Newsletter

III — 1985

Department of Pottery Technology

UNIVERSITY OF LEIDEN - THE NETHERLANDS

NEWSLETTER

Department of Pottery Technology

III - 1985

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INFORMATION

(1-11-1984 to 1-11-1985)

On May 1st, 1985 drs. P. Stienstra joined the Department of Pottery Technology on a part-time basis. He is a geologist, charged with the formalization and building-up of a system of geological methodologies in archaeology, particularly within the scope of technological-archaeological research of pottery.

A. van As participated in á symposium on "Ceramic technology, materials science archaeology interface", one of the symposia held during the annual meeting of the American Anthropological Association in Denver (USA) from November 14th to 18th 1984 (see this Newsletter, p. 6). After the AAA meeting guest lectures were given by A. van As at the City University of New York and the University of Wisconsin in Milwaukee. In Milwaukee a collection of Bronze Age pottery from Tell Hadidi was studied. This pottery was excavated by an American team headed by dr. Rudolph H. Dornemann, Curator of History and Head of the History Section of the the Milwaukee Public Museum.

On May 14th, 1985 dr. Gordon Bronitsky (University of Arizona, Tucson USA) gave a guest lecture on materials science analyses of American pottery in the Department of Pottery Technology. In 1984/85 dr. Bronitsky was guest professor at the Wolfgang Goethe University of Frankfurt.

An article by A. van As entitled "Reconstructing the potter's craft" was published in: Leeuw, S.E. van der and A.C. Pritchard (eds.)(1984), The many dimensions of pottery, ceramics in archaeology and anthropology, Amsterdam: 131-164.

An article by H.J. Franken entitled "Why did attempts to imitate Greek pottery fail in the Near East?" was published in: Brijder, H.A.G. (ed.)(1984), Ancient Greek and related pottery, proceedings of the International Vase Symposium Amsterdam 1984, Allard Pierson Series Volume 5: 9-11.

The exhibition "Clay, a source of life" (see Newsletter II, p. 4) in Tongeren (Belgium) has been prolonged until January 1st, 1986. After this date the exhibition will go to Tübingen (Germany).

Research project Department of Pottery Technology

Last spring the Department of Pottery Technology (Department of Palestinian Archaeology/General Archaeology) submitted a request for approval of a new research project to the Board of the Faculty of Arts of the State University of Leiden. This project is called: "Explaining the technical aspects of the pottery craft within the frame of the archaeological discipline". The project aims at setting up an explicative model of archaeology-related pottery research by means of studying the relations between technical, functional and scientific aspects of ancient pottery. The project will include the following subjects:

. Experimental research into the relation between raw materials and the production and function of pottery.
. Ethnoarchaeological research on pottery: investigations into the activities of traditional potters working at present and a study of the interaction of factors playing a part in the pottery production process so as to come to a correct interpretation of archaeological phenomena.
. Study of the contribution of modern laboratory research into physical/chemical properties of pottery and pottery raw materials to technological research.
. Research into the effects of the results of technological

pottery analyses on existing archaeological pottery typologies.

. Comparative studies on pottery repertoires from various regions in the world in order to test the research methods developed by the Department of Pottery Technology.

Summarizing, the project aims at carrying out fundamental research in order to bring about improvements in archaeological pottery research methods.

Participants in the project are: M. Beatrice Annis, A. van As, L. Jacobs and P. Stienstra. Project leader is A. van As.

Below a summary is given of <u>continuation and new projects</u> carried out by the Department of Pottery Technology in 1984/1985. The results are published in the Newsletter or somewhere else.

- <u>Continuation projects</u> (see Newsletter II. pp. 2, 3):

. For dr. M. Beatrice Annis (Leiden)
  Sardinia (ethnoarchaeological research).

. For drs. P.W. van den Broeke (Leiden)
  Oss/Ussen (Iron Age pottery).

. For Professor L. de Meyer (Ghent, Belgium)
  Tell ed-Der (2nd millennium BC pottery)(see this Newsletter, p. 15).

. For drs. Josine Schuring (Leiden)
  San Sisto Vecchio/Rome (Roman pottery).

. For "Archeologische Werkgemeenschap Nederland"/Haarlem
  Medieval pottery from Haarlem.

- <u>New projects</u>:

. For Professor A.R. al-Ansary (Riyad, Saudi Arabia)
  Pottery from Qariyat al-Fau.

. For dr. R.M.A. Bedaux (Utrecht)
  Mali (ethnoarchaeological research).

- <u>Service</u>:

. For dr. D.W.J. Meijer (Amsterdam)

Firing of ancient unbaked clay figurines from Tell Hammâm et-Turkmân, Syria.

From February 23d till March 23d, 1985 A. van As and L. Jacobs carried out technological research on Palaeo- and Meso-Babylonian potttery at Tell ed-Der, Iraq. This research work was done within the scope of activities of the Belgian Archaeological Expedition to Iraq headed by Professor L. de Meyer (see this Newsletter, p. 15).

Working Group on Mesopotamian Pottery

In March 1985, during the excavation season of an Belgian Archaeological Expedition to Iraq the "Working Group on Mesopotamian Pottery" was set up. This working group aims at carrying out an integrated study into the technological, archaeological and cultural-historical aspects of Mesopotamian pottery. It will try to find out whether there is a relation between pottery shape, function, clay composition and pottery production techniques in Mesopotamia and to what extent. For this purpose, representative collections of pottery from various Mesopotamian sites and various periods should be studied, ancient and recent clay deposits from different geographical areas examined and compared and data collected on the present activities of potters now living in the region. The final results of this technological research programme will be presented by integrating them in an archaeological shape classification of Mesopotamian pottery. The problems involved in establishing an archaeological/technological pottery typology will regularly be discussed in meetings held by the working group. The technological analyses will be executed by the Department of Pottery Technology in cooperation with the Department of Soil Science and Geology of the Agricultural University of Wageningen (Professor L. van der Plas). The progress results of the working group will be published in the

Northern Akkad Project Reports and summaries thereof will regularly appear in the Newsletters of the Department of Pottery Technology.
Close cooperation with other archaeologists is essential for the success of the research project of the working group. If you are interested in participating in the activities of the working group, please contact A. van As, University of Leiden, Department of Pottery Technology, Reuvensplaats 4, POB 9515, 2300 RA Leiden, Holland, or Ö. Tunca, University of Ghent, Sint-Pietersplein 6, B-9000 Ghent, Belgium.

A. van As

POTTERY TECHNOLOGY: THE MATERIALS SCIENCE/ARCHAEOLOGY INTERFACE: A SYMPOSIUM HELD DURING THE 83RD ANNUAL MEETING OF THE AMERICAN ANTHROPOLOGICAL ASSOCIATION

From November 14th to 18th 1984 the 83rd annual meeting of the American Anthropological Association was held in Denver/Colorado (USA). About 2000 anthropologists and archaeologists, mainly from the USA, participated in this congress. In total 458 symposia were held on very divergent subjects. A few symposia, such as the ones on "Contemporary Archaeological Theory", "The Construction of Residential Architecture in Neolithic Europe and the Near East" and "Environmental and Ecological Models", were dedicated to archaeological subjects.

The Department of Pottery Technology participated in this annual meeting in connection with a symposium dealing with "Pottery Technology: the Materials Science/Archaeology Interface", organized by Gordon Bronitsky (University of Arizona, Tucson). In the abstracts of the 83rd annual meeting of the AAA he wrote the following introduction to this symposium: "Archaeologists have been aware of the existence of a variety of measures derived from materials science and their utility in archaeological research at least since Shepard's pioneering work. Until recently, little use has been made of such measures beyond an increased emphasis on analysis of materials for provenance studies. A recent resurgence of interest in prehistoric ceramic technology has led to a reevaluation of these measures, and their utility in archaeology research is presented".

The following persons contributed to the symposium: Abraham van As (State Univ. of Leiden), Gordon Bronitsky (Univ. of Arizona), Terry S. Childs (Boston Univ.), Alex Clarke (Medical

College of Virginia), Robert B. Heimann (Whiteshell Nuclear Research Establishment), Robert H. Johnston (Rochester Institute of Technology), Timothy Kaiser (Univ. of Toronto), William Lucius (Univ. of Toronto), Kenneth C. Reid (Washington State Univ.), James Skibo (Univ. of Arizona) and James Stoltman (Univ. of Wisconsin). Unfortunately some lecturers could not attend the symposium, so that only the summaries of their papers could be passed on to those present. The organizer of the symposium, Gordon Bronitsky, was not able to come because of a visiting lectureship at the Wolfgang Goethe University of Frankfurt. In his place James Stoltman acted as chairman of the symposium.

The various approaches to the symposium's theme by the resp. participants gave a clear idea of the current developments in techno-archaeological pottery research. The contributions of the symposium's participants made it clear that material analyses of pottery are not only important with respect to archaeological provenance studies. They also yield interesting data concerning the technology, function and durability of pottery and the postdepositional history of sherds. Some research techniques were discussed: xeroradiography, scanning electron microscopy, petrographic thin section analysis, thermal expansion measurement and the use of a so-called pendulum-type impact tester. Some of these scientific research techniques, such as petrographic thin section analysis have been applied in archaeological pottery studies for rather a long time. They have often proved to be useful for the solution of specific archaeological problems. In his paper Stoltman demonstrated the value of petrographic thin section analysis for generating interpretable data concerning the significance of technological variation within a single ceramic province. Thin sections from 50 ceramic vessels - 20 Classic Mimbres B/W bowls, 20 Brownware jars, and 10 Brownware bowls - from 10 sites in the Mimbres region of New Mexico were the basis for this analysis. Mineralogical types and relative quantities of mineral inclusions were compared between sites and between vessel classes to evaluate the effects of form, function and space upon technological variation. In his paper on "Possibilities and Limitations of Materials Science: Pottery from the Northern Euphrates Region in Syria" Van As pointed out that for various regions petrographic thin section analyses of pottery do not always yield useful archaelogical results (see also Stienstra, this Newsletter, p. 10). If scientific material analyses are not integrated in technological-archaeological research, some scepticism is justifiable. This does not alter the fact that the development of new analysis techniques by natural scientists is very important for archaeology, provided that such techniques are interdisciplinarily elaborated.

Johnston explored in his paper the applicability of xeroradiography, scanning electron microscopy and petrographic thin section analysis, along with etnographic study, to problems of ceramic technology encountered in a complex excavation. These technologies and methods are examples of the current interdisciplinary interpretive analytical and technical processes.

Although known for 20 years thermal expansion measurement is not widely used in the determination of ceramic firing temperatures. Kaiser and Lucius discussed in their paper some of the advantages and disadvantages of TEM. Experiments on Balkan Neolithic sherds showed that TEM is especially suited for determining the temperatures of high-fired ceramics and yields accurate estimates regardless of whether the ceramic sample was originally oxidized or reduced.

In Bronitsky's and Clarke's contribution a description was given of a pendulum-type impact tester specifically designed for analysis of low-fired ceramics and of its utility in the assessment of ceramic durability in the form of impact resistance. The relevance of such measurements - were the ancient potters aware of the factors contributing to the durability of their ceramics? - were discussed.

During the symposium not only the current developments in scientific analysis techniques were discussed, but also their utility for archaeological research. The latter issue is very important since the gap between natural scientists and archaeologists with respect to archaeometric studies threatens to become wider and wider.

P. Stienstra

TECHNOLOGICAL RESEARCH ON COMPOSITION AND TEXTURE OF ANCIENT POTTERY - A NOTE ON SENSE AND NONSENSE

The idea that there is more to ancient pottery than its external appearance (size, shape, decoration) becomes more and more accepted in archaeology. This is due to the growing understanding that this appearance is not merely a result of the artistic feelings and preferences at the time of production. In reality the exterior of old ceramics is the product of a complex system of interacting factors. In this system the "demands" of the cultural pattern and the level of general development play as much a part as do the ruling traditions regarding food preparation, the organization of the pottery production, the natural environment and the raw materials available therein, and much more.

If one seeks to understand ancient pottery to the fullest extent possible, it is important to collect all available information. On its origin (where, when and how was the object made), on its use, and on all aspects of its "life cycle". Studying the place and time of origin of ancient objects has been an integrated part of archaeology for a long time now. Research on the production methods used is of more recent date. The Department of Pottery Technology was one of the first archaeological institutions to incorporate methodological aspects into its research on ancient pottery.

Two dominant factors can be distinguished within the production process of pottery. In the first place the potter (including, for instance, his technical insight and know-how, the technical methods at his disposal, his socio-cultural status, or the organization of his branch). Secondly the raw materials available at or close to the place of production (e.g. quantity and quality of the natural clay, of material usable as temper, of fire wood, water etc.). Any full pottery description should evaluate what can be revealed on these two issues.

For many years the Department of Pottery Technology has focussed its attention on the dominant role the craftsman played in the complex process of pottery production. By studying ancient objects and describing the features from the viewpoint of the craftsman, by studying the relatively primitive production processes still in use in many developing countries, and by reconstructing pottery following as much as possible the old shapes and sizes, much valuable insight could be gained on the level of general expertise and on many particular "tricks" the craftsman once used when preparing the "body", and when shaping and firing the pottery. Research on these issues will continue in the future.

Obviously the materials used during the production process were of at least equal importance to the final product as was the potter. In some cases these materials may even have been of more importance: even very skilled potters could not produce high-quality objects from unworkable clays. It may therefore be concluded that to a large extent the raw materials set the limits within which the potter could design and produce his pottery. Equally, the availability of certain types of raw material dictated whether or not a significant amount of pottery of a certain fabric could be produced.

Obviously, the material composition of ancient pottery deserves much more attention than sometimes thought, because it certainly has had direct influence on the ultimate shape and size of the objects under archaeological research. Regrettably, archaeological methods are usually not very well attuned to the requirements of research on composition and fabric of pottery. Therefore it has become common practice to "borrow" methods of analysis from other branches of science.

Pottery consists of sedimentary particles like clay- and sandsize grains.

The potter mixed natural clays with other (often natural) elements, shaped the desired objects, and made the shape permanent by firing. Except with respect to the time and scale involved this firing process can be compared with the natural process of rock metamorphosis defined by conditions of very low pressure and relatively high temperature ("contact metamorphosis"). It is not surprising therefore that when looking for technological methods applicable in pottery research archaeology turns to the many techniques used to study rocks.

In geology numerous research techniques are available, varying from simple ones, which do not need much expertise or equipment to execute the tests and evaluate the results, to complex ones which do need specialist know-how and sophisticated equipment. Clearly it is not simple to choose, in the context of archaeological research, the most appropriate geological techniques. Some archaeological publications suggest that the authors refrained from deciding between methods. Instead they seem to have applied all tests at their disposal simply because these tests exist and render beautifully systematic results in the shape of impressive tables full of figures. Regrettably such an attitude often comes down to a mere waste of time and money.

When choosing the most appropriate research methods the archaeologist should take into consideration:

- the archaeological question to be answered.
- the limitations and possibilities of the research methods to be applied.
- the limitations and possibilities of the material to be investigated.

Surely the archaeologist is the one to define the archaeological question to be answered. But in some cases it seems that archaeological research would benefit from the input of specialist advice on the advantages and disadvantages of each of the available methods, and even on the answerability of the question when using specific methods. In this context it may be important to note that scientists usually expect miracles from research methods they are not personally acquainted with. Expectations that often cannot be fulfilled.

To illustrate this point an example from archaeological practice. Many archaeologists think that the geographical place of origin of pottery can always be defined simply by describing the mineralogical composition of the (non-plastics of the) pottery and comparing the outcome with the geology of the potential source areas. Although some remarkable results have been accomplished by such a method it is unrealistic to expect that it can be applied with success always and everywhere.

Usually the average composition of the "clay-body" as prepared by the potter does not represent the general geology of the area. Furthermore many processes may have caused the present mineralogical composition of the pottery to be in disagreement with its primary composition: (1) in choosing the clays or the source rock for the temper the potter may decide to use materials which are very scarce in his environment. Such a choice may be based on personal or professional preferences or on any other reason unknown to us. In this case the ultimate mineralogical composition of the pottery will anything but provide information on the general geology of the region; (2) the processing of the material (grinding, sieving, selection by floatation etc.) may very well lead to a relative depletion of specific minerals in the resulting mixture due to characteristics which influence the behaviour of the minerals during the processing phase (differences in specific weight, strength, resistability, average grainsize etc.). Again the resulting mixture will not provide a full picture of the normal mineralogy of the source rock; (3) the firing of the shaped objects can severely change the mineralogical characteristics of certain minerals, making them partly or totally indiscernible during analysis. This is most obvious in minerals containing water (like many clay minerals) or carbon dioxide (calcite, dolomite). Furthermore the high temperatures can cause certain minerals to break down and disappear or to react with other components to form new minerals; (4) less radical but similar mineral transformations can occur during each and every one of the subsequent phases of the "life" of the object: the period of use, the period of burial after use, and even the phase of excavation or restoration.

Evidently these and other possible influences have to be taken into consideration before one can use the mineralogical composition of ancient pottery in provenance studies.

This example illustrates that research on composition and fabric of ancient pottery is less straightforward than sometimes thought. It demands the input of both archaeologists and non-archaeological scientists, who should support the archaeological research when it approaches their field of specialization. The recent recruitment by the Department of Pottery Technology of the present author, a geologist with sedimentological and sediment-petrographic specializations, is meant to strengthen the input of general geological methodology into the research presently carried out at the Department. Furthermore a new programme will be implemented which combines fundamental and applied research on pottery fabric and composition. This programme is designed to contribute to the further improvement of systematic "technological" pottery research through prudently selecting and subsequently introducing into archaeology usefull research techniques from other disciplines.

A. van As
L. Jacobs

TECHNOLOGICAL RESEARCH OF PALAEO- AND MESO-BABYLONIAN POTTERY FROM TELL ED-DER (IRAQ) - A REPORT

Introduction

Since 1970 the Belgian Archaeological Expedition to Iraq(1) headed by Professor L. de Meyer has been excavating at Tell ed-Der (De Meyer 1971. 1978, 1980, 1984; De Meyer, Gasche and Tanret 1984). This site, about 70 kilometers north of Babylon on an ancient branch of the Euphrates river, has been identified with ancient Sippar Amnanum (Fig. 1).

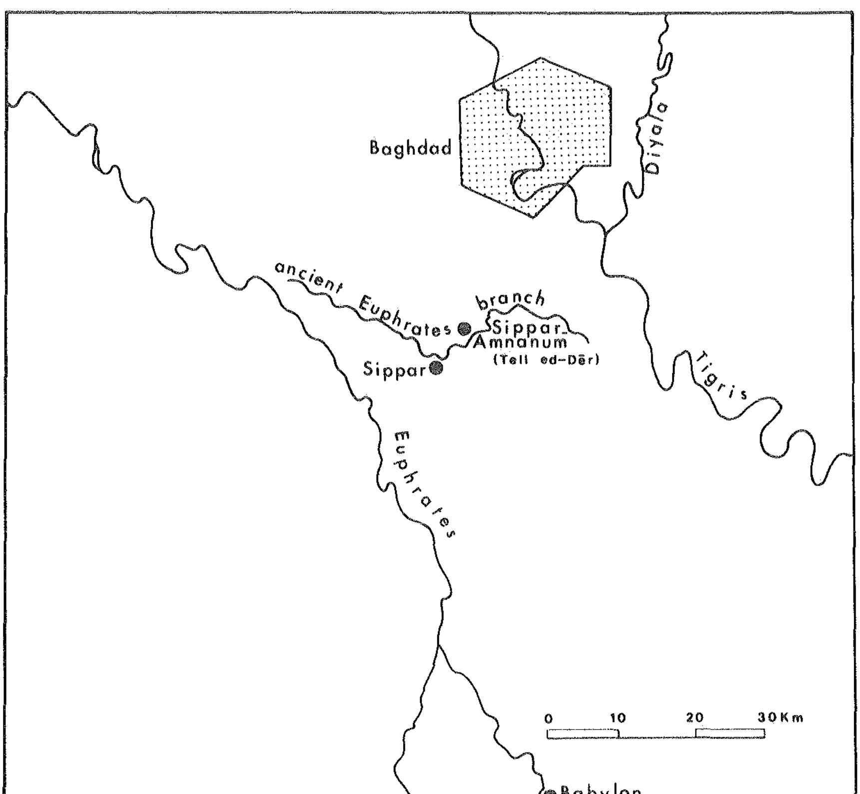


Fig. 1. Map of the region south of Baghdad.

At the request of L. de Meyer and H. Gasche the Department of Pottery Technology recently investigated a small collection of Palaeo(2)- and Meso-Babylonian(3) pottery from Tell ed-Der (Franken and Kalsbeek 1984). The results of this research work stimulated a further technological research into the pottery from Tell ed-Der at a larger scale on the spot. For this reason the Department of Pottery Technology set up a research programme of which the major part could be executed in the field. A report of the initial technological research work, which was executed at Tell ed-Der from February 24 until March 22, 1985, is given below.

Aims and methods

The aim of the overall technological research programme(4) is to investigate whether a classification based on technological analysis may fit in with an archaeological shape classification of Palaeo- and Meso-Babylonian pottery(5). The final results of the technological investigation will be presented by integrating them in an archaeological shape classification of Mesopotamian pottery.

During the research work in Iraq technological data with respect to the pottery itself (shaping technique and raw materials) were collected. Clay samples have been taken at Tell ed-Der and its surroundings and analysed on the spot as much as possible. Small field kilns were built for firing tests and an initial visit was paid to brickworks and potteries just northeast of Baghdad. This visit will be continued in the future, as they may provide the research workers with important technological information.

Preliminary results of the fieldwork

(1). Technological research on Palaeo- and Meso-Babylonian pottery

A representative collection of about 400, more or less complete Palaeo- and Meso-Babylonian pots excavated previously were analysed in the field. This technological analysis comprised: (a). analysis of shaping techniques and (b). analysis of raw materials.

(a). Analysis of shaping techniques

The shaping techniques of the pottery from Tell ed-Der were analysed by means of so-called "pot reading", i.e. observing any traces left by the potter on the pot so as to reconstruct the entire forming process. These traces can be divided in primary traces pointing to the shaping technique applied (throwing, use of a mould etc.) and secondary traces caused by finishing (rim trimming etc.) and decorating. The pottery repertoire consisted of small and large dishes, small bowls, bowls with a flat base, goblets and pots (Fig. 2). On account of the above-mentioned primary and secondary technological characteristics, various shaping techniques were found(6). By means of some refiring tests in a gas-fired test kiln for use in the field (Fig. 3)(7) the original firing temperature of the majority of the pottery could be established at ca. 800o C.

(b). Analysis of raw materials

The variety in colour of the excavated pottery(8) was assumed to have been caused by differences in clay composition and original firing conditions, and by soil influence. To confirm this assumption the raw materials of 127 test sherds representative of the pottery repertoire were analysed. Refiring of the sherds in the test kiln under oxydizing conditions yielded three different firing colour categories: 1. pink-light to reddish brown, 2. pale yellow and 3. very pale brown. The exact significance of these categories still has to be evaluated. Study of the non-plastics in the test sherds under 30 x magnification did not show qualitatively different groups. Quartz, gypsum, lime, muscovite, iron particles and burnt organic material were mainly observed.

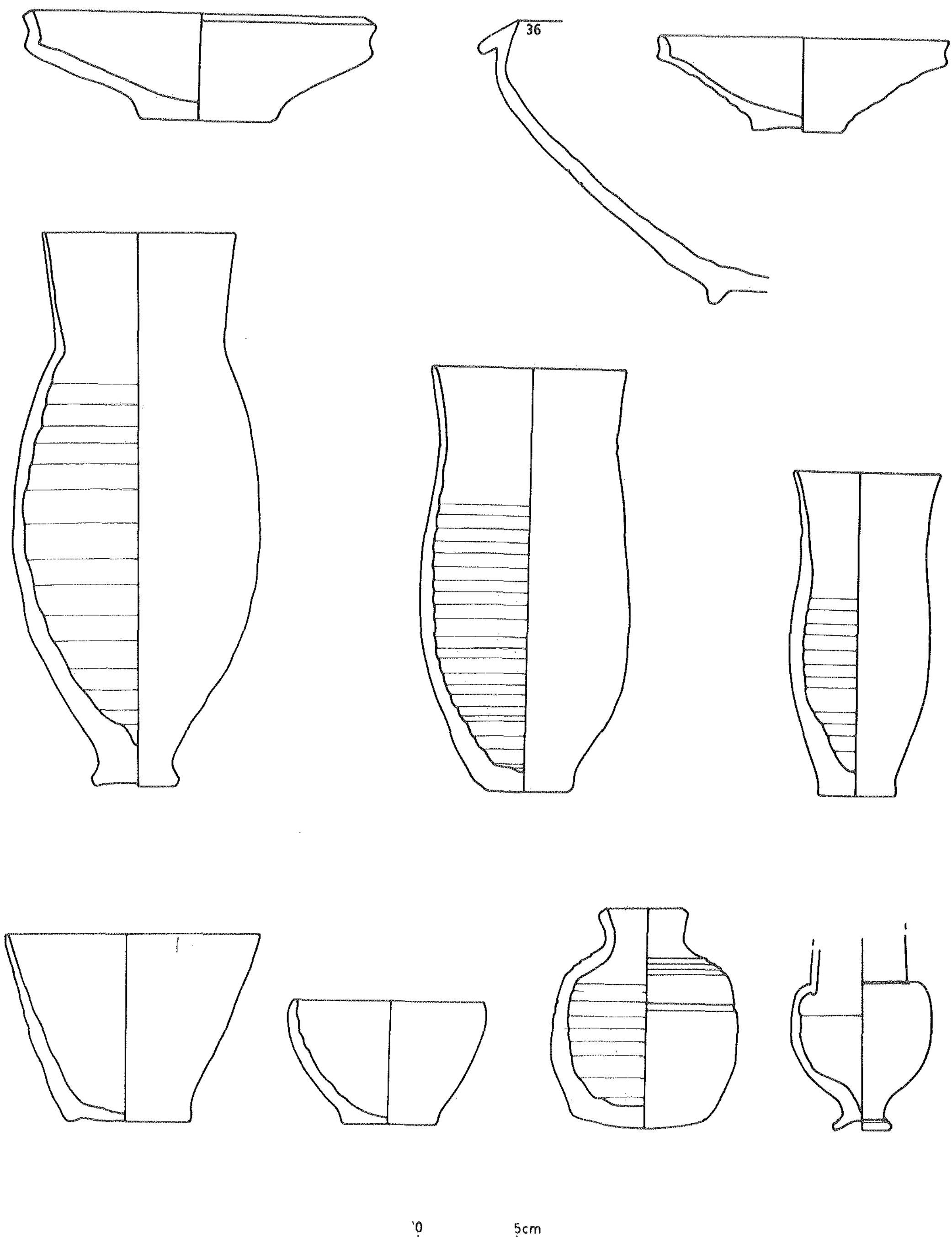


Fig. 2. Pottery from Tell ed-Der.

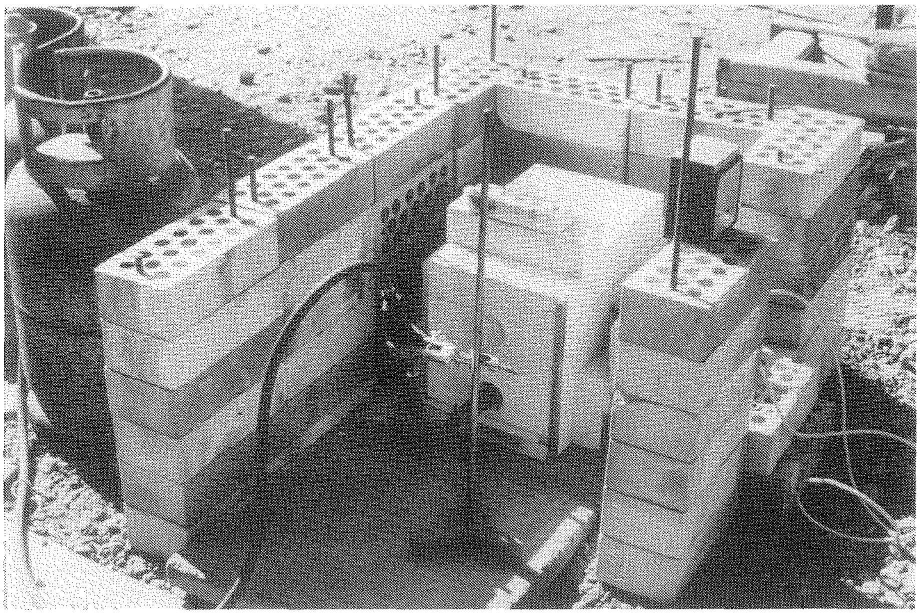


Fig. 3. Gas-fired test kiln for use in the field.

(2). Examination of clay samples

31 Samples from ancient and recent clay deposits were taken of Tell ed-Der and surroundings(9) and tested for their workability. In the field 120 test bars were made of them(10). Using the Munsell Soil Color Charts the colour of the test bars was recorded after drying and after firing in the test kiln at 700o C under oxydizing conditions. In addition, the firing shrinkage was determined. As a general impression of all clay samples the following was recorded: suitable/unsuitable for throwing, hand shaping etc. The results of these tests will be compared with the results of the technological analysis of the pottery.

(3). Experimental kiln firing

In addition to the gas-fired test kiln a small updraft kiln was built in the field, using local building material - stones

Fig. 4. Local fuel used for experimental kiln firing.

daubed with clay - and local fuel - shrub and palm leaves (Fig. 4). Purpose of this experiment was to see whether this local material was suitable for firing. After about three hours firing a temperature of ± 900o C was measured. The kiln functioning well, it seems useful to continue the experiment during future research work in Iraq so that test pottery made in the field of local clay can be fired on the spot under conditions more or less similar to these in antiquity. The clay samples can then be better selected with respect to

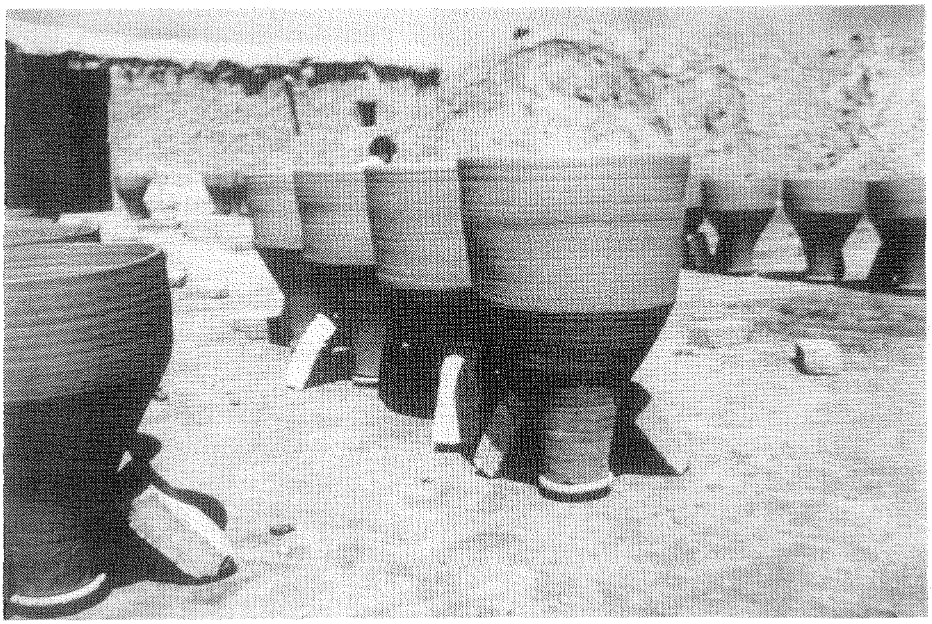


Fig. 5. Lower parts of water jars drying in the sun.

workability, as direct insight will be obtained in the firing properties. In addition clays used in the present-day potteries northeast of Baghdad can be fired in the test kilns for comparison.

(4). Brickworks and potteries northeast of Baghdad

A short first visit was paid to brickworks and potteries to the northeast of Al Thawra (situated in the north of Baghdad).

The bricks of the brickworks are of bad quality. They are soft, brittle and not able to stand up to moisture and frost. Because of the relatively low firing temperature the clays do not yield a good product. Firing at higher temperatures is apparently too expensive or too time-consuming. The softness of the bricks is probably caused by a combination of low firing and the presence of salt in the clay. In view of the salinization problem of the Mesopotamian clays, an investiga-

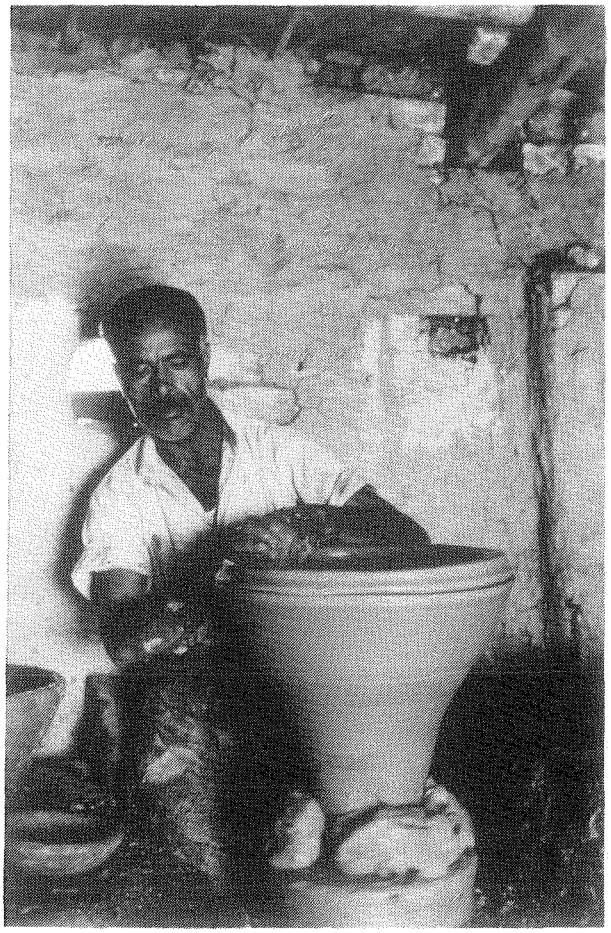


Fig. 6. Throwing the upper part of a water jar.

tion into the properties and composition of the clays used in the brickworks might provide interesting results.

The majority of the production in the potteries seems to exist of water jars (Fig. 5). These water jars are made in two stages: the lower part is thrown and put outside for drying in the sun. After drying it is brought to the thrower again and fixed on the wheelhead with a lump of clay. Then the upper part is thrown in three coils up to the rim (Fig. 6). The outside is scraped and finally decorated with a roulette wheel.

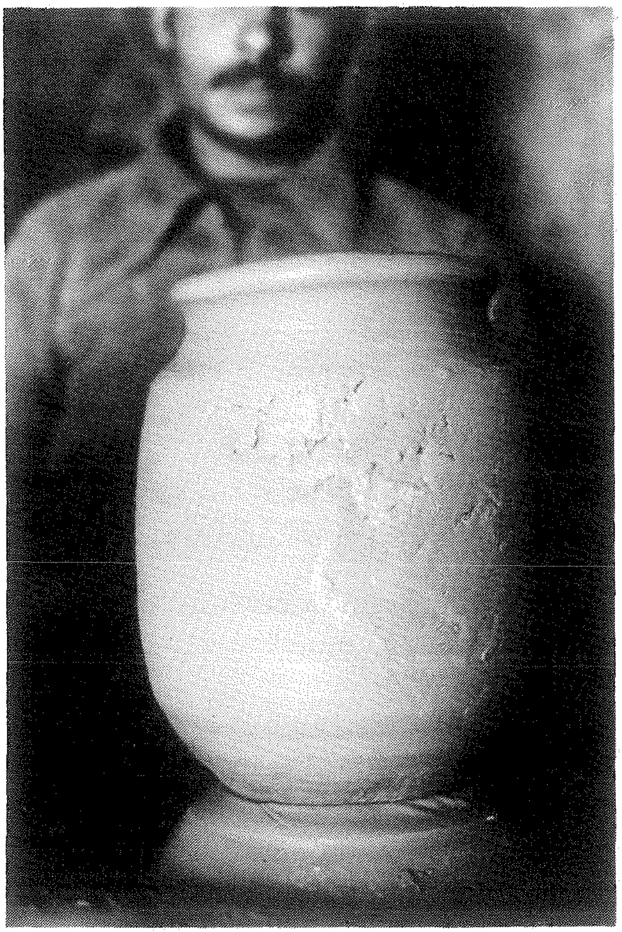


Fig. 7. Stretching traces.

The clays used in the potteries are not very plastic and not very cohesive. Consequently stretching traces easily occur (Fig. 7) and the pots easily crack while drying. This difficulty is prevented by adding a kind of white long-fibrous fluff. By "potreading" it was established that the clays used in antiquity caused the same problems and that they were met with by adding chopped straw probably from dung to the clay.

According to one of the potters 80 water jars are made in his workshop every day. The jars are fired in a closed chamber

Fig. 8. Closed chamber kiln near Baghdad.

kiln (Fig. 8). The crude oil, used as fuel, is thrown in the dug out fire chamber again and again.

Future research

At the moment the field data are being evaluated in the Department of Pottery Technology. The shaping techniques of the sample collection have already been analysed(11). Research on the raw materials used in antiquity and the clay samples will be continued. In connection with the salinization of the Mesopotamian clays the raw material research will concentrate on the possible influence of salts in clays used for making pottery. One of the future activities of the Working Group on Mesopotamian Pottery will be to study pottery from Tell ed-Der and from other sites in the field. For this purpose longer stay near the potteries northeast of Baghdad will be desirable.

The intended integrated technological/formal pottery classification will not be set up until extensive research has been carried out. Regular discussions will be held by the Working Group on the realization of such and integrated technological/formal pottery typology.

Notes

1. The Belgian Archaeological Expedition to Iraq is sponsored by the Belgian Committee for Historical, Epigraphic and Archaeological Research in Mesopotamia.
2. ± 2075 - ± 1625 BC.
3. around 1400 BC.
4. The research programme will initially be limited to the pottery from Tell ed-Der and the Northern Akkad Area. At a later stage the project will geographically be extended to the entire Mesopotamian area. Close cooperation with fellow archaeologists and the Department of Antiquities in Baghdad is necessary for the success of this research programme. For this reason the Working Group on Mesopotamian Pottery has been set up. The main activity of this working group is integrated research into the technological, archaeological and cultural-historical aspects of Mesopotamian pottery.
5. The shape classification is being prepared by H. Gasche.
6. It was not possible to carry out verification tests in the field. They were done in the Department of Pottery Technology, using clays from Tell ed-Der.
7. This kiln was made of fire-proof bricks. A pyrometer was used for reading the temperature in the kiln. The atmosphere in the kiln was determined with an oxyprobe.
8. The colours of the outside, inside and core of the test sherds were recorded according to the Munsell Soil Color Charts.
9. Samples from ancient clay layers, the so-called "rakubs" (ancient, partly Sassanian irrigation canals), clays from

an ancient Euphrates branch, and Palaeo-Babylonian clays from Tell ed-Der (5.00 m depth). The samples from recent clay layers belong to Euphrates depositions.

10. Four test bars were made out of each clay sample, if possible. Some samples were not suitable for making test bars. They were too loamy/sandy.
11. The results will be published in the Northern Akkad Project Reports.
12. An article on the raw materials is in preparation.

References

Franken, H. J. and J. Kalsbeek (1984), Some techniques used by the potters of ed-Der. In: L. de Meyer (ed.), Tell ed-Der IV, Leuven: 81-89.

Meyer, L. de, H. Gasche and R. Paepe (1971), Tell ed-Der I,Leuven.

Meyer, L. de (ed.) (1978), Tell ed-Der II, Leuven.

Meyer, L. de (ed.) (1980), Tell ed-Der III, Leuven.

Meyer, L. de (ed.) (1984), Tell ed-Der IV, Leuven.

Meyer, L. de, H. Gasche and M. Tanret (1984), Tell ed-Der,la vie en Babylonie il y a 4000 ans, Archéologia 195: 8-25.

H.J. Franken.

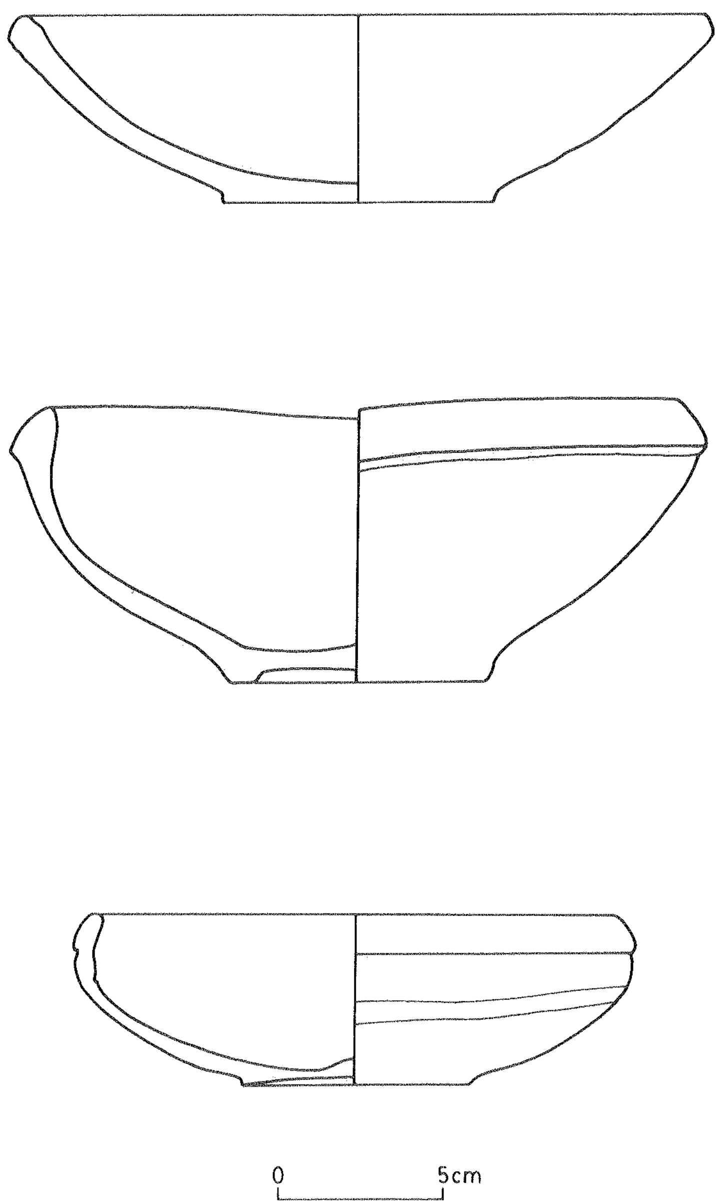
A CLASS OF IRON AGE BOWLS FROM JERUSALEM

Abstract

This article deals with one typological question. To illustrate this question the so-called Iron Age Bowls "B" from the excavations of the British School of Archaeology in Jerusalem on the Ophel Hill are used. These bowls were considered to form one class by the excavator, the late Dame Kathleen Kenyon. She devised a kind of "geometric" system of subdividing the bowls, for which she only used the bowl rims. The purpose of constructing such a system is described below as well as the question as to whether it fitted the type of pottery to which it was applied. Keeping in mind the original purpose of the system, a different approach is suggested which may produce better results.

Kenyon had only one, rather straightforward phenomenological approach to the study of shape development of pottery. The results of such a study were required to enable her to date her finds. She arranged the pottery according to a stratigraphic sequence, and made each stratigraphic unit as small as possible. A very finely divided stratigraphic sequence of earth deposits and their pottery contents was to reveal the slightest changes in pottery form.

In view of the great masses of broken pottery excavated in Jerusalem, Kenyon needed a standard description of shapes. She had already developed such a standard description for her excavations at Jericho (Kenyon & Holland 1982), but she did not use the Jericho criteria for the Iron Age pottery of Jerusalem. She omitted some aspects and concentrated entirely on the shape of the rim. She defined the bowls "B" as "bowls with thickened rim, small", and divided the class into nine subclasses, each of which she subdivided again. Fig. 1a is a "prototype" of these bowls B and fig. 1b and c are two shape examples. Five subclasses are described below.



a

b

c

Fig. 1. Prototype of bowl B (a) and two shape examples (b, c).

Subclass B 1, triangular, thick, rounded (see fig. 2).

- a. convex externally, square base of rim externally.
- b. curved externally, rounded base of rim externally.
- c. straight internally, rounded base of rim externally.
- d. straight internally, square base of rim externally.
  - d.1. sharper and more pointed than d.
- e. thickened projection at lip internally, square base to rim externally.
- f. rim thicker at top than at base, incurving, no ridge externally.
- g. deep fold on outside, sharply undercut.

Subclass B 2, triangular, thick, pointed.

- a. straight internally, square base of rim externally.
- b. straight internally, rounded base of rim externally.
- c. curved internally, square base of rim externally.
- d. convex internally, rounded base of rim externally.
- e. bulging inward internally, square base of rim externally.
- f. rim straight internally joining exterior wall with projecting pointed ridge.
  - f.1. less pointed at lip than f.2.
  - f.2. holemouth bowl, tapering and pointed lip.
- g. rim straight internally, overhanging ridge base of rim externally.

h. straight internally, external groove at wall, rim has obtuse angle between groove and lip.

j. wall straight, lip thicker and more rounded.

k. holemouth jar, straight wall, lip almost flat.

l. holemouth jar, burnished, sharp flat lip.

Subclass B 3, triangular, thin, pointed.

a. straight internally, square base of rim externally.

b. curved internally, vestigial ridge at join of wall externally.

c. straight internally, sloping base of rim externally.

d. curved internally, sharp lower edge of external fold.

e. straight rim, shorter fold than 3a, burnished both sides.

f. oval in section, pointed on top, deeper collar than 3b.

Subclass B 5, oval, thick, pointed.

a. straight internally, ridged base of rim externally.

b. straight internally, round base of rim externally.

c. curved internally, round base of rim externally.

d. rim curves in, lip curving back internally and externally.

e. sharply undercut at outer base of fold, on inside the wall of rim has convex curve.

f. similar to 5e except that outer fold is not

sharply undercut, inside wall of rim has
convex curve.

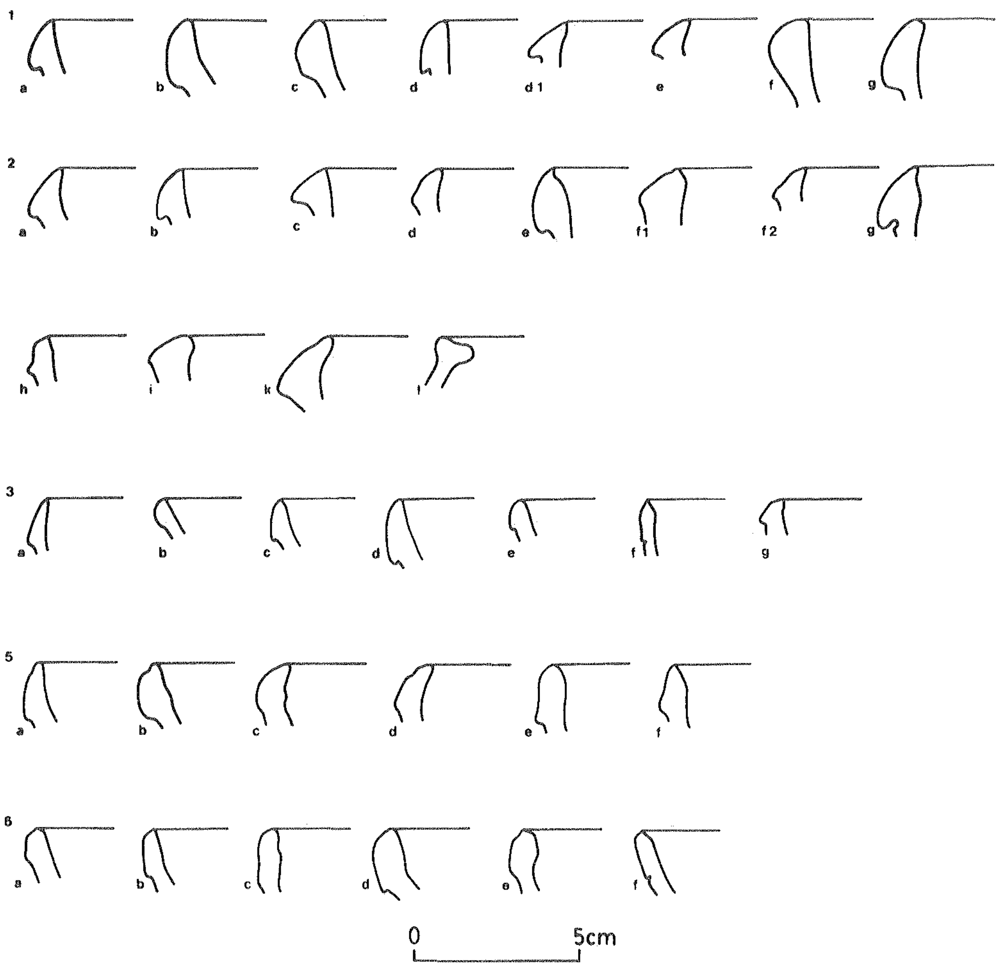


Fig. 2. Subclasses B1, B2, B3, B5 and B6.

Subclass B 6, oval, thin, rounded.

a. curved internally, rounded base of rim externally.

b. straight internally, rounded base of rim externally.

c. straight internally, ridged base of rim externally.

d. curved internally, ridged base of rim externally.
e. more rounded internally and externally than 6a, definite outer lower ridge.
f. thicker near lip, very slight indication of outer base of rim.

Including the subclasses B4, B7 and B9, Kenyon came to a total of 66 rim types, leaving the classification open so as to add more shapes, if required. The impression one gets from her system is that it is straightforward and linear. The rims are triangular or oval, thick or thin, pointed or rounded and each rim meeting the "oval, thin, rounded" description of subclass B6 can be attributed to one of the six subdivisions of B6, or, if the discriptions listed under B6, a - f, do not apply, to an additional subdivision "g". Hundreds of bowls B that were excavated were identified under this system and written up on type cards in the pottery files and on phase cards showing the stratigraphic sequence. This was done under high pressure of time in the field. As soon as Dame Kathleen had studied and written up the stratigraphy of an excavated site the registrar was given the stratigraphic list, whereupon all the pottery kept for registration was described. The bowls discussed here are only a small part of the total amount of pots and sherds registered and still to be registered.

Kenyon s system could be tested with large quantities of sherds still waiting to be written up for those squares that were not stratigraphically studied. In this respect much preliminary work has been done by J. Kalsbeek and the present author on similar materials excavated by the British School at tell es-Sultan (ancient Jericho) (Franken 1974). A large quantity of rims were studied and it appeared that the linear arrangement could not be maintained. The differences between triangular/oval, thick/thin and rounded/pointed lips appeared to be gradual only with many "transitional" stages. It was usually possible to apply the description of four or more of Kenyon's "type sherds" to one and the same sherd. The sherds of the type series themselves could be arranged in such a way that almost every single one of them had features in common with more than two other sherds in the series which in Kenyon's linear arrangement were far removed from one other. This defeated the purpose of her system.

The rim-shape variety in the bowls "B" may have been caused by many quite different circumstances which are discussed below.

It was found that two different clays were used by the Jerusalem potters to make the bowls. One is very common and the other is rare. The clay most used is a red clay, which by nature, is full of microfossils, at least 1000 - 1500 per cm2. The other clay burns from very pale brown to yellow and contains by nature extremely fine calcite grains, more than 1000 per cm2. Sometimes these two clays were mixed. Potters using the red clays added non-plastics as temper, mostly lime sand but also quartz sand or even a blend of the two. The yellow clay was occasionally mixed with quartz sand temper. For various reasons it is assumed that both clays originate from the immediate vicinity of Jerusalem. In a prepared state the clays did not cause any problems to the potters. They dried quickly but were not fit for throwing. The bowls were made on a small hand-operated turning base or tournette. The potter first prepared a number of clay balls of the required size for each item. Then he took a ball, fixed it on the wheel head and shaped the bowl, leaving the lower part rather thick. Only half way up the height to be obtained he gave the wall of the bowl the required thickness, but quite often he made the wall thicker again near the projected rim. The rim was thickened by pushing clay down (see fig. 3). The pot was turned round several times before the rim was finished. Clay

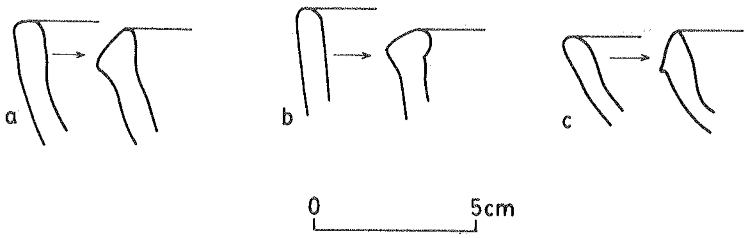


Fig. 3. Thickening the rim by pushing clay down.

was pushed down several times as shown in fig. 4. Sometimes the potter left the bowl at this stage with the folds of the clay visible on the outside at the base of the rim. Clearly, it was not possible to put much downward pressure on the upper edge of the rim which might otherwise easily collapse. Fig. 4b shows that the potter, while pressing down clay sideways to the outside, could unintentionally push the lip somewhat down on the inside, thereby making it more pointed.

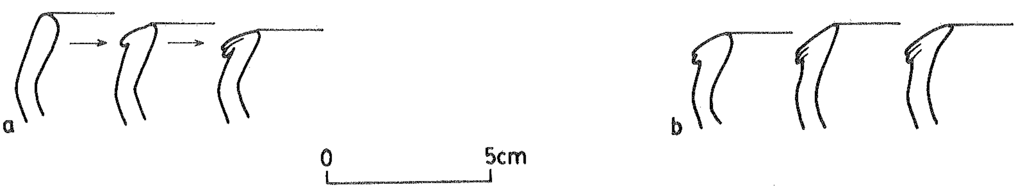
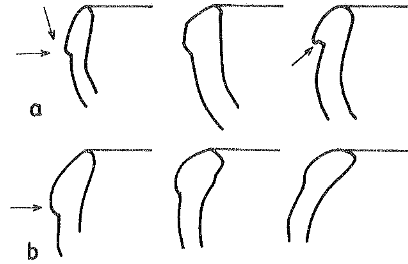


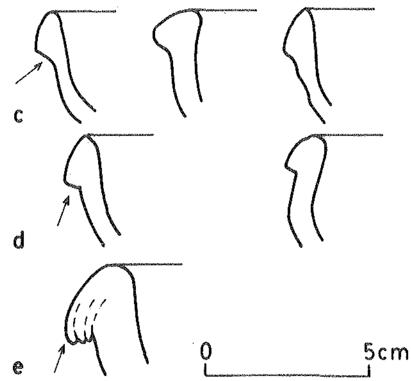
Fig. 4. Pushing clay down several times.

The potter usually gave the lower outside edge of the rim a finishing treatment (Fig. 5), such as by:

a. downward and horizontal pressure against the wall.

b. horizontal pressure to smooth the edge against the wall.





c. pressure sideways from below.

d. using a rib to make a straight edge, but

e. a straight edge may also consist of some ends of the folds.

Fig. 5. Finishing treatment of the lower outside edge of the rim.

As long as the potters used the type of clay paste described above and applied the above method of shaping the rim, any of these treatments may have been applied at any time as long as these bowls were produced. The type of finishing method may well have been characteristic of each individual potter. Some potters may always have used the rib while others never did.

Dame Kathleen did not take into account the position of the wall just below the rim. This is, however, an important feature, if one is to get a general impression of the shape of the complete bowl (see Fig. 6).

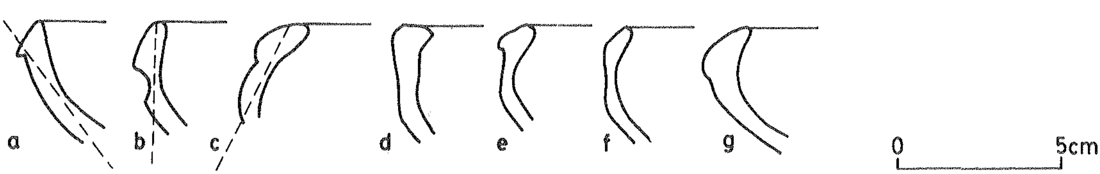


Fig. 6. Position of the wall just below the rim.

A study of sherds by the author showing this feature resulted in a scheme for a typological division (see Fig. 6, a-g). This scheme illustrates that a simple division into the types a, b and c did not suffice here, as several sherds have shown that bowls curving in on the inside did not curve in on the outside (see "types" d-g).

Some archaeologists have divided the larger fragments and complete shapes of the bowls "B" into two types: "carinated" bowls and bowls with a curving wall. This is, however, disputable, as the presence of carination may again be due to the work of some individual potter or just to chance. After completing the bowl the potter used a wire to separate the

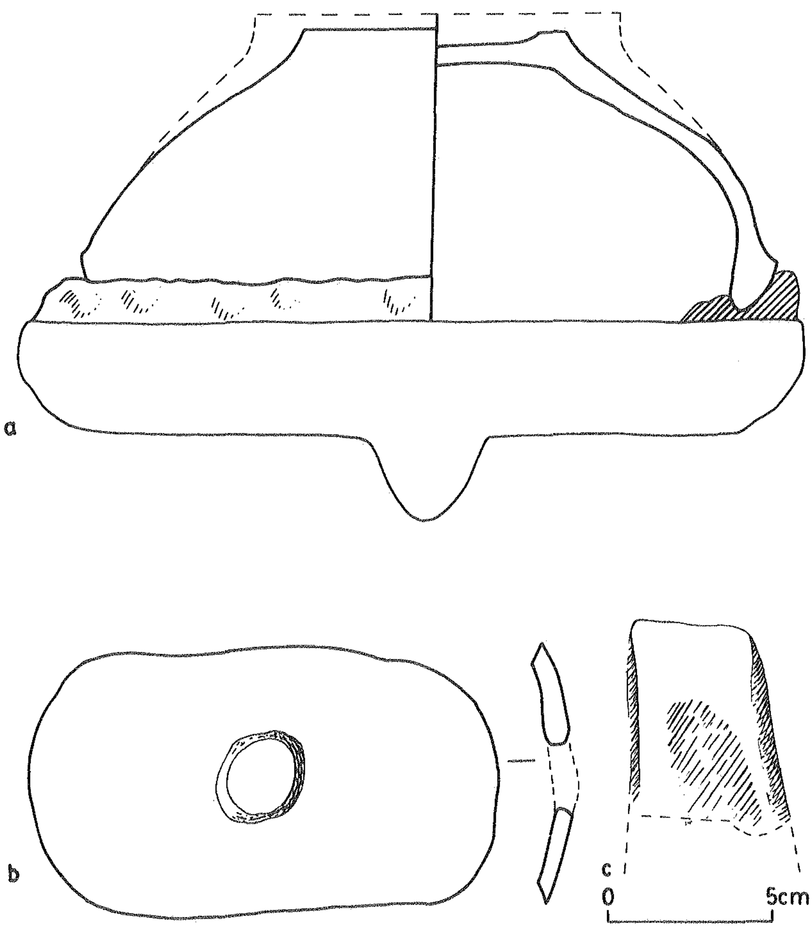


Fig. 7. Finishing the bowl.

bowl from the wheel head. The bowl was then put aside to dry. When the upper part, being thinner than the lower part and therefore drying more quickly, was dry enough to carry the weight of the wet lower part, the bowl was put back on the wheel head in an upside down position and centred. The potter used a wet clay roll to keep the bowl in position (see Fig. 7a. He then shaved off surplus clay from the lower part of the wall with the aid of a rib, thus giving the base its final shape and the entire bowl a reasonably even wall thickness. He may have used a potsherd (see Fig. 7c) for this purpose, or the rib of an animal, or a special rib provided with a finger hole for better grip (see Fig. 7b). Quite often pottery ribs are found on excavations. Clay is a highly abrasive material and the edges of such pottery ribs always show traces of wear. The rib left clear marks on the outside lower half of the bowl. By studying the larger fragments and complete shapes it was found by the author that in some cases these traces are only visible well below the rim or even nearer to the base than to the rim. In most cases, however, they appeared to stop nearer to the rim or even quite close to it. By using a rib (Fig. 8a) the potter

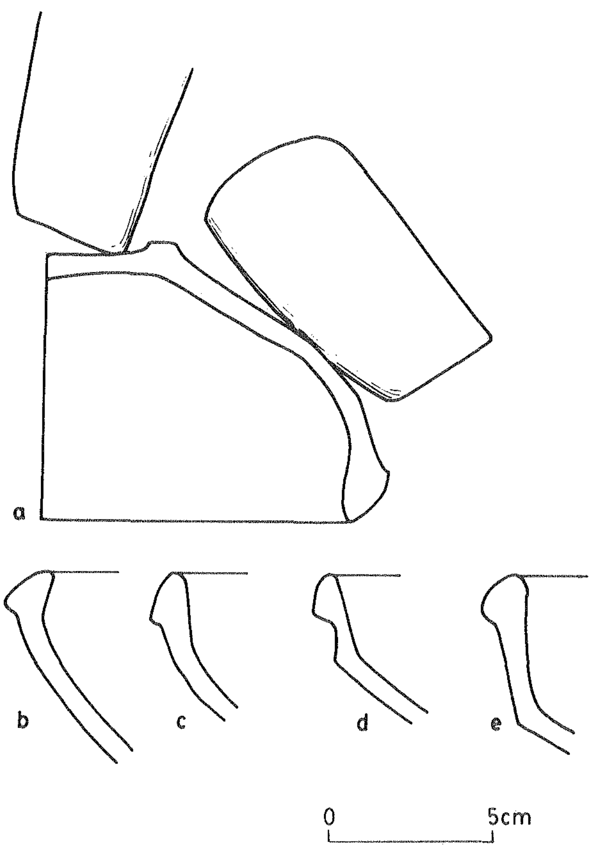


Fig. 8. Scraping of the wall.

could give the bowl a fairly straight wall (Fig. 8b), a curved wall (Fig. 8c), a carination near the rim (Fig. 8d), or a carination lower down the wall (Fig. 8e). The ultimate shape depended on the original thickness of the wall before scraping, which may have varied with the degree of wetness of the clay paste used by the potter. This original thickness of the wall was obviously necessitated by the "weak" or probably "sloppy" nature of the prepared paste which also explains the treatment of the rims.

From this it can be deduced that a high degree of uniformity of the final shape of the bowls "B" cannot be expected. A straight, a rounded or an angular wall was not necessarily made straight, round or angular on purpose. The paste used only allowed for a remote degree of precision in shaping. In addition it should be taken into account that individual potters had their own practical way of making these bowls.

To all intents and purposes there seems to be only one way in which archaeologists can classify the bowls. Their shape was the result of a fixed set of "steps" taken by the potters from the moment they started to make clay balls. They all followed the same steps in a fixed order and the result was the "Bowl B". But within these limits they made shapes that were all individually different. In technical respect they were a long way away from producing repeat items.

In her study Dame Kathleen only looked at the shape of the rims. Very many fragments consist of a rim only and this may have been a reason for her to work with the rims only. Many sherds, however, allow a detailed study of other features, such as:

1. the position of the upper part of the wall.
2. the wall: straight, rounded or angular.
3. the diameter of the bowl.

4. the temper groups.
5. the shape of the base.
6. slibs that were used to cover the inside of the bowl.
7. burnishing.

For the purpose of classification not all the features as listed above are equally important. The diameter of practically all bowls is 12 to 24 cm. This range can be divided into six groups, 12 - 14 cm, 14 - 16 cm, etc. This division is useful to see what the most frequently used sizes were. Quite important are the temper groups, because they may very well point to different workshops. The bowls appeared to contain different non-plastics. Furthermore, it was found that, after a certain point in the stratigraphic sequence, quartz sand was not used anymore as a temper. Thinslides have already been made to identify the non-plastics, and large quantities of sherds are now being processed according to the system described in Newsletter I, p. 6. With this system statistically reliable samples can be obtained in a quick and fairly accurate way. For a detailed study of the temper groups of the bowls "B" other pottery classes of the Jerusalem excavation will have to be examined as well.

The system of subdividing the bowls "B" into subclasses as devised by Kenyon has now been replaced by a system based on three aspects of the manufacturing methods, and three rather subjective elements of the rim shape. The number of 66 shapes has been reduced to 20. The new system (see Fig. 9) is described below.

The letters A and B represent clearly pointed rims, C and D rounded rims. A and C have a flat rim base, B and D a rounded base. The columns 1 and 4 show rims which are "vertical" along a line drawn from the lip to the point where the rim merges into the wall. The columns 2, 3 and 5 represent oblique rims according to this line. The columns 1 and 2 include clearly

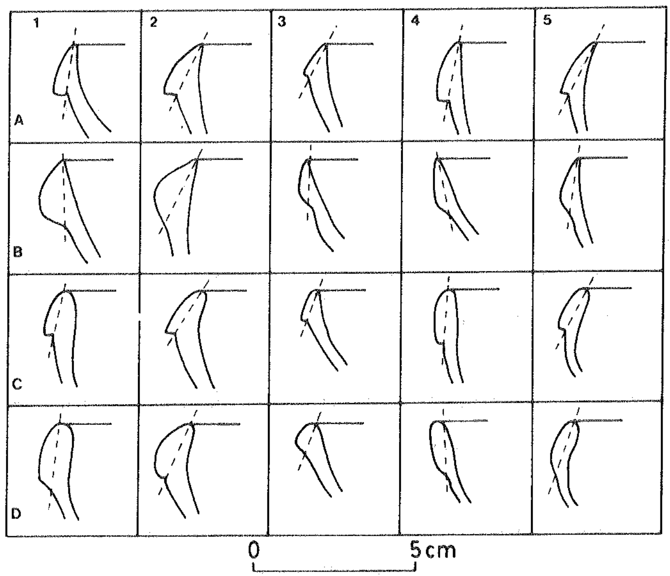


Fig. 9. System of subdividing the bowls "B" into subclasses.

thickened rims which form the normal pattern. Column 3 in which B3 is an exception as being vertical, which is very rare, represents very slightly thickened rims. The columns 4 and 5 show thin rims, usually thinner than drawn here, and usually less than twice the thickness of the wall.

This system is far more manageable than Kenyon's scheme. A test with about one thousand rims has shown that types belonging to the columns 4 and 5 increased in quantity as production of the bowls continued, whereas the types shown in columns 1 and 2 were common at the early stages of production, and type D2 occurred most frequently. In the stratigraphic sequence no noticeable shift could, however, be observed in the total numbers within the vertical columns. When sorting out these sherds during the test a subjective element remained but it was found that the criteria described above - three elements of the manufacturing combined with three observations of rim thickness - helped greatly in accuracy and in speeding up the processing of the sherds, which included the determination of non-plastics added to the sherds. Right through time there was a tendency to make the rims more oblong and thinner, to make smaller diameters and thinner walls, or, in short, to make more delicate bowls.

The original typological system did not fit the type of pottery to which it was applied. It was based too much on a standard production system. When testing Kenyon's system, it often appeared that the two ends of a large rim fragment, when taken separately, could be attributed to more than one subclass. The profile of the rim of one bowl may show differences.

The analysis of the production methods of the bowls "B" has produced some usefull results. The bowls are the result of a coherent set of steps taken by the potter. Other classes show a different set of steps. The production method was such that repeat items did not occur; every bowl had its own individual appearance. The finishing touches given to the bowls by the potters may be used by the archaeologist to bring some order in a vast quantity of sherds, but may not allow him or her to draw definite conclusions. The original system of subdividing the bowls suggested a degree of reliability which is not warranted by the material. The preliminary results of the study of the temper materials showed that there must have been several production centres or workshops; at least two workshops could be distinguished, where only a limited number of pottery classes was made. It now seems that the final study of the statistical evidence obtained from the study of the various aspects discussed above will lead to a better understanding of the chronology of this pottery.

References

Franken, H.J. (1974), In Search of the Jericho Potters, Amsterdam.

Kenyon, K.M. and T.A. Holland (1982), Excavations at Jericho, Vol IV, BSAJ, Chapter V.

M. Beatrice Annis

ETHNOARCHAEOLOGICAL RESEARCH WATER VESSELS IN SARDINIA

I. Traditional production

II. Recent transformations

III. Defining stability and change - a conclusion

I. TRADITIONAL PRODUCTION

Introduction

In Sardinia there were, until the beginning of the 1960s, ten production centres of terracotta ware. On the island as a whole we may speak of a single technical and formal tradition, but in the separate villages the activities were carried out according to different organizational forms connected with the varying environmental and socio-economic conditions: urban and rural workshop industry; individual workshop; household industry (Peacock 1982: 6-11).

As to the roles of the various centres, these are not always well differentiated. It is rather a question of an equilibrium, sometimes subtle and not without mutual influences which are especially apparent in the formal aspects of the production and in interferences in the respective areas of distribution. On the whole, we are dealing with a modest activity, in conformity with the context in which it had to develop (Annis 1983). A comparison with other productions showing similar organizational forms elsewhere in the Mediterranean (Lisse and Louis 1956; Hampe and Winter 1962, 1965; Combès and Louis 1967; Vossen 1972; Llorens Artigas and Corridor Matheos 1974; Cuomo di Caprio 1982) accentuates the limitations of the Sardinian ceramic industry.

In the Sardinian terracotta production as a whole the water

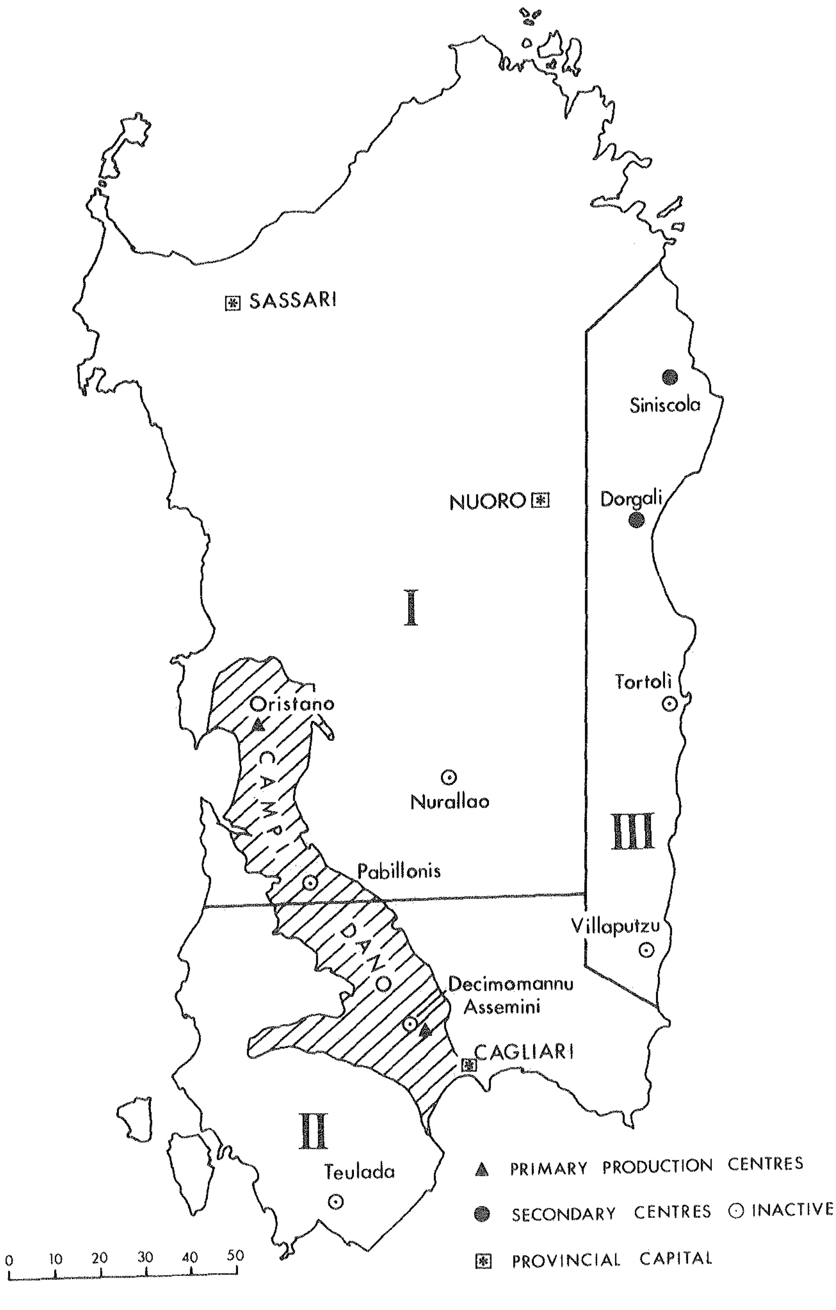


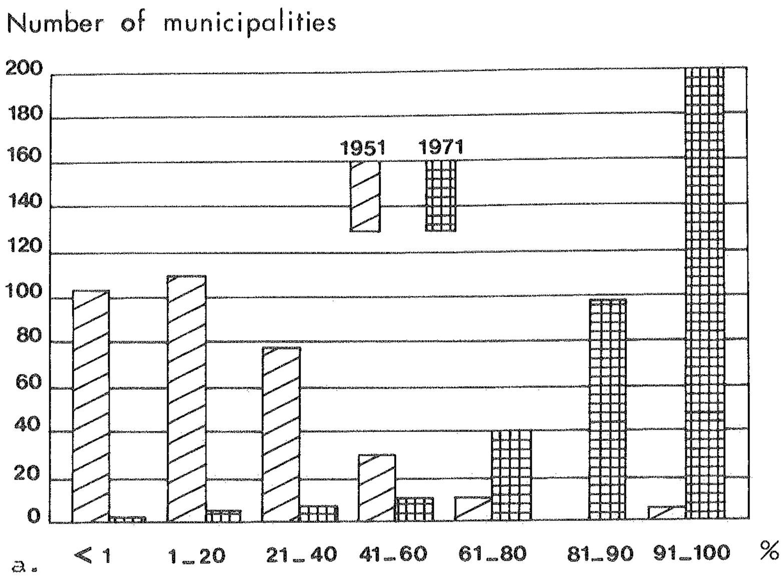
Fig. 1 : SARDINIA, distribution areas of watervessels
I. mainly Oristano; II. mainly Assemini; III. mainly Dorgali and Villaputzu

vessels occupy a predominant place. Not only do they constitute the bulk of the productions of Oristano and Assemini - the largest centres as regards the number and the mode of organization of the craftsmen, the output, and the range of distribution - but they are also manufactured in the other centres. Of these, Dorgali and Villaputzu produce considerable quantities and for a wide area of distribution (Fig. 1).

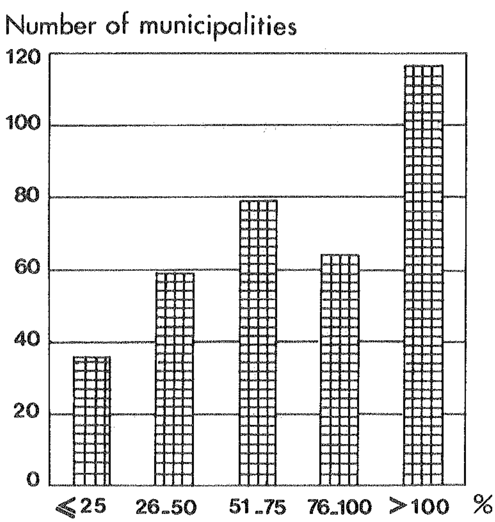
Environment

The causes of the predominance of the water vessels in Sardinia are, as I have previously pointed out, in the first place to be found in the environment: the hydrographic conditions of the island where, owing to a concurrence of morphological and climatic factors, utilizable water is scarce and of poor quality (Annis 1984). According to the social geographer Maurice Le Lannou (1941: 147), there are also historical factors besides the mentioned environmental ones. From the Middle Ages onwards the availability of water does not seem to have played and important part in the formation of settlements, either nucleated or scattered, so that in most cases the sources lie at a considerable distance from the dwellings. After the decay of Roman aqueducts, which, however, served a type of settlement completely different from the successive medieval one (Meloni 1975: 201-98, Plate I), little was undertaken to improve the island's water supply until the period 1950-1970. Even today (Brandis 1982) these problems cannot be considered solved (Fig. 2).

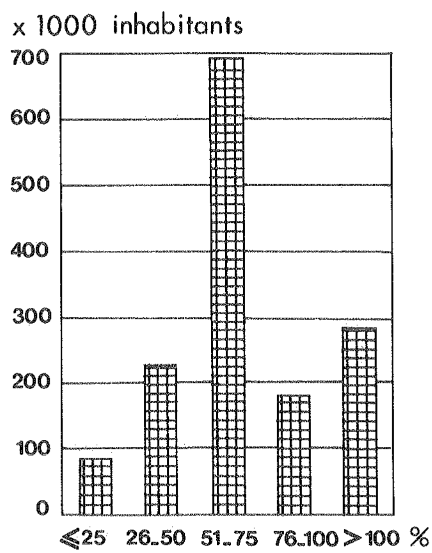
The water vessels, present all over the island and in much larger quantities than the other ceramic products, constitute archaeological evidence of the described situation. Other material evidence is to be found in the traditional domestic architecture. In the kitchen or its annexes a special area is reserved for the jars containing drinking water. Here a thick stone lies on the ground (sa pedra de sas brokkas: "the stone



a.



b.



c.

Fig. 2a. Development of the water connections in the houses.
2b. Percentage of sufficiency of water supply in the separate municipalities.
2c. Division of the population according to the percentage of sufficiency of water supply. (from: Atlante della Sardegna, II, 1980: plates 72-73; p. 244 fig. 2.).

of the jars") or is supported by one or two small pillars like a bracket or a table (sa strada de sas brokkas: "the shelf of the jars") (Manconi and Angioni 1982: fig. 218). The stone is hollowed out to form a shallow basin into which the vessels are placed. A narrow duct lets the water oozed from the jars drain away and be collected again. A third possibility is that the vessels are arranged in a niche in the wall (sa fentana de sas brokkas: "the window of the jars") (Mossa 1957: 70; Angioni 1976: Plate 23).

The archaeological identification of the function of the described areas and objects is only possible if vessels are discovered "in situ". If this is not the case, we may still have the specific names of the vessels and the historical records. Another non-material sign of the importance of water in traditional Sardinian society is to be found in the wedding ceremonies. In the prescribed order in which the household goods are to be carried into the couple's future home, the water vessels, as a sign of the woman's first task, are assigned the first place immediately after the augural gifts alluding to subsistence that are presented to the bridegroom: a basket of seed-grain, a cup of wine and a white egg-laying hen. Sayings and proverbs, prayers, processions and magic rites invoking the rain are known from the past and the present agro-pastoral society of Sardinia (Barbiellini Amidei and Bandinu 1976: 102; Atzori and Satta 1980: 115-116). In geographical and historical sources there is often mention of the rows of women taking their jars along with them to refill them at the springs, rivers, wells and reservoirs. There are also numerous representations in regional art of women bearing water vessels.

This need, originating in an environmental situation, is thus reflected in a series of material, linguistic, ethnological, literary and figurative data that may constitute an assemblage of perceptible evidence to be used in the archaeological interpretation of the function of these vessels in their context (Stiles 1977: 93; Binford 1983: 19-30).

Of the production centres of terracotta ware in general, and of water vessels in particular, Oristano is by far the most important both as regards its output and its extensive area of distribution. It is also the only centre enjoying the rank of a town in which, besides five other guilds, there was, from the end of the seventeenth century onwards, also a potter's guild (Virdis 1960): 4). The mode of production can be defined as "urban workshop" (Peacock 1982: 9 and 38-43). The abundance of clay and fuel in the vicinity, the geographical position favouring commercial contacts and the town's economic function as an important agricultural centre are all conditions favouring the development of a manufacturing activity. But according to consumers information, the supremacy of Oristano in ceramics is first of all due to the quality of its water vessels. These not only keep the water cool or even cool it, but also purify it and keep it fresh for a long period of time. In this journal I have in the past discussed the physical (degree of permeability of the vessel) and chemical (ion-exchange between the liquid and the clay wall) qualities that originate from the raw material and from the manufacturing process (Annis 1984) and cause the Oristaneian vessels to surpass all the others.

According to the potters information, which has been confirmed by research that is being carried out in this Institute and of which a preliminary account has recently been published (Annis 1985), the clay of Oristano imposes limitations on the potter in his work at the wheel as well as in the firing of the pots. The result is indeed a relatively weak and quite permeable product. Other centres, such as Assemini, Dorgali, Villaputzu and Nurallao, having at their disposal more plastic clays requiring a longer firing time

(Hamer 1983: 121, 226), produce pots that are more compact, harder, and far less porous. From a ceramic point of view, these are therefore better products, but, viewed from the angle I have defined the function of a pot, these vessels are much less efficient. This also points to the relative importance of the technical properties of a vessel when assessing its performance in a given context (Shepard 1965: 362; Balfet 1973; Peacock 1982: 24). The functional qualities of a vessel can be determined according to parameters that are considered indispensable in order to obtain a certain function. For cooking vessels this has been demonstrated by the technological researches conducted by Rye (1976), Steponaitis (1984) and Bronitsky (in press). The functional qualities of water vessels are determined by the chemical composition of the wall of the vessels, as regards the ion-exchange, and by the degree of permeability of the vessels, which is related to both the properties of the raw material and the manufacturing techniques. The third functional quality of these vessels, their ability to keep the water fresh, that is, the antibacterial function in which the Oristaneian vessels excel, also appears to be connected with the composition of the clay wall(1).

Shapes

The water vessels are usually produced in three different shapes. These shapes are the same in the various centres in which the vessels differ only in details. From a formal point of view we may therefore speak of a single tradition all over the island. The three shapes are: the two-handled jar, the barrel and the flask (Fig. 3).

The two-handled jar is by far the most important of not only the group of water vessels , but also of the entire range of shapes. At Oristano and Assemini, the two main centres, it constitutes approximately 50% of the entire production. This

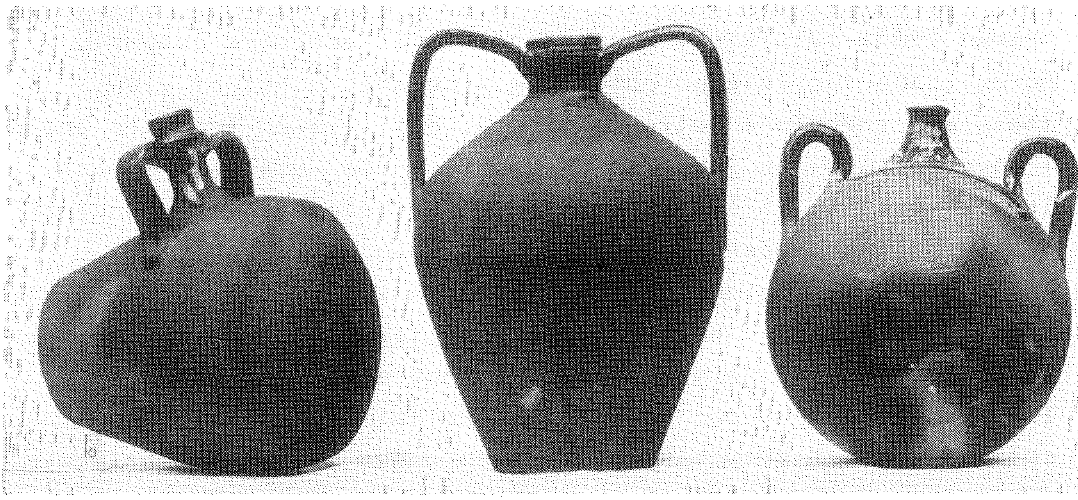


Fig. 3. Water vessels: barrel; jar; flask.

shape displays the most variation and the largest range of capacities. Until the 1950s, that is, before substantial measures were taken to improve the island's water supply (Atlante della Sardegna 1980: 226-248; Plates 72-73), the jar formed part of the domestic economy of every household, ranging from the shepherd's hut to the homes of the "signori", whose occupations involve neither farming nor sheep-herding (Angioni 1974).

The barrel and the flask together account for approximately 10 to 12% of the entire production. Their use is limited to the countryside. The barrel is used especially in areas abounding in corn cultivation, in particular on the plain of the Campidano and on the cultivated table-land adjoining it. It is transported by cart, packed in baskets filled with straw and is used especially at harvest-time. The flask is used prevailingly in pastoral areas, but it is also found elsewhere. It is transported on the backs of animals or across one's back.

The finish of these vessels consists of a touch of green or brown lead glaze around the neck and the top part of the handles, which only at Oristano is applied over a coating of white engobe.

Within the range of each single shape, the pots produced at Oristano show the most variants. This is related to the centre's large area of distribution. The Oristaneian jar par excellence has a biconical body, a short, cylindrical neck and flat, widely curved handles. This is the most-produced shape (70-75%). It is distributed in the first place to villages in which the water is obtained from rivers or from wells and reservoirs. The specific name of one of the most common sizes, the brottikku de funi = "rope jar", indicates that this jar was tied to a rope and then lowered into the river. Into wells and reservoirs, however, metal buckets are lowered and, in order to be able to pour the water from the buckets into the jars, the latter have to have a fairly wide neck (Figs. 4 and 10).

Two variants make up 25-30% of the total. These are produced according to the special demands of a few regions. Various villages in the centre and in the mid-west, situated in mountainous regions where the springs are shallow and not powerful, require a squat shape with a short base, a wide belly and a tapering neck (Fig. 5). On account of the poor cohesion

Fig. 4. Oristano: water jar, cylindrical neck.

and plasticity of the clay of Oristano, this shape demands a certain technical skill, with which not every potter is familiar. The second variant is required in the north: it has a tubular neck just like or resembling that of the barrel, and, consequently, corresponding handles (not flattened at the bottom, but leaning on the belly which, in the case of particularly large pots, are reinforced by a stirrup) (Fig. 6). The reason for this demand lies in the habit in these villages of taking a jar rather than a barrel along into the country(2) As it is transported by cart and is then left out in the open or in huts, it is essential that the jar can be firmly corked. This variant is also found in the upper part of Campidano, where it is used for the purpose of supplying drinking water in the huts of the transhumant shepherds coming from the same regions in the north.

At Oristano the barrel also shows a variant that bears witness to interferences between two different areas of distribution. A few villages in the southern part of the Campidano and in the adjoining cultivated table-land to the east require a vessel similar in shape to that of the barrel from Assemini. On account of the particularly calcareous water in that region, these villages, situated on the southern boundary of Oristano's area of distribution and geographically closer to Assemini, have a preference for the Oristaneian vessels where their function is concerned, but for their use they prefer the shape from Assemini.

Besides their quantity and the variety in shapes and sizes, another sign of the importance of the jar, that can be observed in all the centres of production, is the ceremonial function acquired by this vessel when it is not intended for sale and for use, but to be given away as a show-piece: a large size, three or four handles, a rich incised and plastic decoration and abundant glaze on the outside are the general

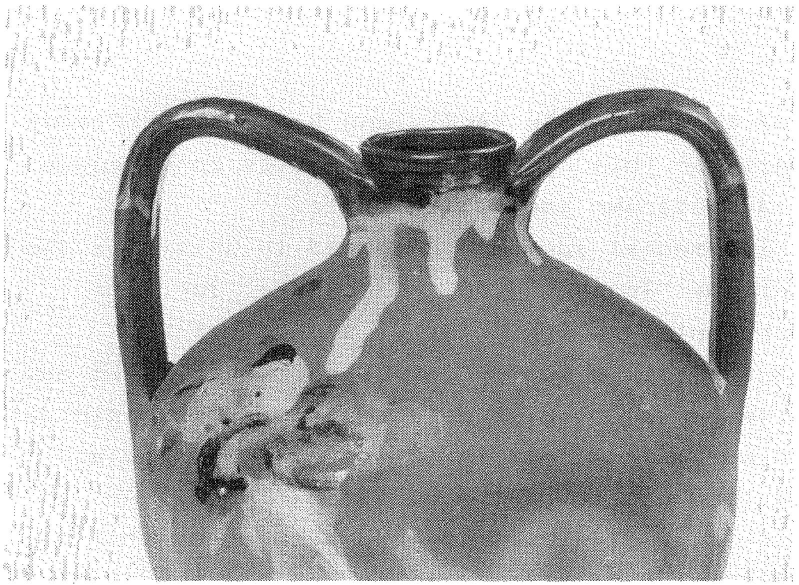


Fig. 5. Oristano: water jar, tapering neck.

Fig. 6. Oristano: water jar, tubular neck.

characteristics of these vessels (Arata and Biasi 1935: Plates CLXXI, CLXXIV). Also in this respect, Oristano is conspicuous for more variety and its own decorative style.

Two different ceremonial jars are produced in Oristano: the "bride's jar", and the "four-handled" or "ornate" jar. The first is a gift presented to the bride by the potter who supplied her with her entire set of domestic crockery that may include up to 60 vessels. The gift in question is an ornate jar usually decorated with floral motifs incised in the clay and applied in relief, and glazed on the outside (Fig. 7). An object that is much more difficult to manufacture and that is therefore the prerogative of a few families of old tradition, is the "four-handled jar", characterized by a decoration in the round. This vessel is produced in the wintertime, when the pressure of the ordinary work is less (Arnold 1985: 92). The

Fig. 7. Oristano: "bride's jar".

"ornate jar", bearing the name of the potter who made it, is offered to important persons whose social rank may range from fellow craftsmen to politicians, farmers or foreigners. The decoration - often entire scenes with a religious, historical or symbolic contents and populated with numerous figures - consists of elements mounted on clay pins that are stuck through the wall of the unfired pot and attached with slurry that is reinforced by the glaze during firing. Taking into account the rather rudimentary techniques of the Oristaneian potters, the production of these vessels involved a fair amount of risk, because they took a long time to make and were fired once. Two standard motifs are: winged figures and festoons composed of clusters of coils (Fig. 8).

I would like to make a few comments on these vessels and on the general character of the pots. Whereas the motifs used in the decoration of the ceremonial jars of the other centres do not differ much from those generally found in other forms of popular art in Sardinia, such as carvings, and even more so in the festive bread (Cirese et. al. 1977), there seems to be nothing resembling the decoration of the Oristaneian four-handled jar on the rest of the island or indeed elsewhere in the Mediterranean. This is the reason why the Oristaneian ornate jars have been regarded as the representatives of a "continuation" of ancient Greek and Italic decorative traditions (Arata and Biasi 1935: 100-102), particularly of the pots with plastic decoration dating from the Hellenistic period (end fourth/end second century BC) that characterize the production of Canosa di Puglia (EAA II: 315-318; Van Wonterghem-Maes 1968; Genava 1978: 141-169). Considering the difference in time and space between the two phenomena, any supposition of historical continuity is indemonstrable and thus untenable.

An analogy between the two productions is provided by certain decorative similarities, by the narrative or symbolic

Fig. 8. Oristano: "ornate jar".

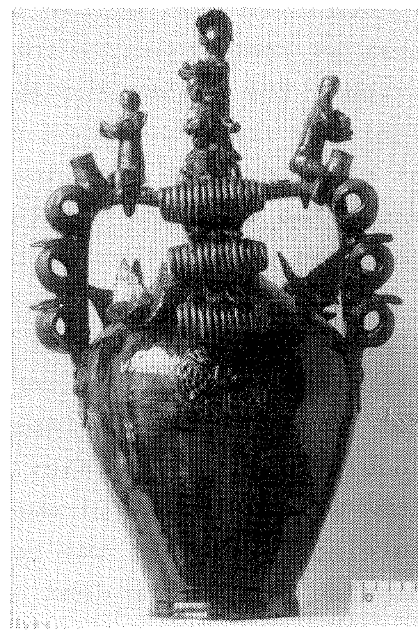


Fig. 9. Oristano: recent "ornate jar".

contents of the representations, by some details in the manufacturing techniques and above all by the fact that, as revealed by the characteristics of the vessels themselves, this production neither is nor can be utilitarian (E.A.A. II: 317; Genava 1978: 149; Van der Wielen-Van Ommeren 1982: 80-81; Lohman 1982). This non-utilitarian function, determined by the formal and decorative character of the vessels and by their manufacturing techniques, can be ascertained archaeologically, irrespective of their context (Annis 1984: 43). As to these vessels' relation to the context, on the other hand, the use of the pots as ornamental household goods seems to have been the same in both centres of production (E.A.A. II: 317-318) and their social distribution also extends to all classes (Van der Wielen-Van Ommeren 1982: 90-91). The funerary aspect characterizing the pots from Apulia is, however, absent in Sardinia, where, as we have already seen, these vessels are symbols of social and economic relations (Wolf 1966: 7-9). The same may well apply to the vessels from Apulia, but since it is not perceptible in the archaeological context, this is an indemonstrable assumption.

Here we must ask ourselves, however, to what extent this "formal" analogy may be used for "relational" or interpretative purposes (Hodder 1982: 12-27). I am referring to questions such as why did this type of production arise and flourish in the region of Canosa between the end of the fourth and the end of the third century BC, what was its function within the range of that mode of ceramic production and within that society, and, finally, why did it dwindle and come to an end when the cultural context changed in consequence of the Romanization of the region between the end of the third and the end of the second century BC. The variety and the complexity of the causes that give rise to the demand for not strictly utilitarian vessels and the variability of the responses to this demand are gradually being revealed by ethnoarchaeological researches (Arnold 1985: 158-166 and 232; Kramer 1985: 83-88). To conclude, we do not arrive at definitions of human behaviour in the past via direct and particular analogies, but through the formulation of general theories on the processes of interrelations between physical environment, society and material culture (Hodder 1982: 210-216; Arnold 1985: 1-19).

It should finally be noted that the Oristaneian four-

ORISTANO: jars (I) units of sale and capacities

Category	Number of set	Capacity of vessel in litres	Increase in number per set	Decrease in litres per vessel	Total capacity of set	Details
I	20	18/20			360/400	exceptional / storage
II	30	15	+ 10	-3/-5	450	ordinary / transport
	40	10	+ 10	- 5	400	
	60	6	+ 20	- 4	360	
	100	3	+ 40	- 3	300	
III	150	1	+ 50	- 2	150	small / thrown from a hump of clay
	200	½	+ 50	- ½	100	
	250	¼	+ 50	- ¼	75	(toys)

ORISTANO: jars (II) prices

Category	Number of set	Price per set in £ire	Price per vessel in centimes	Capacity of vessel in litres	Price per litre in centimes	Details
I	20	5.00	25	18/20	1.4/1.25	exceptional / storage
II	30	5.00	16.7	15	1.1	ordinary / transport
	40	5.00	12.5	10	1.25	
	60	5.00	8.3	6	1.4	
	100	5.00	5	3	1.7	(2/1 soldo)
III	150	5.00	3.3	1	3.3	(3/1 soldo) small / thrown from a hump of clay
	200	5.00	2.5	½	5	
	250	5.00	2	¼	8	

Table 1 Oristano: units of sale, capacities and prices of the jars.

handled ornate jars, which are often treasured in the homes for generations, which are presented to foreigners, form part of ethnographical museum collections on the island and elsewhere, and are often quoted and reproduced as representations of Oristaneian craft, could constitute archaeological and historical evidence that is not consistent with the rather secondary place they actually occupy in the production.

Sets and Categories(3)

Irrespective of the mode of production in the various centres, the ordinary vessels are produced in sets.
A set consists of a certain number of vessels with the same shape and capacity that constitutes the unit of sale. The number of vessels constituting a set gives the set its name (e.g.: set of 30) and the vessel belonging to that set on account of its capacity is also given that name (e.g. jar of 30). The price of each separate set is the same and the price of each separate vessel is obtained by dividing the bottom price by the number of the set(4). Oristano differs from the other centres in that it has a system with larger sets. This is consistent with the importance of this centre and with its distribution system that includes a re-distribution net via middlemen (Annis 1985: fig. 2; Vossen 1984).

Jars:

From the Table of the Oristaneian sets of jars (p. 58) the following conclusions can be drawn.

a. The number of vessels per set is inversely proportional to the capacity expressed in litres: the smaller the vessel, the higher its number.
b. The fact that the price remains the same for each set implies that the sum of the costs, including the raw materials, shaping and firing, is the same. However, this does not mean that the separate components of the sum do

not vary.

c. The progressive decrease in total capacity from set 30 to set 250 shows that, from a relative point of view, the costs of the vessels with smaller capacities are higher. In the opposite case the numbers should be higher. For example: 30 x 15 l. = 450 l.; 45 x 10 l. = 450 l.; 75 x 6 l. = 450 l.; 150 x 3 l. = 450 l.

From the analysis of the system a division into categories can also be derived.

Category I:

Set 20 occupies a special place. The dynamics described above should have resulted in a higher number or in a greater capacity. For example: 25 x 20 l. = 500 l., or 20 x 25 l. = 500 l. The fact that this is not the case and that the total capacity of this set lies somewhere between that of set 40 and of set 60 (respectively 400 and 360 l.) indicates that the manufacturing process of a vessel with a capacity greater than 15 l. creates a situation which in some respect differs from that of the following category. Since this difference cannot be caused by the costs of the raw materials - the weight of the jars of set 20 differs only little from that of the following set and the quantity of engobe and glaze used for these vessels is less - it must be due to shaping and firing.

Category II:

The sets of 30, 40, 60 and 100 vessels show sequences in the increase of the numbers as well as in the decrease of the capacities. The capacity of a jar from set 30 is more or less the same as the sum of the capacities of a jar from set 40 and one from set 60. The same applies to the jar from set 40, whose capacity equals that of a jar from set 60 increased by the capacity of a jar from set 100. In addition to this, the increase in number per set in this category is doubled every time.

Category III:

Category III comprises the small vessels. In this group the capacities are halved every time whereas the numbers increase by 50. Set 150 occupies an intermediate position, because where the progressive decrease in capacity is concerned, it belongs to category II, but as to the number of the vessels and the overall capacity, it belongs to category III. This last category takes up considerably less room in the kiln than the preceding categories in which the various sets each take up roughly the same amount of room. The firing of the small vessels is therefore relatively cheap and the fact that the price remains the same is to be ascribed to the higher costs of raw materials and shaping. In fact, taking into account the total weight of a set, it can be deduced that, compared to the sets with lower numbers, approximately the same amount of clay, or more, is necessary to produce the sets with higher numbers and smaller capacities, whereas more engobe and glaze is required to finish these sets. But the difference between low and high numbers is particularly apparent in the amount of time necessary for the finish: the attachment of the handles, the smoothing of the bottom, the application of engobe and glaze. To sum up, for the small vessels we have the following situation: raw materials = larger quantity; finish = more time; volume in the kiln and risk = less.

This analysis of the numerical data is supplemented from several sides. According to the potters information, the largest capacity attainable with the clay of Oristano, providing it is of good quality and thrown by a skilled potter, is that of jar 20 (category I) with a capacity of 18-20 litres. This was confirmed by an investigation into the workability of this clay that was carried out in this Institute (Annis 1985). A comparison with the system of Assemini (see Table p. 63), where the units of sale are much smaller, but where the clay is much more plastic than that of Oristano, shows that here three different sizes of storage vessels are produced, beside the four current sizes intended for transport - the largest of which already corresponds to the largest shape attainable in Oristano. Of these storage vessels only those of set 2 (with a capacity of 25 litres or more) are rarely made and sold. The competitive qualities of the vessels produced in Assemini are the strength of the pots and their large capacities. In this context it should be observed that throwing a large vessel with a wide belly and a narrow neck from a single ball of clay not only requires time and skill, but also a physical constitution that not all the potters possess (Leach 1978: 73-83). With reference to this, the Oristaneian clay that is fairly short and tends to tear easily, requires particular skill, whereas the plastic clay of Assemini that is rather "heavy", requires considerable physical strength. Moreover, the risk factor in drying and firing large vessels is notoriously greater. In Sardinia the larger jars are placed at the bottom of the load in the kiln which means that, apart from being almost in contact with the fuel, they also bear the weight of the load (Fig. 15). Consequently, the loss factor is much greater. For these reasons it is economically unattractive to manufacture jars with large capacities and these vessels are therefore only made to order. On the other hand, because they are used for storage purposes, they are not strictly necessary and since they are not moved around, they last longer.

To category II belong the ordinary sets of 30, 40, 60, 100. When an apprentice succeeds in making a jar of 30 he rises to the rank of craftsman. A potter who is capable of producing two sets of 30 jars in one working day (on average about 10 hours work) is considered a first class craftsman. In this category

ASSEMINI: jars (I) units of sale and capacities

Category	Number of set	Capacity of vessel in litres	Increase in number per set	Decrease in litres per vessel	Total capacity of set	Details
I	2	25			50	(exceptional) storage
	3	22	+ 1	- 3	66	ordinary storage
	4	20	+ 1	- 2	80	ordinary storage
II	5	18	+ 1	- 2	90	ordinary transport
	6	14	+ 1	- 4	84	ordinary transport
	8	10	+ 2	- 4	80	ordinary transport
	10	5	+ 2	- 5	50	ordinary transport
III	20	2	+ 10	- 3	40	small / thrown from a hump of clay
	30	1	+ 10	- 1	30	

ASSEMINI: jars (II) prices

Category	Number of set	Price per set in £ire	Price per vessel in centimes	Capacity of vessel in litres	Price per litre in centimes	Details
I	2	1.00	50	25	2	(exceptional) storage
	3	1.00	33	22	1.5	ordinary storage
	4	1.00	25	20	1.25	ordinary storage
II	5	1.00	20	18	1.1	ordinary transport
	6	1.00	16.7	14	1.2	ordinary transport
	8	1.00	12.5	10	1.25	ordinary transport
	10	1.00	10	5	2	ordinary transport
III	20	1.00	5	2	2.5	(2/1 soldo) small
	30	1.00	3.3	1	3.3	(3/1 soldo) small

Table 2 Assemini: units of sale, capacities and prices of the jars. Numbers and price of the sets are equivalent to one fifth of those in Oristano (Table 1).

the total costs of raw materials, shaping and firing are well balanced, but this does not mean that each set is equal in these respects. For example, the daily productions of set 40 and set 30 are not in the proportion of 80:60, but 70:60. It is also difficult to obtain a ratio of 200:60 for the set consisting of 100 vessels. On the other hand, however, what is lost in one respect is regained in another in the sense that, quite unexpectedly, the daily productions of set 60 and set 30 are not in the ratio of 120:60 but of 180:60. These differences can be explained by returning to the properties of the clay and the manufacturing techniques. As already pointed out, the properties of the clay of Oristano do not make it ideal for wheel-thrown large vessels. One pot from the set of 40 requires almost the same amount of concentration of the potter as is required to produce a vessel from set 30, whereas there are no difficulties involved in the throwing of a vessel from set 60. As regards the set of 100, since the clay, which is lean, tends to dry soon, the balls of clay cannot be prepared in advance and placed near the wheel, but have to be made separately for each new pot, and thus the rhythm of the throwing is frequently interrupted. In this case it is not the throwing of the vessel that requires time, but the frequency of the preparations before throwing and the finishing of the vessels afterwards. On the other hand, the set of 60 and the next one of 100 have the advantage of a very small amount of wastage in firing. As to the use of the vessels, the pots from category II are normally used for collecting, transporting and storing water. From a quantitative point of view these pots are produced the most, both because they tend to break more frequently (see below) and because they are distributed over a wider area.

Category III shows a numerical leap indicating that those vessels are shaped from a hump of clay instead of from a single ball, which is a much faster process. The shape of the vase and the marks produced by the thread on the bottom of the pot, indicating that the vessel was cut off without interrupting the movement of the wheel, are the signs of this technique. Since these vessels, which are intended for several uses in the home and the kitchen, are small, they can also be used by children for collecting water. Set 250 is also intended for children, not for work, but for play.

Barrels and flasks:

The observations made with respect to the jars also apply to this group. Not only the handles, but also the necks of these vessels are thrown and attached separately. In addition to this, more engobe and glaze is used on these vessels than is required for the finishing of the jars. This explains why the price is the same even though the capacity of these pots is about half of that of the jars (cf. Table p. 66).

System:

The rationalization of the system of production and sale is not limited to the water vessels, but extends to all the shapes. In general, it seems that such a system is based on a series of different capacities, reflecting the different uses of the vessels, as we also find (Angioni 1975: 131-135) in the traditional system of the measures for liquids and dry substances. The round figures of numbers and capacities, respectively increasing and decreasing, are on the other hand signs of the rationalization of the production in relation to the manufacturing and the selling of the artefacts.

To summarize, in a geographically well-defined context we have a predominant ceramic category, namely the water vessels. These do not differ essentially in shape or in manufacturing techniques, but are produced in different places and according to different modes of production. In all of the centres the pots are sold in sets, but the number of vessels per set and

ORISTANO: barrels and flasks							
Category	Number of set	Capacity of vessel in litres	Total capacity of set	Price per set in £ire	Price per vessel in centimes	Price per litre in centimes	Details
I	20	10	200	5.00	25	2.5	exceptional
II	30	7	210	5.00	16.7	2.4	ordinary
	40	5	200	5.00	12.5	2.5	
	60	3	180	5.00	8.3	2.8	
	100	1	100	5.00	5	5	
III	150	½	75	5.00	3.3	6.7	small
	200	¼	50	5.00	2.5	10	

Table 3 Oristano: units of sale, capacities and prices of barrels and flasks.

the variety of sizes are in direct proportion to the extent and the density of the area of distribution and the economic calibre of the middlemen. The area of distribution may be limited to the village and its immediate surroundings, extend to the region in which the centre is situated, or, as in the case of Oristano and Assemini, it may concern a large territory. In the first case the pots are usually sold directly, in the second case they may also be sold via middlemen, and in the third case they are sold almost exclusively via middlemen: travelling salesmen and redistributors. The difference in the units of sale between Oristano and Assemini (cf. Tables p. 58, 63) is related to the different calibre of the middlemen operating in the two areas of distribution. For the reconstruction of a similar system the means that have become common in archaeology are the mineralogical and technological characterization of the various fabrics and their spatial distribution.

Names

Brokka = "two-handled vessel", referring to the shape of the pot, is the most common name for this form of earthenware. More specifically, however, the term brokka ("mariga" in Assemini) is used only for storage vessels. The vessels belonging to category II are not called brokka, but brottikku ("marighedda" in Assemini), which indicates a smaller size. In the same way the vessels belonging to category III are called brokkittedda ("brokkuittu" in Assemini) or malittu = "small shape", referring to their minute size. The terms faťa bascia (= "low artifacts") and brokka bukk'istrinta (= "jar with a narrow neck") or brokka bukka de frasku (= "jar with a barrel's neck") respectively indicate the two regional variants shown in Figs. 5-6. The term frasku fundi ladu (= "flask with a wide base") is used to indicate the type of barrel that is made specially for the southern part of Campidano and that has the same shape as the barrels produced in Assemini.

Other specific names may refer to the manufacturing technique, the sale system or the use of the vessel. For example, at Oristano the sets of 40 and of 60 are also called strexiu de mazza de qoranta/de sessanta (= "crockery from the middle (of the load) of 40/60"), which indicates the position of this set in the kiln, namely between the larger pots that are placed below and the smaller ones that are placed above. Mazza literally means "abdomen and its contents".

Set 150 is also called tres un soddu (= "three for one soldo") and that of 100 dus un soddu (= "two for one soldo"). For a long time, at least until the Second World War, the price of a set was 5 Lires, which was the same as the price of a bushel (moju) of grain (approximately 35 kilogrammes) and of five kilogrammes of cheese. A jar from set 150 therefore cost 3,3 centimes and three jars from set 150, or two from set 100, cost 10 centimes which was the same as one soldo.

The name brottikku de funi = "rope jar" used for set 30 has

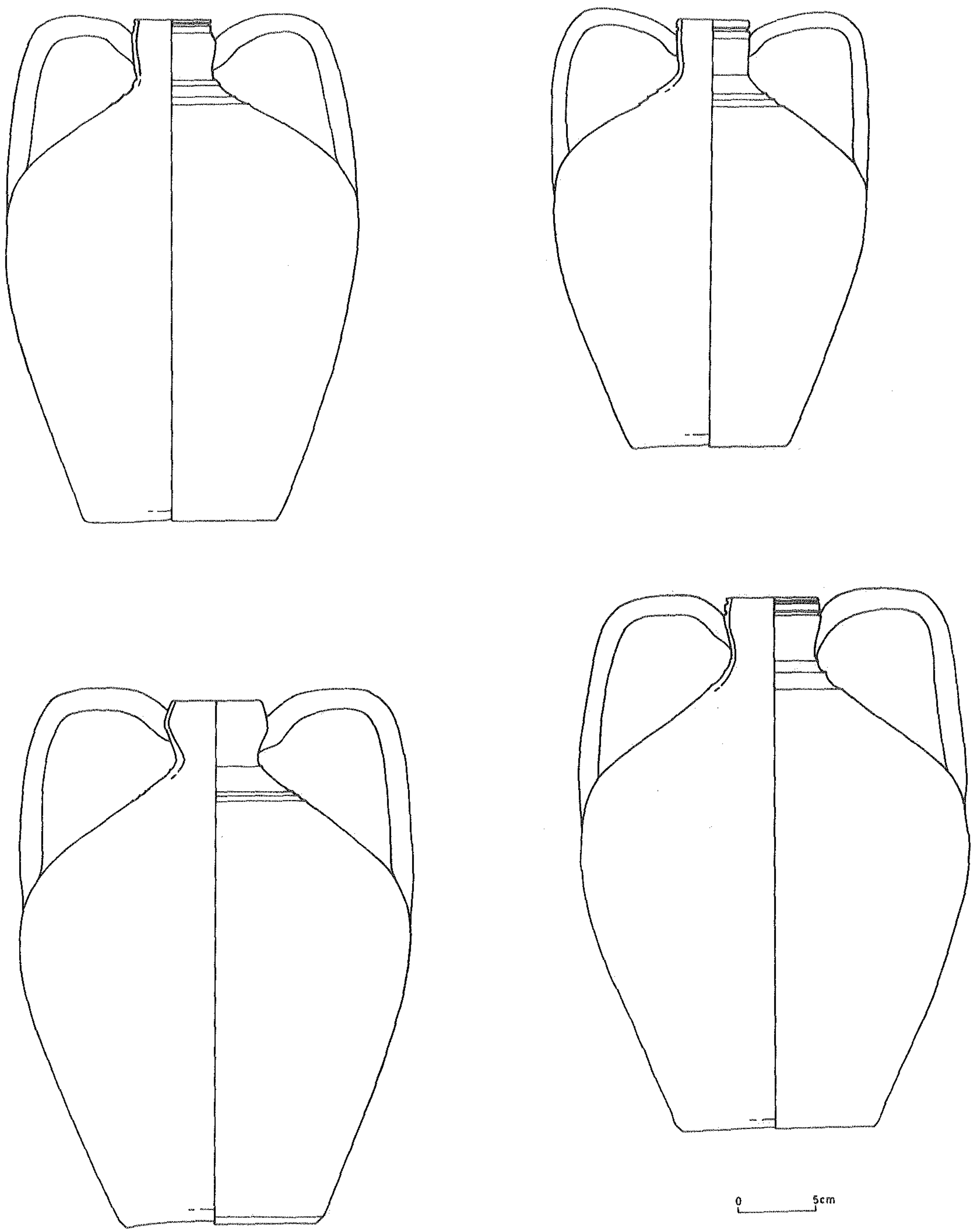


Fig. 10. Oristano: "signatures" of four different potters.

already been mentioned. Set 250 is called giogu = "toy".

"Signatures" and style

It is a well known fact that what we would regard as an anonymous ceramic production is something quite different to the potters who manufacture the vessels in the sense that each craftsman is not only capable of recognizing his own products, but also those of his colleagues (Kramer 1985: 82). I have often asked what the "signatures" consist of, i.e. the differences enabling us to distinguish the various hands. As far as the jar is concerned, the characteristic features that are unanimously indicated by the potters are (Fig. 10):

1) The finish of the top part of the vessel: the number and the profile of the grooves drawn with the rib to mark the transition from the shoulder to the neck.
2) The closing of the vessel: the profile of the neck and that of the lip which are shaped with the finger tips and sharpened with the rib.
3) What many potters also consider important is the proportional relation between the height of the base and the maximum diameter of the belly. The vessel may in fact be given a relatively high, narrow base and a wide belly or, vice versa, a low, wide base and a relatively narrow belly (cf. Fig. 10).

Similar criteria also apply to the barrel and the flask.

There are certain rules for shaping the vessels that are regarded as merely aesthetic canons by the potters. In many cases, however, there appear to be technical reasons for these rules. At Oristano the body of the jar has to be biconical. The belly should not be globular, but must open out gradually and the outline of the shoulder should not be convex, but must run up obliquely and remain taut. Experiments carried out in the laboratory of this Institute have shown that it is indeed difficult to shape a pot with a globular belly from a type of clay with the properties of that found at Oristano.

At Assemini, Villaputzu and Dorgali, where the clays are more plastic and of a better workability on the wheel, the vessels have to be given a wide globular belly on a relatively narrow and slender base and a rather high cylindrical neck (Fig. 11).

Fig. 11. Assemini: water jar (set 2).

At Oristano, the handles, departing from the neck, must rise above the level of the lip and then make a right angle before being attached to the belly. Since, on account of the limitations imposed by the clay, the Oristaneian jar has a short neck, the handles are given this shape in order to create sufficient room for a comfortable grip. The length of the handles causes no difficulties, because they are thrown on the wheel anyhow, since they cannot be pulled.

An entirely aesthetic function on the other hand has the application of a coat of engobe under the glaze, which, as I have already mentioned, is also a characteristic of the Oristaneian production. The engobe prevents the green and brown pigments (copper and iron oxides), used to colour the lead glaze, from becoming too dark through direct contact with the reddish brown clay. Thanks to the engobe coating, the colours remain bright and clear. The application of the engobe indeed constitutes a phase in the manufacturing process of a vessel expressed in time and work. Moreover, especially when, as in the Sardinian tradition, the vessel is fired once, it also involves a certain amount of risk and the complication of procuring a suitable kind of engobe (Hamer 1983: 116). In the case of Oristano for example, it has to be brought from Nurallao, a village lying about 50 km away. Within a utilitarian production such as this, which is usually termed "beautiful" by the producers and the consumers if it reflects a technical perfection that should guarantee a good performance, the engobe coating is not a technical or utilitarian improvement, but is applied for merely aesthetic purposes. This function of the engobe coating can be defined archaeologically by examining the products from a technological point of view.

Life and replacement

In traditional Sardinian society the value of things depends on how long they last. This also has ethical implications: "something that lasts long is good" (Barbiellini Amidei and Bandinu 1976: 70). This explains why a terracotta vessel is regarded as something of little value that should therefore cost little, despite - and this applies to the water vessels in particular - its importance. To pay the same price for a short-lived pot as for other objects that "last a life time" would be immoral.

The life of the water vessels is limited by breakage due to use and by aging due to their function. Breakage not only depends on the fact that the vessels are moved about frequently, but also on the size of the pots, and therefore the jars with greater capacities belonging to the transport category will break more often. Consequently, in regions situated particularly far from the centres of production, such as those in the northeastern part of the island, chestnut tubs, rather than jars, are used to collect and transport water (Pilia 1980: figs. 197 and 213-218). The larger percentage of breakage among the large jars intended for transport has an effect on the proportional quantities of production. Until the 1950s the approximately 20 workshops active in Oristano each had a kiln with a capacity of about 5,4 m3. These kilns could contain 18 sets of different kinds of vessels (the average set consists of approximately 42 vessels). In the months in which the production of water vessels was the most intense (June/September) the kilns were usually charged with no less than 6 1/2 sets of jars 30 and 40, that is, the larger vessels intended for transport.

Aging is caused by saturation of the wall of the vessel due to the ion-exchange between the water and the clay wall (Annis 1984). This saturation prevents the vessel from performing its function and it is therefore replaced. In general, according to producers' and consumers' information, the jars intended for transport are replaced annually whereas the storage jars are replaced every two years (Foster 1960; DeBoer and Lathrap 1979). It is however obvious that in regions in which the ground is almost impenetrable (granite and basalt) and where the water is of excellent quality, a storage jar will last for much longer than in regions with penetrable soils (calcareous surfaces and schists beneath) or where the water is obtained from rivers or wells. Here even storage jars do not last longer than one year. An old or cracked jar is not thrown away. Traditionally, it is often re-used as a pot for basil plants and will then last for several years longer. But the jars are not always re-used; sometimes they are kept for generations, waiting for the time when they "may come in handy".

II. RECENT TRANSFORMATIONS

From the 1950s onwards the production of water vessels has progressively decreased in a dramatic way. It has died out in all the smaller centres and, in so far as it has survived in Oristano and Assemini, the quantitative differences are impressive. In the early 1950s there were still approximately 30 master potters in Oristano and the total number of craftsmen engaged in pottery production amounted to about 90 divided over approximately 20 workshops. In Assemini the number of active potters was more or less the same. In the early 1980s, by which time the Sardinian population had increased by c. 220,000 (17%), there were only three potters producing water vessels in Oristano and six in Assemini. These were divided over a total of seven workshops.

To these facts, which are themselves eloquent enough, must be added the reduced kiln capacity and the marked decrease in the percentage of water vessels in the overall production. As already mentioned, until the 1950s most of the kilns in use in Oristano had a capacity of about 5,4 m3 and could contain 18/20 sets of vessels intended for various uses. In the months of June, July and August the water vessels constituted 70% of the load. What was regarded as a large kiln in 1980 had a capacity of about 3,6 m3 and could contain 12 sets of vessels. The water vessels then accounted for 25% of the load.

There are various causes of these phenomena: the transformations in the social structure; an altered environment; cultural changes. It would, however, be insufficient to limit ourselves to a list of the different causes without attempting to determine their chronological and hierarchic order.

The first cause in time is to be found in the changes that took place in the years immediately after the war in the <u>social structure</u> of Sardinia. The agro-pastoral society changed into a more articulate and more open one, offering young people new and more attractive possibilities, whereas compulsory education and the new social laws in favour of labourers and apprentices forced the master potters to make do without them. The assistance in the workshops and the auxiliary services (day labourers, transporters, woodgatherers etc.) gradually disappeared and thus the infrastructure which supported the organizational forms of the production broke up. Where the mode of production had been that of full-time urban workshop industry or rural workshop industry, the new organizational form becomes that of individual workshop: also a full-time activity, whose technical and commercial organization is entirely in the hands of the potter alone (Peacock 1982: 25-31; Annis 1985). From this moment onwards the traditional uniformity of the manufacturing techniques and equipment, of the formal and functional repertory, and of the clientele disappears. Each potter must suit his production to his own customers and must find his own technical solutions (Annis in press).

The second cause is the alteration of the environment. The first important steps to improve the island's water supply were made in the period 1950-1970. The diagram in fig. 2a shows what was undertaken to provide the houses with running water in those 20 years, but figs. 2b, and in particular 2c, reflect the actual situation which, on account of the scarcity of the water and increased consumption, is far from ideal. Even today the water supply constitutes such a problem in some regions that there is a trade in drinking water in the summertime. All this explains that the drop in demand was not felt until the 1960s (Cp. Birmingham 1967), by which time the crisis in the production was already a fact. In this respect the middlemen all agree that it was not the demand, but the supply that was the first to drop. For the reasons described above, the potters were no longer able to produce enough pots and the clients had to look for other solutions.

Some of the solutions were found in the new alternative materials which are now widely available. This brings us to the third cause: the cultural context. From a chronological and hierarchic point of view the use of substitutive materials comes last. The process of change in the relation man/object and the acceptance of new objects, unknown in the context of traditional Sardinian society, did not begin until the later part of the 1960s and started to gain importance in the early 1970s (Barbiellini Amidei and Bandinu 1976: 95).

These transformations in the environment and in the cultural context caused the disappearance of the less organized forms of production, the individual workshop and the household industry, in centres such as Tortoli, Nurallao and Decimomannu which only had a function complementary to that of the larger centres towards which they gravitated.

Despite Oristano's role as a manufacturing centre of water vessels par excellence, its production decreased earlier than that of Assemini. In my opinion the greater endurance of Assemini is mainly accounted for by the fact that from the 1930s onwards a process of technical modernization has taken place here (Da Re 1983: 176-188). The replacement of manual work by machines in the entire process of mining and preparing the clay and the introduction of the electric wheel have made the potters' work much quicker and easier. This has two consequences: (1) the potter is more autonomous and his situation is therefore more in accordance with the new times; (2) in these terms being a potter seems a much less ungrateful profession to young people who are indeed no longer having recourse to other activities. Eloquent in this context is the analysis of a young potter from Assemini: "My father was a slave to his profession. His normal working day consisted of 10-12 hours and in the high season days of 15 hours or more were not exceptional. Abused by his clients who claimed that a clay vessel has no value and should therefore cost little, he did not even have the satisfaction of seeing his hard work well rewarded and from a social point of view he was respected less than other craftsmen, because he was also dirty and had to go barefooted. I now work eight hours like everyone else, sell my pots at the same prices as those of other artisanal objects, I dress as I like, because the clay is now mined and prepared by machines. I am quite capable of providing for my family and I am respected".

Whereas Oristano, still hanging on to the old techniques, is forced to give up producing vessels as it once did, Assemini is gradually absorbing the part of the market that Oristano is no longer able to satisfy. Better roads and the widespread use of trucks instead of horse- or ox-drawn carts shorten the distances for the wholesalers. In the regions in which water vessels are still in use, we therefore see that the Oristaneian products are being replaced by those from Assemini. Harder and less porous products are taking the place of weaker and more permeable products. However, we have already seen that it would be incorrect to interpret these phenomena archaeologically as signs of preference for better vessels from a ceramic point of view.

Shapes

Besides the jar, the shape that has endured best in the altered circumstances and which is still produced in relatively large quantities, is the flask. The barrel (Fig. 3), however, has now vanished completely from the production.

The causes of these phenomena vary. The greatest demand for flasks comes from the regions in which drinking water is scarce or, above all, of poor quality (see above). These are mostly mountainous and pastoral regions that tend to adhere to traditional usages. Moreover, since the farmers and shepherds are making more and more use of motorcycles, cars and tractors, rather than travelling by foot, on the backs of animals or by cart, the shape of the flask has proved rational and well suited to rapid transport and short journies. For the same reasons it is also required by transporters, hunters and trippers. And for the producers it is economically attractive to manufacture pots of this shape, which are easy to make and which occupy only little room in the kiln.

The variants in the shape are disappearing or are being reduced to the odd exception, made only to order. This change is also connected with the new requirements of the producers and the consumers. An eloquent example is the squat neckless jar produced in Oristano for the mountainous regions in the centre and mid-east of the island (Fig. 6). As I have already mentioned, this variant requires clay of a good quality and technical skill, conditions which are not easy to fulfil in the new precarious situation of the producers. Moreover, now that there are aqueducts in most parts of the island and public fountains in the villages, this shape, which is connected with the natural morphology of certain regions, is no longer required and today it has disappeared completely.

Exhibitions on the island and elsewhere, organized by the government or by private initiative with the purpose of stimulating tourism and commerce, are causing a marked increase in the manufacture of the "four-handled ornate jar". But the character of this type of vessel has changed essentially. Sold at a high price, it has become a commercially attractive object of "ordinary" and no longer exceptional production (Fig. 12). The plastic decoration has become stereotype; the contents - if any - of the scenes invariably refers to the unrealistic image of Sardinia intended for the tourist market (Fig. 9). This routine production results in a sketchy execution of the decoration. The use of a gas kiln in which the vessels are now fired twice has eliminated the risk factor. On account of the new firing techniques the potters have to use modern industrial glazes instead of the old lead glaze, which is not suitable for gas kilns. In short, the only elements of continuity of the tradition are the clay, the type of decoration in the round, a few surviving motifs and the ornamental function of the vessels. As to the occurrence of the pots, the emphasis has been shifted from the private to the public sphere, from the

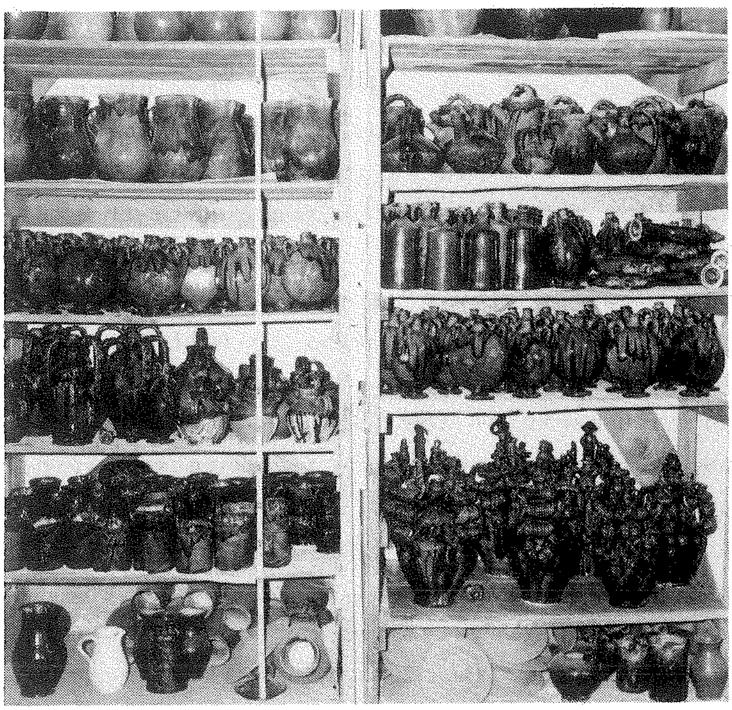


Fig. 12. Oristano: routine production of ornate jars and other ornamental vessels.

home to public buildings.

Sets

The potters who remained true to the old tradition, still produce and sell pots according to the system of the set, even though the vessels are usually sold by the piece these days. The developments in the two main centres differ.

As mentioned before, at Oristano a critical point in the manufacture of, in particular, the jars, was the quality of the clay and great attention was therefore paid to its mining and preparation. Every potter not only mines his own clay, but as a member of the Società, he is also obliged to assist and advise his colleagues in this task (Annis 1985). In the late 1940s the potters were forced to move to quarries where the clay appeared to be of poor quality and the manufacture of the largest jars (set 20 = 18 litres) started to cause problems. By mutual consent the potters dicided to stop producing jars of this size and to reduce the capacity of set 20 from 18 to 15 litres. This used to be the capacity of set 30. The latter was in its turn reduced to the size of set 40 etc.

In the early 1960s, when the infrastructure of the organization of the workshop industry had broken up, the potters could no longer count on assistance in mining the clay. The clay-pits were therefore abandoned and the potters had to have recourse to firms digging wells for the building industry. As a result of this they no longer had control over the quantity and the quality of their raw material. This situation, along with the reduced kiln capacity (likewise owing to the lack of assistance during firing) caused further reductions in the capacities of the pots (Fig. 13). Moreover, whereas, when the kilns were still large, the production of large vessels was predominant (sets 30 and 40 in particular), the proportions are now inverted in order to ensure a profitable yield from the smaller kilns. A new set of 400 was added to the traditional ones. These minute vessels are intended to be sold to shop-keepers for the tourist market. Since they fetch a good price, by producing them the potters almost double the yield of their kiln (Fig. 14).

The ordinary large jars, having become rare objects, are going through a period of reappraisal. Anyone owning one will guard it with care. In the convents for example, in which terracotta vessels have vanished almost completely, a jar is still used for storing the holy water. The consequence of this reappraisal is that ordinary vessels are put on display in exhibitions. As a result of this, in 1985 two Oristaneian

Fig. 13. Oristano: water jars (set 30), original size (left) and reduced size (right).

potters received a big order of large jars from the USA. Attracted by the sum offered, the two potters succeeded in procuring the clay of the required quality and enlarged their kilns for this purpose. This once more shows that the demand itself is not a strong enough incentive to organize a production; the economic interest of the producer also plays a part.

Assemini on the other hand, where, on account of the technical modernizations, the social changes have had less traumatic consequences than at Oristano, has retained its vitality of a longer period of time. Here the real çrisis in the traditional craft took place when, after the insland's water supply had been improved, the demand was no longer sufficient to provide for the same number of craftsmen.. Competition forced the potters to increase the capacity of the vessels while keeping the price of the set the same in order to attract clients. For example: the set with the capacity of 18 litres which orogonally consisted of five vessels, became a set of six vessels; the set of six became a set of eight etc.

Fig. 14. Oristano: kiln, 1979.

All this was possible because, as already pointed out, the clay of Assemini imposes no restrictions as regards the size of the vessel. And as to the effort and the amount of time involved in shaping a large pot from a single ball of plastic clay, the application of an electric motor to the fly-wheel eliminates the tiring work of the potter's foot (Fig. 15).

Names

The general names of the vessels have survived, but the full meaning of the names referring more specifically to a vanished reality is understood only by the older people who were the

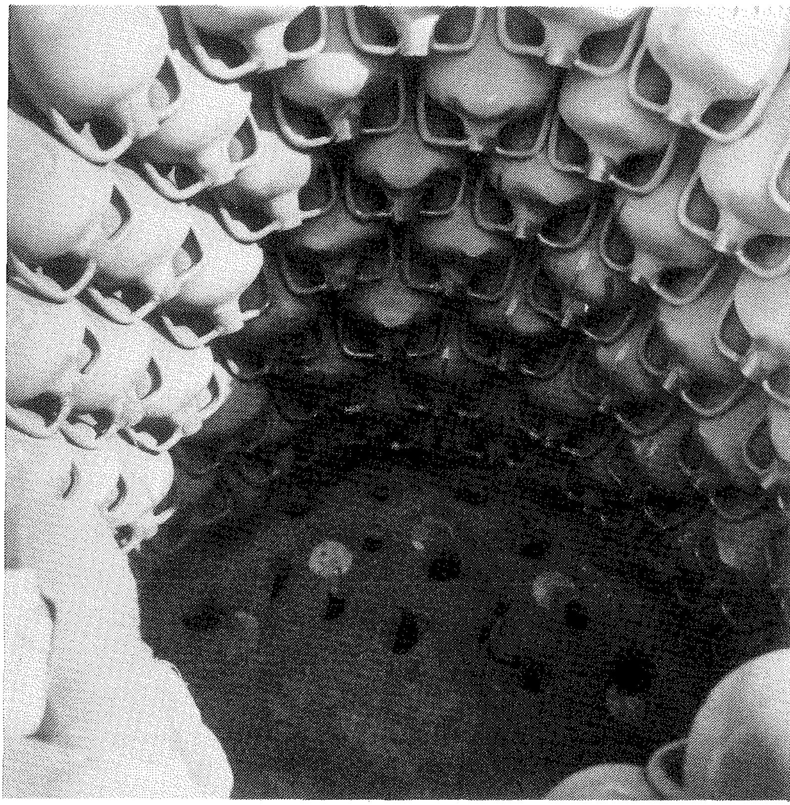


Fig. 15. Assemini: kiln, 1980.

protagonists of this reality. The younger people have a vague understanding of the term, but, as Bandinu (1976: 155) commented in reference to the disappearance of the pastoral Sardinian language, "a word that is disconnected from the things to which it refers exploits its remaining inertia only for a short while" and then disappears. In the language of the Sardinian potters the old surviving terms are gradually being replaced by a new terminology referring to the new technical and social organization of their production.

Life and replacement

In line with the substantial quantitative and qualitative change that has taken place in the material world in the last 30 years, the relation between man and the things surrounding him is also changing (Barbiellini Amidei and Bandinu 1976: 93-106). Having become more difficult to get, terracotta vessels are now being reappraised by old people and are generally well appreciated by those who are still using them for their function, that is, to keep water cool and fresh. On the other hand, on account of a widespread modern mentality, they have acquired value as "handmade" objects. This new conception lengthens the life of the water vessels, because when they are used they are handled with greater care, or they are reserved for ornamental uses. Thanks to this last change even the pots that would have been considered unfit for sale in the old production, for instance cracked pots or vessels that are too permeable as a result of insufficient firing, are sold at the same price as the others.

III. DEFINING STABILITY AND CHANGE: A CONCLUSION

The production of water vessels in Sardinia and its development have been analysed by means of a progressive definition of the environmental and cultural aspects involved and of their interrelations. This essentially ecological (Matson 1965; Arnold 1985) approach on which the ethnoarchaeological research in Sardinia is based (Annis 1983), corresponds to the analogous approach of the technological studies conducted by this Institute (Franken & Kalsbeek 1975; Franken 1983; Jacobs 1983; Van As 1984).

Another fundamental feature of this ethnoarchaeological research is the diachronic aspect. The processes operating in an environmentally and culturally changing context are also reflected in the ceramic production that is part of that context. Within a span of approximately two generations (the years 1920/80) the symptoms of resistance, extinction, adaptation and innovation have been studied in order to define their significance by determining the causes of the phenomena. The archaeological aim of this research is in fact to contribute towards the formulation of an interpretative theory of the dynamic processes operating in the ceramic productions of complex societies in historical times, particularly in the Mediterranean area (Annis 1985).

A few years ago a model of the synchronic variability of the modes of production related to environmental and cultural conditions was proposed by David Peacock (1982) and applied to pottery of the Roman world. Recently Dean Arnold (1985), through a wide-ranging synthesis based on a large number of ethnographic studies, formulated a general theory about the relationships between ceramics and environment and culture. These relationships are regarded as diachronic processes that either favour or counteract the appearance of a ceramic production and its development from a part-time activity practised alongside agriculture to a full-time activity of specialized craftsmen. Basing himself on the system theory and on an ecological view of culture, Arnold, in order to explain phenomena such as stability and change in an environmental and cultural system, adopts the cybernetic theory of feedback mechanisms which counteract (regulatory feedback) or amplify (positive feedback) deviations from a stable situation in the system. According to Arnold, a ceramic production forms part of the techno-economic sub-system, which adapts and modifies the environment for cultural purposes. In order to specify the conditions under which the feedback processes operate in ceramics, Arnold utilizes synchronic categories (Peacock's "modes of production"), which he defines as "system states" that are subject to stability or evolution, depending on the feedback processes.

Being based on the same ecological and diachronic points of view as those of the research in Sardinia, Arnold's theory offers me the opportunity of a direct application. In Sardinia the drop in demand caused by the changes in the environment (the aqueducts) and, later, by the cultural changes (new materials) had a decisive influence on the entire production of water vessels, irrespective of the mode of production. When, on the other hand, we are confronted with changes in the social structure, the influences are not the same for all the modes.

We have already seen that the mode that appeared less flexible with respect to social changes and which suffered the heaviest damage from these changes, was the urban workshop industry of Oristano. In the old socio-economic structure the Società, of which every Oristaneian potter wanting to practise the craft had to be a member, had a conservative and protective function. At the same time, however, the organization had a freezing effect on technological and economic progress and this became the first cause of the crisis in the production as soon as the infrastructure on which the organization rested began to fail (Annis 1985).

Assemini, on the other hand, where we also find a full-time mode of production, but where the socio-economic ties between the craftsmen are less strict and less regulated, proved more capable of adjusting itself to the crumbling of the infrastructure thanks to its more modern technology. This technical modernization not only enabled Assemini to overcome the difficulties encountered in the years immediately after the war, but, in the following period, stimulated by the new commercial and tourist market, it gradually improved and expanded until it finally caused a real innovative process in the production, which today is no longer limited to terracotta, but has been enriched with table ware and ornamental ware. At present Assemini is the most active and most prosperous centre of ceramic production on the island.

In the villages where we find part-time modes of production, that is, individual workshop and household industry(5), social changes have no effect. The environmental conditions and the demand on which the potter is dependent in fact remain unchanged. These activities cease only when the demand drops.

These observations lead to the concepts of the resistance of the various modes of production and of their flexibility, that is their ability to react to stimuli by adjusting or renewing themselves. These two qualities are proportional to the degree of dependence of a given organizational form on its own environmental and cultural context. This theoretical generalization is an important criterion when we want to interpret the evolutive processes, either positive or negative, in the ceramic productions of complex historical societies.

The more a mode is conditioned by social, economic, or political structures, the more vulnerable it will be, because these are subject to alteration. The more complex the organization, the stronger the stimuli will have to be to induce adaptation or change, because the conservative forces are directly proportional to its degree of dependence on the social structure.

The simpler organizational forms, however, are more directly connected with the physical environment, which is less subject to changes; they answer to basic needs such as the preparation of food or the collecting of liquids, and are more generic - less specialized. Consequently, they are on the one hand more stable, because they are less involved in social changes, and on the other more flexible - and therefore also more dynamic - because they are able to react to external stimuli with less risk for the organization.

From this point of view the potter's conditions with respect to his own means of production and distribution are also of importance. In the simple organizational forms he needs only little in order to be able to practise the craft and he is the owner of his means. This may change when the organization becomes more complex, until in the manufactory the potter is simply a worker (Peacock 1982: 9-10; Pucci 1973). In Oristano the clay was mined from communal clay-beds and the Società of the master-potters decided who was admitted to the pits and, in general, who was allowed to practise the craft and who was not (Annis 1985). This was different in the other centres in which there were also forms of dependence and control, especially within the mode of production of workshop industry, but not to this extent. The importance of the potter's freedom with respect to the practice of his craft is particularly clear in the case of Los Pueblos (Mexico). When these potters gained control over their own means of distribution, which had previously been in the hands of a complex hierarchical organization of middlemen and monopolists, the new condition had a stimulating effect on the development of their craft (Papousek 1981).

Moving on to classical archaeology, the endurance of the coarse and utilitarian pottery productions and their coexistence along with large manufacturing industries (e.g. terra sigillata) are well known phenomena (Riley 1981a, 1981b; Peacock 1982; Fulford and Peacock 1984). Unfortunately however, these categories which are rather unattractive from an aesthetic point of view, which show little typological variation and which are considered "local" and therefore of little importance for commercial relations, have for a long time been neglected. Consequently, now that new approaches in ceramic studies have brought to light the value of ecological, socio-economic and historical information that may also be obtained from these "humble" categories, classical archaeologists still lack many data without which they are unable to define either the role of the organizational forms of simple productions with respect to those of complex ones or their development. In particular I am referring to the lack of technological data (by which I do not only mean mineralogical and chemical analyses of the fabrics, but also investigations into their artisanal and functional properties), and of quantitative data with respect to spatial distribution.

The improvement of the theory of the modes of production and of their reaction to stimuli may also render it possible to interpret problems concerning ceramic categories with which classical archaeologists are better acquainted. In my opinion the deductive method may prove effective in, for instance, the interpretation of the productive structures of the ceramic industry of Roman Africa from the late Imperial period until the Arab conquest. These structures have already shown in the past (Carandini 1970), and more and more in recent studies, on the one hand variety (e.g. Fulford and Peacock 1984; Riley 1981b), on the other signs of constant transformations even within the framework of the production of the African sigillata only (e.g. Tortorella 1983).

Moreover, the technological "decadence" which once was supposed to characterize (I am referring to Italy in particular) the transition from Late Antiquity to the Early Middle Ages and the subsequent technological progress of the central Middle Ages in contrast with Roman conservatism acquire a new perspective when they are regarded respectively, the first as a sign of the endurance of simple modes of production after the breakdown of the Roman "industrial" production, the second as a sign of the positive dynamism with which the organizational forms of the (Early, Middle Ages reacted to the stimuli of the new social context(6).

Notes

1. The programme of this investigation also includes research in this direction.
2. I do not yet know the reason for this preference. At the moment I can only assume that it is connected with the

greater capacity of the jar in relation to that of the barrel which may be more useful in regions characterized by scattered habitation (Le Lannou 1941: 222-236) because it allows greater autonomy.

3. I would like to thank Herman Geertman for his contribution to the analysis of the numerical system.
4. In the Communal Archives of Oristano there is a letter, dated 1906, in which the Società of the potters asks the major for permission to increase the prices for Oristano and the villages. The town council refused and published a bill in which the prices agreed upon in 1777 were reconfirmed (Virdis 1960: 59).
5. The first one is an irreplaceable means of subsistence besides agriculture, whereas the second is limited to the months in which the demand is the greatest, coinciding with the time of the year in which agricultural activities are suspended.
6. Roman technological conservatism in contrast with the technological progress of the Middle Ages is a well-known historical theme (Finley 1965; Pleket 1967; White L.Jr. 1962) which has recently received a good deal of attention in the congress held in Como: Tecnologia, Economia e Società nel mondo Romano (1980). An outline of the problems regarding the relation between ceramic production and socio-economic changes in the period ranging from the late antiquity to the Middle Ages with particular attention to Italy is to be found in an article by H. Blake (1978). The rapid development of the researches can be followed in the journals Papers B.S.R. and Archeologia Medievale.

References

Angioni, G. (1974), Rapporti di produzione e cultura subalterna, contadini in Sardegna, Cagliari.

Angioni, G. (1976), "Sa Laurera": il lavoro contadino in Sardegna, Cagliari.

Annis, M.B. (1983), Potters from Sardinia, an interim report (March 1982). Newsletter Department of Pottery Technology Leiden I: 13-26.

Annis, M.B. (1984), Pots in Oristano: a lesson for the archaeologist. Newsletter Department of Pottery Technology Leiden II: 32-51.

Annis, M.B. (1985), Resistance and Change: pottery manufacture in Sardinia. World Archaeology 17 (2): 240-255.

Annis, M.B. (in press), Pots and Potters in Sardinia: tradition and innovation. Paper presented at the Symposium "Töpfereiforschung zwischen Archäologie und Entwicklungspolitik" (Jahrestagung der Deutschen Gesellschaft für Völkerkunde), Lübeck 1985.

Arata, G.V. and G. Biasi (1935), Arte Sarda, Sassari.

Arnold, D.E. (1985), Ceramic Theory and Cultural Process, Cambridge.

Atlante della Sardegna 1980: R. Pracchi and A. Terrosu Asole (eds.), Atlante della Sardegna, fasc. II, Roma 1980.

As, A. van (1984), Reconstructing the Potter's Craft. In: S.E. van der Leeuw and A.C. Pritchard (eds.), The Many Dimensions of Pottery, Ceramics in Archaeology and Anthropology, Amsterdam: 131-164.

Atzori, M. and M. Satta (1980), Credenze e riti magici in Sardegna, Sassari.

Balfet, H. (1973), A propos du tour de potier: l'outil et le geste technique. In: L'Homme, hier et aujourd'hui: recueil d'études en hommage à André Leroi-Gourhan, Paris: 109-122.

Barbiellini Amidei, G. and B. Bandinu (1976), Il re è un feticcio, Milano.

Binford, L.R. (1983), In Pursuit of the Past, London.

Birmingham, J. (1967), Pottery Making in Andros, Expedition 10: 33-39.

Blake, H. (1978), Medieval Pottery: technical innovation or economic change? In: H. McK. Blake, T.W. Potter and D.B. Whitehouse (eds.), Papers in Italian Archaeology. Recent research in prehistoric, classical and medieval archaeology, vol. I, part 2., BAR Suppl. Ser. 41: 435-473.

Brandis, P. (1982), L'acqua della Sardegna. In: M. Brigalia (ed.), La Sardegna, vol. I, part 1. Cagliari: 124-132.

Bronitsky, G. (in press), The use of materials science techniques in the study of pottery construction and use. (Advances in Archaeological Method and Theory, vol. 9).

Carandini, A. (1969/70), Produzione agricola e produzione ceramica nell'Africa di età imperiale: appunti sull'economia della Zeugitana e della Byzacena. In: Studi Miscellanei 15, Roma: 95-122.

Cirese, A.M., E. Delitala, C. Rapallo and G. Angioni (1977), Pani tradizionali, arte effimera in Sardegna, Cagliari.

Combès, J.L. and A. Louis (1967), Les potiers de Djerba, Tunis.

Cuomo di Caprio, N. (1982), Ceramica rustica tradizionale in Puglia, Lecce.

Da Re, M.G. (1983), I ceramisti di Assemini. In F. Manconi (ed.), Il lavoro dei Sardi, Sassari: 176-188.

De Boer, W.R. and D.W. Lathrap (1979), The making and breaking of Shipibo-Conibo ceramics. In: C. Kramer (ed.), Ethnoarchaeology: implications of ethnography for archaeology, New York: 102-138.

EAA II: Enciclopedia dell'Arte Antica, Classica e Orientale, vol. II (1959), s.v. Canosa, Canosini Vasi (D. Elia), Roma: 315-318.

Finley, M.I. (1965), Technical innovation and economic progress in the ancient world. Economic History Review, 2nd S., 18: 29-45.

Foster, G.M. (1960), Life expectancy of Utilitarian Pottery in Tzintzuntzan, Michoacan, Mexico. American Antiquity 25: 606-609.

Franken, H.J. (1983), Scope of the Institute's Research Work. A short introduction. Newsletter Department of Pottery Technology Leiden I: 1-4.

Franken, H.J. and J. Kalsbeek (1975), Potters of a Medieval Village in the Jordan Valley, Amsterdam.

Fulford, M.G. and D.P.S. Peacock, (1984), Excavations at Carthage, The British Mission, vol. I (2): The Avenue du Président Habib Bourguiba, Salammbo. The pottery and other ceramic objects from the site, Sheffield.

Genava 1978: Rinuy, A., F. van der Wielen, P. Hartman and F. Schweizer, Céramique insolite de l'Italie du Sud: les vases hellénistique de Canosa. Genava, n.s., 26: 141-169.

Hamer, F. (1975), The Potter's Dictionary of Materials and Techniques, London, New York.

Hampe, R. and A. Winter (1962), Bei Töpfern und Töpferinnen in Kreta, Messenien und Zypern, Mainz.

Hampe, R. and A. Winter (1965), Bei Töpfern und Zieglern in Süditalien, Sizilien und Griechenland. Mainz.

Hodder, I. (1982), The Present Past. An Introduction to Anthropology for Archaeologists, London.

Jacobs, L. (1983), A Summary of the Research Methods. Newsletter Department of Pottery Technology Leiden I: 34-35.

Kramer, C. (1985), Ceramic Ethnoarchaeology. Annual Review of Anthropology 14: 77-102.

Leach, B. (1978), A Potter's Book, London.

Le Lannou, M. (1941), Pâtres et Paysans de la Sardaigne, Tours.

Lisse, P. and A. Louis (1956), Les Potiers de Nabeul, Tunis.

Llorens Artigas, J. and J. Corredor Matheos (1974), Spanish

Folk Ceramics, Barcelona.
Lohman, H. (1982), Zu technischen Besonderheiten apulischer Vasen. Jahrbuch des Deutschen Archäologischen Instituts 97: 191-249.
Manconi, F. and G. Angioni (eds.) (1982), Le Opere e i Giorni. Condadini e pastori nella Sardegna tradizionale, Cinisello Balsamo (Mi).
Matson, F.R. (1965), Ceramic Ecology: an approach to the study of the early cultures of the Near East. In: F.R. Matson (ed.), Ceramics and Man, Chicago: 202-207.
Meloni, P. (1975), La Sardegna Romana, Sassari.
Mossa, V. (1957), Architettura domestica in Sardegna, Cagliari.
Papousek, D.A. (1981), The Peasant-Potters of Los Pueblos. Stimulus Situation and Adaptive Processes in the Mazahua Region in Central Mexico, Assen.
Peacock, D.P.S. (1982), Pottery in the Roman World: an ethnoarchaeological approach, London, New York.
Pilia, F. (1980), Sardegna tra due secoli nelle cartoline illustrate della collezione Colombini, Cagliari.
Pleket, H.W. (1967), Technology and society in the Greco-Roman world. Acta Historiae Neerlandica 2: 1-25.
Pucci, G. (1973), La produzione della ceramica aretina. Note sull'"industria" nella prima età imperiale. Dialoghi di Archeologia VII: 255-293.
Riley, J.A. (1981a), Italy and the Eastern Mediterranean in the Hellenistic and Roman periods: the evidence of coarse pottery. In: G. Barker and R. Hodges (eds.), Archaeology and Italian Society. Prehistoric, Roman and Medieval Studies, BAR S102, Oxford: 69-78.
Riley, J.A. (1981b), The pottery from the cisterns. In: J.H. Humphrey (ed.), Excavations at Carthage conducted by the University of Michigan VI, Ann Arbor: 85-124.
Rye, O.S. (1976), Keeping your temper under control: materials and manufacture of Papuan pottery. Archaeology and

Physical Anthropology in Oceania XI: 106-137.

Shepard, A.O. (1965), Ceramics for the Archaeologist, Washington.

Steponaitis, V.P. (1984), Technological Studies of prehistoric Pottery from Alabama: Physical Properties and Vessel Function. In: S.E. van der Leeuw and A.C. Pritchard (eds.), The Many Dimensions of Pottery, Amsterdam: 79-127.

Stiles, D. (1977), Ethnoarchaeology: a Discussion of Methods and Applications. Man (N.S.) 12: 87-103.

Tecnologia, Economia e Società nel Mondo Romano (1980), Atti del Convegno di Como 27/28/29 settembre 1979, Como

Tortorella, S. (1983), Produzione e circolazione della ceramica africana di Cartagine (V-VII sec). Opus II (1): 15-30.

Virdis, F. (1959/60), I Gremi di Oristano, Tesi di Laurea Università degli Studi di Cagliari. Anno Accademico 1959/60, Cagliari.

Vossen, R. (1972), Töpferei in Spanien, Hamburg.

Vossen, R. (1984), Towards Building Models of Traditional Trade in Ceramics: Case Studies from Spain and Morocco. In: S.E. van der Leeuw and A.C. Pritchard (eds.). The Many Dimensions of Pottery, Amsterdam: 341-397.

White, L., jr. (1962), Medieval Technology and Social Change, Oxford.

Wielen, van der - van Ommeren, F. (1982), Deux vases à entonnoir au Musée de Leyde et un groupe funéraire de Canosa. Oudheidkundige Mededelingen Rijksmuseum van Oudheden Leiden 63: 77-131.

Wolf, E.R. (1966), Peasants, New Jersey.

Wonterghem-Maes, K. van (1968), De polychrome en plastische keramiek van Canosa di Puglia gedurende de Hellenistische periode, Leuven (Typewritten Dissertation).