THE GOA STONE: MYTHS, EMPIRICISM AND INSIGHTS ON CHEMISTRY

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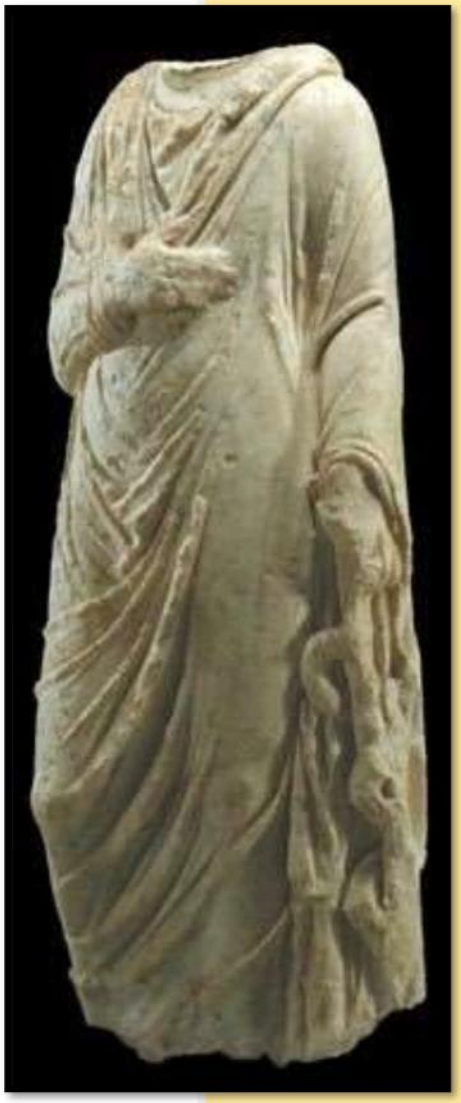

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Cover image - Statue of Aesculapius, Roman period, 1st/2nd century AD, marble, Lisbon National Museum of Archaeology Inv. 994.7.1. DGPC Photo credit: José Pessoa, 1994.
Courtesy of the Lisbon National Museum of Archaeology.

THE GOA STONE: MYTHS, EMPIRICISM AND INSIGHTS ON CHEMISTRY

Maria do Sameiro Barroso[1]

Abstract

The Goa Stone or Cordial Stone, an artificial bezoar created by the Jesuit Gaspar Antonio in the mid-seventeenth century, was composed of precious animal ingredients, such as scrapings of bezoar stones and unicorn horns, and vegetable and mineral ingredients, bringing together respected, long-standing traditions, imported from the Oriental and Arabic Medicine. Ancient myths built upon these substances and possible evidence of empirical effectiveness sealed their path to glory. Although the composition of the Goa Stone was kept in secrecy, it was reputed, or even more, as bezoars. Its splendour lasted for about 150 years until the end of the eighteenth century when chemistry emerged and significant advances in medicine put forward new diagnostic and therapeutic approaches which enabled more accurate scientific theories that replaced myths.

Keywords

Goa Stone; bezoars; unicorn horns; medicinal use of gems; Company of Jesus; History of Pharmacy

Résumé

La Pierre de Goa ou Pierre Cordiale est un bezoar artificiel, créé au milieu du XVIIe siècle par le Jésuite Gaspar Antonio, et qui était composé d'ingrédients précieux animaux comme des fragments de pierres de bezoar ou de cornes de licornes, etd' ingrédients végétaux et minéraux. La Pierre de Goa incarnait une tradition très ancienne, importée de la médecine orientale et arabe. Des mythes anciens, relatifs à ces substances et leur efficacité empirique potentielle avaient assuré leur gloire. Bien que la composition de la Pierre de Goa ait été gardée secrète, elle était réputée, ou même plus, comme des bézoards. Sa splendeur a duré approximativement 150 ans, jusqu'à la fin du XVIIIe siècle, alors que la chimie s'épanouissait et que la Médecine progressait à grands pas vers des approches nouvelles en matière de diagnostic et de traitement, en remplaçant les mythes par des théories scientifiques.

Mots-clés

Pierre de Goa; bézoars; cornes de licorne; usage medical de pierres précieuses; Compagnie de Jésus; histoire pharmaceutique

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Introduction

In the middle of the seventeenth century, the Jesuit Gaspar António created the Cordial Stone or Goa Stone, an artificial bezoar, probably destined to be an affordable good-quality product, providing an alternative to bezoar stones. Notwithstanding, most of the ingredients of the Goa Stone were rare and costly, and the recipe remained in secrecy. The Goa stone became as legendary as its most expensive ingredients.
This article aims to disclose some myths and highlight some possible empirical effectiveness. We consulted the recipes that had been kept at the Jesuit Archives in Rome. The belief in mythic and magic healing power of the main ingredients was focused by screening the possible pharmacological efficacy that could have validated their use through insights on the chemical composition of their main compounds.

The Society of Jesus

The Society of Jesus, founded in 1540 by Ignatius of Loyola (1491-1556), played a crucial role in the patient assistance, after arriving in Goa under the patronage of Francis Xavier (1506-1552), a former Spanish noble, in 1542. Until 1601, the Goa province comprised the Goa islands, certain areas in the North and the South of India, Japan and China. At Goa, the College of St Paul was their most valuable possession (1).
Medical assistance in the missions was poor since physicians and pharmacists were hard to find. Therefore, although the Jesuits did not possess medical training, they devoted themselves to the study of medicine and pharmacy, also getting knowledge from local expertise. Later on, they founded pharmacies and launched new drugs that were introduced in Europe (2). Living from small subsidies of the Portuguese Crown, they had to work hard to survive. They bought lands, received donations and endowments from pious lay people; they became slowly powerful landlords and financiers (3).

Lisbon in the mid-seventeenth century

Lisbon continued to be the centre of knowledge on Eastern lands even though the Dutch explorer Jan Huygen van Linschoten (1563-1611) had disclosed the secrets of the Portuguese and opened maritime routes to the Oriental Indies to English and Dutch sailors, traders and scholars.
Benefiting from the confidence that Vicente da Fonseca, the Dominican Archbishop of Goa, had in Jan Huygen van Linschoten as his secretary, this explorer released top secret information kept by the Portuguese, in his work *Itinerario*, published in 1596, which had an immediate massive impact on geopolitical issues and economic trade (4).

The German-born botanist Georg Eberhard Rumphius (1627-1702) was one of those who benefited from Jan Huygen's legacy and sailed to the East where he worked for the renowned East India Company (Eastern Indonesia). However, before leaving, Rumphius wrote in a letter from 1680 that, when he felt the urge to "know foreign lands", he "went first to Portugal" (5).

Figure 1 - Georg Eberhard Rumphius.
Portrait from Herbarium Amboinense, 1741.

The Goa stone

Rumphius gives the earliest account on the Goa Stone, approved by "the Inquisitors and the representatives in the assembly of St Paul, the new order of the Jesuits in Goa 1655". Rumphius brings rave news about Gaspar António's brainchild:

> This is the stone made by the Portuguese in Goa, but that is now transported throughout the Indies because of its beneficial powers; I do not know of what it is made, except that from its appearance and taste, I would say its most important ingredients are ground salt, Bezoar, Ambra and Musk. It has the size and shape of a pigeon egg or small chicken egg, seems guilded on the outside, while inside it is dark grey, glistening with small gold dots, soft to rub, and clearly smelling like Muscus and Ambra (…) This Stone is the best and most effective Cordial that has been discovered up till now, and there is no other like it: a Bezoar or other Cordial cannot compare to this, and he who examines it, will acknowledge this himself, nay, will experience this even more than what I say or indicate here (6).

He enumerated a long list of therapeutic indications of the Goa Stone taken from a Portuguese manuscript. The indications included fevers and melancholy; scorpion stings when drank and applied on the bites; preserving against venoms if drank with water or wine every day while fasting; most useful to stop bleedings of chest or nose by snuffing and drinking the dust of the stone; effective against tumours if taken with water; also preserving sight and protecting against foul air. It would also protect against four- and three-day fever, give a good memory and protect against contagious leprosy if taken with wine.
Other indications included smallpox, improving the appetite, being useful against stomach worms, clearing the reins of gravel, helping against bites from mad dogs and poisoned weapons. It would also be helpful as a diuretic, laxative and against the falling sickness. The Goa Stones were sold by weight in Goa, Cutschyn, and Ceylon (7).
The English doctor John Freyer (c.1650-1733), Fellow of the Royal Society of Medicine, described Gaspar António in his book relating his travel in Persia and East India. He described the Paulistines as possessing the biggest of all monasteries of Goa, which included a Library, a Hospital and an Apothecary's shop:

> well furnished with medicines where Gaspar Antonio, a Florentine, a lay-brother of the Order, the Author of the Goa Stones, brings them in 50 000 Xerephins, by that invention annually; he is an Old Man, and almost blind, being of great Esteem for his long practice in Physick, and therefore apply to by the most Eminent of all Ranks and Orders in this City (8).

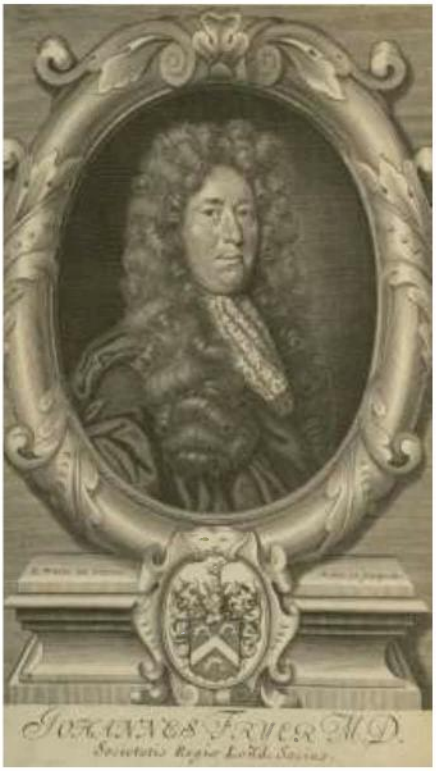

Figure 2 - John Fryer, from the frontispiece to his New Account, 1698.
The income from the sale of Goa Stones was very high since the Royal Hospital managed by the Jesuits received an annual sum of 14000 Xerephins (9).

The recipes of the Cordial Stones

Three recipes of Cordial Stone recipes figure on a manuscript currently kept at the Jesuit Library of Rome, which include the instructions for preparation and posology. The ingredients of the first recipe are as follows: seed pearl (aljôfar), musk (almíscar), ambergris (âmbar griz), red coral (coral vermelho), white coral (coral branco), emerald (esmeralda), fossil shark´s teeth (línguas de S. Paulo), topaz (topázio), white Saint Paul's earth (terra branca de S. Paulo), rubies (rubins), Cananor stone (Pedra de Cananor), hyacinths (jacintos), deer horn tips (pontas de veado queimadas), sapphires (safiras) and Oriental bezoar (pedra bezoar oriental). The ingredients passed through a long and thoroughly elaborated preparation. After being grounded and weighted, they were mixed with orange flower or other aromatic water. Oriental bezoar, musk and ambergris were put aside. The paste was left fermenting from six months up to a year. Then, Oriental bezoar, ambergris and musk were added to some stones, and the paste was ground again with orange flower water, making it softer. The balls were formed and kept in stone or ivory containers until they were dry. The balls from the former paste were odourless and cheaper (10). In the second recipe, called reformed stones of Gaspar Antonio, prepared in the pharmacy of Goa, amber replaced ambergris, Malta earth replaced white St Paul's

earth; fossil shark teeth were missing and unicorn horn (corno de cervo) being added (11).

The third recipe was produced in the pharmacy of Macau. Comparing to the second recipe, fossil shark teeth and Cananor stone are absent. Armenian earth (bolo arménio) and *terra sigillata* replaced the earth of Malta. Spode (ispódio), garnet (granadas), unicorn horn scrapings (raspas de unicórnio), ivory scrapings (raspas de marfim), crab's eyes (*oculi cancrorum*) and camphor were added (12).

The ingredients

They included the minerals, earths, animal and vegetable ingredients, listed in Table I

	1st recipe	2nd recipe	3rd recipe
Minerals	Emeralds	Emeralds	Emeralds
	Topazes	Topazes	Topazes
	Rubies	Rubies	Rubies
	Hyacinths	Hyacinths	Hyacinths
	Sapphires	Sapphires	Sapphires
	Cananor stone		
			Granats
Earths	White St Paul's earth	Earth of Malta	Armenian earth *Terra sigillata*
Animal ingredients	Seed pearl	Seed pearl	Seed pearl
	Oriental bezoar	Oriental bezoar	Oriental bezoar
	Musk	Musk	Musk
	Ambergris		
		Amber	Amber
	Deerhorn tips	Unicorn horn	Unicorn scrapings
	St Paul's tongues		
			Ivory scrapings
			Spode
Vegetable ingredients		Amber	Amber
	Red and white coral	Red and white coral	Red and white coral
			Camphor

Medicinal use of the gems

Earlier in history, leading medieval Arabic authors on medicine and pharmacy had used and traded gems as valuable magic, apotropaic and medicinal materials. According to Cyril Elgood (1893-1970), a British medical historian of Persia:

> The history of pharmacy of stones is by far the most exciting part of Persian therapeutics. None of the ancient writers could resist the lure of ascribing marvellous properties to the strange coloured stones which were occasionally discovered (13).

In the Middle East, gems were related to sacred and royal power since ancient times, providing elevation of the spirit, carrying brilliance, light and happiness, and mediating the relationship between the human and the divine as stated in an ancient Assyrian charm:

Glänzende, prächtige Steine; glänzende prächtige Steine Steine der Freude und des Glucks Leuchtende Pracht für das Fleish der Götter Der Hulalini Stein, der Sigurru Stein Der Hulalu Stein, der Sandu Stein Der Uknu Stein, der Dushu Stein, der wertwolle Elmeshu Stein, Vollendet in himmlischer Schönheit Auf die glänzende Brust des Königs als Ornament gelegt Azagud, Höhepriester von Bel, bringe sie zum Glänzen, Bringe sie zum Leuchten Bewahre dieses Haus vor dem Bösen	Shiny, magnificent stones; shiny, magnificent stones Stones of joy and happiness Brilliant splendor for the flesh of the gods The Hulalini stone, the Sigurru stone The Hulalu stone, the Sandu stone The Uknu stone, the Dushu stone, the precious Elmeshu stone, Perfect in heavenly beauty Put on the shiny breast of the king as an ornament Azagud, High Priest of Bel, make them shine, Make them shine Ward this house from bad luck.

(14) Translated from the German by the author.

Abu Ray an Muhammad ibn Ahmad Al-Beruni (973-after 1050) had been one of the most remarkable authors on this subject. He lived in India where he learned the Hindu language and embraced their philosophical and pharmacological knowledge, describing 1197 drugs.
He conveyed a catalogue of seventy recipes of comminuted gems, gold, silver, mineral bezoar, unicorn and other organic, vegetable and mineral ingredients and spices, taken in electuaries, moulded in pills or to be applied in

plasters or eye collieries, indicated as analeptics, invigorators, and in the treatment of epilepsy and other conditions (15).
For Ahmad al Tīfāsi (1184-1253), a polymath born in Tifas, Tunisia, the hyacinth, a golden gem, was, based on alchemical assumptions, at the origin of the other stones, as gold was at the origin of metals (16).
The Arabic taste for compounds of comminuted gems taken orally comes up in the early Middle Ages in Europe. One of the earliest recipes, he *Confectio de Hyacinto,* a recipe from the *Antidotario Napolitano*, written by an unknown author of the medical school of Salerno in the early Middle Ages (10^{th}-12^{th} century), is surprisingly similar to the Goa Stone, including Oriental hyacinths, rubies, emeralds, sapphires, topazes, pearls, red and white coral, spodium, ivory scrapings, unicorn horn, stag´s heart bone and vegetable ingredients (17).
In the seventeenth century, the Gascoigne´s powder, figuring in a book by Elizabeth Grey, Duchess of Kent (1581-1651), included comminuted bezoars:

> Apothecaries Gaſcon powder, with the uſe. Take of Pearls, white Amber, Harts-horn, eyes of Crabs, and white Corral, of each half an ounce, of black thighs of Crabs calcined, two ounces, to every ounce of this powder put a dram [1/16 of an ounce] of Oriental Bezar, reduce them all into very fine powder, and fierce them, and with Harts-horn´s jelly with a little Saffron put therein, make it up into paſt, and make therewith Lozenges, or Trochifes for ' your uſe. (18)

The Goa Stone is one of the last and most celebrated of these compounds that flourished in the European medical literature until the end of the eighteenth century. Grounded in rare and expensive ingredients of often unknown origin, its symbolic, apotropaic and therapeutic properties were highly overstated.

The gems of the Goa Stone

The concept of a mineral as a chemically and physically uniform, natural constituent of the solid earth crust, whose building blocks of rocks periodically arranged three-dimensionally, was fully established at the beginning of the nineteenth century (19).
Minerals often come up with different names before that time, some of them remaining obscure. Nevertheless, the gems of the Goa Stone have been identified, and two main groups of minerals stand out: aluminium minerals, including corundum like rubies and sapphires, and silicate minerals like emerald, topaz, hyacinth, garnet and the Cananor stone.
Rubies, known as carbuncle in medieval lapidaries, had a significant symbolic and medicinal meaning. In the Peterborough Lapidary, a late fifteenth-century treatise in Middle English, the ruby, a red gem, was considered the lord of precious stones, having virtues above all the other gems, helping people to get rid of sickness. Beholding it would bring comfort to all distress, being a flood of paradise (20).

Rubies were used in cordials against poisons to absorb the humours, to strengthen and rejoice the heart, restore weakness and to predict future diseases to those who carrying them (21). Konrad von Megenberg (1309-1374), a German catholic scholar who wrote the first German book on Nature (*Das Buch der Natur*), referred to sapphire. The best sapphire came from India. It resembled the pure sky, and it was the most effective to cure headaches, tongue palsy, poor sight. It was helpful against unfaithfulness and fright; required chastity and brought peace of mind (22).
In the middle of the eighteenth century, this stone was credited for many virtues such as fortifying the heart and other noble parts of the body and removing the poison from pestilent carbuncle (or anthrax, skin ulcer caused by Bacillus anthracis) (23).

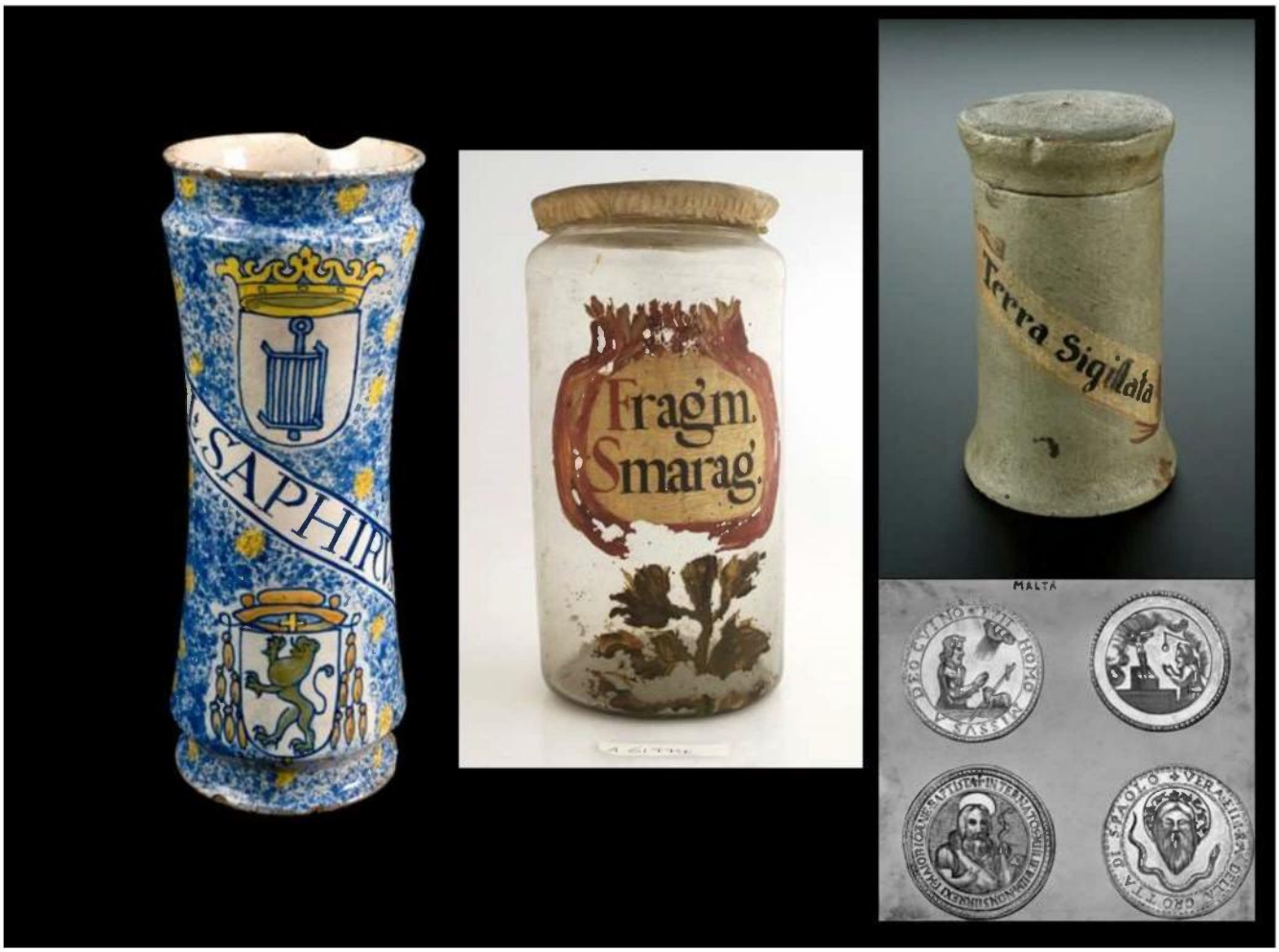

Figure 3 - Albarello from the royal monastery El Escorial, Spain, 1600-1625. Credit: Science Museum, London. Figure 3a - 'Apothecary jar used for emerald fragments'. Credit: Wellcome Collection. Figure 3b - Earthenware jar for terra sigillata, Spain, 1601-1700. Credit: Science Museum, London. Figure 3c -'Terra sigillata: seals Malta.'Credit: Wellcome Collection.

In 1800, the crystallographic analysis recognized the kinship between ruby and sapphire. Ruby is a mineral corundum, aluminium oxide (Al_2O_3). Sapphire is a variety of corundum; its colour is due to the presence of iron and a small amount of titanium (24).

It is difficult to assess the effectiveness of powdered rubies and sapphires taken orally. Aluminium (Al), their main chemical component, stands as the most abundant metal in the earth crust. Leading scientific consensus has not proved regular intake of aluminium products as being harmful; instead, aluminium salts have been used to improve the immune system's response to vaccines (25).

Emerald, Beryllium aluminium silicate ($Be_3Al_2Si_6O_{18}$), was credited as being efficacious against poisonings, curing epilepsy, accelerating parturition, being absorbent of acids and acrid humours, and also helpful against gastric pains, intestinal colics and stopping haemorrhages (26). Topaz [Al_2SiO_4 $(FOH)_2$] and Hyacinths, a variety of zircon (zirconium silicate [$ZrSiO_4$]), were credited as cordials, absorbents, antacids, and useful against fever and melancholy (27).

Garnet [Orthosilicat X_3Y_2 $(SiO_4)_3$]. The X site is usually occupied by divalent cations $(Ca, Mg, Fe, Mn)^{2+}$ and the Y site by trivalent cations $(Al, Fe, Cr)^3$. Garnet was deemed as a cardiac tonic, calming palpitations, bringing a good mood and resisting poison (28).

The Cananor Stone was a rare and costly stone. Engelbert Kaempfer (1651- 1716), the German naturalist, physician and explorer, gave the following description:

> The stone is so named from its source, the district of Cananoor in Malabar. The Portuguese there call it Pedra frigue for its cooling effect. There are three kinds or colours, to be sure: white, citrine, and dark blue, the last of which is very likely nephritic stone in all respects but lightness (29).

The Cananor Stone was identified with the nephrite stone in the Pharmacopea Tubalense. The best such stone came from Oriental Indy and was used as a diuretic in renal colic and to help expelling calculus and urinary sand (30).

Nephrite, a variety of jade, calcium, magnesium and iron-rich amphibole, $Ca_2(Mg,Fe)_5Si_8O_{22}$ $(OH)_2$, was known as the 'Stone of Heaven', highly valued by the Chinese (31).

Earths

Terra sigillata is a thin, dry, friable earth, yellow or reddish and without flavour. It has different names according to the place where it came from: Lemnian if it came from the Turkish island of Lemnos; earth from Malta if it came from that island. St Paul's earth is the same earth of Malta, recording the stay of St Paul on the island after a shipwreck. Samian earth came from the Greek island of Samos, and Chios earth from Chios.

The earths were purified in water, moulded in troches and sealed according to their origin, deemed as absorbent, astringent, good to treat intestinal colics, haemorrhages, gonorrhoea, vaginal discharges, vomits, and also suitable against poisons and pestilent fevers (32). Armenian earth is similar to *terra sigillata* (33).

The adsorbent clays used in Antiquity played a prominent role in toxicology, standing as the precursors of activated charcoal (34). Silica is a natural compound from all around the world in Nature, found in most rocks, clays and sands. When inhaled in its crystalline form, it causes severe lung damage.
However, water-soluble forms found in plants such as horsetail, a herb traditionally used to treat wounds, helps to strenghthen the connective tissue and improve the renal function.
Wholegrains, green beans, rice, cucumber and tomatoes also contain water- soluble silica. Although the role of silica in the human body is still not fully understood, it is known to support bone formation, helping in the production of collagen, improving the cardiac function and boosting the immune system (35).

Bezoar stones

Bezoar stones were certainly discovered by earlier hunter cultures and praised as magic devices (36). Animal concretions were regarded with fear and awe in primitive cultures, possibly because they penetrated the body without making a wound.
Bezoars were held in high esteem not only to counteract bites of poisonous animals, but also to counteract the so-called poison of 'malignant' diseases, used to prevent and cure the plague, smallpox, measles, and pestilences of all kinds (37).
According to Cyril Elgood:

> The most famous of all and the most universal in its potency is surely the Bezoar-stone, a native Persian stone, whose fame spread to Europe and whose very name is a corruption of the Persian words *bád-zuhr* or antidote (38).

After the arrival of Vasco da Gama (1469- 1524) in India in 1498 and the Portuguese taking over, bezoars were traded and studied by the Portuguese physicians Garcia de Orta (1501-1568) and Amato Lusitano (1511-1568) (39).
Bezoars decorated with delicate Indo-Portuguese filigree or kept in silver and gold containers are extant and evidence their high place of esteem in the past (40).
Chemically, the composition of bezoars is related to the animals from which they originate, as well as to their diet.
In a study by Van Tassel, a Persian bezoar (from the *Capra aegagrus*), was composed of calcium phosphate (whitlockite) (41).
A recent experiment of bezoars immersed in an arsenic-containing solution proved that they were able to inactivate the poison: arsenate and arsenite, the two toxic compounds of arsenic, being inactivated effectively, arsenate by phosphate, found in the mineral brushite of the bezoar stones, arsenite by binding to Sulphur found in degraded hair, a key component of bezoars (due to the ingestion of hair by the animals licking themselves) (42).

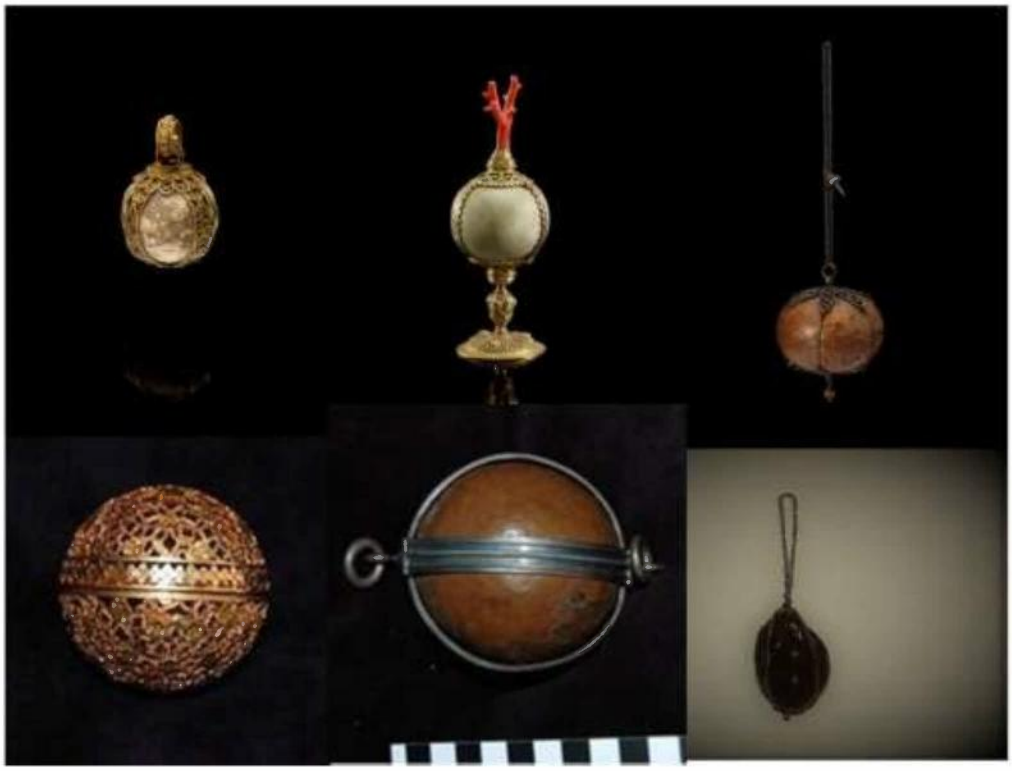

Figure 4 - Bezoars from the Távora Sequeira Pinto Collection. (Oporto) From left to right: 4a-Oriental bezoar from Ormuz mounted in Indo-Portuguese golden filigree pendant. 1580-1600. 2b-Oriental bezoar mounted on a golden filigree stand, decorated with a coral branch on the top. 18th century. 4c-Oriental bezoar mounted on Indo-Portuguese golden filigree pendant in the form of a fruit. 17th century. Figure 4d- Spherical Oriental bezoar within a silver Indo-Portuguese filigree container. 17th century (?). Figure 4e- Bezoar with silver mounts, probably German, 17th/18th century. Photo credits: Pedro Lobo. Figure 4f- Oriental bezoar stone pendant, attached to a golden chain. 17th century. Photo credit: Chris Duffin.

Unicorns

Ctesias, the Cnidian, a physician and historian from the fifth century BC, introduced the myth of unicorn in European medicine, art and literature (43). Aelius or Claudius Aelianus (175 – c. 235 AD) summarized the belief in the existence of horned animals in India:

> India produces horses with one horn, they say, and some country fosters asses with a single horn. And from these horns, they make drinking vessels, and if someone put deadly poison in them and a man drinks, the plot will do him no harm. For it seems that the horn both of the horse and the ass is an antidote to poison.[2](44)

Aelian seems to describe the Indian rhinoceros. The belief in the alexipharmic virtue of the rhinoceros horn, freeing from certain diseases and poisons those who drank from beakers made out of it, is still current in the Orient (45). The myth of the unicorn

2 Translation by Scholfield 1958, 201 - Aelian, *On Animals*, Book III, Chapter 41.

flourished throughout the Middle Ages. Philippe de Thaon, the first known Anglo-Norman poet from the 11th century, gives a full report of the unicorn associated with Christianity:

> Monoceros is an animal which has one horn on its head,
> it is caught by means of a virgin, now hear in what manner.
> When a man intends to hunt it and to take and ensnare it,
> he goes to the forest where is its repair;
> there he places a virgin, with her breast uncovered,
> and by its smell the monoceros perceives it;
> then it comes to the virgin, and kisses her breast,
> falls asleep on her lap, and so comes to its death;
> the man arrives immediately, and kills it in its sleep,
> or takes it alive and does as he likes with it.
> It signifies much, I will not omit to tell it you.
> Monoceros is Greek, it means one horn in French:
> a beast of such a description signifies Jesus Christ;
> one God he is and shall be, and was and will continue so[3](46).

Curiously enough, Thaon does not describe the Indian rhinoceros (*Rhinoceros unicornis*), but the spiral twistings of a marine mammal corresponding to the teeth of the whale from the North Sea *Monodon Monoceros.* In 1638, the Danish zoologist and antiquarian Ole Worm (1588-1654) wrote a dissertation on the narwhal tusk, showing the skull of the whale with the tusk. He concluded that all unicorns from Europe were whale tusks and that the unicorn, the mythical animal, did not exist (47).

In the *Pharmacopeia Tubalense*, Coelho refers to the ancient myth of the unicorn, the real unicorn, kept in the treasures of kings and nobles, its white horn looking like ivory. The unicorn continued to be regarded as the most potent poison antidote, also of great help in severe diseases like smallpox, plague, measles, epilepsy, and as a blood purifier (48).

Narwhal and elephant tusks are mainly composed of ivory, a white and hard substance consisting mainly of dentine, the primary component of teeth and tusks of mammals, regardless of the origin of the species (mammoth, walrus, narwhal and elephant).

Tusks are composed of inorganic substances such as calcium and phosphates ($Ca_{10}(PO_4)_6(CO_3)\ H_2O$)(49). The main component of the horns of animals including the Indian rhinoceros (*Rhinoceros unicornis*) is keratin, a protein, also the main component of human and animal hair. Cups made of Indian rhinoceros horns were worked in beautiful Indo-Portuguese jewelry.

3 Translation by Wright 1841, 81 – Philippe de Thaon, vv; 198-210.

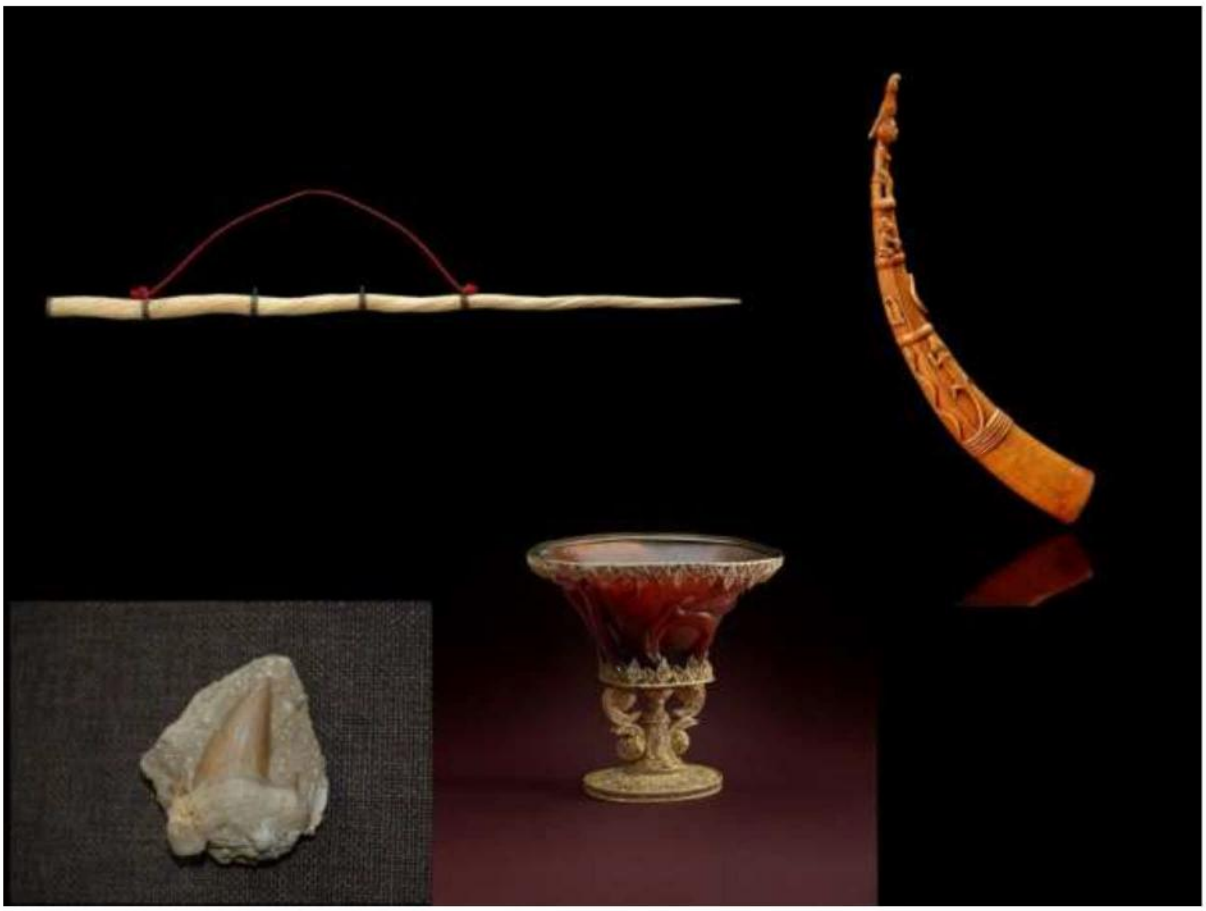

Figure 5 - Narwhal tusk of an Arctic cetaceous (*Monodon monoceros),* 16th/17th century, European silver mounts. 5a- Carved rhino cup. China, Goan filigree holder with vegetal decoration, late 16th century. 5b- Elephant tusk. Probably from Sierra Leone or Congo, 16th century. 5c- Fossil shark tooth from a Dutch Kunstkammer. 17th century. Távora Sequeira Pinto Collection (OOporto) Photo credits: Pedro Lobo.

From the biochemical point of view, animal tusks and horns are, like bezoars, rich in phosphates and keratin of proven effect in inactivating arsenic (and possibly other poisons).

Ivory scrapings

Ivory tusks from the African elephant (Elephas (Loxodonta) africanus A.) front growing teeth were most prized in decorative arts. Ivory scrapings were employed in medicine, in the treatment of intestinal colics, diarrhoea, epigastric pain, jaundice, intestinal worms, epilepsy, melancholy, fevers and other conditions (50).

Saint Paul's tongues

These tongues are fossils, *glossopetra*, petrified teeth from gigantic sharks, *Carcharodon megalodon*, which once ruled the Tertiary seas. The best were found on he island of Malta, and were used as amulets and credited as antidotes because they

were believed to originate in a mythic poisonous dragon (51). Like the earth of Malta, St Paul's tongues owe their name to the alluded stay of St Paul in the island of Malta. Despite being fossils, they are possibly organically similar to narwhal and elephant tusks.

Seed pearl

Pearls, organic concretions originating in marine bivalve mollusks of the family of Unionidae and Margaritiferidae, are composed of aragonite (calcium carbonate) and conchiolin, a protein, being perfected by Nature. They are amongst the most celebrated gems. However, they are no minerals (52). The best pearls were said to come from the East, where they were surrounded by legends and myths (53). Oriental seed pearls were deemed as cordials, useful against poison, and efficacious to restore strength and purify the blood. They would fight all acids better than any other alkaline substance, and alleviate haemorrhages, diarrhoea and similar gastrointestinal complaints (54).

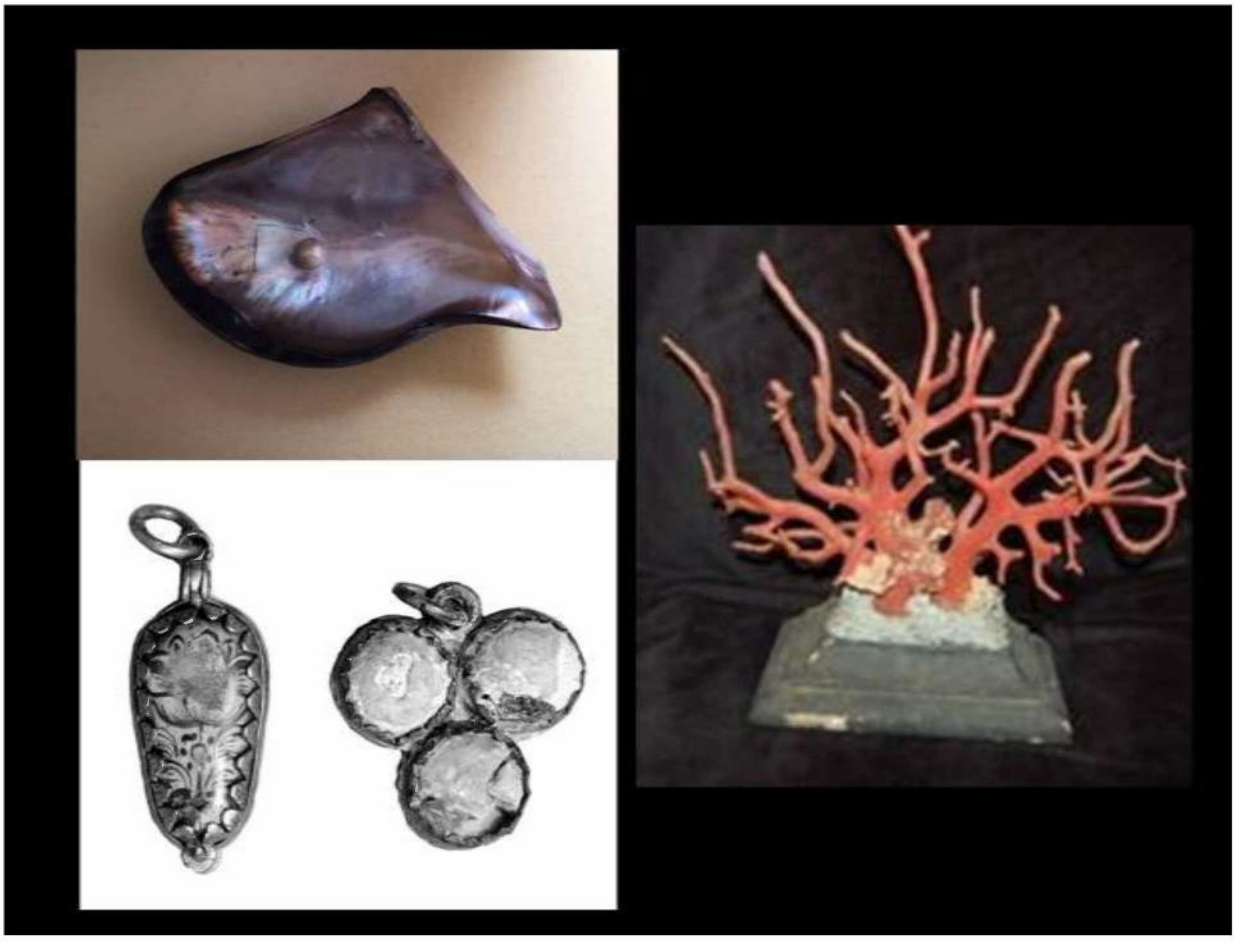

Figure 6 - Encysted pearl in the shell from a Dutch 'kunstkamer' 17th century and 6a-Red coral branch from a German 'Kunstkammer', 17th century. Távora Sequeira Pinto Collection (OOporto). Photo credit: Pedro Lobo. 6b- Crabs eyes, 2 pendants, one consisting of a group of three.' Credit: Wellcome Collection.

Coral

Corals, skeletons secreted by small marine cnidarian animals, known as polyps, were supposed to be a sea plant turned to stone hardened by the air. They were esteemed as powerful amulets bringing heath to its wearers and averting the harmful results of misfortune (55). Coelho recommended red coral to bring comfort and joy to the heart because of its red colour, to purify the blood, to act as an antacid, being useful in the treatment of dysentery, diarrhoea, helping in haemorrhoids and vaginal haemorrhages because of its alkaline properties (56).
Calcium carbonate ($CaCO_3$) is a common substance found in rocks such as the minerals calcite, aragonite, limestone and calcite. It is currently used in medicine mainly as antacid and as a source of calcium which plays a crucial role in the body, being necessary for normal functioning of nerves, cells, muscles and bones (57). The role played by calcium in the human organism provides insights into some medical indications of substances mainly composed by calcium carbonate (58).

Crab's eyes

Consisting of calcareous concretions, found in the stomach of the river Crawfish, Astacus fluviatilis, crab's eyes were very valued medicines. Calcium carbonate ($CaCO_3$) is their main chemical compound. They were absorbent of the acids, employed in cordials, and in the treatment of gastric pain, urological pain provoked by the obstructive kidney and bladder stones and locally applied in wounds, bruises and haemorrhages (59).

Deerhorn tips and spodium

The ancients used to burn animal bones (*spodium*) and deer horn tips which turned it into a white powder, rich in calcium, that they added to cordials and believed to be effective against fevers, epilepsy paralysis and convulsions (60).

Musk

This valuable substance secreted by the male musk deer for scent marking is strong-smelling reddish-brown, used in medicine and perfumery since ancient times. It figures in Hippocratic gynaecological recipes and is a frequent ingredient of cordials. A prominent constituent of its intense odour is the hydrocynamic acid. It is also rich in salicylic acid and salicylaldehyde (the basic ingredients of aspirin), which the beaver gets from its natural diet of willows. Its constituents are mainly amounts of benzoic acid, benzyl alcohol, borneol, catechol and various phenols, giving castor a decidedly acidic and 'cleaning nature' (61).

Ambergris

Ambergris is a rare product that occurs in around 1 per cent of sperm whales, provoked by the fatal intestinal rupture due to curved like parrot squid beaks, ingested by the sperm whale, passing from the stomach chafing and irritating the intestinal lining. A growing mass is formed becoming a concretion that is expelled floating on the sea until it comes ashore (62).
Coelho discusses the origin of ambergris, unknown at his time, describing white, grey and black amber, ambergris being the best for medicine, as a fortifier for the brain and heart, acting as anti-depressive. It was effective against melancholia, very useful against poisons, and most helpful against pestilence and also an excellent aphrodisiac. It should not be prescribed to women since it provokes hysteria (63). Ambrein, a major constituent of ambergris, has proved to act as a male sexual stimulant in rats by producing recurrent episodes of penile erection (64).

Amber

Amber, the Baltic fossil resin from *Sciadopityaceae,* was identified in the early nineteenth century as a product of pine-like prehistoric trees, dated to the Tertiary Period (65).
This fragrant and mysterious essence from the Baltic Sea has been regarded as an amulet against evil external forces and as a medicine to facilitate fertility, cure fever, and drive off evil spirits, among other indications. Amber acid (butanedioic acid, ethane -1, 2- diccarboxilic acid), HOOC - CH_2 - CH_2 - COOH, participates in the process of cell respiration and in the Krebs cycle.
This substance, known as 'succinate', a synonym of 'amber acid', strictly speaking means the anion of succinic acid, and has stimulating properties as a bronchial antispasmodic; it boosts biochemical and physiological reconstructive processes in different organs, as recent studies have proven (66).

Camphor

Camphor is of widespread use in medicine. *Cinnamomum camphora* (L.) is a plant of the Lauraceae family of Asiatic origin. Its oil, containing camphor and safrole, borneol, heliotropin, vanillin and terpineol, as well as sesquiterpene alcohols, is used in the preparation of expensive perfumes.
It is used in medicine due its mild antiseptic properties and mainly indicated in respiratory conditions, also used for muscular strains and rheumatic conditions. In small doses, it stimulates respiration, being employed against asthma, bronchitis, emphysema, lung congestion, rhinitis, and also an analeptic in cardiac depression (67).

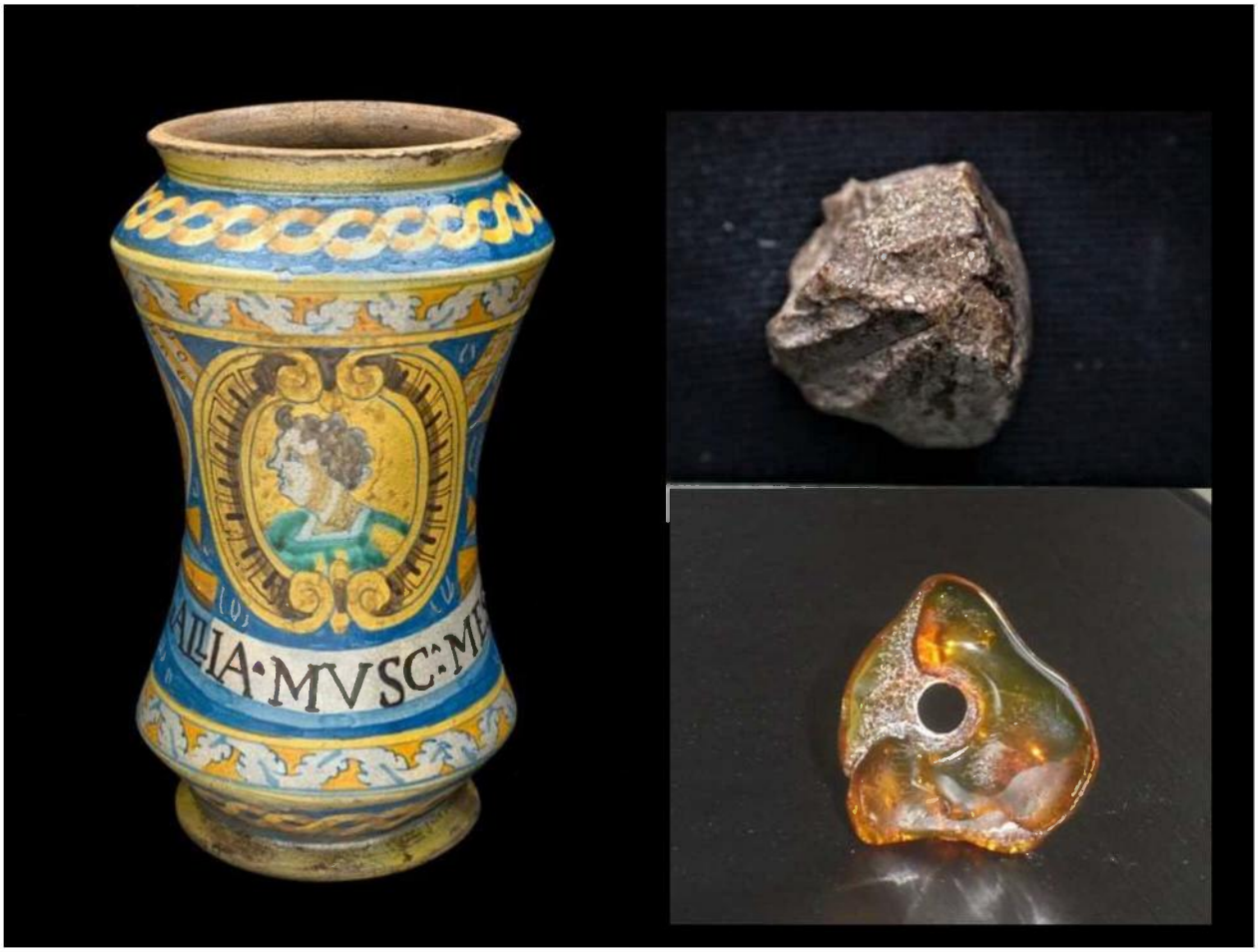

Figure 7 - Albarello for Mesue's French Musked Lozenges of Aloeswood from Sicily, Italy. Credit: Science Museum, London. 7a- Piece of grey amber, belonging to the Vigani Cabinet of Queens's College, University of Cambridge, early 18th century (compartment E17). Image reproduced with kind permission of the President and Members of Queens' College. 7b- Baltic amber. Author's collection.

The end of myths

When Gaspar Antonio created the Goa Stone, severe criticism on the medicinal properties of precious stones had already been arising. The Irish natural philosopher, chemist and inventor, Robert Boyle (1627-1691), known as the Father of Chemistry, dismissed the therapeutic value of gems:

> For my part, I never saw any great feats performed by those hard and costly Stones, (as Diamonds, Rubies, Sapphires) that want to be worn in rings (68).

A similar dissatisfaction arises when we go through the ingredients of the Goa Stone. When reading its indications in the work of Rumphius, a long repetition of the same medicines with similar effects and some variations seems to emerge.
Some groups of different and costly ingredients currently prove to belong to the same chemical substance, as summarized in Table 2.

Ruby Sapphire	Aluminium minerals
Emerald Topaz Hyacinth Granat Cananor Stone (Nephrite) Earths (*Terra Sigillata,* Malta Earth, White St Paul's Earth)	Silicat minerals
Bezoar stones Narwalh teeth, Ivory scrapings, Unicorn scrapings, Rhino horns St Paul's tongues (Glossopetra) Deerhorn tips Spodium	Calcium Phosphates And Keratin
Seed pearls Coral Crabs eyes	Calcium carbonate
Musk	Benzoic acid, benzyl alcohol, borneol, catechol and various phenols
Amber	Amber acid
Ambergris	Ambrein
Camphor	Camphor and safrole, borneol, heliotropin, vanillin and terpineol, and sesquiterpene alcohols

In the mid-17th century, William Heberden (1710-1801) one of the most reputed doctors of the time, wrote Heberden completely ridiculed and disallowed the theriacs and mithridatics that, like bezoars, were considered as alexipharmacs and all cure diseases (69).

The English physician and chemist Frederick Slare (1647?-1727) carried out experiments to test the efficacy of bezoar stones, the result being unsatisfying:

> From the experiments we «My infer, that Bezoar ought not to be truſted to, as an *Alkali* to correct poiſonous or other corrosive Salts or Humours, notwithstanding the great Encomium given to it. (70)

As time went by, bezoars lost their credit. In the 19th century, they were no longer

decorated (71). Despite the reputation and prestige of the Goa Stone, wrapped in gold foil and carefully kept in beautiful containers of Indo-Portuguese gold and silver filigree, its therapeutic efficacy was also increasingly dismissed.

In a recent survey of the Goa Stone, very popular and esteemed in Great Britain at the end of the 17th century, the British geologist and pharmaceutical historian Christopher J. Duffin gives full account of the disbelief in the efficacy of the Goa Stone in the treatment of severe conditions, being sometimes associated with the Gascoigne's powder or other alexipharmic compounds.

Controversy also came up because the secrecy of recipes was also being challenged and doctors realized that they had been prescribing medicines of unknown composition.

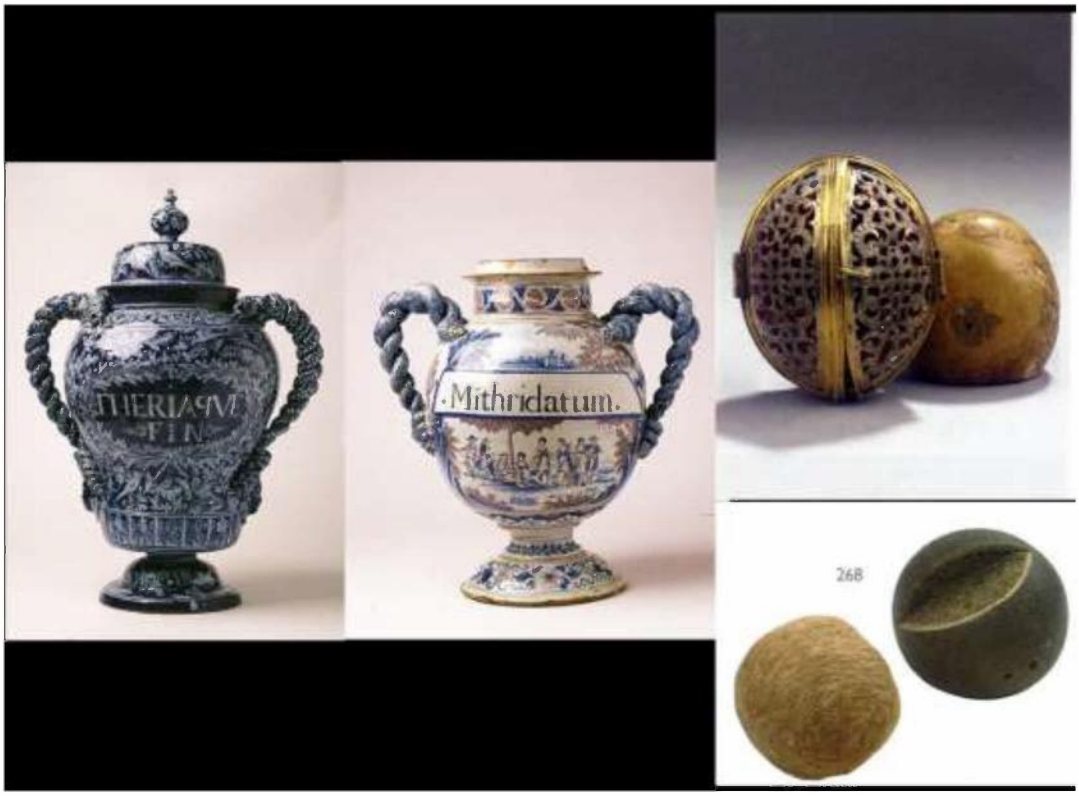

Figure 8, 8a - Mithridaticum and Theriac porcelain jars. 18th century. 8b-Bezoar stone with decorated oval gold filigree container, 17th century 8c- Two bezoars. Open bezoar with slice removed and German trichobezoar, 19th century. Courtesy of the Health and Pharmacy Museum, Lisbon.

The disbelief in the Goa Stones followed closely the decline of the belief in the miraculous properties of the bezoars and other mythicized substances such as the unicorn (72). Laterly, R. van Tassel studied the composition of bezoars from the Collection of Henri van Heurck. Seven incomplete egg-shaped objects were Goa Stones, the smooth outer surface coated with gold foil. The X-ray diffraction proved that the coating was gold. The artificial nature of the specimen was apparent due to the absence of any scaly or radiating structure.

The inner material looked homogeneous, granular and porous, and had a grey sandy, white or light brown colour. It reacted strongly with effervescence in contact with diluted acid. The X-ray diffraction powder data indicated calcite in addition to plenty of quartz (73). Some bezoars of this collection are calcite concretions and calcite 'Pebbles' (74).

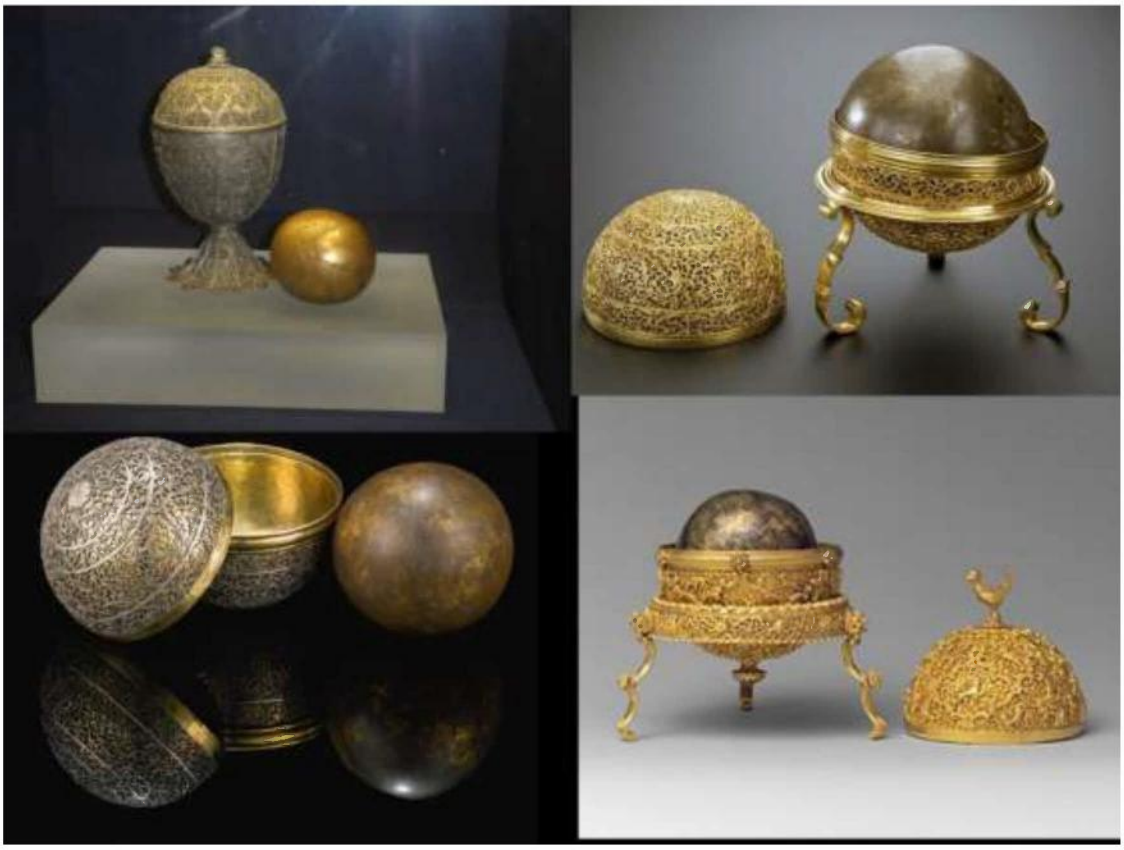

Figure 9 - Spherical Goa Stone with silver Indo-Portuguese filigree container, cup with stand and cover decorated with arabesques. Late 17th century. Courtesy of the Lisbon Health and Pharmacy Museum. 9a - Oval Goa Stone, Europe, 1601-1800. Credit: Science Museum, London. 9b - Goa Stone and gold and silver container. Indo-Portuguese filigree, end of the 17th century. Távora Sequeira Pinto Collection (OOporto). Credit: Pedro Lobo. 9c- Goa Stone and container of gold with cast legs and finials, late 17th- early 18th century. Metropolitan Museum of Art New York.

Conclusion

The Goa Stone shared the splendour of bezoars, unicorns and gems as the most expensive medicines, endowed with mythical and magic powers of cure. It was created in the mid-seventeenth century when Lisbon was still the centre of knowledge of the Eastern lands; it took one hundred and a half years before the ancient medicinal use of rarities came definitively to an end by the late 18th century, lasting as the most remarkable pharmacological achievement of the Portuguese Jesuits.
Insights of modern chemistry shed some light on possible therapeutic effects of each compound. When the compounds were put together, one does not know how they would react. Some main groups of substances: aluminium, silicate minerals, calcium

carbonate and amber acid are essential to the human organism. However, high doses of aluminium, silica and calcium carbonate are toxic. So far, no thorough studies have been carried out on this issue. The only recent study on the composition of the Goa Stones just showed gold (used to cover the costliest specimens), calcite and calcite and quartz pebbles. From the only extent study, only calcium (from calcite) and quartz (SiO2) (from the silica minerals employed) prevailed.

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References

1. Borges C. J. *The Economics of the Goa Jesuits 1542-1759.* New Dehli: Concept Publishing Company, 1994, 15-19.
2. Anagnoustou S. The International Transfer of Medicinal Drugs by the Society of Jesus (Sixteenth to Eighteenth Centuries) and Connections with the Work of Carolus Clusius. In: *Carolus Clusius: Towards a Cultural History of a Renaissance Naturalist.* Florike Egmont et al. (Eds). Amsterdam: Koninklijke Nederlandse Akademie van Wetenschappen, 2007, 293-312.
3. Borges 1994, 35- 41.
4. Van Loon, H.W. *The Golden Book of the Dutch Navigators.* New York: The Century Co., 1916, 39, 12-16.
5. Beekmann E.M. (Ed.,transl., intr.). *The Ambonese Curiosity Cabinet Georgius Everhardus Rumphius.* New Haven and London: Yale University Press, 1992, xlvi.
6. Beekmann 1992, 374-375.
7. Ibidem.
8. Freyer J., Chiswell R., Roberts R. & White R. *A New Account of East-India and Persia, in Eight Letters, Being Nine Years travels, Begun 1672. And Finished* 1681. London: Printed by R.R., 1698, 149-150.
9. Borges 1994, 86.
10. A.A.V.V. *Colleção de Varias Receitas e segredos particulares das principaes boticas da nossa Companhia de Portugal* (…). Roma: Archivum Romanorum Societas Iesu (ARSI), 1766, 262-267.
11. AAVV 1766, 265.
12. AAVV 1766, 266.
13. Elgood C. *A Medical Story of Persia and the Eastern Califate from the earliest times until the year A.D. 1932.* Cambridge University Press, 1951, 369.
14. Rätsch Chr. & Guhr A. *Lexikon der Zaubersteine aus ethnologischer Sicht.* Wiesbaden:

VMA-Verlag, 1989, 75.
15. Said, H.M. *Al-Beruni's Book on Mineralogy. The Book most comprehensive in the knowledge of stones. Kitab Al-Jamahir Fi Marifat Al-Jawahir.* Islamabad: Pakistan Hijra Council, 1989, 172 and 281-336.
16.Zilio-Grande. *Ahmad al-Tīfāsī. Il libro delle pietre preziose.* Venezia: Marsilio editore, 1999, 60.
17.Donzelli G. *Antidotario Napolitano.* Napoli: Francisco Savio, 1652, 49.
18.Grey. *A Choice Manuall, or Rare and Select Secrets in Physick and Chyrurgery*. London: Printed for John Clarke, 1671, 90.
19.Lüschen H. *Die Name der Steine. Das Mineralreich im Spiegel der Sprache.* Basel: Ott Verlag Thun, 1979, 276.
20.Evans J. & Serjeantson M. S. *English medieval lapidaries.* London: Humphry Milford Oxford University Press, 1933, 110.
21.Coelho M. R. *Pharmacopea Tubalense Chimico-Galenica*. Lisboa Occidental, 1735, 316-317.
22.Pfeiffer, F. *Das Buch der Natur von Konrad von Mengeberg. Die erste Natur Geschichte in Deutsche Sprache.* Stuttgart: Verlag Karl von Aue, 186, 457-458.
23. Coelho 1735, 318.
24. Lüschen 1979, 305.
25. Health, Myths and Facts About Aluminium in Human Health, https://www.aluminum.org/resources/electrical-faqs-and-handbooks/health (accessed on the 27th October 2019).
26. Coelho 1735, 306.
27. Coelho 1735, 308 & 320.
28. Coelho 1735, 308-309.
29. Carrubba R.W. (Transl.). *Engelbert Kaempfer. Exotic Pleasures. Fascicle III Curious Scientific and Medical Observations.* Southern Illinois University Press, 1996, 105.
30. Coelho 1735, 311.
31. Chu A. & Chu Gr. *Jade-Stein des Himmels*. Stuttgart: Kosmos, 1978.
32. Coelho 1735, 318-319.
33. Coelho 1735, 301.
34. Pillay V.V. Current Views on Antidotal Therapy in Monitoring Cases of Poisoning and Overdose. *Journal of the Association of Physicians of India*. 2008, 56: 881-892.
35.Silica: benefits, dosage, side-effects. https://www.hollandandbarrett.com/the-health-hub/vitamins-and-supplements/supplements/what-is-silica/ (accessed on the 27th October 2019).
36. Rätsch & Guhr 1989, 49.
37. Mackenzie D. *The Infancy of Medicine.* London: Mcmillan and Co. Limited, 1927, 211-212.
38. Elgood 1951, 369.
39. Barroso M. D. S. Bezoar stones, magic, science and art. In: *A History of Geology and Medicine.* Duffin, C.J., Moody, R.T. J. & Gardner-Thorpe, C. (eds). London: Geological Society, Special Publication, 2013, No. 375, 193-207.
40. Barroso M. D. S. The Bezoar Stone: a princely antidote. The Távora Sequeira Pinto Collection – OOporto. *Acta Medico-Historica Adriatica*, 2014, 12 (1): 77-98.

41. Van Tassel R. Bezoars. *Janus*, 1973, 241-259.
42. Malcom C. Bezoar Stones. *The Navigator: Newsletter of the Mel Fisher Maritime Heritage Society,* 1998, 13: 2.
43. Nichols A. *The complete fragments of Ctesias of Cnidos. Translation and Commentary with an Introduction*. Dissertation for the degree of Doctor of Philosophy, University of Florida, 2008, 115.
44. Scholfield A. F. (Ed., Transl.). *Aelian*, *On Animals. Books I-V*. London: William Heinemann Ltd, 1958.
45. Shepard O. *The lore of the Unicor.* New York: Avenue Books, 1930, & 36.
46. Wright Th. (Ed., Transl.). *Philip de Thaon. Popular Treatises on Science written during the Middle Ages, in Anglo-Saxon, Anglo-norman, and English*. Cambridge: R. and J. E. Taylor, Red Lion Court, 1841.
47. Worm O. *Museum* Wormianum. *Historia rerum rariorum, tam naturalium, iconibus illustra*. Amsterdam: apud Lvdovicvm & Danielem Elzevirios, 1655, 325.
48. Coelho 1735, 186-187.
49. Espinosa E. O. & Mann M-C. *Identification Guide for Ivory and Ivory substitutes.* Baltimore: World Wildlife Fund and The Conservation Foundation, 1999, 4.
50. Coelho 1735, 175-176.
51. Rätsch Chr. *Die Steine der Schamanen. Koralle, Fossilien und die Landschaft des Bewußtseins.* München: Eugen Dierichs Verlag, 1997, 117.
52. Schlüter, J. & Rätsch, C., Perlen und Perlmutt, Ellert & Richter Verlag GmbH, Hamburg, 1999, 4 & 23.
53. Barroso M. D. S. Pearl. An ancient antidote of Eastern origin. In: *Toxicology in Antiquity*
II. Wexler, P. (Ed.). Second edition. Bethesda (USA): Academic Press Elsevier, 2018, pp. 401-410.
54. Coelho 1735, 164.
55. Riddle J. M. (Ed.). *Marbode of Rennes' (1035-1123) De Lapidibus.* Wiesbaden: Franz Steiner Verlag, 1977, 59.
56. Coelho 1735, 230-231.
57. https://www.webmd.com/drugs/2/drug-16642/natural-oyster-shell-calcium-oral/details| (accessed on the 31st December 2019).
58. Barroso M. D. S. Coral in Petrus Hispanus' 'Treasury of the Poor'. In: *Geology and Medicine: Historical Connections.* Duffin, C.J., Gardner-Thorpe, C., Moody, R.T. J. (Eds). London: Geological Society, Special Publication, 2017, No. 452, 267-282.
59. Coelho 1735, 178.
60. Coelho 1735, 328.
61. Scarborough J. Pharmacology in the Early Roman Empire: Dioscorides and His Multicultural Gleanings. In: *Science and Medicine in the Classical World.* Keyser, Paul T. Scarborough, J. (Eds). Oxford: University Press, 2018, 527-529.
62. Kemp Chr. *Floating Gold. A Natural (And Unnatural) History Of Ambergris.* Chicago: The University of Chicago Press, 2012, 11-113.
63. Coelho 1735, 296-297.
Taha S. A., Islam M. W. & Ageel A.M. Effect of ambrein, a major constituent of amber gris, on masculine sexual behavior in rats. *Archives Internationales de Pharmaco dynamie et de Therapie.* 1995, March-April, 329 (2): 283-294.

64. Rice P. C. *Amber. The Golden Gem of Ages.* New York Van Nostrand Reinhold Company, 1980, 149.
65. Bogdasarov A.A. & Boddasarov M.A. Amber derivatives in medicine: Historical Background. In: *Amber in the History of Medicine.* Polyakova Irina, Duffin Christopher John, Sororova, T. J. (Eds). Kaliningrad: Regional Museum, 2016, 16-23.
66. Duke J. A. *CRC Handbook of Medicinal Herbs.* Boca Raton: CRC Press, 1985, 125.
67. Heberden, W. Antitheriaka: An essay on mithridatium and theriac. [London], 1745.
69. Barroso. 2014, 77-98.
70. Slare, F., *Experiments and observations upon oriental and other bezoar-stones, which prove them to be of no use in physik,* Tim Goodwin, London, 1715, 4.
71. Boyle R. *Essay about the origin & virtues of gems wherein are propos'd and historically illustrated some conjectures about the consistence of the matter of precious stones, and the subjects wherein their chiefest virtues reside.* London: William Gobbid, 1672, 4-5.
72. Duffin C. J. Lapis de Goa: the 'cordial stone' – part two. *Pharmaceutical Historian*, 2010, 40: 42-46.
73. Van Tassel R. *Bezoars and the Collection of Henri van Heurck (1838-1909).* Antwerpen: Koninklijke Maatschappij voor Dierkunde van Antwerpen, 1970, 19.
74. Van Tassel 1970, 13.