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Crafts of India

Traditional Potters of India

Ethnoarchaeological Observations in America

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We stood on a hillside surveying the landscape for just the "right spot." M. Palaniappan preferred the low, more level area near the base of the hill, while Jhithru Ram favored the more sloping crest. Three others of us stood by observing as they spoke animatedly in Hindi.

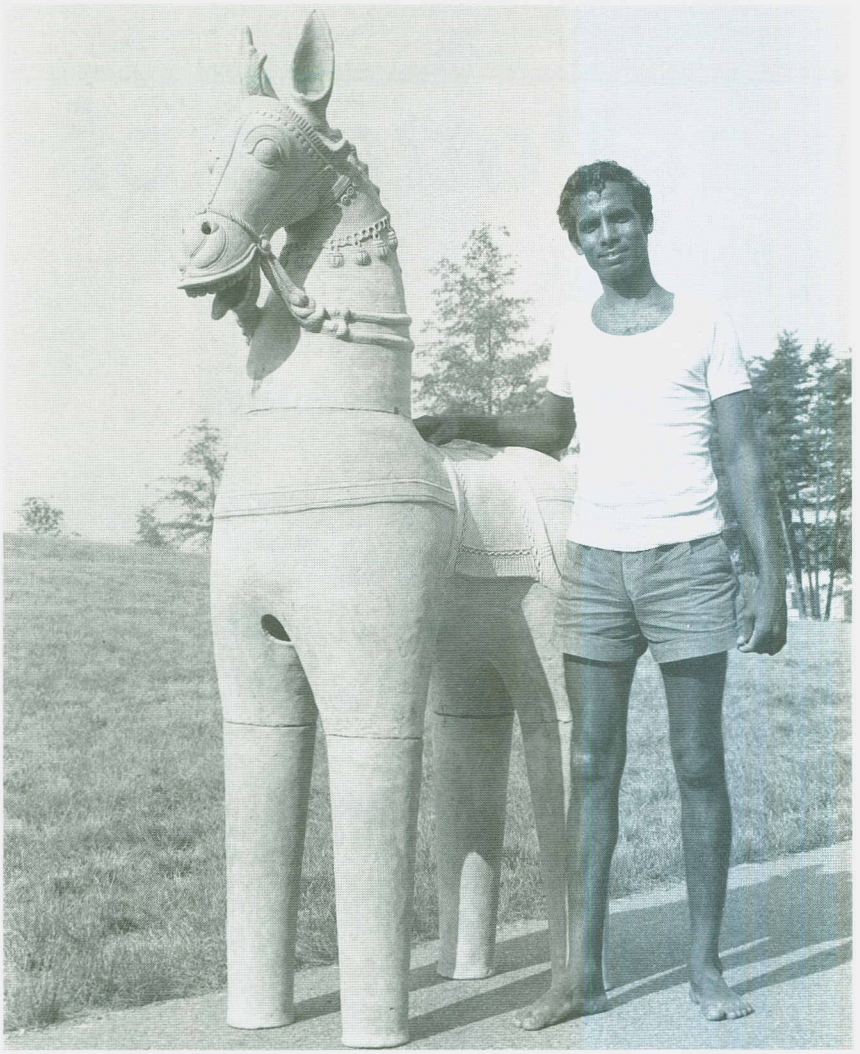
The day, a steamy one in early June, marked the beginning of a research project that was to last some two months. It included two village potters from India who had come to the Smithsonian Institution as participants in the Aditi Exhibition, and three archaeologists with interests in ancient pottery. The project involved the study of the production techniques used by traditional Indian potters and their ability to adapt to new materials and to produce their ceramics in a new environment. Today, we were selecting the site for the kilns in which they eventually would fire their ceramics.

The Aditi exhibition, subtitled "A Celebration of Life," originally was put together in New Delhi. In 1985 it was brought to the Smithsonian to mark the year of India. The 2000 objects and 40 artisans and performers gave visitors to Washington, D.C., an unparalleled glimpse of life in India. The two potters were commissioned by organizers of the exhibition to serve as representatives of traditional craftsmen from India. Each day they practiced their craft in the halls of the Museum of Natural History at the Smithsonian. They also spent time at the Smithsonian's Museum Support Center in Suitland, Maryland, where they built the kilns described in this article.

1
Jhithru Ram (pictured here) and M. Palaniappan (Fig. 2) spent the summer of 1985 in Washington, D.C., as part of a "living exhibit" at the Smithsonian Institution. The potter's wheel shown in the photo is the one Jhithru used at the Aditi exhibit.

Potters at Work: A New View for Archaeologists

Our study revolved around three concerns, two of which pertained to our interests in the production process, and one of which was a result of the special conditions of the potters' presence at the exhibition. The first involved observation of the methods or techniques used in producing the pottery and related equipment, such as kilns; the second involved ethnographic data on how the potters set up their workshops at home, information to be acquired through a series of interviews. The third was related to



2
M. Palaniappan, like Jhithru Ram, is a member of the Kumhar *potters caste and produces both utilitarian and ritual pottery. He is shown here with one of the large votive horses that he prepared for the Aditi exhibit.*

how the craftsmen adapted to their new materials and environment in Washington, D.C.

Observations on the production process would be a reversal of our usual archaeological view that begins with fragments of pottery, or the "end result," from which we try to reconstruct products and behavior. Our observations of living potters would provide a check on our inferences about past production processes since we could view and record the process itself. We also would have an opportunity to examine the physical evidence remaining from the construction of the kilns and the debris after the pottery was fired.

The special circumstances of the potters' presence in Washington provided us with the opportunity to watch them build their kilns and for us to set up equipment and to monitor changes in temperature and atmosphere during the entire process of the firing and cooling of the kilns. Debris encountered in excavation situations can be difficult to interpret and to relate to ceramic production. For example, does a concentration of ash from pottery firing look different from ash produced during normal domestic activity such as heating? Will a burned area resulting from drying the ground prior to pottery firing be distinguishable by size or other attributes from a cooking hearth? Can the size of a kiln be used to estimate the scale of production? All of these present puzzles, the answers to which could be observed and recorded during the project.

Specifically, we intended to observe how the potters reacted to different raw materials, working conditions, and firing circumstances. *Raw materials:* Due to the logistical problems of shipping large quantities of clay from India, the potters would use local clays which could be different in workability and other properties from the raw materials with which they are familiar. *Working conditions:* They would be producing the ceramics inside of the Museum of Natural History, working in a totally enclosed environment rather than in their outdoor courtyards and without the assistance of family members. *Firing circumstances:* The pottery would be fired in kilns to be constructed on the grounds of the Museum Support Center. The different environment and available materials could result in unexpected variables not encountered in their home situations.

These differences gave us a chance to see how traditional potters cope with unfamiliar situations and whether the results of these adjustments would be evident in the objects produced under these altered circumstances. Not only could we observe these adaptations, but we could also talk to the potters about how they perceived the differences in materials and what they intended to do about them.

Two Village Potters

The two potters, Jhithru Ram and M. Palaniappan (Figs. 1 and 2), although both from India, come from different cultural backgrounds, and practice somewhat different techniques of pottery manufacture. They also share important similarities. Jhithru Ram is a native of the village of Nagar Nath near Jagdalapur in the state of Madhya Pradesh. His teacher was also his father, and Jhithru has continued to use the same methods he learned from him. M. Palaniappan is a native of the southern Indian village of Sathiyamangalam in the Pudukkottal district. He also learned the potter's craft from his father, but in addition attended a craft school in Bombay, where he learned techniques not previously known to his

3
After the hard chunks of clay are compressed into smaller particles, water, sand, and rice husks are added to increase the workability range of the clay.

4
Palaniappan mixes the sand thoroughly by "working" the clay with his feet until it is completely mixed.

village. Unlike his ancestors who were landless, Palaniappan has been able to purchase land with the money he has earned.

Both potters belong to the traditional *Kumhar* (*Kumbhakar*) potter caste. Their products—pots, figurines, and large figures—are usually made for local farmers or landowners, who exchange grain for the pottery. However, they also produce pots for cash sale in local markets. Because a wide variety of people acquire vessels by exchange and in the market, each potter makes a range of utilitarian and ritual pottery to cater to the different groups. Ceramic figurines and large figures are also made and exchanged in the same manner. A variety of figures are made for the worship of different deities; some are simple and others are more elaborate.

The tourist market in larger cities has brought about several changes in traditional pottery production. First, there has been a flowering of stylistic forms to cater to non-traditional purchasers for whom iconographic details are not important. Second, the more lucrative monied market, along with new government policies on land ownership, has provided each of these potters with capital to purchase land. Both Palaniappan and Jhithru are involved with agricultural work as well as their pottery-making. In the past, too, potters often worked as farmers, but they rarely owned their own land.

M. Palaniappan

In the context of the Aditi Exhibition, M. Palaniappan was involved only in the construction of votive figures, primarily horses, which are built up by hand and strengthened with a paddle and anvil. In his village he uses hand-building methods but also throws pottery on a fast wheel. At home, ceramic vessels are slipped or painted prior to firing, while the figures are generally colored after they are fired. His wife and mother assist him in obtaining raw materials and in mixing and wedging his clays. They also help with the paddle and anvil work during manufacture, with the painting of the vessels, and with the stacking and firing of the kiln. As a consequence, the first adjustment Palanniappan had to make was working without his usual helpers. To provide him with the necessary assistance, one of us, Mark Kenoyer, and a local potter from a Washington pottery, Rene Altman, assisted him throughout the project.

In India, both potters procure their clay from local reservoirs or from the river banks. Clay used during the Aditi exhibit was obtained from a large deposit at Maryland Clay Products in Beltsville. It is an extremely fine clay with about 6 percent iron when the various clay pockets are mixed together. Palaniappan selected and processed the clay for himself and for Jhithru by picking out the dark grey and red clays that most resembled those he uses at home. Later, he mixed the two together in a proportion of two parts grey to one part red. By mixing them together, he hoped to achieve in the final firing the soft red color that he prefers for his pottery.

After the clay was collected it was dried in the sun for a few days and then broken into small nodules by hand or with a wooden plank. Large concentrations of iron were picked out by hand, and then the clay was put into a tub and slaked by sprinkling water on it. The wet clay was left for one day before mixing in the various tempers such as plant material or sand that are added to the clay to make it more workable. Palaniappan uses two kinds of temper for his clay, regular "sandbox" sand and ground rice husks. In India he gets the sand from the banks of the reservoirs or rivers and the rice husks from a local rice mill. Before arriving in the United States he had sent us samples of both the sand and the rice husks which he normally uses. In preparation for his arrival, we obtained the rice husks from a mill in Arkansas, and they were ground to the exact specification (16/80 ground rice hulls) that Palaniappan's sample indicated.

Figures 3 and 4 show Palaniappan processing his clay. After the clay is

sufficiently wet he removes it from the tub and spreads it out on a flat surface that has been liberally sprinkled with rice husks. The top of the clay is again sprinkled with rice husks and sand which he works into the clay with the edge of his foot. Working from the outside to the center in a spiraling or concentric circular pattern, he spreads out the entire lump by stamping with the edge of his foot, occasionally sprinkling on more rice husks and sand. Next he rolls the flattened clay together and folds it over, beginning the process once again. The exact proportion of temper to clay is impossible to measure, since it is a function of the specific batch of clay, which is different each time. Some of his clay mixtures had more rice husks than did other mixtures. His criteria for determining the right proportions were that the clay should stick to his foot, but could also be pulled away without falling apart, a combination of elasticity and cohesion. When the mixing was complete, he rolled the clay into large balls and wrapped them in cloth or plastic to keep them moist until ready for use.

One of Palaniappan's main tasks while at the exhibition was to produce several large horses. These horses are votive figures presented to the God Aiyanar, the village guardian deity of Tamil Nadu, South India. The large horses are 4 to 6 feet high when completed (see Fig. 2) and the small ones are a foot and a half high (Fig. 5). The figures produced by Palaniappan were made in eight parts—four legs, the central body, the combined neck and head and two ears—that were assembled and decorated after firing. Other potters make horses in one piece, usually in the place where they will be used.

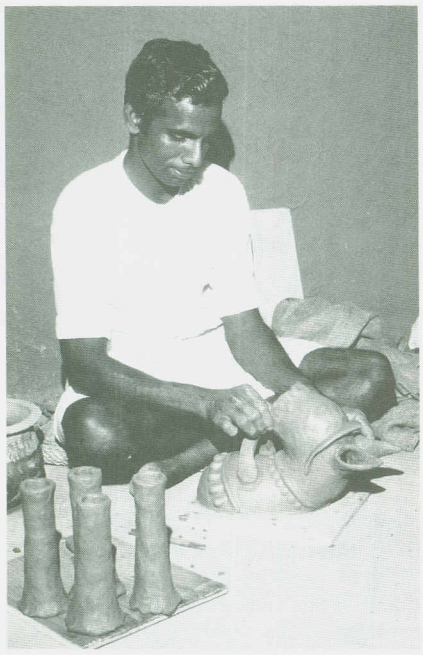
The individual parts are initially made using a series of short coils formed by holding the clay between the two palms and rolling them in a back and forth motion. The uniformly thick coils are joined together by overlapping them while simultaneously shaping them into the desired form. In each case, the initial form was a cylinder, the diameter of which was determined by whether it would eventually serve as a leg, a body, or a head (Fig. 6). To aid in the shaping of the individual parts Palaniappan applied force to each side of the cylinders with a paddle and anvil. Using this procedure he was able simultaneously to mold and thin the clay coils. Decorative elements such as necklaces or ovoid eyes were applied either as pre-formed pieces, such as the rounded "beads" at the horse's neck, or were carved out of the coiled clay and smoothed over with the finger. The eyes were formed in this manner. These elements were final components, however, as Palaniappan did not attempt to add them until the clay was leather hard so he would not disturb the basic shapes of the individual pieces of the horse.

One of the questions most frequently asked by visitors observing the potters while they were working on votive animals was "How long does it take to make one?" The questions probably reflected an interest in efficiency, as one would evaluate a machine-made object. For Palaniappan and Jhithru, however, the question was not pertinent to their activity, since no one piece was worked on continuously. The production process involves a number of steps which are done sequentially, as each piece reaches its correct stage of drying (the leather-hard state) and the potter decides to do that particular task. Over a three-day period, for example, Palaniappan not only worked on the large votive horse but also made two or three smaller animals. Due to the moisture in the air inside the Museum, the large horse took 10-12 days to complete, during which time five small horses and other animals were produced.

5
A collection of the small votive figures and utilitarian pots made by Jhithru.

Jhithru Ram

Jhithru Ram builds his figures differently. His technique involves throwing the parts on a wheel. The wheel, which he brought from India, is common there but was new to us. As Figure 1 shows it consists of a small circular piece of wood with four radiating spokes. The spokes are joined at the outer edge with a hoop made from strips of bamboo tied with hemp cord. This webbed hoop is packed with clay and then bound with more cord. After the cord has dried, additional layers of clay reinforced with cord are applied until the wheel is sufficiently heavy and perfectly balanced. Centered on the underside of the central wooden plate is a short, pointed stake. In order to spin the wheel, the stake or pivot is set in a depression that has been made in a terracotta brick. The particular brick that Jhithru uses has several depressions on each side, showing repeated use. The brick itself is firmly set into a low mound of clay so that when the wheel is placed on the brick it is one



6
Palaniappan makes both small and large figures by hand building. He forms the wet clay into six different segments, which are assembled when the clay is leather hard. Here he prepares the head of a horse, which will be attached to the body and the legs (seen at left).

"thumbed fist" above the ground level.

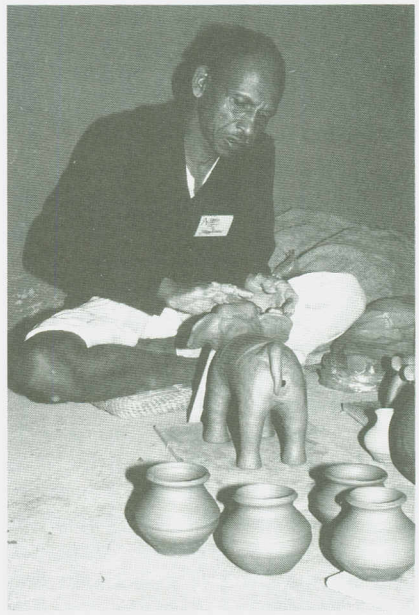
Jhithru Ram also uses a different construction method from Palaniappan. He first throws the separate pieces of each animal from a lump of clay and then sets them to dry until they are leather hard. His small animals are made of the same pieces as Palaniappan's—four legs, one body, and a neck and head (Figs. 6 and 7). When they are suitably dry, the legs are attached to the body by piercing holes in the bottom of the body piece, moistening the clay and pressing the pieces together. The final bonding is done by pressing and smoothing the joined portion. The neck and head are then attached in the same manner. When the joins are sufficiently dry, he applies various decorative motifs either with applique or by impressing the designs into the body. Figures were taken outside to dry before application of the slip which Jhithru had brought from India.

Jhithru was at first very casual and unconcerned about the materials he would be using. He had brought some clay with him from Delhi and he also had the local clay processed by Palaniappan. He did not test either clay before using it and initially decided to make some vessels and figures without adding any temper. "At home," he said, "I would need some sand, but these clays do not need anything." In addition, the slip he brought from India was a bag of red ochre (*gerua*) given to him in Delhi. In his own village he would have mixed the ochre with a fine clay slip, but he believed that the mixture from Delhi was already prepared in such a manner. Later, he was to experience a 50 percent loss of his pottery due to the poor clays, and the ochre rubbed off to the touch due to the lack of fusion.

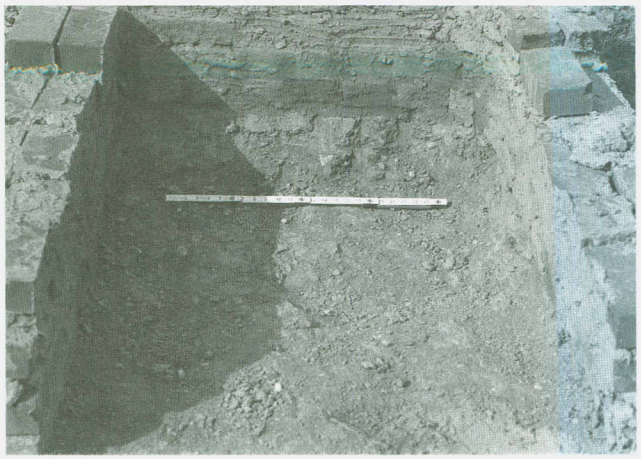
Constructing the Kilns

The day on which we built the kilns was the start of our understanding of the different ways in which the two potters were adapting. It was then that we learned how markedly different had been the two potters' reactions to their new surroundings. First, the kilns to be built—an open structure and an updraft type—were significantly different both in scale and in design. In India Jhithru would have built his kiln into the slope of a hill or against an abandoned mud wall. Jhithru explained that in his village when houses (traditionally made of sun-dried mud brick or packed mud) are abandoned, potters use them as the back wall of their kilns. The fuel for the kilns consists of layers of straw, wood, and dried cow dung patties set in a semicircle which emanates from the corners of the abandoned house wall or from a "wall" made by cutting into a pre-existing hill slope. Vessels, small and large figures, and figure components are stacked on top of this fuel layer and additional combustibles are placed over the entire lot. Finally, the pile is covered with straw and then plastered with mud, leaving an opening at the bottom for introducing fuel. The pottery is fully fired within three or four hours and then allowed to cool overnight. This method can only be used in the dry season when the pottery is fully dry and when there is no chance of a rainstorm interrupting the firing process, since the contents of the kiln are not well protected from the elements.

Jhithru was unable to build his kiln according to the method normally used in his village, since there were no abandoned buildings available. In addition, he yielded to Palaniappan's suggestion that he build the kiln in the same flat area where the updraft kiln was to be constructed. He therefore decided to build a rectangular three-walled kiln, a type which he apparently had not attempted previously. Furthermore, baked terracotta brick, the material available for building the kilns, was new to him. When it came to actually building the wall of his kiln, he did not know how to bond individual layers and their corners. As he rapidly laid layers of the wall, he imitated the procedure being used by Palaniappan, looking to him for guidance. In the end, his rectangular kiln consisted of bricks on three sides laid three courses high, each brick stacked directly above



7
Like Palaniappan, Jhithru makes his figures in separate segments, but instead of making them by hand, he uses the potter's wheel, creating small, narrow cylinders for the four legs and wider ones for the neck, head, and body. Decorative elements, such as harnesses and ornamental jewelry fashioned of clay, were added when the clay was leather hard.



8
Jhithru built a three-walled kiln out of terracotta bricks in the rectangular shape shown here.

9
The fuel and pottery were loaded into the structure by placing a layer of hay and small pieces of wood on the kiln floor and setting down a layer of tiles. The ceramic pieces were placed on top of the tiles at the back of the kiln. Later, they were covered entirely with hay and mud, with additional scrap terracotta tiles set along the back of the kiln to serve as baffles.

10
Palaniappan constructed an updraft kiln which included two chambers, a firing box, and a setting level for the ceramics. The metal grate shown in the photograph was one foot from the floor of the kiln and separated the firing box from the setting chamber. Here, Palaniappan is shown applying mud mortar to the interior of the kiln as a sealant against external drafts.

the other (Fig. 8). There were noticeable breaks at the two corners. The crudeness of the structure might have affected the firing itself, except for the fact that Jhithru compensated by adding terracotta baffles and a covering of straw and mud (Fig. 9).

M. Palaniappan's kiln was a simple updraft type. In India, it is often built inside a house or shelter to protect it from the rain, but at the Smithsonian's Museum Support Center, we built it outside in the open. The kiln was constructed out of red terracotta bricks, a piece of old wrought-iron fence for a grate, and mud for mortar (Fig. 10). The interior diameter of the kiln was 5 feet, measured by Palaniappan as 5 pairs of thumbed fists. It was 4 feet high, with the grate set a foot above the base of the kiln. Using mud plaster made from the local soil, Palaniappan quickly and very precisely laid each layer of bricks—one row of stretchers and a double row of headers—occasionally laying the headers on their edge. The internal surface was carefully sealed with mud plaster, but the cracks on the outside surface were left untouched. Although he was planning to do only one firing in this kiln, Palaniappan pointed out that under normal usage the cracks on the internal surface would have to be replastered after each firing. Palaniappan had made several such kilns and seemed to know in advance exactly what needed to be done and how he wanted to do it.

The Stages of Firing

On the day of the firing there were several problems to overcome. First came the difficulty of transporting the unfired pieces of the large horses to the kiln site. Traveling on the Suitland Parkway from Washington, D.C., to the Museum Support Center in Maryland, we noticed many puzzled expressions when people viewed the dismembered parts.

Another challenge consisted of procuring wood and straw, both of which were essential to the firing. It turned out that straw, in addition to being a staple in barns, is a common material used by local construction companies and so was easily obtainable. Wood, on the other hand, is expensive. We finally resorted to using the scrap wood from crates that had been shipped from India, as well as wood left from the construction of the Folk Festival. This fuel was primarily of soft woods and resinous pine and fir. Both Palaniappan and Jhithru had trouble regulating the speed with which the wood burned and had to keep a close watch on the firing.

Jhithru actually had had a "practice" run with this wood, having fired a load of 47 objects several weeks before the main firing. On that occasion the pottery did not have time

to "sweat" or dry out and began to burst with the first blast of heat. Pyrometers inserted in the kiln to measure temperatures gave readings indicating that the heat at the center of the kiln climbed from 45 to 457 degrees C. in 34 minutes. In addition, temperatures varied some 470 degrees C. from the back to the front of the kiln. Although the increase in temperature was reasonably gradual for an open firing, the lack of uniformity of heat and the production-related problems described above resulted in over 50 percent breakage. Breakage occurred primarily at those places in which the figures were put together, for example, the joins between the body and the legs. Breakages at these points apparently were due both to their thickness (these areas dry more slowly) and to their poor adherence.

At Jhithru's second firing he stacked his kiln with small, kindling-size pieces of wood rather than the thick blocks he had selected the first time. He placed the kindling in rows at the bottom of the pit and set a second layer at an angle to the first, leaving air space between the pieces. The unfired pottery, altogether 70 pieces, was set directly on top of this wood. Additional pieces of small wood and charcoal left from the previous firing were set in front of the pottery. Terracotta rooftiles then were placed over the wood and slanted forward toward it. A layer of straw was placed directly over the tiles, the straw was covered with mud, and additional straw was placed at the front of the kiln.

The updraft kiln built by Palaniappan was filled with a variety of ceramic pieces, but in view of the large size of the two horses, the loading proceeded more slowly. Each large horse consisted of eight pieces. (Larger figures had a head ornament added.) The individual pieces were fitted gingerly against the metal grate on which they were being stacked. Tiles were set beneath or around the individual pieces to stablize them. The tiles also were used as receptacles for smaller pieces that might have fallen through the grate (Fig. 10). As Jhithru had done, Palaniappan covered the loaded kiln with roof tiles, then laid a thick covering of straw on top, followed by a "mortar" of mud. A second and thinner layer of straw and mud was applied. Twelve small holes were poked through this cover to let out smoke and to draw the fire.

This entire process took a little over an hour, by which time a large crowd had gathered. Among them were Ed Sayre and David von Endt of the Smithsonian's Conservation Analytical Laboratory. They had agreed to set up and to monitor the pyrometers which recorded temperatures in the kilns and to install instruments with which to extract gases. This information would allow us to reconstruct the range of variation in temperature and air throughout the firing. Since we had photographed the placement of individual ceramic pieces, we could assess the effects of these variations on the specific objects.

A small ceremony or ritual preceded the actual firing of the kilns. Palaniappan set a straw fire just outside of the mouth of the kiln, and a coconut was broken as a sacrifice to insure success of the firing. A pack of incense also was lit and marigolds were placed over the smoke holes on the top of the kiln.

Palaniappan built an additional small fire at the entrance to the fuel box of his kiln, where he allowed it to burn for one hour during which time it was gradually introduced into the box. The procedure was intended to heat the kiln and its contents slowly to avoid cracking the sides of the kiln or exploding its contents. It insured that the pottery had dried out gradually before the full firing began. The timing was based on a test known to Palaniappan. He said the time would be right when the top layer of tiles (which he reached by pushing his fingers through the smoke holes) could be touched for only a second.

Throughout the firing, the potters devoted their entire attention to adding fuel and to controlling the drafts in the kiln. The latter was managed by opening and closing the smoke holes which each potter had made in the straw and mud cover.

There were other concerns as well, and the potters yelled back and forth about these as they stoked their kilns. Something that troubled Jhithru was the wetness of the soil, which he said would affect the fire

11
Palaniappan's kiln, shown here during the firing, gave him few problems. He gauged the completion of his firing by the color of the pottery, which he said would glow "like the sunset," a process which took five hours. Once the fire was quelled, the kiln was sealed in order to allow the pottery to cool slowly and efficiently. The cooling lasted through the night.

and blacken his pottery. Since it had been raining off and on for the previous few weeks the soil was damp, and he had wanted to cover the bottom of the kiln with a piece of iron sheeting to keep the dampness out of the kiln.

When asked how he would deal with such a problem in the village if he had no iron sheeting, he replied that he would burn a fire inside the kiln to dry out the soil before stacking the pottery. In fact, a joke between the two potters centered around whether or not their pottery would turn out black. It was a way of humorously accusing the other of not knowing what he was doing. Jhithru, who claimed not to have seen an updraft kiln before, said to Palaniappan, "Your horse will be black because your kiln is too large," while Palaniappan joked that the wet soil would turn Jhithru's pottery black.

The firings lasted a number of hours and were the most dramatic part of our study. Temperatures reached their peak an hour before the potters stopped stoking them, while we watched captivated by the process—the bright burning fires, clouds of smoke, and visibly transformed clay, now hard and permanent. Palaniappan timed the end of the firing by the color of the pottery, which he said should glow like the sunset (Fig. 11). This glow was observable through the smoke holes made to control the drafts and through the peek holes we used to monitor our pyrometers. The timing varied—3 hours for the pit kiln and 5 hours for the updraft one. The kilns then were sealed off so that the heat would be maintained and the pottery would cool slowly. This cooling lasted until morning, when the firing would be complete.

The Rewards

It was nightfall before we were able to stop and to think over the day's events. By peeking through the holes that we had made for our pyrometers, we could watch the soft orange glow of the fired pottery fade as it cooled in the night air. Each of us, lost in thought, mused over the events that had led to that peaceful moment. For the two potters, the challenge of working with new and strange materials had been met. We archaeologists remembered excavations of ancient kilns and incorporated insights from our observations on the firing procedures into our interpretive framework. In all, the work had come full circle and we anticipated the excitement of the morning, when the pieces would be unloaded and each would be examined for its finished characteristics—clarity and evenness of color, lack of cracks, breaks or spalls, and so forth.

12
Palaniappan, assisted by Rene, removes the head of a large votive horse from the kiln.

In the morning, when that moment came, we lifted the roof tiles from the top of the two kilns and took out the individual pieces one by one (Fig. 12). First came the horse's legs, then its torso and head—all perfect except for a minor spall on the tip of one leg, probably the result of an air bubble, since Palaniappan remembered having patched the piece while finishing it. For Jhithru, his entire lot, with the exception of one piece, had survived, although many were blackened.

For each of us the project had been a rewarding experience. We, the archaeologists, have valuable factual information: a body of observational data on hand building, wheel throwing, kiln construction and firing; scientific measurements of firing curves and gas analyses; physical evidence of the results of kiln use. And we also have benefited from intangibles: a heightened awareness of the episodic nature of pottery making, an increased understanding of the roots of potters' conservatism.

The potters left also with tangible and intangible rewards. Palaniappan had earned sufficient money to complete a new house and had acquired new ideas about glazes from observing Rene Altman's work. Jhithru had plans to build a new two-room brick house and to buy some more land.

The Smithsonian's Aditi Festival has ended and we are left with our more familiar archaeological evidence: the debris from the firing, but also the end result of the production process, the pottery itself.

Through this study we have seen how these two potters maintained the core of their craft—their varied techniques of forming and shaping—while the other components, the raw materials and firing circumstances, had changed. In this case the change was brought about by the potters being physically transferred out of their village environments. In prehistoric situations, various fac-

tors could have required potters to adapt to different raw materials or to change their firing procedures. For example, the exhaustion of a nearby clay deposit would result in the use of alternative raw materials with different working or firing properties. Decreasing availability of wood brought about by pressures of an expanding population could trigger a search for a more "cost effective" method of firing—larger quantities fired at one time, a different kiln layout, and so forth. An expanding population could also force the removal of pottery production and firing loci to more peripheral locations, leaving archaeological evidence of sequentially used production facilities.

In these cases, the end products of the process—the pottery objects themselves—would appear unchanged, suggesting continuity and stability as did the horses and pots resulting from the Aditi study. Changes in the other components, however, might speak of variables operating on the social or physical environment.

While the end product will continue to be a main focus of studies of ancient pottery, added attention to the other technological components represented by raw materials and firing procedures will enrich the reconstructions archaeologists are able to make. This research project reinforced the importance of this expanded perspective while giving us an unparalleled opportunity to watch traditional craftsmen create cultural objects from the basic commodities available to them.

Bibliography

Arnold, Dean E.
1978
"The Ethnography of Pottery Making in the Valley of Guatemala." In *The Ceramics of Kaminaljuyu*, ed. R. K. Weatherington, 327-400. University Park: Pennsylvania State University Press.

Blurton, T. Richard
1985
"Tribal Terracotta Figurines in Gujarat: The Technology of Their Production." *South Asian Studies* 1:67-78.

Dhamija, Jasleen
1985
Crafts of Gujarat. New York: Mapin International. (See especially Haku Shah's, "Pottery and Votive Teracottas," pp. 137-44.)

Kramer, Carol
1985
"Ceramic Ethnoarchaeology." *American Review of Anthropology* 14:77-102.

Rye, Owen S.
1981
Pottery Technology. Washington, D.C.: Taraxacum Inc.

Saraswati, B., and N.K. Behura
1966
Pottery Techniques in Peasant India. Calcutta: Memoirs of the Anthropological Survey of India, No. 13.

Smithsonian Institution
1985
Aditi: The Living Arts of India. Catalog published on the occasion of the exhibition, June 4-July 28, 1985. Washington, D.C.: Smithsonian Institution Press.

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Several of M. Palaniappan's large figures were on display at the Arthur M. Sackler Gallery at the Smithsonian. The large horse described in this study was placed at the entrance on the ground level near the visitor information desk in May 1988.

Marilyn P. Beaudry specializes in the study of production and distribution of archaeological ceramics and the economic organization of complex societies. Her major geographic concentration is Mesoamerica and she has field experience in Guatemala, Honduras, and El Salvador. She received her Ph.D. from the Interdepartmental Archaeology Program, UCLA, in 1983. She was a postdoctoral fellow in material analysis of archaeological ceramics at the Conservation Analytical Laboratory (CAL) of the Smithsonian during 1984-1985 when the project described in the article was undertaken. During 1985-1986 she was Senior Fulbright Scholar with the Sula Valley Project in Honduras and is the co-director of the Tiquisate Archaeological Project on the Pacific Slope of Guatemala (UCLA Institute of Archaeology sponsored). With a research appointment at UCLA and at CAL of the Smithsonian, she pursues both anthropological and materials analytical approaches in studying archaeological ceramics.

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