

RESIN AND PINE TAR IN GREECE: ANCIENT TECHNIQUES AND TRADITIONAL PRACTICES

Dorina Moullou^{1✉}, George I. Mantanis²

¹Ephorate of Antiquities of East Attica, Hellenic Ministry of Culture

98–100 Syggrou Avenue, 117 41 Athens, **Greece**

²Department of Forestry, Wood Sciences and Design, University of Thessaly

11–13 Vassileiou Griva Street, 43100 Karditsa, **Greece**

ABSTRACT

This paper investigates the production and use of resin and pine tar in ancient Greece and beyond, from prehistory through the Byzantine and early modern periods. Drawing on ancient literary sources alongside archaeological, archaeometric, and ethnographic evidence, the study reconstructs resin tapping and tar-making techniques from antiquity to modern times, with a particular focus on the ancient pitch industry and the long-surviving use of *katramokámina* kilns in modern rural Greece. Resinous substances obtained either by tapping live trees for resin or by subjecting resinous wood to pyrolysis to produce tar served diverse functions in Greek society: sealing ships and wine jars, healing wounds, perfuming spaces, and fuelling torches and weapons. The study emphasizes both the material applications and symbolic roles of these substances in domestic, maritime, medical, and religious contexts. By tracing technological continuity and adaptation across millennia, the paper highlights the ecological knowledge embedded in resin-related practices. It contributes to the study of ancient woodland industries and the preservation of intangible cultural heritage, offering insights into the long-standing relationship between natural resources, artisanal expertise, and cultural resilience in the Greek world.

Keywords: resin, pine tar, pitch, Greece, ancient Greek technology, traditional crafts, forest products, forest heritage, diachronic perspective, practical uses

INTRODUCTION

Resinous substances, such as *resin*, *pitch* or *tar*¹ and their derivatives, have long played a central role in

the technological, economic, and medicinal practices of the Greek world. Resin (Greek *ρητίνη*, *rhētínē* or *ρετσίνη*, *retsini*) refers to the viscous exudate from trees (notably pines and pistachio trees), obtained by tapping live trunks (fig. 1a), while pine tar – often termed *πίσσα* (*píssa*), or *κατράμι* (*katrámi*) in modern Greek – is a black, sticky distillate produced by the destructive heating of resinous wood in low-oxygen conditions (Fig. 1b).

Both substances were ubiquitous in Greek life, serving a wide range of artisanal, medical, religious, and maritime functions across eras, a pattern mirrored

¹ Although various types of resin and pitch were recognized in antiquity and denoted by different terms (see Table 1), there was no clear distinction between *pitch* and *tar* in the modern technical sense, where *tar* refers to the liquid distillate and *pitch* to the thicker byproduct of further heating. For bitumen and crude oil, the Greeks used primarily the words *ἄσφαλτος* (*asphalt*) and *νάφθα* (*naphtha*) respectively. For an overview of the terminology, see Forbes, 1936; André, 1964; Schramm, 1937; Wartke and Burford-Cooper, 2006; the section titled “Pitch” in Appendix 7 of Meiggs, 1982; as well as Vassiliadou, 2011 and Panagou, 2019.

✉tmoullou@culture.gr; https://orcid.org/0000000307046098

Table 1. Ancient greek terms for resin and pitch

Tabela 1. Starożytne greckie określenia żywicy i dziegiu

Greek Term	Transliteration	Explanation / Use
πευκίνη ρητίνη	peukinē rētinē	pine resin
πιτυίνη ρητίνη	pityinē rētinē	pine resin (different s. than above)
στροβιλίνη ρητίνη	strobilinē rētinē	possibly cone resin (pine or fir)
ἐλατίνη ρητίνη	elatinē rētinē	fir resin (<i>Abies</i> s.)
κυπαριτίνη ρητίνη	kyparittinē rētinē	cypress resin
τερμινθίνη/τερεβινθίνη ρητίνη	terminthinē/terebinthinē rētinē	terebinth resin
σχινίνη	schininē rētinē	mastic (<i>Pistacia lentiscus</i>) resin
πίσσα/πίττα	pissa/pitta	pitch or tar
πίσσα ύγρά	pissa hygra	liquid tar
πίσσα ξηρά	pissa xēra	dry pitch
πίσσα ώμη	pissa ōmē	raw or unboiled resin, before further refinement.
παλίμπισσα	palimpissa	reused or reboiled pitch
λάριξ	larix	thick or solid resin (possibly from larch)
ζώπισσα	zōpissa	pitch and wax mixture used a sealant, or pine-resin
βοσκάς	boskas	viscous derivative of liquid tar produced through boiling
φρυκτή	phryktē	torch-pitch or flare material
κῶνα	kōna	liquid tar
βῶλος πίττης	bōlos pittēs	lump of hardened pitch
Κολοφώνια	Kolophōnia	liquid resin; originally from the city of Colophon
πισσέλαιον	pisselaion	oily fluid that rises to the surface when the raw pitch is left to stand/ mixture of oil and pitch
πίσανθος	pissanthos	oily fluid that rises to the surface when the raw pitch is left to stand
ὀρός πίσης	oros pissēs	oily fluid that rises to the surface when the raw pitch is left to stand
ρητινίτης οἶνος	rhētinitēs oinos	resinated wine
πισσίτης οἶνος	pissitēs oinos	pitch-flavoured wine
πισσίζων οἶνος	pissizōn oinos	wine tasting of pitch

in other world cultures, where resins have historically played comparable roles in traditional technologies and healing systems (Langenheim, 2003). Their importance in Greek society is extensively documented in ancient botanical, medical, and encyclopaedic literature,

including the works of Theophrastus, Dioscorides, and Pliny the Elder (see, for example, Pliny, *Naturalis Historia* (HN), 14.20, 16.19-24, 24.33; Dioscorides, *De Materia Medica*, 1.74). In *Historia Plantarum* (Hist. Plant., 9.2.1–4), Theophrastus provides the earliest



Fig. 1. (a) A drop of pine resin exuding from the trunk of a tree; (b) freshly produced pine tar flowing from a wooden stirring stick produced during the Tar (Resin & Pitch Workshop, 18–20 June 2025, Tomas Chlup: photo archive of the Czech Academy of Sciences)

Ryc. 1. (a) Kropla żywicy sosnowej wypływająca z pnia drzewa; (b) Świeżo wytworzona smoła drzewna spływająca z drewnianego patyczka używanego do mieszania, uzyskana podczas warsztatów Tar (Resin & Pitch Workshop, 18–20 czerwca 2025) (fot. Tomas Chlup, archiwum fotograficzne Czeskiej Akademii Nauk)

systematic description of resin (*rhētīnē*, ῥήτινῇ in Ancient Greek) and pitch (*pissa or pitta*, πίσσα ή πίττα in Ancient Greek), distinguishing between the natural exudate from incised bark of trees and its thermally transformed derivative, produced through heating and/or distillation processes (pyrolysis).

Although no securely identified pitch production installations from the ancient or byzantine periods have been excavated in Greece, the scale of its use suggests that specialized processing methods were known and practised, as described by ancient authors.

Modern and early modern resin and pitch production in Greece preserve key features of ancient techniques. Traditional resin collection through bark incisions, the use of clay or metal containers, and pitch production through slow carbonisation in shallow pits or kilns are well documented in ethnographic and historical studies (Kommatas, 1999). Notably, the traditional production technology of pine tar (*ka-trami*) was recently inscribed in the National Inventory of Intangible Cultural Heritage of Greece (Ayla, 2025). These survivals provide valuable analogies for

understanding ancient methods, offering insights into seasonal labour organization, woodland management, and artisanal knowledge.

The present study explores how resin and pitch were produced, transformed, and used in Greece from antiquity to modern times. Drawing on ancient textual sources, material analyses, archaeological finds, and modern ethnographic documentation, it adopts a multidisciplinary approach to reconstruct the technical processes and cultural significance of these substances over time. In doing so, the study highlights both the persistence and adaptation of resin-related knowledge across historical periods, contributing to a broader understanding of craft continuity, resource use, and environmental adaptation in the Greek world. The geographical scope includes mainland Greece, the Aegean islands, and select cross-referenced case studies from Asia Minor, Cyprus and the Levant. This synthesis allows for a diachronic reconstruction of resin and tar-related technologies and practices, highlighting continuities, adaptations, and regional variations across millennia.

HISTORICAL CONTEXT AND LITERARY SOURCES ON RESINOUS SUBSTANCES IN GREECE

Resinous substances have been exploited in the Greek world since prehistoric times. In northern Greece, finds from the 6th to 5th millennium BCE attest to the exploitation of both pine pitch and birch bark tar in domestic and craft contexts. At several Neolithic sites – including Makriyalos, Stavroupoli and Paliambela – archaeometric residue analyses have identified pine-derived pitch used as a glue, as well as pine resin employed to seal ceramic vessels intended for the storage of liquids. In parallel, evidence has revealed the use of birch bark tar – a material less common in the later Greek world. This tar functioned as an adhesive, particularly for repairing broken pottery, and as a waterproofing agent for closed ceramic vessels (Urem-Kotsou et al., 2002, 2004, 2018; Mitkidou et al., 2008). Moreover, at Dikili Tash – dated to around 4300 BCE – two-step GC-MS analysis of Neolithic jars revealed not only fermentation biomarkers (tartaric, malic, and succinic acids) indicative of red wine production, but also residue from resinous materials from conifers used to seal the vessels before fermentation. This is the earliest documented evidence in the Eastern Mediterranean and Europe for the combined use of resin sealing and wine-making (Garnier and Valamoti, 2016).

These early uses mark the beginning of a long tradition in the Greek world of transforming resinous substances into multipurpose materials. From this early phase onward, resin and pitch were gradually integrated into broader systems of craft production, food storage, seafaring, medicine, and ritual – a development that can be traced through ancient literary sources and continues, in modified forms, in traditional practices of rural Greece.

In the Bronze Age (3200–1050 BCE), the aromatic resins of *Pistacia* trees (terebinth or mastic) were important trade commodities, indicating an early demand for resin in the region (Merousis, 2010; 2012; 2019). Canaanite merchants shipped terebinth resin in large pottery amphorae to Mycenaean Greece and Minoan Crete. Notably, the 14th-century BCE Ulu Burun shipwreck off Anatolia contained Canaanite jars loaded with resin, likely collected from the Levant in late summer and destined for Aegean markets (Merousis,

2012). In Egypt, terebinth resin (possibly referred to as *sntr* in texts) was so prized that during the reign of Thutmose III an average of 9,000 L were imported yearly for use as incense and embalming material (Loret, 1949; Merousis, 2012). In Minoan and Mycenaean periods (ca. 2000–1050 BCE), resins served as incense in cult practices, adhesives in crafts (e.g. glue for gold leaf on the Palaikastro ivory kouroi), and additives to wine for flavour and preservation (Merousis, 2010). Resinated wine became increasingly widespread, as shown by ceramic residue analyses, and was linked to domestic consumption, feasting, and ritual contexts (Merousis, 2019). Palatial economies likely systematized resin, its production and storage. Textual evidence confirms resin use, for example, Linear B tablets (a Mycenaean syllabic script used for administrative records) may reference *ki-ta-no* (possibly *kritanos* or *tsikoudia*, i.e. terebinth plant or resin) administered by palace industries (Merousis, 2012; 2019). Similar practices are also attested noted also in the western Mediterranean, where Rageot (2015) has shown that Neolithic and Bronze Age communities used both raw and pyrolyzed resinous substances – such as pine resin and vegetable tar – and often blended them with beeswax, animal fats, or oils to enhance their sealing, adhesive, or preservative qualities. These findings demonstrate that empirical knowledge of resin manipulation was widespread across prehistoric societies, extending beyond the Aegean.

The first literary reference to pitch appears in Homer's *Iliad* (4, 277), where it is used metaphorically to describe dark clouds gathering before battle. By the Classical period (5th–4th centuries BCE), the focus shifted to pine resin and pine-derived tar as critical resources in Greece. Ancient literary sources distinguished a famed Pierian (a region within Macedonia) or Macedonian pitch, suggesting Macedonia as a major production center. Herodotus (*Histories*, 4.195) in the 5th century BCE is the first to mention “Pierian pitch,” implying it was a well-known commodity by his time. Indeed, Macedonia's extensive pine forests (notably on Mount Olympus and around Pieria) became the heart of a large-scale tar industry. Theophrastus (*Hist. Plant.*, 9.2.1ff) and Pseudo-Aristotle (*mir. Auscultationibus*, 842b) both refer to a renowned “Macedonian pitch” as distinct from other grades. In fact, Macedonia had monopolistic supremacy in tar

production during the Classical and Hellenistic eras (Vassiliadou, 2018).

Tar from Macedonia was considered among the highest quality in the Greek world – Pliny the Elder later rated it “premium” and most in-demand (*HN*, 14, 25). Hence, it became a significant export commodity. Macedonian control over pitch production was tied to royal authority (Vassiliadou, 2018).

The forests of Mount Olympus and other uplands were royal property; harvesting resin or wood for tar required a crown license (Borza, 1982; Hatzopoulos, 1996, p. 176, 226). The Argead and Antigonid kings derived revenue from this industry. Philip V of Macedonia, for instance, raised rents on royal forests as a wartime fiscal measure (Hatzopoulos, 1996, p. 433). The scale of production and trade is underscored by a remarkable historical episode: around 225 BCE, King Antigonos III Doson donated 1000 talents of Macedonian pitch and 1000 metretai of raw liquid pitch to Rhodes to aid in rebuilding their fleet after an earthquake (Polybius, *Hist.*, 5.89) – an extraordinary shipment equating to roughly 26 tons of solid pitch and 39 tons of liquid (unrefined) tar, which is the largest tar consignment on record of the Greco-Roman world (Vassiliadou, 2019). By the Hellenistic period, Macedonian pine tar had become a strategic resource, fueling naval maintenance and other industries, and functioned as a “brand-name” product (to use Vassiliadou’s 2018 terms) in the international tar market of the era.

Ancient inscriptions, such as those from Delos dating to the 4th–3rd centuries BCE, offer valuable insight into the economic role of pitch in the classical and Hellenistic world. These records indicate that pitch was marketed and priced in two distinct forms: as a liquid (*pissa ygra*), it was measured and sold in *keramia* – ceramic storage vessels of approximately 26 liters – meters (approx. 39.3 liters) or *hemiamphoria* (half amphoras), while in its solidified state (*pissa xēra*), it was traded in *bōloi*, or lumps (Bean, 1954; Chankowski, 2023, Vassiliadou, 2011; for volumes, see Grenquist, 2018). On Delos, the price of a keration of pitch ranged between 17 and 22 drachmas (Chankowski, 2023). Given that a non-specialized labourer in Classical period earned about half a drachma per day and a skilled worker about one drachma (Guthmann and Scheidel, 2025), purchasing a single unit could cost the equivalent of 17 to 44 days of

wages. This highlights the considerable market value of pitch, especially considering its essential role in sealing, waterproofing, and ship maintenance. The Kaunos Customs Law further underscores its importance by recording the taxation of pitch sold in lumps (Bean, 1954), demonstrating its integration into regulated trade networks and the fiscal priorities of Hellenistic authorities.

The Roman conquest of Macedonia in 167 BCE brought changes to this industry. The *lex Aemiliana* imposed by the Roman general Aemilius Paulus abolished royal monopolies and forbade the Macedonians from exploiting royal forests (Livy, *Ab urbe cond.*, 39, 24). This likely disrupted large-scale pitch production. Vassiliadou (2018) notes that Roman policy “signaled the end of the industrial production and wide-range trade of Pierian-Macedonian pitch” as an export industry. Nevertheless, production continued at a reduced scale, likely serving local and regional markets. In 63 BCE, a century after the conquest, Cicero mentions former royal lands in Macedonia being managed by Roman contractors, suggesting that forest resources (including pitch) were again being tapped under new administration (Cic. *De leg. agr.*, 2.50). During the Roman Imperial era, tar and resin remained in steady demand across the Mediterranean. Greek and Roman writers like Dioscorides (*De mat. Med.* I 71,3), Atheneus (*Deipnosophistae*, V.40), Pliny (*HN*, 16.20), documented multiple production locales and techniques beyond Macedonia, including Italy, Gaul, Spain, Syria, Cyprus, Asia Minor and more (for references see Panagou, 2019; Vassiliadou, 2011, pp. 73–82; Vassiliadou, 2019). A 1st–2nd-century CE funerary relief from Thasos is especially intriguing: it depicts tools (an axe-like implement, tripod legs, etc.) and bears the partial inscription “Artemidoros... pissokaustēs” (pitch-burner), revealing the profession of tar maker in the Roman period (Archaeological Museum of Thasos, see Panagou, 2019). This unique find suggests that Thasos (in the northern Aegean) was another pitch-producing area by the Imperial era, and it provides a rare iconographic representation of tar-making technology in antiquity.

In the Byzantine era (4th–15th centuries CE), pine resin and tar continued to play an important role, although albeit the historical spotlight shifts more to its consumption and less to large-scale export

(Germanidou, 2019). Forests rich in coniferous trees, especially pines (genus *Pinus*), were a crucial part of the imperial landscape. Their exploitation was often tied to monastic estates, aristocratic landholdings, or state-administered properties (Germanidou, 2019). Evidence from legal, fiscal, and agronomic sources suggests that the collection of resin and the production of tar were subject to customary rights, labour arrangements, and sometimes taxation or regulation. The *Eparchikon Biblion*, a 10th-century manual regulating the guilds and trades of Constantinople, reveals that tar is among the goods associated with the provisioning of the city, pointing to its recognized economic role in urban supply chains (Koder, 1991, 13.1.118).

The geographic distribution of resin-bearing forests shaped regional economies across the empire. Areas such as Macedonia, the Peloponnese, Attica, the islands of the Aegean (notably Chios), Asia Minor, and parts of the Levant appear in Byzantine references to resin and pitch (Anagnostakis, 2013; Jacoby, 2013; Koukouni, 2011; Vroom, 2018). These zones were not only natural habitats for pine but also hubs of local production that fed into interregional trade. The importance of Chios, for example, known for its *Pistacia lentiscus* resin (mastic), persisted into the Byzantine period, linking ancient traditions with medieval commerce (Koukouni, 2011).

The strategic significance of pine-derived materials, especially resin and tar, further explains the continuity of their extraction and management. As Byzantium inherited and developed a complex naval infrastructure, including shipyards and fleets vital to its defence and communication, the empire had a direct interest in securing materials necessary for ship maintenance (Koukouni, 2011). In Byzantium, pine resin held not only practical value but also symbolic significance. While primarily used in medicine, ship maintenance, wine-making, sealing, and adhesives, it was also endowed with spiritual meaning in Christian allegory and monastic literature (Germanidou, 2019). Resin's role in healing wounds was likened to the healing power of divine grace, and its preservative and adhesive properties were interpreted as symbols of spiritual preservation and the soul's bond with God (Germanidou, 2019). These allegorical interpretations appear especially in moral and didactic texts, where natural substances served to illustrate theological concepts.

Following the fall of Byzantium in 1453, the production of pine tar and resin in Greek-populated regions continued as a traditional craft under Ottoman rule and into the early modern period (Dursun, 2007). While maritime powers in the 17th to 19th centuries increasingly sourced tar from Northern Europe – especially Sweden – for large-scale naval use, indigenous methods of small-scale pitch production persisted in Greece for domestic and artisanal purposes. These practices involved the dry distillation of resin-rich pine wood (particularly stumps and heartwood) in sealed, low-oxygen earthen kilns known as *katramokámina*, a technique maintained across mountainous landscapes including Epirus, Pieria, the Geraneia Mountains (Attica), Crete, Thassos, and parts of western Macedonia (Ministry of Commerce, 2025).

In particular, the region of Distrato in Epirus retained this knowledge well into the 20th century. Ethnographic evidence and oral traditions document the role of itinerant craftsmen – known as *katranádes* – many of whom were of Vlach or Sarakatsani origin. These tar-burners would move seasonally through forested areas, harvesting and processing pine wood and collecting the viscous pitch in sheepskins or ceramic vessels (Tzora, 2025). Their knowledge of terrain, tree species, and controlled carbonization or destructive distillation techniques was passed down from generation to generation, forming part of a broader local ecological knowledge system.

The uses of pine tar in post-Byzantine agrarian society were diverse and deeply integrated into daily life. It was employed to preserve and protect wooden implements such as ploughs, cartwheels, and yokes; to waterproof barrels, roofs, and small boats; to seal ceramic containers used for storing oil, wine, or water; and to repel insects and rodents from storage areas and wooden structures (Arı et al., 2014; Kızılarıslan and Sevgi, 2013; Lardos et al., 2011; UNESCO Cyprus, n.d.). Pine tar also served important roles in veterinary and folk medicine: it was applied to wounds, hooves, and udders of livestock as a protective salve and antiparasitic agent; it was used in poultices for skin diseases such as mange and eczema; and, in some rural communities, poured along the backs of freshly shorn sheep to prevent mite infestations (Arı et al., 2014; Lardos et al., 2011).

The katrámi also played a key role in long-term timber preservation in humid, mountainous environments, reinforcing its value in self-sufficient rural economies. A similar pitch-making tradition is documented across the border in Turkey's Küre Mountains, where comparable kiln-based techniques were practised by Turkish and Greek-speaking forest dwellers, suggesting a broader trans-Balkan and Anatolian continuity (Dursun, 2007).

Despite industrial decline in the 20th century, isolated production survived into the 21st. The community of Distrato continues to host occasional kiln firings, and in 2025, the Greek Ministry of Culture inscribed “the traditional technology of making katrámi” into the National Inventory of Intangible Cultural Heritage. This recognition acknowledges both the survival of the craft and the continuity of forest-based knowledge systems that have adapted across centuries of post-Byzantine transformation. The case of pine tar reflects how traditional ecological practices outlived imperial systems, adapted under Ottoman provincial life, and maintained cultural value into modern Greece (Τέσσαρα..., 2025).

PRODUCTION METHODS

Ancient sources describe two main methods of obtaining pine products: (1) tapping live trees for resin, and (2) burning resinous wood to extract tar/pitch. Theophrastus (4th c. BCE), in his *Historia Plantarum* (9.2-3), provides a detailed account of both approaches, which he notes could vary by region. His descriptions align remarkably well with techniques used in later historical periods and even recent folk practice (For a translation in English of his work, see Theophrastus, 1916).

Resin tapping

In Theophrastus' account (*Hist. Plant.*, 9.2), harvesters would cut incisions into the trunks of pine or related trees to stimulate resin flow. Typically, the bark was stripped or scored during the warm season, after the tree had leafed out when resin flow was strongest. Different species yielded resins of different quality: terebinth (*Pistacia terebinthus*) resin was considered the finest – “firm-setting and most fragrant” – though available only in small quantities. The resin of “pine of the seashore” according to Theophrastus terms (likely

P. halepensis or *P. pinea*) and silver-fir (*Abies* sp.) was next best, more delicate than that of common pine. Common pine (*P. brutia* or *P. nigra*) yielded resin in the greatest volume, but it was “the grossest and most pitchlike” (for species identification, see Karakatsani, 1998).

Collectors sometimes removed a piece of resin-rich wood (“the resinous wood after the tree has been tapped”) to create a reservoir cavity, into which resin would collect more abundantly. The fresh resin would be liquid and sticky; harvesters allowed it to thicken and solidify for ease of transport, often gathering it in leather flasks until it congealed into the familiar solid form. No uniform rule applied – for instance, Theophrastus notes that with terebinth they tap both trunk and branches, whereas with pines they might focus on the trunk. The timing and frequency of tapping were also regulated to avoid killing the tree. Generally, trees were not tapped every single year; they were given time to recuperate resin. Theophrastus (*Hist. Plant.*, 9.2.5-8) remarks that in Mount Ida (Troas, Asia Minor) and Macedonia, tapped resin pockets would refill after one to three years depending on the tree's vigour, after which another round could be collected. In one described method on Mt. Ida, collectors would ring-bark one side of the pine's trunk (the sun-facing side) for a height of 2–3 cubits (0.92 to 1.39 m; for the metric system, see Smith and Anthon, 1851), leave it for a year to let that section become saturated with resin, then cut out that resin-impregnated wood the next year, and repeat on a new section; after a few such cycles the weakened tree would finally blow down, at which point its resin-rich stump and roots could be dug up for pitch wood. This method reflects a sustainable sequence to maximize resin yield over a tree's life. Notably, byproducts of resin tapping included turpentine (the liquid oleoresin) and rosin (solidified resin); these terms are rarely distinguished in ancient sources but were certainly obtained in practice. Tapping techniques, consisting of simple incisions with knives or chisels and collection of resin droplets (the famous “tears”), remained essentially unchanged into modern times, as seen in the traditional harvesting of pine resin in various regions of Greece and mastic (*Pistacia lentiscus*) on the island of Chios. Whether for pine or mastic, the tools (scrapers, gouges) and the careful timing of cuts were crucial to yield a good flow



Fig. 2. Resin tapping scars on Aleppo pines in Evia, Greece, showing bark removal (left) and collection gutters (right)
Ryc. 2. Ślady nacinania pni sosny alepskiej na wyspie Eubea (Grecja) – widoczne usunięcie kory (po lewej) i rynienki do zbierania żywicy (po prawej)

without killing the plant (for the tools in antiquity, see Vassiliadou, 2011).

In modern Greek practice – especially in Aleppo pine forests – two main resin tapping methods have been documented: the traditional “chipping” method and the more recent “debarking with sulfuric acid”. The older chipping technique, now obsolete, involved creating 1.5 cm-deep wounds in the trunk using an axe. Three variations of this method existed in Greece, depending on the tool used and the interval between applications. In contrast, the modern method involves peeling the bark and applying a chemical irritant paste (typically containing sulfuric acid) to stimulate resin flow (Papadopoulos, 2013). These activities left distinctive scarring patterns – “tapping faces” – on mature and older trees, still visible in many forest stands today (Fig. 2).

Pine tar production

A relatively simple method for producing pitch from resin involved collecting the raw material in containers

and then boiling it to obtain tar (Theophr., *Hist. Plant.*, 9.2.5; Plin, *HN*, 14.25; 16.22). According to Pliny (*HN*, 16.22), one technique consisted in placing red-hot stones into oaken tubs or basins (*alvei*) filled with “pitch resin” (*picea resina*), which facilitated its liquefaction through direct heat. In another method designed to produce a medicinal-grade tar, various resinous substances were boiled in water, and the fatty residue (*expressum pingue*) was likely skimmed off the surface once it rose to the top (*HN*, 16.32).

To obtain large quantities of tar, however, the ancient Greeks relied on heating resinous wood in an oxygen-poor environment (pyrolysis) so that liquid tar could exude. Theophrastus (*Hist. Plant.*, 9.3) calls this procedure “pitch burning” and describes the Macedonian method in detail. Macedonian pitch-burners would prepare a level, smooth area of ground, slightly sloping to a collection hollow at the centre. They split pine logs and stacked them upright leaning against each other to form a conical pile, much like a charcoal kiln, but without an underground pit, as the pile was

built above ground. The wood mound was enormous: Theophrastus reports an optimal pile might reach 180 cubits (≈ 80 m) in circumference and 50–60 cubits (≈ 22 –27 m) high, using hundreds of talents of wood, although bigger stacks (of 100 cubits ≈ 46 m) were also made if the wood was very resinous (Makkonen, 1969 suggests this may be an exaggeration or a textual distortion, and that the actual mound was likely smaller; for a discussion, see Vassiliadou, 2011, 84). Once stacked, the entire mound was covered with brushwood and then a thick layer of earth, sealing it completely except for a single opening through which it could be ignited. The makers would start a fire at the base of the pile (using the small opening), then immediately close that aperture with wood and earth, essentially creating an anaerobic slow-burn inside the mound.

As the wood smouldered, the heat would liquefy the resin contained in the pine wood, and liquid tar would drip down, guided by a stone or ceramic-lined channel, toward a collection pit about 15 cubits (≈ 7 m) away. The distance allowed the tar to cool as it flowed through the channel before reaching the pit. After ~ 48 hours (maximum) of controlled burn, the tar flowed out and was gathered; the process was complete by the second day, when the pile eventually collapsed inward, having yielded all its pitch. Throughout, workers vigilantly monitored for any outbreak of open flames or leaks in the earthen seal, smothering any smoke vents with more dirt, since exposure to air could cause flaming combustion that would ruin the pitch by burning it off. Theophrastus vividly notes that the Macedonian pitch-burners offered sacrifices and prayers during the burn, effectively holding a vigil and festival in hopes of a bountiful, high-quality tar yield. The tar obtained in this manner could be used as is, or further heated to make a thicker pitch. The distinction, as modern analysis confirms, is mainly one of consistency; ancient practitioners generally conflated the terms, simply calling the product *pissa* (pitch/tar) unless a specific differentiation was needed (Murray, 2009).

Other regions also developed distinct pitch-making techniques. Theophrastus (*Hist. Plant.*, 9.3) contrasts the above with a Syrian method: in parts of Syria, where true pines were less available, people extracted tar from terebinth trees by applying fire directly to a living tree. They used a specialized iron tool to set a portion of the tree on fire in a controlled way,

melting the resin out of that spot, then moved the tool to another spot to continue the extraction. Essentially, the tree itself served as the “kiln,” and the process was stopped when tar ceased to flow. This method was likely inefficient and potentially destructive to the tree, but Theophrastus notes it was used particularly because Syria had abundant terebinths and lacked large pines. Interestingly, he adds that even terebinth resin (akin to turpentine) could be turned into a form of pitch through burning in this way. He also mentions that some claimed this Syrian method could be applied to Aleppo pine and Phoenician cedar as well, though he notes such uses were rare and not commonly practised. Modern experimental studies have confirmed that cedar wood, particularly from species such as *Cedrus libani*, can yield a distinctive, aromatic pitch via controlled pyrolysis, although in lower quantities than pine (Kılıç Pekgözlü et al., 2017; Ninich et al., 2024).

Pliny the Elder, writing in the 1st century CE, echoes much of Theophrastus’ information but also describes a distinct Roman variant (*HN*, 16.21–23). He describes a method where cut pine logs were enclosed in a purpose-built kiln or furnace, which was heated from the outside, causing tar to exude and be collected in a vessel. This may represent Roman-era technological refinement – an approach to pitch-making that is more contained and controllable than the giant earth mound, perhaps on a smaller scale (Orengo et al., 2013). All these methods, however, operate on the same principle of destructive distillation of pine wood. Chemical analyses of Hellenistic-Roman pitch samples from Pieria show terpenoid degradation signatures consistent with pine wood pyrolysis (Vassiliadou, 2018).

Resin tapping and pitch burning often went hand-in-hand. In some contexts, resin was collected from live trees for certain uses (like medicine or wine-making), while the same trees’ wood (rich in resin after years of tapping or after death) might eventually be burned to produce tar. Theophrastus (*Hist. Plant.*, 9.2) observes that Macedonians preferred to only burn the “male” pine trees (those without cones) for tar and normally did not burn the “female” (cone-bearing) pines unless they found a fallen pine with especially resinous wood or roots. This suggests a deliberate management strategy: some trees were left to grow and be tapped for resin, whereas others (perhaps inferior for tapping or at end of life) were converted to pitch.



The base pit for tar collection. Left – the pit. The sloped channel will guide the tar into a vessel placed at the lowest point. Right – participants carefully arrange kindling into a circular core, forming the central shaft of a traditional tar mound.

Fig. 3. A revived experimental demonstration in Distrato village in Ioannina, Greece (Phot. K. Paganias, November 2024)
Ryc. 3. Odtworzony pokaz eksperymentalny w miejscowości Distrato, Ioannina, Grecja (fot. K. Paganias, listopad 2024)

The season and environment also influenced the quality and quantity of resin produced. According to both Theophrastus (*Hist. Plant.*, 9.2) and Pliny (*HN*, 16.23), wood from trees in sunny, facing slopes produced the best, clearest resin, whereas shaded-site trees gave a more turbid, lower grade. Moderately

cold winters would result in greater resin production the next summer (hence more tar), whereas extremely harsh winters reduced the flow. Even the weather during the burn mattered: people observed that a given quantity of wood would yield more tar in wet weather than in drought, because the moisture prevented the tar



Fig. 4. Traditional tar kiln prepared by stacking split pine wood into a conical mound (left). The tar kiln is covered with soil and ignited (Phot. by K. Paganias, November 2024)

Ryc. 4. Tradycyjny piec do wypału smoły przygotowany przez ułożenie rozłupanego drewna sosnowego w stożkowatym kopcu (po lewej). Piec zostaje przykryty warstwą ziemi i podpalony (fot. K. Paganias, listopad 2024)

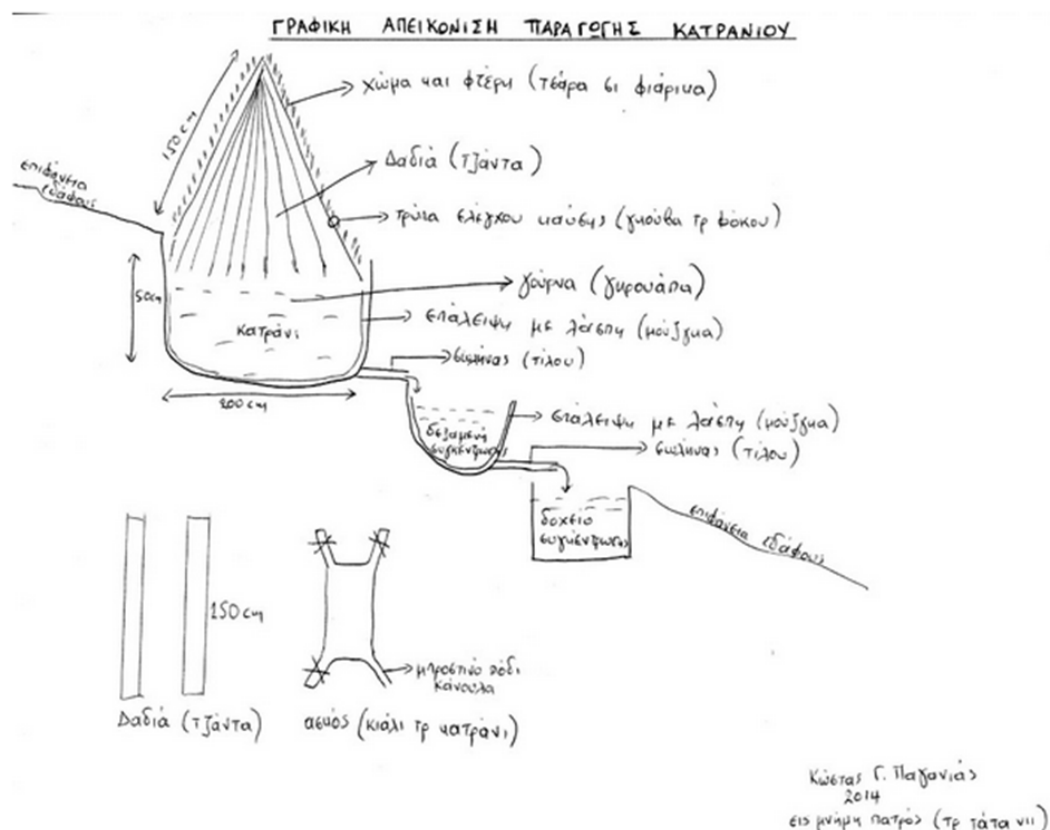


Fig. 5. Graphical representation of the traditional Pine Tar production in Distrato, Ioannina (Drawing by K. Paganias)

Ryc. 5. Graficzne przedstawienie tradycyjnego procesu produkcji smoły sosnowej w miejscowości Distrato, Ioannina (rys. K. Paganias)

from volatilizing away and allowed it to flow out more completely (Theoprhr. *Hist. Plant.*, 9.2.5).

From the above, it is evident that Greek and Roman pitch producers had a deep understanding of resinous combustion and distillation techniques. The process was labour- and resource-intensive, often requiring communal effort. Archaeologically, no physical tar kilns from antiquity have been identified in Greece, likely because they were temporary earth mounds or simple pits that leave scant traces. However, the written descriptions confirm how it was done.

Notably, the traditional tar-making pits used by Greek villagers in the 19th century, called *katramo-kámina* (tar kilns), were essentially smaller versions of the ancient mound described by Theophrastus: a conical stack of pine logs, covered with turf, slowly burned

so that tar could be tapped from a collecting channel at the base. The continuity of this technique over two millennia is striking and illustrates the resilience of resin-processing knowledge in Greek woodland communities (Figs. 3–5).

USES OF RESIN AND TAR

Ancient Greeks and Romans found a remarkably wide range of uses for tree resins and pine tar, exploiting their waterproofing, adhesive, aromatic, and medicinal properties. The ubiquity of resin and tar in daily life is attested by both literary sources and material remains. Here we outline the major applications across different spheres, noting continuity (and changes) through Byzantine and later times.

Shipbuilding and waterproofing

Perhaps the most critical use of pine tar in antiquity was in maritime technology. Wooden ships were preserved and sealed with pitch – a practice so common that it was effectively universal among Greek shipwrights. This included techniques such as caulking: sealing seams between planks with resinous substances or with textiles soaked in pitch, paying: smearing seams or surfaces with pine pitch or resin, and pitching: coating timber with heated pine pitch for waterproofing and preservation (Beresford, 2013, p. 196; Meunier and Guyon, 2020; Pomey et al., 2012; Pomey and Boetto, 2019; see also Homer, *Iliad* B 524; Aristophanes, *Acharnenses*, 190; ib. *Ranae* 354). In Athens, the 4th-century BCE Naval Records of the Neorion (shipyard) show that each warship (trireme) on active duty was issued an amphora of tar and/or tar-based paint for maintenance, among other amenities (IG II2 1627.313). Tar was such a strategic resource that during the Peloponnesian War (431–404 BCE), Athens restricted or banned its export, likely to ensure adequate supplies for its fleet (Aristophanes, *Ranae*, 361–364). Tar and pitch were applied liberally to ship hulls (usually on the interior of planks, and sometimes the exterior below the waterline) as a waterproofer and to impede shipworm damage. Archaeological evidence confirms this (Parker, 1992). For example, the 4th-century BCE warship battering ram found at Athlit had timbers coated in tar, as did hull fragments of many shipwrecks (Casson and Steffy, 1991). Tar may also have been used to coat other textiles, such as ropes, cordage, and sails, for waterproofing and preservation (Meunier and Guyon, 2020; Wartke and Burford-Cooper, 2006). These same materials and techniques – especially the use of pine tar for sealing and protecting wooden hulls – remained central in shipbuilding throughout the Byzantine period as well. Resin and tar continued to be employed in the construction and maintenance of dromones (war galleys), merchantmen and other naval vessels (Kahanov and Royal, 1996; Kocabaş, 2015; Pomey et al., 2012; Pryor and Jeffreys, 2006). This continuity extended into the post-Byzantine and modern periods. Traditional wooden caiques (kaikia in Greek) are still maintained with resinous substances, applied to seams, hulls, and rigging to preserve seaworthiness and protect against decay – evidence of the longevity of this artisanal knowledge (Lagontzou, 2017; Oikonomou, 2012).

Pitch was widely employed in ancient construction to preserve and protect wooden architectural elements from moisture and decay. It was used in structural timbers, beams, and fittings, particularly in areas exposed to weathering or in contact with masonry. Vitruvius (VII.4.2) advises its application to walls and roofs to prevent dampness, and Plautus (*Mostellaria*, III.2.140–141) mentions its use in maintaining wooden doorposts. Pliny notes that pitch from wood was used to waterproof roofs and even to protect certain soft building stones from weathering (*HN*, 36.48, in Carthage). Epigraphic evidence further confirms its role in building maintenance: inscriptions from Eleusis (IG II2 1672), Athens (IG II² 659 and 659b), Epidaurus (IG IV2 1, 102), Delos (indicatively REG XXVI, 1913, 26), and Delphi (FD 5 (3), 19, 55) to name a few, record the procurement and application of pitch as part of official construction or repair works. Archaeological evidence, such as pitch-coated timbers from a 3rd-century BCE site in Katerini, supports the textual record, highlighting pitch's routine role in the upkeep of built environments (Vassiliadou, 2011). Pitch was also used for sealing a wide range of materials, including ceramic vessels, wooden barrels, leather wineskins and baskets (Panagou, 2019).

Beyond its well-attested role in waterproofing and preserving wooden architecture and containers, the smearing of pitch also served ritual and symbolic purposes. At the Anthesteria festival (an Athenian celebration of Dionysus associated with new wine, the dead, and liminal rituals), Athenians applied pitch to their doorways (πίττη τὰς θύρας ἔχριον), an apotropaic gesture likely intended to protect the household from harmful spirits during this transitional period. As Roussel (1934) observes, this practice is echoed in inscriptions from Eleusis, Athens and Delos (mentioned above), where pitch was applied to temple doors, suggesting a continuity between domestic ritual and sacred architectural care. He further notes parallels with modern Greek customs such as whitewashing houses before Easter to dispel pollution and misfortune.

Wine preservation and flavouring

A distinctive ancient practice was the use of resin in winemaking. Greeks would coat the inside of wine amphorae and storage pithoi with pine tar (*pissōma*) as a sealant (Fig. 6). The pitch lining inside amphorae



Fig. 6. Mosaic from Saint-Romain-en-Gal showing the application of pitch to a *dolium* (large ceramic storage vessel)
Ryc. 6. Mozaika z Saint-Romain-en-Gal ukazująca nakładanie dziegiu na *dolium* (duże naczynie magazynowe z ceramiki)

served a dual purpose: it prevented wine from seeping into the porous ceramic fabric and acted as an antioxidant preservative. As Panagou (2019) notes, the presence of a pine tar coating is often taken as an indicator that a vessel once held wine, although there are also many documented cases where amphorae were themselves used to transport pitch or tar. The practice of lining wine jars with pitch was so routine that even Egyptian papyri from the 3rd–2nd centuries BCE include instructions specifying that the amphorae be “pitched from bottom to brim,” and even detail the amount of tar to be used – approximately 70–80 grams per amphora (Panagou, 2019). In addition to sealing the vessel, the resin imparted a distinctive aromatic quality to the wine. This was not always a mere byproduct; often it was deliberate: fresh resin (*retinē*) from Aleppo pine or terebinth was added directly into grape must to produce resinated wine. Pliny mentions that some wine jars were not just lined but that the wine itself was mixed with resin and other aromatics (*HN*, 14.25). The resulting beverage had a piney flavour. The practice had preservative benefits – the resin acted as an antimicrobial, preventing souring and masking oxidative off-tastes (Merousis, 2010). In Classical and later

times, references abound: Aristophanes jokes about pitch-smelling wine (*Acharnenses*, 190), and later Columella (*De Re Rustica*, 12,18–24) advised Roman vintners on how much resin to add for storage wines. Byzantine agriculture manuals (*Geoponica*, 6,4) continued to endorse pitching wine vessels while they were still hot from the kiln.

By the middle Byzantine period, resinated wine (later known as *retsina*) had become a common beverage, particularly among the lower classes. Michael Choniates, a 12th-century Bishop of Athens, famously criticized the “bitter” taste of the resin-treated wine consumed by locals. Liutprand of Cremona, a 10th-century Lombard ambassador to Constantinople, famously condemned it as *undrinkable*, mocking the taste of the resin-treated wine served at the Byzantine court. Later foreign visitors echoed this sentiment: Pietro Casola remarked on its disagreeable flavour in the 15th century, while in the 19th century, Edward claimed that even sour English beer was more palatable than the resinous wine consumed by the Greeks (Germanidou, 2019). Despite such disdain, resinated wine remained popular in Byzantium and in Piost Byzantine eras as an affordable and chemically stable option for everyday consumption, storage and transport. Today’s Greek *retsina* – wine flavoured with pine resin (usually from *P. halepensis*) – is a direct descendant of this practice (Fig. 7).



Fig. 7. A selection of modern *retsina* wine brands in Greece
Ryc. 7. Wybór współczesnych marek wina *retsina* w Grecji

Beyond wine, ancient authors such as Pliny the Elder also report that pitch was used in the preservation of certain fruits – such as pears, apples, and pomegranates – by sealing their stalks or containers to prevent

spoilage (*HN*, 15.18). Additionally, resin was used to seal other food containers. Large clay pithoi storing oil were sometimes sealed with resin or wax around the lids (Panagou, 2019). However, Columella (XII 49,11) warned not to use a tar-lined container for olives or olive oil, as it could spoil their taste.

Incense, cosmetics and aromatics

Resinous substances held a prominent place in ancient aromatic, culinary, and cosmetic practices. Resins, especially from terebinth and mastic, were commonly burned as incense in religious and domestic contexts, appreciated for their fragrant smoke and purifying properties (Merousis, 2010). In perfumery, resin served as both a fixative and a scent component, contributing to the composition of complex aromatic oils (Plin. *HN*, 16.40, Galen XII 423). Culinary uses are also attested (Roumpou and Tsafou, 2023; and perhaps Poulaki, 2003).

In cosmetics, resin was valued not only for its fragrance but also for its functional properties: certain resinous mixtures were employed in depilatory preparations for hair removal (Plin. *HN*, 14.25, 16.40; Souda sv. Pitta) or as a skin conditioner (Plin. *HN*, 28,37 138-9). Mastic, in particular, was incorporated into oral hygiene routines, chewed as a form of ancient chewing gum (Gil-Merlo et al., 2021). Dioscorides in *De Materia Medica* (1.69–1.77) provides further evidence for such uses: soot derived from burning pine resin or pitch is repeatedly cited for its use in eyelash enhancement, eye ulcer treatment, and pigment preparation, serving both aesthetic and therapeutic functions (1.69.3, 1.72.4 for cedar oil serving a similar cosmetic pigment function 1.77.4). Such soot, when processed from lamp-burning resins, also produced a black dye used as eyeliner or ink (1.72.4). Mastic appears in ointments and creams to brighten the face and affix artificial lashes, while also freshening breath and whitening teeth (1.70.3). Similarly, zōpissas (ζώπισσα), mixtures of resin and wax scraped from ship planks, were applied as softening agents for skin subjected to harsh exposure (1.72.5).

Medicine and veterinary uses

Pine resin and tar were part of the ancient medicinal toolkit. The Hippocratic corpus (5th–4th c. BCE) already mentions pitch in topical preparations for

wounds (Hippocrates, *De Fistulis*, 10.3, *De Ulceribus*, 12.49). Pine pitch has natural antiseptic and antifungal properties due to its resin acids; thus, ancient doctors applied it to cuts, sores, and skin infections as a salve (often blended with animal fat or olive oil). Hippocrates used pine tar to treat pulmonary and dermatological conditions (*De mulierum affectibus*, 201.16., 203.4, *De articulis*, 39.3) Dioscorides (*De Mat. Med.*, 69-72) goes into detail on different resins: he recommends pine resin for respiratory ailments (e.g. taken in drink for coughs), for stomach problems, and as a mild diuretic, while tar is suggested for skin afflictions like ulcers, scabies, and lice (even fumigating with tar smoke to drive off pests). Tar water and tar fumes were disinfectants as well. Galen (2nd c. CE) inherited and systematized these uses. He employed both tar and resin in numerous compound medicines. He used pine resin to soften, warm, and dry wounds, often blending it with wax, fat, or oil to make plasters more adhesive and pliable (*De comp. med. gen.*, VII, 470.8, 476.6, 496.2). Tar, by contrast, was valued for its astringent and sealing qualities, helping to dry ulcers and stabilize salves (*De comp. med. gen.*, VII, 624.14, 709.7). In Byzantine times, these uses persisted and even expanded. Oribasius and other medical texts list resin and tar in numerous recipes – from poultices for inflammation to ingredients in compound drugs (Germanidou, 2019; Lardos et al., 2011). Veterinary texts (e.g. the *Hippiatrica*) similarly advise coating animal wounds with tar and using tar to strengthen horse hooves (McCabe, 2007). In fact, a very enduring traditional use of pine tar – right up to modern village practice – was to paint it on livestock hooves to prevent rot and on sheep/goats to repel flies and fungal infections. Farmers also dabbed tar on the wool of lambs to mark them and to discourage predators (Calpurnius Siculus, *Eclogae*, V.78–85). The materia medica of resin was not limited to pine: Chios mastic gum was esteemed as a medicinal resin for gastrointestinal health and oral hygiene – Galen (*Simp. med. temp. ac fac.*, XI. 113) and later physicians, as well as scholars praised mastic for many medical properties, including soothing stomach ailments and its use in dental pastes (Merousis, 2022). In general, the ancient belief was that resinous substances were warming, drying, and cleansing. Modern pharmacological studies have validated some of these effects (e.g. mastic's antiulcer

activity, pine tar's antimicrobial action), explaining the longevity of these remedies (Dimas et al., 2012; Huwez et al., 1998).

Adhesives and utility products

Beyond the high-profile uses, resin and tar served countless quotidian purposes. One was as an adhesive or glue. Pine pitch, especially when mixed with other ingredients, made an effective glue for crafts. Mycenaean artisans used resinous adhesives to attach thin gold foil onto ivory or stone, e.g. resin was found affixing gold leaf on the Palaikastro ivory figurine and tin rivets to a vase in Asine (Merousis, 2010). In classical times, tar could mend broken pottery: a ceramic vessel cracked could be “pitch-glued” back together and reused (IG XI 2, 154 A 37). Tar was also used to caulk and seal wooden wine barrels, once coopers began using barrels in the Roman period – a Gaulish wine barrel found at Reims had interior pitch lining similar to amphorae (Mille and Rollet, 2020). Its adhesive properties were also exploited in hair removal (Aetius, *Med. Lib.*, III, 180). In painting, tree resins (like pine resin or mastic) were key components of varnishes and binding media; In antiquity tar was also used to produce black ink (Christiansen, 2017). Later Byzantine and pPost- Byzantine iconographers used resins in their varnish (Abdel-Ghani et al., 2009; Mastrothodoros and Beltsios, 2021). Tar was also employed in the preservation and cleaning of bronze objects (Pausanias, I 15,4), and played a role in the production of copies of bronze statues (Lucian, *Zeus Tragōdos*, 33).

Fire, light and warfare

The flammable nature of pine resin and tar made them natural pyrotechnics. Greeks realized that soaking fibrous material in pitch created excellent torches and firebrands (Moullou, 2011; Moullou and Topalis, 2022). Indeed, the common Greek word for torch, *peuke* (“pine brand”) in ancient sources (e.g. Aeschylus, *Agamemnon*, 287; Sophocles, *Oedipus Rex*, 214; Euripides, *Ion*, 716; Aristophanes, *Clouds*, 604), reflects that resinous pine was preferred for torches. When the wood used for a torch lacked natural resin content, it was necessary to enhance its flammability by adding combustible substances such as resin or tar (Aristophanes, *Vespae*, 1373–1377; Athenaeus, *Deipnosophistae*, 15.57.22). In some cases, the torch head may

have been wrapped in tow soaked with tar, as illustrated on a red-figure skyphos now housed in the Arthur M. Sackler Museum, Harvard University (formerly in the Hoppin Collection; BAPD 13322). A torch could also take the form of a vessel (a pot-torch) containing flammable substances such as oil, tallow, resin or tar, possibly combined with a slow-burning material serving as a wick (Phrynichus, *Praeparatio sophistica* 87.3–4) (Fig. 8).



Fig. 8. Experimental reproduction of a pot-torch containing heated resin (Phot. D. Moullou)

Ryc. 8. Eksperymentalne odtworzenie pochodni garnekowej zawierającej podgrzaną żywicę (fot. D. Moullou)

Soldiers and sailors weaponized tar: Thucydides describes how during the siege of Delium (424 BCE) the Boeotians used a makeshift flamethrower – a hollow log filled with pitch, sulphur, and charcoal – to blow fire onto the Athenian wooden fortifications (Thuc. 4.100). Alexander the Great's engineers were familiar with combustible mixtures of pitch, oils, and quicklime used to create incendiary grenades (Aeneas Tacticus, *Poliorketika*, 35). Caesar, in the *Commentaries on the Gallic War* (8.42), notes defenders throwing pitch and sulphur on Roman siege works to set them alight. All these heralds the Byzantine-era Greek Fire (Haldon et al., 2006; Partington, 1960). Liquid pitch (tar) was a major ingredient in the feared “liquid-fire” deployed by the Byzantine navy, as well as in primitive hand grenades and firepots used in siege defence (Triantafyllidis, 2016). Byzantine treatises

on warfare (e.g. Anna Komnene on the 12th-century navy; Reinsch and Kambylis, 13.6, 391–392) list *pissa* (pine pitch) as a primary ingredient of the liquid incendiary launched by flamethrowers in naval battles. Mixed with other chemicals like petroleum and saltpetre, pitch gave the mixture its stickiness and high burn temperature. The use of tar in warfare thus persisted from the classical world straight through to the end of the Middle Ages.

Resin and pitch also served as instruments of torture, particularly in Christian martyrdom accounts. Victims were often cast into cauldrons filled with boiling resin or pitch, or had the burning substances poured over them. Amphilochios was thrown into a cauldron “heated and filled with resin” (*Acta Sanctorum*, 29 March); similarly, Artemōn was burned in a vessel containing both pitch and resin (12 April); Saint George (23 April) was tortured by being immersed in a mixture of pitch and resin as fire boiled beneath him (Germanidou, 2019).

These examples demonstrate how resin and pitch were not only essential materials of daily life and technology but also instruments of extreme violence, capable of inflicting horrific physical suffering in both warfare and punishment.

CONCLUSION

The production and use of resin and pine tar in Greece illustrate a long-standing interplay between natural resources and cultural practices, persisting from antiquity into modern times. In the Classical and Hellenistic eras, Greece – particularly Macedonia – emerged as a key supplier of pine pitch, leveraging its forest wealth to support shipbuilding, trade, and warfare on an international scale. State control of pitch under the Macedonian kings underscores its strategic and economic importance. Roman rule disrupted monopolies but not the utility of resin and tar: these materials remained fundamental to daily life, from lining ubiquitous wine amphorae to providing medicines and torch fuel. In Byzantine times, pine resin was still, in a sense, “the gold of the pines”, valued in medicine, used in the iconic *retsina* wine, and indispensable for Greek Fire. Production techniques showed remarkable continuity – a Byzantine resin tapper or a 19th-century *katranádēs* would find much familiar in Theophrastus’ description

of tar kilns and resin gathering. Over centuries, new applications emerged (such as gunpowder-era incendiaries), but many old ones – sealing a wine jar or healing a wound – remained the same. By the post-Byzantine/Ottoman period, large-scale industrial tar production had shifted elsewhere, yet Greek communities preserved the traditional knowledge of resin-tapping and tar-making on a local scale. That continuity, now recognized as heritage, speaks to the deep-rooted presence of these practices in Greek culture.

In sum, the story of resin and pine tar in Greece is one of resourcefulness and adaptation. A simple substance exuded by wounded trees became, in Greek hands, an adhesive, a preservative, a flavouring, a disinfectant, a weapon, a waterproofing and a perfume – in short, a multipurpose material that oiled the wheels of ancient economy and society. The exacting descriptions by ancient scholars, the analyses by modern archaeologists, and the survival of folk techniques together give us an unusually comprehensive view of an ancient craft. From the naval stores of Classical Athens to the monastic wineries of Byzantium to the mountain kilns of Epirus, resin and tar production form a continuous thread. It is a testament to human ingenuity in using natural products – and to the enduring legacy of Greek silviculture and craftsmanship – that even today one can sip a glass of resin-infused wine or see a wooden boat sealed with pine tar and be directly connected to practices that are more than five millennia old.

ACKNOWLEDGMENTS

The authors wish to sincerely thank Mr. Kostas Paganias, traditional pine tar producer from the village of Distrato (Ioannina Prefecture), for kindly providing images documenting the pine tar production process at Distrato.

REFERENCES

- Abdel-Ghani, M., Edwards, H. G., Stern, B., Janaway, R. (2009). Characterization of paint and varnish on a medieval Coptic-Byzantine icon: Novel usage of dammar resin. *Spectrochim. Acta Part A: Molec. Biomolec. Spectr.*, 73(3), 566–575. <https://doi.org/10.1016/j.saa.2008.10.050>

- Anagnostakis, I. (2013). Byzantine diet and cuisine: In between ancient and modern gastronomy. In: I. Anagnostakis (Ed.), *Flavours and delights: Tastes and pleasures of ancient and Byzantine cuisine* (pp. 43–64). Athens: ARMOS Publications.
- André, J. (1964). La résine et la poix dans l'Antiquité: Technique et terminologie. *Antiq. Class.*, 33, 86–97. <https://doi.org/10.3406/antiq.1964.2426>
- Ari, S., Kargioğlu, M., Temel, M., Konuk, M. (2014). Traditional Tar Production from the Anatolian Black Pine [*Pinus nigra* Arn. subsp. *pallasiana* (Lamb.) Holmboe var. *pallasiana*] and its usages in Afyonkarahisar, Central Western Turkey. *J. Ethnobiol. Ethnomed.*, 10, 29. <https://doi.org/10.1186/1746-4269-10-29>
- Bean, G. E. (1954). Notes and Inscriptions from Caunus (Continued). *J. Hellen. Stud.*, 74, 85–110. <https://doi.org/10.2307/627558>
- Beresford, J. (2013). *The ancient sailing season* (Mnemosyne Supplements 351). Boston & Leiden: Brill.
- Borza, E. N. (1982). The natural resources of early Macedonia. In: W. L. Adams, E. N. Borza (Eds.), *Philip II, Alexander the Great and the Macedonian heritage* (pp. 1–20). Lanham: University Press of America. Reprinted in: C. G. Thomas (Ed.), *Makedonika: Essays by Eugene N. Borza* (pp. 37–55). Claremont: Regina Books.
- Casson, L., Steffy, J. P. (Eds.). (1991). *The Athlit ram*. Texas A&M University Press.
- Chankowski, V. (2023). Parasites of the god: Accountants, financiers and traders on Hellenistic Delos. BEFAR 409. École française d'Athènes.
- Christiansen, T. (2017). Manufacture of black ink in the ancient Mediterranean. *Bull. Am. Soc. Papyrol.*, 54, 167–195. Retrieved from: <http://www.jstor.org/stable/44972209>
- Dimas, K., Pantazis, P., Ramanujam, R. (2012). Chios mastic gum: A plant-produced resin exhibiting numerous diverse pharmaceutical and biomedical properties. *In Vivo*, 26(5), 777–785. Retrieved from: <https://pubmed.ncbi.nlm.nih.gov/22949590/>
- Dursun, S. (2007). *Forest and the state: History of forestry and forest administration in the Ottoman Empire* [Doctoral dissertation, Sabancı University].
- Forbes, R. J. (1936). The nomenclature of bitumen, petroleum, tar, and allied products in antiquity. *Mnemosyne*, 4, 75–77.
- Garnier, N., Valamoti, S. M. (2016). Prehistoric wine-making at Dikili Tash (Northern Greece): Integrating residue analysis and archaeobotany. *J. Archaeol. Sci.*, 74, 195–206. <https://doi.org/10.1016/j.jas.2016.03.003>
- Germanidou, S. (2019). Resin in the Byzantine Era: Symbolism, Practices, and Uses. In: G. A. Pikoulas (Ed.), *Oionon Historō XI: Retsina – The diachronic history of resin in winemaking technique* (pp. 67–82). Athens. [in Greek]
- Gil-Merlo, E., Matallana-González, C., Torija-Isasa, E. (2021). Almástiga y mirra: De la planta a la higiene bucal [Mastic and myrrh: From the tree to oral hygiene]. *Bol. Real Soc. Españ. Hist. Nat.*, 115, 111–129.
- Grenquist, S. (2018). Ancient dimensions and units: Ancient Greek unitary systems and their evolution from earlier systems of measurement. *ATINER Conference Proceedings Series ELE2018-0014*, 1–15.
- Guthmann, R., Scheidel, W. (2025). The economics of Greco-Roman slavery. *Explor. Econ. Hist.*, 97, 101689. <https://doi.org/10.1016/j.eeh.2025.101689>
- Haldon, J., Lacey, A., Hewes, C. (2006). Greek fire revisited: Recent and current research. In: E. M. Jeffreys (Ed.), *Byzantine style, religion and civilization: In honour of Sir Steven Runciman* (pp. 291–325). Cambridge: Cambridge University Press.
- Hatzopoulos, M. B. (1996). *Macedonian institutions under the kings II: A historical and epigraphic study* (Epigraphic Appendix) (Meletēmata 22). Athens: De Boccard.
- Huwez, F. U., Thirlwell, D., Cockayne, A., Ala'Aldeen, A. A. D. (1998). Mastic gum kills *Helicobacter pylori*. *New Eng. J. Med.*, 339(26), 1946. <https://doi.org/10.1056/NEJM199812243392618>
- Jacoby, D. (2013). Rural exploitation and market economy in the late medieval Peloponnese. In: S. E. J. Gerstel (Ed.), *Viewing the Morea: Land and people in the late medieval Peloponnese* (pp. 213–276). *Dumbarton Oaks Byzantine Symposia and Colloquia*. MA: Harvard University Press.
- Kahanov, Y., Royal, J. G. (1996). The 1995 INA/CMS Tantara A Byzantine shipwreck excavation: Hull construction report. *CMS News*, 23(December), 21–23.
- Karakatsani, R. (1998). *Theophrastus: Collected works*, Vol. 11. *Botanical Lexicon according to Theophrastus* [in Greek]. Athens: Kaktos Editions.
- Kılıç Pekgözlü, İ., Kuştaş, S., Mercan, B., Biçer, A. (2017). Chemical characterization of Lebanon cedar tar obtained by traditional and retort methods. *Drvna Ind.*, 68(2), 107–112. <https://doi.org/10.5552/drind.2017.1607>
- Kızıllarslan, Ç., Sevgi, E. (2013). Ethnobotanical uses of genus *Pinus* L. (Pinaceae) in Turkey. *Indian J. Trad. Knowl.*, 12(2), 209–220. Retrieved from: https://www.researchgate.net/profile/Cagla-Kizilarslan-Hancer/publication/236865243_Ethnobotanical_uses_of_genus_Pinus_L_Pinaceae_in_Turkey/links/56bd944c08ae9ca

- 20a4dfd75/Ethnobotanical-uses-of-genus-Pinus-L-Pinaceae-in-Turkey.pdf
- Kocabaş, U. (2015). Istanbul University Byzantine-Era ship-finds from Yenikapı. *Int. J. Nautic. Archaeol.*, 44, 5–38. <https://doi.org/10.1111/1095-9270.12084>
- Koder, J. (1991). *Das Eparchenbuch Leons des Weisen* [The Book of the Eparch of Leo the Wise]. Vienna: Verlag der Österreichischen Akademie der Wissenschaften.
- Kommataş, D. (1999). Tar production in the area of Thelologos (Thasos). In: Ch. Koukouli-Chrysanthaki, A. Muller, S. Papadopoulos (Eds.), *Thasos: Raw materials and technology from prehistoric times to the present: Proceedings of the International Conference, Limenaria, Thasos, 26–29 September 1995* (pp. 413–422). Kavala–Athens: 18th Ephorate of Prehistoric and Classical Antiquities & French School at Athens [in Greek].
- Koukouni, I. N. (2011). *Capitania Valisso Castrum Dicti Loci: Settlement patterns and defence on Northern Chios, 9th–16th centuries* [Doctoral dissertation, University of Birmingham].
- Lagontzou, M. (2017). The traditional craft of the Ierissos boatbuilders. *Eranistis*. Retrieved July 1st 2025 from: <https://eranistis.net/wordpress/2017/10/03/karavomaragkoi-ierissos/>
- Langenheim, J. H. (2003). *Plant resins: chemistry evolution ecology and ethnobotany*. Timber Press.
- Lardos, A., Prieto-Garcia, J., Heinrich, M. (2011). Resins and gums in historical *Iatrosophia* texts from Cyprus: A botanical and medico-pharmacological approach. *Front. Pharmacol.*, 2, 32, 1–26. <https://doi.org/10.3389/fphar.2011.00032>
- Loret, V. (1949). La résine de térébinthe (sonter) chez les anciens Égyptiens [Turpentine resin (sonter) among the ancient Egyptians]. Cairo: Institut Français d'Archéologie Orientale.
- Makkonen, O. (1969). *Ancient forestry: A historical study. Part II. The procurement and trade of forest products*. *Acta Forest. Fen.*, 95, 7603. <https://doi.org/10.14214/aff.7603>
- Mastrotheodoros, G. P., Beltsios, K. G. (2021). Original varnish recipes in post-Byzantine painting manuals. *Heritage*, 4(4), 3572–3582. <https://doi.org/10.3390/heritage4040197>
- McCabe, A. (2007). *A Byzantine encyclopaedia of horse medicine: The sources, compilation, and transmission of the Hippitrica*. Oxford: Oxford University Press.
- Meiggs, R. (1982). *Trees and timber in the ancient Mediterranean world*. Oxford: Clarendon Press.
- Merousis, N. (2010). The “tears” of the trees: The uses of resins in the prehistoric Aegean. In: N. Merousis, E. Stefani, M. Nikolaidou (Eds.), *Iris: Studies in memory of Professor Angeliki Pilali-Papasteriou*. Thessaloniki: Sfakianaki Editions [in Greek].
- Merousis, N. (2012). Resins, spices, and perfumes from Canaan to the Aegean. In: P. Adam-Veleni, E. Stefani (Eds.), *Greeks and Phoenicians at the Mediterranean crossroads*. Thessaloniki: Ministry of Culture and Tourism [in Greek].
- Merousis, N. (2019). Resinated wine and resinated drinks in Prehistoric Aegean: Data, hypotheses, and interpretations. In: G. A. Pikoulas (Ed.), *Oionon Historō XI: Ret-sina – The diachronic history of resin in winemaking technique* (pp. 19–42). Athens [in Greek].
- Merousis, N. (2022). The uses and circulation of mastic in Greek antiquity: Data and hypotheses. *Archaeologia kai Texnes*, 140, 110–123 [in Greek].
- Meunier, L., Guyon, M. (2020). Waterproofing material from a 2nd-century AD barge from Lyon: Looking for the Roman know-how to caulk with pitched textiles. In: M. Bustamante-Álvarez, E. H. Sánchez López, J. Jiménez Ávila (Eds.), *Purpureae Vestes VII* (pp. 161–169). Granada: Universidad de Granada.
- Mille, P., Rollet, P. (2020). Étude de trois grands tonneaux mis au jour à Reims/Durocortorum (Marne): le savoir-faire des tonneliers antiques. *Gallia*, 77(2), 123–155. <https://doi.org/10.4000/gallia.5242>
- Mitkidou, S., Dimitrakoudi, E., Papadopoulou, D., Urem-Kotsou, D., Kotsakis, K., Stephanidou-Stephanatou, I., Stratis, J. A. (2008). Organic residue analysis of Neolithic pottery from North Greece. *Microchimica Acta*, 160, 493–498. Retrieved from: <https://link.springer.com/article/10.1007/s00604-007-0811-2>
- Moullou, D. (2011). Lighting the fire and illumination in antiquity. In: I. Motsianos, E. Bintsi (Eds.), *Light on Light: An illuminating story* (pp. 44–57). Thessaloniki: Folklife and Ethnological Museum of Macedonia and Thrace.
- Moullou, D., Topalis, F. V. (2022). Reconstructing artificial light in ancient Greece. In: C. Papadopoulos, H. Moyes (Eds.), *The Oxford handbook of light in archaeology* (pp. 604–627). Oxford: Oxford University Press.
- Murray, W. (2009). The cargo of pine tar (from the Tektaş Burnu shipwreck). Paper submitted for publication in the final volume dedicated to the wreck edited by D. N. Carlson. Retrieved from: <https://www.academia.edu/82298849>
- Ninich, O., El Fahime, E., Satrani, B., Ouajdi, M., El Younsi, H., Burri, S., Ettaleb, I., Chauiyakh, O., Aarabi, S., Ettahir, A. (2024). Wood tar properties in Morocco: Yield, pH, and density analysis. *Res. J. Pharm. Technol.*,

- 17(8), 3920–3928. <https://doi.org/10.52711/0974-360X.2024.00608>
- Oikonomou, D. (2012). Wood in traditional shipbuilding – a practical application [Diploma thesis, National Technical University of Athens, School of Naval Architecture and Marine Engineering] [In Greek].
- Orengo, H. A., Palet, J. M., Ejarque, A., Miras, Y., Riera, S. (2013). Pitch production during the Roman period: an intensive mountain industry for a globalised economy? *Antiquity*, 87(337), 802–814. <https://doi.org/10.1017/S0003598X00049474>
- Panagou, T. (2019). Resins and wine in antiquity: The evidence of transport amphoras. In: G. A. Pikoulas (Ed.), *Oinon Historō XI: Retsina – The diachronic history of resin in winemaking technique* (pp. 43–66). Athens [in Greek].
- Papadopoulos, A. M. (2013). Resin tapping history of an Aleppo pine forest in Central Greece. *Open Forest Sci. J.*, 6, 50–53. <https://doi.org/10.2174/1874398601306010050>
- Parker, A. J. (1992). *Ancient Shipwrecks of the Mediterranean and the Roman Provinces*. Oxford: Tempus Reparatum. BAR International Series, 580.
- Partington, J. R. (1960). *A history of Greek fire and gunpowder*. Cambridge: Heffer and Sons.
- Pliny the Elder (1938–1962). *Natural History* (Trans. H. Rackham, W. H. S. Jones, D. E. Eichholz). Loeb Classical Library (vol. 1–10). Cambridge, MA: Harvard University Press.
- Pryor, J., Jeffreys, E. M. (2006). *The Age of the ΔΡΟΜΩΝ*. Leiden, The Netherlands: Brill. <https://doi.org/10.1163/9789047409939>
- Pomey, P., Boetto, G. (2019). Ancient Mediterranean sewn-boat traditions. *Int. J. Nautic. Archaeol.*, 48(2), 5–51. <https://doi.org/10.1111/1095-9270.12340>
- Pomey, P., Kahanov, Y., Rieth, E. (2012). Transition from Shell to Skeleton in Ancient Mediterranean Ship-Construction: analysis, problems, and future research. *Int. J. Naut. Archaeol.*, 41(2), 235–314. <https://doi.org/10.1111/j.1095-9270.2012.00357.x>
- Poulaki, E. (2003). Catalogue. In: P. Adam-Veleni, E. Poulaki, K. Tzanavari (Eds.), *Ancient farmhouses on modern roads – Central Macedonia* (p. 234, cat. no. 296). Athens: Archaeological Receipts Fund.
- Rageot, M. (2015). *Les substances naturelles en Méditerranée nord-occidentale (VIe–Ie millénaire BCE): Chimie et archéologie des matériaux exploités pour leurs propriétés adhésives et hydrophobes* [Natural substances in the northwestern Mediterranean (6th–1st millennium BCE): Chemistry and archaeology of materials exploited for their adhesive and hydrophobic properties] [Doctoral dissertation, Université de Nice–Sophia Antipolis].
- Reinsch, D. R., Kambylis, A. (Eds.). (2001). *Annae Comnenae Alexias* (Corpus Fontium Historiae Byzantinae 40). Berlin & New York: De Gruyter.
- Roumpou, M., Tsafou, E. (2023). Culinary practices and pottery use in Minoan Crete: Integrating lipidic residue analysis in the study of cooking vessels from Sissi and Malia. *J. Archaeol. Sci. Rep.*, 50, 104050. <https://doi.org/10.1016/j.jasrep.2023.104050>
- Roussel, P. (1934). La poix des Anthestéria. *Rev. Étud. Ancien.*, 36(2), 177–179. <https://doi.org/10.3406/rea.1934.2753>
- Schramm, A. (1894). Pech [Pitch]. In: G. Wissowa (Ed.), *Realencyclopädie der classischen Altertumswissenschaft* (vol. 19.1, pp. 1–5). Stuttgart–Weimar.
- Smith, W., Anthon, C. (1851). *A new classical dictionary of Greek and Roman biography, mythology, and geography*. New York: Harper & Brothers.
- Theophrastus (1916). *Enquiry into plants* (Trans. A. F. Hort). Loeb Classical Library (vol. 1–2, pp. 70–79). Cambridge, MA: Harvard University Press.
- Triantafyllidis, P. (2016). War in medieval Mytilene, Lesbos, Greece: Glass grenades of the 14th and 15th centuries. *J. Glass Stud.*, 58, 296–300. Retrieved from: <https://www.jstor.org/stable/90000985>
- Tzora, M. (2025). The pitch of Distrato in the Intangible Cultural Heritage [in Greek]. Retrieved May 28th 2025 from: <https://www.archaiologia.gr/blog/2025/05/12/το-κατράνι-του-δίστρατου-στην-άυλη-πολ/>
- UNESCO Cyprus (n.d.). Traditional uses of aromatic and medicinal plants of the Troodos mountainous region. Retrieved July 14th 2025 from: https://www.unesco.org.cy/Programmes-Paradosiakes_chriseis_ton_aromatikon_kai_farmakeytikon_fyton_tis_oreinis_periochis_toy_Troodoys%2CGR-PROGRAMMES-04-02-03-47%2CGR [In Greek]
- Urem-Kotsou, D., Stern, B., Heron, C., Kotsakis, K. (2002). Birch-bark tar at Neolithic Makriyalos, Greece. *Antiquity*, 76(294), 962–967. <https://doi.org/10.1017/S0003598X00091766>
- Urem-Kotsou, D., Copley, M. S., Evershed, R. P. (2004). The use of birch bark tar on Late Neolithic pottery from Stavroupoli, North Greece. In: D. Grammenos, S. Kotsos (Eds.), *Rescue excavations at the Neolithic settlement of Stavroupoli, Thessaloniki, Part II* (1998–2003) (pp. 339–347). Thessaloniki: Society for Macedonian Studies.
- Urem-Kotsou, D., Mitkidou, S., Dimitrakoudi, E., Kokkinos, N., Ntinou, M. (2018). Following their tears: Production and use of plant exudates in the Neolithic of

- North Aegean and the Balkans. *Quat. Int.*, 496, 68–79. <https://doi.org/10.1016/j.quaint.2018.10.027>
- Vassiliadou, I. (2011). Rural life in ancient Pieria: Archaeological evidence. Thessaloniki: Kornelia Sfakianaki Editions [in Greek].
- Vassiliadou, I. (2018). Pierian-Macedonian pitch: A brand name agricultural product of ancient Macedonia. In: M. Heinzlmann, M. Bentz (Eds.), *Sessions 2–3, single contributions (Archaeology and Economy in the Ancient World: Proceedings of the 19th International Congress of Classical Archaeology, Cologne/Bonn 2018 (vol. 53, pp. 333–346). Heidelberg: Propylaeum.* <https://doi.org/10.11588/propylaeum.999.c13362>
- Vassiliadou, I. (2019). Pierian pitch – Macedonian pitch. In: S. Pigniatoglou (Ed.), *Dion University Excavation: Newer studies (pp. 111–118). Thessaloniki: University Studio Press [in Greek].*
- Vroom, J. (2018). The ceramics, agricultural resources and food. In: J. Haldon, H. Elton, J. Newhard (Eds.), *Archaeology and urban settlement in Late Roman and Byzantine*
- Anatolia: Euchaïta–Avkat–Beyözü and its environment (pp. 134–184). Cambridge: Cambridge University Press.
- Wartke, R., Burford-Cooper, A. A. (2006). Pitch. In: *Brill's New Pauly Online.* Brill. https://doi-org.proxy.eap.gr/10.1163/1574-9347_bnp_e911120
- Ayla (2025). Εθνικό Ευρετήριο Άυλης Πολιτιστικής Κληρονομιάς της Ελλάδας. Retrieved from: <https://ayla.culture.gr/ellada/to-ethniko-evretirio-aylis-politistikis-klironomias-tis-elladas/>
- Ministry of Commerce (2025). The traditional technology of tar production in the Konitsa District (and in Pieria, Crete, Thassos, Attica), in the Intangible Cultural Heritage of Greece. Culture archive. Retrieved from: <https://arxeion-politismou.gr/2025/05/katrami.html>
- Τέσσερα νέα στοιχεία στο Εθνικό Ευρετήριο Άυλης Πολιτιστικής Κληρονομιάς της Ελλάδας (2025). Retrieved from: <https://www.culture.gov.gr/el/Information/SitePages/view.aspx?nID=5323>

ŻYWICA I SMOŁA SOSNOWA W GRECJI: STAROŻYTNE TECHNIKI I TRADYCYJNE PRAKTYKI

ABSTRAKT

W artykule przeanalizowano produkcję i wykorzystanie żywicy oraz smoły sosnowej w starożytnej Grecji i poza jej granicami, od czasów prehistorycznych po okres bizantyjski i wczesnonowożytny. Na podstawie starożytnych źródeł literackich, a także danych archeologicznych, archeometrycznych i etnograficznych zrekonstruowano techniki pozyskiwania żywicy i wytwarzania smoły drzewnej od antyku po współczesność, ze szczególnym uwzględnieniem starożytnego przemysłu smołowego oraz długo utrzymującej się w nowożytnej wiejskiej Grecji praktyki wykorzystania pieców katramokámina. Substancje żywiczne – uzyskiwane przez nacinanie żywych drzew lub poddawanie drewna bogatego w żywicę pirolizie w celu otrzymania smoły drzewnej – pełniły w społeczeństwie greckim różnorodne funkcje: służyły do uszczelniania statków i amfor na wino, leczenia ran, aromatyzowania pomieszczeń, a także jako paliwo do pochodni i broni. W opracowaniu podkreślono zarówno materialne zastosowania, jak i symboliczne znaczenie tych substancji w kontekstach domowych, morskich, medycznych i religijnych. Śledząc ciągłość oraz adaptację technologii na przestrzeni tysiącleci, autorzy wskazują na wiedzę ekologiczną zakorzenioną w praktykach związanych z żywicą. Studium wnosi wkład w badania nad starożytnymi praktykami przemysłu leśnego oraz ochroną niematerialnego dziedzictwa kulturowego, oferując wgląd w trwałe związki między zasobami naturalnymi, rzemieślniczą wiedzą a odpornością kulturową w świecie greckim.

Słowa kluczowe: żywica, smoła sosnowa, dziegieć, Grecja, starożytna technologia grecka, rzemiosło tradycyjne, produkty leśne, dziedzictwo leśne, perspektywa diachroniczna, zastosowania praktyczne