

# Textual Research on Dioscorides and *De Materia Medica*

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## Abstract

The Greek pharmacologist Dioscorides's *De Materia Medica* is one of the greatest works in the history of Greek-Arabic Traditional Medicine, and also is an essential medical textbook and pharmacological standard in Europe. This paper studied the historical background, academic characteristics, editions, and significant contributions to traditional medicine of *De Materia Medica* and Dioscorides. It was concluded that the book has substantial scientific importance and remarkable cultural attributes. *De Materia Medica* of Dioscorides has both nourished world traditional medicine and promoted the communication and development of medicinal knowledge worldwide. It is significant for us to explore further the related understanding of traditional medicine, history, society, and culture.

## Keywords

*De Materia Medica*, Dioscorides, Traditional Medicine

## 1. Introduction

*De Materia Medica* is a traditional Greek medical book written between 50 and 70 AD by Pedanius Dioscorides, a famous pharmacologist in Greek history. It was used in medicine in the Middle East as soon as it was introduced in the second half of the 1st century AD, and its influence gradually expanded. Undoubtedly, *De Materia Medica* was a well-known and influential work throughout the Roman, Byzantine, Arab and early European eras, guiding the development of medicine and herbalism in the Mediterranean and Europe. It had been the ultimate authority on pharmacology in Turkey and Spain until the 19th century, and it was the foundation for an extended period in the fields of medicine

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and pharmacology, with unquestionable authority. It also formed the basis of modern botany, establishing the link between botany and medicine, and giving rise to what we know as herbal medicine and to disciplines such as ethnobotany. So far, it is also of excellent research significance and reference value for our understanding of the development of natural sciences in ancient times.

## 2. Dioscorides and *De Materia Medica*

### 2.1. Introduction of Dioscorides

In the 1st century AD, Dioscorides (c. 40-90 AD) was a pharmacologist and botanist from Anazarbus, a small town northeast of the Roman city Tarsus in Cilicia (Türkiye) [1]. He was interested in various natural substances for medicinal purposes and might have served as a military doctor or in a related position in the Roman army. So he had access to the entire eastern half of the Greek-speaking Roman Empire in his livelihood during travels, and possibly visiting Greek communities in Sicily, southern Italy, or perhaps southern Gaul, mainly along the present border between Turkey and Syria.

Dioscorides had received professional training, read various authoritative writings, and observed deeply in the habitats of widely available medicinal plants and other resources. Instead of blindly following the conclusions and hearsay of his predecessors, he conducted rigorous scientific exploration, not explaining the action of drugs in terms of philosophical theories but focusing on the drugs themselves and the empirical data of therapeutic applications. He exchanged experiences with local people talking about the use of drugs to gain knowledge, combined with personal investigations and experimental research, which led to the understanding of the effects and actions of natural medicines on human beings and the acquisition of scientific and reliable pharmacological information. These experiences enabled him to write the oldest and most valuable five volumes of the history of botany and pharmacology in Greek, *De Materia Medica*. When discussing specific claims and practices that were not personally practiced but merely “hearsay”, Dioscorides often uses terms, such as, “they say,” “it was said,” “it seems,” and so on, as opposed to scientific conclusions reached through his observations and research. These valuable characteristics demonstrate Dioscorides’ outstanding scientific spirit.

### 2.2. Introduction of *De Materia Medica*

*De Materia Medica* by Dioscorides was written around 65 AD, which systematically contains essential information, medical uses of about 600 species of plants, 35 species of animals, and 90 species of minerals, covering more than 1000 medicines made from these species and more than 4700 non-medicinal uses. The whole book was divided into five volumes: Book 1 on aromatic plants, ointments, sap, resins, gums, fruit trees, etc.; Book 2 on animals (including shellfish, insects, spiders, snakes, birds, etc.), honey, milk, grains, etc.; Book 3 on roots, stems and juices of herbs, etc.; Book 4 on other herbs and roots, etc.; and Book 5 on vines, wines, and minerals, etc. [2].

This monumental work found a certain similarity between its writing style and modern scientific writing, with concise language and scientifically rational classification methods, which were organized according to the nature of the drugs while abandoning the traditional alphabetical arrangement for easy memorization and use of reference. With these various considerations and orderly organization, his work was characterized by its noble scientific, guiding, and practical qualities.

In the preface, Dioscorides described the main points about the collection and storage of drugs in a few words and the standard of pharmacy regulation that still has essential guidance today. The text uses a scientific and rigorous narrative method, accurately depicting the origin, species origin, trait characteristics, harvesting time and location, processing, storage, use parts, dosage, authenticity, compounding, indications, etc. The drugs' color, appearance, odor, and taste were recorded truthfully, and the description of what was of good quality and how to adulterate was also highlighted. Of course, the identification of animals was not easy to be confused. Therefore most of them needed to be more detailed than the description of botanical drugs, while mineral drugs were mainly described in terms of geographical location and preparation methods. Examples were as follows.

1) Place of origin: From the drugs recorded in this book it was mainly related to species native to Greece, Egypt, Palestine, Syria, Asia Minor, Cyprus, Crete, Sicily, etc.

2) Time and place of harvest: The medicinal plants contained in this book were mainly from the *Asteraceae*, *Umbelliferae*, *Labiatae*, *Leguminosae*, and *Rosaceae*. Dioscorides attached great importance to the timing of plant collection. They suggested that the appropriate parts of the plant need to be collected for medicinal use during its prime, when the plant was robust, before the flowers bloomed, before the seeds grew, or when the fruits were ripe and so on. Similarly, Dioscorides has strict requirements for the season in which materials are obtained, for example, honey collected in winter is considered inferior and causes pimples, while spring is of the best quality and summer the second best. Dioscorides also said that the best places to mine and smelt high-quality ores must be known to obtain the best mineral medicine.

3) Processing: Dioscorides wrote down the processing methods for medicines in a realistic way, either simple or complicated, which was very suitable for operation. From harvesting, sun-drying, shade-drying, grinding, and crushing of conventional botanicals, to refining and preparing olive oil and castor oil, etc., it was extremely instructive for others to prepare them as they do. It also recorded dozens of wine-related preparation processes, technical details, flavoring methods, and medicinal values.

4) Storage: Dioscorides, in his preface, emphasized that flowers and scented materials should be stored in dry lime wood boxes, that all containers made of silver, glass, or cows horn were suitable for holding medicinal solutions, other containers such as earthenware or boxwood were equally suitable. Copper containers were suitable for eye drops, and all preparations were made of vinegar, raw pitch, or Syrian cedar oil, but hard fats and bone marrow should be stored in

tin containers.

5) Drug quality: Dioscorides focused on the quality of the drug and put forward the precautions for authenticity identification. For example, he described in detail what was quality of saffron from the origin, appearance, color, feel, and smell of the drug, pointing out that saffron was easy to be artificially mixed with debris residue or even gypsum and other mixtures to increase the weight, and coated with grape juice to disguise; and proposed that frankincense should also pay attention to whether it was mixed with impurities such as club moss resin.

*De Materia Medica* covers many drug dosage forms, including ointments, enemas, suppositories, and other important pharmacological dosage forms still in use. The book records over 1000 treatment methods, with a broad range of indications for clinical diseases covering various medical fields. The symptoms and diseases it targets were largely consistent with the treatment range of general practitioners.

As a contemporary of the ancient Roman scholar Pliny the Elder (Gaius Pinius Secundus 23/24-79 AD), Dioscorides provided detailed information on plants, animals, etc., in his *De Materia Medica*, similar to the encyclopedia *Historia Naturalis*, but more systematic and practical. *De Materia Medica* and the *Historia Naturalis* became an important source of documentation on medicines in the early Roman Empire. Thus, the book belongs to pharmacology and has an important natural history value, encompassing knowledge of all aspects of life. It was recorded that wild olive oil can be applied daily for skin care and hair care, delaying the production of gray hair; saffron was used for dyeing from early times. The small green wood of the mucilaginous frankincense tree of the *Anacardiaceae* can replace toothbrushes for wiping teeth, and the leaf juice can be used to clean the mouth by making mouthwash. Furthermore, the decoction of its leaf juice was sticky. It can be used to fill cavities (used as tooth-filling material in Western medicine) and as a thickening agent, and its resin also has various applications. In addition, there were also records of a wide variety of cleaning and beauty products, hair dyes and additives, etc. The content was comprehensive and rich.

### 3. Studies on the Circulation of Editions of *De Materia Medica*

The *De Materia Medica* by Dioscorides was a glorious chapter in the history of Islamic scholars with far-reaching historical implications. It has been the authoritative standard for the sources and preparation of medicines for over a thousand years (Table 1). Its contents have been widely copied, edited, and translated into different languages. By the end of the 15th century, many manuscripts and translations in Greek, Latin, Syriac, Arabic, and other languages were produced, some interrelated, and further circulated. Dioscorides was organized into five books according to drug affinities, while later revisions were reorganized and arranged chiefly in alphabetical order; the original edition of the *De Materia Medica* was without illustrations, and various editions containing different styles of illustrations were gradually created in later times.

**Table 1.** Examples of editions of *De Materia Medica*.

Period	Edition	Language	Availability of Illustrations	Collection/Publication Information
65 AD	<i>De Materia Medica</i> by Dioscorides	Greek	No	Anonymous
512 AD	Vienna Codex (Vienna Transcription)/Juliana Anicia Codex (Transcript of Juliana Anicia)/Codex Vindobonensis	Greek	Yes	Austrian National Library, Vienna
About 600 AD	Codex Neapolitanus	Greek	Yes	Naples National Library
About 9th century	Dioscorides Longobardus	Latin	Yes	Munich National Library
Between 847 and 861 AD	Translation by Stephanos, Revised by Hunayn	Arabic	No	Library of the Suleiman Mosque (date unknown); Bibliothèque Nationale de Paris (1219)
Between 927 and 985 AD	Pierpont-Morgan transcription Pierpont Morgan manuscript	Greek	Yes	Pierpont Morgan Library, New York
990 AD	Translation by Hunayn, Stephanos, revised by Hunayn, Natili revised again	Arabic	No	Anonymous
1083 AD	Leiden Manuscript, Hunayn, translation by Stephanos, revised by Hunayn, a later copy of Natili's revised version	Arabic	Yes	Leiden University Library
Unknown, for Najm al-Din Alpi, who reigned from 1152-1176 AD	Mashhad's original manuscript Hunayn translated from Greek into Syriac, and Mihran ibn Mansur further translated into Arabic	Arabic	Yes	Holy Mausoleum Museum of Imam Reza, Mashhad
1461 AD	Mashhad manuscript copy	Arabic	Yes	Topkapı Palace, Istanbul
1544 AD	Matthioli first edition (1507-1577)	Italian	No	Published in Venice
1572 AD	Matthioli French edition	French	Yes	Sibbald Library
Between 1652 and 1655 AD	John Goodyer English edition	English	No	Unpublished
Between 1904-1916 AD	Pedanii Dioscuridis Anazarbei De Materia Medica Libri Quinque (Max Wellmann Greek edition)	Greek	No	Reprinted in Berlin, Germany, 1958
1934 AD	Published by Robert T. Gunther from a manuscript by John Goodyer	English	Yes	Hafner Publishers, New York, and London reprinted 1959, 1971
2000 AD	The Herbal of Dioscorides the Greek (Tess Anne Osbaldeston English edition)	English	Yes	Ibidis Publisher, Johannesburg, South Africa
2005 AD	<i>De materia medica</i> (Lily Y. Beck English edition)	English	No	Georg Olms Verlag, New York, four editions between 2005 and 2020

### 3.1. Vienna Transcripts

The illustrated Vienna Codex (the Juliana Anicia Codex, or Codex Vendobon), also known as the Constantinople Codex, was produced in Constantinople around 512 AD then was elaborately illustrated by Byzantine artists for the *De Materia*

*Medica* and presented to Princess Juliana Anicia of the Western Roman Empire as a gift [3]. The Vienna Codex is the best of all Byzantine manuscripts of the *De Materia Medica*.

With a total of 383 lifelike botanical illustrations, the Vienna Codex was the earliest preserved exquisite drawing of Dioscorides' *De Materia Medica*. All the illustrations were presented as refined and naturalistic, showing a naturalism difference from the Byzantine art of the time. Some studies have shown that these high-quality illustrations were not original and were not done by one person [4]. The comparison of the illustrations with modern plants showed a striking similarity, indicating that our plant forms have not changed much over the last thousand years and that they were botanically more stable genetically [5].

### 3.2. Leiden Manuscript and Mashhad Manuscript

With the rise of Arabic medicine in the 5th-12th centuries, the *De Materia Medica* became popular in eastern Arabia around 854, coinciding with the centenary translation movement of the Abbasid dynasty in the Arab Empire. Stephanos of Baghdad translated it from Greek into Arabic, and numerous Arabic translations subsequently sprang up [6], an excellent example of its widespread use in the Islamic world. Hunayn ibn Ishaq (809-877 AD), the most excellent translator in the history of Arab culture, translated the *De Materia Medica* from Greek into a Syriac version; later, Hunayn and Stephanos made another translation from Greek to Arabic, and this work circulated the Islamic world for nearly a century with significant influence.

By 990 AD, al-Natili, the teacher of the famous Arabian physician Avicenna, had collated and embellished the work jointly translated by Husnain and Stephanos, making the text accessible, fluent, and linguistically beautiful. He illustrated and dedicated the manuscript to Abu Ali al-Simjuri, the governor of Khorasan. Although the original work was lost, the famous Leiden manuscript was a later copy of it.

The Leiden manuscript was the most complete surviving Arabic manuscript and the earliest to be illustrated. It contains seven volumes with 620 illustrations, of which 467 were of plants, 75 of trees, and 78 animals. The Leiden manuscript was a collection of scientific, artistic, and literary texts that helped us to study and appreciate Islamic culture and civilization.

In terms of Arabic translations, the best was undoubtedly the Mashhad manuscript and its copy in Istanbul, further translated from the Syriac version of the Husnain. The Mashhad manuscript contains five volumes of text and elaborates illustrations, translated by Mihran ibn Mansur, best known for his translations of Aristotle's works. In Diyar Bakr, in south-eastern Turkey, Mihran completed this work and dedicated it to King Najm al-Din Alpi (reigned 1152-1176 AD).

### 3.3. Matthioli Translation

Born in the central Italian city of Siena, Pier Andrea Matthioli (1500-1577 AD)

was a renowned botanist and physician who devoted himself to studying medicine and botany. He was the most important and renowned commentator on Dioscorides and his works during the Renaissance.

Through the help of de Busbeck, Matthioli could borrow the Vienna codex before it entered the Vienna National Library and carry out an in-depth study. Firstly, Matthioli identified the plants recorded in Dioscorides and added some 600 new medicines to the original, including plants imported from the New World, such as peppers, greatly enriching the herbal medicine of the ancient Mediterranean, as well as adding 562 woodcut illustrations. Secondly, Matthioli conducted human trials to determine the lethality threshold of toxic plants, using scientific data to promote the book's important impact on medical progress [7] [8].

### 3.4. Goodyer's English Translation and Osbaldeston's English Translation

The English botanist John Goodyer (1592-1644 AD), based on an earlier printed version, completed a four thousand five hundred pages English translation of *The Greek herbal of Dioscorides* by hand over a period of three years (1652-1655 AD). This was the first English translation of the *De Materia Medica*, but it was not published then, and the work was eventually bequeathed to Magdalen College, Oxford [9]. Until 1933 AD, the book was edited by Dr. Robert T. Gunther, librarian of Magdalen College. The English translation retains Goodyer's medieval English text with 396 illustrations (copied from the Vienna codex), then first printed and published by the Hafner Press in New York and London and reprinted in 1959, 1971 [10]. The book fills a gap where there was no English version, but in the process, Goodyer neglected to correct it against the Greek version.

A new English translation of Tess Anne Osbaldeston's *De Materia Medica* was published in South Africa in 2000. Osbaldeston used Gunther's edition as a base for the new translation, translating the medieval English of Goodyer into readable, contemporary English. *The herbal of Dioscorides the Greek* was shown in the colophon, echoing the title of Gunther's translation, and the book was marked 'Being an herbal with many other medicinal materials.' This showed that the information in the colophon had been supplemented by including more than just medicinal plants. The text gave many possible names of plants, animals, or minerals, with fine illustrations and a helpful index, and was of some scholarly value to the history of ancient medicine and related scholarship [11]. However, this edition was somewhat controversial in academic circles because it does not refer to the original Greek version.

### 3.5. Wellmann's Version and Beck's English Translation

The various Greek manuscripts on Dioscorides were numerous and intricately interconnected. There needed to be more content, substitutions of synonyms, and errors caused by the scribes. It makes restoring the work to its original form

very complex, laborious and requires much critical skill. Professor Max Wellmann in Berlin worked hard on it (1906-1914 AD). He collated the text from the cumbersome extant edition of Dioscorides' *De materia medica*, corrected spelling errors, filled in some important manuscripts, and published three volumes of the critical Greek text, the most authoritative edition available, which was reprinted in 1958 [12].

Professor Lily Y. Beck brought a modern English translation of *De Materia Medica* in 2005. Out of avid interest in the book's outstanding scholarly value, Professor Beck devoted herself to this challenging task after retirement, carefully selecting the Greek text edited by Max Wellmann for its preparation and releasing four consecutive editions between 2005 and 2020. The readership mainly was scholars of traditional medicine, ethnobotany, pharmacology, history, etc., and the influence of the academic community was evident. Thanks to her solid botanical foundation, Professor Beck's translation also showed the best thinking about the Greek text regarding linguistic variation in scientific and technical terminology, mastery of botanical knowledge, and identification of plant species (based on the latest research in Greco-Roman botany).

Given the enormous influence of Dioscorides' *De materia medica*, there were countless important editions and related works based on or derived from it, such as Ibn Juljul (944-994 AD), the famous 10th-century Spanish court physician, who published *Tafsir Asma' al-Adwiya al-Mufrada min Kitab Dioscorides* (*The Explanation of the Simple Medicines in the Book of Dioscorides*). What was listed in this study was only a drop in the ocean. The scientific guidance of the *De Materia Medica* has been universally accepted and assimilated during its transmission, and the various editions produced over the millennia have contributed to the continuous progress of traditional medicine.

#### **4. Dioscorides and the Important Influence of the *De Materia Medica* on Traditional Medicine Worldwide**

In order to wipe out diseases, plants, animals, minerals sources of medicines with local characteristics have been discovered, thus giving birth to distinctive and relatively independent system of traditional medicine systems and promoting human health and well-being. Traditional Chinese Medicine, Greco-Arabic Medicine, and Indian Medicine continue to play important roles worldwide today. Between the 8th and 13th centuries, Greco-Arabic Medicine, which originated in ancient Greece and Rome and flourished in the Arabian Empire, absorbed the advanced cultures of the time and directly guided the revival of medicine in Europe. Greek-Arabic Medicine spread advanced medical knowledge and technology to all corners of the world. It promoted the emergence or development of other medicines such as Unani, Hebrew, Roman, and Persian. The progress of medicine in the world was strongly promoted. With the help of the Silk Road, it facilitated the spread of *De Materia Medica* and gave a strong impetus to the advancement of medicine in the world.



#### 4.1. *De Materia Medica's* Transcendence of Previous Medical Writings

Many medicines described in Dioscorides' *De Materia Medica* had been used in the Greek world for at least four centuries before he wrote it. But the scale of the medicines recorded was small, with only about 130 drugs in numerous works, and almost all the books on them have been lost. The *Historia Plantarum* by Theophrastus (371-287 B.C.), a disciple of Aristotle and a great botanist, recorded the medicinal plants sought and collected with their efficiency; In the 2nd century B.C., the famous Greek physician Nicander of Colophon (who flourished in 275 B.C.) wrote the *Theriaca, Antidotes*, in which he recorded animal and plant medicines used to detoxify the body, etc. [13]. Dioscorides' scientific and systematic contribution to medicine was more widely recognized and praised than the achievements of Theophrastus, Nicander, or even Pliny, the Elder.

#### 4.2. Influence of *De Materia Medica* on Subsequent Medical Writings

Dioscorides' achievements have influenced many scholars and their medical writings. Galen highly praised the *De Materia Medica* and partly quoted it in his works. The centuries-long translation campaign of Persian, Indian, Greek, Roman, and other scholarly texts into Arabic peaked during the Abbasid caliphate, the second dynasty of Arabia, to consolidate Islamic rule and prosper the scientific and technological culture. Thus the treasures of human civilization and science have been preserved and developed. It was also thanks to such brilliant medical translators as Hunayn that later generations were able to draw on the experience of Greek Medical civilization, create the conditions for Arab scholars to study the *De materia medica*, and produce a large number of relevant works. It can be said that Dioscorides' achievements influenced most of the medical practice and writings of Arab physicians from the 9th to the 17th century. *The Canon of Medicine*, a glorious chapter in the history of Islamic scholarship, was written by Avicenna (980-1037 AD, the most famous Arab medical writer and Muslim philosopher) [14], and *the book of medicinal and nutritional terms* written by Ibn al-Baitar (1188-1248 AD), the most remarkable medieval medicinal botanist), both made extensive references and quotations from the *De materia medica*, from content to the form of presentation. Ibn al-Baitar even drew on all five volumes of the original text [15] [16].

Thanks to the Harakah al-Tarjamah in the Islamic golden age, which allowed the near-extinct Greco-Roman writings to reappear in the West. In addition, the ancient Arabic codes and records were translated into Latin during the great Spanish-centered translation movement. Meanwhile, in southern Italy and Sicily, there were also ancient Greek classics translated directly into Latin. The successive arrival of ancient science and culture in Europe positively impacted the progress of European civilization, for example, the spread of medicine. Until the late 19th century, many Greek and Arabic medical books continued to be used as

medical textbooks, pharmacopeias, and norms in medical education in Europe. More than 40 medicines recorded by Dioscorides in the 1st century AD were still preserved today in the modern official pharmacopeias of civilized Europe, including almonds, aloe vera, fennel, chamomile, cinnamon, gentian, ginger, juniper, myrrh, olive oil, pepper, mint, poppy, and rhubarb, which have far-reaching effects [17].

### 4.3. Dissemination of *De Materia Medica*

The medical knowledge of ancient Greece, which followed Arabic-Islamic Medicine through The Silk Road, was also introduced to China one after another. The Yuan Dynasty's *Hui Hui Pharmacopoeia* was an encyclopedia on Hui Medicine resulting from the exchange and fusion of Arabic Medicine and Traditional Chinese Medicine. The book draws on the best techniques from Greco-Arabic Medicine and contains a wealth of medicines and prescriptions, many of which come from the works of Dioscorides, Avicenna, and Ibn al-Baitar [18] [19]. According to *the book of medicinal and nutritional terms* written by Ibn al-Baitar, some of the medicines recorded in the *Hui Hui Pharmacopoeia* have already been described and analyzed in *De materia medica*. In the content, lavender is called Itsukhdns and it is also called by Dioscorides in the third chapter as Sanjadus, the name of an archipelago [20].

The Mattioli translation of the *De Materia Medica*, now collected in the National Library of China, was introduced by European missionaries around the beginning of the 17th century, with the notes in the book showed that the plants and illustrations recorded had been studied by matching and recording them with Chinese plant or animal species. Although we cannot confirm the identity and specific purpose of the missionaries and the commentators, the communication and exchange between China and Europe in terms of culture, technology, and natural history were undoubtedly produced [21]. In different periods of history, Traditional Chinese Medicine has always been open and tolerant in absorbing and nourishing the World's Traditional Medicinal knowledge while enriching and improving its theories and systems. Frankincense, myrrh, and saffron, included in the *De Materia Medica* nearly 2000 years ago, are still commonly used in Chinese medicine today.

## 5. Conclusion

Dioscorides' *De Materia Medica* was the foundation of modern botany and contributed to establishing links between botany and medicine. For more than a thousand years from its inception, the *De Materia Medica* was widely circulated and used, shining in Arabic Traditional Medicine, then disseminated and passed on as an authoritative work and medical textbook. It laid the foundation of Western pharmacology, nourished traditional medicine worldwide, and promoted the interchangeable dissemination and development of medicinal knowledge. Accompanying the progress of human civilization and in the course of the gradual

flourishing of science, it has produced a wealth of multilingual and multi-styled editions as an important marker of the progress of human civilization in science, technology, culture, and art, reflecting the exchange of medical and human society over more than a thousand years. Given its scientific importance, the associated study will help us to explore the knowledge of traditional medicine and ethnomedicine. Also, it will provide practical guidance for excavating and collating exotic drugs and verifying their names and facts.

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### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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