STUDIES IN OTTOMAN SCIENCE

II

SUMMARIES

Editor
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Foreword

The fact that the second volume of the *Studies in Ottoman Science* is ready for print, two years after the first volume appeared, may be considered as an indication of the increasing research activities in history of science in Turkey. Contributions to the second volume reveals also the increasing interest in Ottoman science in recent years. Whereas the first volume, prepared on the occasion of the 10th foundation year of the Department of History of Science, Istanbul University, included the research articles by the department staff, the present volume welcomes the works of both Turkish and foreign scholars.

The present volume includes twelve research articles. A number of these study the scientific activities in the classical period. Others deal with the modernization period, namely the eighteenth and nineteenth centuries. The articles provide a variety of subjects ranging from the history of mathematics, astronomy, medicine and natural sciences to industry, technology, technical military training, mechanics and metrology. A number of the articles are the outcomes of the masters and Ph.D studies carried on by young colleagues in the Department of History of Science. A report on the activities of the History of Science Department between 1994-1997 as well as its English translation are included in this book.

I would like to thank here all the authors who have kindly contributed to this second volume with their research, and Miss Aysu Albayrak for editing the English translations. I am especially grateful to Professor Ekmeleddin İhsanoğlu for his valuable comments and suggestions.

26 May 1997 Feza Günergun

Modernization efforts in science, technology and industry in the Ottoman empire (18th and 19th centuries)*

Ekmeleddin İhsanoğlu

Ottoman science emerged and developed on the basis of the scientific legacy and institutions of the Seljukid Turks. It greatly benefited from the activities of scholars who came from Egypt, Syria, Iran, and Turkistan, which were homelands of some of the most important scientific and cultural centers of the time. The Ottomans preserved and enriched the cultural and scientific heritage of the Islamic world, giving it new dynamism and vigor. Thus, the Islamic scientific tradition reached its climax in the sixteenth century. Moreover, proximity allowed the Ottomans to learn early on of European innovations and discoveries. The Ottomans began, already in fifteenth century, to transfer Western technology (especially firearms, cartography, and mining), and they also had some access to Renaissance astronomy and medicine through emigrant Jewish scholars. The interests of the Ottomans remained selective, however, because of their feelings of moral and cultural superiority and the self-sufficiency of their economic and educational system. They thus did not track the scientific and intellectual developments of the Renaissance and the Scientific Revolution, during their heyday.

In the seventeenth century, contacts with Europe became closer and Ottoman knowledge of the West came through translations made from European languages, personal observations of Ottoman ambassadors who paid official visits to Europe and the modern educational institutions established in the eighteenth and nineteenth centuries.

The first work of astronomy translated from European languages was the astronomical tables by the French astronomer Noel Duret (d. ca. 1650). The translation, made by the Ottoman astronomer Tezkereci Köse İbrahim Efendi (Zigetvarlı) in 1660 was also the first book in Ottoman literature to mention Copernicus and his heliocentric system. Astronomy books subsequently translated from European languages also dealt mostly with astronomical tables. From the sixteenth century onwards, the arrival of physicians and diseases from the West introduced new medical ideas and methods of prophylaxis and treatment. The medical doctrines of Paracelsus and his followers began to appear

* For the English version of this article see *The Introduction of Modern Science and Technology to Turkey and Japan*, Feza Günergun & Shigehisa Kuriyama eds., International Research Center for Japanese Studies, Kyoto 1998, pp.15-35.

in Ottoman medical literature under the names of *tıbb-ı cedid* (new medicine) and *tıbb-ı kimyaî* (chemical medicine).

Instructors at the imperial schools of engineering or medical sciences translated and compiled books from European scientific literature. They relied on the textbooks used in European military technical or medical schools. In the nineteenth century, modern education became widespread, civilian education was reorganized, and new scientific and technical books were printed. The mid-nineteenth century thus witnessed an increase in both the number of printed books on modern science and techniques, and in the variety of subjects introduced.

Prior to the eighteenth century, it was not difficult for the Ottomans to keep up with European technology, for it changed relatively slowly. Large state enterprises such as the Maritime Arsenal, the Arsenal of Ordnance and Artillery, the Powder mill and the Mint, functioned fairly successfully to meet the needs of the military. In the eighteenth century, forced into constant retreat in Central Europe, the Ottomans gave up their policy of conquest and began to follow European developments closely, turning their attention to the cultural and technical sources of European superiority. Thus commenced a period of affluence, called the Tulip Age (1718-1730); under Western influence, new developments emerged not only in the technical fields, but also in art and architecture. Innovations such as the fire pump and the printing press were established in the Ottoman capital. Ottoman administrators who learnt about European daily life also developed a great interest in nonmilitary European inventions.

During the eighteenth century, innovation in European war technology began to accelerate, and it became harder for the Ottomans to keep pace. The Ottomans sought gradually to import Western military science and to modernize their army. A first attempt was the creation in 1735 of the Corps of Bombardiers, under the supervision of the Comte de Bonneval. Besides undergoing drills, the bombardiers in this corps received theoretical training in geometry, trigonometry, ballistics, and technical drawing. In the second half of the eighteenth century, a group of French experts came to Istanbul within the framework of military aid agreements. One of them, the Baron de Tott, was employed in building fortifications, in teaching new European military techniques. He established a new foundry, the "Corps de Diligents" where artillerymen were trained in the European manner, a school where courses were given for the first time on theoretical mathematics and military techniques. He introduced European techniques to the Imperial Maritime Arsenal as well. De Tott's cooperation with the Ottoman lasted six years, and he returned to France when local, French, and personal interests ceased to overlap. Between 1783-1788, numerous French military experts and officers came to Istanbul to work on various technical projects and the fortification of the Ottoman borders. When French experts, masters and teachers left Istanbul in 1788, their native Ottoman counterparts were employed in their place. In the nineteenth century, European technical knowledge continued to filter through previously established schools of engineering and also through the students sent abroad to study in various fields.

During the early decades of the eighteenth century, while transferring European techniques to strengthen they military power, the Ottomans started industrialization by establishing in İstanbul small-scale workshops for wool, cotton, paper, silk and porcelain manufacture. Fostered by the reforms of Sultan Mustafa III (1757-1774) and Selim III (1789-1807), the workshops established in the late 18^{th} century were generally designed to serve the military. As early as 1793-1794, Sultan Selim III introduced contemporary European methods and equipment for the production of cannons, rifles, mines, and gunpowder. As late as 1804, he undertook the construction of elaborate buildings to house a woolen mill for uniforms, and a paper factory. During Sultan Mahmud II's reign (1808-1839) a spinning mill and a a leather tannery were built and boot works were improved. After the abolition of the Janissary Corps (1826), the army adopted European-style equipment; this, however, worked against domestic self-sufficiency. A factory was opened in 1832-1833 to manufacture the fez, a kind of headgear. In 1841, the Ottomans began to produce the fez with steam powered machines.

By 1841, the need for a massive industrial program became obvious. The enterprises set up between 1847-48 can be called imperial factories. Among these, were the Zeytinburnu Iron Factory, Izmit Woolen Cloth Factory, Hereke Silk Cloth Factory, Veliefendi Printed Wool-Cloth Factory, Mihalic State Farms, the School of Iron Ore and Agriculture in Büyükada. There were also plans to open *talimhanes* (training courses) on "mines, geometry, chemistry and sheep-breeding".

To serve the army's needs, the Gun Foundry and the Arsenal were installed with steam engines. The Arsenal at the Golden Horn, provided with European equipment and personnel, typifies the attitude of the Ottoman state toward technology transfer. Like the Feshane, it employed numerous foreign (particularly English, French and American) workers and administrators. Until the end of the century, Ottoman industries equipped with Western technologies depended largely on a foreign labor force.

The main purpose of founding and building imperial factories was to produce the necessary materials for the army, and to meet expenses with internal rather external resources. The bureaucrats of the Tanzimat were aware that it was as important to encourage exports as to limit imports. Nevertheless, this objective went unrealized.

In 1880's, the state shifted its emphasis from building factories to encouraging their creation by entrepreneurs. Thus, the role of the entrepreneurs gradually increased, and the number of factories grew significantly in the 1880s, when three-quarters of the Ottoman factories were established. The nineteenth century attempts to industrialize, and to transfer Western technology didn't yield the expected results. This limited success may have resulted from mistakes in Ottoman policies and the pressure of foreign powers. To begin with, it was very hard for the Ottomans to find the necessary capital for industrialization; western capital investments, which entailed heavy conditions and difficulties, did not develop in the direction that they wished. Instead, Western investments favored the interests of the non-Muslim subjects and ethnic groups who had cultural affinities with Europe. Moreover, the West quite naturally made its investment decisions with an eye, above all, toward profits. Ottoman attempts in the nineteenth century to transfer modern technology and to found independent industrial enterprises were also hindered by deep-rooted European hostility. Although the initiatives in heavy industry met with limited success, there was a rapid growth in low-level technology transfer. For example, the yarn and dye technologies were adopted quickly and quite extensively.

The Ottomans' haste to bridge the gap with Europe and regain their old power led them to commit political errors. The Ottomans adopted modern science and technology mostly through "translations" and "purchase", and failed to produce science and develop a technology –failed, that is to establish an indigenous tradition in science and industry which would decrease their dependence on the West. I believe that this was the most critical factor that made the Ottoman experience different from that of Russia and Japan.

The equivalents of Ottoman weights and measures in pre-metric and metric systems: the early comparisons and conversion tables

Feza Günergun

The attempts to transfer and adopt the European science and technology unavoidably brought along the need to compare the Ottoman measures with their European counterparts at the end of the eighteenth century. The Mühendishane (Engineering School) that was a forerunner in the introduction of European techniques into the Ottoman Empire played a similar role in the field of metrology. Political conditions of the late eighteenth century led to the recruitment of French and English experts in the Mühendishane, whereas the employment of texts translated from these languages for engineering education rendered it necessary to ascertain the Ottoman equivalents of French and English measures. Thus, a comparison was made between the French and Ottoman measures of length and the results were published by Hüseyin Rıfkı Tamanî in his *Telhis-ül Eşkal* (written in 1794, printed in 1801) and *Mecmuat-ül Mühendisin* (Istanbul, 1805). Once the ratio between the French and Ottoman measures was known, it became much easier to calculate the Ottoman equivalents for the measures of various countries since the equivalence of French measures with the others was already known.

Starting from the first half of the nineteenth century, metric weights and measures became included in the European books of science and technology. Ottoman engineers mentioned *metre* in the books they translated or compiled from Europeans sources and calculated the metric equivalents of Ottoman weights and measures. In the calculation they used the results of the comparisons made by H. Rıfkı between the Ottoman measures and the pre-metric French measures (6 *usbu-i osmani*=7 *usbu-l française*).

The direct comparison of the *zira* to the *metre* was made in 1841 in Paris through the initiatives of Mehmed Emin Pasha, which was an important step in the standardization of Ottoman measures of length. The value of 0,757 738 m. was accepted as the official metric equivalent of the *zira* after the adoption of the new system by the Ottoman government in 1869. The metric equivalent of *okka* (1,282 945 kg.) as calculated by Mehmed Emin Pasha in 1842 was officially included in the conversion tables. These values rounded as 0,758 *metres* and 1,283 *kilograms* were frequently used in the conversion tables from 1870s on. On the other hand, the metric equivalent of *zira* (0,757 9586 m.) calculated by İshak Effendi (1834) and İbrahim Pasha (1836) based on the measurements made in Istanbul at the end of the eighteenth century by Tamanî approximated the value obtained in Paris in 1841 by using a comparator equipped with microscopes.

The establishment of the engineering schools (mühendishanes) in the Ottoman empire

Mustafa Kaçar

The Ottomans' interest in European science and technology which developed in the 18th century was highly influential in the foundation of new scientific and educational institutions. In 1735, the *Ulufeli Humbaracı Ocağı* (Corps of Bombardiers) was created under the supervision of Comte de Bonneval. In addition to drills, the bombardiers received theoretical instruction in geometry, trigonometry, ballistics, and technical drawing in the course of their training. The establishment of this corps was a first step in the creation of a new military organisation in the Ottoman army.

The second attempt started in 1770 when Baron François de Tott was charged by the Ottomans with several military and technical projects. A class of geometry called Hendesehane or Ecole de Théorie et de Mathématiques was established under his supervision and opened on April 29, 1775. The Hendesehane was originally a school where different branches of mathematics were taught to students coming from various military corps(es) such as artillery, fortification and the Ottoman navy. It was different from the above-mentioned corps of bombardiers where mathematics was taught as a part of the bombardier training. Baron de Tott, the French Kermovan and Campbell Mustafa of Scottish origin lectured mathematics in the Hendesehane for about four months until September 1775.

In 1776, with a new regulation issued by Grand Admiral Gazi Hasan Pasha, Hendesehane was re-organized in line with the classical Ottoman bureaucratic and financial structure. After Baron de Tott left İstanbul, Cezayirli Seyyid Hasan Hoca, the Second Captain of the imperial fleet, was appointed professor to the school. Thus, established under the administration of European specialists, Hendesehane continued to give instruction in mathematics and fortification through the contributions of native teachers. It was originally established in the storage rooms of the Imperial Maritime Arsenal and was run by a professor from the *ulema* class who had sound knowledge in geometry. Foreign specialists could also teach in this institution. The teaching staff included a professor *(hodja)*, an assistant professor *(halife)* and a keeper of instruments. There were about ten students *(sakird)* in the Hendesehane.

From 1781 on, Hendesehane was also called Mühendishane (School of Engineering). During Halil Hamid Pasha's term of office (Grand vizier between 1782-1785), the Ottomans were on good terms with France. Upon the request of the Ottoman State, Lafitte-Clavé and Monnier, French military experts, were sent to Istanbul and put in charge of the reformation projects in the Ottoman army. They were also asked to strengthen the fortifications at the Empire's borders and to organise the training in the Maritime Arsenal, and the School of Engineering as well. Thus they started to train officers in modern military arts and sciences (artillery, navigation and fortification etc.) together with teachers from the Ottoman *ulema* class. After 1788 when the Frenchmen left the Empire, the native *madrasa* teachers undertook the instruction in the imperial schools of engineering where the classical Ottoman science books were used alongside with European books until the end of the eighteenth century.

With the reign of Sultan Selim III (1789-1808) started a military reform movement called the *Nizam-ı Cedid* (New Order). Within the framework of this reform, new regulations were prepared for the imperial schools of engineering. Accordingly, *Mühendishane-i Cedid* (New *Mühendishane*) was established in 1793 to train military units (i.e. corps of canoniers, bombardiers and miners) that required mathematical and technical knowledge. The Ottoman engineer-teachers who had been the students of French engineers such as Lafitte-Clavé and Monnier and taught fortification in the Arsenal in 1784, lectured in this new *Mühendishane*. The teaching staff included a professor (*hodja*) and four assistant professors *(halifes)* who instructed the bombardiers and miners in geometry, trigonometry, measuring the altitude and land surveying.

Between 1801-1802, about one hundred students selected from the corps of bombardiers, sappers, miners and architects were recruited in the *Mühendishane* to be trained as engineers.The teaching staff included a professor and five assistant professors. With a regulation issued in 1806 carrying the imprints of the European educational system, the school was organised as to have four classes and four teachers. This regulation also started the practice of passing from one grade to another which was a novelty in Ottoman educational life.

When compared with the nineteenth century European military and civil engineering schools, the number of the graduates of Mühendishanes was relatively low. This was due to the fact that students of this institution were state officials (soldiers) paid by the government.

The educational system in the Ottoman classical institution "madrasa" and the newly introduced European system were reconciled within the framework of the Otoman traditional bureucracy.

Thus, with the establishment of the mühendishanes, an Ottoman-European synthesis started to gain ground in Ottoman educational life.as a result of the research conducted so far, it's clear that modern science and technology was introduced to the Ottoman State upon the demand and through the efforts of Ottoman scholars and administrators. Experts recruited from Europe contributed mainly to the teaching of new techniques.

The cannons founded in the Tophâne-i Amire for Cıgalazâde Sinan Pasha's eastern campaign and the account book dated 1012 (1604)

Salim Aydüz

The Ottoman archival documents may help to understand the scopes of the transfer of Western technology to the Ottoman world. Among them, the account book of Tophâne-i Amire (State Cannon Foundry) about Cıgalazâde Sinan Pasha's campaign over Iran known as the "Eastern Campaign", provides detailed information on materials used for cannon casting and cannons produced in State Cannon Foundry in the seventeenth century.

This book which covers the period between 10 Şa'ban - 26 Dhul hijja 1012 (12 January - 26 May 1604) may be considered as one of the first budgets of the State Cannon Foundry. It is available at the Ottoman Archives of Prime Ministry (Maliyeden Müdevver Defter, Nr. 2515, pp. 1-16) and begins with a one-page introduction which gives general information on the raw materials and cannons as well as the artisans working in the foundry. Pages 2 to 4 cover the *icmâl muhasebe* (abstract accountancy) section; and the rest of the book consists of the *mufassal muhasebe* (diffuse accountancy). Pages 5 to 7 are blank. The book gives the number of cannons founded, the income, the expenditure of the Tophâne as well as other activities carried out in the foundry. According to the book, 2 *şakaloz*, 46 *şâhî darbzen* and 4 *kolomborna* cannons were founded for the Eastern Campaign and for the castle of Ocsakow. 70 *kefçeha-i top* were produced as well. For all this equipment 533 *kantar*s of copper, bronze and tin were used. The book also records the resources of materials used. It gives the names and salaries of the staff, however do no mention their number.

Considering the information given in this early seventeenth century account book, we may conclude that a considerable number of cannons were sent to the "Eastern Campaign" both from Erzurum region and from the State Cannon Foundry in Istanbul. Besides, the book helps us understand the organisation and capacity of this institution around 1604.

Undershot driven water mills and water raising devices in Ottoman Anatolia

Atilla Bir & Mahmut Kayral

For about two thousand years water was the main source for milling and other industrial purposes. The oldest known water wheel used for grinding corn existing in Cebeira (near the present day Niksar) in the Kingdom Mithridates was described by the historian Strabo about the first century BC. Water mills need high and constant flow rates to operate. In this region of Anatolia, river flow rates were high and constant all throughout the year.

Water wheels are generally classified into two categories according to the position of their axles. These are: a) vertical axled water wheels, b) horizontal axled water wheels. Due to technical difficulties vertical axled water wheels were not frequently used, thus they were not found in archeological excavations. On the other hand, horizontal axled water wheels using gear wheels to transfer the movement to the vertical mill stone axle were mostly preferred. However, the gears caused a great loss of efficiency.

Water wheels are also classified as undershot and overshot water wheels. The wheel type to be used depends on the flow rate and speed of the river. The undershot driven water wheels are used in rivers having abundant and constant flow rates. The more efficient overshot driven wheels need higher settlement costs and are preferable in rivers having low and varying flow rates.

In this article two types of undershot driven horizontal axled water wheels used in Anatolia during the Ottoman period are studied. The first type is mounted on boats or rafts and is driven by river currents. These wheels are generally established at river turns where water speed is high or at roadsides near bridges to ease the transportation of wheat and flour. This mobile type of wheels have superiority over fixed types since they are not much affected by the changes in river beds. The second type called noria (*dolap* in Turkish) is an undershot driven water raising device which is usually built on rivers with high flow rates. However, throughout antiquity and the middle ages, these wheels were also driven by human or animal power to raise water from low rate rivers. Norias continued to be used until the end of the nineteenth century.

In this article, the technical properties such as efficiency, flow rate, capacity, rotation frequency, height of water elevation and irrigation distance of the two types of water wheels are calculated. Pictures and photographs of these nineteenth century Anatolian devices are annexed to the article.

The use of decimal fractions in trigonometry and astronomy by Taqî al-Dîn

Remzi Demir

European historians have for long believed that Turkish scholars did not contribute to the medieval exact sciences. The reason was that historical studies about Turkish scholars were fairly inadequate. However, in recent years, research made on the works by al-Harezmî, Abd al-Hamid ibn Türk, al-Farabî, Ibn Sina, Ulugh Beg and Ali al-Qushji altered this conviction, though did not abolish it completely.

In this article, the contributions of the Turkish mathematician and astronomer Taqî al-Dîn ibn M'aruf (1521-1585) to the use of decimal fractions is studied. Founder of the Istanbul Observatory (1575), Taqî al-Dîn observed the celestial bodies (especially the sun, the moon and the stars) for about five years. He learned the decimal fractions from Ghiyath al-Dîn Jamshid al-Kashi's work *Miftah al-Hisab* (1427). He improved al-Kashi's studies on fractions and prepared zijs, in which he used the decimal fractions instead of the sexagesimal ones. According to Taqî al-Dîn, al-Kashi's knowledge on the decimal fractions was limited. He could only perform the four basic operations such as addition, substraction, multiplication and division with these fractions. However, he did not use them in trigonometry or astronomy.

Why did Taqî al-Dîn use decimal fractions in trigonometry and astronomy? Taqî al-Dîn's main purpose was to make the trigonometrical and astronomical calculations easier and simpler. He wrote an arithmetical treatise called *Bugya al-Tullab* where he introduced two different calculation systems, namely al-Hisab al-Hindî (the decimal system) and al-Hisab al-Müneccim (the sexagesimal system), that were familiar to Ottoman mathematicians and astronomers. After describing in detail the concept of "decimal fraction" in the ninth chapter, he showed through examples the way to operate the four basic operations and duplications as well as to take their halves and square roots. He also explained the way to convert the sexagesimal fractions into the decimal fractions or vice versa. However, Taqî al-Dîn did not introduce any symbols to distinguish the integers from the decimal fractions. He transcribed for example, the number 532,876 in the form of *5 hundreds 3 tens 2 ones 8 one tenths 7 one hundredths 6 one thousandths* or in the form of *532876 one thousandths*; that is, the forms used by Taqî al-Dîn were verbal.

In *Bugya al-Tullab*, Taqî al-Dîn pointed out that the sexagesimal system used by astronomers in spherical astronomy to determine the positions of the heavenly bodies was not adequate for the calculations. The reason was that in the sexagesimal system doing multiplications and divisions was rather troublesome and these operations were time consuming for the astronomers. Moreover, the sexagesimal multiplication table which was similar to the decimal one was not very efficient. He argued that the arithmetical calculations as well as the preparation and use of astronomical tables would be made more easily through decimal fractions.

Taqî al-Dîn decimalized the fractions of trigonometrical functions, angles and arcs. In *Sidra al-Muntaha*, he assumed the radius of the circle as 10 units and not 60 or 1. Moreover, he divided one of the two surfaces of Zat al-cayb (an astronomical instrument used at Istanbul observatory) into 10 equal parts.

He put his theoretical knowledge into practice in his zij called *al-Teshil* (1580) where he minutely defined the application of decimal fractions to trigonometry and astronomy. In this zij based on observations made at the Istanbul Observatory, all fractions were decimalized.

In *Carida al-Durar*, a zij dated 1584, Taqî al-Dîn calculated a sine-cosine table and a tangent-cotangent table where he took the radius of the trigonometrical circle as 10 units and decimalized the fractions of trigonometrical functions. If he had assumed the radius as 1 unit and not 10 units, he would have calculated the trigonometrical tables that we are using today.

In Europe, the first treatise introducing the decimal fractions was *De Thiende* (Leiden, 1585) written by the Dutch mathematician Simon Stevin. In this 32-page booklet, although Stevin suggested signs designating the decimal fractions and used decimal notations for weights and measures, there is no evidence that he applied them to trigonometry or astronomy. Therefore, it may be well stated that decimalization in these fields started with Taqî al-Dîn, one of the distinguished scholars of the sixteenth century Ottoman Turkey.

Immigration of the Iranian scholars and the transfer of Iranian intellectual traditions to the Ottoman Empire from the early Timurid period to the late Safavid period

Tofigh Heidarzadeh

This article attempts to examine the cultural relationships of Iran and the Ottoman Empire between the fifteenth and seventeenth centuries. It deals with the causes of the immigration of a large number of Iranian scholars and explores the transmission of intellectual traditions between the two regions as well as the influence of this transmission. Brief biographies of some one hundred immigrants are included, particularly the scholars who were either famous for or wrote at least one treatise on the rational sciences.

The article is divided into two parts: The Timurid Period and the Safavid Period. In the first part, the intellectual activities during the reign of Timur and his successors -Shahrokh and Ulugh Beg - are described. During this period cultural activities flourished with the establishment of several madrasas in Herat, Samarqand and Shiraz under the patronage of Timurid rulers. The Ottoman Empire was growing, but from the reign of Shahrokh until the end of the Timurid Period, political and religious considerations were not serious conflicts between Iran and the Ottomans. Rather, a vast cultural relationship had developed between the two neighbours.

However after the death of Ulugh Beg (1449), socio-economic unrest, the lack of patronage, and the collapse of a stable government in Iran caused scholars to seek refuge elsewhere. The Ottoman Court, especially after the conquest of Constantinople by Mehmed II (The Conqueror) who had good relations with Iranian scholars, was an appealing haven. During this period, and also after the defeat of Uzun Hasan by Mehmed II (1473), some scholars from Khurasan and Transoxiana immigrated to the Ottoman Empire, and obtained positions as advisors to the Ottoman Sultans, judges, and teachers in madrasas.

The second part of the article is concerned with the rise of the Safavids and one of the most important cultural changes in Iran, namely the conversion of the state religion from Sunnite to Shiism. The proclamation of Shiism as the official religion by Shah Ismail unified Iran; however, his insistance on the people's conversion caused many famous Sunni scholars to immigrate. Due to the past amicable relations between Iranian and Ottoman scholars, the Sultan's patronage, and the state religion of the Ottoman Empire which was Sunni, the vast majority of these Iranian immigrants fled to the Ottoman land. Immigration due to religious conversion continued until the second half of the Safavid Period.

During the first half of the Safavid Period, the Sunni immigrations caused a significant decline in the scientific endeavours in Iran since Shiite scholars had still needed to establish cultural and educational centers. On the other hand, this immigration had a considerable impact on the cultural and scientific activities in the Ottoman Empire; scholars from Herat and Samarqand thus played a significant role in the development of mathematics and physics in the Ottoman Empire.

Diplomas, certificates and licences given by the medical schools in İstanbul (1853-1909)

Turhan Baytop

During the early periods of the Ottoman Empire, one did not have to apprentice a master or get a certificate from a medical school to practice medicine, surgery and pharmacy. *Mütetabbibs* could easily and freely treat patients. Some of them even claimed that they inherited the medical profession from their fathers.

In 981 (1573) Sultan Selim II issued an edict in order to prevent persons who did not have adequate knowledge in medicine, surgery and drugs from harming the patients. In this edict addressed to the *kadı* (judge) of Istanbul, it was stated that people dwelling in some shops introduced themselves as surgeons, physicians and oculists and prescribed to the patients fatal medicines without scientific qualities. The edict banned them from acting as physicians unless examined by the chief physician.

Another edict dated 1001 (1592-93), addressed to the chief physician Yusuf Effendi prevented people without medical education from working as doctors, surgeons or oculists. A book dated 1111 (1700), containing the list of the physicians and surgeons who had passed the examinations by the chief physician and given licences, is available.

In 1840 the *Meclis-i Umur-i Tıbbiye* (Conseil des Affaires Médicales) was founded within the *Mekteb-i Tıbbiye-i Askeriye-i Şahane* (École Impériale de Médecine Militaire). Some of the chief-physician's duties were assigned to this assembly. The first act of the assembly was to check the diplomas and licences of the physicians, surgeons, pharmacists, midwives and cooks working in Istanbul and deliver new licences to the appropriate ones.

The assembly issued important regulations concerning public health, medicine and pharmacy. The first of these was the *Tababet-i Belediye İcrasına Dair Nizamname* (Réglement sur l'exercise de la médecine civile en Turquie) dated 1861. The second was the *Belediye İspençiyarlık Sanatının İcrasına Dair Nizamname* (Réglement de la pharmacie civile) dated 1862. According to these regulations, to become a physician or a pharmacist, one had to receive a diploma from a medical school or achieve *Ustalık İcazetnamesi* (Certificat de Maître) as well as *Ruhsat Tezkîresi* (Permis de libre exercise).

In this article, 15 documents issued for students, physicians, surgeons, pharmacists and midwives prepared by the medical schools in Istanbul are presented. These documents ranging from the *ulum-i ibtidaiye* diplomas to the *icazetnames* in medicine&surgery and pharmacy are given below.

1. *Şehadetname-i Mekteb-i Tıbbiye-i İdadi* dated 11 June 1293 (23 June 1876), 28.5 x 41 cm, delivered to Süreyya Mehmed Efendi, second year student at the *Mekteb-i İdadi-i Tıbbiye-i Şahane* as he moved up to the first class of the *Mekteb-i Tıbbiye-i Şahane.*

2.*Mekteb-i Tıbbiye-i Mülkiye-i Şahane Sınıf Geçme Şehadetnamesi* dated 15 Şaban 1292 (16 September 1875), 27x40 cm, delivered to the third year student Nişan Korkis Efendi.

3. *Darü'l-ulumi'l-Hikemiyye-i Şahane (Mekteb-i Tıbbiye-i Şahane) Ulum-i İbtidaiye Diploması* dated 5 Cemaziyelevvel 1302 (22 March 1885), 38 x 50 cm, delivered to Süreyya Mehmed born in 1276 in İzmit.

4. *Mekteb-i Tıbbiye-i Şahane Sınıf Geçme Tasdiknamesi* dated 21 Rebiyülahir 1289 (28 June 1872), 29 x 40 cm, delivered to the fifth year student Asfadour Hatchadour as he moved up to the next class.

5. *Mekteb-i Tıbbiye-i Şahane Sınıf Geçme Tasdiknamesi* dated 24 July 1298 (5 August 1882), 33x40 cm, delivered to the eighth year student Vebouh Agob.

6. *Şehadetname-i Mekteb-i Tıbbiye-i Mülkiye-i Şahane* dated 15 Şaban 1305 (27 June 1888), 24 x 34 cm, delivered to the second year student Şemseddin Mustafa Efendi certifying his success in anatomy, botany, inorganic chemistry courses and French composition.

7. *Şehadetname-i Mekteb-i Mülkiye-i Şahane* dated 15 Haziran 1307 (27 June 1891), 24 x 34 cm, delivered to the fifth year student Şemseddin Mustafa Efendi upon his success in courses in internal and external diseases, midwifery.

8. *Mekteb-i Tıbbiye-i Şahane Mezuniyet Tezkîresi* dated 19 Şevval 1290 (10 December 1873), 34 x 50 cm, delivered to the 70 year old Kirkor Sahatyer giving him permission to cure breaks, dislocations and sprains.

9. *Fenn-i Kıbâle (Ebelik) Şehadetnamesi* dated 26 Muharrem 1315 (27 June 1897), 41.5 x 57 cm, giving permission to Ayşe Mustafa to perform midwifery.

10. *Dişçilere Mahsus İcazetname (İkinci Sınıf)* delivered by *Nazır-ı Mekteb-i Tıbbiye-i Şahane ve Umur-i Tıbbiye-i Mülkiye* dated 16 Safer 1293 (13 March 1876), 26 x 38 cm, giving permission to 32 year old Grégoire Haviaropoulos to perform dentistry in the Ottoman Empire.

11. *Dişçilere Mahsus İcazetname (İkinci Sınıf)* delivered by *Nezaret-i Mekteb-i Tıbbiye-i Şahane ve Umur-i Tıbbiye-i Mülkiye* dated 23 Şaban 1325 (1 October 1907), 26 x 38 cm, giving permission to the 24 year old Philippos Demosthény G.Haviaropoulos to perform dentistry in the Ottoman Empire.

12. *Mekteb-i Tıbbiye-i Şahane Eczacı İcazetnamesi* dated 24 Receb 1312 (21 January 1895), 40 x 52.5 cm, delivered to Ahmed Refik Abdullah born in 1282 in Tokat.

13. *Mekteb-i Tıbbiye-i Mülkiye Eczacı İcazetnamesi* dated 7 Muharrem 1327 (29 January 1909), 43 x 53 cm, delivered to Mehmed Tevfik Mehmed Salih born in 1305 in Edremit.

14. *Diplome de docteur en médecine et en chirurgie* dated 23 Şaban 1269 (1 June 1853), 40x56 cm, delivered by *Mekteb-i Tıbbiye-i Şahane* to Michel N.Didymos born in 1826 in Edirne.

15. *Mekteb-i Tıbbiye-i Şahane Tıp ve Cerrahi İcazetnamesi* dated 11 Receb 1320 (14 October 1902), 41.5 x 58 cm, delivered to Mehmed Nuri Mahmud born in 1297 in Erzincan.

Ottoman medicine and transculturalism from the sixteenth through the eighteenth century*

Rhoads Murphey

The notion is generally accepted that a society's attitudes toward health, as well as its development of particular medical practices, are reflective of its social order and religo-cultural value system. According to this precept it should be sraightforward task to situate the development of Ottoman medical practice within the appropriate societal context. The Ottomans fostered an environment in which nonconforming cultures and unassimilated subcultures -ranging from the full spectrum of Judeo-Christian sectarien traditions to a variety of heteredox Islamic communities- coexisted comfortably. The examination of Ottoman medicine allows us significantly to change how we see segmentary Ottoman society-which in the crudest portrayals has been shown as divided into two mutually hostile groups: the priviledged Muslim majority, on the one hand, and the non-muslim, or "subject" peoples, on the other - and shows us some of the ways in which certain groups' material interests, otherwise seen as divergent, converged at certain key points. It may be stated in semiaxiomatic fashion that it was the trinity of syncretism, multiculturalism, and ethnic and religious pluralism that gave Ottoman civilization its characteristic stamp; and the creative blending of traditions which the Ottomans achieved in the field of medicine serves as a clear example of the multicultural character of Ottoman action and thought.

Traditionally, the study of Ottoman medicine has been relegated to one of four main methodological schools. In the first and perhaps most prevalent approach, the history of Ottoman medicine has been studied as a branch of the history of science and technology. In the second approach, it has been studied as a branch of history of ideas. A third approach has been to study Ottoman medicine as a branch of Ottoman institutional history, placing the major emphasis on the education and training of physicians. Finally, there is the school that studies Ottoman medicine as a branch of biography; this school's main concern is to analyze well-known physicians' written works and assess their professional reputations.

To properly assess the evolution of Ottoman medicine, one must examine the broadest possible spectrum of evidence from both artifactual and written sources. The following account of the state of current and prospective research on Ottoman medicine is an attempt to identify and assess the relative importance of some underutilized and not very accessible categories of information. From clues

* For the full text see *Bull. Hist. Med.*, 1992, 66: 376-403.

gleaned from a broad array of different source, it may be possible to identify popular attitudes on health and health care issues, and to isolate those elements- apart from the preference for self-administered drug therapy and the avoidance of inessential surgery that can be said to typify the style of Ottoman medicine. Among the potential sources for this study, the following five types of data should be given special consideration:

* Archival evidence, in particular the Ottoman judicial recods, or *kadı sicilleri*, which can serve as a source for official regulations and legislative activity, and for registration of individual complaints
* Autobiographical accounts, personal reminiscences, and the Ottoman biographical literature
* The *atasöz* (folk sayings) collections, poetry, and popular theater; that is, the literary evidence
* Rural medicine and folk practices and beliefs as documented by field observation, collection of the material evidence (e.g., artifacts such as written charms and amulets), and oral histories;
* The travel literature, a corpus that has a particular value for the study of Ottoman medicine because of the fact that the travelers, in their search for the exotic and unusual, were likely to comment in detail on matters that Ottoman sources passed over without mention as either common knowledge or unimportant.

It is valid, I believe, to speak of the Ottomans as having developed something that in its approach and spirit -though not, of course, in its content or methods- was very close to modern holistic medicine. In both, the emphasis is placed upon the triad of body, the mind, and the environment. The Turks also emphasized the importance of empathetic care and good bedside manner to the patient's quick recovery; and to my mind it is these aspects of Turkish medicine rather than its much discussed "empiricism" that most typify it. Another characteristic feature of Ottoman medicine is the multiplicity of its sources of inspiration. The Ottomans inherited their medical lore from a variety of different and sometimes antithetical traditions, which included their own Central Asian and shamanistic folk traditions, Hellenistic medicine, Romanized Galenic medicine, and the rich scientific tradition of Middle Eastern and Arab Islamic medicine, in addition to the traditions of their most immediate imperial predecessors in Anatolia, the Seljukids and the Byzantines, both of whom possessed well-developed health care systems of their own. Some of these traditions continued in only superficially Ottomanized form, but the Ottoman tradition was created syncretically from all of these disparate elements, and was uniquely interpreted and blended for application according to the Ottoman's own cultural and pragmatic priorities.

Insufficient attention has been paid to identifying those aspects of Ottoman medical lore which bore a uniquely Ottoman stamp. Unavoidably, during the long historical period between roughly AD 1300 and 1900, there arose from eternal as well as axternal sources much that was new, and these novel aspects deserve more thorough investigation and treatment than they have received to date. As I have attempted to show, once we have sufficiently broadened our focus it may be possible to reconstruct a more balanced view of the Ottoman physician's world and to describe the nature of his connection with the social environment in which he operated.

An Ottoman professor of botany: Salih Efendi (1817-1895) and his contributions to botanical education

Feza Günergun - Asuman Baytop

Although botany was not included in the curriculum of the *medrese*, the classical Ottoman institution of learning and education, the Ottomans were acquainted with botanical knowledge, especially with the properties of medicinal plants through the translations based on Ibn el-Baithar's *El-Müfredat* (Traité des Simples), Dioscorides' *Materia Medica* or Avicenna's *Kitab el-Nebat* (Book of Plants).

The teaching of botany started in Turkey within the medical education in the first half of the nineteenth century. In the early years of Tıphane-i Amire (State School of Medicine, est. 1827), the Turkish and Arabic names of plants were taught to the first year students. In 1834, a course titled İlm-i Nebat (Botany) had been added to the program of the fourth year. In the Mekteb-i Tıbbiye-i Şahane (Imperial School of Medicine) established in 1839, botany was initially lectured in the first grade by the Austrian physician Dr.C.A. Bernard, director of the same school. As the teaching was in French, botany courses were also given in French and Dr. Bernard's book *Elémens de Botanique* (1842) was used by the students. This book, written in French, on the basis of A.Richard's system, is the first textbook of medical botany published in Turkey.

The teaching of botany at the Imperial School of Medicine was carried on by Salih Efendi, a meticulous and diligent student of Dr. Bernard. Indeed, Salih Efendi started teaching "Ilm-i Nebatat" (Botany) even before graduating and took part in the establishment of a botanical garden within the school. In 1843 he was among the first graduates of the Imperial School of Medicine and received the title of "Docteur en Médicine et en Chirurgie". After C.A.Bernard's death in 1844, he was appointed to teach botany at the Imperial School of Medicine.

In addition to his post as professor at the Imperial School of Medicine, Salih Efendi was appointed as the "Hekimbaşı" (the chief physician) to the Sultan. He was also appointed twice to the directorship of the Imperial School of Medicine in the years 1849 and 1865. He also served as a councillor to the Ministry of Education and the Ministry of Trade as well as member and chairman of various state offices and assemblies. He chaired the International Health Congress held in Istanbul in 1865. He received the "Bâlâ" degree and was conferred with medals of honour by foreign states such as France, Prussia, Portugal, and Spain.

Despite his several administrative posts, Salih Efendi never gave up teaching botany. He translated a book on natural sciences in 1865 and prepared its second edition in 1872. After being retired from the Imperial School of Medicine, he carried on lecturing botany for many years at the Mekteb-i Tıbbiye-i Mülkiye (Civil School of Medicine). He gave natural history courses at Darülmuallimin and Darülfünun, Ottoman institutions founded for training teachers and the general public. He arranged the garden of his house in Anadoluhisarı as a botanical garden and grew various kinds of plants and fruit trees. He died in 1895 in this house which is still one of the most beautiful waterside residences on the Bosphorus.

The aim of this paper is two-fold. The first is to introduce Salih Efendi, an Ottoman physician and buraucrate reknown for his keen interest in plants and his contributions to the teaching of modern botany in Ottoman Turkey. The second is to review briefly the botanical section of Salih Efendi's book *İlm-i Hayvanat ve Nebatat* (Zoology and Botany, first printed in 1865) to find out the original book it was translated from; and then to bring to light its second modified edition made in 1872.

As far as we know, the botanical section of *İlm-i Hayvanat ve Nebatat* is the first illustrated text on systematic botany published in Turkish. Beside, it is the first book in Turkish used in the teaching of botany. Salih Efendi probably used this book in the botany courses he gave at the Civil School of Medicine (est. 1867) and in the natural history courses he taught in the Darülfünun.

İlm-i Hayvanat ve Nebatat (1865) consists of 90 pages and 25 plates with illustrations. As Salih Efendi explains in the foreword, the book contains a lot of illustrations and the text is rather short, for it was intended for general use and especially as a textbook for secondary schools. 54 pages (p. 4-57) are devoted to the zoology and the last 32 pages (p.58-89) deal with botany. Annexed to the text, there are 18 plates (plates 1-18 including 184 figures) about animals and 7 plates (plates 19-25 with 106 figures) on plants. The total number of figures in the plates are 290. Under each figure, the Latin name of the plant in the Latin and Arabic characters, its Turkish name and Turkish family name are given. If any figures of plant sections are added, these are also explained.

After a brief introduction, where subject matters of zoology, botany and mineralogy are discussed, comes a chapter on general botany where cells, tissues, the vegetative organs (root, stem and leaves) and sexual organs are discussed. The French names in Latin characters of these organs and tissues together with their Turkish names are given. The number of French terms in the whole book is around 70. In the following pages (p.69-89) artificial and natural classifications of plants are discussed and the systems of Linné and Jussieu are introduced.

Research we made at Heidelberg University Library in June 1995, enabled us to determine that the book translated by Salih Efendi was Dr. Carl Arendts' (1815-1881) *Éléments d'Histoire et de Technologie à l'Usage de la Jeunesse.* The latter was translated into French by Dr. Royer from the *Arendts' Naturhistorischer Schulatlas.* When Arendts' French edition is compared to *İlm-i Hayvanat ve Nebatat,* it is clear that Salih Efendi translated only the zoology and botany sections and added the related 25 plates to the end his translation.

İlm-i Hayvanat ve Nebatat (1865) was republished seven years later in 1872 in İstanbul. The 1872 edition starts directly with a chapter titled "Usul-i Menakıb-ı Tabiiyat" meaning natural sciences. As this title entered the library and book catalogues as the title of the book, it has not been realized that this was a new edition of *İlm-i Hayvanat ve Nebatat* (1865) and was regarded as a distinct work by Salih Efendi. Thus we introduce here this second book of Salih Efendi's, dated 1872, to the botany literature as the second edition of *İlm-i Hayvanat ve Nebatat.*

When the two editions are compared, the first point that strikes the reader is that the all Latin and French botanic terms written in Latin characters in the first edition are eliminated in the second. Secondly, there is a preference to use Turkish syntax instead of the arabic one. The removal of the French and Latin equivalents of Ottoman botanic terms from the text by Salih Efendi should be evaluated within the attempts undertaken by Turkish physicians to establish the medical education in Turkish. The second edition of Salih Efendi's book came out just at the time of serious discussions between the Turcophone and Francophone physicians. The elimination of French and Latin terms by Salih Efendi reflects the support he brought to the medical teaching in Turkish.

Salih Efendi, reflects perfectly the cultural and scientific transformation which occured in the Ottoman world throughout nineteenth century. Born in the second decade of this century, he probably was educated in the madrasa, the classical Ottoman institution of learning where he excelled in Arabic. He studied in the Imperial School of Medicine founded in 1839 where the teaching was in French. His duties in educational institutions, as well as the lack of a botany book in Turkish, led him to write a book focusing on general and specific features as well as introducing the important principles of botany. The translation he made from C.Arendts' book on natural history is published in Istanbul in 1865. It contains the first Turkish text on systematic botany. The second edition made in 1872 represents the change occured in the teaching language in medical education where Turkish replaced French. In coining new scientific terms, he followed his contemporaries by using Arabic vocabulary. Thus Salih Efendi's career is a concrete example illustrating the transformation in which Islamic and European scientific traditions were concurrently present.

Teaching of botany, zoology and geology in the Darülfünun and Istanbul University Faculty of Science between 1900-1946

Sevtap İshakoğlu

Although books dealing with natural sciences were taught in the madrasa, the regular teaching of natural sciences in Turkey originated within medical education in the nineteenth century. Zoology, botany and geology were taught as supplementary courses to students of medicine, veterinary, pharmacy and dentistry. These courses were mainly taught by physicians. In the Darülfünun, established in 1863, zoology, botany and geology were taught in lectures called ilm-i mevalid (natural sciences).

This article aims to give a detailed account of the teaching of natural sciences in the Darülfünun and Istanbul University within the period 1900-1946, including the course schedule, chairs and the teaching staff, and research activities. Based on information collected so far, it is clear that courses on zoology, botany and geology were given in the Darülfünun-ı Şahane (Imperial Darülfünun) prior to the 1933 University Reformation. Their teaching as regular courses started in the Ulum-ı Riyaziye ve Tabiiye Şubesi (Department of Mathematical and Natural Sciences) established in 1900 and carried out later on in the Darülfünun Faculty of Science.

During World War I, German professors of botany, zoology and geology namely Leick, Boris Zarnick and Walter Penck were recruited in the Darülfünun. Beside contributing to the teaching of natural sciences, these scholars undertook also research and field studies. After foreign scholars left in 1918, research and educational activities were carried on by their Turkish colleagues. Among scholars brought to the Faculty of Science in 1926 from France, there was also a professor of zoology, namely Raymond Hovasse. After the University Reformation in 1933, the staff of the botany, zoology and geology chairs were dismissed and new Turkish and foreign scholars were recruited. In this reorganisation, the administration of botany and zoology chairs were entrusted to foreign scholars (L.Brauner, A. Heilbronn, A. Naville) whereas a Turkish scholar, Hamit Nafiz Pamir, became the head of the geology chair.

Following the Reformation, the chair of botany was divided into two new institutes. The first institute was called Umumi Nebatat Enstitüsü (Institute of General Botany) headed by Leo Brauner. The other was the Farmakobotanik ve Genetik Enstitüsü (Institute of Pharmacobotany and Genetics) directed by Alfred Heilbronn. Professor Andre Naville was appointed the director of the zoology chair. After his death in 1937, he was succeeded by the German professor Kurt Kosswig.

With the 1933 reformation, Ph.D studies started to be conducted for the first time in the Faculty of Science. In the period covered, a total of nineteen Ph.D theses were prepared under the supervision of foreign scholars in natural sciences -eight in botany, six in zoology and five in geology. The majority of students who completed their Ph.D. studies between 1933-46 carried on their academic life in the Faculty of Science and later became members of the teaching staff.

Although there had been a few individual efforts in conducting research in natural sciences during the 19th century Ottoman educational institutions, these efforts did not lead to a research tradition. Research based studies started in the Darülfünun from 1914 on with the field studies conducted on Anatolian fauna and geology. This bias toward research amplified with the new organisation and staff implemented by the 1933 University Reformation.

Dr. Şerafettin Tevfik Tertemiz (1879-1957) and his publications on botany

Asuman Baytop & Feza Günergun

Dr. Şerafettin Tevfik (Tertemiz) was botany lecturer at the Istanbul Darülfünun between 1909-1933. Graduated from the Civil School of Medicine in 1903, he practised medicine for a few years in Beirut and in Bartın. Having returned to Istanbul, he first became assistant to Dr. Esad Şerefeddin (Köprülü) (1868-1942) and then a professor of botany at the Civil School of Medicine. From 1909 on, he taught botany at the schools of pharmacy and dentistry within the Darülfünun. He retained in this position until the University Reformation in 1933. He retired in 1934 living thereafter as a physician and dealt no more with botany.

His publications on botany consist of four textbooks on pharmaceutical botany and an article: *İlm-i Nebatat-ı Tıbbîden Mebhas-ı Ensice* (İstanbul 1910, 109 pp.); *İlm-i Nebatat-ı Tıbbîden Mebhas-ı Tasnif-i Nebatat* (or *İlm-i Nebatat-ı Tıbbî / Botanique Medicale)* (İstanbul 1910, 446 pp.); *İlm-i Nebatat / Botanique* (İstanbul 1340, 208 pp.); *Tıbbî Nebatlar / Botanique Medicale* (İstanbul 1932, 276 pp.); "İlm-i Nebatat hakkında konferans", *Genç Kimyager* (Nr.1,2,3,4,5, 1337/1920).

The first book is a collection of his lectures jointly edited by four of his students. It only deals with descriptive botany. The other three are written by Dr. Şerafettin himself. The second book treats the medicinal plants in a systematic sequence and includes both the Spermatophytes and the Cryptogams. The third is apparently the second edition of the first, while the fourth is a re-edition of the second, but in Latin characters and without Cryptogams. The article by Dr. Şerafettin which appeared in five successive issues of *Genç Kimyager* (Young Chemist) is the full text of a conference he gave on spontaneous generation. A particularity of Dr. Şerafettin's books is that they included the Latin and French equivalents of all family names and most botanical terms as well as the names of active chemical compounds.

Although he has not attempted to inititate any scientific research in this field, Dr. Şerafettin was a dedicated teacher of botany. The textbooks he prepared for the schools of pharmacy and dentistry, the emphasis he gave to practical courses in teaching botany, and his endeavours for the foundation of a botanical garden in Kadırga are all indicative of his devotion to botanical education.