Photo 6 The wood tar made during the course of this experiment was strongly contaminated with charcoal and the remnants of untransformed birch bark. ■

A Method of Wood Tar Production, Without the Use of Ceramics

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● **The project studies a possible method of gaining birch tar suitable as a binding agent preceding wood tar production in ceramic vessels, which would leave little or nodeterminable traces.**

Introduction

Wood tar was one of the basic binding agents used in the Stone Age. It was made through the process of "destructive wood distillation" of birch bark. This process consists of heating organic compounds to a high temperature without air access in order to split it into simple compounds (*Dubisz 2003*). In practice this means that the raw material is roasted and the released vapour is collected by a method which cools it down (*Langer 1989*, p. 14). During destructive wood distillation of birch bark, material of differing consistency and properties can be made. "Proper" wood tar is formed when the temperature of the "firing" reaches above 220-280 °C (*Kośko, Langer 1986*, p. 589).

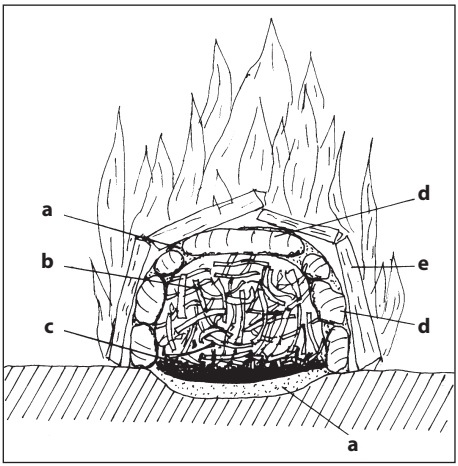

Fig. 1 A method of wood tar production, without the use of ceramics: **a** mixture of clay and sand; **b** birch bark; **c** birch tar; **d** stone; **e** wood. ■

Starting from the Neolithic Period, pottery vessels were used in the process of wood tar production. Two methods were used: One-vessel and the two-vessel methods (*Kośko, Langer 1986*, p. 589, *Todtenhaupt, Kurzweil 2000*). Both techniques require the digging of a pit and placing the vessel(s) filled with birch bark into it. The vessel(s) are sealed with grogged clay and roasted for a few hours. Wood tar made by the one-vessel method is often tainted with charcoal (*Kośko, Langer 1997*). Material made by the two-vessel method, where two vessels are set one on another, is much more pure and semi-liquid. The larger (upper) vessel, which contains the bark, has small holes in its bottom. The wood tar is acquired during firing by it running through the holes into the smaller vessel placed underneath the big one. In this way the material obtained is separated from the charcoal rather than being contaminated by it as in using the one-vessel method.

What kind of method could have been employed for wood tar production before the invention of pottery vessels? Recent excavation of a flint tool hafted with wood tar at Königsaue (Germany) suggests that wood tar was known of during the Palaeolithic as early as 40,000-45,000 years ago (*Junkmanns 2001*, p. 7). During the Mesolithic, wood tar was a basic binding agent used for the setting arrowheads and harpoon points (*Clark 1957*, p. 248, *Galiński 2002*, p. 312). For example, an arrow from Lilla Loshult (Sweden) with two flint microliths were set with wood tar dates to 7500 years BC (*Junkmanns 2001*, p. 15). Wood tar has also been identified on fragments of arrows and arrowheads found near Egozwil (Switzerland) (*Junkmanns 2001*, p. 15) and in Poland a perfectly preserved harpoon from Tłokowo (*Sulgostowska 1997, Sulgostowska, Hoffmann 1993*) has two rows of flint insertions set with wood tar. A similar find (dated to the Late Mesolithic/Early Neolithic Period) was also described by G. Clark (*1957*, p. 68).

Despite these finds of wood tar, no remnants of the wood tar production process have been uncovered. So far no pits, no concentrations of burnt clay, and no sand hearth lining, that could be considered remnants of wood tar production have been uncovered on any Mesolithic or earlier sites. Is it possible that during this period, a method leaving no signs in the archaeological record was in use? If so, is it possible to reconstruct it?

The following presents one such experimental technique that does not use ceramics. Its possible use during the Stone Age would have left no signs recognized today. Though no argument can prove that this method of wood tar production

Photo 1 The dome-shaped kiln was 40 cm in diameter and of a similar height. ■

Photo 2 A fire was started about 30 cm away all the way around. ■

Photo 3 After the drying the firing started and the fire was moved directly onto the kiln. ■

Photo 4 After the firing was finished remnants of burned wood and ashes were removed from the surface of the kiln and it was left for 3 hours to cool down. ■

Photo 5 Opening of the kiln. ■

was used during the Late Palaeolithic or Mesolithic Periods, they may have at least been similar to this one.

The technique described below has been tested several times.

The Experiment

The Kiln

The basic problem to be solved before beginning the experimental firings was to work out how to seal the kiln. Without an airtight firing chamber, the wood tar would either evaporate or (more often) the bark would simply burn away failing to produce any wood tar.

The kiln used in the experiment was built directly on to the ground (i.e. no "wood tar pits" were dug). For its construction, small (Ø ca 8-15 cm) pebbles were used. These were covered with a mixture of "pugging", i.e. clay (30-40%), sand, and grass to seal the firing chamber (**Fig. 1**). When dry, this "pugging" behaves like very dry sand which crumbles even when delicately scratched. Yet, it forms a solid and compact shell, resilient (in comparison to raw clay) to cracks which can form during drying or firing. As the experiments showed, a the use of proper proportions of sand and clay are very important for a successful "firing".

After the kiln walls were sealed, their thickness was about 8-10 cm. The dome-shaped (**Photo 1**) kiln was 40 cm in diameter and of a similar height. The bottom of the kiln was covered with a 2 cm thick layer of strongly thinned clay, formed in a depression. The kiln opening was covered with a stone about 20 cm wide and sealed with a mixture

of sand and clay. Before the "firing" started the kiln was left to dry for 16 hours, after which its interior was fired for about 30 minutes by burning dry grass and reed.

The Charge

The kiln was charged with fresh birch bark ripped into narrow strips (around 1 cm wide) of differing lengths. The kiln was filled with as much bark as possible.

The Firing

After the kiln was charged and sealed its final drying began. A fire was started about 30 cm away all the way around it and this was burned intensively for approximately 90 minutes (**Photo 2**). During this process no cracks of any kind which could affect the outcome of the experiment formed on the surface of the kiln. After the final drying, the proper firing started and the fire was moved directly onto the kiln (**Photo 3**). The kiln was fired for about 3 hours, mainly with poplar (approximately 0.5 m^3 of wood was used). Again, no cracks of any kind which could allow "wood tar gases" to escape formed on the surface of the kiln. After the firing was finished remnants of burned wood and ashes were removed from the surface of the kiln and it was left for 3 hours to cool down (**Photo 4, 5**)[(1)]. During this stage the kiln was "sprinkled" with small amounts of water. While cooling down, small cracks formed on the surface of the kiln.

Experimental Results

The wood tar made during the course of this experiment was strongly contaminated with charcoal and the remnants of untransformed birch bark (**Photo 6**). The material was very hard and resilient to crushing; even at high temperatures it retained its solid form. Heating the substance to a high temperature softened it, but did not transform it into a liquid. Reducing the temperature caused the material to harden very fast. This substance is different from the one obtained through firing with the use of ceramics. Those substances are usually at least semi-liquid and they melt even during a warm day; and as a result, they are not very useful for setting flints or points. In contrast, the wood tar obtained during our experiment is very good for such a use. Arrowheads set with it broke away much more seldom then ones set with other binding agents. The possibility of fast and simple exchanges or the resetting of arrowheads is an additional advantage of our experimentally produced substance. Such actions can be performed usually in less than a minute. Besides the wood tar collected at the bottom of the firing chamber, charcoal was also formed during the firing process. About 5% of the birch bark does not undergo any transformation. This percentage is similar to the quantities left untransformed in other experiments.

[(1)] The kiln cannot be opened before it has cooled down (Photo 5) because this might cause the charcoal that has formed inside the firing chamber to explode.

Identifying This Method at Archaeological Sites

As noted above, so far, no signs have been found on any Late Palaeolithic or Mesolithic sites for the wood tar production process, beyond the wood tar itself. No signs of burnt clay, no sand hearth lining, and no pits have been found. The experimental method presented here would probably not have left any clear signs in the archaeological record. The kiln's construction with ordinary pebbles and the relatively few signs they showed of having been burned, would probably suggest to an archaeologist that they were simply the remnants of an open fireplace. What would have happened to the hearth lining? An additional test was performed to check the quality of the lining after firing. Fragments of the clay and sand lining were placed in water, where most of them dissolved within 5 minutes. This suggests that such a prehistoric hearth lining would have dissolved in the rain leaving little or no sign of its existence.

Conclusions

The technique described here is probably one of many similar methods which may have been used during the Late Palaeolithic and Mesolithic Periods for the purpose of wood tar production before the invention of pottery. Unfortunately, such techniques would have left no clear signs in the archaeological record to identify their use. But the quality of wood tar produced by this fairly simple technique adds further support to its likely use. The wood tar material produced is a good binding agent that is extremely hard and resilient to crumbling and warm temperatures. The substance can also be transported without the use of any containers and may be used at any time after simple heating over a fire.

Bibliography

Brzeziński W., Piotrowski W. (ed.) 1997: Proceedings of the First International Symposium on Wood Tar and Pitch, Warszawa

Clark G. 1957: Europa Przedhistoryczna. Podstawy gospodarcze, Warszawa

Dubisz S. (red.) 2003: Uniwersalny słownik języka polskiego, Warszawa

Galiński T. 2002: Społeczeństwa mezolityczne. Osadnictwo, gospodarka, kultura ludów łowieckich w VIII-VI tysiącleciu p.n.e na terenie Europy, Szczecin

Junkmanns J. 2001: Pfeil und Bogen. Herstellung und Gebrauch in der Jungsteinzeit, Biel

Kośko A., Langer J. J. 1986: Z badań nad wytwarzaniem i użytkowaniem dziegciu w neolicie, Kwartalnik Historii Kultury Materialnej, nr 4/86, s. 587-600, Warszawa

Kośko A., Langer J. J. 1997: Wood Tar in the Culture of Early Agrarian Communities in Europe, [in:] Brzeziński, Piotrowski (ed.), s. 15-29

Langer J. J. 1989: Fizykochemiczne metody analizy pozostałości pradziejowego dziegciarstwa, Archeologia Polski, Tom XXXIV, z. 1, s. 13-27, Wrocław

Sulgostowska Z. 1997: Examples of the Application of Wood Tar During the Mesolithic on Polish Territory, [in:] Brzeziński, Piotrowski (ed.), s. 19-24

Sulgostowska Z., Hoffmann M. 1993: Kościane ostrze mezolityczne z wkładkami krzemiennymi z Tłokowa, woj. Olsztyńskie – Aspekt technologiczny. Archeologia Polski, Tom XXXVIII, z. 1, s. 75-87, Wrocław

Todtenhaupt D., Kurzweil A. 2000: Bericht der Arbeitsgruppe „Chemische Arbeitsverfahren" auf der Tagung der Experimentelle Archäologie in Zug/Schweiz am 10.11.Okt.98, Experimentell Archäologie, Bilanz 1999, Beiheft 30, Oldenburg

Summary

Eine Methode zur Herstellung von Holzteer ohne Einsatz von Keramik

In der Steinzeit war Holzteer eines der wesentlichen Binde- bzw. Klebemittel. Während des Mesolithikums wurde es für die Befestigung von Pfeilspitzen oder Harpunen benutzt. Seit dem Neolithikum wurde Holzteer mit Hilfe von Keramikgefäßen produziert, aus den älteren Zeiten haben wir aber keine Belege für die Art der Herstellung von Teer aus Holz.

Dieser Bericht beschreibt ein Projekt, mit welchem eine Methode der Holzteerherstellung ohne Nutzung von Keramikgefäßen überprüft wurde; es handelt sich dabei um einen kuppelförmigen Ofen, der direkt auf der Bodenoberfläche errichtet wurde. Er wurde aus gewöhnlichen Kiesel- bzw. Feldsteinen und einer Mischung aus Ton, Sand und Gras gebaut. Der Ofen wurde dann mit so viel frischen, langschmalen Birkenrindenstücken wie möglich befüllt und mit einem flachen Stein verschlossen. Die Birke wurde vorher getrocknet; der geschlossene Ofen wurde dann direkt anschließend mit einem umgebenden Feuer versehen. Das dabei gewonnene Teer war durch Holzkohle und die übriggebliebene Birkenrinde stark verschmutzt, aber es konnte als effizienter Kleber eingesetzt werden; das Teer war hart und geeignet, um es in Stücke zu zerbröckeln oder um es aufzuwärmen. Außerdem konnte es einfach – ohne ein Behältnis – transportiert werden.

Die Konstruktion des Ofens hinterließ nur geringe Spuren im Boden, die Reste der Tonwände waren schnell verschwunden und die Steine, die nur wenige Brandspuren aufwiesen, würden eher auf eine Feuerstelle als auf einen Ofen deuten.

Mode de fabrication du goudron végétal sans utiliser les céramiques

A l'Age de pierre, le goudron végétal a été l'un des liants ordinaires. Au Mésolithique, on s'en est servi pour fixer les pointes de flèches et les harpons. A partir du Néolithique, on l'a fabriqué dans des vases céramiques; par contre, aucuns vestiges n'existent qui attestent sa production plus ancienne.

Cet article décrit le projet qui a expérimenté la fabrication du goudron végétal dans le four, sans céramiques. Pour sécher le four, on a fait du feu à l'intérieur de celui-ci. Puis, rempli de bandes d'écorce de bouleau au plus possible, le four a été fermé avec une pierre aplatie. Ensuite, on a complètement séché le four en allumant le feu tout autour; le feu a été plus tard rapporté sur le four même. Le goudron obtenu a été contaminé de braise et de restes d'écorces, il s'agissait pourtant d'une colle efficace, dure, résistant à l'effritement et au chauffage, facile à transporter, sans devoir disposer d'un récipient.

Quant au four, on n'en aurait conservé que trop peu de vestiges; le revêtement en argile se décompose bien facilement et seules les galets relativement peu brûlés auraient indiqué la présence du foyer.