

TAR PRODUCTION IN POLAND FROM A COMMON CRAFT TO A FADING TRADITION

Maria Legut-Pintal^{1✉}, Joachim Popek², Alicja Młynarczuk³, Monika Bartkowiak⁴, Magdalena Zborowska⁴

¹Institute of Archaeology, University of Wrocław
Szewska 48, 50-137 Wrocław, **Poland**

²Institute of History, College of Humanities, University of Rzeszów
Aleja Rejtana 16c, 35-959 Rzeszów, **Poland**

³Faculty of Archaeology, Adam Mickiewicz University
Uniwersytetu Poznańskiego 7, 61-614 Poznań, **Poland**

⁴Faculty of Forestry and Wood Technology, Poznań University of Life Sciences
Wojska Polskiego 38/42, 60-637 Poznań, **Poland**

ABSTRACT

This article highlights the significant yet previously underestimated role of wood tar in the economic history of the Polish lands. The literature reveals its multifaceted use as an adhesive, preservative, medicine, and ritual substance. Tar production expanded locally and industrially during the Middle Ages and early modern period, particularly in the Carpathian and Białowieża, Tuchola, and Solska forests, reaching a European scale by the 19th century, before declining in the 20th century, due to petroleum-based alternatives. Today, traditional tar-making survives mainly through educational and museum initiatives. The study presents an overview of production technologies, archaeological contexts, and written sources, and emphasizes the need for further interdisciplinary research and the creation of a database of production sites documented in archaeological and historical records.

Keywords: tar, birch tar, forest by-products, archaeology, history, PoTaRCh

INTRODUCTION

This article offers a synthesis of the current state of research on wood tar production in the historical Polish lands, covering the development of this craft from the earliest archaeological evidence through the early modern period and into contemporary times. The primary aim is to gather and organize existing knowledge on the various technologies used in tar distillation, the archaeological contexts in which such activities have been identified, and the information derived from written sources. In parallel, the study also examines the diverse applications of wood tar throughout history,

ranging from everyday use to its economic, medicinal, and ritual functions. Our methodological approach is grounded in a brief review of the literature and a selective compilation of site data. Sources and sites were included based on explicit criteria, including their chronological relevance, direct association with tar production, and reliability of documentation, ensuring the clarity and reproducibility of the analysis. Based on existing synthetic studies and selected case studies, the current state of knowledge in the subject area was analysed. For the prehistoric period, it was

✉ maria.legut-pintal@pwr.edu.pl, <https://orcid.org/0000-0001-6406-1038>

possible to create a georeferenced database of sites associated with tar production. In addition to synthesizing the available data, this article seeks to evaluate the significance of tar-related activities in different historical contexts, with particular attention to their scale and socio-economic role. At the same time, the study identifies key gaps in existing research and outlines essential directions for future investigations in this still-underexplored area of the history of technology.

DEFINITION OF TAR

Wood tar is a substance obtained through the dry distillation of wood or tree bark, a process of pyrolysis. This process typically starts at the temperature of 200°C and depending on the wood species, it proceeds until the temperature of 450–500°C is reached (de Wild et al., 2011). Pyrolysis produces charcoal, wood tar and gases. The course of the pyrolysis process, the efficiency of individual product groups, and the quantitative and qualitative composition of the liquid product and gases depend on the process parameters and the type of wood (Fengel and Wegener, 1984). Tar could be the primary product or a secondary result of charcoal production. In Polish, this product was called *smoła* or *maź*, while only birch tar received a specific name, known in every Slavic language as *dziegieć*. Tar produced from different wood species varied in composition and properties.

The main tree species used for tar production were birch, pine, and spruce, with willow, juniper, fir, larch, and linden being used less frequently. Pine tar was the most popular, which is related to the species composition of forests in Poland, where pine predominates (Samojlik, 2006). Pine tar was known as ship tar and was used for waterproofing ship hulls.

Wood tar is a complex mixture of many different hydrocarbons (up to several hundred), and as such it has not been categorically defined in the literature. Milne et al. (1998) defined wood tars as an organic substance formed in the thermal decomposition or gasification process of any organic material; it is generally assumed to be primarily a mixture of aromatic compounds. Evans and Milne (1987a, 1987b) used molecular beam mass spectrometry (MBMS) for the qualitative analysis of wood tar and proposed the following classification: primary, secondary, and tertiary

tar. As a result of the reaction and thermal transformations occurring in the gaseous phase, four main groups of products were identified:

- Primary products: derivatives of cellulose (levoglucosan, hydroxyacetaldehyde and furfurals); analogous products based on hemicelluloses; and methoxyphenols derived from lignin
- Secondary products: phenols and olefins
- Tertiary alkyl products: methyl derivatives of aromatic compounds (methylacenaphthylene, methyl naphthalene and toluene)
- Condensed tertiary products: non-substituted polycyclic aromatic hydrocarbons (PAH), i.e. those with no substituents (benzene, indene, naphthalene, acenaphthylene, anthracene, phenanthrene, pyrene).

Wood tars have a low pH (3–5), and are miscible with water, with a medium heating value (15–20 MJ/kg) (Tintner et al., 2021). The crude wood tar, when left for an extended period, would split into three layers. The upper layer is formed by a thin film of light oil, the middle layer contains water-soluble components of wood tar (e.g. acetic acid, methanol, phenols), while the bottom layer is an oily, very dense liquid (Tiilikala et al., 2010; Yang et al., 2017).

Birch bark tar is an organic substance that can only be obtained by dry distillation of the bark of the birch tree. It is a dark liquid with a characteristic smell and is a mixture of many chemical compounds. The main compounds were water, acetic acid, methanol, hydroxypropanone, furfurals, acetone and syringol, catechol, and phenol derivatives, and sugar-like compounds (Fagernäs et al., 2012). A characteristic feature of the chemical composition of birch bark tar is the presence of compounds obtained as a result of the pyrolysis of typical components of birch bark, i.e. suberin and suberan (Schmidt and Koch, 2024).

ARCHAEOLOGICAL EVIDENCE OF PREHISTORIC TAR PRODUCTION

Production methods of wood tar in the areas of present-day Poland were known as early as the Mesolithic period (8000 – 5500 BCE). This is evidenced by a find from Woźniki (Sulgostowska, 1991/1992), where a decorated bone object was discovered with carvings

filled with tar. Another interesting example is a harpoon from Tłokowo (Sulgostowska and Hoffmann, 1993), where flint blades were attached to the handle using tar. A large number of artifacts are discovered at Neolithic, Bronze Age, Iron Age, and medieval sites. The earliest of these are visibly concentrated in the regions of Greater Poland, Kuyavian-Pomeranian, and to a lesser extent, Lesser Poland and Mazovia (Fig. 1). This distribution of sites where ceramics with traces of tar were found may be due to the current state of archaeological research in Poland, rather than a lack of knowledge or ability to produce this material in other regions.

During the Neolithic period, wood tar was produced mainly using single-, double-, or triple-vessel systems. The production method involved placing

wood or bark in a tightly sealed container. When the substrate was subjected to high temperatures, it underwent a process of dry distillation. In the single-vessel method, the produced tar was collected at the bottom of the container. The double- and triple-vessel methods assumed that the upper vessel held the raw material, and the lower one collected the product (Table 1). This required special containers with a hole in the bottom, through which the tar could flow into lower vessels. The addition of a third vessel served to further purify the tar of volatile substances. No containers that could have served as production vessels survive from the Mesolithic period. Since many communities of that time were unfamiliar with ceramics, tar was produced without the use of containers. Polish researcher Grzegorz Osipowicz conducted an archaeological

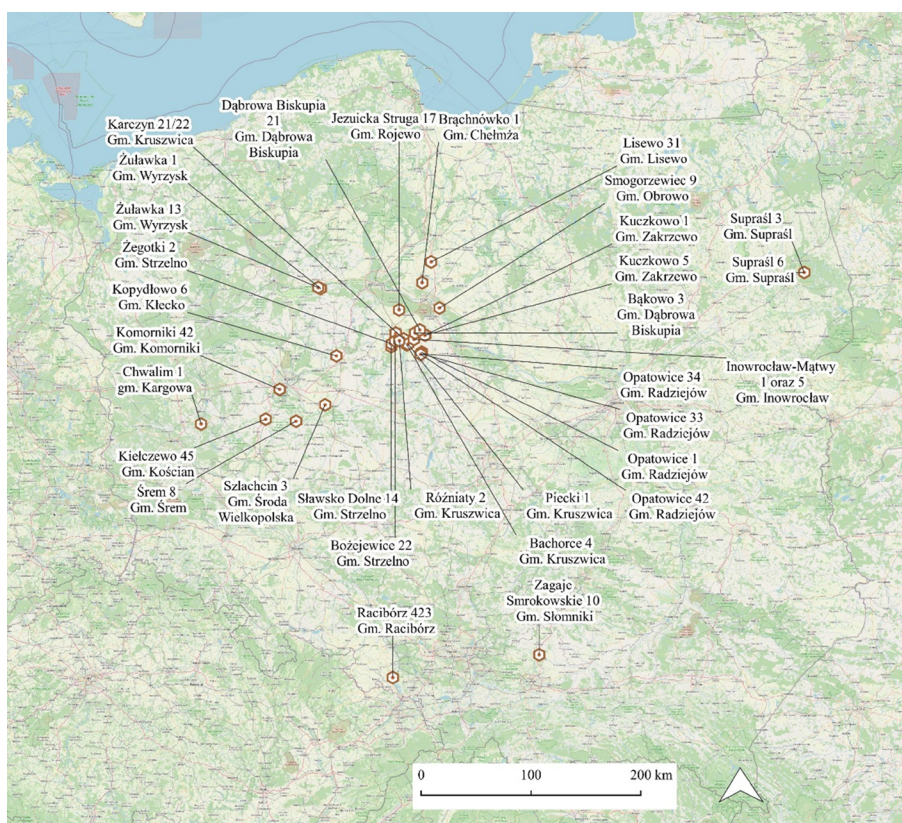


Fig. 1. Map of Neolithic and Bronze Age sites in Poland where traces of wood tar production have been discovered (Młynarczuk and Popek)

Ryc. 1. Mapa stanowisk z okresu neolitu i epoki brązu w Polsce, na których odkryto ślady produkcji smoły drzewnej/dziegiu (Młynarczuk i Popek)

Table 1. Basic methods of historical wood tar production in the Polish lands (Legut-Pintal)

Tabela 1. Podstawowe metody historycznej produkcji dziegiu drzewnego na ziemiach polskich (Legut-Pintal)

Method	Brief description	Periods of use
Non-vessel method	Tar produced in clay-lined pits by covering wood and bark with stones and clay and lighting a fire outside	Prehistoric – Early Middle Ages – Modern Period
Single-vessel method	Birch bark placed in a vessel buried in a pit and surrounded with fuel	Prehistoric – Early Modern Period
Double-vessel method	Two connected chambers one with birch or wood, second to collect tar	Prehistoric – 19th century
Triple-vessel method	Improved vessel method with an additional third chamber designed to further purify the tar by removing volatile substances	Prehistoric – Early Modern Period (?)
Pile kiln	Conical wood piles covered with soil or peat, slow burning; tar collected in a pit beneath the pile; traditional forest method	Middle Ages – 20th century
Brick/stone kiln	Stone or brick kilns with combustion chamber and tar collection system; allows temperature control and higher product quality	16th century – 20th century

experiment with the aim of producing wood tar without ceramic vessels (Osipowicz, 2005). In his experiment, he demonstrated a method for creating anaerobic conditions and producing tar, proving the method's effectiveness. Similar successful experiments were also conducted by researchers outside Poland. Thus, although we cannot definitively recreate the method of tar production used by pre-ceramic communities, we can demonstrate that they were capable of doing so.

In addition to knowledge about the production of wood tar, archaeological findings also provide information on how this substance was used in prehistoric times. It was used to decorate vessels or objects by filling pre-made grooves or using it as paint (Langer and Koško, 1999). It served as an adhesive for joining fragments of ceramics, for example, tar was also used to coat the inside of vessels to make them hydrophobic. Isolated finds of tar lump with probable human tooth imprints, such as at the Żuławka site no. 13, may indicate the use of tar as a chewing gum for maintaining oral hygiene (Pietrzak, 2012).

The state of archaeometric research on wood tar in Poland is still in its early stages. The pioneers in this field were Aleksander Koško and Jerzy Langer in the 1980s (Koško and Langer, 1986). Their work was continued by Sławomir Pietrzak (Pietrzak, 2010; 2012). Since then, research on prehistoric wood tar has largely ceased. Analyses are performed using methods

such as fourier transform infrared (FTIR), gas chromatography – mass spectrometry (GC-MS), and scanning electron microscope (SEM). The composition of tar is examined, which allows researchers to determine the type of wood it was made from and whether it contains organic additives. However, these are isolated studies, even though the number of artifacts and researchers' interest in the topic continues to grow.

MEDIEVAL PRODUCTION OF TAR

Traces of an early medieval tar production, dating back to the 8th–11th century, were discovered in several sites across the Polish lands. In most cases, a double-vessel method was used in the production. A ceramic vessel with a perforated bottom was filled with birch bark and covered with a lid, then covered with clay. A pyre was lit over the vessel. At the bottom of the clay-lined pit stood a vessel for collecting tar (Szafranski, 1950; 1997). Isolated tar production features have been identified at several early medieval sites dated to the 8th–11th centuries, including Biskupin site 6, Glińsk site 1, Sulechów sites 10 and 28, as well as Klenica site 4 (Gruszka, 2011). A more extensive complex of six tar-burning pits was discovered at the site of Prósak I (Limisiewicz, 2014). These installations consisted of 6 pits dug into the ground, over which layers of bark and kindling were stacked and then covered with turf.

The resulting pyrolysis caused the tar to drip down into a vessel placed in a channel below. Researchers suggest that these features were likely to have been used repeatedly.

An example of a find related to production for one's own needs is a tar pit discovered near a water mill in Ptakowice. It had a rectangular outline measuring 160 × 135 cm, with walls secured with diagonally driven planks (Bagniewski and Kubów, 1977). A layer of partially charred birch bark was discovered at the bottom, which gave rise to the interpretation of it being a pit used for tar production. It would therefore be a variant of vessel-less production. In the mill, tar was needed to impregnate wooden materials in contact with water, as well as to lubricate the mill wheels. It was therefore essential for the maintenance of the mill, as well as the wagons carrying flour.

The scale of tar production is evidenced by the significant number of pottery fragments with traces of tarry substances found in archaeological research. In the Middle Ages, tar was used to seal stave containers such as buckets or barrels, boats, and wooden construction elements of buildings (Miazga, 2010; 2017). However, traces of production sites from the high Middle Ages surviving in the form of tar kilns are less common. Larger-scale production was achieved by lining a sunken pit with clay, in the middle of which there was a hole where a vessel was placed. Bark and torches were placed in the pit, and then the whole thing was covered with earth and turf, leaving holes to allow the pyre to be lit. When the tar cooled, the vessel with liquid tar was taken out (Dymaczewski, 1950). An example of such a structure dating from the Middle Ages was found in Jastrzębsko Stare, Nowy Tomyśl district, where research conducted before the war revealed a tar kiln with a diameter of 6–8 m and a depth of 1 m, and next to it, a pit with ceramic vessels used to store the finished product (Dymaczewski, 1950). Similar kilns have been sporadically discovered in various parts of the country, for example, in Piła, Świętokrzyskie Voivodeship (Pyzik, 2000).

Tar could also be a by-product of charcoal production. In a similar process, channels were sometimes dug during charcoal burning to collect tar, allowing tar products to flow out as a secondary yield (Rutkiewicz et al., 2019).

EARLY MODERN AND MODERN PERIOD

Tar production developed alongside the timber trade with Western Europe from the 16th century onwards. In the case of the most common, i.e. traditional form of forest exploitation by the rural population (Kubrak, 1986; 2010), the production of forest by-products, including tar, increased with the establishment of new settlements in cleared forest areas (legally as part of location based on law and illegally through peasant clearing). The process of deforestation, or the so-called forest retreat, was primarily associated with the extension of agriculture from the 16th to 18th centuries. New settlements determined the development of the forest industry – not only in terms of meeting the demand for firewood and construction timber (shingle mills, sawmills, etc.), but also the production of forest by-products, i.e. potash, charcoal, ore mining and iron smelting, and tar production.

At the turn of the 18th and 19th centuries, tar production was recorded in most of the major forests of present-day Poland, especially in the Białowieża Forest, the Tuchola Forest, and the Carpathians (Słowiński et al., 2024). A 19th-century Geographical Dictionary of the Kingdom of Poland and other Slavic Countries (Sulimierski et al., 1880–1902) listed around 300 tar production sites within the borders of the Polish-Lithuanian Commonwealth (18th century), most of which were located in present-day Belarus, Ukraine, and Lithuania. One of the most developed places for the production of forest by-products in the 18th-century Polish-Lithuanian Commonwealth was the former Sandomierz Forest, including the areas belonging to the Zamoyski family (in particular, the area of today's Roztocze). Contemporary research conducted by Róg (2021) indicates that in the 18th and 19th centuries, small forest settlements (even over a hundred) operated on a large scale on the Zamoyski estate, consisting of what were called *Budziarze*, i.e. people engaged in the production of tar. Unlike the rural population, which was typically engaged in agriculture, one of the main occupations of the *Budziarze* was the production of tar and potash (depending on the development of the household or settlement).

The twilight of traditional forms of tar production was marked by the Enlightenment rationalization of forestry, implemented by the states that incorporated

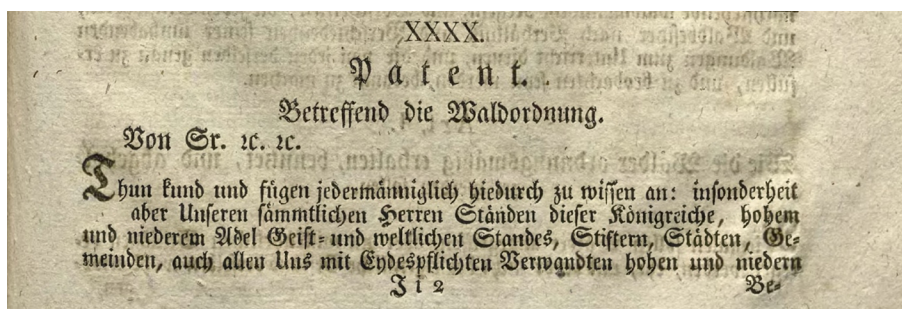


Fig. 2. Excerpt from the Forest Universal of 1782 (*Continuatio edictorum et mandatorum universalium in Regnis Galiciae et Lodomeriae, Lemberg*)

Ryc. 2. Fragment Uniwersału leśnego z 1782 roku (*Continuatio edictorum et mandatorum universalium in Regnis Galiciae et Lodomeriae, Lemberg*)

parts of the Polish-Lithuanian Commonwealth at the end of the 18th century. Prussia and Austria were particularly active in introducing a new and sustainable (*Nachhaltigkeit*; Carlowitz, 1713; Steinsiek, 1999; Stuber, 2008) model of forest management and cultivation. In accordance with the mercantile state policy, forests (as one of the natural resources) were to serve the economy and enrich the state. The basic function of forest areas therefore changed, and its creation became a matter of concern for state authorities (Bonan, 2019; Watkins, 2014). Rationalization also meant the elimination of all (allegedly) inefficient forms of forest exploitation (traditional forestry, including tar production) in favour of wood mass production. In the north-eastern part of Austria (i.e. Galicia, the south-eastern part of present-day Poland), general recommendations and instructions were developed to regulate tar production by law. These guidelines, implemented by the Austrians in the Carpathians, were primarily included in the Forest Act of 1782 (*Continuatio... 1782, 151–173*) (Fig. 2).

The legal provisions were primarily aimed at preventing fires and accidents such as kiln explosions. The introduction of underground kilns also saved fuel and minimized the risk of accidents. Moreover, the regulations were intended to reduce the waste of fuel and building materials – the use of ‘valuable wood’ suitable for construction was prohibited, and tar was to be produced only from waste, such as fallen trees. The raw materials for tar production had to be carefully measured. Larger production centers initially existed on noble estates (such as those of the Zamoyski family), while in the second half of the 19th century,

they were established in newly formed companies. An example of mass production was the Terebenthen company, which had approximately 100 kilns for the production of tar and turpentine scattered in rural areas around the Białowieża Forest (Fig. 3). Brick kilns were also known in the Tuchola Forest. These were used to obtain tar and turpentine.



Fig. 3. Tar kiln near the village of Stoszek (Białowieża Forest) in 1937 (National Digital Archives, ref. no. 3/131/0/-/8)

Ryc. 3. Smolarnia koło wsi Stoszek, Puszcza Białowieńska, w 1937 r. (Narodowe Archiwum Cyfrowe sygn. 3/131/0/-/8)

CULTURAL ASPECTS

Similar to other European countries, wood tar was used in medicine. Different types were applied in the treatment of skin diseases, to promote wound

healing, and in the fight against lice (Wiorogórski and Zajączkowski, 1892–1918, vol. 1, 898). Among the highlander minorities inhabiting the Carpathians, such as the Hutsuls and Lemkos, wood tar was also used to treat stomach pain, colic and diarrhoea (Magowska, 2020). The introduction of modern rifles and cartridge ammunition in the 19th century transformed warfare in Europe and North America. Multiple gunshot wounds often led to severe fractures and gangrene, against which medicine was largely powerless. Natural antiseptics such as wood tar and wood vinegar became a means of saving wounded soldiers. Their effectiveness prompted scientists to identify the active compounds—creosote and guaiacol. Soon, pharmacists began extracting creosote from wood tar, and its use in treating internal and skin diseases grew popular. Doctors eagerly embraced this pharmaceutical innovation, while pharmacists developed their own formulations. In 1891, at the National Exhibition in Kraków, Marian Zahradnik, a pharmacist from Jeziorna, was awarded a silver medal for his creosote capsules (Proń, 1967).

Until the 19th century, tar played an important role in beliefs and rituals. It was believed to protect against malevolent forces. Crosses smeared with tar were supposed to protect against the arrival of evil. Tar was also placed by the cradles of newborns, and cattle's heads were also smeared to ward off plague. It was also applied to the lips of the dead people to prevent them from returning from the grave (Moszyński, 1967).

CONTEMPORARY AND CURRENT PRODUCTION

The Industrial Revolution, accompanied by the growing demand for new materials and the rapid development of petroleum-based products, led to the decline of traditional tar production. Once a vital component of rural economies and forest-based industries, tar gradually lost its significance as synthetic alternatives became widely available and more cost-effective. Today, tar production has largely transformed into a niche craft, primarily preserved through cultural, educational, and artisanal initiatives.

Currently, tar is mainly used in pharmacy, cosmetics, and traditional applications rooted in local heritage. Its production is often demonstrated during educational events organized by museums or research

institutions aiming to preserve and promote knowledge of this once-thriving craft. Notable examples include live demonstrations during the Archaeological Festival in Biskupin (MAB, n.d.; Bartkowiak et al., 2025) or thematic meetings at the Zagroda Maziariska in Łosie (MAB, n.d.), both of which celebrate the historical importance of tar and its role in shaping local economies, technologies, environmental practices, and social interactions.

However, with the growing global interest in sustainable and natural materials, tar is gaining renewed attention. As a multifunctional product derived from the pyrolysis of renewable raw materials such as bark and wood, tar holds great potential for modern applications. With minor adaptations to meet contemporary standards and consumer expectations, tar could re-enter the market as an eco-friendly component of wood preservatives, pharmaceuticals, or even smart packaging, where its natural properties may help extend product shelf life.

In light of the depletion of fossil fuel resources, such traditional forest-based by-products offer a promising and sustainable alternative, bridging the past and the future through innovation rooted in heritage (Brózdowski et al., 2025; Dąbrowska et al., 2025).

DISCUSSION AND CONCLUSION

Wood tar production in the territory of present-day Poland dates back to the Neolithic period, with archaeological evidence suggesting its use and manufacture from prehistoric times. The best-documented periods in terms of sources are tar production in the Neolithic and Bronze Age, the late Middle Ages, and modern times, which reflects the selective interest of researchers in these eras. Conversely, far less is known about tar production in the Bronze Age, with the Middle Ages and the early modern period representing a significant knowledge gap. During the Middle Ages, tar became a widely used material, serving various purposes such as sealing, waterproofing, and as an adhesive. Products of wood origin played a significant role in the medieval economy, functioning as versatile adhesives, lubricants, and preservatives. In the context of the Polish lands, however, there is a noticeable absence of comprehensive studies addressing the scale of production, its organization, and the distribution

of these materials. Despite its importance, no major production centres from the early modern period have been firmly identified. However, historical and toponymic evidence—such as the persistence of village names like *Smolarze* (“Tar Makers”) – suggests the presence of specialized forest-based communities engaged in tar production. These communities produced tar in kilns or pit structures, and the product was exported for use in shipbuilding, leather tanning, and medicine. Although several archaeological sites have confirmed evidence of small-scale, localized production, only a handful of sites suggest the possibility of more centralized or large-scale manufacturing.

The process of tar production expanded significantly during industrialization, particularly in the 19th century, when tar production reached a European scale. Companies were established to produce tar for export, including to Great Britain. This marked the peak of organized tar manufacturing in the Polish territories. However, by the 20th century, wood tar had gradually been supplanted by petroleum-based products and other mineral oils. As a result, traditional tar production declined sharply and survived only as a local, small-scale activity for personal or community use.

Despite the long-standing significance of tar production, scholarly research in this field remains limited. Archaeological investigations of production sites are rare, and tar residues are infrequently recognized in excavations, which is likely due to a general lack of awareness or methodological frameworks for identifying such features. Most known examples are incidental finds rather than results of targeted research. Archaeometric analyses of tar fragments, employing techniques such as FTIR, GC-MS, and SEM, are becoming more common, yet interpreting them still depends on the development of robust comparative databases and broader international collaboration.

The historical context of tar production is closely tied to charcoal manufacturing and the settlement of specialized groups in forested and marginal agricultural areas, such as mountain regions or poor soils. In these contexts, tar making provided a vital supplementary source of income. The pre-industrial and early industrial periods, in particular, offer a rich array of documents and considerable potential for further interdisciplinary study. Given the economic and cultural significance of tar production across different

historical periods, expanding the research undertaken in this area remains an important scholarly priority.

Future research aimed at filling existing gaps in the knowledge of wood tar production in the historical Polish lands should be based on interdisciplinary research teams, combining archaeological and historical methods with physicochemical and environmental analyses. The first priority should be to conduct a systematic inventory of production sites, including those documented in historical sources as well as those identified through archaeological investigations. Subsequently, new planned field research should be undertaken, incorporating a range of physicochemical analyses to enable a detailed characterization of materials and production techniques. Conducting such studies requires not only substantial financial resources but also a carefully structured, multi-stage project approach to ensure methodological consistency and fully leverage the interdisciplinary potential of the research team. To advance this field further, it is also essential to intensify research efforts and establish a centralized, accessible database compiling dispersed archaeological and historical reports on tar production. Such a resource would enable systematic comparison of production techniques, regional practices, and chronological developments. It would foster the identification of patterns in site distribution and technological evolution, thereby facilitating more comprehensive interpretations and fostering collaboration across disciplines and national borders. This integrated approach would not only fill existing knowledge gaps but also provide new insights into the historical and technological aspects of wood tar production and its economic and cultural significance.

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PRODUKCJA SMOŁY DRZEWNEJ W POLSCE – OD POWSZECHNEGO RZEMIOSŁA DO ZANIKAJĄCEJ TRADYCJI

ABSTRAKT

W artykule przedstawiono krótki przegląd produkcji smoły drzewnej na ziemiach polskich – od czasów prehistorycznych po współczesność. Omówiono technologie wytwarzania, konteksty archeologiczne oraz źródła pisane. Smoła drzewna, uzyskiwana z drewna i kory, pełniła różnorodne funkcje – stosowano ją jako klej, środek konserwujący, lekarstwo oraz substancję rytualną. W średniowieczu i we wczesnej epoce nowożytnej produkcja rozwijała się lokalnie i przemysłowo, szczególnie w Karpatach oraz w Puszczech Białowieskiej, Tucholskiej i Solskiej. W XIX w. osiągnęła skalę europejską, lecz w XX stuleciu zaczęła podupadać z powodu pojawienia się alternatyw na bazie ropy naftowej. Obecnie tradycyjne wytwarzanie smoły drzewnej przetrwało głównie w formie działań edukacyjnych i inicjatyw muzealnych. Autorzy podkreślają potrzebę dalszych interdyscyplinarnych badań nad tym słabo rozpoznanym aspektem dziedzictwa technologicznego oraz konieczność stworzenia bazy danych stanowisk produkcji znanych ze źródeł archeologicznych i historycznych.

Słowa kluczowe: dziegieć, dziegieć brzozowy, produkty uboczne leśnictwa, archeologia, historia, PoTaRCh

