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Inorganic Ingredients in Aelius Promotus' Dynameron - Relevance to Current Scientific Data

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ABSTRACT

Inorganic Ingredients in Aelius Promotus' Dynameron

The Dynameron of Aelius Promotus is a manuscript written in Greek, with 130 chapters devoted to the therapy of various diseases. The author was a physician, who lived in Alexandria, presumably in the turn of the 1st to the 2nd century AD. The 830 recipes of Dynameron contain information for the preparation of composite medicaments, with 484 ingredients of herbal (288), animal (133), or inorganic origin (63). Inorganic ingredients are present in about 700 recipes concerning mostly topical preparations for ailments of the skin, the genitals, the eyes, the ears, the nose and the mouth. These applications are supported by modern scientific data proving the antibacterial action of the inorganic substances used. There are also examples of cataplasms on the chest and the abdomen, intended to treat diseases of the respiratory or the peptic system. Recipes for internal use are rare. Even rarer are recipes for mouthwashes, enemas and fumigations. The inorganic ingredients present in Promotus' Dynameron have been evaluated in comparison with earlier medical authors, like Hippocrates and Dioscorides, and also with the content of other treatises of late antiquity and Byzantium.

Key words: Aelius Promotus - Dynameron - Inorganic remedies - Alexandrian medicine

1. Introduction

The present study focuses on the use of inorganic substances, such as chemical elements, mineral salts and earths, in medical practice during the era of the Imperial Rome (1st-3rd century AD). Relevant information was traced down in a Greek therapeutic manual, entitled *Dynameron*, which was written by an Alexandrian physician named Aelius Promotus[1].

In the Hellenistic era, starting the 3rd century BC, Alexandria became an important financial and cultural center, gathering competent scientists and physicians from many other places. A central role was played by Ptolemy II Philadelphus and his successor Ptolemy III the Benefactor, who established the Library of Alexandria and also allowed and encouraged anatomical studies by dissection of the human body[2]. Having adopted the basic Hippocratic principles, Alexandrian medicine developed new theories and accomplished a remarkable progress in anatomy and physiology[3]. Many archaeological findings show the existence of a large variety of elaborate surgical instruments, made mainly of bronze[4].

Characteristic of that era is the prevalence of the so-called Empiric school of medicine, which pursued therapies with the combination of numerous different remedies, believing that by doing so they learn through experience[5].

Many famous physicians lived and worked in Alexandria or visited the city for a certain time. It has been documented that also Galen (c. 121-200 AD) travelled to Alexandria, in order to complete his medical education[6]. Having lived in a period of vivid and divergent scientific theories and arguments, Galen was able to combine the knowledge of all schools of medicine that preceded him. This is the reason why his work has been attributed to the so-called Eclectic school of medicine, which was initially introduced by Archigenes of Apamea[7].

According to his treatise entitled *Dynameron*, Aelius Promotus lived and worked as a physician in Alexandria. The manuscript starts with the sentence *Αἰλίου Προμώτου Ἀλεξανδρέως Δυναμερόν*, suggesting that the author may have been born in Alexandria. Very little is known about his life, but there are several indications that his book was written in the first half of the second century AD. Except *Dynameron*, Aelius Promotus is the author of a short book with the title: *Therapeutics, physical means and remedies against diseases*[8]. Additionally, an anonymous manuscript with the title: *On venomous animals and poisonous drugs,* has also been attributed to him[9].

In the preface of his manuscript, Aelius Promotus clearly states that he has written *Dynameron* in order to leave a document to the young physicians, with the knowledge and the experience he had gained by practicing medicine throughout his life:

> *After having practiced medicine for many years and having gained remarkable experience and deep knowledge of the power of the various therapeutic means, I have undertaken the task to pass on to you this art, beloved lads, because it would be really unfair to deprive young people of something good* [10].

This is a clear message of an old person ready to retire.
Aelius Promotus has used the Greek language of the late antiquity, known as "koine Hellenike", also as "Alexandrian dialect", "common Attic", "Hellenistic Greek" or "Biblical Greek", which was the common supra-regional form of Greek spoken and written during the Hellenistic period, the Roman Empire, and the Byzantine era. It evolved from the spread of the Greek language, along with the conquests of Alexander the Great in the 4th century BC, and served as the *lingua franca* of much of the Mediterranean region and the Middle East during the following centuries[11]. Several linguistic imperfections in the text of *Dynameron* have been pointed out by expert scholars[12], suggesting that perhaps Greek was not the mother tongue of the author.
In the article that follows, we present and discuss for the first time the inorganic remedies included in Aelius Promotus' *Dynameron*.

2. Material and methods

There exist three known copies of the original text of *Dynameron*[13]. The oldest one (14th century) is a fragment, consisted of only two folios kept in Vatican[14]. In Madrid[15], there is another manuscript with 52 folios, dating back to the 15th century. Finally, another manuscript of the 15th century in Venice[16] is the most complete text, and has been published by Crismani with a critical edition and an Italian translation of the original Greek text[17]. This critical edition was chosen for our research, in order to trace down all relevant information concerning inorganic remedies, their preparation and their application on various diseases according to the therapeutic indications proposed by the author. The number of chapters and recipes mentioned in the present article refer to this edition.
Aelius Promotus' *Dynameron* consists of 130 chapters devoted to various diseases and ailments, with detailed descriptions of 830 recipes containing 484 active ingredients of herbal (288), animal (133), or inorganic origin (63). The chapters do not follow any clear anatomical order (as would be, e.g., from head to feet). It seems more plausible that the author has made an effort to describe the treatment of ailments according to their frequency in the everyday practice of a physician at that time.
Speaking of the historical period during which Aelius practiced medicine, some indirect conclusions can be drawn from three recipes, which are acknowledged to other physicians, namely Soranus[18], Menemachus[19] and Hermogenes[20]. It is documented that Soranus and Menemachus lived and worked in Alexandria during the first half of the second century AD[21]. On the other hand, "Hermogenes" was the name of the personal physician of Emperor Hadrian and most probably accompanied him during his visit in Egypt between the years 128-130 AD[22]. Perhaps to this physician refers Aelius Promotus when he comments on a recipe:

...as my colleague Hermogenes told me from his own experience ...[23],

implying that he had met him in person. If this holds true, it is reasonable to suggest that Aelius Promotus wrote *Dynameron* after 130 AD. In any case, *Dynameron* could not have been written before 117 AD, because it contains a recipe for treating respiratory diseases, which had been used by the troops of Emperor Trajan[24]. We know that Trajan became Emperor the year 98, and he died the year 117 AD, while still in charge of a military expedition against Parthians in northern Mesopotamia[25].

Additionally, in his book on *Composite medicines* Galen describes a collyrium for trachoma acknowledging it as a "recipe of Aelius"[26]. In fact, *Dynameron* contains many ophthalmic recipes, very similar to the one described by Galen. Knowing that Galen had lived for a while in Alexandria, he was very likely to have known the work of Aelius Promotus. Therefore, the first version of Aelius Promotus' *Dynameron* must have been written after 117 and before 180 AD, when it is believed that Galen had started gathering the material for his own books[27].

Aelius Promotus' *Dynameron* could be characterized as a therapeutic index, or a compilation of recipes. As a matter of fact, the word *Dynameron* is relevant to the Greek word *δύναμις* (dynamis, i.e. action of a medicinal product), where also the modern term "pharmacodynamics" originates from. The title *Dynameron*, is also found in the well-known byzantine medical book of Nikolaos Myrepsos, which was written probably in Nicaea of Bithynia, in Asia Minor, during the 13th century[28].

The manuscript edited by Crismani was copied in a monastery of Messina in Sicily upon order of Bessarion (1403-1472), an illustrious Greek clergyman and scholar, who at that time acted as a Cardinal of the Catholic Church in Rome. His collection of manuscripts was donated by him to the Senate of the Republic of Venice, in 1468, and was eventually incorporated into the famous St Mark's library. Bessarion's collection contained 482 Greek and 264 Latin manuscripts, many of which were related to medicine[29].

The inorganic remedies and their clinical indications proposed by Aelius Promotus have been tabulated in order to determine whether their use is in agreement with our current medical knowledge. In *Dynameron*, pathological conditions and therapeutic means are described with terms found also in texts of earlier authors. It is noteworthy that these terms are not always clear and are not used by all ancient authors in the same way. Special attention has been paid to the possibly misleading medical terms or names of illnesses, which despite apparent similarities to modern terminology may actually imply something completely different[30].

For the identification of the inorganic ingredients in the text of Promotus and the appropriate use of scientific terms, we consulted the dictionaries of Liddel-Scott-Jones[31], Apostolides[32] and Souda[33], as well as our relevant previous publication on Nikolaos Myrepsos[34].

3. Results and discussion

Aelius Promotus' *Dynameron* is a well-structured medical text, with therapeutic indications classified into groups, according to the ailments and diseases of each chapter. It contains instructions for the selection, preparation and use of specific medicinal products. Most recipes concern "composite medicines" (σύνθετα φάρμακα), which represent mixtures of various active ingredients of plant, animal or mineral origin. The preference for such recipes was a characteristic feature of the followers of the Empiric school of medicine. However, as it appears from his text, Aelius Promotus applied also therapies according to the principles of the Methodic school. We may conclude that he actually belonged to the Eclectic school, like Galen and most of their colleagues in Imperial Rome, who adjusted their practice by choosing treatments for the best of every single patient[35].

Since the archaic period, minerals, metals, clays, and rocks were among the natural products used by the healers in different civilizations. Later on, inorganic medicinal substances can be found in the writings of Hippocrates, Dioscorides, Galen and many other Greek, Roman, Byzantine and Arabic physicians.

In about 700 recipes of composite medicines in Aelius Promotus' *Dynameron*, we traced down 63 inorganic ingredients. Of these, only 32 can be found in the books of *Corpus Hippocraticum*[36] and only 34 in Dioscorides' *Materia Medica*[37]. These data show that in the active medical environment of Alexandria the treatises of previous authors were enriched with new remedies, at least as far as the inorganic ingredients are concerned.

On the contrary, the *Dynameron* of Nikolaos Myrepsos contains all inorganic remedies mentioned by Aelius Promotus, with only three exceptions (aluminium silicilate, dew on cabbages and kallaite turquoise)[38].

3.1. Inorganic materia medica in *Dynameron*

As shown in Tab. 1, several inorganic remedies were used in treating a wide variety of illnesses, mainly in topical solid formulations like plasters, patches, poultices and dry collyria. Liquid formulations like liniments, mouthwashes and liquid collyria are also mentioned, but to a lesser extent. Moreover, inorganic remedies are remarkably rare in oral formulations like potions, pills, and lozenges (*trochisci*).

From a chemical point of view, in addition to copper, iron, lead and sulfur, which are used also in their native form, other inorganic remedies of *Dynameron* are various simple or complex salts, oxides and sulfides of many different elements. On the other hand, with some vaguely described ingredients like "rust of metals" (σκωρίαι), or "earths" (γαῖες) from different places, the description and the exact identification of their composition becomes extremely difficult. It is important to notice, that "earths" may be used as such, like the various clays from the islands of Kimolos, Lemnos and Samos, or they may represent metallic ore minerals. Due to the impressive early de-

velopment of metallurgic techniques, some *materia medica* do not occur in nature but they are by-products of cupellation, the refining process where ores or alloyed metals were treated under high temperatures to separate noble metals, like gold and silver, from base metals, like lead, copper, zinc, arsenic, antimony, or bismuth, present in the ore. Such examples are cadmia and litharge.

"Cadmia" (earth of Cadmus) was initially the name of a zinc ore, containing zinc, and to a lesser extent copper, silicon, iron, manganese and cadmium. By heating this ore, zinc was sublimed and formed deposits on the walls of the furnace. Zinc is a transition element in the center of the periodic table and its sublimation happens at a relatively low temperature. Thus, the deposits on the inner surface of the furnace contained high quantities of zinc oxide and zinc carbonate, and to a lesser extent some other metals, depended on the temperatures applied. Eventually, the deposits of the furnace became synonymous with the ore used as a starting raw material and were called also "cadmia". Moreover, Aelius Promotus mentions "cadmia botrytis", a deposit similar to a bunch of grapes. Other known types of cadmia, not mentioned in *Dynameron*, were "ostracitis" for resembling a seashell, "placitis" for resembling a crust, and "calamitis", which hung around certain iron rods that were used to stir material in the furnace. When it was shaken off, these sticks of cadmia resembled the figure of a quill, described with the Greek word *κάλαμος* (*calamus*)[39]. Because of this adjective, cadmia became also known as "calamine", a name that prevailed among Latin writers[40]. As mentioned already, the deposits of cadmia formed on the furnace walls contained also traces of many other metals. In fact, cadmium was isolated for the first time in 1817 by Friedrich Stromeyer in products of cadmia (calamine) sold in pharmacies in Germany[41]. Another example of an inorganic remedy originating as a by-product of cupellation is litharge, the oxide of bivalent lead. As described by Dioscorides, litharge was formed after heating galena ores in order to separate silver from lead[42]. There is archaeological evidence that this refinement process was developed and practiced already in the fourth millennium BC in Anatolia, in Syria and in Iran. It seems that this mineral residue was initially discarded, because there was no practical use for lead in this period. Since litharge does not occur in nature, its presence in a place is a secure proof of cupellation[43].

If we classify the inorganic remedies according to the frequency of their appearance in the recipes of *Dynameron*, we come up to some interesting observations. As expected, water, being a common excipient for solutions, has a very high rate of frequency in all kind of formulations (105 recipes). Then, follow prescriptions of combined medicines, containing various forms of copper (95 recipes), lead (93 recipes), alum (71 recipes), sodium carbonate (56 recipes), iron (51 recipes), arsenic (43 recipes), zinc (39 recipes), lime (31 recipes), sulfur (31 recipes), and chalcopyrite (30 recipes).

Many ingredients were imported to Alexandria from remote areas. There are several examples, where the place of origin is mentioned by the author himself, such

as Armenian bole, cadmia and copper flakes from Cyprus, earth from the islands of Kimolos, Lemnos, and Samos, Phrygian stone, and salt of Cappadocia. Then, we should also add "fragile stone", which according to Dioscorides originated from the Iberian peninsula[44], pumice (most probably from the volcanic deposits in the island of Thera), jet stone (or *lapis gagates*, from the town of Gagae of Lycia in Asia Minor), and amber (from the Black Sea, or even from far north).

The presence of gemstones in the lists of remedies has a long tradition in the history of pharmacology. Especially, in the primitive first steps of medicine, when therapy was based on magical rituals and religious beliefs, gemstones were used as spectacular amulets protecting the body from all kind of "evils". Aelius Promotus cites therapies with amber, emerald, jet stone, and kallaite turquoise. Moreover, some other inorganic ingredients in the recipes of *Dynameron*, like cinnabar, red ochre (unhydrated haematite, or earth of Sinope), pink salt of Cappadocia and the red Phrygian stone, may have been used due to both their pharmacological properties and their impressive colourful appearance.

With the exception of kallaite turquoise, which is abundant in Egypt and had been used as a decorative stone since the time of the first Pharaohs, all other gemstones were imported to Alexandria from remote areas. This fact underlines the central commercial role of the city, as an important harbor in eastern Mediterranean Sea, Middle East and northern Africa. It seems that treatment with exotic and luxury remedies was a common practice already in the classic Greek medicine. For instance, cinnabar (an impressive mineral with bright red color) can be found also in *Corpus Hippocraticum*[45]. It has been suggested that such rare and expensive pharmaceuticals added to the prestige of the physicians and to the expectations of the patients for a better and quicker cure[46].

3.2. Formulations and routes of administration

Usually, the composite medicines of *Dynameron* concern therapeutic formulations intended to be applied topically, such as balms, cataplasms, collyria (dry or liquid), dressings, ear drops, liniments, mouthwashes, ointments, poultices, and salves.

Formulations for oral intake are relatively rare and refer to potions, pills and *trochisci*, in connection with the treatment of cough (sodium carbonate), dysentery (arsenic, copper, iron flakes, lime, powdered seashells), pulmonary infections with haemoptysis (earth from the island of Samos), epilepsy (jet stone), cachexia (tar), and kidney stones (Jews' stone). Even rarer are enemas, which are recommended for the treatment of dysentery (arsenic and arsenic sulfide, asphalt, lime, tar), anal fissures and fistulas (haematite), and for colic pains (tar). Mouthwashes are mentioned for four ingredients, recommended in gingivitis (cadmia, sodium chloride), loose teeth (iron flakes, sodium carbonate), and toothache (sodium carbonate). For two ingredients,

fumigation is also proposed as the preferred route of administration (treatment of epilepsy with jet stone or with sulfur). Suppositories are mentioned only once, with sodium carbonate as the active ingredient for colic pains (Tab.1).
Interestingly, one recipe for nasal polyps recommends the use of a tube for blowing into the nostrils the ingredients (copper flakes, chalcanthite, sandarac and black hellebore):

> *...make a powder and blow it with a tube...*[47].

In addition, ear wax is cleaned with a clyster:

> *...after heating sodium carbonate on a flame, mix it with vinegar, instill it in the ear and, inserting a wad of wool, leave it stay overnight, and the next day use a clyster to wash it out with warm olive oil and water...*[48].

These descriptions reveal that an Alexandrian physician had several useful instruments and medical devices at his disposal, which facilitated the administration of remedies to the patients.
Since many formulations were intended for topical use on the eyes for various ocular disorders and diseases, it is worth commenting on the preparation of collyria, which Aelius Promotus distinguishes in either "dry" or "liquid". Dry collyria were formulated as smooth and malleable little balls, which were flattened to be fitted on the surface of the closed eyes. In fact, collyrium is the Latin word of the Greek *κολλούριον* (small loaf)[49]. Liquid collyria were viscous solutions, applied topically as such, or as a cataplasm of a small piece of fabric soaked with the active ingredients.

Table 1. The inorganic remedies encountered in Aelius Promotus' Dynameron

Ingredient [Greek name] Origin and Chemistry	Clinical indications suggested by the author (Number of recipes)
Alum [Στυπτηρία, ἡ] A complex sulfuric salt of potassium and aluminium. $KAl(SO_4)_2 \cdot 12\ H_2O$	With various indications as an astringent for the skin and the mucous membranes (13). As "breakable alum" [Στυπτηρία σχιστή] (48). As "liquid alum" [Στυπτηρία ὑγρά] (6). As "productive alum" [Στυπτηρία φόριμη] (3). As "round alum" [Στυπτηρία στρογγύλη] (7).
Aluminium silicilate [Ὕαλος βωλική, ἡ] A clay rich in aluminium and silicon oxides. $Al_2O_3 \cdot 2SiO_3 \cdot 2H_2O$	Topical treatment of abscesses (1).
Amber [Λυγγούριον, τὸ] A variety of amber, i.e. fossilized resin of pine trees. It was believed to be formed from the crystallized urine of *Lynx lynx*.	Part of a liniment applied topically all over the body as an antipyretic (1).

Antimony [Στῖμι (sic!), τὸ] In nature, antimony occurs mainly as a sulfide mineral called stibnite or antimonite. Sb_2S_3	In dry or liquid collyria, in poultices and salves, for treating trachoma and other ocular diseases (25).
Armenian bole [Ἀρμένιος λίθος, ὁ, and Ἀρμένιος βῶλος, ὁ] An earthy clay native to Armenia, but also found in other places. It has a bright red colour due to the presence of iron oxide. It contains also hydrous silicates of aluminium and possibly magnesium.	In dry collyria, for improving visual acuity, for preventing cataract and for treating xanthelasmas (3).
Arsenic [Ἀρσενικόν, τό] As	As anti-inflammatory cataplasm for the abdomen, antiseptic salve for genital ulcers, or liniment and poultice for abscesses, scrofulous glands, nasal ulcers and bleeding of the nostrils. Also, as enema in dysenteries. As a powder blown into the nostrils with a tube, to stop nasal bleeding (21). As "arsenic sulfide" ("sandarac") [Σανδαράχη, ἡ] (As_2S_3), with similar indications and additionally as a collyrium for trachoma (22).
Asphalt (Bitumen) [Ἄσφαλτος, ἡ] A naturally occurring solid material found at the bottom of lakes, where prehistoric organisms have since decayed and have been subjected to heat and pressure. It contains complex hydrocarbons, calcium, iron, sulphur and hydrogen.	In cataplasms for the treatment of hernias and sciatica. In poultices for lesions of the external ear. Also, in enemas for dysenteries (10).
Chalcopyrite [Χαλκῖτις, ἡ] A mineral containing a complex sulfide of copper and iron. $CuFeS_2$	Orally for headaches and dysenteries. In salves for genital ulcers, erysipelas, fistulas, abscesses, carcinomas, gangrene and diffuse ulcers of the skin. In collyria for ocular infections, pterygia, or lesions of the lacrimal ducts. Also, for treating ulcers of the nasal mucosa and nasal bleeding (30).
Cinnabar [Κιννάβαρι, τό] Mercury sulfide. HgS	In a dry collyrium, for ocular infections (1).
Clay [Πηλός, ὁ] A mineral of hydrous aluminium phyllosilicate, composed of aluminium and silicon ions bonded into tiny, thin plates by interconnecting oxygen and hydroxide ions.	As an excipient in preparing chest cataplasms for respiratory ailments. Also, in a dry collyrium for treating lesions of the eyelids and the canthi (2).
Copper [Χαλκός, ὁ] Cu	In collyria for xanthelasmas (2). Also, as "burned copper" [Χαλκός κεκαυμένος, ὁ], probably denoting copper oxide (CuO), in collyria for trachoma and other infections of the eyes, cataract, pterygia, staphylomas of the sclera, blurred vision, excess lacrimation, lesions of the lacrimal ducts and xanthelasmas. Topically, for nasal polyps and ozena, for skin disorders, such as erysipelas, hyperplasias, chronic ulcers, abscesses, fistulas, animal bites and genital ulcers. Also internally, as a pill, for dysenteries (15). Similar indications as above are depicted for preparations with "copper flakes" [Λεπὶς χαλκοῦ, ἡ] (25) and "copper flakes from Cyprus" [Κυπρία λεπίς, ἡ] (3), with "copper ore" [Μίσυ, τὸ], a soil rich in substances containing copper (23), and with "copper sulphate" [Χάλκανθος, ὁ] ($CuSO_4$) (27).

Dew on cabbages [Δρόσος, ἡ ἐπὶ ταῖς κράμβαις]	As a liniment with honey for treating mosquito bites (1).
Earth from the island Kimolos [Κιμωλία γῆ, ἡ, and Κρητάριον, τὸ] Calcium carbonate ($CaCO_3$) with traces of magnesium carbonate ($MgCO_3$).	In a poultice for the treatment of erysipelas. Also, in a poultice for the inflammation of the lacrimal ducts (2).
Earth form the island of Samos [Σαμία γῆ, ἡ, and Σάμιος ἀστήρ, ὁ] A clay mineral from Samos, very similar to kaolin (hydrated aluminium silicate). $Al_2Si_2O_5(OH)_4$	As a pill internally in patients with haemoptysis. In collyria for treating painful ocular inflammations (5).
Earth of Cadmus (Cadmia or Calamine) [Καδμεία, ἡ] A mineral with complex salts of zinc, mainly zinc carbonate or smithsonite, $ZnCO_3$, and zinc silicate or hemimorphite, $(Zn_4Si_2O_7(OH)_2 \bullet H_2O$. Also, with traces of copper, iron, manganese and cadmium.	In many preparations for topical use, due to its reputation as an astringent, antiseptic and anti-inflammatory remedy. In poultices for fistulas. In collyria for visual acuity, excess lacrimation due to ocular injury or irritation, trachoma and other infections, for pterygia, staphylomas, xanthelasmas and cataract. In mouthwashes for treating gingivitis (36). As cadmia from Cyprus [Καδμεία Κυπρία, ἡ], in a collyrium for pterygia (1). As cadmia botrytis [Καδμεία βοτρυῖτις, ἡ], in a collyrium for trachoma, staphylomas, and xanthelasmas (1).
Earth of vineyard [Γῆ ἀμπελῖτις, ἡ]	In a poultice for treating excess lacrimation, due to infections of the eyes and inflammations of the canthi. Also, in cosmetic preparations for the eyelids (8).
Emerald [Σμάραγδος, ἡ and Πρασῖτις λίθος, ἡ] A green gemstone, variety of the mineral beryl with trace amounts of chromium and/or sometimes vanadium. $Be_3Al_2(SiO_3)_6$	In collyria for the treatment of ocular ailments and for improving visual acuity (2).
Fragile stone [Λίθος σχιστός, ὁ] A remedy of unidentified nature.	In a collyrium for staphylomas and xanthelasmas (1).
Galena [Μολίβδαινα (sic!), ἡ] Lead sulfide. PbS	Topically in salves for the treatment of erysipelas and fistulas. Also, as a liniment on skin ulcers, in order to prevent scar formation (3).
Gypsum [Γύψος, ὁ] A soft sulphate mineral composed of calcium sulphate dihydrate. $CaSO_4 \bullet 2\ H_2O$	Topically in poultices applied on the periorbital areas, admixed with other ingredients, to sooth eye aches (1).
Haematite [Αἱματίτης λίθος, ὁ] Iron oxide compound widely found in rocks and soils. As unhydrated haematite, “red ochre” (Fe_2O_3), or as hydrated haematite, “yellow ochre” ($Fe_2O_3 \bullet H_2O$).	In collyria, to treat excess lacrimation due to inflammations of the canthi. Also, for xanthelasmas and pterygia (5). As “earth from Sinope” [Σινωπὶς γῆ, or Μίλτος, ἡ], a red clay rich in unhydrated haematite. In dermal cataplasms, for treating erysipelas, abscesses, steatomas and hyperplasias. Topically in the nostrils for patients with ozena, and in collyria for removing pterygia. Also, topically on genital ulcers. In enemas for anal fissures and fistulas (8). As “ochre of Attica” [Ὤχρα Ἀττικῆς, ἡ], most probably the “yellow ochre” from the mines of Lavrion in southern Attica. It is suggested as an ingredient in a cataplasm intended to treat erysipelas, bleeding wounds, genital ulcers and chronic otitis with puss (1).

Iron flakes [Σιδήρου λεπίς, ἡ] Fe	In a pill, combined with other ingredients, for treating dysenteries (1). As "iron sulphate" [Σῶρυ, τὸ], a naturally occurring compound (Fe2SO4•7 H2O) in various minerals, like melanterite. Topically for the treatment of genital ulcers, lesions of the testicles and for umbilical hernias. Also, for erysipelas. In the cavities of teeth, to prevent further decay (4). As "heated iron stick" [Σίδηρος πεπυρωμένος, ὁ]. An iron stick is heated to redness and then rinsed with a solution of strong vinegar and alum. The liquid thus obtained is used as a mouthwash, in order to strengthen lose teeth (1). As "small and rusty iron nails" [Ἡλάρια παλαιά, τά], which are left for five days in a solution of vinegar. Then they are boiled in melanteria (see word), for the solution to evaporate and become viscous like thin honey. The mixture of iron oxides thus obtained is used in a liquid collyrium to treat infections of the canthi (1).
Jet stone (Lapis gagates) [Γάγατον, τὸ, and Λίθος Γαγάτου, ὁ] A type of lignite coal, which is derived from wood that has changed under extreme pressure. Unlike many gemstones, jet is not a mineral, but is rather a mineraloid. The name denotes an origin from the ancient city Gagae of Lycia in Asia Minor.	For the treatment of epilepsy, either orally, or with fumigations. Topically, for the treatment of ulcerative lesions of breast cancer (3).
Jews' stone (Lapis Judaicus or Stone of Syria) [Τηκόλιθος, ὁ] Mineral limestone rich in calcium and magnesium. It is found in fossil deposits of the sea urchin *Balanocidaris marginata* (now extinct)	Powder or shaves of the Jew's stone are taken orally, in combination with other substances, for dissolving urinary stones (4).
Kallaite turquoise [Καλλάϊνος λίθος, ὁ] An opaque, blue-to-green mineral (hydrated phosphate of copper, aluminium and iron). $Cu(Al,Fe^{3+})_6(PO_4)_4(OH)_8•4\ H_2O$	In a collyrium for improving visual acuity (1).
Lead [Μόλυβδος, ὁ, and Μόλιβδος (sic!), ὁ] Pb	In dry collyria for trachoma and other ocular infections, excess lacrimation and xanthelasmas. In a dermal poultice for erysipelas. Intranasally for treating ulcers, polyps and sarcomas of the nostrils. Topically for genital ulcers (15). As "white lead" [Ψιμύθιον, τὸ], a mineral complex salt containing both carbonate and hydroxide ions ($2PbCO_3•Pb(OH)_2$). It was used as a remedy and also as a whitening cosmetic for the complexion of women. In abdominal cataplasms for patients with ascites and in poultices, for infections and ulcers of the skin and the external genitalia. Also, for erysipelas, gout, herpes, oedemas, hyperplasias, chronic ulcers, scrofulous glands, animal bites, fistulas and abscesses. In collyria, for trachoma and other ocular infections, staphylomas, cataract and xanthelasmas. Intranasally, for ulcers of the nostrils (52). As "lead oxide" or "litharge", [Λιθάργυρος, ὁ], an oxide of bivalent lead (PbO). It is a secondary mineral, formed from the oxidation of galena ores. In a chest cataplasm for respiratory infections. In healing skin poultices, for animal bites, persistent chronic ulcers, anthrax, herpes zoster, erysipelas, fistulas, and lesions due to cauterization. Topically, for nasal ulcers, in exacerbations of gout and hyperplasias of the skin (22). In one recipe, specified as "Syrian litharge" [Λιθάργυρος Συρικός, ὁ] is used topically for treating anal fissures (1).

Lime (Calcium oxide or Quicklime) [Άσβεστος, ή, and Τίτανος, ή] A white solid with strongly basic properties. With water, it produces calcium hydroxide (slaked lime or limewater), which may in turn react with carbon dioxide to yield calcium carbonate. CaO, $Ca(OH)_2$ and $CaCO_3$	In poultices for soothing abdominal pain, for treating ulcers of the external genitalia, skin abscesses, fistulas, erysipelas, persistent chronic ulcers, skin lesions due to cauterization, and for removing "soldiers' seals" and tattoos in general. Also, for chronic otitis with discharge, for ocular styes and chalazia, infections of the lacrimal duct, nasal bleeding and polyps of the nostrils. For dysenteries, either as enema or in pills (31).
Lodestone (Magnet stone) [Μάγνης λίθος, ό] Naturally occurring magnetic mineral, consisted of bivalent (ferrous) and trivalent (ferric) iron oxides, with impurity metal ions of titanium, aluminium and manganese. Fe_2O_3 (maghemite) and Fe_3O_4 (magnetite)	Orally with warm water in cardiopathies. In collyria for improving visual acuity and for treating pterygia (5).
Melanteria [Μελαντηρία, ή] A black pigment, obtained from melanterite, a secondary sulphate mineral that forms from the oxidation of primary sulfide minerals such as pyrite and marcasite. $FeSO_4 \bullet 7\ H_2O$	In cataplasms, for the treatment of hernias in adults and children. In liquid collyria for the treatment of ocular infections, staphylomas and xanthelasmas. In nasal solutions for the treatment of ozena and ulcers of the nostrils (10).
Phrygian stone [Φρύγιος λίθος, ό] A light, spongy stone, resembling pumice, used in the past as a red dye, and also in medicine as a drying and astringent material.	In collyria for chronic infections of the eyelids, against excess lacrimation and for improving visual acuity (3).
Pumice [Κίσηρις, ή] A spongy inert aluminosilicate material composed primarily of silica and also metal oxides, calcite, or salts. Usually from the volcanic stone layers of the island Thera (Santorini).	Topically on the head as a desiccating powder. In poultices, for dermal abscesses. In dry collyria, for trachoma and other ocular infections (5).
Rust of metals [Ίός, ό, and Πομφόλυξ, ή] Although not accurately defined, these remedies usually refer to rust of iron or copper.	In powders, topically in the nostrils for ozena, and also for treating ulcers of external genitalia. In poultices for abscesses, scrofulous glands, chronic skin ulcers, fistulas and animal bites, in order to enhance healing and to diminish scar formation. In collyria, for ocular infections, cataract, pterygia and xanthelasmas, and also for improving visual acuity (26).
Sal ammoniac or Salmiac [Άλς ἀμμωνιακός, ό] The chloride salt of ammonium. NH_4Cl	As an astringent and antiseptic on chronic ulcers of the skin and for ulcers of the oral or the nasal mucosa. Also, in collyria for improving visual acuity (13).
Salt [Άλς, ό, and Άλας, τὸ] The common salt. A mineral composed primarily of sodium chloride. NaCl	In poultices for the treatment of frostbites, skin ulcers, abscesses, steatomas and fistulas, as well as for pediatric hernias. Also, for effusions of the elbows and the knees. In emollients for treating neuropathic pain, soothing muscle spasticity and preventing calcifications. In collyria for cataract. In mouthwashes for gingivitis and gum bleeding, and for toothaches. In otic drops for ear pain. In oral solutions for abdominal pain and dysenteries (13).
Salt of Cappadocia [Άλς Καππαδοκικός, ό] Probably salt from the "pink salt lake" of Cappadocia.	In collyria, for treating ocular lesions with scars, cataract and xanthelasmas (1).

Sea water [Θάλασσα, ἡ]	Lukewarm sea water is proposed as an ingredient in a cataplasm for hernias in children, as well as in collyria for staphylomas and xanthelasmas (2).
Seashell [Ὄστρακον κογχυλίου, τὸ, and Ὄστρακον σηπίας, τὸ] Seashells are a natural source of calcium carbonate. $CaCO_3$	In poultices for abscesses. In collyria, for improving visual acuity, excess lacrimation, prevention of scar formation, trachoma, staphylomas, pterygia and xanthelasmas. Orally, in pills for treating dysenteries (9).
Silver tarnish [Ἔλκυσμα, τὸ] A dull, gray or black film or coating over metal, which contains silver sulfide (a reaction product with the sulphur of the air). Ag_2S	In collyria, against ocular infections (2).
Sodium carbonate (native) or Natron [Νίτρον, τό, and Ἀφρόνιτρον, τό] A naturally occurring mineral, as a mixture of sodium carbonate decahydrate (Na_2CO_3•10 H_2O) and sodium bicarbonate ($NaHCO_3$) along with small quantities of sodium chloride, sodium sulphate and sodium nitrate.	In mouthwashes for treating toothache and loose teeth. Topically, as a liniment on the head, to treat hair loss and alopecia. Also, as a liniment on the chest in patients with cardiac and respiratory problems, as well as on the neck for treating scrofulous glands. As an emollient or a poultice, for abdominal pains and for genital ulcers, sebaceous cysts, abscesses, fistulas, swollen and painful joints, pediatric hernias, testicular inflammations, dermal hyperplasias and gout. In otic solutions, for cleaning the ear wax with a clyster, as well as for treating earache, or tinnitus. In collyria, for cataract, trachoma, and xanthelasmas. In suppositories and cataplasms, for colic pains. In fumigating trochisci, for dyspnoea. Internally, as a potion, for soothing cough (56).
Soot [Αἰθάλη, ἡ] Soot consists of very small carbon particles created by incomplete combustion.	Soot of cedar wood is recommended in collyria against excess lacrimation. Soot from olive oil burned in a copper lamp is recommended for the treatment of eye infections in children (2).
Sulfur [Θεῖον, τό] Usually as natural mineral (crude sulphur), without further refinement. S	In liniments on the head for stopping hair loss. Also, for skin infections, such as erysipelas, anthrax and herpes. In liquid collyria, for ocular infections and pterygia. Topically on the forehead, as antipyretic. In cataplasms, for treating skin hyperplasias, respiratory infections with coughing, abdominal pain, sciatica, genital ulcers, hernias and swollen joints. Orally, in pills, for dyspnoea. As fumigations, for treating epilepsy (31).
Tar [Πίσσα, ἡ] A dark brown or black viscous liquid of hydrocarbons and free carbon, obtained through destructive distillation of organic materials. In antiquity, tar was produced from coal, wood or peat.	Topically on the skin of the head for the prevention of hair loss. In poultices for abdominal pains and dysenteries, hernias, scrofulous glands, herpes, fistulas, varicose veins, myoskeletal pain and sciatica. In emollient poultices for skin hyperplasias, abscesses and for preventing calcifications. Internally, as a pill, in combined remedies for cachexia. In enemas, for colic pains and dysenteries (22).
Terra sigilata (Earth from the island of Lemnos) [Λημνία σφραγίς, ἡ] A mineral clay, consisted mainly of silicate salts with oxides of iron, aluminium and calcium. It was called "sigilata" (sealed) because cakes of it were pressed together and stamped with various seals.	Internally, in a trochiscus or as a solution in acidic wine, for patients with respiratoty disease and haemoptysis (5).
Water [Ὕδωρ, τό]	As a dissolving excipient, water is present in numerous recipes of combined remedies. Mostly as plain water (in some recipes specified as warm or cold water) (86). As "rain water" [Ὄμβριον ὕδωρ] (15). As "rose water" [Ὕδωρ ῥόδων] (4).

Zinc oxide [Σάνδυξ, ὁ] A natural mineral with red colour, containing zinc oxide and also traces of sodium carbonate. ZnO	Topically, combined with other substances, for cauterization of wounds (1).

3.3.Pharmacological appraisal

Inorganic remedies were usually included in recipes intended for treating inflammations, infections and ulcers of the skin and the mucous membranes. Many of these substances were highly estimated in antiquity, with the belief that they accelerate healing and at the same time, they prevent excess scar formation. Topical use concerned several non-metallic substances, such as sulfur and sal ammoniac, the metalloids alum, arsenic and antimony, as well as the metals copper, iron, lead, mercury, silver and zinc.

There are several modern experimental studies showing the astringent properties of various metal ions, which are attributed to their ability to bind and denature mucopolysaccharides, the main constituent of mucus secretions[50]. On the other hand, metals exhibit significant toxicity against Gram-positive and Gram-negative microbes, by binding to protein molecules, by producing reactive oxygen species, and by accumulating to the cell wall and other cellular components, perturbing their structure and function[51].

Copper was one of the first elements to be isolated in human history, with the development of cupellation techniques. It is documented that some metallic ores of copper, while processed, gave by-products rich in other substances like arsenic, lead and zinc[52]. The use of copper for treating wounds is mentioned in the papyrus of Smith (c 3200 BC), as well as in recipes of *Corpus Hippocraticum* (5th to 3rd centuries BC)[53]. In a typical Hippocratic recipe, the ingredients of a solution intended for wound cleaning "should be mixed in a jar made of red copper and should be left in the sun to dry up so that as much copper as possible is extracted from the container"[54]. According to ancient Ayurvedic texts of India, copper utensils could preserve water for longer periods of time, compared to the ceramic ones[55]. Moreover, it is worth mentioning that in Greco-Roman medicine surgical instruments were mostly made of copper and copper alloys, such as bronze (copper and tin) or brass (copper and zinc)[56].

In Aelius Promotus' *Dynameron*, copper is present in 95 recipes, either as an element or in the form of various salts and ores. We should add to these also the 30 recipes containing chalcopyrite, a complex sulfide of copper and iron. In addition, copper is also found in cadmia (38 recipes), rust of copper (26 recipes), kallaite turquoise (1 recipe) and soot from copper olive oil lamps (1 recipe). These recipes concern mainly topical preparations for treating infections and ulcers of the skin, and to a lesser extent ocular and nasal diseases. Oral administration is recommended only in one recipe for

treating headaches with a preparation of chalcopyrite (Tab. 1). Galen also describes copper as an ingredient suitable for the treatment of ulcers[57]. Current scientific data show that copper containing compounds exhibit antiseptic properties, because they destroy bacteria and fungi with mechanisms implying interaction with nucleic acids, interference with energy transport, disruption of enzyme activity and damage of cell membranes[58]. In agriculture, the use of copper containing bactericides and fungicides is very common. Copper ions are toxic to bacteria, fungi, algae and water molds, but are innocuous to plants or humans[59]. Chalcopyrite, being a complex sulfide of copper and iron, could in theory exhibit bactericidal and fungicidal properties, especially when applied topically on the skin. However, there is no scientific evidence that it might treat a headache when taken orally, as proposed in *Dynameron* (Tab. 1).

Lead is easily isolated from lead ores and it was the first metal to be smelted around Mediterranean, at least as early as the late fifth millennium BC[60]. Moreover, argentiferous lead ores, like galena, were smelted to obtain silver. Ancient slag heaps and processing installations, such as those at Lavrion in Greece, demonstrate that vast quantities of argentiferous lead ores were mined during the first millennium BC[61]. As mentioned already, during this process lead oxide (litharge) was a by-product[62]. Aelius Promotus uses preparations of lead, lead oxide and white lead (Tab. 1) only for topical application on infections and lesions of the skin, the eyes, the nostrils and the external genitalia. Therefore, it is reasonable to assume that he was aware of the toxicity of lead when taken internally. Similar uses of lead are mentioned in the works of both Galen[63] and Paul of Aegina[64]. The topical antiseptic action of lead is fully justified in the light of current microbiological data[65].

Iron appears in several forms within the text of *Dynameron* as iron oxides (haematite, earth from Sinope, and old and rusty nails rinsed with a vinegar solution), and as a sulphate salt (melanteria). Additionally, there are several other ingredients with traces of iron in the form of complex salts (Armenian bole, asphalt, chalcopyrite, kallaite turquoise, lodestone, *terra sigilata*). Recipes containing iron are recommended for the topical treatment of infections and ulcers of the skin and the mucous membranes. Internal use is mentioned for dysenteries and cardiopathies. For the latter indication, warm water is given with magnet stone (lodestone), which is a source of iron oxides (Tab. 1).

The antibacterial properties of iron have been shown in various experiments. Iron oxides hinder the growth of Gram-positive and Gram-negative bacteria, with mechanisms related to ion transport, enzymatic activities and formation of toxic free radicals[66]. On the other hand, although *Dynameron* describes various iron containing collyria for ocular ailments, none of them has trachoma as an indication. This fact may be related with the current scientific knowledge that iron ions are not toxic to *Chlamydia trachomatis*, but on the contrary they are necessary for this micro-organism to grow and thrive[67].

Substances containing zinc are present in many recipes of *Dynameron*, as astringent and desiccative ingredients, to promote healing of wounds and to prevent excessive

dermal scarring. Cadmia, as a source of zinc carbonate and zinc silicilate, is recommended in the preparation of collyria for trachoma and other infections of the eyes, ocular injuries, cataract, pterygia, staphylomas and xanthelasmas. Zinc oxide is included only in one recipe, aiming to the chemical cauterization of wounds and the enhancement of healing. Several experimental studies have documented the antibacterial properties of zinc[68]. Commercial salves with zinc oxide are still in use today, as popular desiccative products soothing the irritated skin and the diaper rashes of the babies. Additionally, lotions, liniments and ointments of "calamine", a mixture of zinc oxide with a small amount of ferric oxide, are applied on the skin to treat mild itchiness from sunburn, insect bites, or irritation due to stinging plants[69].

The red dye cinnabar (mercury sulfide) is mentioned only in one recipe for a dry collyrium to treat ocular infections. It is worth noticing that an organic mercury compound (merbromin) is still in use as a topical antiseptic to treat minor wounds, burns, and scratches, with the generic name "Mercurochrome".

Apart from the metals already mentioned, Aelius Promotus uses many recipes with the metalloids alum, antimony and arsenic (Tab. 1).

Alum (the double sulphate salt of aluminium and potassium) is an odourless and colourless crystallized metalloid, which is currently used in food preservation and as an antiseptic for many preparation processes such as pickling, fermentation, and water purification[70]. Alum has also been recommended as category I active ingredient in mouthwashes by the Counter Advisory Panel of U.S. Food and Drug Administration (FDA)[71]. It has been shown that alum is an astringent with antibacterial activity, inhibiting the growth of Gram-positive and Gram-negative bacteria isolated from various infection sites[72]. In *Dynameron*, alum is widely used in topical preparations for treating lesions of the skin and the mucous membranes, apparently due to its ability to dry up excessive secretions. The same qualities of alum are described by Aetius of Amida in the 6th century[73], as well as by Nikolaos Myrepsos in the 13th century[74].

Stibnite, the sulfide of antimony, is used by Aelius Promotus in collyria for treating trachoma and other ocular infections, as well as pterygia, staphylomas and xanthelasmas. Stibnite has been shown to possess bactericidal activity against *Escherichia coli* and *Staphylococcus aureus* by evaluating minimum inhibitory concentration, colony counting and microbial survival[75]. Various compounds of pentavalent antimony were synthesized in the beginning of the 20th century and were successfully used to treat leishmaniasis[76]. The intravenous antimonial compounds sodium stibogluconate and meglumine antimoniate are still in use in treating this parasitosis in many countries. However, due to the development of resistance and the high incidence of side effects after intravenous administration, their use is currently declining in favour of orally given drugs, like paromomycin and amphotericin B[77].

Arsenic is included in 21 recipes as an element and also in 22 recipes as arsenic sulfide (sandarac). As an element, it is recommended for the topical treatment of skin inflam-

mations and abscesses, scrofulous glands, genital ulcers and nasal lesions. Moreover, one recipe with arsenic refers to an enema for dysentery. It is noteworthy that in Nikolaos Myrepsos' *Dynameron,* are described almost identical uses of arsenic, showing that some recipes of Aelius Promotus were apparently so effective that they could retain their therapeutic value throughout centuries[78]. Concerning the therapy of genital ulcers (τὰ ἐν αἰδοῖοις ἕλκη), it is worth reminding the organic arsenic compounds developed by Paul Ehrlich and his collaborators, who in 1910 synthesised Salvarsan and Neosalvarsan for the treatment of syphilis[79]. On the other hand, treating genital ulcers with arsenic and arsenic sulfide (sandarac), according to *Dynameron*, implies that the genital ulcers described by Aelius Promotus were not simple soft ulcers due to *Hemophilus ducreyi* (canchroid), but real syphilis ulcers due to *Treponema pallidum*. In other words, this piece of information gives further support to the view that syphilis was not "imported" from America, but endemic infections were already present in the Old World long before Christopher Columbus set sail from Spain to start his voyage across the Atlantic Ocean[80].

Referring especially to trachoma (τράχωμα), the recipes of *Dynameron* contain antimony, arsenic, calcium carbonate (seashell), cooper, lead, silica (pumice), sodium carbonate (natron) and zinc (Tab. 1). No current scientific evidence exists to support the sensitivity of *Chlamydia trachomatis* to these substances. One reason might be the technical difficulties to perform *in vitro* experiments, because this micro-organism is an obligate intracellular parasite of eukaryotic cells. In any case, trachoma is currently treated with antibiotics (tetracyclines or azithromycin), so there has been no need to pursue scientific evidence for proving the possible value of any of these inorganic substances of the past[81].

Lime (calcium oxide) is used by Aelius Promotus in plasters for the treatment of infections and ulcers of the skin and the mucous membranes. When soaked in water, lime produces calcium hydroxide, which has fungicidal and bactericidal properties and it is traditionally used to disinfect premises and tree trunks[82]. Due to its high alkaline reaction (pH=12.4) calcium hydroxide is caustic to the tissues, being able to remove plane warts and moles from the skin. In dentistry, it is currently applied as an endodontic antibacterial agent for root canal treatments[83]. Aelius Promotus advocates the use of lime in a poultice:

> *...for erasing soldiers' seals and all kind of tattoos on the body...*[84].

This is an interesting recipe, which implies that Roman legionaries had specific marks on their skin, serving presumably identification purposes.

Natron, a mixture of sodium carbonate and sodium bicarbonate, has alkalinizing properties when dissolved in water, because it forms carbonic acid and sodium hydroxide. As a strong base, sodium hydroxide neutralizes gastric acid, acting as an antacid.

Natron shows antibacterial activity, because in addition to the high pH it has also the ability to bind magnesium and other bioactive elements essential for the growth of micro-organisms[85]. Several studies have shown that the use of natron had a central role in the process of embalming and mummification in ancient Egypt[86]. Aelius Promotus uses natron mainly in topical dermal formulations, collyria, otic solutions and mouthwashes. For colic pains, he proposes abdominal cataplasms and suppositories. In addition, he adds natron to a fumigating *trochiscus* for dyspnoea, and to a potion for soothing cough (Tab. 1).

Ammonium chloride (salmiac) is recommended in *Dynameron* for the topical treatment of infections and ulcers of the skin and the mucous membranes. It is also included in collyria, for improving visual acuity. However, none of these indications is supported by current scientific data. In modern pharmacy, salmiac has a traditional use as an expectorant, with a mechanism of action not fully understood. Part of its popularity may be explained by its taste, which is similar to that of licorice.

Topical formulations with sulfur are very common in *Dynameron*, with a great variety of indications (Tab. 1). For some uses, like head liniments to prevent hair loss (anti-dandruff action) and topical treatment of skin infections and ulcers (antibacterial action), there are supportive data in current scientific literature[87]. On the other hand, for some recipes it is difficult to find a satisfactory explanation. Such examples are the fumigations with sulfur for epilepsy, the cataplasm on the forehead for headache, the intake of sulfur pills to treat dyspnoea, or the topical sulfur preparations for swollen joints.

Although Aelius Promotus was apparently a knowledgeable physician, some of his remedies are obscure and questionable. Perhaps the most typical example is Jews' stone (τηκόλιθος), as an agent that contributes to the dissolution of renal stones. This very specific product was included in the official British Pharmacopoeia until the middle of the 19th century[88], but the scientific community has not come yet to a conclusion on its therapeutic efficacy[89].

4. Conclusions

Aelius Promotus' *Dynameron* is a concise text with the format of a therapeutic manual, addressing common diseases and ailments an Alexandrian physician of the 2nd century might encounter in his everyday practice. It is a valuable text on therapeutics, with a lot of interesting information, which has not been given yet the attention it deserves.

Recipes of *Dynameron* with inorganic ingredients describe composite medicines intended mostly for topical use. In this category are included various metals, metalloids, salts, oxides, sulfides, clays and earths. When recipes are put under scrutiny in the light of current experimental data, the properties attributed to any single ingredient are very often compatible with modern scientific findings. Pharmaceutical formulations

with antimony, mercury, sulfur, tar, or zinc are still in use today, with similar if not identical indications with those proposed by Aelius Promotus.

Studying the text and analyzing the details of many recipes, the reader comes across interesting data, such as the incidence of various diseases, therapeutic practices, surgical instruments and medical devices, exotic remedies, superstitions, religious beliefs, and information on other physicians. Furthermore, there is plenty of information revealing various aspects of everyday life, such as metallurgy and exchange of commercial products.

Overall, Aelius Promotus was an experienced and knowledgeable physician of the Imperial Rome. Most recipes with inorganic compounds are applied topically on the skin and the mucous membranes, in order to treat wounds and infections. Many of these formulations possess antiseptic properties, as has been demonstrated in many modern experimental studies. Additionally, it is worth noticing that for substances with high toxicity, such as antimony, lead and mercury, medical applications were restricted to topical use only. These examples show clearly that the recipes of Aelius Promotus reflect a certain degree of accumulated wisdom, through successful and failed trials. Comparing the therapeutic armamentarium of *Dynameron* with texts of authors that preceded or followed Aelius Promotus, we can easily realize the continuity of a long medical tradition from classical Hippocratic medicine to late antiquity, Byzantium, Arabic medicine, European Renaissance and modern medicine. In this course of medical wisdom, Alexandrian physicians had undoubtedly a central role between early antiquity and Byzantium.

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