Typology and Classification

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Abstract and Keywords

The systematic arrangement of empirical evidence is the necessary premise of any archaeological enquiry. If the process that generated an observed pattern has to be investigated, archaeologists need to choose scales and units of analysis that are appropriate for their specific context and the relative research questions. Typology, classification, and grouping techniques were developed in the last century so that archaeological datasets could be ordered and analyzed. This chapter provides an overview of the most relevant approaches to archaeological sorting. By presenting the history and development of the notion type, the emergence of diverging trends in archaeological thought is discussed. A brief digression on the basic tenets that link pottery typology to relative dating techniques is followed by an overview of the many, possible approaches to pottery description.

Keywords: classification, grouping, dating techniques, archaeological sorting, pottery typology

Introduction

IMAGINE that an archaeologist was abruptly brought to a table covered with the most disparate objects: a mug, a cookie jar, a spoon, a miniature car, a bicycle bell, a light bulb, a shoe, a glass, a stapler, a nail, a book, a sponge, a note pad, pens, a fork, a pair of keys, a pipe, and many others.

Imagine now the same archaeologist being asked to sort all the items covering the table in an ordered and logically sound way; a way that possibly represented the flow of time or the basic mechanisms of interaction between the individuals that made and/or deposited these items. The sorting should be flexible, replicable, and yet designed for the case at hand. How would our archaeologist divide them? Would she or he look at their shape, color, and overall appearance? Would it be preferable to think of their constituent materials? Or, rather, would it be better to start from their function? Should she or he look at the entire object or should she or he focus on some specific elements?

This fictive example is not dissimilar to the actual challenge archaeologists face when they uncover a context for the first time, or when they want to analyze an already known or familiar set of materials from a completely new perspective. Archaeological materials provide information about their producers and/or consumers, and their respective social, cultural, and economic contexts. However, this vast and fluid data needs to be ordered and divided in more manageable units, so that inferences about causal processes and/or relationships are possible.

Ordination techniques in archaeology have been developed for precisely this reason, to "put order into disordered evidence" (Renfrew and Bahn, 2004: 118). Variability in material culture derives from the cumulative effect of individual choices, copying errors, social preference, interaction, taphonomic processes, and multiple loss-of-knowledge events. If researchers want to identify directions in this sea of variation without sinking or getting lost, they need to produce a map in which landmarks are clearly indicated. A systematic arrangement of material culture is the archaeologist's map towards understanding and explanation. Nevertheless, there is no definitive classificatory structure that can encompass all possible (p. 652) datasets and answer all possible questions. In fact, many different approaches have developed over time, and scholars have often proposed antithetic explicit definitions or implicit uses for the terms type, class, group, and assemblage. Most of the archaeological approaches to typology and classification draw on the different directions that emerged from the archaeological debates of the 1940s and 1950s.

Studies on typology, classification, and ordination techniques have always involved a number of cultural expressions, from early lithic industries to complex pyrotechnical products. Among the latter, ceramics acquired a particularly relevant status partly owing to their abundance in later prehistoric and historic archaeological contexts, which can be in turn ascribed to the durability of pottery compared to more perishable materials, but mostly because they were increasingly used to measure time in terms of relative chronology where absolute dating was unavailable (O'Brien and Lyman, 2006). Observation of change in the formal and, potentially, functional attributes of pottery has been the key to building models of diachronic variability (ibid.). Therefore, the theory and practice of archaeological typology and classification is strongly interwoven with the study of ceramic materials.

Typology or Classification? Some Preliminary Definitions

The terms *typology* and *classification* are often thought of as synonymous and interchangeable (Adams, 2008). However, a thorough examination of these terms and their definition suggests that this is not the case.

Archaeologists, and researchers involved in many other disciplines, developed methods for systematizing and ordering the archaeological record in order to *analyze* the emerging picture of past human activities. Analyze literally means to divide something into man-

ageable and interpretable units, and to infer the dynamic relationship between them. *Classification* refers to a series of methods that can be used for the deductive categorization of observable phenomena. Approaches that rely on different or sometimes antithetical principles should not be confused with classification but instead be identified as inductive or *grouping* methods (after Dunnell, 1971; see the section “Classes and Groups” for a detailed explanation).

Typology is a technique developed by archaeologists in which artifacts are arranged according to perceived or measurable similarity between observed data and specific analytical units. These units, called *types*, are aggregates of diagnostic attributes recorded at a particular sampling site at a particular moment. Similarity is therefore based on the quality or the quantity of diagnostic attributes that *types* and data appear to share. *Types* can either be conceived as abstract models—theoretical units with no actual counterpart in the real world—or as real, empirical entities (see Hill and Evans, 1972, for discussion). While a *typology* can be a particular form of *classification*, the opposite is not always true (Adams and Adams, 1991; Adams, 2008). It follows, therefore, that the terms *typology* and *classification* cannot be used interchangeably because each term has a precise meaning and background in archaeological ordination.

(p. 653) Development of the Concepts of Typology and Classification

The Beginning

Systematization in archaeology dates back to the nineteenth century, when the large amount of evidence uncovered by antiquarians started to be rigorously compared. European prehistory offered the first framework for the identification of diagnostic artifacts and assemblages. The main objective of this early systematization was to determine a suitable chronological ordering for dividing collections in museums and other public and private institutions.

Scandinavian scholars are renowned for having formulated the famous “three-age system” based on the ordered succession of three main cultural stages, that is Stone Age, Bronze Age, and Iron Age. The system drew on the direct observation of materials repeatedly used in different assemblages over a period of time, and ordering relied upon the idea of a progressive and unidirectional technological development. The system, already known from Classical authors and endorsed by many Danish collectors, was first used in 1819 by Christian Jürgensen Thomsen to arrange temporally the prehistoric collections of the Danish National Museum (the method was published in 1836 in Danish and later translated into English; see Ellesmere, 1848).

Further archaeological investigations across Europe made it immediately clear that this simple and effective scheme could be adopted for the entire continent. This moment represented a shift towards the identification of novel *types*. **A** type—as intended at this early

stage—can be generally defined as a single artifact which embodies a specific stage of cultural development with defined temporal and spatial coordinates. At the same time, John Lubbock formalized the “Palaeolithic–Neolithic” sequence (Lubbock, 1865), and the idea of a sequential, linear development of humanity was further cemented by the acceptance of geological stratigraphy (Lyell, 1863). In this context, Oscar Montelius developed the three-stage idea of European Later Prehistory into a series of local or regional chronologies that could be directly compared and refined into a succession of subperiods. His relative dating was based on the presence of artifact *types* or “good finds” (Montelius, 1899: 308), which helped to seriate phases in different contexts through cross-site comparison. Montelius coined the terms “typological evolution” and “typological series” (ibid.), and his approach inspired directional trends on a continental scale over more than two millennia.

Refinement of the concept of type proceeded with the work of William Matthew Flinders Petrie (1899), who developed five methods to arrange artifacts from funerary contexts according to their plausible original chronological order. Among these methods, Petrie proposed the analysis of “development or degradation of form” (Petrie, 1899: 297) to be performed through the “grouping of similar *types*” based on stylistic resemblance (ibid., emphasis added). By sorting pottery according to these principles, Petrie was able to chronologically seriate vessel *types* over the whole study period, and to arrange them in a single-rooted genealogy with just one main branch based on formal resemblance (Figure 35.1). Although the model of shape evolution he proposed was simplistic and relied upon the concept of unilinear development, (p. 654) Petrie succeeded in creating *types* that had a chronological value and allowed him to explore issues of “functional versus stylistic” variability over time.

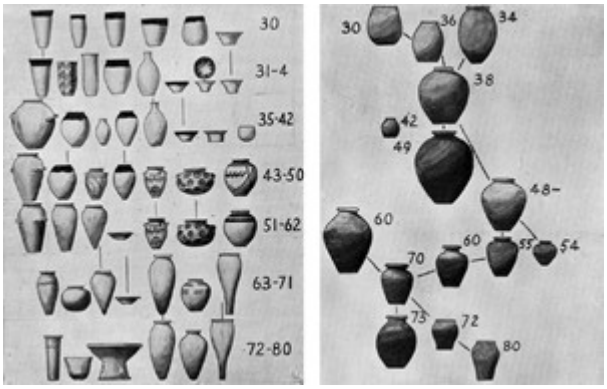

Figure 35.1 Two graphical representations of Petrie's chronological ordination of archaeological types. On the left there is a summary of diachronic trends articulated in seven successive stages. Some diagnostic vessel shapes exhibit continuity between adjacent stages. The graphs on the right consists instead of an attempt of genealogical sorting. Petrie's assumption was that of unilinear and unidirectional change over time.

(Reprinted with permission from Petrie, 1899, plates XXXI fig. 1 and XXXII fig. 3 respectively.)

Culture History

The early twentieth century represented a moment of divergent trends in the use of archaeological typology and classification, especially in Europe and the New World. On the one hand, scholars involved in the study of European and Asian prehistory built upon typologies that functioned as the basic observational unit for the different archaeological cultures documented by researchers. These "cultural markers" facilitated the systematization of the conspicuous amount of data continually emerging from new excavations on the Continent and in the Mediterranean. This work developed from the seminal contribution of Vere Gordon Childe (1925, 1929, 1930, 1932), and many specialized trends across Europe originated from it.

For example, just to mention two cases for their abundance of programmatic and methodological literature on the topic, French prehistorians focused on production techniques (the concept of *chaîne opératoire* is an example) and on the formal as well as functional attributes of artifacts (Laplace 1966, 1968; Bordes, 1988, among others). Italian prehistorians focused instead on the highly articulated and hierarchical arrangement of pottery and other artifacts, (p. 655) based upon the occurrence of specific formal attributes (Peroni, 1967, 1998, among others). These complex and rigidly defined ordination systems were empirically determined by grouping together observed materials in order to identify basic *types*. Their normative character favored the emergence and spread of an *essentialist* approach towards archaeological types. This meant that many archaeologists advocated the existence of *types* in the real world; that is, the existence of material expressions of mental templates which are immanent and invariable, models whose essence can be re-

constructed by archaeologists or directly grasped by ethnographers (Hull, 1965a, 1965b; Sabloff and Smith, 1972). The term *typology*, therefore, began to indicate a systematization based on formal resemblance between observed data and empirical *types*. This similarity was measured either on a number of diagnostic attributes or on the object as a whole.

New World archaeology proceeded slightly differently. Although it adopted the same approach as in Europe, archaeologists started looking at typology and classification as a means to address specific questions of relative chronology and human interaction (Adams and Adams, 1991; Adams, 2008). Alfred Kroeber refined and used *types* in order to produce effective relative chronologies by observing increase, peak and decrease in their relative frequency at different sampling sites (the method is known as *frequency seriation*; Kroeber, 1904, 1916a, 1916b, 1919, 1948, 1952). Chronologies obtained by frequency seriation have been used to investigate the genealogy of cultural *types*, going beyond the strict unilinear model proposed by Petrie (Kroeber 1948). Although Kroeber was explicitly referring to his *types* as artificial units imposed by the archaeologist over the continuous variability of human material culture, he also revealed an essentialist approach (1916a, 1916b; see Sabloff and Smith, 1972 and Lyman and O'Brien, 2006: 27–70 for a more detailed discussion).

A Brief Digression: Frequency Seriation

The method of *frequency seriation* assumes that a portion of total variation expressed by formal attributes is a function of time (see Figure 35.2). In other words, if time and human interaction are considered the main factors governing change in formal attributes (or some aggregate of the same attributes, i.e. *types*), time can be represented as a gradient along which sites or assemblages are sorted. The chronological scaling of sampling sites follows the relative abundance of chosen attributes or *types* at each location. More specifically, sites are arranged so that each attribute/*type* shows the longest possible historical continuity and its frequency distribution through time is unimodal. Graphic representations of such ordinations are often symmetric curves traditionally labeled *battleship-shaped* curves (Petrie, 1899; Phillips et al., 1951; Dunnell, 1970; Neiman, 1995; Lipo et al., 1997; O'Brien and Lyman, 1999; Lyman and O'Brien, 2006; Smith and Neiman, 2007).

The imposition of a unimodal or roughly normal distribution represents a strong analogy with ecological and biological phenomena. Species follow a unimodal distribution along environmental gradients, with the highest frequency around optimal values (mean) and decreasing abundance towards the tails (Hutchinson, 1957; Hill, 1973). The same principle can be applied to the ideas embedded in material culture. Cultural elements are first introduced into a population and its cultural background, then gradually spread until they reach a peak in popularity (i.e. they become the *modal class* at a specific location in time), and (p. 656) eventually decrease to extinction as they are replaced by other, newer ideas (Phillips et al., 1951: 220; Dunnell 1970: 309).

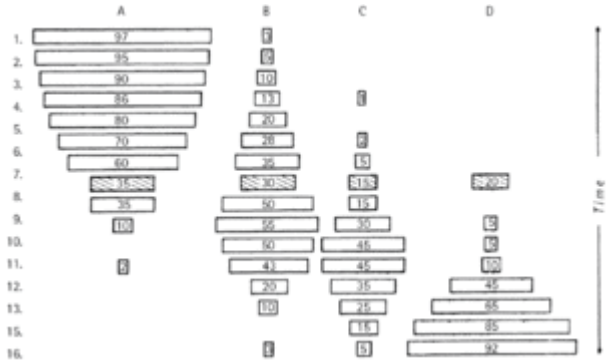

Figure 35.2 An example of frequency seriation. The relative abundance in sixteen sampling sites of four variants (A–D, expressed in percentage) is arranged so that their overall frequency/probability presents a unimodal distribution. These battleship-shaped curves effectively represent the flow of time due to the apparent trends in popularity of the observed types or classes. The graph shows that the space occupied by the earliest variant (A) is progressively invaded by two, low-frequency traits (B, C). These are in turn are replaced by a later innovation (D) that progressively leads to the extinction of all other variants. As suggested by the double time-arrow on the right, frequency seriation gives no preliminary indication of time directionality. This has to be archaeologically inferred.

(Reprinted with permission from Dunnell, 1970:312, fig. 3.)

This working assumption has been further developed by observing (Dunnell, 1978, 1980, 1986; Teltser, 1995) and demonstrating (Neiman, 1995) that the frequency distribution of specific formal traits (e.g. decorative attributes) predicted by frequency seriation resembles that of non-selective alleles studied in biology and genetics. This parallel suggests that when cultural elements, not subject to any functional preference or social bias, are free to vary over time according to the exchange of information between humans (i.e. in the presence of cultural drift), they produce a unimodal distribution analogue to that of non-selective genetic variants (determined by genetic drift; see Cavalli-Sforza and Feldman, 1981, and Boyd and Richerson, 1985, for a detailed discussion of parallels between genetic and cultural transmission).

Ordinations generated through seriation are merely formal and their chronological value must be inferred. For this inference to be robust, frequency seriation must meet three conditions: (i) all sampling groups or sites must have the same or comparable duration in time, so that frequency distribution is not affected beyond sample-size effects; (ii) all groups in a seriation must be *homologous*; in other words, deriving from a shared ancestor and presenting (p. 657) heritable continuity aside from historical continuity (Cochrane, 2009); and (iii) seriation has to be conducted to an appropriate spatial scale, so that attribute or *type* frequency distribution can be considered as determined by chronology

rather than geographical distance, information transfer, and migration (Dunnell, 1970: 316; Lipo et al., 1997).

Early Debates over the Notion Type

The first epistemological discussion on typological ordination appeared within the framework of Americanist archaeology by Irving Rouse (1939) and Alex Krieger (1944). The meaning that Rouse assigned to the term *type* was radically different from that established by early nineteenth-century archaeologists. In his words, the concept *type* indicates a theoretical unit, a class to which empirical objects can be assigned if they present a set of necessary and sufficient *modes* or attributes (Rouse, 1939:9). Rouse's *type* was intended to be immutable, and its origin, diffusion, persistence, decreasing popularity, and replacement could be used to investigate change in a given culture (Rouse, 1939: 14; see Dunnell, 1986: 169–176, for further discussion). Rouse's units were based on stylistic and formal attributes and—similarly to Kroeber's—could be used to generate relative chronologies (Rouse, 1939: 18).

Krieger expanded upon Rouse's work from both a theoretical and practical perspective. In his words, an archaeological *type* "should represent a unit of cultural practice," that is, the fossil of an ethnographically observable cultural trait (Krieger, 1944: 272). The function of *types* was to identify patterns in material culture that would facilitate inferences about the mechanisms of information transfer, human interaction, and culture change. *Types* were, therefore, "organizational tools" that enabled researchers to divide artifacts into groups with "demonstrable historical meaning" (Krieger, 1944) (see Figure 35.3).

Krieger refused the use of hierarchical arrangements of artifacts or assemblages (i.e. taxonomic classifications) and envisaged a six-stage process named "the typological method" (Krieger, 1944: 279–281). The process started by grouping together artifacts that could be the product of similar design or mental templates. Groups were progressively refined, and clusters with comparable distributions were merged into higher-level *types*. Consistency and robustness of the obtained *types* were iteratively tested through comparison with independent information and other collections. *Types* were then formally described and finally used for cross-cultural comparisons.

In Krieger's work, *types* emerged as artificial entities which defined particular instances of association between a determined number of variables. These units were distinct from the empirical objects that may or may not have belonged to a given *type* (Dunnell, 1986: 171; O'Brien and Lyman, 2002: 39–40). At the same time, when Krieger proceeded toward interpretation and archaeological inference, *types* were implicitly considered as phenomena of the real world, a conflation of analytical units with observed patterns (Krieger, 1944; Cochrane, 2001; O'Brien and Lyman, 2002). Therefore, his seminal paper reiterated the idea of *types* having a chiefly chronological relevance, as well as the incongruence between "types as mere tools" and "types as existing entities or mental templates."

The post-war discussion on typology is exemplified by the so-called Ford–Spaulding debate. James Ford's contribution to the notion of *type* consisted of a long sequence of problem-oriented works, aimed primarily at systematizing ceramic materials of the American southeast (Ford, 1938, 1952; see also Dunnell, 1986, for a more detailed discussion), (p. 658) and of a single, programmatic paper on the concept of *type* (1954a). Ford's work effectively shifted the focus of typology from lithic industries and other classes of material culture to pottery (Ford, 1938, 1952; Dunnell, 1986). Ford used *types* as instruments, abstract concepts that were arbitrarily formed by selecting specific attributes. In his view space, time, chance, and the derivative mechanism of cultural drift strongly affected the formation of archaeological records (Ford, 1954: 52). Therefore, archaeological *types* encompassed these processes in addition to actual individual choices (ibid.).

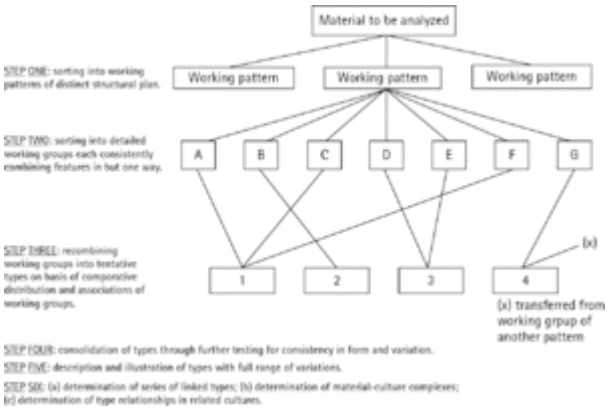

Figure 35.3 The original diagram by which Krieger explained in detail the procedure for a correct application of his typological method.

(Reprinted with permission from Krieger, 1944:279, fig.25.)

In the same years, Albert Spaulding published a paper (1953) in which he strongly opposed the notion of *types* as artificial instruments created ad hoc by archaeologists. If, as culture historians claimed, *types* represented mental templates equivalent to ethnographic cultural behaviors, they had to be considered as real entities belonging to the past. The only way for archaeologists to avoid discretion in *type* description was to make *types* emerge as non-random patterns from raw data. This could be achieved through the application of rigorous and explicit statistical techniques based on attribute association. Spaulding's approach, predating the requirements of Processualism and New Archaeology, aimed at replacing the iterative testing of the Krieger–Ford approach, and directly addressed the issue of *types*' cultural–behavioral value. Spaulding explicitly relied on an essentialist view of *types*, that is, he considered types as real entities (Hull, 1965a, 1965b; Sabloff and Smith, 1972), and his method was purely inductive. This created a problem of an overlap between the definition of types and their empirical test (Dunnell, 1982, 1986; Cochrane 2001), and did still not eliminate subjectivity from the critical step of attribute choice.

(p. 659) Spaulding's paper was followed by a heated debate (Ford 1954a, 1954b, 1954c; Spaulding 1954a, 1954b) in which two fundamentally opposed views—that of *types* as theoretical, artificial constructs functional to specific enquiries and that of *types* as existing entities that could naturally emerge from the noise of empirical data—confronted each other. Ultimately, Spaulding won the debate and had a greater influence on the research of the following decades, as it was more in line with the changing attitude of archaeologists toward function and behavior.

Classes and Groups

Over the last thirty years, archaeological sorting methods have been refined, elaborated on, and perfected. Nevertheless, all typologies and classificatory arrangements in the literature, no matter how sophisticated, are rooted in one of the models proposed by Rouse–Krieger–Ford on the one hand and Spaulding on the other. All systematic arrangements may be conveniently divided into *deductive* (top-down) *classifications* and *inductive* (bottom-up) *grouping* methods (after Dunnell, 1971).

Deductive classification consists of generating theoretically derived units (*classes*). In other words, a number of diagnostic attributes and a particular observational scale are selected depending upon the initial research question. Membership in each *class*, by any of the observed objects, is defined by the exhibition of these attributes (Dunnell, 1971: 15). Deductive classificatory processes constantly test and update theoretical units based upon the available evidence (as suggested by Krieger). *Classes*, therefore, are tools produced to verify expectations about the relationship between categories (Dunnell, 1971: 24).

In a *deductive classification*, a *class* can be structured according to two different principles: *monothetic classes*, which assume diagnostic attributes that are mutually exclusive and represent the necessary and sufficient condition for an object to be included in a given class; and *polythetic classes*, in which *classes* are defined by the collocation of a number of diagnostic attributes, none of which alone can ever be considered as necessary or sufficient. In a *polythetic* system attributes are never mutually exclusive.

An example of monothetic approach is *paradigmatic classification* (Dunnell, 1971; O'Brien et al., 2001, 2002; O'Brien and Lyman, 2002a, 2002b). This system produces a non-hierarchical arrangement of classes defined by the necessary and sufficient exhibition of equally weighted, mutually exclusive attributes. The high level of redundancy offered by this method has proven to be particularly useful in tracking change over time and investigating cultural phylogenies (O'Brien and Lyman, 2003).

The primary weakness of *monothetic* arrangements is that, in order to create classes that are strictly defined by necessary and sufficient conditions, the number of attributes that can be used is considerably lower than all the possible dimensions of variation observable

in the data. Therefore, this classificatory approach simplifies empirical reality by focusing on only a limited number of diagnostic variables.

The term *polythetic* was first coined in biology by Sokal and Sneath (1963), and was adopted into archaeology by David Clarke in 1978 (Clarke, 1978: 35ff.). Clarke claimed that, unlike natural phenomena, cultural entities could not be forced into strictly *monothetic* parameters. Artifacts and products of human culture could be systematically described, but (p. 660) not severely defined by necessary and sufficient attributes. A *polythetic* approach to classification enables the archaeologist to preserve most of the available information about artifact variability and respects the idea of continuous variation in the real world, although these features make it more challenging for the analytical and inferential stages of research.

A theory-driven or *deductive* classification, whether *monothetic* or *polythetic*, conceives of *classes* and *types* as heuristic tools, in other words theoretical units with no necessary counterpart in the real world, and uses these tools to answer specific research questions about a specific dataset (Klejn, 1982). Deductive *classes* are abstract models distinct from the groups of objects they create, and function as an ideational meter of comparison for empirical observations.

In *inductive grouping* archaeological materials are observed and divided according to shared attributes, and *types* emerge from the analysis itself. Therefore, *groups* are not predetermined theoretical units; they are purely empirical units overlapping with their own definition, with no distinction being made between actual assemblages and the conditions for membership in each group. This approach derives from Spaulding's definition of type and has benefited from the increasingly efficient development of clustering and distance-based phylogenetic algorithms (Whallon, 1972, 1982; Read, 1982; Whallon and Brown, 1982).

The *inductive* method is both viable and indicated for the initial exploration of archaeological datasets through pattern-recognition techniques (Christenson and Read, 1977; Aldenderfer and Blashfield, 1978; Hodson, 1982; Legendre and Legendre, 1998; Smith and Neiman, 2007). Among its objectives are explicit methodological explanation and a tendency towards quantification. However, as in the case of theoretical *classes*, inductive *grouping* methods have some important limitations (Dunnell, 1971, 1986). For example, the approach is not designed to test hypotheses or to infer processes assumed a priori (Read, 1987). In addition, this approach supports an essentialist view, in which "natural" *types* emerge from data and represent mental templates existing in the real world (Hull, 1965a, 1965b; Read, 1987; although see Hill and Evans, 1972, for a critical review of this epistemological problem).

To conclude, *groups* and *types* obtained by inductive ordination may result from generalizations based only on observed phenomena (Willer and Willer, 1973; Dunnell, 1982; Cochrane, 2001). The potential issue is that units obtained through empirical generalizations are easily falsifiable; they are unable to change or adapt. Rather, these units are

stretched to cover an increasing diversity in the available evidence, and eventually succumb to continuously emerging exceptions.

How Many Typologies and Classifications?

The systematic arrangement of materials, particularly ceramics, is one of the most common and critical activities in archaeology. Researchers can adopt different theoretical perspectives, a number of possible methods, and almost infinite attributes to describe variation in equally valid and useful ways (Sinopoli, 1991: 44). Specialist, applied, and generalist literature on the topic is considerable, and every author explicitly or implicitly emphasizes the approaches and perspectives that she or he considers more applicable.

(p. 661) But "which is the *right* ordination method?" The quick answer is that there is no right or wrong arrangement of artifacts or ordination method (Hull, 1970; Sinopoli, 1991). There are simply techniques that can be designed and adapted for individual datasets or to answer specific questions. Some arrangements may not be appropriate for some contexts, but this does not make them invalid in other contexts or for other questions. Every systematic approach has its problems and limitations. It is important to be aware of these issues, and to be explicit in detailing the chosen method and its pitfalls (Krieger, 1944; Dunnell, 1971).

The first choice that researchers have to make when designing a classificatory strategy is between structuring their types, classes, or groups in *qualitative* or *quantitative* terms. The former refers to the identification of nominal or categorical variables as diagnostic attributes (color, shape, formal aspects, decorative motifs) in order to observe their presence or relative frequency within a context. The latter refers to higher-level variables that can be quantified at ordinal, interval, or ratio scale (Shennan, 1998: 8–12) and usually focus on aspects of a vessel that are directly measurable, such as height, width, diameter, angles, percentages of ware components, and so on.

Describing the distribution of attributes in a quantitative fashion is the most appropriate way to provide explicit, sharable, replicable, and testable units or types. However, it is worth remembering that any ordination process is based on the subjective discrimination of specific qualities over others. In other words, archaeologists choose what to observe and measure, depending on their questions and objectives. This choice is arbitrary by definition. Therefore, any systematic description consists first of a qualitative process drawing on discrete variables or attributes, followed by the quantification of attribute distributions (Dunnell, 1971: 54–55).

It follows, therefore, that the mandatory first step in any classification is attribute selection (Rice, 1987: 285). Ceramics possess a seemingly infinite number of measurable attributes, characteristics, and dimensions. Therefore, the choice of diagnostic attributes should be oriented toward answering specific questions on specific sets of data. Attributes might constitute the best scale of analysis, in which case they should be consistently observed through time and space. Alternatively, spatially and/or temporally bounded ag-

gregates of chosen attributes can be selected. In the latter case, observational units consist of the product of an ordination process, whether these are types, classes, or groups.

As far as the systematic description of ceramics is concerned, dimensions of pottery variability may be roughly divided into *formal dimensions* and *technological dimensions* (Sinopoli, 1991: 56–65; Orton et al., 1993: 152–165). The former refer to observations concerning the shape of the entire vessel, the shape of any specific components of the vessel, or any type of surface treatment (Rice, 1987: 287). Entire vessel shapes can be described by using established typological categories or developing new ones. Some formalized descriptions of individual vessel parts have been published (Gardin, 1976, 1978, among others), and can be used to achieve a more standardized and replicable representation of vessel design.

Alternatively, and preferably, description of shapes can be reached through direct measurement and quantification of relevant attributes. The use of complete or almost complete vessels is preferable, in order to reduce the risk of sample inflation and inference over a non-representative assemblage, although a number of techniques have been developed to overcome these limitations (Orton et al., 1993; Orton, 2000). An entire vessel shape might be directly compared with abstract or primitive geometric forms (truncated or overlapping (p. 662) cones, cylinders, spheres, ellipsoids, etc.) or with several composite forms in order to systematically measure volume (Shepard, 1956: 233; Gandon et al., 2011).

Measurement of both complete vessels and fragments of shapes is possible by theoretically slicing the vessel into standardized horizontal sections and measuring the absolute radius of each slice (Wilcock and Shennan, 1975), the relative distance from a tangential imaginary line, or mathematically describing body curves (see Orton et al., 1993: 159–163, for a detailed discussion). These methods have greatly benefited from the increasing use of informatics (Gilboa et al., 2004; Kampel and Sablatnig, 2007; Martínez-Carrillo et al., 2009, to quote some recent examples). Vessel size is most commonly a measurement of absolute height and diameter, lip angles, shoulder angles, angles at the base, thickness of rim, neck, body, and base (see Sinopoli, 1991: 61–62). It is also possible to classify vessels according to ratios between pairs of the above-mentioned measures, so that individual specimens are more directly comparable (see Figure 35.4). These procedures can be used to infer differences in the manufacturing process, the transmission of knowledge, and the skills of individual potters (Roux, 1990; Gandon et al., 2011).

Surface treatment comprises observations on surface color, level of elaboration, smoothness, the presence of glazing or slips, and the presence of appliques or comparable (p. 663) ornaments. All these elements can be systematically described and useful classifications can be drawn on such data. Because quantification is often more difficult for surface attributes, archaeologists tend to divide them into categorical units (either presence–absence or multistate variables) and quantitatively treat their distribution through space and time. The classification of decorative patterns as categorical attributes has been fruitfully employed to investigate mechanisms of cultural transmission, adoption, and selec-

tion responsible for the formal evolution of material culture (Neiman, 1995; Shennan and Wilkinson, 2001; Cochrane, 2009). Interesting correlations between formal attributes and potentially functional characters have also been explored (Steele et al., 2010) (see Figure 35.5).

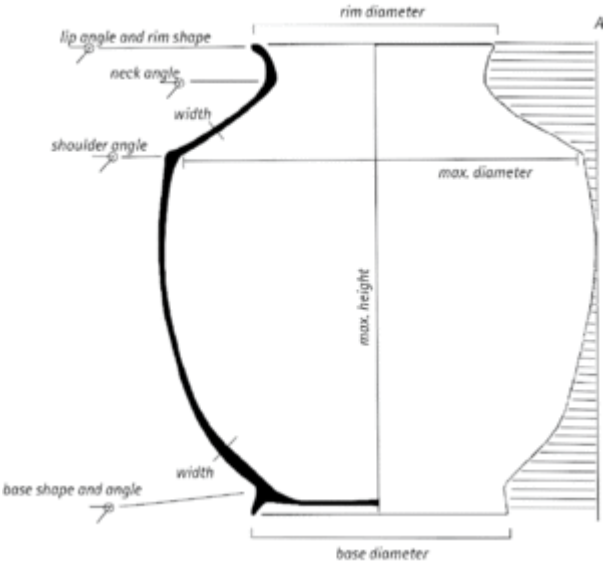

Figure 35.4 Some quantifiable formal dimensions in pottery. It is possible to use ratios between pairs of measures so that the effects of marked differences in absolute vessel size can be controlled. A is a tangential, vertical line that can be used to obtain a numerical representation of vessel shape. Alternatively, standardized horizontal sections can be theoretically traced and measured for their absolute radius.

In addition, *technological dimensions* can be chosen for ceramic description. Typologies based on technological characters are comparatively rarer (Rice, 1987: 286–287). One of the most explored attributes of ceramic wares is their composition. The chemical and mineralogical analysis of ceramic fabrics is often used to infer the potential raw material sources (Neff, 1995; Méry, 2000). Tempers are used to distinguish different technical traditions, to make inferences about functional aspects of the finished vessels that influenced individual and group choices, and/or to generate hypotheses about the temper sources chosen by potters (Feathers, 2006). Firing techniques can be investigated through the analysis of minerals and components in different wares, as well as through the color of both surface and core (for example to distinguish between oxidizing and reducing kiln environments; see Rye, 1981: 114–118).

Conclusion

In summary, it is important to remember that:

• Ordination methods have been developed to systematically arrange disordered information contained in the empirical record.

• The systematic description of material culture is at the root of archaeological practice and significant effort has been invested in the classification of archaeological ceramics in particular.

• The systematic arrangement of archaeological phenomena originated from the need for reliable chronological sequences. Initial typological and classificatory efforts led to normative approaches and involved the classification of cultures supported by a unilinear and progressivist view of human societies.

• Later developments focused on *typology* and *classification* as tools for generating effective relative chronologies (frequency seriations), and to investigate the interaction between individuals and human groups.

• The term *type*, although it generally refers to an aggregate of particular characteristics in space and time, has been used alternatively to refer to actual objects, abstract units, mental templates, analytical tools, and groups of real entities.

• As emerged in the debates over typology in the 1940s and 1950s, all systematic arrangements, no matter how sophisticated, can be divided into *deductive* and *inductive* approaches. The first generate abstract or theoretical units starting from a particular set of research questions. These units (*classes*) are then used to divide observable (p. 664) (p. 665) phenomena, and each class may or may not have an actual counterpart in the real world. The second approach allows analytical units to emerge from empirical data as “natural” *groups* based on shared attributes.

• It is impossible to create a single classificatory structure for general purposes or to answer questions that are not theory and context specific (Hull, 1970). In fact, different sorting methods need to be developed to meet the requirements of different contexts and datasets. In addition to the choice of an appropriate observational scale, attribute selection is the most critical step to build effective units (types, classes, or groups).

• The explicit definition of categories and the replicability of their quantitative evaluation make classificatory practices the most amenable to communication and problem-oriented archaeological enquiry.

• Ceramic materials can be arranged according to a vast number of variables. These comprise both *formal dimensions* (shape and size of entire vessels or their portions, surface treatment), and *technological dimensions* (composition, firing techniques, tempering, and manufacturing processes).

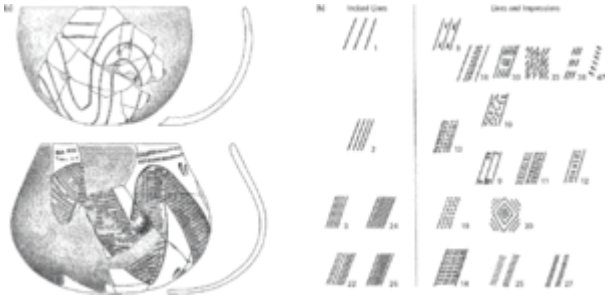

Figure 35.5 An example of categorical classification of pottery surface decoration from a Central European Neolithic context. a) Two almost complete Bandkeramik vessels from Merzbach valley (reprinted with permission from Shennan and Wilkinson, 2001:581, fig.2, after Lüning and Stehli 1994, plate 6.3 and 29.7); b) diagnostic decorative motifs used for classification and to investigate potential processes of cultural transmission

(reprinted with permission from Shennan and Wilkinson, 2001:582, fig.3, after Frirdich, 1994, fig.10).

A famous quote by Box on model building stated that “all models are wrong, but some are useful” (Box and Draper, 1987: 424). This means that all abstract representations of reality elaborated by researchers are, by definition, distinct from reality itself (from a linear meter to increasingly complex simulations, from weight units to mathematical abstractions). By pointing at selected elements models offer useful and often repeatable comparisons with observed phenomena. For us to understand and explain the empirical world, models need to be rejected and hypotheses need to be tested; only then can causal processes be inferred.

In the same way, one could state that all classes and types are wrong, but some are useful. All arrangements of empirical objects conducted by researchers are models of reality. Types, classes, and ordination systems constitute, for the archaeologist, a door connecting a theoretical, abstract, or ideational level to an empirical, material, or phenomenological level (Dunnell, 1971: 26–30). In order to generate knowledge, the archaeologist has to move between these worlds in both directions, which means she or he must view material culture both deductively (from theoretical to empirical, or top-down) and inductively (from empirical to theoretical, or bottom-up; Willer and Willer, 1973). Types and classes, therefore should offer a controlled, repeatable, and formally testable background against which observed phenomena can be measured in order to answer specific questions.

As in the case of models, building problem-oriented types and effective classificatory systems implies the simplification of reality. The large amount of variability expressed by human actions at an individual level has unpredictably broad consequences at the population level. Artifact variation in a population generally results from the cumulative effect of change, innovation, and taphonomic processes through space and time. If an ordination system is limited by the investigator’s criteria and purposes, it cannot encapsulate this immense range of variability. Rather, it must consistently represent a smaller number of

dimensions in order to account for at least some of their causative processes, and to avoid drowning the investigator in the flood of data generated by the richness of individual creativity (Filippucci, 2011: 190).

It has been pointed out that there is no fixed or optimal number of attributes that an archaeologist should include in her or his descriptive system. On the one hand, the more attributes or characteristics analyzed the more accurate the description. However, if a (p. 666) cautious researcher considered *all* the possible attributes of an object in her or his description, she or he would end up with an *exact replica* of the object itself which would clearly not be very helpful in exploring variation, its possible causes, or its patterning and directionality. This archaeologist would find herself or himself in a sea of variability with only a 1:1 map of it, unable to focus on information of immediate importance; and, ultimately, she or he would be forced to abandon the search altogether.

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