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Ionone: The Molecule that Shaped the History of Western Civilization

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1. Cleopatra and Turpentine

Cleopatra VII (69–30 BC) was the last Ptolemaic ruler of Hellenistic Egypt (the Dynasty was started upon the death of Alexander the Great by Ptolemy the Savior, one of his generals or body guards, and ended with the death of Cleopatra and the Roman conquest in 30 BC). The Queen is probably best known for her love affairs with Julius Caesar (100-44 BC) and then Marcus Antonius (83-30 BC). Rightly or wrongly she became the epitome of shrewd seduction, leading brave Roman commanders on a path to debauchery and destruction. Among the customs of the time was the heavy use of perfumes. The sails of the ship on which Cleopatra received Marcus Antonius, we are told by Enobarbus in Shakespeare's eponymous play, were soaked in fragrances: *Purple the sails and so perfumed that the winds were lovesick*. Cleopatra's willingness to please went beyond the external use of perfumes; attributed to her is the ingestion of small amounts of turpentine [the resin of the terebinth tree (Pistacia terebinthus)] or of the derived oil (Oleum terebinthinae) with the purpose of conferring to her urine a more pleasing scent reminding of violets (***Figure 1***).

In his textbook of pediatrics John Apley (1908-1980) states *I have sniffed a smell like violets in the urine of a child who drank turpentine, as Cleopatra of Egypt did for that effect* (1,2).

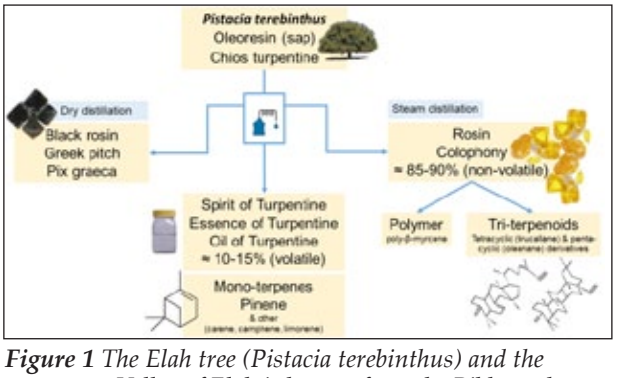


Figure 1 *The Elah tree (Pistacia terebinthus) and the eponymus Valley of Elah is known from the Bible as the place where the battle of David and Goliath took place. The oleoresin from this tree can be separated by steam distillation in the two main components: Essence of Turpentine and the non-volatile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

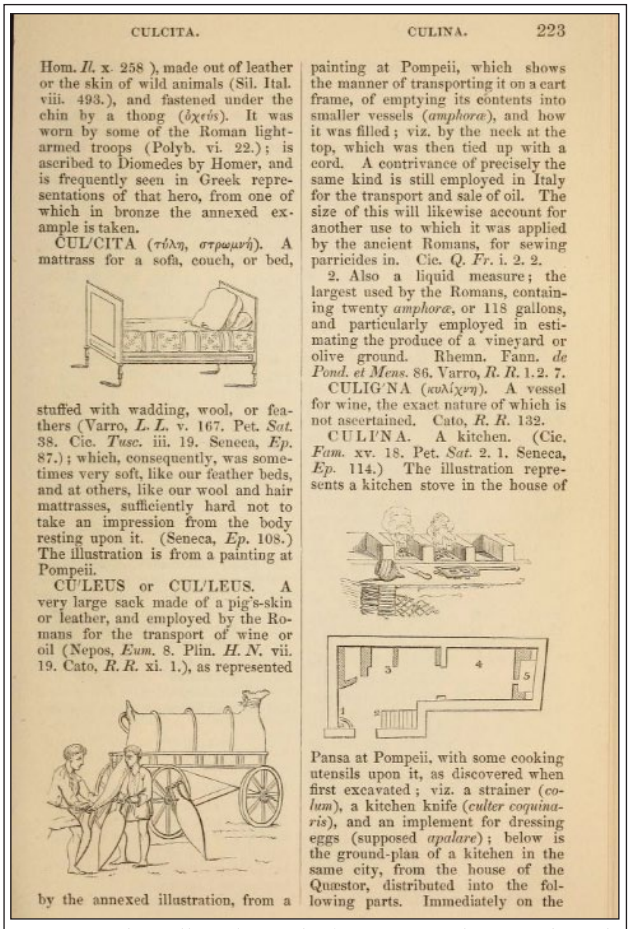
2. The scent of violets

The scent of violets is due to various mono-cyclical terpenoids, mainly ionones (C13) and irones (C14). Ionone synthesis was first achieved in 1893 by Ferdinand Tiemann (1848-1899) and Paul Krueger (1859-1916). They condensed citral with di-methyl-ketone (acetone) thus generating an intermediate which upon exposure to an acidic environment cyclizes to ionone. The name is obtained from merging iona (greek for violet) and ketone.

The earliest specific reference to the scent of violets (we have been able to identify) is from Michel de Montaigne (1533-1592) describing his voyages: in Rome (November 1580), affected by renal colic, he is treated by the personal physician of the French ambassador to the Holy See, Charles d'Angennes (Cardinal Rambouillet) (1530-1587) with (among other things) *terebenthine de Venise*. Montaigne notes somewhat sarcastically that he observed no other effect than a smell of violets (*urine a la violette de mars*) in his urine (3).

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 Sloane and later by Stehberger (4,5).

The fate of turpentine in the human body was examined by Friedrich Wöhler (1800-1882); he won a prize whilst a medical student for his studies on the passage of metabolic products into the urine; many of the investigations were carried out on either himself or a/his dog. 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. (6). The topic was also examined by Edmund Sachs (1837- † after 1907): he noted that only oil of turpentine but not colophony (rosin) produces the violet scent in urine in humans. Fur-



CULCITA. CULINA. 223

Hom. *Il.* x. 258), made out of leather or the skin of wild animals (Sil. Ital. viii. 493.), and fastened under the chin by a thong (ὀχεύς). It was worn by some of the Roman light-armed troops (Polyb. vi. 22.); is ascribed to Diomedes by Homer, and is frequently seen in Greek representations of that hero, from one of which in bronze the annexed example is taken.

CUL'CITA (τύλη, στρωμνή). A mattrass for a sofa, couch, or bed,

stuffed with wadding, wool, or feathers (Varro, *L. L.* v. 167. Pet. *Sat.* 38. Cic. *Tusc.* iii. 19. Seneca, *Ep.* 87.); which, consequently, was sometimes very soft, like our feather beds, and at others, like our wool and hair mattrasses, sufficiently hard not to take an impression from the body resting upon it. (Seneca, *Ep.* 108.) The illustration is from a painting at Pompeii.

CU'LEUS or CUL'LEUS. A very large sack made of a pig's-skin or leather, and employed by the Romans for the transport of wine or oil (Nepos, *Eum.* 8. Plin. *H. N.* vii. 19. Cato, *R. R.* xi. 1.), as represented

by the annexed illustration, from a painting at Pompeii, which shows the manner of transporting it on a cart frame, of emptying its contents into smaller vessels (*amphoræ*), and how it was filled; viz. by the neck at the top, which was then tied up with a cord. A contrivance of precisely the same kind is still employed in Italy for the transport and sale of oil. The size of this will likewise account for another use to which it was applied by the ancient Romans, for sewing parricides in. Cic. *Q. Fr.* i. 2. 2.

2. Also a liquid measure; the largest used by the Romans, containing twenty *amphoræ*, or 118 gallons, and particularly employed in estimating the produce of a vineyard or olive ground. Rhemn. Fann. *de Pond. et Mens.* 86. Varro, *R. R.* 1. 2. 7.

CULIG'NA (κυλίχνη). A vessel for wine, the exact nature of which is not ascertained. Cato, *R. R.* 132.

CULI'NA. A kitchen. (Cic. *Fam.* xv. 18. Pet. *Sat.* 2. 1. Seneca, *Ep.* 114.) The illustration represents a kitchen stove in the house of

Pansa at Pompeii, with some cooking utensils upon it, as discovered when first excavated; viz. a strainer (*colum*), a kitchen knife (*culter coquinaris*), and an implement for dressing eggs (supposed *apalare*); below is the ground-plan of a kitchen in the same city, from the house of the Quæstor, distributed into the following parts. Immediately on the

Figure 2 *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 (10).*

thermore he pointed out that admixture of turpentine (oil of) to urine does not create the violet scent either (7). These indicate the need for metabolic conversion of turpentine oil components in order to obtain the violet-like scent. A possible metabolic transformation pathway from pinene to ionone was proposed by our group (poster presentation at DDRS 2020; Aloum et al.).

3. Turpentine and wine-making

Turpentine was widely used in Antiquity in wine-making, both as taste enhancer and conserving agent (8). Consequently, there was widespread exposure of the population to its effects. 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 (9) (***Figure 2***).

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.

4. Conclusion

Terebinth resin was widely used in Antiquity for medicinal and wine preservation purposes. It is 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 is likely that attempts at manipulation would have been popular or simply mandated by market forces. While Cleopatra would have been in a position to afford oil of turpentine, the general population was likely to enjoy the same benefits by indulging in the resinated wines which were standard in those days. Cleopatra's love affairs with Julius Caesar and then with Marcus Antonius played a key role in the struggle for power in Rome. The ionone molecule enhanced her seductive powers and accelerated the demise of the Republic after the Battle of Actium in 31 BC.

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