Fig. 9 Firing in a bonfire. ■

Experiments on pottery manufacture

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• The article describes the first attempts to recreate pottery production of the Romanian Neolithic including building and testing of various firing devices confirmed or supposed to have been used in that era.

Pottery is, by the plasticity of its forms and decoration, very sensitive to the cultural imprint of human groups. For the prehistoric period, in particular, it serves as a "guiding fossil" to distinguish different cultures. However, using the classical methods of archaeology, it is difficult, if not impossible, to determine how Neolithic people made pots with such exquisitely beautiful forms and decorations. Instead, it is left to experimental archaeology to find possible answers, and confirm or refute hypotheses or theories concerning the techniques of pyrotechnology and Neolithic pottery production.

Our project, which begun only recently, proposes to replicate some of the techniques and technologies related to this very important aspect of prehistoric communities. In Romania, experimental archaeology is just beginning to take its first steps. One such project took place at Vădastra, with the participation of Professor John Chapman (www.vadastra.ro), while another was led by archaeologists from the History Department of Alba Iulia University (*Anghel 1999, 167-173*).

Our own experiments took place in the villages of Cucuteni and Isaiia, in the county of Iaşi where there are two well-known sites belonging to the Precucuteni-Cucuteni

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complex. At Cucuteni, as part of the Cucuteni Archaeological Park, the pottery production experiments complemented experiments on the construction of prehistoric houses and the manufacturing of stone tools. (**fig. 1**) At Isaiia, the experiments were undertaken while excavating the site during the months of July and August of 2003 (**fig. 2**).

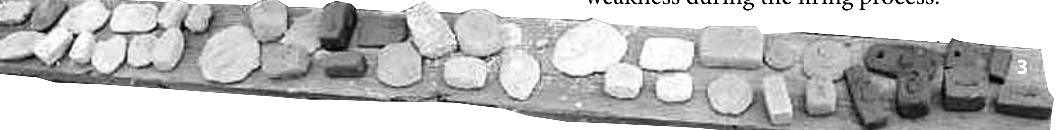
The Experiments

The first step was the identification of possible clay sources in the area and the determination of their respective qualities. For this, we had the help of two geologists and a ceramicist. From the vicinity of the Cucuteni village, we gathered 18 samples of clay with different physical properties (**fig. 3**). The analysis of these samples is now in process. For our pottery replication experiments, we chose a grey type of clay, greasy and very plastic, but with enough sand in its structure to make the addition of another temper unnecessary (**fig. 4**). We based our choice on the advice of the ceramicist, who considered this type of clay to be ideal for a fine paste. It also resembled the one used by the Cucutenians for their painted pottery, and the clay came from a ravine at the base of Cetățuia hill on which a Neolithic settlement had been situated. Once gathered, the clods of clay were crushed and crumbled manually or with the help of a wooden hammer to separate out the impurities. Water was then added until the necessary consistency for kneading the clay was achieved. The kneading process took a long time, and involved both the hands and legs and continued until all the impurities were separated (**fig. 5**). From the kneaded clay, moulds were made that were then beaten with a piece of wood. This removed the air from the clay, and also homogenized the paste, making it more malleable and easier to shape.

Ethnographic observations of ceramicists suggest that some people let the clay soak in water for an entire winter. When the water freezes, this can cause impurities to detach, resulting in a more malleable and consistent clay (*Klusch 1981*, 256).

After further kneading, we moved to shaping the vessels. This involved making forms specific to the Cucuteni culture (e.g. biconical vessels, binocle-vessels, goblets, cups, vessel stands, and lobed vessel), as well as forms close to contemporary ones. We also made a series of feminine anthropomorphic figurines from single pieces of clay, after those known from the Precucuteni culture.

To form the vessels, we used the *en colombin* or coil method. We began by making the bottom, flattening and rounding a clod of clay/paste until we obtained a cylinder. On this cylinder we overlapped coils of clay which formed the walls of the vessel. The length and width of these coils were in direct relation to the diameter and width of the future vessel. The most important step was the homogenisation of the overlapped coils. This is first done by hand with a gentle pressure to fix the coils together, and then with more prolonged pressure on both the interior and exterior margins of the coils (**fig. 6**). Then, while the vessel is supported on the inside with one hand, the other hand scrapes the paste using a bone or wooden spatula (**fig. 7**). Simultaneously, one can also easily beat the walls of the vessel with the same tools. This evens out the clay and eliminates the air between the coils, a potentially fatal weakness during the firing process.



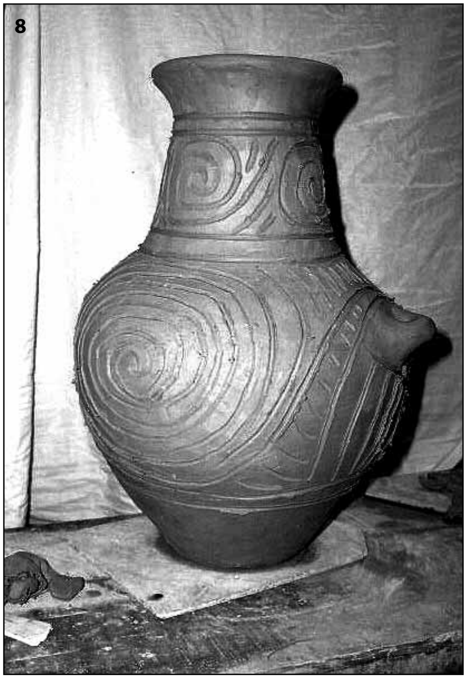


Fig. 1 Cucuteni Archaeological Park. ■ **Fig. 2** Excavation at Isaiia. ■ **Fig. 3 (at the previous page)** Clay samples. ■ **Fig. 4** Source of clay used in experiments. ■ **Fig. 5** Kneading of the clay. ■ **Fig. 6, 7** Shaping of vessels. ■ **Fig. 8** Pot decoration. ■

The shape of the vessel is determined by the use of longer or shorter coils and by the hand pressure or the striking of the vessel with the respective tool. For the application of polishing and/or decoration, it is necessary to smooth the vessel's walls very well. This can be done with a wet hand, a clay or bone tool, or a wet cloth. During all these procedures, it is necessary for the ceramicist to support the vessel on a mobile platform, since both hands are being used and it is necessary to rotate the vessel. In our case, we used wooden slates or smooth stones. We also noted that it was important to finish a vessel in a single work session, without long breaks. Otherwise, after a while, the paste got dry and, despite further moistening, the next coil of clay would not adhere as well as before, resulting in the cleaving of the vessel during drying.

The polishing of the vessels has both an aesthetic purpose and a practical one; it makes the vessels less permeable to liquids. We polished the vessels during the drying phase, using some river stones and other tools on the wet walls. At the site of Isaiia, several bovine astragali were discovered which show more or less obvious traces of polishing. Based on our experimentation and the observation of polishing on Precucutenian pottery (e.g. thin lines which imply a small contact area between the polisher and the pottery), we conclude that these astragali could be used for polishing pottery.

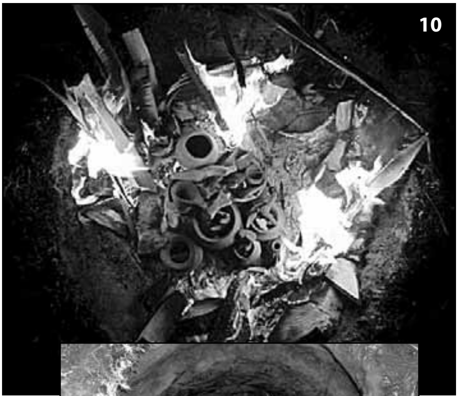
For decoration, we limited ourselves to incised decorations made with a sharp bone and consisting of surrounding lines, spirals, and points (**fig. 8**). We have not yet succeeded in identifying in the field the mineral pigments used for painting the vessels with the exception of some small pieces of white clay found in the sterile archaeological stratum. From one of these we obtained a paste which though we applied it on some vessels, did not remain fixed to them too well after the firing process.

The drying of the vessels is an important stage and must last at least a week to allow the evaporation of water from the clay mixture and the pores. This drying must take place slowly in a place protected against the sun, wind, or strong humidity. At Cucuteni we fired vessels that had been dried for only two to three days and which seemed dry, but they exploded when they reached a high temperature.

The next step is the firing of the vessels. Our goal was to build and use all the various devices, confirmed or supposed, for the firing of pottery in the Romanian Neolithic.

Open-air Firing

Open-air firing (presumed, because it is unknown whether hearths also served this purpose) is directly influenced by atmospheric conditions and based on the location of pots in/near the fire, results in the differential firing both among vessels and on a single piece. In this experiment, we arranged several vessels on a hearth, covered them with wood, and fired them for approximately three hours, continuously stoking the fire (**fig. 9**). After approximately one hour, the vessels became incandescent, but already by this time many of them were cracked or broken. After three hours we noticed that only one third of them remained intact, the rest being ruined either due to some mistakes during their manufacture or sudden rises in temperature during their firing. The good vessels were well-fired and of different



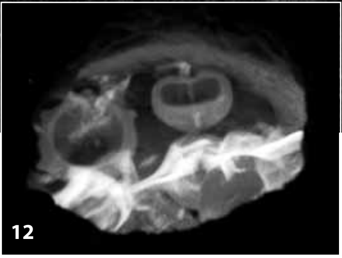


Fig. 10 Firing in a pit. ■ **Fig. 11** Pit after the firing. ■
Fig. 12 View into the pit at the peak of firing. ■
Fig. 13 Fired vessels. ■
Fig. 14 Unfinished two-chamber kiln. ■

colours: black, grey, brown, and even red spots. Their impermeability was good. We served coffee from several cups later.

Pit Firing

Another firing device used was the simple, single chamber pit in which vessels were fired together with wood. The advantage of this device, in comparison to the open hearth, consists of the economy in fuel, the rise in temperature, and the protection it provides against the wind. This firing device is attested to in the Romanian Neolithic for the cultures of Dudeşti (*Nica 1978*, 18-29), Vădastra (*Nica 1978*, 25; *Ellis 1984*, 138), Gumelniţa, and Cucuteni-Ariuşd aspect (*Székely, Bartok 1979*, 56; *Comşa 1976*, 23).

We first experimented with this type of firing at Cucuteni in 2002 (**fig. 10**). Unfortunately, conditions were not ideal: the vessels had not dried for long enough, the depth of the pits (50 cm) were insufficient, and their openings were too wide (~ 80 cm). The shallow pits were the result of a very thick layer of stones at 50 cm below the surface. Overall, the large pit openings and shallow depths prevented the temperature from rising very high and the vessels produced were either broken, cracked, or permeable and fragile.

In 2003, at Isaiia, we tried to avoid these mistakes. We dug a round pit with a depth of 1 m and a blunt cone-shape profile, with a 70 cm diameter opening and 1.20 m diameter base. The bottom of the pit was paved with flat stones to imitate a hearth and to favour the rise and the maintenance of high temperatures. Before putting the vessels inside, the pit was warmed with wood chips and dry leaves in order to avoid a sudden increase in temperature and thus possible accidents. After that, the vessels were put inside, grouped toward the centre, with pieces of wood put around them. For an hour we warmed the pit gradually using only thin rods, after which we started supplying the fire with hardwood to establish a very high temperature. The firing lasted for approximately four hours. After one hour the vessels were incandescent. We did not have a thermometer, so we put a glass bottle into the fire. Glass gets soft at 500-600°C and melts at approximately 900°C. After the firing, the bottle was deformed, meaning we reached over 600°C at the bottom of the pit (**fig. 11**). The temperature got so high that at one point no one could stay around the pit and this made it difficult to supply the fire. The placement of the wood could no longer be arranged by hand, but had to be simply thrown into the fire. This resulted in the breaking of some vessels. The walls of the pit turned a very intense red colour to a thickness of 1.5-2 cm. The resulting vessels were very well-fired (resonant), uniform, without stains, a brown-reddish colour, and with good impermeability. The percentage of waste caused by the firing or by problems during manufacturing was approximately 30%.

Firing Chamber

The early and late Neolithic of Oltenia and Central Transylvania document the existence of a device that has the basic characteristics of a kiln: a firing chamber for the vessels, an opening for loading the vessels, and a tunnel for the fire with an opening for supplying firewood (*Nica 1978*, 18-29, *Ellis 1984*, 130-158). Specifically, it consists of a circular pit (the vessels' chamber), with blunt cone-shape profile and a narrow, upper opening. This pit chamber communicates with a smaller one, of tubular or parallelepiped form, where the fuel is burned.

We tried at Isaiia to replicate this type of firing device, though in our experiment, we built two fireboxes, one on either side of the vessels' chamber. It was necessary to build two access pits because the firing chamber was built on flat ground rather than in a pit. The dimensions can be seen on the device's plan. The advantages of this type of firing device are its independence from atmospheric conditions, its control over the temperature and firing conditions (e.g. oxidizing and reducing firing), and the separation of the burning wood from the vessels.

We arranged a big charge of vessels on the bottom of the central chamber and then covered the opening with a piece of unfired clay. We initiated the fire in both side fireboxes. In the first hour, we burnt only thin rods at the openings to gradually warm the vessels' chamber. We then pushed the fire slowly towards the interior of the device, supplying it continuously with hardwood for five hours. Pulling aside from time to time the cover over the vessels' chamber, we noticed that the vessels reached incandescence quickly without breaking (**fig. 12**). The fire was so intense and the temperature so high (probably 800°C) that the walls of the vessels' chamber (where only the heat entered and very few flames) turned red to a thickness of 4-5 cm. The unburned clay cover, approximately 15 cm thick, also turned entirely red. The resulting vessels were very well-fired, uniformly burned, resonant, brown-reddish in colour, and sometimes whitish (**fig. 13**). There were no wasted vessels. Afterwards, we broke one of the vessels and observed that the firing was complete, the pieces showing the same colour on the entire surface of the breach.

Kiln Firing

Finally, we made a kiln with two chambers located vertically, as documented exclusively for the Cucuteni culture (*Comșa 1976*, 24-26; *Ellis 1984*, 130-158) (**fig. 14**). Unfortunately, this kiln could not be put to use because we failed twice to make the grill, which cracked while drying. We intend to resume our experiments with this type of kiln.

Conclusion

The best solution for making superior quality vessels and avoiding waste involves firing the vessels separately from the fuel in a two-chambered device.

Our experiments are just beginning and we realize that our lack of experience and funding has affected our work. However, with this presentation of our experiments we wish to signal the increasing interest in Romania for experimental archaeology and our understanding of the importance that experimental archaeology has for archaeological research.

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Summary

Experimente zur Keramikherstellung

Der Artikel beschreibt die ersten Versuche, die Keramikherstellung des rumänischen Neolithikums unter Einbeziehung des Aufbaus und der Überprüfung verschiedener Brennvorrichtungen, die für das Untersuchungsgebiet nachgewiesen sind bzw. vermutet werden, auf praktische Weise nachzuvollziehen.

Der erste Schritt war dabei die Identifizierung möglicher Tonlagersstätten in der Region sowie die Bestimmung ihrer Qualitäten. Dazu konnten wir auf die Hilfe von zwei Geologen und eines Keramikspezialisten zurückgreifen. Wir sammelten dabei zu Analysezwecken insgesamt 18 Tonproben mit verschiedenen physikalischen Eigenschaften, die aus der Nachbarschaft des Ortes von Cucuteni stammten.

Für unsere Experimente wählten wir dann auf Anraten eines Töpfers den geeigneten Ton aus. Nach dem Sammeln der Proben wurden die Tonklumpen per Hand oder mit der Hilfe eines hölzernen Hammers aufbereitet, um Verunreinigungen zu beseitigen. Anschließend wurde Wasser dazu gegeben, um die zum Kneten notwendige Konsistenz zu erreichen. Unter Anwendung der Wulstaufbautechnik stellten wir Gefäße in für die Cucuteni-Kultur typischen Formen her. Während dieser Arbeiten konnten wir feststellen, dass es wichtig ist, das Gefäß in einer einzelnen, ununterbrochenen Arbeitssitzung fertig zu stellen, denn – trotz ständiger Befeuchtung – haftete jeder später angebrachte Tonwulst aufgrund des Auseinanderreissens während des Trocknungsprozesses nicht mehr besonders gut. Der Trocknungsprozess der Gefäße sollte mindestens eine Woche dauern, um ein Reissen zu verhindern.

Der darauf folgende Schritt war das Brennen der Gefäße. Unsere Absicht war es, alle für das rumänische Neolithikum nachgewiesenen oder vermuteten Vorrichtungen zum Brennen von Keramik nachzubauen und anzuwenden, angefangen mit einer einfachen Feuerstelle sowie einer Bodenbrandgrube. Wir testeten auch einen horizontalen Brennofen, wie er für das frühe und späte Neolithikum in Oltenia und im zentralen Transsylvanien nachgewiesen ist. Leider war es nicht möglich, einen vertikalen Zweikammerofen nachzubauen.

Fabrication expérimentale de la poterie

L'article décrit les premières expériences avec la fabrication de la céramique néolithique roumaine y compris la reconstitution des installations de cuisson d'après les fouilles ou les hypothèses et leur mise à l'épreuve.

En premier lieu, les expérimentateurs ont identifié les ressources et les qualités de l'argile dans la région examinée. Ils ont collaboré avec deux géologues et un potier. Aux environs du site Cucuteni, ils ont prélevé 18 échantillons d'argile à différentes qualités et ils les ont faits analyser.

Suite à la consultation avec le céramiste, les auteurs ont choisi une argile appropriée pour la fabrication expérimentale. D'abord, ils ont extrait des blocs d'argile qu'ils broiaient à la main ou brisaient avec un maillet en bois pour pouvoir enlever des immondices. Ils ont brassé l'argile avec de l'eau pour obtenir la pâte d'une bonne consistance. Après ils sont passés au montage des vases en forme des céramiques de type cucuten. Ils ont façonné leurs récipients avec des colombins. En travaillant, ils ont remarqué qu'une pièce doit être réalisée d'un seul coup, sans grandes pauses, sinon les colombins ne se joignent même si on les humidifie. De tels vases se cassent pendant le séchage. Il faut les laisser sécher au moins une semaine pour éviter des éclatements au cours de la cuisson.

En ce qui concerne la cuisson, les expérimentateurs ont voulu reconstituer et mettre à l'épreuve toutes les installations néolithiques roumaines, découvertes et supposées, à partir du foyer et de la meule. Ainsi ils ont effectué aussi une cuisson dans le four horizontal attesté pour le néolithique ancien et récent d'Oltenie et de la Transylvanie centrale. Malheureusement, ils n'ont pas réussi à construire le four vertical à deux chambres.