or jet is a bituminous lignite. The Arabic name *sabağ* comes from the Middle Persian *šabak* (New Persian *šabah*). In the field of medicine, jet was used against cataract of the eye and against nightmares.

As deposit sites, al-Bīrūnī (*Ġamāhir*, p. 199) mentions Ṭabarān in Persia and the region to the east of the Dead Sea. Other sources mention India as the place of origin.

v. also *Steinbuch des Aristoteles*, pp. 107, 153–154 (reprint op. cit., pp. 115, 161–162); Tamīmī, *Muršid*, pp. 79–80, 170–171; Tifāšī, *Azhār al-afkār*, p. 48 (reprint op. cit., p. 13); Qazwīnī, *ʿAğāʾib al-maḥlūqāt*, p. 228; Ibn al-Baiṭār, *Ġāmiʿ*, vol. 3, p. 4 (French transl., Leclerc, vol. 2, p. 237; German transl. Sontheimer, vol. 2, p. 4).



ṭīn

Aluminium Oxide

Apart from the use of aluminium oxide for the manufacture of chemical ovens and the *ṭīn al-ḥukamā*¹ (translated by Julius Ruska as “artificial clay”,² see above, p. 134) used in laboratories, Arabic physicians know several kinds of clay the knowledge of which they derived from Dioscorides and Galen. Ibn al-Baiṭār (*Ḡāmi*³, vol. 3, pp. 106-112) mentions among others:

- 1.– *Ṭīn maḥtūm*, “sealed” clay, terra sigillata (σφραγίς), handed down from Galen.
- 2.– *Ṭīn Miṣr*, Egyptian clay (thus Galen; Dioscorides calls it ἐρετριῶς γῆ).⁴
- 3.– *Ṭīn Sāmūš*, clay from the island of Samos (σαμία γῆ), described by Dioscorides and by Galen.
- 4.– *Ṭīn Ḡazīrat al-Maṣṭikī*, clay from the island of

Chios (χία γῆ), described by Dioscorides and by Galen.

5.– *Ṭīn Qīmūliyā*, clay from the Cyclades island Kimolos (κιμωλία γῆ), described by Dioscorides and by Galen, possibly identical with the aluminium oxide that the inhabitants of Basra called *ṭīn ḥurr* (Ibn al-Baiṭār, *Ḡāmi*⁵, vol. 3, p. 111).

6.– *Ṭīn karmī*, “grape-vine clay” (ἀμπελιτὶς γῆ), according to Dioscorides a black aluminium oxide from Seleucia in Syria.

7.– *Ṭīn armanī*, Armenian clay (ἀρμενία γῆ), described by Galen.

8.– *Ṭīn nisābūrī*, clay from Nišāpūr in north-east Persia.

French translation of the relevant descriptions in: Leclerc, vol. 2, pp. 421-427, German translation, v. Sontheimer, vol. 2, pp. 166-176.

v. also Dioscorides, book 5, chapter 172 ff., v. J. Berendes, p. 554 ff; Claudii Galeni opera omnia, ed. C. G. Kühn, vol. 12,

¹ Rāzī, *Asrār wa-sirr al-asrār*, p. 10.

² *al-Rāzī's Buch Geheimnis der Geheimnisse*, op. cit., p. 96.



zabad al-baḥr and *sūraġ*

Sepiolite (Meerschaum)

(1, on the right) smooth.
Dimensions: 35 x 25 mm, 5 g.
(Inventory No. K 3.46a)

(2, on the left) rough
Dimensions: 70 x 40 mm, 32 g.
(Inventory No. K 3.46b)

Arab scholars knew from their Greek predecessors Dioscorides and Galen two kinds of meerschaum under the names halkyonion and adarkes. Even though they generally differentiate between them, they call both of them *zabad al-baḥr* (“meer-schaum”). In the writings of Ibn al-Baiṭār (*Ġāmiʿ*, vol. 3, p. 43) the latter seems to occur as *sūraġ*. It corresponds to sepiolite, which is a component of meerschaum. According to Dioscorides (book 5, chapter 136), adarkes is suitable “for the removal of leprosy, eczema, white spots, liver spots and such ... it also helps with sciatica.”¹

Tamīmī, *Muršid*, pp. 105–108, 187–189; Muwaffaqaddīn al-Harawī, *Abniya*, p. 176 (transl. Achundow, p. 215; reprint p. 87); Ibn al-Baiṭār, *Ġāmiʿ*, vol. 2, pp. 154–155 (French transl., Leclerc, vol. 2, pp. 196–197; German transl. Sontheimer, vol. 1, pp. 518–519); Qazwīnī, *ʿAġāʾib al-maḥlūqāt*, p. 226.

¹ v. J. Berendes, op. cit., p. 541.

durr, lu'lu'

Pearl

In the field of medicine, the pearl is added to medicaments in pulverised form. It is used for strengthening the membranes of the eyes and their muscles, for strengthening the heart and against melancholy. As deposit sites, Arabic sources generally speak of the Indian Ocean, specially Bahrain in the Persian Gulf, Sri Lanka, the Red Sea (Dahlak Archipelago) and Zangibār (Zanzibar).



Diameter: 7.5 mm, 2.5 ct.
(Inventory No. K 3.39)

Steinbuch des Aristoteles, pp. 96–98, 130–133 (reprint op. cit. pp. 104–106, 138–143); Tamīmī, *Muršid*, pp. 35–40, 138–143; Bīrūnī, *Ġamāhir*, pp. 104–137; Ibn al-Ġazzār, *I'timād*, facsimile ed., p. 31; Qazwīnī, *ʿAğāʾib al-maḥlūqāt*, pp. 223–224; v. also E. Wiedemann, *Zur Mineralogie im Islam*, pp. 219–223, 231–232, 237–238, 254–255 (reprint op. cit., pp. 191–195,

203–204, 209–210, 226–227); J. Ruska, *Perlen und Korallen in der naturwissenschaftlichen Literatur der Araber*, in: *Naturwissenschaftliche Wochenschrift* (Jena) 20/1905/612–614 (reprint in: *Natural Sciences in Islam*, vol. 28, Frankfurt 2001, pp. 252–254); J.-J. Clément-Mullet, op. cit., pp. 16–30 (reprint op. cit., pp. 190–204).

mūmiyā'

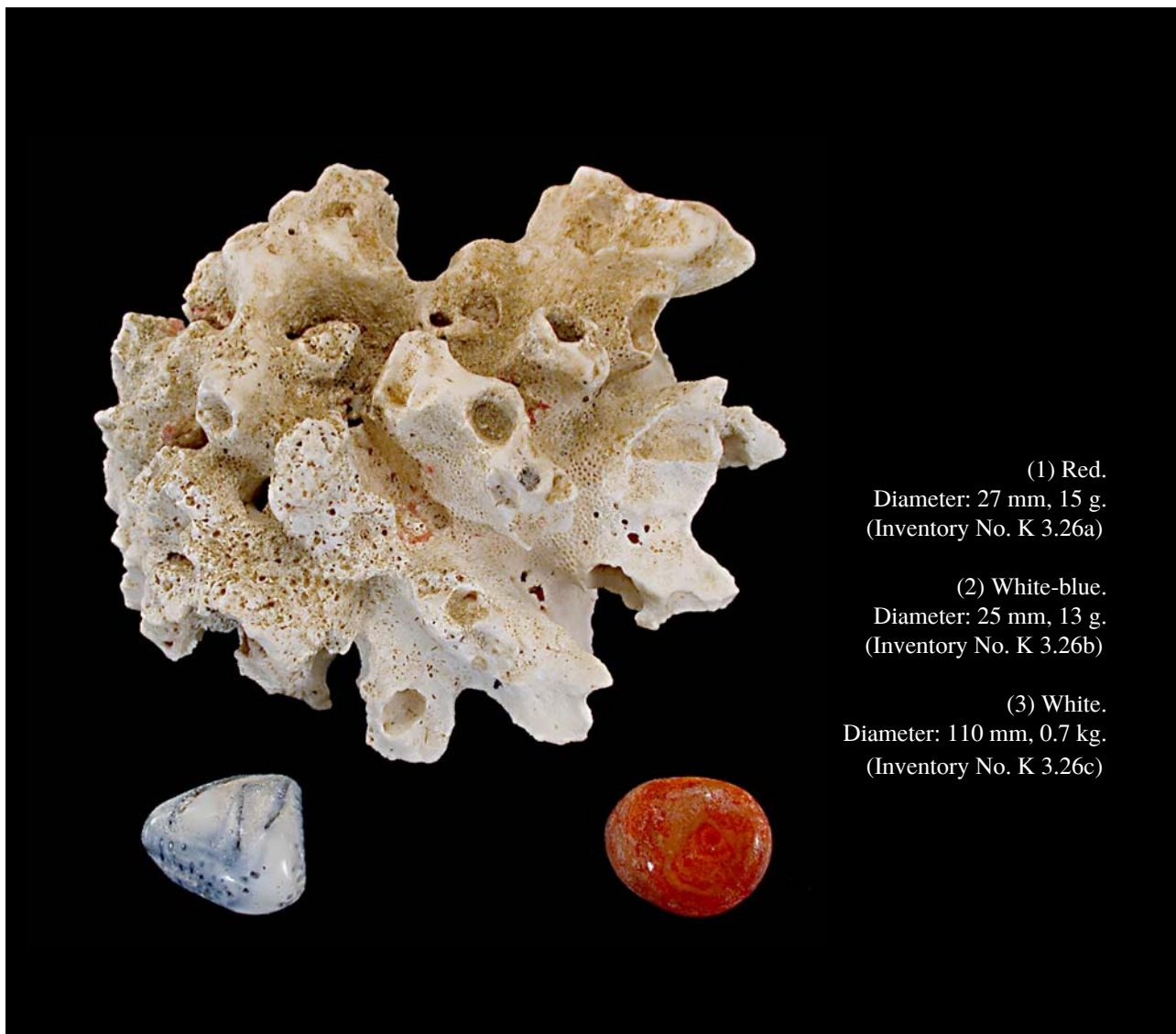
Mineral Wax, Ozocerite

75 x 55 mm, 215 g.
(Inventory No. K 3.16)



“A hard, black and shining mineral liquid which oozes out of rock caves” (Dietrich). It occurs in Yemen, in southern Persia and in India. In medical applications, *mūmiyā'* is used for fractures, sprains, bruises, haematoma and for the treatment of wounds; it is also used as an antidote.

Ibn al-Ġazzār, *I'timād*, facsimile ed, pp. 112–113; Bīrūnī, *Ġamāhir*, pp. 204–207; Ibn al-Baiṭār, *Ġāmi'*, vol. 4, pp. 169–170 (French transl., Leclerc, vol. 3, pp. 346–349; German transl. Sontheimer, vol. 2, pp. 537–538); A. Dietrich, *Dioscorides triumphans*, pp. 20–21 (arabe), 120–121 (German).



(1) Red.
Diameter: 27 mm, 15 g.
(Inventory No. K 3.26a)

(2) White-blue.
Diameter: 25 mm, 13 g.
(Inventory No. K 3.26b)

(3) White.
Diameter: 110 mm, 0.7 kg.
(Inventory No. K 3.26c)

marġān and *bussad*

Corals

Marġān and *bussad* are quite frequently used as synonyms. In North Africa “coral” is called *qarn* (“horn”). It was known in red, white, black and blue colours.

Pulverised coral was used as a remedy for eye diseases, against stomach pain and pain in the spleen. As deposit sites, Arabic sources mention, inter alia, the coasts of the Mediterranean, the Red Sea and Sicily.

Steinbuch des Aristoteles, pp. 120, 176 (reprint op. cit. pp. 128, 184); Tamimī, *Muršid*, pp. 71–76, 164–167; Birūnī, *Ġamāhir*, pp. 189–193; Ibn al-Baitār, *Ġāmiʿ*, vol. 1, pp. 93–94 (French Transl., Leclerc, vol. 1, pp. 223–225; German transl. Sontheimer, vol. 1, pp. 137–139); Qazwinī, *ʿAğāʾib al-maḥlūqāt*, p. 238; for further literature, v. A. Dietrich in: EI, new ed., vol. 6, pp. 556–557.



kahrubā', kahramān

Amber

Amber, in Persian “straw-robber” (*kāh-rubā*) in the sense of attracting straw, is not considered a stone by Arab-Islamic scholars, but mostly as a resin or a plant product. Arab physicians adopted amber from their Greek predecessors¹ as a styptic, a heart-strengthening medicament and as a relief for pain in the eyes. Al-Bīrūnī² says that he included amber in his book of gems only because it was known and popular among the eastern Turks. Obviously the knowledge of amber’s property of attracting straw after being rubbed, which al-Bīrūnī mentions as something that is well known, reached the Muslims from the Chinese via the eastern Turks.³ The coasts of the Caspian Sea, the Mediterranean and the eastern coasts of the northern and southern

(1) Light.

Diameter: ca. 47 mm, 19 g.

(Inventory No. K 3.09a)

(2) Dark.

Diameter: ca. 47 mm, 34 g.

(Inventory No. K 3.09b)

Atlantic Ocean are mentioned as deposit sites.

‘Alī b. Rabban aṭ-Ṭabarī, *Firdaus al-ḥikma*, Berlin 1928, p. 405 (see Werner Schmucker, *Die pflanzliche und mineralische Materia Medica im Firdaus al-ḥikma des ‘Alī ibn Sahl Rabban aṭ-Ṭabarī*, Bonn 1969, pp. 414–415); Ibn al-Ğazzār, *I’timād*, facsimile ed, pp. 18; Qazwīnī, *‘Ağā’ib al-maḥlūqāt* pp. 234; Ibn al-Baiṭār, *Ğāmi‘*, vol. 4, pp. 88–89 (French transl., Leclerc, vol. 3, pp. 209–211; German transl. Sontheimer, vol. 2, pp. 405–406); Georg Jacob, *Der Bernstein bei den Arabern des Mittelalters*, Berlin 1886 (reprint in: *Natural Sciences in Islam*, vol. 28, Frankfurt 2001, pp. 115–126); idem, *Neue Studien, den Bernstein im Orient betreffend*, in: *Zeitschrift der Deutschen Morgenländischen Gesellschaft* (Leipzig) 43/1889/353–387 (reprint in: *Natural Sciences in Islam*, vol. 28, pp. 127–161); Oskar Schneider-Dresden, *Nochmals zur Bernsteinfrage*, in: *Zeitschrift der Deutschen Morgenländischen Gesellschaft* (Leipzig) 45/1891/239–244 (reprint in: *Natural Sciences in Islam*, vol. 28, pp. 163–168); G. Jacob, *Kannten die Araber wirklich sicilischen Bernstein?*, in: *Zeitschrift der Deutschen Morgenländischen Gesellschaft* (Leipzig) 45/1891/691–693 (reprint in: *Natural Sciences in Islam*, vol. 28, pp. 169–171); Eilhard Wiedemann, *Zur Mineralogie bei den Muslimen*, in: *Archiv für die Geschichte der Naturwissenschaften und der Technik* (Leipzig) 1/1908–09/208–211, esp. p. 211 (reprint in: *Natural Sciences in Islam*,

¹ v. Ibn al-Baiṭār, *Ğāmi‘*, vol. 4, pp. 88–89.

² *Ğamāhir*, p. 210.

³ F.M. Feldhaus says in his *Die Technik. Ein Lexikon der Vorzeit, der geschichtlichen Zeit und der Naturvölker* (Wiesbaden 1914, repr. Munich 1970), column 78: “Electricity of amber was already known to the Chinese around 315 AD. In Europe only Gilbert recognised this power of nature (Gilbert, *De magnetice*, London 1600).”

Gallnuts or Galls

Excrescence of plant tissue induced by gall wasps; used in the extraction of tannic acid (Tannin)

20 pieces.
Total weight 50 g.
(Inventory No. K 3.60)

Myrobalans

Fruit of *Terminalia chebula*, rich in tanning agent.

7 pieces.
Total weight 27 g.
(Inventory No. K 3.62)

Gum arabica

Dried juice of African Acacias, high-quality water-soluble bending agent.

7 <tears>.
Total weight 67 g.
(Inventory No. K 3.61)



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