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INHALT

The production of birch pitch with hunter-gatherer technology: a possibility

Roel Meijer, Diederik Pomstra

1. Introduction

In this article, the authors would like to report on a series of experiments aimed at the production of birch pitch. The object was to devise methods to obtain pitch in the simplest possible way, so without pottery or other containers. In the end we came up with two techniques using only stone, sand, birch bark and fire.
For years, archeologists in Europe have found evidence of the use of birch pitch by hunter-gatherers, but it is still unknown how these people managed to make this important adhesive (for example AVELING, HERON 1999. SUŁGOSTOWSKA 1997). To make birch pitch it is necessary to heat the bark while excluding oxygen, a process called 'dry distillation'. In the Neolithic and later periods, this is no problem since ceramics are the perfect fireproof containers for the job. European hunter-gatherers however didn't have this kind of ware. Still, even the Neanderthal of about 80 000 years ago probably knew how to do this in view of the finds at Köningsaue.
Both Diederik and Roel had been pondering the question of birch pitch production independently for a while and had experimented a bit without the desired results. So, when this matter was discussed once again on a meeting of the Association for Archeological Experiments and Education (V.A.E.E.) we decided to try and tackle this interesting problem together.

2. Principles of making birch pitch

To make birch pitch the bark must be heated while oxygen is excluded as much as possible. At 340 degrees Celsius the transformation of bark into pitch or oil begins. There is a maximum to the admissible heat however. If the bark is overheated, the pitch will become hard and brittle. There seems to be some disagreement on this maximum temperature. Both 370, 400 and 420 degrees are mentioned. Our experiments seem to indicate 400 or 420 degrees as a maximum, but establishing this boundary temperature was not our main objective.
While heating the bark, oxygen must be excluded or the bark will burn away. In our experiments we mostly used ash and sand for this purpose.
The main reason for our failures during the series of experiments was either a too low, or too high temperature. As to the material to be used, we never experienced much difference between the use of fresh bark or of dead bark from fallen trees. It is to be expected that fresh bark contains more water, but this doesn't seem to influence the success rate of the methods we developed.

3. Making birch pitch with containers

When fireproof containers can be used, making pitch is a fairly simple matter. A foolproof technique is the two-pots method (Fig. 1). A pot with a few small holes in the bottom is filled with bits of bark and subsequently closed to keep the air out. Small gaps can be filled with for example fresh horse dung or clay. Another pot is dug into the ground and the pot with the bark placed on top. Again any gaps are filled to exclude oxygen. Next a fire is lit around and on top of the pot that contains the birch bark. The

Fig. 1: The two-pots method.

Fig. 2: The one-pot method.

heat of the fire will turn the bark into birch tar which will drip through the holes in the bottom, safely into the cooler pot below. The result is birch oil, which has many uses, but to obtain pitch it has to be carefully boiled to thicken. In the upper pot a black, brittle stuff remains that consists of overheated bark and oil.

With the one-pot method birch pitch is made (Fig. 2). Again a pot is filled with bits of bark and closed with a lid. In the lid a small hole is drilled. Again all other gaps are sealed. The next step is to heap up glowing coals around the pot. Experience should now tell whether the temperature is right and the process finished. The gasses escaping through the hole in the lid give some indication of this. At first, the gasses are white, this is water evaporating from the bark. Next, the gasses become yellowish and the typical smell of birch tar becomes evident. If the temperature is right it will take another fifteen minutes or so before the process is completed. As all water has evaporated, the result can be used as an adhesive immediately.

4. Earlier experiments

We are not the first to do experiments on this subject. Grzegorz Osipowicz made an oven from loam and stones and filled this with birch bark. After lighting a fire on and around the oven he was rewarded with a substantial amount of usable pitch. Kuno Moser made a small amount of birch pitch by heating thick birch branches under a bed of glowing coals. The pitch could be scraped from the wood of the branches. Other experiments, conducted by the 'Arbeitsgruppe Teerschwele' (working group on tar making) from Museum village of Düppel, consisted of heating loam-clad rolls of bark in fire, heating rolls of birch bark in a hole in the ground with heated stones and distilling bark under a fireplace. These methods did not give the desired result. From 2005 onward, Mr. Thomas Pietsch of the Arbeitsgruppe has been working on another technique based on the two-pots method. Instead of the upper pot he uses a loam wrapping. Another experiment of the Arbeitsgruppe was to make a trough using three flat stones. The trough was filled with strips of bark and covered by a fourth stone. Next, the bark was lit and one opening closed so the bark could be converted to pitch.

During our experiments we were only aware of the method devised by Mr. Osipowicz. Admittedly this is not a scientific way to start a series of experiments, but on the other hand it allowed us to work completely unprejudiced.

5. Our experiments

Day 1: Saturday the 24th of January 2009: This day was not very successful. The smell of birch tar was abundant, but that was about all. However, the results of the various methods we tried indicated that we were close to some success at least.

Day 2: Friday 10th of April 2009:
This time we were rewarded with a good result. We managed to make a substantial amount of birch pitch with both of the methods each of us favored. We ran multiple tests making but small changes in the methods used. The key thing during these tests was to reach and maintain the right temperature.
Roel favored a method using a flat quartzite stone, about 15x18 cm and 4 cm thick that was dug into the sandy soil (Fig. 3). On this stone a layer of birch bark slabs was placed that was covered with about three cm's compressed sand to keep the air out. On top of the bark layer the feeler of a pyrometer was placed to keep track of the temperature. Next a fire was lit on top and maintained for about an hour. The temperature rose to 380 degrees Celsius (716F), but as the feeler lay on top of the bark, the fire was allowed to burn a quarter of an hour longer. Then, hoping we were doing the right thing, the fire was removed and the fireplace left to cool down. When we dug up the stone we found that a good amount of pitch was sticking to the stone. Also between the layers of bark some pitch was found. Plenty to haft a few arrowheads, scrapers or other tools. Part of the bark was not yet transformed into pitch, so we should probably have let the fire burn longer. It also seemed wise to use a pile of crisscrossing bark strips instead of slabs next time. This would allow the gasses more space to precipitate on the relatively cooler stone.
Diederik's objective was to find a way to make pitch using only a simple campfire. The experiments were therefore based on

Fig. 3: A flat quartzite stone was dug into the sandy soil.

Fig. 4: After heating between 10 and 25 minutes, this method yielded small amounts of pitch.

Fig. 5: The results were very good.

how a hunter-gatherer would cook food like roots and bulbs. At first, rolls of birch bark were put in a shallow trough in the hot sand next to the fire. These rolls were covered with ashes to keep oxygen out and with coals to provide the necessary heat. The size of the rolls was 10-12 cm long and

5-7,5 cm thick. A willow withy was used to tie the roll. After heating between 10 and 25 minutes, this method yielded small amounts of pitch, trapped between the layers of the roll (Fig. 4).
The next step was to place the roll vertically in the sand with a small container underneath to catch the hoped-for pitch. The result was the same unfortunately. Because of the heat, the bark rolls tightly together so the pitch could not drip down. So it seemed a good idea to roll small green sticks into the roll to give the pitch more room to flow into the container. This was tested for the first time on day 3.

Day 3: Saturday 16th of May 2009:
The results were very good, the sticks did their job (Fig. 5). The container was still empty, but hot drops of pitch dripped from the roll when it was removed from the sand. Roel still has the scars to prove it. Despite this success it was obvious that, as no pyrometer was used, it takes a lot of experience to know when the time is right to remove the bark from the sand. Other attempts on this day were also successful, but the pitch was always retrieved from the core of the roll, just below the part that was transformed. Opening the roll gave ready access to the pitch, but the goal remained to get the pitch to drip into the container.
Roel repeated the experiments from day 2. This time it was apparent to what degree the wind influenced the fire. On this day there was a brisk wind blowing that took so much heat from the fire that even the feeler of the pyrometer, dug into the soil and under a thick layer of glowing coals, registered a dropping temperature. After putting up a windscreen from wood the problem was solved and the temperature began to rise once more. So fast this time that it quickly rose to 400 degrees (752F) and made us fear that the experiment would be a failure.
However, when the fire was removed, only the top few layers of bark had been overheated and charred. Under this layer there was quite some pitch to be found. Strangely however, the pitch had not dripped down to the stone, it was retrieved from the bark strips this time. Still, we were satisfied as both methods had proven to be effective again. Also it had become clear that, if our forebears did use Roel's method, they would probably choose a windstill day, find a sheltered spot, or, as we did, build a windbreak. From the Mesolithic firepits are known that were possibly used to make birch pitch. In a firepit the fire is not only somewhat shielded from the wind, but the pit also keeps the coals together and conserves the heat so less firewood is needed.

Day 4: Saturday 15th of May 2010:
About this day nothing more needs to be said but that man in his arrogance cannot change substantial elements of an experiment and hope to get away with it. Making pitch in and on wet river clay is something completely different from doing the same on dry sand.

Day 5: Friday 11th of June 2010:
It's been a year since the first successful attempts and we want to wind up the experiments. Again Roel's flat stone is put into the sand. The bark is cut is even smaller pieces and covered with a large slab of bark. It had become clear earlier that even when a slab like this is heated it will still keep enough of its structure and shape to protect the pitch below from sand. Again the wind blew hard enough to make us build a windbreak. The temperature rose quickly and after one hour and ten minutes the stone was lifted from the sand to reveal a lot of good-quality pitch (Fig. 6). More even than was made in all other attempts put together. Even so, part of the pitch was burnt so temperature and timing again had not been perfect.
Diederik's method also yielded a good amount of pitch. The only change that was made this time was to dig the rolls less deeply into the sand, just a few centime-

ters. This allowed more of the roll to transform. The pitch kept taking shape in the centre of the rolls and the container below remained empty. However, as has been stated before, this doesn't matter much as the pitch can be taken out easily when the roll is opened (Fig. 7).
After a small and unscientific dance of joy we realized that our experiments were completed. We had repeatedly been successful in making pitch using simple but effective methods that stone age hunter-gatherers could well have used.

Fig. 6: A lot of good-quality pich.

Fig. 7: The pitch can be taken out easily when the roll ist opened.

6. Rejected methods and nice tries

Perhaps the reader may benefit from a short overview of the methods we have tested and rejected. This may prevent fruitless experimentation or could give someone a good idea.
Roel had attempted the method devised by Mr. Osipowicz before. Like Mr. Osipowickz, he had built an oven of stones, loam and grasses that was filled with birch bark. Then the oven was closed with a flat stone, gaps sealed with loam and everything heated with a large fire. The experiment was a success, but Roel still had a feeling that this was too complex a method.
Another successful test was heating a freshly-cut young birch under the coals from a fire. After some time, the bark came loose and under the bark some pitch had formed. Another attempt at this method was not successful however.
Diederik had tried to use a large wooden bowl to make pitch. The bowl was filled with small pieces of birch bark and hot rocks were dropped onto the bark. Then the bowl was closed with a plank and the gaps sealed with horse manure. The next step was to turn the bowl over so the hot rocks lay on the plank, the bark on top of them and the bowl covering all. A tarry substance coming through the small hole drilled in the bowl clearly showed that plenty of tar was formed, but it all burnt on the hot rocks.
A variety on the method with bark rolls explained above gave better results. A green, barked willow branch was stuck in the vertically placed rolls. The pitch precipitated on the wet, and consequently cold, surface of the willow. By pulling the branch from the roll, the attached pitch could be smeared on the surface that had to be glued. Unfortunately, the amount of pitch produced in this way was too small for real use.
A last, unsuccessful experiment was done by digging a narrow, 20 cm deep hole in the ground. This was filled with birch bark with a container at the bottom. Then the bark was lighted. The idea was that the burning fire would draw all oxygen from the hole so dry distillation could take place using the heat of the same fire. This didn't work out at all. The bark burnt away until the fire died down because of lack of oxygen, leaving no trace of any pitch.

7. Concluding observations

Both methods mentioned in paragraph 5 are simple, require no rare materials and have proven themselves to be repeatedly effective on various occasions. They also yield an amount of pitch that, to our mind, is proportionate to the effort involved. Roel's method produces a lot of pitch, but requires the maintenance of a large fire for a long time which makes the production of birch pitch a special activity. Diederik's method yields small amounts of pitch, just enough to haft one or two tools, but is very simple and can be used with every campfire. Of course we do not mean to say that these were the methods our hunter-gatherer ancestors used to make the pitch archeologists find in our time, but they are plausible possibilities.
We're not finished yet: both methods can be improved upon but mainly we need more experience with these techniques to get better results. In the nearby future we plan to experiment with making pitch in firepits with pinewood and birch bark as was done in the Mesolithic in our country.
We are grateful to Annelou van Gijn, Erik Mulder, Roeland Paardekooper, Diedter Todtenhaupt and Annemieke Verbaas for providing us with information and literature on this subject. Also we would like to thank Hans de Haas for his hospitality on the disastrous fourth day of our experiments and Anneke Meijer-Treep and Dorothee Olthof for their comments.

Zusammenfassung

Die Autoren haben mit der Produktion von Birkenpech ohne Gefäße experimentiert. Zwei Methoden waren erfolgreich. Bei der erste Methode legten sie einen Stein in den Sand. Darauf legten sie Birkenrindenstückchen, die sie mit einem großen Stück Rinde abdeckten. Auf die Rinde kam eine Schicht Sand und darauf wurde ein Feuer entzündet. Diese Methode gibt eine größere Menge Pech als die zweite Methode, die aber schneller und einfacher ist: kleine Röllchen Birkenrinde wurden vertikal in den Sand gegraben und mit heißen Kohlen und Asche überdeckt. Das Pech wird geformt in der Mitte der Rolle und kann einfach herausgenommen werden.

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Anschriften der Verfasser

Roel Meijer
Ommelanderwijk 303
9644 TJ Veendam
Netherlands

Diederik Pomstra
Zuiderlaan 35
6869 VK Heveadorp
Netherlands

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