A contribution towards learning about "Forest Industries"

■ **Fig. 1** Finished replicas of so called forestry glass have a unique charm.

In a long term project the Centre of Experimental Archaeology Villa Nova Uhřínov and the Museum of Winter Sports, Tourism and Crafts in Deštné (Czech Republic) study "forest industries" drawing on historical and archaeological excavations as sources.

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Forest industries are among the range of forgotten human activities which are currently attracting the attentions of experimenters. The Centre of Experimental Archaeology Villa Nova Uhřínov in Uhřínov pod Deštnou together with the Museum of Winter Sports, Tourism and Crafts in Deštné v Orlických Horách have engaged in a long term research programme which mainly concerns the production of wood tar, charcoal, potash and glass.

The golden age of all the crafts named finished with the onset of new technologies at the end of the 18th century. Although the methods survived for some time the diminishing volumes of work made them a fringe affair at the level of home production (with exception of glass making). This era is recorded by historical sources in the shape of handbooks, advice and archive materials. It is possible to draw upon these and archaeological excavations to help us reconstruct the techniques.

Production of charcoal

Production of charcoal in clamps is generally the best known of all the forest industries. The earliest archaeological evidence in Central Europe comes from Poland and Germany from the time of Roman Empire (*Bielenin 1974*). In the Czech Republic it is recorded in written sources from the 14th century (*Winter 1890*): the coal market in Prague was noted in 1361. The greatest expansion of production lasted from the 14th to the 16th centuries. Charcoal was needed for iron metallurgy and the metallurgy of precious metals (especially silver from Kutná Hora). In that period the charcoal burners worked in large well organised groups which bought forests and produced large amounts of this sought after produce. The first note on these groups is from 1327 (*Husa 1957*). At the end of their existence the groups were small, about 2-5 people, who ran several clamps at different phases of burning at the same time.

The experiments carried out in Uhřínov used as their source a charcoal platform near Olbramov (Tachov region), excavated by Václav Matoušek in 2001. The experiments intended to answer questions brought up by the excavation. The archaeological situations were used as model for the experiments and were then compared with the remains of charcoal platforms created by the experimental burning (*Dragoun – Matoušek 2004*).

During the project of experimental production of charcoal we built and carried out burning in three clamps. The first burning took place from the 16th to the 26th August 2000 in co-operation with the University of West Bohemia in Pilsen. The next two (from the 2nd to the10th of September 2002 and from the 23rd of July to the 1st of August 2002) were carried out in co-operation with the Faculty of Humanities at Charles University, Prague.

The clamps were relatively small, there are reports of clamps of up to 10 m in diameter or even bigger. Our clamps were in one case 4.5 m diameter and the other two 3 m in diameter. We burnt between 3.5 to 4.5 m^3 of wood of various species. The preparation of the site and stacking of the pile was a relatively fast and easy affair; a group of 4 workers did it in 5 hours as the wood had already been cut and partly split. In each of our experiments we built a different type of clamp known to have been used in our territory. The burning itself was time-consuming but not

■ **Fig. 2** Production of charcoal: **a** Building of a clamp – wood is stacked vertically in layers; **b, c** Covering of the clamp with turf and igniting it from the top. (photo M. Cvejn)

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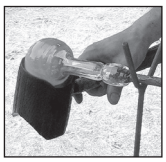


■ **Fig. 3** Glassmakers making from replicas of historical vessels from a melted glass mass.

hard. Our experimental burning, in agreement with the written sources, took between 8 to 10 days. The clamp had to be guarded at all times to seal the cracks. With the gradual roasting of the wood the clamp settles and the chemical process which is going on inside can be determined by the colour of the smoke. In the final phase the smoke is a bluish colour with a specific smell. The opening and raking of the carbonized wood is quite demanding, everything has to occur quickly but the charcoal should not be doused with water as that lowers its quality. Our clamps yielded approximately 1 m^3 of charcoal, approximately one quarter of the starting volume. The results of the experiments brought some information about this technique and also information on the state of single use charcoal platforms (*Dragoun – Matoušek 2004*).

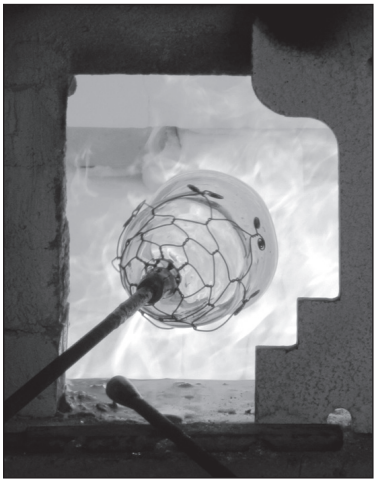
Glass-making

Glass-making experiments are not common because of the technological demands and the necessity of multi-disciplinary co-operation. Despite this, in our country some important experiments have taken place. Eva Černá's experiment with a furnace of Czech type brought interesting results and pointed out the need for further experiments. Experimental glass melting took place at the open-air museum Altamira in Kosmonosy with a crude early medieval furnace.

Since 1990 14 experiments with glass-making have been carried out in the garden area of the Museum of Winter Sports, Tourism and Crafts in Deštné v Orlických Horách. The Museum documents the history of glass-making in the region from its beginning in the 15th century to its liquidation in 1911 (*Šůla 1999, Šplíchal – Šůla 2004*). The technological experiment is a result of the co-operation of historians, glass-workers, furnace men and technicians under the supervision of glass master, Zdeněk Andres from Nová Huť (*Šplíchal 2001*).

The glass furnace was built from fireclay bricks on the basis of a general reconstruction of a 'Baroque' wood burning glass foundry and was rebuilt several times according to the problems being addressed. The experimental glass melting addressed the questions of the method of stoking and the type of wood, design of firebox, usage of material and technological details.

During the years this internal technological experiment turned into a public presentation, visited on one weekend by around 2,500 people. Heating the furnace to the temperature of 1,250 °C takes, because of the protection of the furnace and inserted crucibles, about three days. More and more new factors enter the experimental process from influences of both a technological and natural character and the experimenters have



■ **Fig. 4** Glassmakers warming glass during the making of the vessels. The stokers have to reach and maintain a temperature of over 1200 °C.

to react fast. Crucibles can break, the temperature might not rise according to requirements or the firebox can get blocked with ashes. The fuel wood was divided into thin, roughly 50 cm long spills. In order to reach higher temperatures it is necessary to combine hardwoods, in this case beech with spruce and birch. These have to be dried for at least a year. The glass mass is prepared from cullet (broken old glass), the necessary chemical additives and melted for about 20 hours. After this time the glass mass is malleable and it is the turn of the glass blowers who create, in front of the audiences, replicas of historical designs. This part which has very little to do with experiment is very important from the point of view of popularization as glass-making, of all the forest industries is the most appealing to spectators. It is interesting to watch the glowing furnace, blazing flames and glass blowers forming the molten glass into predesigned shapes. The products are stored in an annealing (cooling) furnace; the cooling of the products in specially preheated thick walled vessels known from iconographic sources was also tested experimentally.

The second stage of the technological experiment we are preparing for 2007 is the experimental reconstruction of the main glass furnace excavated at 'Sklářská louka – Cikánka' in Deštné v Orlických Horách (*Šplíchal 1982*). This glass furnace will have a stone base and the firing chamber will be vaulted with clay. This reconstruc-

■ **Fig. 5** Potash production: Burning of beech wood.

tion should help to answer questions over discrepancies between the iconographic sources and the archaeological finds and will show works of glass foundries at the peak of glass-making in our region.

These glass-making experiments in Deštné v Orlických Horách are, among other things a great popularising activity for the public. The presence of visitors shows that great interest in technological and archaeological experiments is possible.

Potash production

Potash production is important for making gunpowder and glass and belongs also to the forest industries. More than any other, this craft has vanished from historical awareness. Therefore an ethnological-archaeological project of the Ethnographical Institute of Academy of Science in Prague and Association Villa Nova Uhřínov was set up.

Potash producers stayed out of historical documents because this craft did not need any great team work. We would find potash producers in glass foundries for which potash production was necessity between the 11th and 15th century (*Woitsch 2003*). Potash producers are directly noted most often only in the 16th century. The description of the methodology of production can be found in Agricola's twelve books on mining.

Potash producers worked in small groups in inaccessible terrain and at a distance from the glass foundry (*Dragoun – Woitsch 2006*). They burnt wood of low quality in sunken pits so as not to endanger the forest. The more experienced ones could burn whole standing trees. They bored a hole into the trunk at a height of about 6 feet (cca 1.9 m) and there they lit a fire. The tree slowly burned without endangering the surrounding growth. These activities were carried out mostly in autumn and winter during stable weather because the ash must not get wet as this would ruin the final product.

The traditional method of potash production consists of leaching wood ashes with water, filtering it and boiling the gained lye in an iron kettle to make impure potash or so called black salts and finally baking it to gain potassium carbonate or pearlash. The starting material was wood ash, at first gained mostly from beech wood in the forest, later though (after publication of Forest Law in 1754) waste wood or ashes from households was used. Ferns, moss and straw were also used as substitutes (*Andres 1987*).

The methods used did not change from the 16th to the 19th centuries and were uniform practically all over the world. Period sources (handbooks, receipts of single asheries and so on) in Bohemia show fundamental discrepancies in the data on the efficiency and many other specialised questions. Because the production of potash in traditional ways has not been carried out anywhere in the last hundred years, the only possibility to address these discrepancies is with scientific experiment. Similar experiments took place in Poland (1979) and Sweden (1992). In Czechia Zdeněk Andres followed this topic (*Andres 1987, Woitsch 2004*).

The experiments themselves took place partly in the open-air museum of Villa Nova and partly in the garden of the Museum of Winter Sports, Tourism and Crafts in Deštné v Orlických Horách in the second half of 2004.

A precise amount (10 m^3) of wood from two different species (spruce and beech) was burnt on a deturfed, slightly sunken area. After burning the wood for 9 hours two ash platforms were created underneath which had been affected by the heat. The ash platform created under the spruce consisted only of a singed surface, while that under the beech had been burnt to a depth of 7 cm. The amount of ashes was very different. Beech gave 44 kg while spruce produced only 16 kg of ashes. Afterwards the ashes were leached and boiled in iron kettles at the open-air museum Villa Nova. Baking took place in the kiln in the garden of the Museum of Winter Sports, Tourism and Crafts in Deštné v Orlických Horách.

The kiln is a simple device not dissimilar to a bread oven. It was built on the basis of documents from the

■ **Fig. 6** Potash production: Beech ashes are collected after cooling down.

■ **Fig. 7** Ash is mixed with water and filtered through a layer of straw.

■ **Fig. 8** The extracted liquid has dark colour.

■ **Fig. 9** Evaporating of the ash extract on an open fire.

■ **Fig. 10** After evaporation a thin layer of lye stays on the bottom.

19th century but for our purposes was built to half size.

The baking took place in a preheated kiln, heated to about 800° C, the preheating taking about 10 hours. Then black salts were poured onto the bottom. The high temperature finished the chemical process and the brown mass turns white. From beech we gained 1.79 kg of pearlash and from spruce only 0.7 kg (*Woitsch 2005*). The experiment was repeated in 2005 but the results with the use of ferns are not yet fully available although the great yield from this material was surprising (*Dragoun-Woitsch 2006*).

The results of these experiments will hopefully give us answer on the production of a once common material. Potash was added to glass mass to facilitate the melting of siliceous sands and it also influenced the characteristics of glass. Potash was used in the production of dyes, saltpetre, gunpowder and soaps. Solutions of potassium carbonate were also used as bleech, in tanning and in cleaning print types. From the 17th century, potash production was an important industry watched over by the state and bringing large profits to both the owners and managers of asheries.

Tar production

Of all the studied forest industries tar production is, from the experimenters point of view, the easiest and therefore given the most attention, especially in German speaking countries. High quality scientific experiments though have taken place in our country (*Janoušek – Čihák 1987*). A greater interest in the methodology and history of the craft has appeared in the last decade (*Brzeziński – Piotrowski 1997, Belisová 2003*).

The earliest evidence of pitch use comes in the Mesolithic, when it was used to fix arrowheads (*Oettel 1988*). Later pitch was used for repairs to pottery, in healing and shipbuilding (*Lissek 2003*). In the Roman era, similarly to charcoal burning, there is convincing evidence of double-walled kilns and the use of dry distillation (*Bielenin 1974*) from Germany. From Czechia there is archaeological evidence of tar production from the 12th century on (*Weber 1972*). For the 13th century a number of sites have been found thanks to field walking in regions with rugged landscapes (*Lissek 2003, Peša – Jenč 2003*).

Tar makers appear in the historical sources most often in the 16th century. Pitch was in demand but it was usually made seasonally and within single regions.

There are several methods of tar production; the most progressive is in two-walled tar kilns. The experimental production was modelled on a find from Stěžov na Příbramsku (*Nováček – Vařeka 1992, 1993*). Both of the excavators participated in the reconstruction of the kiln in the archaeological open-air museum in Uhřínov pod Deštnou.

The kiln consisted of a ceramic jar about 130 cm high with an outlet in the bottom and a surrounding stone wall in 40-50 cm distance from the jar. It was built by three people in four days, though it is only a 1/3 size reconstruction of the archaeological find from Stěžov. In May 2004 the first destillation took place.

135 kg of birch splinters were put into the inner jar and the jar was closed. The kiln was heated to a temperature of 700 °C and stoked for 4 days. The kiln was stoked through two opposite holes in the stone wall. The destillation was accompanied by a specific smell and after 4 days about 1.6 litres of dark liquid of a honey like consistency flowed out. After this success, despite further heating, we did not gain any more material. On opening the jar was found that most of the wood at the top was charred. The next experiments in June 2004 ended with the ignition of the content of the jar and the destruction of the kiln.

The archaeological experiment proved the usability of the tested device but the experiment was not repeated succesfully and therefore we did not gain any results regarding the effectivness, fuel consumption and suitability of any single wood species.

Evidence of technological experiments

What do these technological experiments contribute to our knowledge of forest industries?

- Verification of the possibility of reconstructing an extinct technology and of the interpretation of archaeological finds
- Verification of effectiveness, time and energy demands
- Determination of the basic range of abilities needed to carry out the craft
- Gaining evidence for interpretation of discrepancies in written sources
- Gaining samples for chemical analysis
- Gaining features for application in archaeological research

On the basis of this information we can more easily reconstruct not only a craft but also the use of landscape by people in the past. Also we contribute to an improvement in research methods when excavating technological devices.

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Summary

Ein Beitrag zur Kenntnis der „Waldwirtschaften"

Das Zentrum für experimentelle Archäologie „Villa Nova Uhrinov" ist zusammen mit dem Museum für Wintersport, Tourismus und Handwerk in Destne (Tschechische Republik) an einem Langzeitprojekt zur Erforschung der so genannten „Waldwirtschaften" beteiligt. Auf der Grundlage von historischen Quellen in Form von Handbüchern, mündlicher Überlieferung, Archivalien und den Resultaten archäologischer Ausgrabungen werden die Techniken der Holzkohleproduktion, der Glasherstellung sowie der Pottasche- und Teerproduktion rekonstruiert. Das Ziel dieser Experimente ist es, die Möglichkeiten der Rekonstruktion heute nicht mehr angewandter Technologien zu erkunden, ihre Effektivität sowie ihren Zeit- und Energiebedarf zu ermitteln. Auch die Ermittlung der grundlegend benötigten Fertigkeiten, um das Handwerk auszuüben, die Verbesserung der Datengrundlage zur Interpretation und die Herausarbeitung von Unstimmigkeiten zwischen den Schriftquellen, den Ergebnissen von chemischen Analysen sowie den archäologischen Befunden sind wichtige Ziele des Projektes.

A la connaissance des métiers de forêt

Le centre d'archéologie expérimentale Villa Nova Uhřínov et le Musée de sports d'hiver, du tourisme et des métiers à Deštné (République tchèque) ont réuni leurs efforts dans un programme de recherche à long terme qui vise les soi-disant métiers de forêt. Etudiant des sources historiques sous forme de manuels, conseilles et archives et encore des résultats provenant des fouilles archéologiques, ils s'efforcent de reconstituer les méthodes de fabrication du charbon en bois, du verre, de la potasse et du goudron végétal. Ces expérimentations ont pour objectif de tester la possiblilité de reconstituer des technologies disparues, d'examiner leur effectivité, leurs exigences en temps et énergie, de définir un spectre de capacités nécessaires pour pouvoir faire les métiers, de se procurer des matériaux pour l'interprétation et l'explication des contradictions présentes dans des documents écrits, d'obtenir des échantillons pour l'analyse chimique et d'avoir des résultats pertinents à être appliqués sur les fouilles archéologiques.

■ **Fig. 11** Building of a kiln for baking of impure potash in the garden area of the Muzeum in Deštné v Orlických horách.

■ **Fig. 12** Kiln for baking of potash. (all photo of production of potash J. Woitsch)