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Vinum resinatum: Scientists and unintended consequences

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Dedicated to the memory of my friend Hartmut Derendorf.

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The art of winemaking has a long history. The methods and techniques changed over millennia as did the consumers taste and habits. Improving the taste of the wine and preventing conversion to vinegar required fantasy and creativity. The principal substances employed as *conditurae* were seawater, turpentine, either pure, or in the form of pitch (pix), tar (pix liquida), or resin (resina); lime, in the form of gypsum, burnt marble, or calcined shells; inspissated must, aromatic herbs, spices, and gums, and these were used either singly, or cooked up into a great variety of complicated confections. Turpentine exposure (oral. dermal. or respiratory) confers urine the scent of violets. It is generally assumed that turpentine's effect on urine was noticed subsequent to its use as medicine, as a component of various remedies popular in antiquity and thereafter. The high price of such elaborate concoctions would have made however such means available to only a privileged few. Furthermore, the high number of components would also have made association of a particular ingredient with a specific effect difficult if not impossible. We examined the possibility that the effect of turpentine on urine was noticed due to its presence in wines and therefore to the likely widespread exposure of the population to its effects. We review the literature supporting this possibility and provide biographic data on some of the pharmacists, chemists, and physicians involved.

1. Introduction

The art of winemaking has a very long history, recent discoveries placing the first attempts to a Neolithic village in Henan province (China) where a mixed fermented beverage of rice, honey, and fruit (hawthorn fruit and/or grape) was being produced as early as the seventh millennium BC (McGovern et al. 2004). Chemical analyses of ancient organic compounds from sites in Georgia in the South Caucasus region, provide biomolecular archaeological evidence for grape wine and viniculture from the Near East, at ca. 6,000-5,800 BC (McGovern et al. 2017).

The methods and techniques used in winemaking certainly evolved over millennia as did the consumers taste and habits. More detailed knowledge about winemaking is available for the Greek and later Roman times. From Wilhelm Adolph Becker we hear that, wine was mixed with either cold or warm water for drinking, that drinking it pure was considered barbaric (*Sitte der Barbaren*) and that Zaleucus (≈ 7th century BC), a Greek lawgiver in Italy banned the drinking of undiluted wine except for medical purposes. He also points out that many additives were used such as pitch (*Pech*), resin (*Harz*), gypsum *(Gyps),* clay *(Thon),* lime (*Kalk)* and burnt marble *(Marmor),* and also seawater for refinement (*Seewasser zur Veredlung)*, not necessarily appreciated by the Romans who apparently detested the *vinum resinatum* (Becker and Göll, 1877; 1882;).

From the *Dictionary of Greek and Roman Antiquities* we hear that the "*principal substances employed as conditurae were seawater, turpentine, either pure, or in the form of pitch (pix), tar (pix liquida), or resin (resina); lime, in the form of gypsum, burnt marble, or calcined shells; inspissated must, aromatic herbs, spices, and gums, and these were used either singly, or cooked up into a great variety of complicated confections"* (Anonymous 1890).

Becker, Wilhelm Adolph (1796 –1846), the son of art historian Wilhelm Gottlieb Becker (1753 –1813) was professor of archaeology at Leipzig and a foreign member of the Russian Academy of Sciences; His classical books printed in numerous editions were revised by Hermann Göll (1822–1886).

The use of *conditurae* (condiments), most notably turpentine, was a widely used and abused attempt at improving the taste of wine and preventing its conversion to vinegar (McGovern 2003). As a consequence, there was widespread exposure of the population to turpentine effects.

Ingestion of some foods or natural substances can alter the scent of urine: the resin of the terebinth tree (*Pistacia terebinthus*) and the derived distillate (*Oleum terebinthinae*), juniper berries (*Fructus juniperi*) and the oil (*Oleum juniperi*) as well as eucalyptus oil, all can to various degree confer urine a scent reminiscent of violets (Petroianu et al. 2018).

The most efficacious – according to lore – appears to be the distillate from the *terebinth* resin: the oil of turpentine. It is generally assumed that turpentine's effect on urine was initially noticed subsequent to its use as medicine, as a component of the various universal remedies available in Antiquity (Petroianu et al. 2018).

However, the high price of such elaborate concoctions would have made such remedies available to only a privileged few. Furthermore, the high number of components would have also made association of a particular ingredient with a specific effect difficult. We suggest that the effect of turpentine on urine was noticed due to its presence in the wines of Antiquity. We review the literature supporting this possibility and provide biographic data on some of the pharmacists, chemists and physicians involved.

2. Turpentine

Chios turpentine is the oleoresin (sap), Terebintha resina, of the terebinth tree (*Pistacia terebinthus)*. The addition of the name of the Greek island of Chios is due to it being the main growing area of the terebinth tree. Sap harvesters injure the tree by removing the bark. Debarked, trees secrete resin in an attempt to seal the wound. In addition to the eponymous terebinth tree, many other

tree species – mainly pine – produce protective resins; the chemical composition of the sap varies widely not only with the species but also with season and geographical distribution.
Steam distillation of resin separates the volatile components (pinene and other terpenes) from the solid residue called colophony or rosin (French *colophane*, German *Kolophonium*). The name colophony is derived from the Ionic city of Colophon, one of the main trading places for *terebinth* in antiquity. If the more ancient and rudimentary dry distillation is performed a dark(er) residue called *pix graeca* (Greek pitch or black rosin) is obtained. The names are however not consistently used and a high degree of context sensitivity is required when interpreting old texts.
The volatile component is the *spirit of turpentine,* also called *essential oil of turpentine* or *oil of turpentine (Oleum terebinthinae*) or simply turpentine. The term *essential* is a contraction of the original *quinta essentia* or fifth element, the *quintessential* one, as used by Paracelsus (1493–1541). This stems from the Aristotelian concept that matter is composed of the four elements as described by Empedocles (fire, air, earth, and water) plus a fifth one, the spirit or life.
The most prevalent components in (the oil of) turpentine are the bicyclic mono-terpenes (C_{10}) alpha- and beta-pinene, with lesser amounts of carene, camphene and limonene, and trace amounts of many other compounds. The colophony (rosin) contains a polymer, most likely poly-myrcene and tri-terpenoids (tetra- and penta-cyclic) (van den Berg et al. 1998; Mills and White 1989; Mahjoub et al. 2018; Xynos et al. 2018) (Fig. 1).

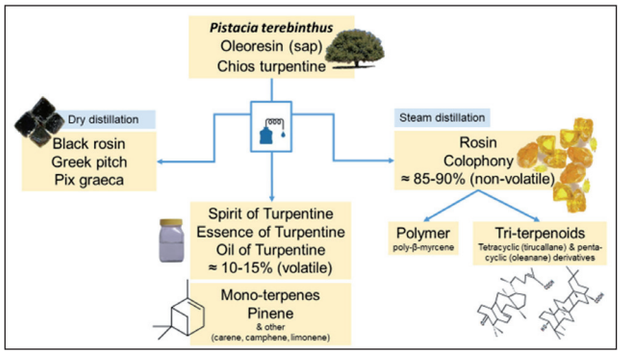


Fig. 1: The Elah tree (*Pistacia terebinthus*) and the eponymus Valley of Elah is known from the Bible as the place where the battle of David and Goliath took place. The oleoresin from this tree can be separated by steam distillation in the two main components: Essence of turpentine and the non-volatile colophony (rosin).

The tell-tale tri-cyclic di-terpenoids found in the resin of the unrelated pine trees (abietic or silvic acid) are not present in *Pistacia* resin, allowing differentiation (Tzedakis et al. 2008).
The ability to separate various fractions of a liquid by distillation was apparently acquired very early in history: based upon the discovery in the Indus valley of an earthenware distillation apparatus, a rudimentary process must have been developed some five millennia ago (Rovesti 1977).
Plinius the Elder ((23–79 CE); Book XV, Chapters 7) describes a method of condensing (most likely) turpentine vapor on fleeces of wool hung over the pot containing the heated material; this is the same method as that used by sailors at sea to obtain potable water from seawater during long voyages. For superb reviews of the topic, see Fairley (1908), and Liebmann (1956).

3. What smells like violets?

The scent of violets is due to various mono-cyclical terpenoids, mainly ionone (C_{13}) and irone (C_{14}). The ability not only of ingested, but also of topically applied or inhaled turpentine essence to confer a violet-like scent to urine was experimentally confirmed by Sir Hans Sloane (1660–1753) and later by Stehberger in Heidelberg under the supervision of anatomist and physiologist Professor Friedrich Tiedemann (1781–1861) (Sloane 1743; Stehberger 1827). Stehberger writes "*Turpentine inspired, was exhibited in the urine in a quarter of an hour; rubbed upon the skin, twenty-five minutes past before it was perceptible*".
Georg Adam Stehberger (1799–1866), son of Georg Michael Stehberger (1769-1837), was physician in Bruchsal and later *Assistenzarzt* (medical resident) in Mannheim, Grand Duchy of Baden (Germany). He was appointed *Geheimer Hofrath* (Privy Court Councilor) and *Ritter* (Knight) of the Zähringer Löwenorden (established 1812). His son Georg Carl (1831–1907) was a prominent physician in Mannheim, *Gründungsmitglied* (constitutory member 1863) of the Society of Physicians in Mannheim and initiator of the construction of the new city hospital (*Städtische Krankenanstalten*) (Gawliczek 1978).
The fate of turpentine oil in the human body was examined by Friedrich Wöhler (1800–1882). He pointed out that internal and external use of this oil, as well as the inhalation of its vapor, very quickly communicates a violet odor to the urine. Mixing oil of turpentine with urine however does not generate the violet smell (Woehler 1824). This indicates the need for metabolic conversion of turpentine oil components (pinene) in order to obtain the violet-like scent. A possible metabolic pathway from pinene to ionone was recently proposed (Al-Tel et al. 2020).
The topic was also examined by Sachs: he noted that only oil of turpentine but not colophony (rosin) produces the violet scent in urine in humans. Furthermore, he pointed out that admixture of turpentine (oil of) to urine does not create the violet scent either (Sachs, 1862).
Edmund Sachs (1837– 912) was physician in Lublin; his Doctoral Dissertation was defended 1862 in Dorpat. He was the father of Edward (1868–1957), doctor in Warsaw, after the Second World War in Lublin.
Brümmer examined the effect of daily administration of a low dose of oil of turpentine in humans: when receiving daily 20 drops (1 mL) of a 0.1% oil of turpentine solution the violet scent of urine appears after 3-4 days, or after administration of a cumulative dose of 4 mg of oil of turpentine (Brümmer 1900).
Theodor Brümmer (1873–1959) hailed from Lindloh (Haren; Ems) at the German-Dutch border. He studied Medicine in Göttingen, Kiel and Greifswald. His Doctoral Dissertation defended 1900 in Greifswald was titled *Wie wirkt das Terpentinöl in kleinen Dosen längere Zeit genommen?* (What is the effect of turpentine oil in small dose when administered for extended time?) (Fig. 2). He practiced medicine and pharmacy in Ter Apel, the Netherlands. There, with local chemist Dirk Steenbeek (1868–1951), Brümmer developed and successfully marketed a medicinal drink "*Brummersdrank*".

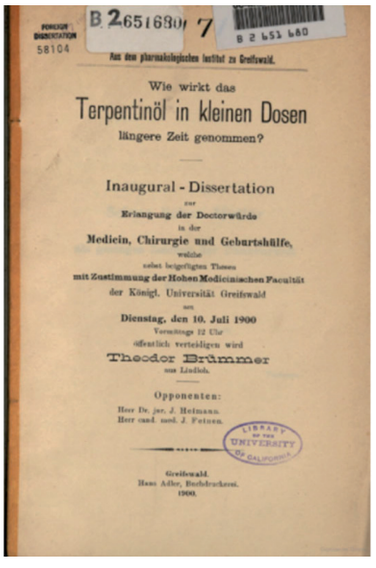

Wie wirkt das
Terpentinöl in kleinen Dosen
längere Zeit genommen?
Inaugural - Dissertation
Medicin, Chirurgie und Geburtshülfe,
Dienstag, den 10. Juli 1900
Theodor Brümmer
Opponenten:
Greifswald.
1900.

Fig. 2: Title page of Brümmer's doctoral dissertation defended 1900 in Greifswald entitled *Wie wirkt das Terpentinöl in kleinen Dosen längere Zeit genommen?* (What is the effect of turpentine oil in small dose when administered for extended time?).

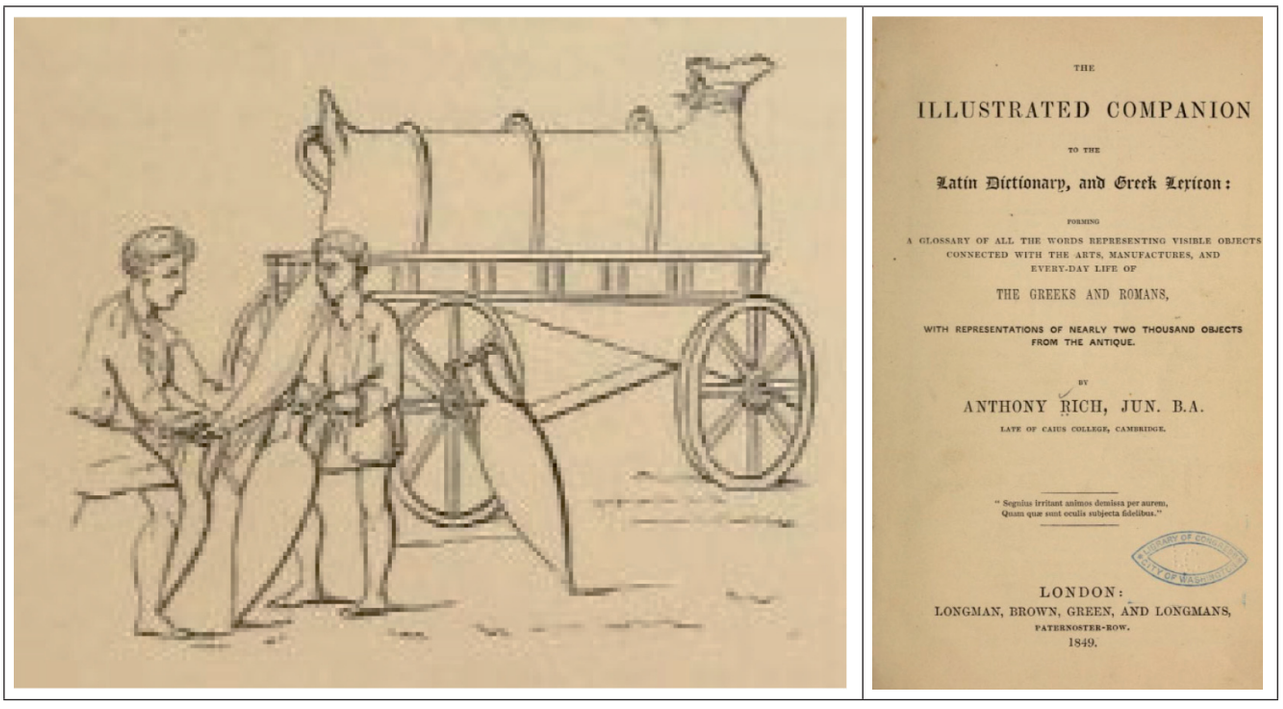
4. Resin in wine making

Resin was one of the most traded goods in the late Bronze Age and Antiquity. The Ulu Burun (Grand Cape) shipwreck (dated to the late 14th century BC) discovered close to Smyrna (Izmir) in Turkey contained at least 149 Canaanite jars of whom the majority contained *Pistacia terebinth*us resin (estimated one metric ton) (Peachey 1995). Plinius describes the addition of resin to wine (Book XIV, Chapter 20).

Marcus Porcius Cato (234–149 BC) recommends the addition of three (Roman) pounds (3 * 326 g) of resin to one culeus (525 liter) of wine; he recommends placing the resin in a small bag and shaking it regularly to enhance solubility (Thielscher 1963) (Fig. 3).

Assuming (very conservatively) an oil of turpentine content in resin of 10% and thus – according to Cato's recipe – turpentine in wine solution of 0.02%, a 100 mL glass of wine would suffice to provide a multiple of the dose required (4 mg) for urine perfumeation.

Pharmacist Franz X. Landerer (Fig. 4) describes the addition of 6-10 Okka (1 Okka = 1282 Gramm) resin to 100 Maass (1 Maass = 1,069 Liter) grape juice; he also attempts adding 2 pounds of Venetian turpentine (oil of turpentine) to the same volume of wine



THE

ILLUSTRATED COMPANION

TO THE

Latin Dictionary, and Greek Lexicon:

FORMING

A GLOSSARY OF ALL THE WORDS REPRESENTING VISIBLE OBJECTS CONNECTED WITH THE ARTS, MANUFACTURES, AND EVERY-DAY LIFE OF

THE GREEKS AND ROMANS,

WITH REPRESENTATIONS OF NEARLY TWO THOUSAND OBJECTS FROM THE ANTIQUE.

BY

ANTHONY RICH, JUN. B.A.

LATE OF CAIUS COLLEGE, CAMBRIDGE.

" Segnius irritant animos demissa per aurem,
Quam quæ sunt oculis subjecta fidelibus."

LONDON:
LONGMAN, BROWN, GREEN, AND LONGMANS,
PATERNOSTER-ROW.
1849.

Fig. 3: The culleus (wineskin) was a very large sack made of animal skin and used by the Romans for wine production and transport; also a unit of volume equal to 20 amphorae or 525 liters. Illustration from page 223 of *The illustrated companion to the Latin dictionary and Greek lexicon*, London 1849 (Rich 1849).

Ὁ Καθηγητὴς τῆς χημείας Κύριος Λάνδερερ.

Fig. 4: Franz Xaver Landerer (1809-1885): German pharmacist and chemist from Bavaria, joined 1832 the Court of Otto von Wittelsbach, King of Grece (1815 –1867) as Court Pharmacist. He was co-founder of the "Society of Natural History" and of the "Medical Society of Athens". With the establishment of the Othonian University of Athens (1837) he became full professor of pharmaceutical chemistry, prescription and botany. Published numerous works on botany and chemistry (Kahlheber 2006).

(0.6% solution) but describes the product as undrinkable (Landerer 1856).

Experiments performed by Walther N. Clemm suggest that due to solubility issues the maximum terpene concentration achievable by addition of (pine) resin to wine is 0.75% (Clemm 1907).

Walther Nicolaus Clemm (1865–1930) studied in Freiburg (1886). He defended his doctoral Dissertation titled *Heftpflaster- und Bindenbehandlung der Bauchorgane* in Darmstadt (Hesse) where he later practiced medicine. Interested mainly in nutrition and gastroenterology, he treated a number of conditions with *Teerwein* (Pitchwine; resinated vine) and published numerous related books such as *Weingeist als Schutzmittel gegen giftige Eiweisskörper* (Wine spirit as a protective agent against poisonous proteins).

5. Evidence in the literature

By the 15th century the effect of turpentine on urine's scent was common knowledge (Petroianu et al. 2018; Petroianu 2019). But was it used for this purpose?

The *oldest* reference (we have been able to identify) to Roman women ingesting turpentine for boosting their attractiveness by means of changing the odor of urine is from 1844 written by German poet Heinrich Heine (1797-1856) (Heine 1844).

Birch-Pfeifer söffe Terpentin,
Wie einst die römischen Damen.
(Man sagt, daß sie dadurch den Urin
Besonders wohlriechend bekamen.).

Birch-Pfeifer allegedly drinks turpentine
As once the Roman ladies did
(to obtain by doing so, it is said,
a particularly fragrant urine)

Charlotte Birch-Pfeiffer (1800–1868) (Fig. 5) was a German actress and prolific writer of whom Heine was obviously not particularly fond; Heine refers not to the Rome of the Antiquity but to that of Renaissance.

Fig. 5: Cover of *Theaterstücke* (German Edition); Publisher: Jazzybee Verlag (2012); Charlotte Birch-Pfeiffer (1800–1868), Lithography 1831 by Franz Hanfstängl (1804–1877)

Austrian psychologist and physician Wilhelm Stekel (1868–1940) (Fig. 6), a pupil of Freud, published 1908 *Nervöse Angstzustände und ihre Behandlung* (Conditions of nervous anxiety and their treatment). The book's second edition came out 1912, the third 1921, while in 1923, the English translation (of the 3rd German edition) was published by Routledge & Kegan Paul in London. In the German second edition (1912), a very interesting case (# 31) is included (not present in the first Edition); the case is also included in the English edition as # 37.

No. 31.
Ein zirka 30jahriger Mann erkrankt an heftigem Heufieber, so bald er Veilchen riecht.....
Nach einem längeren Aufenthalt bemerkte er nach der Miktio des Mädchens wieder den ihm
verderblichen Geruch von Veilchen. Das Mädchen hatte zur Verbesserung ihres Geruches auf Empfehlung eines Arztes Terpentinkapseln eingenommen. Nach Terpentin tritt bekanntlich ein sehr intensiver Veilchengeruch des Urins auf.

No. 37.
A man of about thirty gets violent hay fever as soon as he smells violets. This idiosyncrasy is so pronounced that even violet perfume brings on an attack. ……..The patient once went to a prostitute and got hay fever afterwards. He went again and forbade her to use violent scent. She assured him that she had never used it. After a prolonged stay he again noticed the pernicious odor of violets, following her micturition. The girl had taken turpentine capsules on the advice of a doctor in order to disguise the odour. It is well known that turpentine causes the urine to smell strongly of violets.

This is (to our knowledge) the first reference to the prescription of turpentine by a physician for the purpose of masking the scent of urine. Noteworthy is the *matter-of-fact* mentioning of the occurance by Stekel, pointing towards a wide-spread and well known practice (Stekel 1912, 1923). It is likely that in the described case turpentine capsules were primarily prescribed to treat the patient's gonorrhea, the change in urine odor beeing an added bonus.

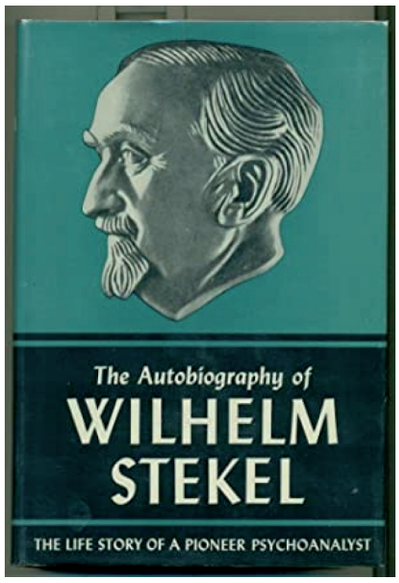


Fig. 6: Cover of *The Autobiography of Wilhelm Stekel*, 1950.

Elizabeth Blachrie Blackwell (1707(?)–1758) published 1737 her superb *Curious Herbal: Containing Five Hundred Cuts of the Most Useful which are now used in the Practice of Physick To which is added a short Descriptim of ye Plants and their common Uses in Physick* (Fig. 7). Describing the Turpentine tree (Plate 478) she (or her imprisoned physician husband Alexander Blackwell) writes „*The liquid rosin of this tree was prefered by the Ancients to all other Kinds.....It is frequently used for the Fluor Albus and the Gonorrhaea*.".

Gottfried Eisenmann (1795–1867) in his book *Der Tripper in allen seinen Formen und in allen seinen Folgen* (The Tripper in all his Forms and in all his Consequences) (Erlangen, 1830) highlights the use of turpentine and states that turpentine *use against tripper is as old, if not older, than that of guaiac* (guaiac, the resin from the wood of the South American *Guajacum officinale*; lignum vitae).

In Rutgers' (Fig. 8) German language sexual enlightenment book *Das Sexualleben,* the reference is to the courtesans of the Renaissance using both turpentine (for scent alteration) and atropine to induce mydriasis (Rutgers 1922). The book, a huge success, was translated into English by Norman Haire (1892–1952) and became available to the North American readers some ten years later, after the book was removed from the index (Rutgers 1923).

6. Conclusion

Terebinth resin was widely used in Antiquity and thereafter, both for medicinal and wine preservation purposes. It is almost certain that the effect of ingestion on the scent of urine could not have gone unnoticed. Considering the importance placed on *smelling good* by Egyptians, Greeks and then Romans, it appears likely that attempts at manipulation would have been popular or simply mandated by market forces. While the upper class would have been in a position to afford oil of turpentine, the general population was likely to enjoy the similar benefits by indulging in the resinated wines which were standard in those days. The treatment of venereal disease with turpentine and turpentine containing mixtures probably accelerated the dual use.

Conflicts of interest: None declared.

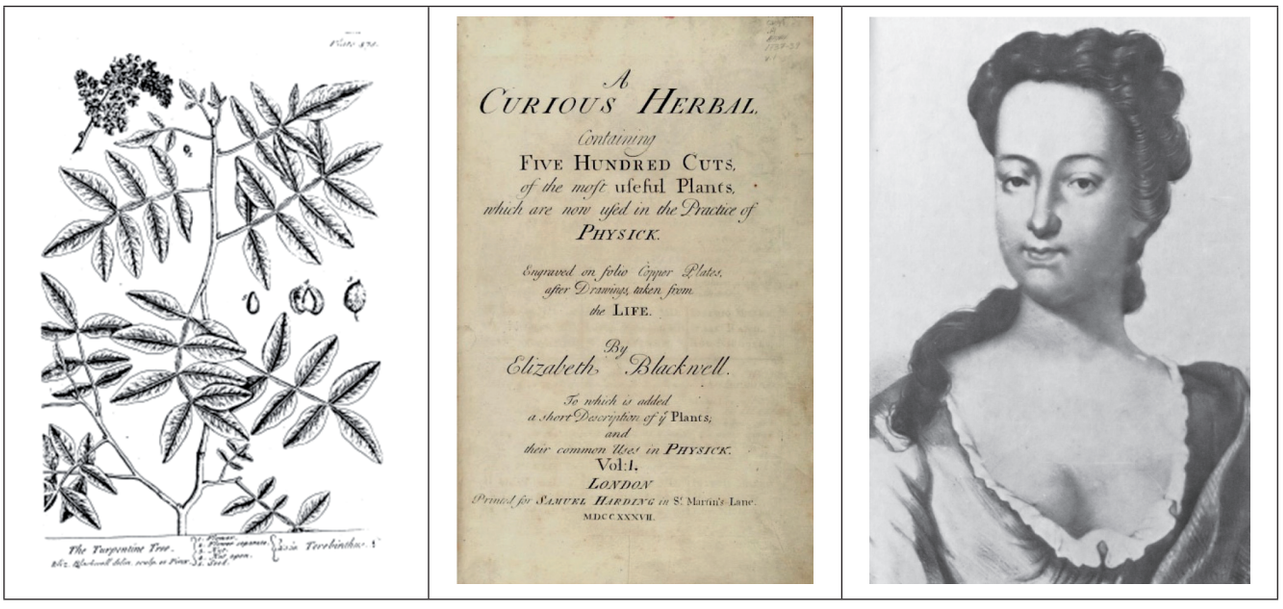


Fig. 7: Plate 478 and Title page of *Curious Herbal: Containing Five Hundred Cuts of the Most Useful which are now used in the Practice of Physick To which is added a short Descriptim of Plants and their common Uses in Physick* Elizabeth Blackwell 1737 printed by John Nurse, London. Portrait of Elizabeth Blackwell from *Biographie des Sages – Femmes Célèbres.* Dr. Aloïs Delacoux (1792–1860), Paris 1834 (Blackwell 1737; Delacoux 1834).

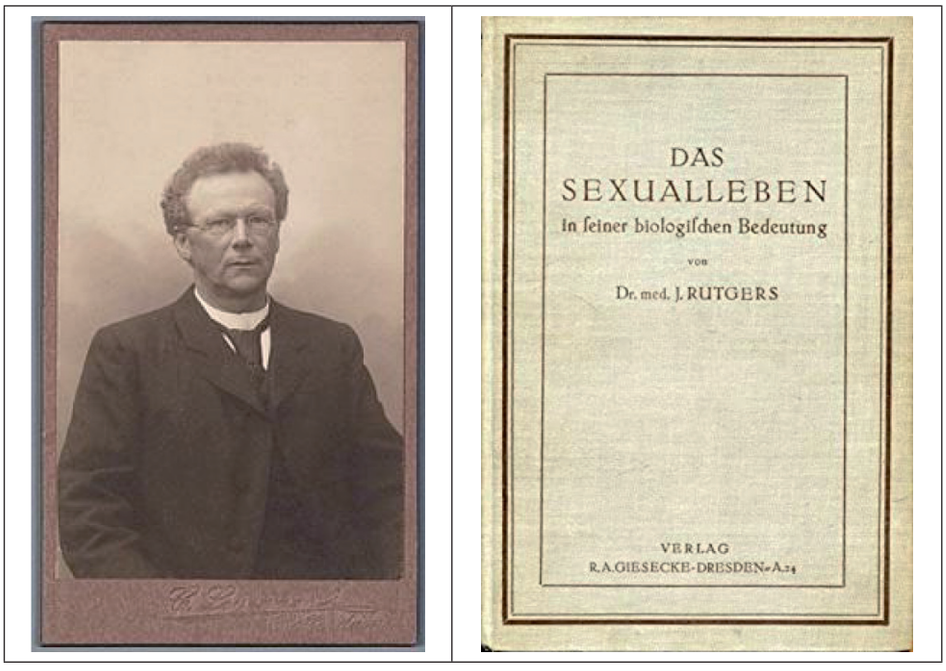


Fig. 8: Johannes Rutgers (1850–1924) was a general practitioner in Rotterdam; he drifted into politics supporting feminism and socialism.

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