

The Wavy Line and the Dotted Wavy Line Pottery in the Prehistory of the Central Nile and the Sahara-Sahel Belt

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The two type-sites of the Khartoum Mesolithic and Khartoum Neolithic (Khartoum Hospital and Shaheinab), in Central Sudan, were excavated at the end of the 1950s. The ceramics recovered from these sites, characterized by wavy line and dotted wavy line decoration, formed a cornerstone for identifying Mesolithic–Neolithic components along the Central Nile and across the Sahara-Sahel Belt. Moreover, they formed a model for an evolutionary sequence, and suggested a level of cultural uniformity for the Nilo-Sahara-Sahel Belt from the eighth to the fourth millennia BC. This paper examines these and other related issues.

L'hôpital de Khartoum et Shaheinab, qui se situe au centre du Soudan, sont les deux sites archéologiques principaux de la civilisation mésolithique et néolithique. Ces deux sites furent découverts et excavés au cours des années 1950s. Les céramiques découvertes dans ces deux sites se caractérisent par leurs lignes continues et onduyantes, et d'autres onduyantes mais discontinues. Ces céramiques représentent la pierre angulaire pour les caractéristiques de la période mésolithique et néolithique dans le centre de la vallée du Nil et à travers la zone du Sahara-Sahel. De plus, elles ont constitué un modèle pour l'évolution et ont suggéré une certaine uniformité culturelle entre la vallée du Nil, le Sahara et le Sahel de huitième au quatrième millénaires avant J.-C. Cette recherche traite donc de ces points et d'autres aspects s'y rapportant.

KEY WORDS: Khartoum; Mesolithic; Neolithic; pottery; Nilo-Sahara; wavy line.

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INTRODUCTION

The last few decades have witnessed a significant number of excavations of early ceramic-bearing sites of the widely known Khartoum “Mesolithic” and Khartoum “Neolithic” components in the Central Nile and along the Sahara-Sahel Belt (e.g., Abdul Magid, 1988, 1998; Arkell, 1947, 1949, 1953, 1972, 1975; Bailloud, 1969; Barthelme, 1977; Camps, 1982; Caneva, 1983a, 1987b, 1988a,b, 1991; Clark, 1973, 1989; Elamin and Khabir, 1987; Gabriel, 1981; Haaland and Abdul Magid, 1995b; Hugot, 1963; Khabir, 1981, 1985, 1987a; Krzyzaniak, 1974, 1984, 1990; Marks and Mohammed-Ali, 1991a,b; Mohammed-Ali, 1982, 1984, 1987, 1991a,b; Sutton, 1974; Wendorf *et al.*, 1984; Wendorf and Schild, 1980). Both components were originally discovered, excavated and defined by Arkell (1949, 1953) at Khartoum, Shaheinab, and el-Qoz, in the Khartoum district of the Central Nile (Fig. 1). Here, Arkell set a typology which was followed and, with some modifications, implemented by other researchers working on comparable material (e.g., Caneva, 1987a; Haaland, 1987; Haaland and Abdul Magid, 1995a; Khabir, 1981, 1985; Mohammed-Ali, 1973, 1982). Arkell’s model for the Central Nile has been taken further west to form a cornerstone for identifying Neolithic components along the African Sahara-Sahel Belt. It has been acknowledged that Arkell’s typology suffers major pitfalls, which have resulted in some confusion, and hence it has been criticized (Hays, 1971; Khabir, 1981, pp. 124–172; Marks *et al.*, 1968; Mohammed-Ali, 1973). Nonetheless, it has been widely used and it remains the basic framework within which the subsequent ceramic finds of Khartoum Mesolithic and Khartoum Neolithic components have been fitted in (see *infra*).

The sites with these early ceramics in the Central Nile include Khartoum Hospital (also known as Early Khartoum), Shaheinab and el-Qoz (Fig. 1). On the basis of excavations of these sites, and his perception of ceramic evolution, Arkell proposed a cultural and evolutionary sequence from what he termed “Khartoum Mesolithic” (the Khartoum Hospital component) to “Khartoum Neolithic” (the Shaheinab component), spanning, as it transpired, the eighth millennium BC to the early third millennium BC (Caneva, 1983b, pp. 149–152; Marks, 1991a, p. 61).

Arkell described the ceramic collections recovered from his sites (Arkell, 1949, 1953) as being characterized by decorative motifs well and widely known in the literature of Sudanese and African archaeology as “wavy line” and “dotted wavy line” (e.g., Abdul Magid, 1988, 1991, 1992; Bailloud, 1969; Banks, 1980, 1984a; Barthelme, 1977, pp. 33–34, 1985, p. 119; Camps, 1982; Camps-Fabrer, 1966; Caneva, 1983c, 1987b, 1988b; Caneva and Marks, 1990; Chlodnicki, 1984; Clark, 1973, 1989; Haaland, 1987, 1989, 1992, 1995; Hays, 1971, 1975; Hugot, 1963; Khabir, 1985, 1987a; Mohammed-Ali, 1982; Phillipson, 1977a, p. 27, 1977b; Sutton, 1974, pp. 527–547; Wendorf *et al.*, 1984). The apparent presence of these and/or similar motifs on ceramics from numerous localities along the Nile, from Shabona in the south (Clark, 1973) to the second cataract in the north (Shiner,

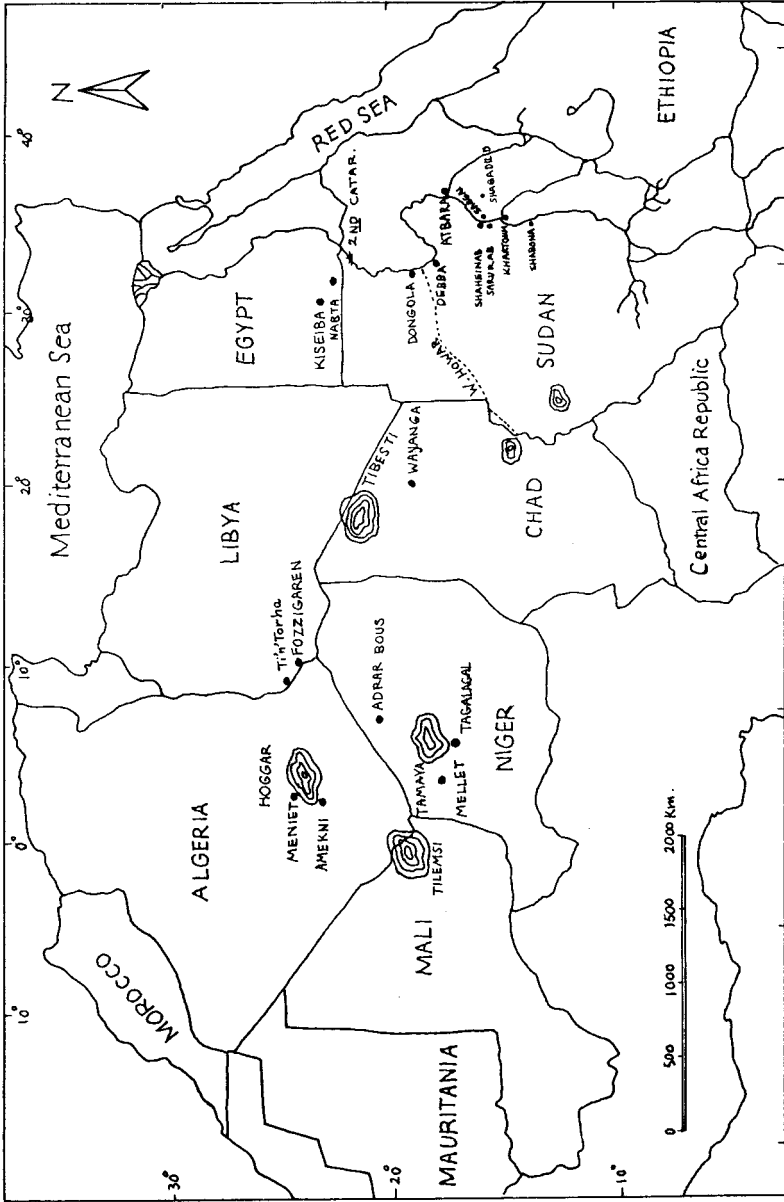


Fig. 1. Wavy line and dotted wavy line sites in the Nile Valley and the Sahara-Sahel Belt.

1968) and from the Sahara-Sahel Belt (Banks, 1984b; Gabriel, 1981; Mohammed-Ali, 1987; Mohammed-Ali and Jaeger, 1989; Wendorf *et al.*, 1984), as well as from sites east of the Nile Valley in Sudan (Mohammed-Ali and Marks, 1984; Shiner, 1971; Fig. 1), has suggested a certain level of cultural uniformity which was considered evidence, along with other objects such as bone harpoons, stone adzes, and gouges, for widespread east-west cultural connections across the Nilo-Sahara-Sahel Belt. These have been thought by some workers to represent a “cultural tradition” (Hugot, 1963) and viewed by others as a “horizon style” (Hays, 1971).

In a situation such as the one under consideration, where a huge area shares certain cultural similarities, there is often a tendency to emphasize those material elements which seem to support homogeneity rather than those which emphasize heterogeneity. The two ceramic motifs under consideration, the wavy line and the dotted wavy line, fall into the former category. Arkell’s work (Arkell, 1949, 1953) has influenced those who came after, even when different taxonomic procedures have been emphasized (Camps-Fabrer, 1966; Caneva and Marks, 1990). Those of us working on similar components in the Central Nile and its adjacent areas have utilized Arkell’s concepts to a greater or lesser extent (e.g., Caneva, 1983b, 1987a,b; Haaland, 1987; Hays, 1971; Khabir, 1981; Marks *et al.*, 1985; Mohammed-Ali, 1982). Accordingly, these later works have inherited the weaknesses and confusions embedded in Arkell’s typology and hence presented a distorted picture of the early ceramic industries of the Central Nile.

Indeed, it is rather surprising that, despite the fact that over 50 years have elapsed since Arkell’s works were published (Arkell, 1949, 1953), and a significant amount of ceramic data has subsequently been unearthed and studied, researchers have failed to surpass the problem. This paper is not meant to criticize these works or to generate a current paradigm, but rather to isolate the inconsistencies and confusions flourishing in the literature.

PREVIOUS KHARTOUM MESOLITHIC–NEOLITHIC POTTERY CLASSIFICATIONS

Arkell’s Work

For his time, Arkell was a meticulous field archaeologist, whose pioneering work placed the Central Nile on prehistoric maps for the first time. His work has resulted in the perception of two distinct modal ceramic components, each characterized by a decorative motif: the Khartoum Mesolithic, associated with a “wavy line” and the Khartoum Neolithic associated with a “dotted wavy line.” However, a number of other ceramic elements were included in Arkell’s “wavy line” and “dotted wavy line” definition, taking these types well beyond surface decoration. He describes the “wavy line” as “a very hard ware, in which the clay

is full of fine angular quartz sand grains and which breaks with either a black or red-brown fracture . . . decorated with a comb moved horizontally and at the same time up and down so as to produce a number of parallel wavy lines” (Arkell, 1949, p. 81).

This definition includes, as can be seen, not only a decorative motif but also a decorative technique, together with other variables such as fabric, ware, temper, and firing. Although it was not so demonstrated, these variables were combined as if they covaried. One problem arises from the fact that Arkell has failed to select mutually exclusive variables and that he was unable to control them in a manner to avoid any overlap. Additionally, some of his classificatory attributes are unsatisfactory. For instance, he categorized some “Mesolithic ceramics” from squares X39 and P40 at el-Qoz as “probable wavy line pottery” and “probable dotted wavy line,” while Neolithic ceramics were described as “Gouge Culture” and “probable Gouge Culture” and some potsherds were classed as “doubtful ware” (Arkell, 1953, pp. 98–100). In the authors’ view descriptions such as “probable” and “doubtful” do not qualify for a class. Not only that, but even some of his distinctive decorative motifs are devoid of wavy lines, whereas others are produced in a manner which cannot be described as wavy line (Arkell, 1949, plates 63: 2, 65, 69: 1, 70: 3, 71: 3, 73: 1, top row, third from left, bottom row, plate 73: 3). Apparently one feature which these motifs held in common was the implement used to produce the decoration, which he identified as “the spine of the catfish *synodontis*” (Arkell, 1949, p. 81). Catfish spine, or any other implement of its kind, could be used differently to produce different motifs, and this gave rise to the confusion between the implement, the technique, and the motif. This has resulted in the “wavy line” type of pottery accounting for 80% at the type-site, and accordingly characterizing the Khartoum Mesolithic.

In reality, the “wavy line,” as a type, comprised sherds exhibiting a number of different motifs, produced by different techniques (e.g., combing, rocker stamping) and possibly by a number of implements. The combination of different motifs into one type would have been justifiable had the classification been based on technological criteria.

As for the “dotted wavy line,” Arkell stated that “the pot was first combed with wavy lines and then dots have been impressed along the grooved lines so formed” (Arkell, 1947, p. 178). At a later date, he partly altered this definition to read “a variety of the ordinary wavy line decoration. . . produced by combing a band of wavy lines in ordinary wavy and then impressing dots by rocker technique along the grooved lines so formed” (Arkell, 1949, p. 84). Both definitions demonstrate a mixture of variables, the motif, the technique and the implement, and Arkell included in this group motifs which cannot be so classified (Arkell, 1953, plate 29: 2). Moreover, the dotted wavy line creates another problem; that is, while the wavy line often appears by itself as a distinctive motif, the dotted wavy line appears, in many cases, as an element of a complex motif confined to the upper part

of the pot. Considering that 99% of the body of Mesolithic and Neolithic ceramics is made up of sherds, we can see how much this could affect our types.

It was also assumed, and generally accepted, that the wavy line developed into the dotted wavy line (Arkell, 1949, pp. 84–85, 1953, p. 68). However, contrary to what Arkell states, the ceramic assemblages from his sites on the Central Nile do not show this (Arkell, 1949, pp. 84–85, 1953, p. 68). In 1972 Arkell wrote that “unburnished dotted wavy line ware is typical of the late horizons of the site of Early Khartoum (Khartoum Hospital) but not of the site at Shaheinab. Though the dotted wavy line motif did continue for a time at Shaheinab, the ware exhibiting this form of decoration there is to be distinguished by its being burnished” (Arkell, 1972, p. 221). This has added more confusion. The distinction here was clearly made on surface treatment (burnished versus unburnished) rather than on the decorative motif.

For its time and region, Arkell’s ceramic typology was acceptable, but it is not satisfactory for the increasing ceramic data being recovered, spanning a long period of time (eighth–fourth millennium BC) and covering a wide area (ca. 5300 km east-west and 1500 km north-south).

Camps and Camps-Fabrer’s Classificatory Schemes

When similar ceramic assemblages were recovered further west of the Nile in the Sahara, Arkell’s typology was inherited by a number of researchers. In his work at the site of Amekni (Fig. 1), Camps classified pottery collections reminiscent of the “Sahara-Sudanese Neolithic” tradition using Arkell’s wavy line determinations (Camps, 1982). Camps-Fabrer (1966) emphasized the technique and the implement used as dependent variables.

Hays’ Classificatory Scheme

Further attempts have followed to assess the Nilo-Saharan Neolithic ceramic connections using the type variety classificatory system. The first was concerned with ceramics bearing Arkell’s Khartoum Mesolithic decoration (Hays, 1971), and examined assemblages from both the Sahara and the Nile. Hays ended with one “ware” which was made of five decorative techniques (Hays, 1971, pp. 67–88), each associated with one or more decorative motif. In a later paper by Hays and Hassan (1974), he compared these assemblages on the basis of the lithic material and ended by suggesting a “Khartoum Horizon Style.” This can be criticized on the basis that Hays’ “horizon style” was based only on very broad similarities in a single motif, and failed to account for the differences in the decorative patterns. Moreover, it overlooked the absence of any significant features among the lithic material, and failed to demonstrate any of the preconditions considered necessary

for a “horizon style”: (1) the duration of the apparent stylistic horizon; and (2) the uniformity of the ceramic assemblages within the horizon (see Willey, 1945, p. 55; Willey and Phillips, 1958).

Nordstrom’s Classificatory Scheme

Nordstrom’s classification (1972, pp. 33–72) examined the Neolithic and A-Group ceramics in Sudanese Nubia. It was a detailed study that included all the possible combinations of fabrics, techniques, and patterns of decoration. The Neolithic ceramics fall into a single ware (Family K), with two temper-varieties in decorative motifs. Nordstrom’s attempt produced a taxonomic model bearing new technological indices. However, his ceramic material did not provide a comprehensive chronological index, deriving from cemeteries and habitation sites in Nubia which rarely yielded stratified data. This is why his pottery “wares” have remained primarily technological concepts (see Nordstrom, 1972, p. 35).

Caneva’s Classificatory Scheme

Based on Camps-Fabrer’s work (1966), Caneva (1983a, 1984, 1987a,b) emphasized the decorative technique and the implement before the finished result. She believed that the classification of decorative motifs, mainly used by Arkell (1949, pp. 81–98, 1953, pp. 68–77), is not based on syntactic arrangement but on visual impression given by the individual decorative element, and hence it is extremely subjective (Caneva, 1987a,b, p. 233). Therefore, an appropriate alternative—according to Caneva—is the decorative technique approach, where some sequential elements in the data can be observed and the technique, as she believes, can always be defined and always determines the motif. In her work at Uan Muhuggiag and Wadi Teshuinat in the Libyan Sahara (Caneva, 1987a,b), as well as in her work in the Upper Nile, Sudan (Caneva 1988a, pp. 65–147; Caneva and Marks, 1990), Caneva applied the decorative technique as a criterion for the classification of the later prehistoric Saharan and Sudanese ceramics (Caneva, 1987a,b, pp. 233–234; and see supra). However, this attempt suffers a number of deficiencies. Firstly, there are always fewer techniques than there are motifs. Secondly, the technique is not always identifiable and cannot always be recognized from the motif. Thirdly, the use of Caneva’s approach has not brought about alternative satisfactory classificatory designations to replace Arkell’s typology (e.g., wavy lines and dotted wavy lines; Caneva, 1987a,b, pp. 233–234, 1988a, pp. 65–147; Caneva and Marks, 1990).

Physicochemical Analyses

Wavy line and dotted wavy line ceramic samples examined by physicochemical analyses at the intraregional and interregional levels proved to be locally

produced, with their temper inclusions and soil compositions reflecting local materials along the Nile and across the Sahara-Sahel (see *infra*). Mineralogical analyses of pottery samples from the Central Nile Valley (De Paepe, 1991; Francaviglia and Palmieri, 1983, 1988; Hays and Hassan, 1974; Khabir, 1981, pp. 49–123, 1987b; Nordstrom, 1972, pp. 33–58; Williams, 1982) and across the Sahara-Sahel Belt (Banks, 1980; Clark, 1989, p. 403; Hays and Hassan, 1974; Palmieri 1987; Zedeno and Wendorf, 1993) also suggest local manufacture, with their temper inclusions and soil composition indicating local derivation.

Regional variations between the pottery groups of each of these areas are evident. Within the Central Nile, the pottery sherds from Khartoum Province contain numerous nonplastic inclusions of quartz and feldspar (microcline and Ca-plagioclase). Hematite inclusions are also evident. The presence of a few garnet grains, which are common in the Nubian Sandstone, seems to confirm the conclusions that the Nubian Sandstone is the source temper of the ceramics of this area. Such rocks have a wide spatial distribution in the Central Sudan (Whiteman, 1971).

At Shaqadud in the Western Butana (Fig. 1), the physicochemical analyses of Khartoum Mesolithic and Khartoum Neolithic samples (including wavy line and dotted wavy line pottery) present two groups. One is characterized by nonplastic inclusions deriving from granitic and quartzo-feldspathic metamorphic rocks. Such types of rocks have a wide spatial distribution in the Sudan. One of the better known areas is the Sixth Cataract, some 50 miles north of Khartoum. The other group is composed of quartz and sandstone fragments which recall, in many respects, the clastic sediments of Nubian sandstone formation (De Paepe, 1991). These cretaceous rocks are widespread in the Central Sudan (Whiteman, 1971).

In the White Nile Province, the Mesolithic pottery found at Shabona (Fig. 1) shows two distinct pastes, one in which the temper is composed of quartz and grains and the other in which the temper consists mainly of coarse vegetal remains. The grass-tempered sherds show a preponderance of wavy line and dotted straight motifs, while sand-tempered sherds show a predominance of dotted wavy line and straight-line motifs (Clark, 1989, p. 403). Given the uniformity in geology, clay and vegetal belt in the immediate area of the investigated site (see Clark, 1989; Khabir, 1981, pp. 101–123; Whiteman, 1971, p. 68), the suggestion that these ceramics were locally made becomes much more likely.

In the Eastern Butana, the petrological analysis of pottery samples from Khasm el-Girba indicates the predominance of basalt lithic fragments and augite grains which are a derivation from Abyssinian basalts, drained by the Atbara river (Hays and Hassan, 1974, pp. 72–76).

In the north of Sudan, the petrological analysis of pottery samples from Dongola Reach shows the preponderance of quartz, feldspar (orthoclase, microcline, and Na-plagioclase), and sometimes mica (muscovite and biotite), together with polymineralic fragments of biotite gneiss and chlorite schist. The source of these minerals is the Precambrian Complex that consists primarily of granites,

gneisses, and schist. All the sample sites are located in close proximity to an exposure of the Basement Complex (Hays and Hassan, 1974, p. 76).

Further north, in the Second Cataract area (Fig. 1), pottery samples indicate predominant subangular to angular grains of quartz in combination with small amounts of schists, gneiss rock fragments, hornblende, and iron oxides. The presence of a few schist and gneiss rock fragments indicates a mix of tempering material from Nubian Sandstone and the Basement Complex (Hays and Hassan, 1974).

The above groups in the north of Sudan are related to the lithological provenances present in the area on the basis of mineralogical composition (Hays and Hassan, 1974, p. 76, fig. 3). Moreover, most of the sherd-samples consist of montmorillonite and montmorillonite-chlorite with or without illite, consistent with the abundance of this type of clay in the central and northern Sudan (Butzer and Hansen, 1968, p. 487; Buursink, 1971, p. 192; Khabir, 1981, pp. 73, 80; Vail, 1982, p. 52).

The petrological and chemical analyses of the Khartoum Mesolithic and Khartoum Neolithic ceramics recovered from sites across the eastern Sahara (Libyan and Western Egyptian Desert) suggest that most samples were made with local raw materials. The mineralogical analysis shows that the temper composition is extremely uniform among the sample-sets. The samples are mainly sand-tempered (overwhelmingly feldspars and quartz), frequent among the earlier ceramic collections, whereas organic tempers (chaff, shell, bone) become more common in the later material. It is noteworthy that variations in the relative amounts of particular grains were observed, but this would be consistent with variation in transport distance, weathering and depositional environment from a single source area (Banks, 1980; Palmieri, 1987; Zedeno and Wendorf, 1993).

In the Central Sahara (Wanyanga and Amekni), the pottery is characterized by abundant quartz and feldspar (microcline, Na-plagioclase). A considerable amount of vegetal fiber was noticed amongst the samples from Wanyanga, whereas those of Amekni revealed small amounts of schists, gneiss, rock fragments, and iron oxides (Hays and Hassan, 1974, table 1). Chemical analysis (XRF) of dotted wavy line pottery from the sites of Uan Muhuggiag (surface), Fozzigaren, and Wadi Tin-Torha in the southwestern Libyan Sahara provides specific characteristics from each site, suggesting local manufacture and sufficient standardization of pottery-making (Palmieri, 1987).

As it stands, the state of research on these ceramics after decades of work yields a number of questions:

1. Do these wavy line and dotted wavy line wares have any chronological order?
2. Do they have an established form of distribution in time and space to the extent that they form a "culture area"?
3. Can they be used as diagnostic cultural features for the "Mesolithic-Neolithic" adaptations along the Nile and the Sahara-Sahel Belt?

Before we deal with these issues, one confusion needs to be removed. Arkell's wavy line and dotted wavy line components at the type-sites include many decorative motifs which cannot be so called. This shows clearly in what is known as "Khartoum Variant" in the Second Cataract area, whose ceramics are dominated by woven mat, zigzag and other impressed patterns (Hays, 1974; Nordstrom, 1972, pp. 33–80, plate 123: 25–29; Shiner, 1968), and almost lacking the wavy line and the dotted wavy line. Nonetheless, on the basis of the woven mat, zigzag and impressed pattern motifs they have become part of the "culture area."

Both writers of this article have been involved in excavations and studies of ceramic materials of wavy line and dotted wavy line components on the Central Nile and adjacent areas (Khabir, 1981, 1985, 1987a,b, 1991a,b; Marks *et al.*, 1985; Mohammed-Ali, 1982, 1984, 1987, 1991a,b; Mohammed-Ali and Jaeger, 1989; Mohammed-Ali and Marks, 1984). We do not claim that the material we dealt with bears a final solution to the questions involved, but rather contributes towards that end.

WAVY LINE AND DOTTED WAVY LINE DISTRIBUTION: INTRAREGIONAL LEVEL

Stratigraphic Sequencing

In his publication on the type-site (Khartoum Hospital), Arkell (1949, p. 84) claims that the former motif (wavy line) gave rise to the latter (dotted wavy line). Arkell based his argument on two points: firstly, the order of appearance of the former decoration in the stratigraphic layers of Khartoum Hospital site points to its predating the dotted wavy line, and it was embedded in Kanker concretions, associated with artifacts that are typical only in the early settlement (Arkell, 1949, pp. 81–85, plate 59); secondly, the dotted wavy line decoration is approximately contemporary with the early settlement, as sherds ornamented with this pattern, though occurring in some hundreds, are not as numerous as those with wavy lines. Moreover, the dotted wavy line is not entirely coincident with wavy line in time and space, as indicated by the presence of the former without the wavy line sherds on several sites (Arkell, 1949, p. 116, fig. 8, Arkell, 1953, pp. 68–77; Caneva, 1988b, fig. 4: 1).

To further test the notion that Khartoum Mesolithic pottery inventories preceded the Shaheinab ones, Arkell conducted a trial excavation at el-Qoz (see *supra*) on two less distributed layers of squares: X38 and P40. The outcome of his work shows that the Khartoum Mesolithic pottery (unburnished wavy line and dotted wavy line) was predominant in the bottom layers (86–200 cm), while the Khartoum Neolithic styles (burnished dotted wavy line and other later motifs) were present in the upper layers (0–86 cm; see Arkell, 1953, pp. 98–102). It is noteworthy that in the present authors' classifications of Sarurab pottery (Fig. 1), the two motifs

occurred in the same levels of the site without any marked proportional change (Khabir, 1981, table 12; Mohammed-Ali, 1982, table 24).

At Shaqadud midden the situation is different from Khartoum Hospital and other similar sites (see *supra*) regarding the stratigraphic sequence of dotted wavy line. Being the only site in the Central Nile where both wavy line and dotted wavy line wares were attested in stratigraphic sequence, it remains the sole occupation for deciphering the type of relationship between the wavy line and dotted wavy line decorative motifs, both stratigraphically and chronologically. It presents an undisturbed stratigraphy and continuous Mesolithic–Neolithic sequence of occupation for over ca. 4000 years. The ceramic analysis of the “Mesolithic levels” shows two distinct wares: a hard coarse ware with angular crushed quartz and a friable coarse ware with rounded quartz grains. The surfaces in both types are unslipped and unburnished, and on both most of the decorative motifs are present. The wavy line is solely confined to the hard ware, while the dotted wavy line only appears on the friable ware (Mohammed-Ali, 1991a). Moreover, it was noted that the dotted wavy line appears more often with other motifs on the same sherd, where it is mostly confined to the upper part of the vessel (Mohammed-Ali, 1991a).

Chronological Sequencing

Shaqadud is the sole site outside the Nile Valley that yielded chronological phases spanning Mesolithic–Neolithic and post-Neolithic. The earliest phase of occupation at the site corresponds to what is known on the Central Nile as “Khartoum Mesolithic” (Arkell, 1949). This phase is made of site S-21 and the lower levels of the midden (S1-B) in which the materials correlate in ware and motif. The internal chronology of the Mesolithic phase shows that the wavy line and dotted wavy line wares are not coincident in either space or time. At S-21, the wavy line was made on hard ware, and it appeared without the dotted wavy line. While the deposits in the lower part of the midden yielded wavy line motifs associated with sandy hard coarse ware, the middle portion of the upper midden, between ca. 1 and 2 m below the surface, yielded dotted wavy line motifs with a friable fabric tempered in sand. It is noteworthy that there was a gradual temporal replacement of the wavy line by dotted wavy line wares at the midden, a phenomenon which has not been documented on the Central Nile (see Arkell, 1949; Caneva, 1983a; Khabir, 1981; Mohammed-Ali, 1982). The sole site on the Central Nile where wavy line and dotted wavy line wares were said to show a stratified superposition, as already indicated, is el-Qoz (Arkell, 1953, pp. 98–102), but even there, there was no clear developmental sequence for the ceramics.

The middle phase at Shaqadud is represented by the top 1.5 m of the occupation. Here there is a clear, though gradual, shift from Khartoum Mesolithic pottery types (wavy line, banded motifs) towards Khartoum Neolithic ones (fishnet and continuous straight lines; Mohammed-Ali, 1987, p. 77, 1991a, pp. 92–93).

The pottery of the later phase at Shaqadud, represented by 3.35 m of cultural deposits in the cave, is characterized by unslipped black ware with fingernail impressions, parallel grooving or cord marks over the whole body, which shows smoothing or burnishing (Mohammed-Ali and Marks, 1984, p. 57, fig. 4: top row; Robertson, 1991, fig. 17-3: a,d,f,h). This kind of pottery is clearly affiliated to ceramics found to the east in the Gash Delta, Kassala Province (Fig. 1; see Fattovich *et al.*, 1984, pp. 182–183, fig. 6: 3, 4b).

Four radiocarbon dates were obtained from the Mesolithic levels of the midden (SI-B). A date (based on seeds) derived from level 42 (205–210 cm below datum) gave an age of 5835 ± 445 bc (SMU-1736; radiocarbon dates are cited in bc or bp as given in the original reports, no corrections were made to avoid errors), although this gives a high standard deviation and has been suspected by the excavators as aberrant (Marks, 1991a, p. 61). The oldest level (310–295 cm below datum) was dated to 5920 ± 300 bc (SMU-1290), the middle level (250–245 cm below surface) to 5760 ± 160 bc (SMU-1186), and the upper level (145–150 cm below surface) to 4630 ± 130 bc (SMU-1287). All these dates were corrected for isotopic fractionation.

The Neolithic levels provided distinct pottery virtually different from its Mesolithic counterpart. In these levels wavy line is absent and dotted wavy line is scarce. The radiocarbon dates obtained were 4880 ± 180 bc (55–62 cm below datum; SMU-1735) and 4430 ± 180 bc (85–90 cm below datum; SMU-1134; Marks, 1991a, p. 61; Mohammed-Ali, 1991a, p. 92).

THE WAVY AND THE DOTTED WAVY LINE DISTRIBUTION: INTERREGIONAL LEVEL

The wavy line and dotted wavy line motifs are widely spread in space and time. They cover the area from the Red Sea to Mauritania and from the eastern Sahara to the savanna, an area of ca. 5300 km (east–west) and 1500 km (north–south). In time they range from the eighth millennium to the third millennium BC.

Two major limitations are inherent in the discussion of the horizontal distribution of wavy line and dotted wavy line wares in African prehistory:

1. Space dimension: In regard to the spatial distribution, it is not possible to provide quantitative comparisons between the wavy line and dotted wavy line wares of the Central Nile and the Sahara-Sahel Belt. This is because the surveys and excavation reports are, in most instances, either devoid of quantitative data or the information available is inadequate to allow for the unitary quantitative comparisons needed to make full use of the data (e.g., Arkell, 1949, pp. 84–85, 1953, pp. 68–69; Bailloud, 1969; Barthelme, 1977, pp. 33–34; Camps, 1982; Camps-Fabrer, 1966; Clark, 1973, 1989; Gabriel, 1981, pp. 199–202; Haaland, 1984; Haaland and Abdul-Magid,

1991, 1992; Hugot, 1963; Khabir, 1981; Marks *et al.*, 1968; Mohammed-Ali, 1982; Smith, 1980; Sutton, 1974, pp. 527–546).

2. Time dimension: It is noticeable that, since Arkell's work in the 1940s, several Khartoum Mesolithic sites have come to light in the Nile Valley, and the Sahara-Sahel Belt, but unfortunately the adequate well-dated material necessary for comparisons is still lacking (see *infra*). Nevertheless, on the basis of the available information, an attempt will be made to draw a general picture.

Wavy Line Pottery Distribution

Spatial Distribution

If we combine the wavy line patterns of the Central Nile and the few examples from the Sahara-Sahel Belt, six broad subtypes are discernable, despite the fact that in some cases subtypes may grade into one another:

1. Classic waves (Fig. 2 (2-1) (a–b)): Pottery specimens ornamented with classic waves are the most prevalent in the Central Nile. This variety has been reported from sporadic sites in Khartoum Province (Khartoum Hospital: Arkell, 1949, plate 59; Sarurab: Khabir, 1981, plate 3, fig. 14: a–b; Mohammed-Ali, 1982, fig. 34A; Kadero: Chlodnicki, 1984, fig. 111b; Saggai: Caneva, 1983c, figs. 6: 5, 9: 5; Kabbashi Haitah: Caneva *et al.*, 1993, fig. 20: 1–4, 6–7). It has also been discovered on potsherds from Shaqadud midden (Mohammed-Ali, 1991a, fig. 5–2, a–d, m–o) and from survey sites around Shaqadud in the Western Butana (Elamin and Khabir, 1987, fig. 2: a).

In the north of Sudan, classic wavy line motif has been recorded from the Mesolithic sites of Abu Darbein, el Damer, and Aneibis in the Atbara reach (Haaland, 1987, fig. 2: a–b; Haaland and Abdul Magid, 1995a, figs. 16: b–c, 17: b,d). It is noteworthy that all the wavy line varieties from Atbara reach sites occurred in markedly low frequencies (Haaland, 1995, p. 113). Further north, this wavy line variety was represented in the ceramics of the Early Khartoum related group in Dongola reach (Marks *et al.*, 1968, fig. 5: c) and Khartoum Variant sites of the Second Cataract (Nordstrom, 1972, plate 123: 27, 29; Fig. 1).

Along Wadi Howar in the southern Sahara, Khartoum Mesolithic pottery has also been collected from several sites. Classic wavy line variety has been found at a site located some kilometers north of the Wadi banks (Richter, 1989, fig. 2: 11, 15).

2. Angular waves (Fig. 2 (2-1) (c–d)): Angular wavy line variety is rare, being reported from sporadic Mesolithic sites on the Central Nile (Sarurab: Khabir, 1981, fig. 4c; Saggai: Caneva, 1983a, fig. 10; Kabbashi Haitah:

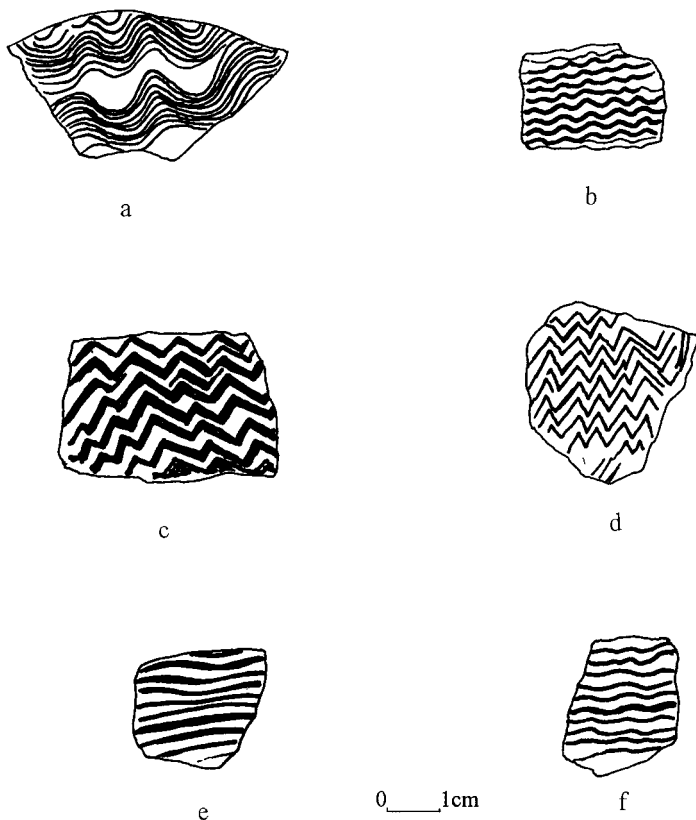


Fig. 2. (2-1): Wavy line pattern subtypes. (a-b) Classic waves; (c-d) Angular waves; (e-f) Mild waves. (2-2): Wavy line pattern subtypes. (a-b) Arched waves; (c-d) Serpentine waves; (e-f) Composite waves.

Caneva *et al.*, 1993, fig. 20: 5; Shaqadud midden, lower levels: Mohammed-Ali, 1991a, fig. 5-2: e-h; Abu Darbein: Haaland and Abdul Magid, 1995a, fig. 16: d). In the Central Sahara, this kind of pottery decoration was found at Jebel Eghei in Tibesti (Fig. 1; Gabriel, 1981, plate 1: e).

3. Mild waves (Fig. 2 (2-1) (e-f)): This variety of wavy line decoration was grouped by Caneva (1983c, p. 169, fig. 12: 3-6), in her work on wavy line pottery from Saggai, under the subtype "straight line" motif. The decoration—as she describes—gives the impression of carelessly made work. However, with the exception of a sole example from Saggai (Caneva, 1983c, fig. 12: 4) which shows continuous mild waves, atypical to that found at Kadero (Chlodnicki, 1984, fig. 111: a), at Shaqadud midden (Mohammed-Ali, 1991a, fig. 5-2: i-j) and at El-Damer (Haaland and Abdul Magid, 1995a, fig. 16: a), the remaining examples from Saggai (Caneva,

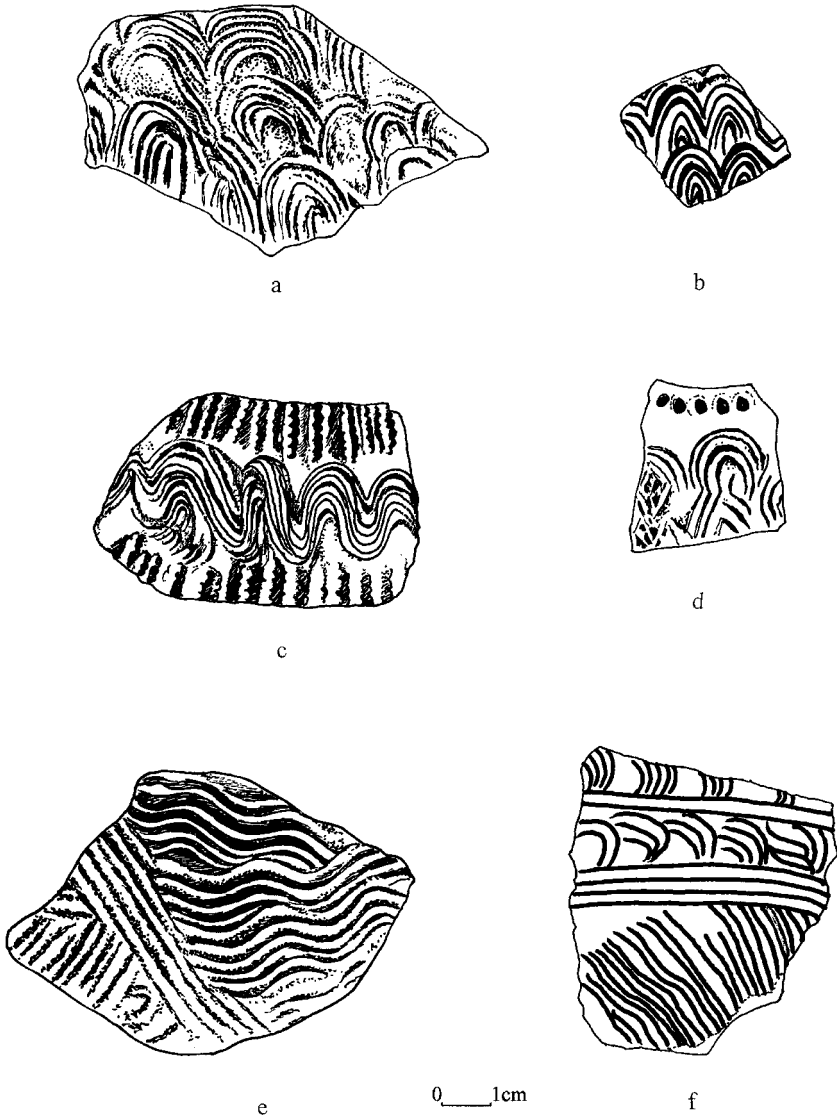


Fig. 2. (Continued.)

1983c, fig. 12: 3, 5-6) do not exhibit wavy lines per se and hence cannot be classed as “wavy line.”

4. Arched waves (Fig. 2 (2-2) (a-b)): Wavy lines with arch-shaped motifs, occasionally noncontinuous, were recorded from sporadic sites in the Nile

- Valley. They are common at Saggai (Caneva, 1983c, pp. 167–173, figs. 11: 2–6, 18: 5), but infrequent amongst the wavy line collections which have been recorded from Khartoum Hospital (Arkell, 1949, p. 82, plate 62, bottom row) and Shaqadud midden (Mohammed-Ali, 1991a, p. 69, fig. 5-2: K, 1). This type of decoration has also been recorded from Abu Darbein (Haaland and Abdul Magid, 1995a, pp. 94–114, fig. 17: a,e).
5. Serpentine waves (Fig. 2 (2-2) (c–d)): This wavy line variety, occasionally coated with a bright red slip made with a type of red ochre (hematite), is seen on sherds with wavy line motif at Khartoum Hospital site (Arkell, 1949, plate 68, fig. 2: bottom, plate 70: 2,3).
 6. Composite motif (Fig. 2 (2-2) (e–f)): A number of sherds on which wavy line decoration is combined with other motif(s) were collected from sporadic sites in the Central Nile and the Sahara. Examples from the Central Nile came from Khartoum Hospital (Arkell, 1949, plates 62: 2, 63: 1), where the comb was used for making more or less straight lines which meet other sets of wavy lines at an angle. At Saggai (Fig. 1), a combination of classic wavy lines with straight lines is seen on some sherds (Caneva, 1983c, fig. 12: 1).

In northern Sudan, pottery embellished with wavy line pattern in the form of arches in conjunction with straight incised lines has been reported from Abu Darbein (Haaland and Abdul Magid, 1995a, fig. 17: c). Further north, a single potsherd ornamented with wavy lines in combination with parallel dots was recovered from a Khartoum Variant site of the Second Cataract (site 428; Nordstrom, 1972, plate 123: 28).

Further afield, in the eastern Sahara, composite wavy line motif was identified on 54 sherds collected from Bir Tarafawi. However, mild wavy lines were found on vessel surfaces in combination with parallel zigzag lines that encircle the body at the neck (Banks, 1980, p. 314). In the southern Sahara, classic wavy line motif in combination with zigzag or straight lines was reported on three sherds at Taferjit and Tamaya Millet in Niger (Fig. 1; Arkell, 1949, plates 63, 65: 3). Wavy line pattern with rouletted decoration was also recorded from Adrar Madet in Niger (Smith, 1980, plate 18.1, bottom).

Temporal Distribution

In the Central Nile Valley, there are early dates for wavy line-dotted wavy line ceramics from Saggai (Caneva, 1983b) and Sarurab (Khabir, 1981, pp. 160–161; Mohammed-Ali, 1982, p. 173, fig. 1). From Saggai a suspect date, based on Pila shell, of $10,060 \pm 150$ bp, was obtained from the Mesolithic assemblage (Caneva, 1983b, p. 149). It is, in any case, the earliest date so far obtained for a ceramic-bearing site not only in the Sudan but in the whole of

Africa and the Middle East. Four other radiocarbon dates, based on Pila shell, were obtained for the site ranging between 7410 ± 100 bp (T-5025) and 7230 ± 100 bp (T-5024; Caneva, 1983b, p. 152). Remarkably, the early dates of Saggai are not discordant with those obtained for a wavy-dotted wavy line sequence at Sarurab.

Sarurab, a site with a Mesolithic assemblage, located on the west bank of the Nile, ca. 25 km north of Khartoum (Fig. 1), was excavated in two stages. The first author conducted a test excavation on the site as a part of his PhD research on the Neolithic of the Sudan (Mohammed-Ali, 1982). The larger portion of the site was excavated by the second author (Sarurab-2: Khabir, 1981, 1985, 1987a). Samples from both tests gave four dates: 9330 ± 110 bp (HAR-3476), 9370 ± 110 bp (HAR-3475), 6407 ± 80 bp (Q 1536), 555 ± 350 bp (Q1534). The dates were in association with various types of wavy line pottery, ground stones, microlithics, and bone harpoons (Khabir, 1981, pp. 160–161, 1987a; Mohammed-Ali, 1982, p. 173).

Another wavy line site in close proximity to Sarurab, ca. 3 km to the north, is Jebel Um Murrabi. It yielded rather comparable radiocarbon dates based on shell, falling in the ninth millennium bp (Elamin and Mohammed-Ali, in preparation).

In the eastern bank of the Main Nile, the wavy line site of Kabbashi Haitah provided two radiocarbon dates, based on shell, of 6030 ± 90 bp (Rom-259) and 7470 ± 90 bp (T-66-54). Two more radiocarbon dates based on shell were obtained; one of 6150 ± 80 bp (T-6645) and the other of 6280 ± 80 bp (Rom-262; Caneva *et al.*, 1993, pp. 226–228).

In the White Nile district, Shabona marks the most southerly site at which the Khartoum Mesolithic has been found. The wavy line ceramic assemblage of Shabona gave two radiocarbon dates in the eighth millennium bp. The earliest, based on human bone, provided an age of 7470 ± 204 bp (SUA-2140); the other gave a date of 7050 ± 120 bp (SUA-298; Clark, 1989, p. 389).

In the Western Butana, the bottom levels of Shaqadud midden (SI-B) yielded wavy line pottery, whereas dotted wavy line is entirely absent. The Khartoum Mesolithic levels provided four radiocarbon dates, based on charcoal, ranging from 5920 ± 300 bc (SMU-1290) to 4630 ± 130 bc (SMU-1287). The Khartoum Neolithic units of the midden were radiocarbon dated, based on seed samples, between 4880 ± 330 bc (SMU-1735) and 4430 ± 80 bc (SMU-1134; Marks, 1991a, p. 61). However, the earliest radiocarbon date (based on shell) obtained for the wavy line, 6250 ± 90 bc (SMU-1310), comes from site S21. Shaqadud is the first site which shows a gradual developmental transition between the Khartoum Mesolithic and Khartoum Neolithic ceramics, providing the first stratigraphic temporal sequence between wavy line and dotted wavy line wares (Mohammed-Ali, 1991a, pp. 87–88).

Further north, in the Atbara reach, wavy line and dotted wavy line ceramics are well dated at Abu Darbein, el-Damer, and Aneibis Mesolithic settlements.

The wavy line and dotted wavy line were radiocarbon dated at Abu Darbein by eight samples ranging between 8640 ± 120 bp (T-8624) and 7700 ± 140 bp (T-5728; Haaland and Abdul Magid, 1992, p. 23). El-Damer has yielded 13 radiocarbon dates, seven of which were obtained from graves. The oldest date is 8390 ± 50 bp (T-7485), whereas the youngest is 7260 ± 110 bp (T-8631). Aneibis has provided 17 radiocarbon dates, providing a time span ranging from 8230 ± 120 bp (T-8643) to 6820 ± 170 bp (T-7481; Haaland and Abdul Magid, 1992, p. 23).

In the Sahara, the evidence of wavy line is very scanty. This type of pottery has been recorded from a few sites in the south, central, and eastern Sahara: Adrar Madet in Niger (Smith, 1980, p. 452), Delibo Cave (Bailloud, 1969, pp. 37–38), Wanyanga (Arkell, 1964, p. 6), and Jebel Eghei in Tibesti (Gabriel, 1981, p. 199), all of which are located in Chad, Amekni in the Hoggar mountains in Algeria (Camps, 1969), and Bir Tarafawi (Banks, 1980, pp. 313–314) and Gilf Kebir (Kuper, 1989, p. 200) in the eastern Sahara.

Wavy line pottery is rare across the Sahara. In the southern Sahara, Delibo Cave in the Ennedi mountains gave two radiocarbon dates in the range of 5230 ± 300 bc (Gif-351) from level 11 (Bailloud, 1969, pp. 37–38). In the Central Sahara, the earliest radiocarbon dates for wavy line and dotted wavy line pottery came from Amekni; 6720 ± 150 bc (MC-212) and 6100 ± 100 bc (UW-87; Camps, 1969, pp. 206–207).

Wavy Line Varieties: Temporal Variability

The question here is whether these wavy line varieties represent temporal variability. The aforementioned information is not in favor of this probability, either because of the small size of stratified samples of each variety (e.g., Saqadud midden, lower levels: Mohammed-Ali, 1991a, p. 69), or the absence of information pertinent to the stratigraphic distribution of these varieties (Khartoum Hospital: Arkell, 1949, pp. 81–97; Saggai: Caneva, 1983a, pp. 377–380; Shabona: Clark, 1973, 1989; Atbara reach sites: Haaland and Abdul Magid, 1995a, pp. 17–29; Ti-n-Torha facies: Barich, 1987; Bir Kiseiba site 79–8: Connor, 1984). Moreover, several of the wavy line contexts, whether in the Nile Valley (e.g., Dongola reach: Marks *et al.*, 1968; Hays, 1971, pp. 84–153; Western Butana survey sites around Shaqadud Cave: Elamin and Khabir, 1987; Mesolithic sites on the east bank of the Nile, Khartoum: Caneva *et al.*, 1993, table 2; eastern Butana: Mohammed-Ali and Jaeger, 1989) or the Sahara (Wadi Howar: Richter, 1989; Selima Sandsheet: Schuck, 1993; Bir Tarfawi: Banks, 1980, pp. 313–315) are mostly surface sites whose cultural deposits, in most instances, rarely reach 20–40 cm. Therefore, at the present level of information, it is not possible to draw any conclusion as to whether wavy line varieties represent consistent temporal distribution or merely idiosyncratic variability.

Dotted Wavy Line Distribution

Spatial Distribution

Dotted wavy line motif was not entirely coincident with wavy line in either space or time. This is indicated by its occurrence without wavy lines at a series of sites on the Central Nile (e.g., Shahienab: Arkell, 1953, pp. 68–77; Kabbashi: Caneva *et al.*, 1993, pp. 226–227) and the Sahara (e.g., Delibo Cave: Bailloud, 1969; Gabrong, Tibesti, Chad: Gabriel, 1981, pp. 199–200; Wadi Ti-n-Torha: Barich, 1987).

Dotted wavy line has a very wide spatiotemporal distribution in comparison with the wavy line. The former type is attested in several contexts on the Central Nile (e.g., Khartoum Hospital: Arkell, 1949, pp. 84–85, plate 72; Jebel Moya: Addison, 1949, plate XCIV-A: 1–13; Caneva, 1991, pp. 265–267, fig. 3: 1–4; Shaheinab: Arkell, 1953, pp. 68–69, plates 29: 1, 38: 3; el-Qoz: Arkell, 1953, pp. 98–102, plate 38: 3; Dongola reach: Marks *et al.*, 1968, p. 321, fig. 5: e; Sarurab: Khabir, 1981, p. 133, fig. 15: a–b, plate 14, 1985; Mohammed-Ali, 1982, pp. 76–80, fig. 34: 8; Kadero: Chlodnicki, 1984, fig. 2: 111, c–d; Islang: Abdul Magid, 1988, p. 108; Kabbashi and Kabbashi Haitah: Caneva, 1988b, fig. 5: 3–4; Abu Darbein, el-Damer, and Aneibis: Haaland and Abdul Magid, 1991, fig. 5, 1992, fig. 8) as well as in the south-central and eastern Sahara (e.g., Meniet: Hugot, 1963, figs. 54: 5, 55: 8, 56: 7; Wanyanga: Arkell, 1964, plate 31; Amekni: Camps, 1969, plates 16: 1–3, 19.6; Delibo Cave: Bailloud, 1969, p. 37, fig. 3: b; Adrar Madet: Smith, 1980, pp. 454–464, plate 1B.1: top; Gabrong/Tibesti: Gabriel, 1981, pp. 199–200, plates 1a-1d).

Rather than being simple bands, the lines in the dotted wavy line motif exhibit series of indented dots. Rocker stamp technique using a toothed-comb or a cord-wrapped stick was used to produce dotted wavy lines. Three types of dotted wavy line motif (based on the shape and arrangement of the wave) are discernable on the pottery of the Central Nile and the Sahara-Sahel Belt:

1. Deep dotted waves (Fig. 3(a–b)): Dotted wavy line ceramics with deep spacing of “waves” in the Central Nile Valley include a few examples from the Mesolithic sites of Saggai (Caneva, 1983c, fig. 15: 1–13), Sarurab (Khabir, 1981, plate 4), and Khartoum Hospital (Arkell, 1949, plate 72). In the Western Butana, this variety of dotted wavy line is scarce, but is present in the middle levels of Shaqadud midden (Mohammed-Ali, 1991a, p. 69, fig. 5-3: d–f). In the north of Sudan a few examples from Atbara reach were reported from Aneibis and el-Damer (Haaland and Abdul Magid, 1995a, figs. 19: b, 20: b,e). Further north, scarce examples were evident at Dongola reach Mesolithic sites of Khartoum Mesolithic type (Marks *et al.*, 1968, fig. 5: e) and at Khartoum Variant sites in the Second Cataract (Nordstrom, 1972, plate 123: 25–26).

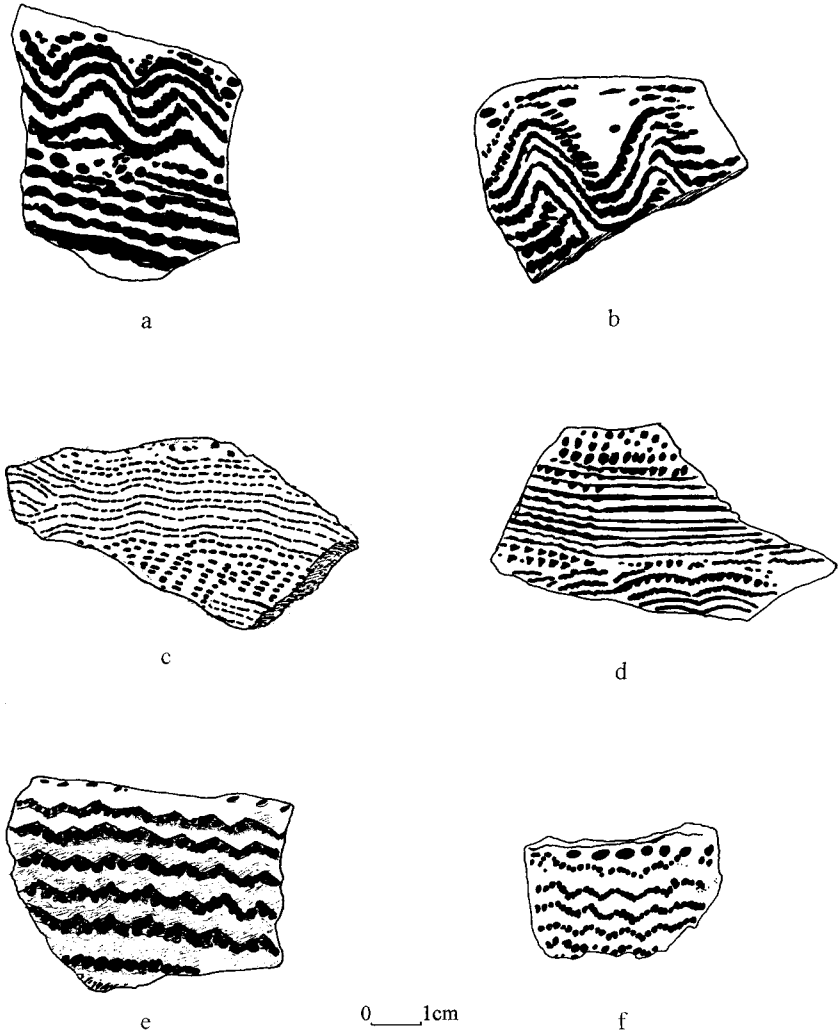


Fig. 3. Dotted wavy line pattern subtypes. (a–b) Deep dotted waves; (c–d) Shallow dotted waves; (e–f) Angular dotted waves.

In the eastern Sahara this decorative variety has been recorded from sporadic sites such as Wadi Howar and Selima Sandsheet in the north-western Sudan (Keding, 1998, plate 1; Richter, 1989, fig. 2: 4; Schuck, 1993, fig. 6: 5). Further west, dotted wavy line pottery with deep waves has been recovered from Gabrong locality in Tibesti (Gabriel, 1981, plate 1: c) and from Ti-n-Torha (Barich, 1987, fig. 5.6: 4–5).

2. Shallow dotted waves (Fig. 3(c–d)): Dotted wavy line pottery with shallow waves has been encountered in the Central Nile Valley at Khartoum Hospital (Arkell, 1949, plate 72: top row, left; second row; third row, middle; fourth row, left), at Shaheinab (Arkell, 1953, plate 29: left and right), and at Saggai (Caneva, 1983c, figs. 15: 4–7, 18: 7). In the Western Butana this decorative variety has been recorded from the middle levels of Shaqadud midden (Mohammed-Ali, 1991a, fig. 5-3: b–c, g–h). At Atbara reach, potsherds embellished with this decorative pattern have been attested at Aneibis (Haaland and Abdul Magid, 1995a, figs. 19: a, 20: d).

In the Sahara-Sahel Belt, the shallow waves variety has been depicted on some sherds derived from the sand dune sites of Wadi Howar (Richter, 1989, fig. 2: 9, 12), at Jebel Eghei site in Tibesti (Gabriel, 1981, plate 1e) and at Tagalagal (Roset, 1987, fig. 11.4: top left). This decorative pattern has also been attested at Ti-n-Torha east (Barich, 1987, fig. 4.6: 2) and at al-Ghorab (site E79-E) in the eastern Sahara (Kobusiewicz, 1984, fig. 18.3).

3. Angular dotted waves (Fig. 3(e–f)): This variety of dotted wavy line, with angular (pointed) waves, is scarce. It has been identified on a few examples from the Central Nile and the Sahara. In the former region, the Mesolithic context of Shaqadud midden (middle levels) yielded a few sherds of this type (Mohammed-Ali, 1991a, p. 69, fig. 5-3a). This kind of decoration has also been found on pottery at Shaheinab (cf. Arkell, 1953, plate 29: 1, middle). In the Sahara, two sherds representing this decoration were recorded from Gabrong in the Tibesti (Gabriel, 1981, plate 1b).

Temporal Distribution

From a chronological standpoint it is apparent that the Khartoum Mesolithic/Neolithic sequence in the Central Nile Valley, apart from the Shaqadud site complex, has not provided absolute dates that indicate a temporal gap between wavy line and dotted wavy line wares (cf. supra, section “Wavy Line and Dotted Wavy Line Distribution: Intra-regional Level”).

Dotted wavy line has an enormously wide distribution west of the Nile across the Sahara-Sahel Belt. Notably, its distribution in this context is much wider in the southern and central Sahara than in the eastern part. At Wanyanga, between Ennedi and Tibesti, unburnished dotted wavy line gave an age of 5230 ± 300 bc (Gif-351; Flight, 1973, p. 537). Burnished dotted wavy line pottery has been attested at Delibo in the southern Sahara, dated to 4950 ± 300 bc (Gif-352; Arkell, 1959, p. 20). Further south in the Sahara, unburnished dotted wavy line sherds were uncovered from Tagalagal (Niger). The associated charcoal samples provided two radiocarbon dates in the range of 9330 ± 130 bp and 9370 ± 130 bp (Roset, 1987, pp. 217–222). From Amekni in the Hoggar, unburnished pottery ornamented

with dotted wavy line yielded radiocarbon dates in the range of mid-late seventh millennium BC (cf. supra, section “Chronological Sequencing”).

In the Tadrat Acacus in the Libyan Sahara, the earliest ceramic evidence was found at Ti-n-Torha, which yielded unburnished dotted wavy line wares. The earliest date is 7400 ± 70 bc (R-1036 OC) and the latest is 6980 ± 60 bc (R-1163 OC; Barich *et al.*, 1984, p. 413; Barich, 1987). Unburnished dotted wavy line has also been recorded from Fozzigaren and Uan Tabu in the Acacus in Fezzan, Libya (Hays, 1975, p. 195). The first locality has produced a radiocarbon date of 6122 ± 100 bc (Pi), and the latter gave an age of 5095 ± 175 bc (Geo; Barich *et al.*, 1984, p. 413).

In the eastern Sahara, a few sherds ornamented with dotted wavy line were recorded from sporadic sites at Nabta Playa and Bir Kiseiba. At Nabta Playa (site E-75-8) 12 radiocarbon dates, ranging from 6240 ± 70 bp (SMU-361) to 7120 ± 150 bp (SMU-242) were provided (Banks, 1984a, pp. 155–157, fig. 5: a,d; Haas and Haynes, 1980, p. 375). Dotted wavy line has been recorded from two localities (sites E-79-2 and E-80-1, area c) at Bir Kiseiba. At site E-79-2 it has been radiocarbon dated to 8130 ± 110 bp (SMU-764). At site E-80-1, area c, the same ware has a few radiocarbon dates, ranging from 8020 ± 70 bp (SMU-915) to 8020 ± 90 bp (SMU-926; Close, 1984, pp. 292–296, fig. 12.19: e–g; Banks, 1984b, pp. 118–120).

Dotted wavy line pottery with angular waves, which is rare amongst the pottery decorations in the Central Nile, has a wide spread in the Saharan sites. This type of decoration has been reported from Tagalagal in Niger (Roset, 1987, fig. 11.4), where it was dated to the tenth millennium bp. Two radiocarbon dates, based on charcoal, were obtained for this type of decoration; the oldest giving a date of 9370 ± 130 bp, while the youngest was dated to 9330 ± 130 bp (Roset, 1987, p. 218). This decorative motif has also been recorded from Delibo Cave and Soro Kezenanga (Chad), where it was radiocarbon dated to 6950 ± 300 bp (Bailloud, 1969, p. 37, figs. 2A, 3A).

Thus the dates associated with angular dotted wavy line ceramics are slightly older in the Sahara than on the Central Nile. In the latter region this kind of decoration has two radiocarbon dates, at Kabbashi, ranging from 6150 ± 80 bp (T-6645) to 6280 ± 85 bp (Rom-262; Caneva *et al.*, 1993, p. 199).

Dotted Wavy Line Varieties: Temporal Variability

Dotted wavy line pottery of the Central Nile and the Sahara-Sahel Belt shows only three varieties (shallow, deep, and angular waves). The shallow and deep waves of dotted wavy line pattern do not exhibit temporal variability, as they were present from the beginning of the occupations (ca. 9730–6100 bp). The mode of their distribution showed marked integrity through the deposits. On the other hand, dotted wavy line decoration with angular waves is almost absent in the prehistoric

pottery contexts along the Nile Valley. It had a wide spatiotemporal distribution in the Sahara (ca. 9370–6950 bp), being more pronounced in the later Mesolithic phase in the Central Sahara (Soro Kezenganga and Delibo Cave).

THE NATURE OF THE WAVY LINE AND THE DOTTED WAVY LINE DISTRIBUTION: RECONSIDERATION OF THE MATERIAL EVIDENCE AND NOMENCLATURE

Wavy line and dotted wavy line pottery appear in the eighth millennium BC in the Nile Valley and as far as west Senegal in the western Sahara, in association with a lacustrine economy based upon aquatic mammals and fish. The occupants of these regions were hunters and gatherers and the material culture associated with their economies—in addition to pottery—is primarily hunting equipment such as arrowheads, bone harpoons, and microlithic-chipped stone (Adamson *et al.*, 1974, pp. 120–120; Smith, 1980, pp. 452–453).

The lithic typologies and technologies of Khartoum Mesolithic and Khartoum Neolithic components in the Central Nile and the Sahara do vary from one area to another at both intraregional and interregional levels. These include ground stone, microlithic chipped artifacts, and bone tools (Abdul Magid, 1995; Arkell, 1949, pp. 41–73, 1953, pp. 25–55; Barich, 1992, pp. 182–204; Caneva, 1988b; Caneva and Zarratini, 1983; Clark, 1980, pp. 565–582, 1989; Close, 1987, 1992, pp. 155–184; Haaland, 1989; Hays, 1971, pp. 84–152, 1974; Khabir, 1981, pp. 146–172, 1985, 1987a; Kobusiewicz, 1984; Marks, 1991a,b,c; Marks *et al.*, 1968; Mohammed–Ali, 1982, pp. 59–87; Mohammed–Ali and Jaeger, 1989; Smith, 1980; Wieckowska, 1984; Zarratini, 1983).

The physicochemical analyses of Khartoum Mesolithic and Khartoum Neolithic ceramics indicate that the bulk of the samples are mineralogically and chemically comparable due to the considerable homogeneity in temper and clay matrices. Nevertheless, the pottery samples are relatively less differentiated in terms of their clay mineralogy (X-ray diffraction and chemical tests) than they are on the basis of their tempering material (petrography). However, for the samples examined using a physico-scientific approach, the wavy line and dotted wavy line wares proved to be locally produced, as their temper inclusions and soil composition reflect local material through the Central Nile and across the Sahara-Sahel Belt (see section “Physicochemical Analyses”).

The local derivation of the raw material (matrix and temper) used in the manufacture of wavy line and dotted wavy line pottery, combined with the utilization of local rock sources for the associated lithic artifacts, do not support a cultural homogeneity of the Mesolithic and Neolithic industries along the Nile Valley and the Sahara-Sahel Belt during the early Holocene. The disparate nature of these sites weakens the possibility of a homogeneous “culture area.” Nonetheless, some workers have held a belief that the recovery of wavy line and dotted wavy line

decorations at a series of sites across these vast zones may indicate the presence of a “culture area” extending from Senegal to the Red Sea. These broad ceramic similarities have been defined as the “Neolithic of Sudanese Tradition” (Hugot, 1963), and the “Saharan Sudanese Complex” (Camps-Fabrer, 1966). The concepts of these terms imply the existence of definable distinct features diagnostic of what might seem to be a “culture area” extending over vast geographical zone (see Willey and Phillips, 1958). When the archaeological remains from a variety of sites within this vast area were examined, these concepts were reconsidered and a model of “Khartoum Horizon Style” was proposed (Hays, 1971, 1974).

The concept of “horizon style” was first formulated by Kroeber (1944, p. 108) as “one showing definably distinct features some of which extend over a large area.” Willey (1945, p. 55) believed that “in theory a horizon style, as the name implies, occupies a great deal of space but very little time. It may be roughly defined as a specialized cultural continuum represented by a broad distribution of a recognizable art style.” Thus the concept of the “horizon style” is based upon two principal criteria:

1. a similarity of certain style groups
2. a rapid spread of this style over a broad geographical area.

When the ceramic materials from the Central Nile and the Sahara-Sahel Belt are examined in the light of these criteria, it becomes clear that a reassessment is required.

As for the spread of motifs, there are more wavy line varieties in the Central Nile (six subtypes) than the Saharan-Sahel (three subtypes; see section “Stratigraphic Sequencing” and Fig. 2(2-1) (2-2)). On the other hand, though the dotted wavy line varieties (deep, shallow, and angular waves) were found along the Nile Valley and the Sahara-Sahel, examples with deep and shallow waves in the latter region have a wider distribution. In regard to the dotted wavy line with angular waves, the picture is reversed and the extreme rarity of this variety along the Central Nile corresponds with its preponderance across the Sahara-Sahel contexts (cf. *supra*, section “Wavy Line Pottery Distribution: Spatial Distribution”). It is noteworthy that the decorative motifs of wavy line and dotted wavy line waves in both areas are diversified. Yet, the motifs of the Central Nile Valley are well spaced as opposed to their parallels in the Sahara-Sahel Belt (see Caneva, 1987a,b, p. 231, figs. 9.1–9.6). Regarding the vessel shapes, as can be inferred from the few vessel fragments of the Saharan pottery—wavy line and dotted wavy line—rims are more varied than their parallels in the Central Nile (cf. Arkell, 1949, pp. 81–97, 1953, pp. 68–77; Banks, 1980; Barich, 1987; Caneva, 1983c, 1987; Clark, 1989; Haaland, 1995; Hays, 1974; Khabir, 1981, pp. 130–146, 1987a; Mohammed-Ali, 1982, pp. 59–87, 1991a; Roset, 1987).

The resemblance of dotted wavy line decorative groups between the Nile Valley and the Sahara-Sahel, coupled with their “fumbling” appearance and rapid

distribution over wide geographical zones in a comparatively short period of time, seems to confirm the validity of applying the designation “Khartoum Horizon Style” as a term delineating this phenomenon. However, this term is questionable regarding the spatial-temporal distribution of wavy line pottery, despite the similar way of life practiced by the owners/producers of both pottery groups. It is evident that both wavy line and dotted wavy line ceramics were associated with sites whose economies were based on seasonal hunting, fishing, and wild grain-collecting, and the same subsistence economy was later supplemented by stock-herding and possibly incipient cultivation. Nonetheless, their spatial-temporal distribution is not invariably synchronous. While the wavy line pottery seems to represent a “pottery-mode tradition,” the dotted wavy line calls for a “horizon style” phenomenon.

The concept of “pottery tradition,” as defined by Willey (1945, p. 53), “comprises a line or a number of lines, of pottery development through time within the confines of a certain technique or decorative constant. In successive time periods through which the history of ceramic development can be traced, certain styles arose within the tradition. Transmission of these styles during particular periods resulted in the formation of a horizon style; other styles in the continuum of the tradition remained strictly localized.” These criteria which define pottery-mode tradition are fulfilled on the wavy line pottery inventory in the Central Nile Valley. The persistence through time of certain wavy line modes of production comprising unburnished surfaces and usage of a sole decorative technique, coupled with a relatively restricted range of distribution of this motif, mainly confined to the Nile Valley over a relatively long period of time, are in favor of a “pottery-mode tradition” rather than a “horizon style.”

As for the validity of the “horizon style” concept for the eastern Sahel, the spread of eastern Sahelian and Central Nile motifs differ in many respects. For example, in their format, motifs of the Central Nile cover the entire surface of the pot, whereas those of the eastern Sahel are restricted only to the upper portion of the vessel. Also, the wavy line motifs of the Nile are always placed horizontally while those of the eastern Sahel are often placed vertically. Moreover, the dotted wavy line and banded motifs of Khartoum Mesolithic were absent in the eastern Sahel, and the knobbed decoration of eastern Sudan has no parallels in the Central Nile (Mohammed-Ali and Jaeger, 1989). The motifs of the contemporary Khartoum Neolithic (e.g., burnishing and/or slipping, triangular patterns, incised straight lines) are absent in the Saroba Neolithic of the eastern Sudan (see Mohammed-Ali, 1987, pp. 84–85; Mohammed-Ali and Jaeger, 1989).

With respect to rapid spread, the wavy line motif, as indicated above, was in use over a long time along the Nile, ranging from ca. 10,000 bp at Saggai (Caneva, 1983b, p. 149), and ca. 9400 bp at Sarurab (Khabir, 1987a, p. 378), to ca. 7000 bp at Shaqadud midden (Marks, 1991a, p. 61).

Thus, at the present level of knowledge, the wavy line, not to mention pottery manufacture itself, may have been present on the Nile, for over 2000 years before

it spread across the Butana to the Atbara river basin. During this time, at least, the Sahel cannot be linked to the Nile Valley by a “rapid” spread of any ceramic style (Mohammed-Ali and Jaeger, 1989, p. 478).

The aforesaid evidence for the wavy line, however, is too little or too general to establish a “horizon style.” In addition, the broad cultural affinities, including a riverine-oriented adaptation as well as the common occurrence of similar techniques of ceramic decoration (e.g., combing, incising, impressing, etc.), which appear much later in the eastern Sahel than the Nile, indicate a rather slow diffusion of features, while a rapid one is required for the horizon style (Mohammed-Ali and Jaeger, 1989, p. 478).

Thus, whatever the validity and utility of the “Khartoum Horizon Style” for the Nile and the area west of it, it cannot be applied meaningfully to the area east of the river. Even for the Sahara-Sahel Belt, this term is solely applicable to the dotted wavy line component and not to the wavy line. The preponderance of wavy line pottery versus dotted wavy line in the Nile Valley (Fig. 3), its restriction in that region for nearly two millennia before it set foot abroad, coupled with its relatively late appearance in the Sahara (ca. 8000 bp) as opposed to the Nile (ca. 10,000–9400 bp), as previously indicated, seem to constitute, for the wavy line, a “pottery mode-tradition” rather than a “horizon style.”

DISCUSSION AND CONCLUSIONS

The wavy line and dotted wavy line pottery pose a problem regarding the terminology and the classificatory attributes being put forward to define these “Khartoum Mesolithic” and “Khartoum Neolithic” ceramic components. The pioneering works of Arkell (1949, 1953) failed to provide rigorous definitions and to select mutually exclusive attributes that would enable us to avoid confusions. However, subsequent classificatory schemes have inherited the shortcomings of Arkell’s typologies, which several attempts were made to surpass.

Hays (1971) has provided a type variety classificatory scheme to assess the Nilo-Saharan Neolithic ceramic connections. His classificatory system ended with one “ware” which was made up of five decorative techniques, each associated with one or more decorative motif. Later, Hays (1974) compared these assemblages on the basis of lithic material and proposed the “Khartoum Horizon Style” as a designation to decipher the nature of cultural mechanisms that existed among the various human groups in the Nile Valley and the Sahara-Sahel Belt during the later prehistoric era. However, Hays’ scheme can be criticized on the grounds that it was based only on very broad similarities; it overlooked the absence of any significant features among the lithic material and failed to take into consideration the prerequisites necessary for a “horizon style” (cf. *supra*, section “Hays’ Classificatory Scheme”).

Following Camps-Fabrer's work (Camps-Fabrer, 1966), Caneva (1983a, 1984, 1987a,b) advocated the decorative technique as an appropriate criterion for the classification of the later prehistoric Nilotic and Saharan ceramics. However, this approach is inadequate, mainly because there are always fewer techniques than there are motifs; and the technique is not always identifiable from the motifs.

Nordstrom's classification (Nordstrom, 1972) is another major contribution to delineate the nature of the Nilo-Saharan ceramics. It is a taxonomic classificatory scheme which includes all the possible combinations of fabrics, techniques, and patterns of decoration. Despite the new technological indices provided by his classification, the heterogeneous nature of his material did not provide a comprehensive chronological index. Hence Nordstrom "pottery wares" have remained primarily technological concepts.

Physicochemical analyses have been utilized to decipher the nature of connections, if any, between the wavy and the dotted wavy line ceramic components at the intraregional and interregional levels. The analyses have provided evidence suggestive of the local production of these ceramic inventories across the Nile Valley and the Sahara-Sahel Belt.

The utilization of local raw materials for ceramics (matrix and temper) and lithic tools strengthens the possibility of cultural heterogeneity of the Mesolithic and Neolithic components along the Nile Valley and the Sahara-Sahel Belt during the early Holocene. The apparent similarities between the wavy line and the dotted wavy line components of the Central Nile Valley and the Sahara-Sahel Belt, coupled with the disparate nature of their lithic tool types and technologies, have been considered a sign of diffusion of ideas to autonomous groups of people (Hays, 1974; Renfrew, 1969).

Despite the broadly similar way of life and the general resemblance in subsistence economy shared by the wavy line and dotted wavy line pottery makers and/or owners, these decorations are not always coincident in either space or time, whether in the Central Nile Valley or the Sahara-Sahel Belt. If we add to that the variations envisioned in the techniques of decoration and surface treatment, the usage of wavy line and dotted wavy line as diagnostic features and temporal-markers to determine the Mesolithic–Neolithic adaptations along those vast areas becomes less plausible.

The chronological index of the wavy line and dotted wavy line pottery has not as yet been fully deciphered. The archaeological evidence from the Central Nile Valley indicates that both types were present at Khartoum district sites in all layers from the beginning of the occupations. Hence, the dotted wavy line was not an outcome of the wavy line, as Arkell has suggested (Arkell, 1949, pp. 84–85, 1953, p. 68). In the Sahara-Sahel context, dotted wavy line pottery appeared earlier (e.g., Tagalagal, ca. 9500 bp: Roset, 1987; Bir Kiseiba, ca. 9100 bp: Connor, 1984; Ti-n-Torha, ca. 9000 bp: Barich, 1987; Nabta Playa, site E.7.8, ca. 8800 bp: Banks,

1980) than the wavy line pottery (e.g., Amekni, ca. 8300 bp: Camps, 1969; Delibo Cave, ca. 7300 bp: Bailloud, 1969).

The recovery of wavy line and dotted wavy line decorations as diagnostic features of the Nilo-Saharan Mesolithic–Neolithic components at a series of sites covering wide areas extending from Senegal to the Red Sea has suggested the presence of a ceramic “horizon style,” being known in the literature of the late African prehistory as “Khartoum Horizon Style” (Hays, 1971, 1974). In the present work, the validity of this term has been examined in the light of the present ceramic inventories reported from these regions. This work has shown that the wavy line reflects a limited distribution and a slow diffusion compared to the dotted wavy line. This seems to validate a “pottery-mode tradition” rather than a “horizon style.” On the other hand, the dotted wavy line pottery presents an inverse situation along the Nilo-Saharan zone. Its sudden appearance and rapid spread over wide geographical regions in a comparatively short period of time suggests the validity of applying the term “horizon style” to delineate the spatio-temporal distribution of this phenomenon.

From the chronological standpoint, it seems that the overall radiometric dates of the early ceramics from the Central Nile Valley are generally in accordance with their counterpart in the Sahara-Sahel Belt, dated to the tenth–eighth millennium bp (eighth–sixth millennium BC).

These dates may suggest that pottery developed locally from early prototypes as early as 10,000 bp. The origin(s) of the wavy line and dotted wavy line ceramics is much more complex than was once thought. The reason(s) behind the invention of pottery lies mainly in the need for containers that permit wider uses of food techniques than is otherwise possible, as well as other different sets of advantages for the general mode of living (Arnold, 1985, pp. 127–166). The invention of pottery and harpoons are critical events in the process that led to the expansion of aquatic resource exploitation, as is manifested in the Nile Valley (see *supra*; Haaland, 1995; Sutton, 1974, pp. 529–531). Also, the Sahara-Sahel Belt might have only opened up for the kind of resource exploitation that necessitates the invention of ceramics by the early Holocene (see Clark, 1980; Hassan, 1986).

The wavy line and the dotted wavy line wares form a major phenomenon among the prehistoric manifestations of the Nile and the Sahara-Sahel Belt. While the latter covers a wide area, the former survives for a long period of time. Therefore, they cannot be considered cultural traits that diagnose Mesolithic–Neolithic adaptations in a certain region or for a specific period of time. Moreover, the fact that quite often the dotted wavy line motif appears with other motifs on the same sherd eliminates the possibility of it being used as a diagnostic motif for one or both phases. As for the varieties of each motif, they reflect in terms of abundance some regional and/or chronological variation which lacks quantification. The fact that the varieties are not confined to a certain area and time forms another obstacle towards their use as diagnostic features.

Despite the fact that a voluminous body of data is available, more information is needed on the distribution of wavy line and dotted wavy line varieties through time and space together with quantifiable samples to finally decide whether they can be utilized as diagnostic features for the Nilo-Saharan industries during the early Holocene. If their distribution turns out to cover more than one culture or ethnic group, we need to look into variations and covariations in other cultural manifestations such as lithic artifacts and economic adaptations.

REFERENCES CITED

- Abdul Magid, A. (1988). *The National and Socio-Economic Context of Plant Domestication in the African Savanna. An Archaeoethnobotanical Case Study From the Central Sudan*, PhD thesis, University of Bergen, Bergen, Norway.
- Abdul Magid, A. (1991). Atbara research project: Field seasons of 1985–87, 98, 90. *Nyame Akuma* **35**: 36–43.
- Abdul Magid, A. (1992). Radiocarbon dates from Mesolithic sites in the Atbara region, Sudan. *Nyame Akuma* **37**: 17–27.
- Abdul Magid, A. (1995). The lithic material. In Haaland, R., and Abdul Magid, A. (eds.), *Aqualithic Sites along the Rivers Nile and Atbara, Sudan*, Alma Mater, Bergen, Norway, pp. 52–83.
- Abdul Magid, A. (1998). Archaeological excavations on the west bank of the river Nile in the Khartoum area. *Nyame Akuma* **18**: 42–45.
- Adamson, D. A., Clark, J. D., and Williams, M. A. (1974). Barbed bone points from the Central Sudan and the age of the “Early Khartoum” tradition. *Nature* **299**: 120–123.
- Addison, F. (1949). *Jebel Moya*, Oxford University Press, London.
- Arkell, A. J. (1947). Early Khartoum. *Antiquity* **21**: 172–181.
- Arkell, A. J. (1949). *Early Khartoum*, Oxford University Press, London.
- Arkell, A. J. (1953). *Shaheinab*, Oxford University Press, London.
- Arkell, A. J. (1959). Preliminary report on the archaeological results of the British Ennedi expedition. *Kush* **7**: 15–26.
- Arkell, A. J. (1964). *Wanyanga*, Oxford University Press, Oxford.
- Arkell, A. J. (1972). Dotted wavy line pottery in African prehistory. *Antiquity* **46**: 221–222.
- Arkell, A. J. (1975). *The Prehistory of the Nile Valley*, Handbuch der Orientalistik, Leiden, Brill.
- Arnold, A. E. (1985). *Ceramic Theory and Cultural Process*, Cambridge University Press, Cambridge.
- Bailloud, G. (1969). L'évaluation des styles ceramiques en Ennedi (Republique du Tchad). In *Actes du Premier Colloque International d'Archéologie Africaine*, Fort Lamy, République du Tchad, 11–16 décembre 1966, Etudes et documents tchadiens, Mémoires 1, Institut National Tchadien pour les Sciences Humaines, Fort Lamy, pp. 31–45.
- Banks, K. M. (1980). Ceramics of the Western Desert. In Wendorf, F., and Schild, R. (eds.), *Prehistory of the Eastern Sahara*, Academic Press, New York, pp. 299–315.
- Banks, K. M. (1984a). Early ceramic-bearing occupations in the Egyptian Western Desert. In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *Origin and Early Development of Food-Producing Cultures in Northeast Africa*, Polish Academy of Sciences, Poznan, Poland, pp. 149–161.
- Banks, K. M. (1984b). Report on site E-79-2. In Wendorf, F., Schild, R., and Close, A. E. (eds.), *Cattle-Keepers of the Eastern Sahara*, Southern Methodist University Press, Dallas, pp. 95–121.
- Barich, B. E. (1987). The Wadi Ti-n-Torha facies. In Barich, B. E. (ed.), *Archaeology and Environment in the Libyan Sahara. The Excavations in the Tadrart Acacus, 1978–1983*, British Archaeological Reports International Series 368, Oxford, pp. 97–112.
- Barich, B. E. (1992). Holocene communities of western and central Sahara: A reappraisal. In Klees, F., and Kuper, R. (eds.), *New Light on the Northeast African Past*, Africa Praehistorica 5, Heinrich-Barth Institut, Köln, Germany.
- Barich, B. E., Belluomini, G., Bonadonna, F., Alessia, M., and Manfra, L. (1984). Ecological and cultural relevance of the recent new radiocarbon dates from Libyan Sahara. In Krzyzaniak, L.,

- and Kobusiewicz, M. (eds.), *Origin and Early Development of Food-Producing Cultures in North-Eastern Africa*, Polish Academy of Sciences, Poznan, Poland, pp. 411–417.
- Barthelme, J. (1977). Holocene sites northeast of lake Turkana. A preliminary report. *Azania* **12**: 33–41.
- Barthelme, J. (1985). *Fisher–Hunters and Neolithic Pastoralists in East Turkana, Kenya*, British Archaeological Reports, Oxford.
- Butzer, K. W., and Hansen, C. L. (1968). *Desert and River in Nubia*, The University of Wisconsin Press, Milwaukee.
- Buursink, J. (1971). *Soils of the Central Sudan*, Grafisch Bedriif Schotanus & Jens, Utrecht, Netherlands.
- Camps, G. F. (1969). *Amékni, Néolithique Ancien du Hoggar*, Mémoires du Centre de Recherches Anthropologiques, Préhistoriques et Ethnographiques 10, Arts et Métiers Graphiques, Paris.
- Camps, G. F. (1982). Beginnings of pastoralism and cultivation in north-west Africa and the Sahara: Origins of the Berbers. In Clark, J. D. (ed.), *The Cambridge History of Africa*, Vol. 1, Cambridge University Press, Cambridge, pp. 548–623.
- Camps-Fabrer, H. (1966). Sur quelques techniques décoratives de la céramique impressionnée saharienne. Paper given at the *XVIIIème Congrès Préhistorique de France*, Ajaccio, pp. 143–154.
- Caneva, I. (ed.) (1983a). *Pottery Using Gatherers and Hunters at Saggai (Sudan): Preconditions for Food Production*, Origini XII, Rome.
- Caneva, I. (1983b). Radiocarbon dates from Saggai-1: An essay of classification. In Caneva, I. (ed.), *Pottery Using Gatherers and Hunters at Saggai (Sudan): Preconditions for Food Production*, Origini XII, Rome, pp. 149–153.
- Caneva, I. (1983c). “Wavy Line” pottery from Saggai I: An essay of classification. In Caneva, I. (ed.), *Pottery Using Gatherers and Hunters at Saggai (Sudan): Preconditions for Food Production*, Origini XII, Rome, pp. 155–189.
- Caneva, I. (1984). Early Neolithic settlement and later cemetery at Geili (Central Sudan). In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *Origin and Early Development of Food-Producing Cultures in North-Eastern Africa*, Polish Academy of Sciences, Poznan, Poland, pp. 353–360.
- Caneva, I. (1987a). Pottery decoration in prehistoric Sahara and Upper Nile: A new perspective study. In Barich, B. E. (ed.), *Archaeology and Environment in the Libyan Sahara. The Excavations in the Tadrart Acacus, 1978–1983*, British Archaeological Reports International Series 368, Oxford, pp. 231–245.
- Caneva, I. (1987b). Recent research in Central Sudan. *Nyame Akuma* **29**: 52–55.
- Caneva, I. (ed.) (1988a). *El-Geili. The History of a Middle Nile Environment 7000 B.C.–A.D. 1500*, British Archaeological Reports International Series 424, Oxford.
- Caneva, I. (1988b). Prehistoric settlements along the Nile between Kabbashi and Geili. In Caneva, I. (ed.), *El-Geili. The History of a Middle Nile Environment 7000 B.C.–A.D. 1500*, British Archaeological Reports International Series 424, Oxford, pp. 321–344.
- Caneva, I. (1991). Jebel Moya revisited: A settlement of the 5th millennium B.C. in the middle Nile Basin. *Antiquity* **65**: 262–268.
- Caneva, I., and Marks, A. E. (1990). More on the Shaqadud pottery: Evidence for Sahara-Nilotic connections during the 6th–4th millennium B.C. *Archeologie Du Nil Moyen* **4**: 11–36.
- Caneva, I., and Zarratini, A. (1983). Microlithism and functionality in the Saggai-1 industry. In Caneva, I. (ed.), *Pottery Using Gatherers and Hunters at Saggai (Sudan): Preconditions for Food Production*, Origini XII, Rome, pp. 209–233.
- Caneva, I., Garcea, E., Gautier, A., and Van Neer, W. (1993). Pre-pastoral cultures along the Central Sudanese Nile. *Quaternaria Nova* **III**: 177–252.
- Chlodnicki, M. (1984). Pottery from the Neolithic settlement at Kadero (Central Sudan). In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *Origin and Early Development of Food-Producing Cultures in North-Eastern Africa*, Polish Academy of Sciences, Poznan, Poland, pp. 337–342.
- Clark, J. D. (1973). Expedition to the Central Sudan, The University of California, Berkeley. *Nyame Akuma* **3**: 55–64.
- Clark, J. D. (1980). Human populations and cultural adaptations in the Sahara and the Nile during prehistoric times. In Williams, M. A. J., and Faure, H. (eds.), *The Sahara and the Nile*, A. A. Balkema, Rotterdam, The Netherlands, pp. 527–582.
- Clark, J. D. (1989). Shabona: An early Khartoum settlement on the White Nile. In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *Late Prehistory of the Nile Basin and the Sahara*, Polish Academy of Sciences, Poznan, Poland, pp. 387–410.

- Close, A. E. (1984). Report on site E-80-1. In Wendorf, F., Schild, R., and Close, A. E. (eds.), *Cattle-keepers of the Eastern Sahara. The Neolithic of Bir Kiseiba*, Southern Methodist University Press, Dallas, pp. 251–297.
- Close, A. E. (1987). The lithic sequence from Wadi Ti-n-Torha (Tadrart Acacus). In Barich, B. E. (ed.), *Archaeology and Environment in the Libyan Sahara. The Excavations in the Tadrart Acacus, 1978–1983*, British Archaeological Reports International Series 368, Oxford, pp. 63–85.
- Close, A. E. (1992). Holocene occupations of the Eastern Sahara. In Klees, F., and Kuper, R. (eds.), *New Light on Northeast African Past*, Africa Prehistorica 5, Heinrich-Barth-Institute, Köln, Germany, pp. 157–183.
- Connor, D. R. (1984). Report on Site E-79-8. In Wendorf, F., Schild, R., and Close, A. E. (eds.), *Cattle-keepers of the Eastern Sahara. The Neolithic of Bir Kiseiba*, Southern Methodist University Press, Dallas, pp. 217–250.
- De Paepe, P. (1991). Appendix A: Ceramics from Shaqadud studies by physical methods. In Marks, A. E., and Mohammed, A. S. (eds.), *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas, pp. 261–266.
- Elamin, Y. M., and Khabir, A. M. (1987). Neolithic pottery from survey sites around Shaqadud Cave, Western Butana, Sudan. *Archeologie du Nil Moyen* 2: 175–184.
- Elamin, Y. M., and Mohammed-Ali, A. S. (in preparation). A Neolithic site, Um Marreh, and the Khartoum Mesolithic–Neolithic transition.
- Fattovich, R., Marks, A., and Mohammed-Ali, A. S. (1984). The archaeology of the Eastern Sahel, Sudan: Preliminary results. *African Archaeological Review* 2: 173–188.
- Flight, G. (1973). A survey of recent results in the radiocarbon chronology of Northern and Western Africa. *Journal of African History* 10(4): 531–554.
- Francaviglia, V., and Palmieri, A. M. (1983). Petrological analysis of the ‘Early Khartoum’ pottery: A preliminary report. In Caneva, I. (ed.), *Pottery Using Gatherers and Hunters at Saggai (Sudan): Preconditions for Food Production*, Origini XII, Rome, pp. 191–205.
- Francaviglia, V., and Palmieri, A. M. (1988). Ceramic fabrics and source locations in the Khartoum Province. In Caneva, I. (ed.), *El Geili: The History of a Middle Nile Environment 7000 B.C.–A.D. 1500*, British Archaeological Reports International Series 424, Oxford, pp. 345–358.
- Gabriel, B. (1981). Die Ostliche Zentralsahara im Holozan klima, landschaft und kulturen (mit besonderer berucksichtigung dr Neolithischen). In Roubet, C., Hugot, H., and Souville, G. (eds.), *Préhistoire Africaine. Mélanges Offerts au Doyen Lionel Balout*, Recherche sur les Grandes Civilisations 6, A.D.P.F, Paris, pp. 195–211.
- Haaland, R. (1984). Continuity and discontinuity. How to account for two thousand years gap in the cultural history of the Khartoum Nile Environment. *Norwegian Archaeological Review* 17(1): 39–51.
- Haaland, R. (1987). *Socio-Economic Differentiation in the Neolithic Sudan*, British Archaeological Reports International Series 350, Oxford.
- Haaland, R. (1989). The late Neolithic cultural–historical sequence in the Central Sudan. In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *Late Prehistory of the Nile Basin and the Sahara*, Polish Academy of Sciences, Poznan, Poland, pp. 359–367.
- Haaland, R. (1992). Fish, pots and grain: Early and Mid-Holocene adaptations in the Central Sudan. *African Archaeological Review* 10: 43–69.
- Haaland, R. (1995). Pottery material: A discussion of the emergence and consequence of pottery production. In Haaland, R., and Abdul Magid, A. (eds.), *Aqualithic Sites along the Rivers Nile and Atbara, Sudan*, Alma Mater, Bergen, Norway, pp. 84–122.
- Haaland, R., and Abdul Magid, A. (1991). Atbara research project: The field seasons of 1985, 1987 and 1990. *Nyame Akuma* 35: 36–43.
- Haaland, R., and Abdul Magid, A. (1992). Radiocarbon dates from Mesolithic sites in the Atbara region, Sudan. *Nyame Akuma* 37: 17–27.
- Haaland, R., and Abdul Magid, A. (eds.) (1995a). *Aqualithic Sites along the Rivers Nile and Atbara, Sudan*, Alma Mater, Bergen, Norway.
- Haaland, R., and Abdul Magid, A. (eds.) (1995b). Radiocarbon dates. In Haaland, R., and Abdul Magid, A. (eds.), *Aqualithic Sites Along the Rivers Nile and Atbara, Sudan*, Alma Mater, Bergen, Norway, pp. 47–51.

- Haas, H., and Haynes, C. (1980). Discussion of radiocarbon dates from the Western Desert. In Wendorf, F., and Schild, R. (eds.), *The Prehistory of the Eastern Sahara*, Academic Press, New York, pp. 373–378.
- Hassan, F. A. (1986). Desert environment and origins of agriculture in Egypt. *Norwegian Archaeological Review* **19**(2): 63–76.
- Hays, T. R. (1971). *The Sudanese Neolithic: A Critical Analysis*, Unpublished PhD Thesis, Southern Methodist University, Dallas.
- Hays, T. R. (1974). Wavy Line pottery: An element of Nilotic diffusion. *South African Archaeological Bulletin* **29**: 27–32.
- Hays, T. R. (1975). Neolithic settlement of the Sahara as it relates to the Nile Valley. In Wendorf, F., and Marks, A. E. (eds.), *Problems in Prehistory: North Africa and the Levant*, Southern Methodist University Press, Dallas, pp. 193–204.
- Hays, T. R., and Hassan, F. A. (1974). Mineralogical analysis of Sudanese Neolithic ceramics. *Archaeometry* **16**(1): 71–79.
- Hugot, H. J. (1963). *Recherches Préhistoriques dans l'Ahaggar Nord-Occidental 1950–57*, Centre de Recherches Anthropologiques Préhistoriques et Ethnographiques 1, Paris.
- Keding, B. (1998). The Yellow Nile: New data on settlement and the environment in the Sudanese Eastern Sahara. *Sudan and Nubia* **2**: 2–12.
- Khabir, A. M. (1981). *Neolithic Ceramics in the Sudan, With Special Reference to Sarurab-2*, Unpublished MA Thesis, University of Khartoum, Khartoum.
- Khabir, A. M. (1985). A Neolithic site in the Sarurab area. *Nyame Akuma* **26**: 40.
- Khabir, A. M. (1987a). New radiocarbon dates for Sarurab 2 and the age of the Early Khartoum tradition. *Current Anthropology* **28**: 377–380.
- Khabir, A. M. (1987b). Petrographic and X-ray analysis of Neolithic pottery from Sarurab. *Nyame Akuma* **28**: 45–46.
- Khabir, A. M. (1991a). The firing index of Neolithic pottery from the Central Sudan. *Nyame Akuma* **35**: 33–35.
- Khabir, A. M. (1991b). A qualitative change in the texture of temper of Neolithic ceramics from the Central Nile Valley. *Sahara* **4**: 145–148.
- Kobusiewicz, M. (1984). Report on site E-79-4: The archaeology of el-Ghorab Playa. In Wendorf, F., Schild, R., and Close, A. E. (eds.), *Cattle-Keeper of the Eastern Sahara. The Neolithic of Bir Kiseiba*, Southern Methodist University Press, Dallas, pp. 135–164.
- Kroeber, A. J. (1944). *Peruvian Archaeology in 1942*, Viking Fund Publications in Archaeology 4, The Viking Fund, New York.
- Krzyzaniak, L. (1974). Kadero: First season, 1972. *Etudes et Travaux* **VIII**: 361–366.
- Krzyzaniak, L. (1984). The Neolithic habitation at Kadero. In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *Origin and Early Development of Food-Producing Cultures in North East Africa*, Polish Academy of Science, Poznan, Poland, pp. 309–316.
- Krzyzaniak, L. (1990). Main aspects of the later prehistoric developments in the Sudan as seen from the point of view of the research on the Neolithic. In Bonnet, C. (ed.), *Seventh International Conference for Nubian Studies*, University of Geneva, Geneva, pp. 1–17.
- Kuper, R. (1989). The eastern Sahara from North to South: Data and dates from the B.O.S. project. In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *Late Prehistory of the Nile Basin and the Sahara*, Polish Academy of Science, Poznan, Poland, pp. 197–203.
- Marks, A. E. (1991a). Shaqadud and the 1981/83 excavations. In Marks, A. E., and Mohammed-Ali, A. S. (eds.), *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas, pp. 33–63.
- Marks, A. E. (1991b). The stone artifacts from Shaqadud midden. In Marks, A. E., and Mohammed-Ali, A. S. (eds.), *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas, pp. 95–122.
- Marks, A. E. (1991c). The stone artifacts from Shaqadud cave. In Marks, A. E., and Mohammed-Ali, A. S. (eds.), *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas, pp. 173–191.
- Marks, A. E., and Mohammed-Ali, A. S. (eds.) (1991a). *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas.

- Marks, A. E., and Mohammed-Ali, A. S. (1991b). The place of Shaqadud in the late prehistory of the Central Nile Valley. In Marks, A. E., and Mohammed-Ali, A. S. (eds.), *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas, pp. 237–259.
- Marks, A. E., Shiner, J. L., and Hays, T. R. (1968). Survey and excavations in the Dongola Reach, Sudan. *Current Anthropology* 3: 319–323.
- Marks, A. E., Mohammed-Ali, A. S., Peters, J., and Robinson, R. (1985). The prehistory of the Central Nile Valley as seen from its eastern hinterland: Excavations at Shaqadud Cave, Sudan. *Journal of Field Archaeology* 12: 261–278.
- Mohammed-Ali, A. S. (1973). *A Re-Assessment of the Neolithic Period in the Sudan*, Unpublished MA Dissertation, University of Calgary, Canada.
- Mohammed-Ali, A. S. (1982). *The Neolithic Period in the Sudan, c.6000–2500 B.C.*, British Archaeological Reports International Series 139, Oxford.
- Mohammed-Ali, A. S. (1984). Sarurab 1: A Neolithic site in Khartoum Province, Sudan. *Current Anthropology* 25: 117–119.
- Mohammed-Ali, A. S. (1987). The Neolithic of Eastern Sudan and its implications for the Central Nile. In Hagg, T. (ed.), *Nubian Culture: Past and Present*, Historie ock Antikvitets Akademien, Stockholm, pp. 75–86.
- Mohammed-Ali, A. S. (1991a). The Mesolithic and Neolithic ceramics from Shaqadud Midden. In Marks, A. E., and Mohammed-Ali, A. S. (eds.), *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas, pp. 65–93.
- Mohammed-Ali, A. S. (1991b). Two sites above Shaqadud Canyon: S21 and S17. In Marks, A. E., and Mohammed-Ali, A. S. (eds.), *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas, pp. 267–276.
- Mohammed-Ali, A. S., and Jaeger, S. E. (1989). The early ceramics of the Eastern Butana (Sudan). In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *Late Prehistory of the Nile Basin and the Sahara*, Polish Academy of Sciences, Poznan, Poland, pp. 473–479.
- Mohammed-Ali, A. S., and Marks, A. E. (1984). The prehistory of Shaqadud in the Western Butana, Central Sudan: A preliminary report. *Norwegian Archaeological Review* 17(1): 53–59.
- Nordstrom, H. (1972). A qualitative analysis of the Early and Middle Nubian pottery. In Nordstrom, H. (ed.), *Neolithic and A-Group Sites*, Scandinavian University Books, Stockholm, pp. 33–96.
- Palmieri, A. M. (1987). Chemical analysis of the Acacus pottery: A preliminary essay. In Barich, B. E. (ed.), *Archaeology and Environment in the Libyan Sahara. The Excavations in the Tadrart Acacus, 1978–1983*, British Archaeological Reports International Series 368, Oxford, pp. 221–229.
- Phillipson, D. W. (1977a). *The Later Prehistory of Eastern and Southern Africa*, Africana, New York.
- Renfrew, A. C. (1969). Trade and cultural process in European prehistory. *Current Anthropology* 10(3): 157–163.
- Richter, J. (1989). Neolithic sites in the Wadi Howar (Western Sudan). In Krzyzaniak, L., and Kobusiewicz, M. (eds.), *The Late Prehistory of the Nile Basin and the Sahara*, Polish Academy of Sciences, Poznan, Poland, pp. 431–442.
- Robertson, R. (1991). The late Neolithic ceramics from Shaqadud Cave. In Marks, A. E., and Mohammed-Ali, A. S. (eds.), *The Late Prehistory of the Eastern Sahel*, Southern Methodist University Press, Dallas, pp. 123–172.
- Roset, J. P. (1987). Paleoclimatic and cultural conditions of Neolithic development in the early Holocene of northern Niger (Air and Ténéré). In Close, A. E. (ed.), *Prehistory of Arid North Africa*, Southern Methodist University Press, Dallas, pp. 211–234.
- Schuck, W. (1993). An archaeological survey of the Selima Sandsheet, Sudan. In Krzyzaniak, L., Kobusiewicz, M., and Alexander, J. (eds.), *Environmental Change and Human Culture in the Nile Basin and Northeast Africa Until the Second Millennium B.C.*, Polish Academy of Sciences, Poznan, Poland, pp. 237–248.
- Shiner, J. (1968). The Khartoum Variant industry. In Wendorf, F. (ed.), *The Prehistory of Nubia*, Vol. 2, Southern Methodist University Press, Dallas, pp. 768–790.
- Shiner, J. (ed.) (1971). *The Prehistory and Geology of Northern Sudan*, Part 1, Report to the National Science Foundation, Washington.
- Smith, A. B. (1980). The Neolithic Tradition in the Sahara. In Williams, M. A. J., and Faure, H. (eds.), *The Sahara and the Nile*, A. A. Balkema, Rotterdam, pp. 451–465.

- Sutton, J. E. A. (1974). The aquatic civilization of Middle Africa. *Journal of African History* **15**: 527–554.
- Vail, J. R. (1982). Geology of the Central Sudan. In Williams, M. A. J., and Adamson, D. A. (eds.), *A Land Between Two Niles. Quaternary Geology and Biology of the Central Sudan*, A. A. Balkema, Rotterdam, The Netherlands, pp. 51–63.
- Wendorf, F., and Schild, R. (1980). *Prehistory of the Eastern Sahara*, Academic Press, New York.
- Wendorf, F., Schild, R., and Close, A. E. (eds.) (1984). *Cattle-Keeper of the Eastern Sahara. The Neolithic of Bir Kiseiba*, Southern Methodist University Press, Dallas.
- Whiteman, A. J. (1971). *The Geology of the Sudan Republic*, Clarendon Press, Oxford.
- Wieckowska, H. (1984). Report on Site E-79-1. In Wendorf, F., Schild, R., and Close, A. E. (eds.), *Cattle-Keeper of the Eastern Sahara. The Neolithic of Bir Kiseiba*, Southern Methodist University Press, Dallas, pp.73–94.
- Wiley, G. R. (1945). Horizon style and pottery traditions in Peruvian archaeology. *American Antiquity* **II**(I): 49–56.
- Wiley, G. R., and Phillips, P. (1958). *Methods and Theory in American Archaeology*, University of Chicago Press, Chicago.
- Williams, D. F. (1982). Appendix 8: Petrological analysis of Neolithic pottery from Sarurab and Umm Barou. In Mohammed-Ali, A. S. (ed.), *The Neolithic Period in the Sudan, c.6000–2500 B.C.*, British Archaeological Reports International Series 139, Oxford, pp. 174–176.
- Zarratini, A. (1983). Ground stone implements from Saggai-1. In Caneva, I. (ed.), *Pottery Using Gatherers and Hunters at Saggai (Sudan): Preconditions for Food Production*, Origini XII, Rome, pp. 234–241.
- Zedeno, M. N., and Wendorf, F. (1993). *Ceramics and Nomads: The Development of Ceramic Production in the Eastern Sahara and Egypt*, Unpublished Report on file, Department of Anthropology, Southern Methodist University, Dallas.