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Seriation of predynastic potsherds from the Nagada region (Upper Egypt)

Introduction

Ceramic collections from Predynastic settlement sites in the Nagada region consist almost exclusively of sherds. The sherds are on the average, small (about 25 sq cm) and are not suitable, except in a few cases, for reconstructing vessel shapes. Accordingly, the majority of the sherds cannot be dated using the seriation scheme known as sequence dating – a system developed to seriate complete vessels from graves (*e.g.*, Petrie 1900, 1901, 1920; Kaiser 1956, 1957; Baumgartel 1965; Kemp 1982) We present here the results of a preliminary analysis of collections of ceramic sherds from settlements using multidimensional scaling showing that, given a large sample size and a sampling strategy minimizing functional variability, a temporal order of the collections can be achieved. We show, in addition, that multidimensional scaling can provide a means for detecting intrasite temporal variations and can thus contribute to an understanding of the occupational history of sites and their spatial pattern of growth.

The ceramic collections

Collections were obtained from Sites KH7, KH3, KH1, KH6, KH4, South Town, and North Town in the Nagada region, Upper Egypt (Fig. 1). The collections were mostly from the surface or near the surface. Three surface collections were obtained from Site KH7 (Table 1). A total of 822 sherds was collected consisting of 159 sherds from Area 1, 161 sherds from Area 2, and 502 sherds from Area 3. The areas were 5×5 m in size.

Collections from Site KH3 consist of ceramics obtained during excavations in four different areas of the site: Area B, Area V, Area X, and Area VIII. The total

from the three top levels in Area B is 1,108 sherds compared with 1,789 sherds from Area V, 8,595 from Area X, and 159 from Area VIII. At Site KH6, one area (Area 1) of 10 × 10 m yielded 109 sherds. Another area (Area 2), also measuring 10 × 10 m, yielded 365 sherds. The collection from KH1 consists of 698 sherds obtained from spot samples from various parts of the site. Collections from Site KH4 were obtained from two areas, Area N in the northern part of the site and Area C in the central part of the site. Each of these areas is 10 × 10 m. The collection from Area N totals 807 sherds compared with 726 from Area C. Collections were also made from immediately below the surface at both areas providing additional samples of 177 sherds from Area C and 106 sherds from Area N.

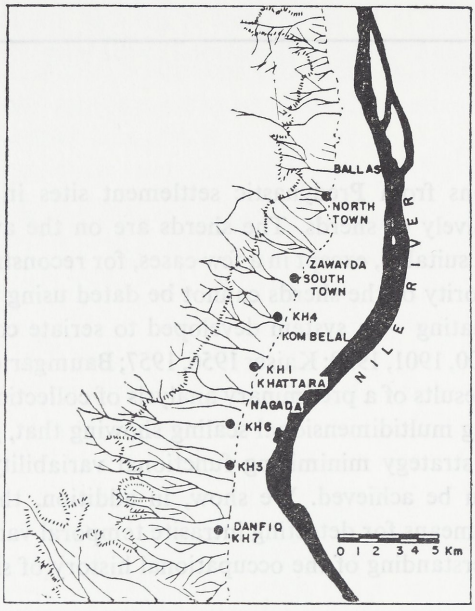

FIG. 1. Location map of Predynastic sites in the Nagada region

At South Town, eight collections were made from 5 × 5 m units from the center of 25 × 25 m site quadrates. A total of 9,521 sherds were collected. At North Town, collections were obtained from four parts of the site. Each of the areas measured 5 × 5 m. A total of 4,390 sherds was obtained. The total number of sherds collected from all sites is 29,375. The collections were obtained in order to assess the possibility of the utility of using Predynastic sherds for temporal ordering. The study was undertaken as an exploratory study since quantitative data on Predynastic ceramics are lacking. Some of the problems that had to be evaluated were the size of an adequate sample, the correspondence between surface and subsurface samples, functional variability.

Table 1

Frequency of ceramic types in Predynastic Nagada settlements

Sites	Total No. of sherds	P		B		R		O		D		Misc.
		#	%	#	%	#	%	#	%	#	%	#
KH7, SC1	159	66	(41.5)	8	(5.0)	84	(52.8)	1	(0.6)	0	0	0
SC2	161	89	(55.3)	8	(4.7)	64	(39.8)	0	0	0	0	0
SC3	502	244	(48.6)	25	(5.0)	231	(46.0)	1	(0.2)	1	(0.2)	0
KH3, Area B												
Level 1	273	99	(36.3)	45	(16.5)	129	(47.3)	0	0	0	0	0
Level 2	447	151	(33.8)	71	(15.9)	225	(50.3)	0	0	0	0	0
Level 3	388	126	(32.5)	72	(18.6)	190	(49.0)	0	0	0	0	0
KH3, Area V	1789	622	(34.8)	271	(15.1)	896	(50.1)	0	0	0	0	0
KH3, Area X	8595	2582	(30.0)	1265	(14.7)	4748	(55.2)	0	0	0	0	0
KH3, Area VIII	159	60	(37.7)	22	(13.8)	77	(48.4)	0	0	0	0	0
KH6, Area 2	365	123	(33.8)	27	(7.4)	213	(58.5)	1	(0.4)	0	0	1
KH6, Area 1	109	26	(24.1)	16	(14.8)	65	(60.2)	1	(0.9)	0	0	1
KH1	698	210	(30.1)	54	(7.7)	430	(61.6)	1	(0.1)	3	4	0
KH4, Area C, Surface	726	255	(35.1)	-	(0.0)	471	(64.8)	0	0	0	0	0
KH4, Area C, Subsurface	177	44	(24.9)	11	(6.2)	122	(68.9)	0	0	0	0	0
KH4, Area N, Surface	807	270	(33.5)	27	(3.3)	505	(62.6)	0	0	0	0	5
KH4, Area N, Subsurface	106	31	(30.4)	3	(2.9)	68	(66.7)	0	0	0	0	4
South Town												
18	2157	73	(3.4)	6	(0.3)	2017	(93.5)	54	(2.5)	7	(0.3)	0
26	1655	80	(4.8)	1	(0.1)	1514	(91.4)	56	(3.4)	4	(0.2)	0
30	1355	137	(10.1)	4	(0.3)	1212	(89.5)	0	(0.0)	1	(0.1)	1
38	948	67	(7.1)	10	(1.1)	859	(90.6)	12	(1.3)	0	(0.0)	0
43	1110	122	(11.0)	0	(0.0)	971	(87.5)	13	(1.2)	4	(0.4)	0
45	982	60	(6.1)	1	(0.1)	861	(87.7)	56	(5.7)	4	(0.4)	0
47	1015	171	(16.9)	6	(0.6)	829	(81.9)	0	(0.0)	7	(0.7)	0
54	301	4	(1.3)	1	(0.3)	295	(98.0)	0	(0.0)	1	(0.3)	0
North Town												
SC4	840	7	(0.9)	1	(0.1)	483	(58.9)	324	(39.5)	5	(0.6)	20
SC1	1061	52	(4.9)	2	(0.2)	998	(94.2)	6	(0.6)	1	(0.1)	2
SC2	868	160	(18.5)	8	(0.9)	689	(79.6)	9	(1.0)	0	(0.0)	2
SC3a	1374	70	(5.1)	5	(0.4)	1275	(92.8)	24	(1.7)	0	(0.0)	0
SC3b	247	14	(5.7)	1	(0.4)	229	(93.0)	2	(0.8)	0	(0.0)	1

P: Polished red; B: Polished black (from black-top polished red or polished black); R: Rough; O: Orange (decorated Late or wavy handled) D; Decorated. Percentages are calculated excluding miscellaneous.

The required sample size is primarily dependent upon the proportion of various ceramic categories or number of attributes and the degree of accepted reliability balanced against time and effort. Our initial impressions indicated that main classes recognized by Petrie (*e.g.*, Polished Red, Rough, *etc.*) were potentially time-dependent. Using these categories it was found that a sample of 177 sherds (KH4, Area C, Subsurface) yielded an estimated frequency of Rough sherds within $\pm 7\%$ of that of the parent target population at a confidence interval of 95%. With a larger sample size of 696 (KH4, Area C, Subsurface) the estimate was within $\pm 3.5\%$ at the same level of confidence. The largest samples obtained provided an estimate of $\pm 1.5\%$. Thus, samples that are less then 500 sherds may be considered inadequate. Accordingly, collections from various parts of Site KH7 consisting of 159, 161, and 502 sherds were combined to arrive at a sample size of 882 sherds. The samples from Site KH3, Area VIII (159 sherds) and that from South Town, Area 54 (311 sherds) are too small to be adequate for seriation. We may note here, however, that

subsurface samples from Site KH4 consisting of small collections of 177 and 106 sherds showed a similar frequency of ceramic categories (Table 1).

Correspondence between surface and subsurface collections was also tested at Site KH3B. Collections from the top three levels (5 cm each) at Area B (Table 1) revealed that there is no significant difference between the levels. A Chi-Square of 1.824 was obtained for a level of confidence of 0.05.

Investigation of the spatial distribution of ceramic sherds at KH3, Area X indicates that units measuring 2×2 m show a wide range of variation resulting from differences in activities, disposal, and randomness. Thus, samples for the purpose of seriation must be obtained from a sufficiently large area to obliterate the effect of functional variability. An area of 10×10 appears to serve that purpose in the present case. In the future, eight to ten collections from 2.5×2.5 m units chosen at random 25×25 m quadrates should be attempted to ensure that variations resulting from differences of activity or disposal are minimized.

At Site KH7, functional or disposal variability is minimized by combining the collections from the three areas of the site. Collections from Areas B, V, and X from Site KH3 are from sufficiently large areas. The effect of functional variability in these collections is considered low. Collections from Site KH4 are from 10×10 m areas and are thus considered suitable for temporal ordering. The collection from KH6 is marginally suitable. The collections from South Town and North Town are from 5×5 m units. The possibility of variations resulting from functional disposal differences is possible. Accordingly, in the future, random samples from large grid units should be obtained.

Methods

Graphic seriation and computerized multidimensional scaling techniques were used to order the collections. The major types used for seriation include Rough (R), Polished Red (P), Black polished sherds presumably from the Black-top Polished Red pottery type (B), Orange sherds (O) which may be derived from Late, Wavy-handled, or Decorated pottery, and Decorated sherds (D) from Decorated pottery. We also used three rim types of Rough sherds to carry out a number of different seriations using metric multidimensional scaling (Principal co-ordinate analysis, Torgerson 1958; Gower 1971) to plot the archaeological components. We report on three different analyses using percentages of the four pottery classes and one using rim types to create matrices of city-block distances (average absolute differences: Sneath and Sokal 1973). These city block distances were then treated as if they were euclidean distances (they are metric) and scaled metrically. The fast graphical technique devised by Meighen (1959) and modified by Ascher (1959) was also used to assess its utility for rapid exploration.

Meighen's method consists of using the three categories. The categories used here were the most common classes: 1. Polished Red; 2. Black Polished sherds,

presumably from Black-topped Red Polished and Black Polished pottery; and 3. All other types. The percentage of each of the types is calculated and plotted on a ternary diagram. Following Ascher (1959) the percentage of two categories (here Black Polished and Red Polished sherds) are used to generate a binary plot. The points are then fitted to a best line. The order of the points, assuming that the variations of data express a linear function of time should reflect their order through time. The adequacy of the seriation can be judged by reference to available radiocarbon dates. The validity of a certain is also related to other factors. According to Dunnell (1970), seriation will not reflect perfect chronological order unless all units included in the seriation, belong to the same cultural tradition, and come from the same area. The collections used here are from the same region, within a total distance of 20 km, and are of the same Predynastic cultural tradition. The requirements for the duration of the units may practically be phrased in terms of the duration of the unit as not much greater than of their time difference (Marquardt 1978). Since the collections come from limited spatiotemporal units of the sites, it is very likely that the time spans they represent are less than those separating them and that they are comparable.

Results and discussion

The results of graphic seriation (Fig. 2) show a clear separation between a group of sites including KH3, KH7, KH1, KH6, and KH4 and another consisting of South Town and North Town. There also appears to be some order within the two groups,

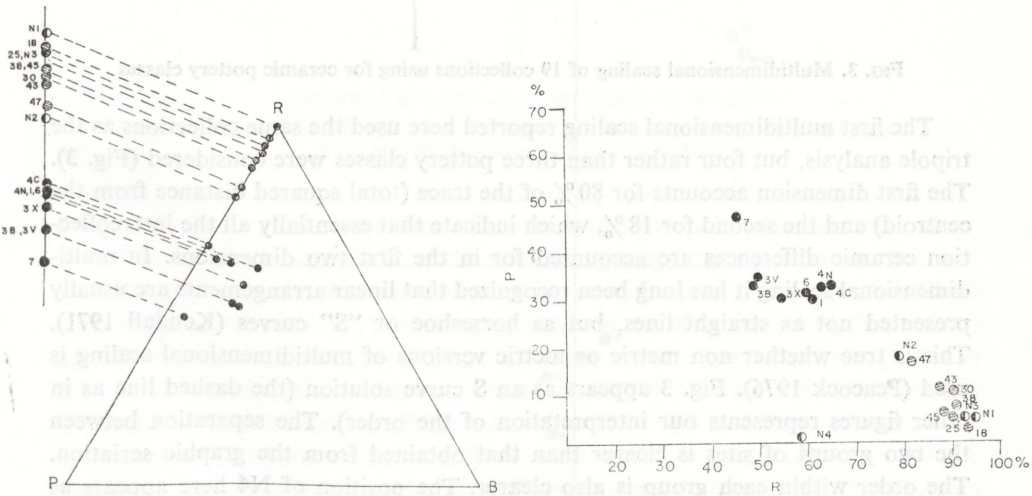

FIG. 2. Results of graphic seriation of ceramic collections from Predynastic sites in the Nagada region: a triple-pole (ternary) diagram and a binary diagram

The notation for the sites in this and other figure sis as follows: *1*: KH1; *3*: KH3; *4*: KH4; *6*: KH6; *7*: KH7; *18, 25, 30, 38, 43, 45, 47*: South Town; *N1, N2, N3, N4*: North Town.

although there are some collections that have no clear position, and the position of Collection 4 from North Town (N4) is uncertain. The first group has a frequency of Polished Red pottery equal to or greater that of Rough Pottery. At South Town and North Town the frequency of Rough Potsherds far exceeds that of the Polished Red sherds.

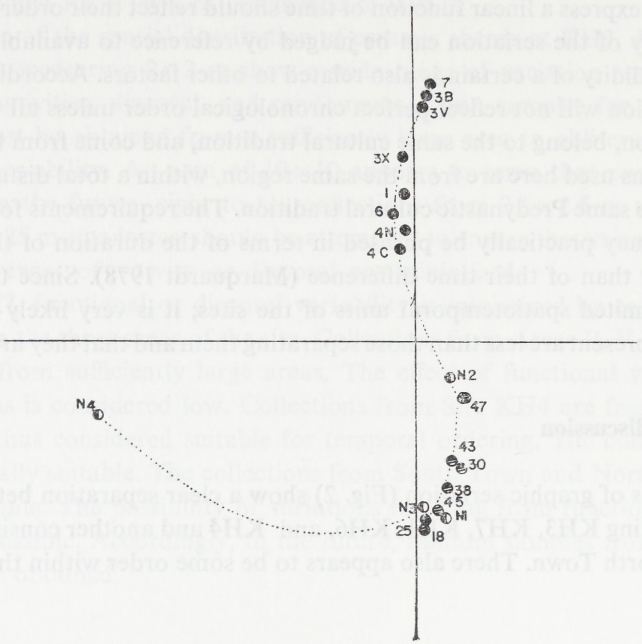

FIG. 3. Multidimensional scaling of 19 collections using for ceramic pottery classes

The first multidimensional scaling reported here used the same collections as the tripole analysis, but four rather than three pottery classes were considered (Fig. 3). The first dimension accounts for 80% of the trace (total squared distance from the centroid) and the second for 18%, which indicate that essentially all the intercollection ceramic differences are accounted for in the first two dimensions. In multidimensional scaling it has long been recognized that linear arrangements are usually presented not as straight lines, but as horseshoe or "S" curves (Kendall 1971). This is true whether non metric or metric versions of multidimensional scaling is used (Peacock 1976). Fig. 3 appears as an S curve solution (the dashed line as in other figures represents our interpretation of the order). The separation between the two groups of sites is clearer than that obtained from the graphic seriation. The order within each group is also clearer. The position of N4 here appears as younger than other collections from North Town. The difference between N4 and the other collections from North Town may well be indicative of both temporal and functional differences. Both North and South Town represent incipient urbanization. The transformation related to rapid urbanization may account for an accelerated

rate of change in ceramics. We suspect that the exceptionally high content of Orange pottery may very well be related to functional changes related to advanced urbanization.

The group consisting of collections from North Town and South Town are temporally younger than other collections. The two sites have traditionally been regarded as Nagada II or Gerzean. The dating is supported by the sequence dates of ceramic collections from the central area at North Town and South Town which indicates a late Predynastic occupation equivalent to Kaiser's Zeitstufe IIcd. Sequence dates on ceramics and other artifacts from Site KH3 indicate that KH3 belongs to Kaiser's Zeitstufe IIab and Kemp's Group I. The radiocarbon age determinations (Hassan 1984) also indicate that the west-central area at South Town dates to 3,440±70 B.C., and that the sites of the first group are older; KH3 dating to 3,830±75 B.C., KH1 to 3,795±75 B.C., and KH6 to 3,715±90 B.C. (these dates are tree-ring calibrated weighted averages). It thus may be concluded that the first group belongs to an early Nagada group dating to about 3,850 - 3,650 B.C. (based on a range given 2 standard deviations of average age estimates from sites KH3, KH6, and KH1) compared with a late Nagada group dating to about 3,580 to 3,300 B.C., based on dates from South Town.

In order to mitigate the possible functional/activity-related variability and to reduce sampling error, we ran a further analysis with the collections grouped into eight larger collections each from one of the sites (Fig. 4). In this analysis the first

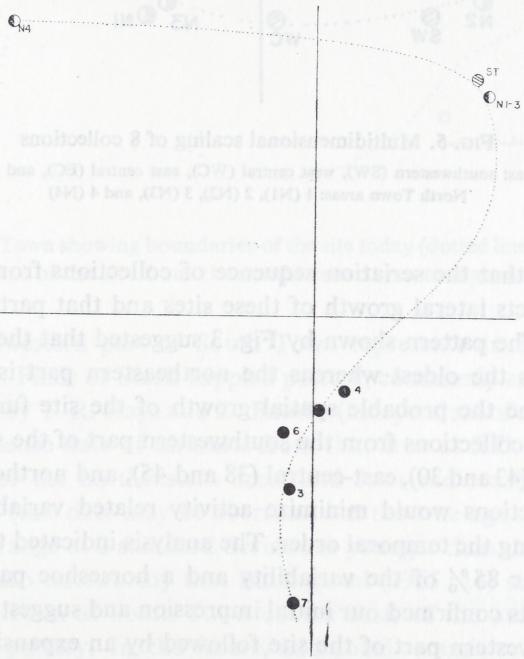

FIG. 4. Multidimensional scaling of 8 collections and 4 pottery classes

dimension accounted for 67% and the second 30% of the squared distance from the centroid. A horseshoe or S shaped curve is again shown with N4 at one end the KH1 - 7 sites at the other end. The sequence of the KH1 - 7 sites runs: KH7, KH3, KH6, KH1, KH4, North Town (Areas 1, 2, and 3), South Town and North Town Area 4 (the northernmost area at that site). North Town 4 was treated separately because of its exceptionally high content of Orange (Late) pottery (Table 1).

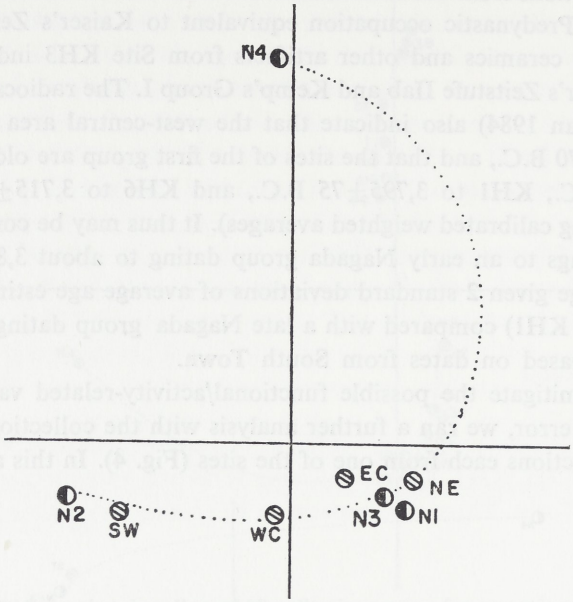

FIG. 5. Multidimensional scaling of 8 collections

South Town areas: southwestern (SW), west central (WC), east central (EC), and northeastern (NE)
North Town areas: 1 (N1), 2 (N2), 3 (N3), and 4 (N4)

We suspected that the seriation sequence of collections from South Town and North Town reflects lateral growth of these sites and that parts of these sites are of different age. The pattern shown by Fig. 3 suggested that the southwestern part of South Town is the oldest whereas the northeastern part is the youngest. We decided to examine the probable spatial growth of the site further by combining the order of large collections from the southwestern part of the site (collection (47), west-central area (43 and 30), east-central (38 and 45), and northeastern (25 and 18). These large collections would minimize activity related variability and sampling error, thus clarifying the temporal order. The analysis indicated that the first dimension accounted for 85% of the variability and a horseshoe pattern was obtained (Fig. 5). The results confirmed our initial impression and suggested an early occupation in the southwestern part of the site followed by an expansion into the central area and finally into the northwestern area (Fig. 6).

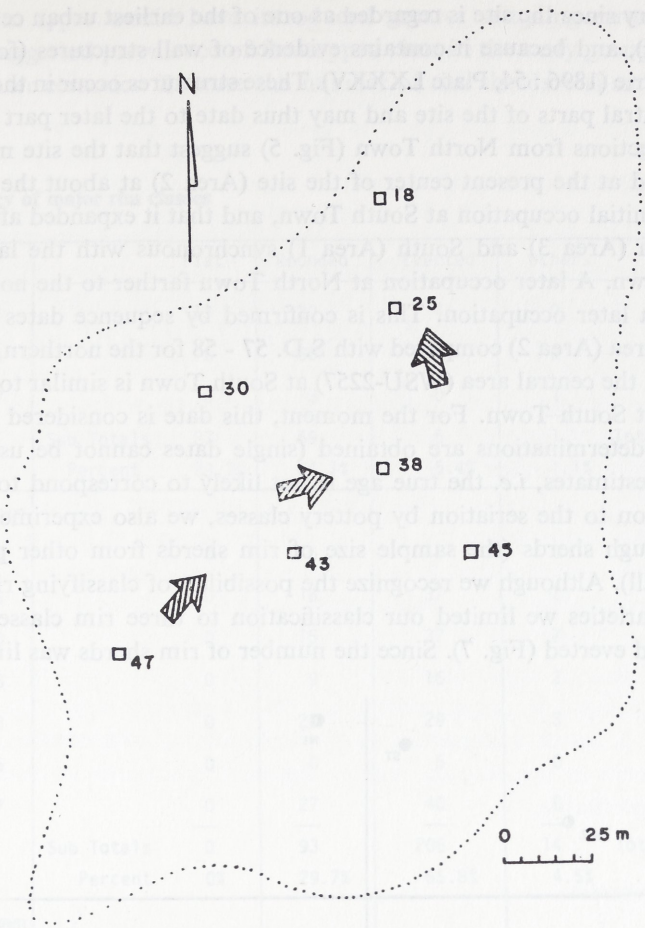

FIG. 6. Map of South Town showing boundaries of the site today (dotted line) and probable spatial growth pattern of the site from the southwestern area to the northeast corner

That the southwestern part of South Town represents an early occupation is also suggested by 1. Finds of Black Rippled pottery, commonly associated with early Predynastic stages, by T. R. Hays and D. Batcho (independent of each other); 2. Estimation of the sequence date of ceramics from that area at S.D. 44 compared with S.D. 52 or later for the northeastern area; and 3. A radiocarbon date (Tx-2465) of 3,845±140 B.C. (this date may be aberrant, but the true age may be close to the younger limit of a range at 2 standard deviations younger than the mean, *i.e.*, about 3,550 B.C.). It is also noteworthy that Baumgartel (1965 : 16) suspected that there was an early occupation at South Town on the basis of the presence of sherds of White Cross-lined pottery. In the future, additional ceramic collections and more radiocarbon dates should be obtained in order to refine the model of site develop-

mental history since the site is regarded as one of the earliest urban centers in Egypt (Kemp 1982), and because it contains evidence of wall structures (fort or palace?) noted by Petrie (1896 : 54, Plate LXXXV). These structures occur in the northeastern and east-central parts of the site and may thus date to the later part of Nagada II.

The collections from North Town (Fig. 5) suggest that the site may have been first occupied at the present center of the site (Area 2) at about the same time as that of the initial occupation at South Town, and that it expanded afterwards both to the north (Area 3) and South (Area 1) synchronous with the late occupation at South Town. A later occupation at North Town farther to the north represents apparently a later occupation. This is confirmed by sequence dates of 46 - 48 for the central area (Area 2) compared with S.D. 57 - 58 for the northern area (Area 4). A date from the central area (WSU-2257) at South Town is similar to that from the older area at South Town. For the moment, this date is considered aberrant until further age determinations are obtained (single dates cannot be used to provide narrow age estimates, *i.e.* the true age is not likely to correspond to the mean).

In addition to the seriation by pottery classes, we also experimented with rim types of Rough sherds (the sample size of rim sherds from other pottery classes was too small). Although we recognize the possibility of classifying rims into many types and varieties we limited our classification to three rim classes: flat-topped, rounded, and everted (Fig. 7). Since the number of rim sherds was limited, a larger

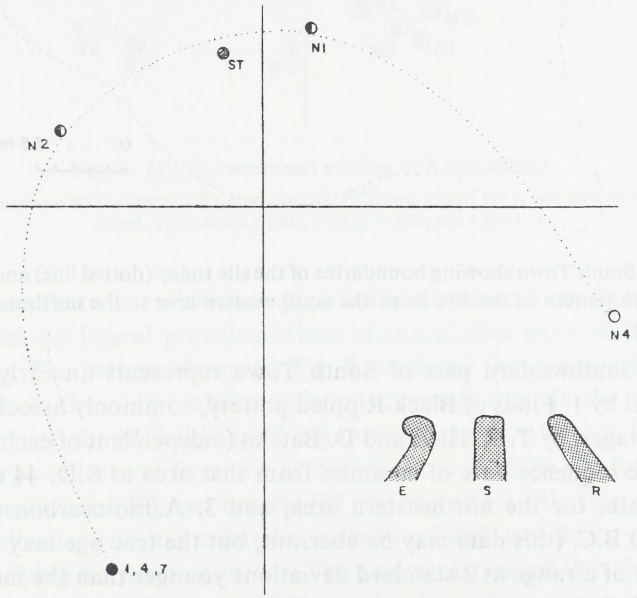

FIG. 7. Multidimensional scaling of three rim classes of Rough Pottery

E: Everted; S: Straight; R: Rounded

1, 4, 7: Sites KH1, KH4, and KH7 from Early Nagada group; *ST*: South Town area; *N1*, *N2*, and *N4*: North Town areas 1, 2, and 4

number of rim types would have introduced greater sampling error. Our initial impressions suggested prevalence of flat-topped rims in the early group and everted rims in the later ceramics. Because the number of rim sherds was small (Table 2),

Table 2

Frequency of major rim classes

Sites		Flat	Rounded	Everted	Others	
KH1		13	20	4	0	
KH4		8	36	1	0	
KH7		6	3	0	1	
	Sub Totals	27	59	5	1	Total 92
	Percent	29.3%	64.1%	5.4%	1.1%	
South Town						
18		0	6	42	0	
25		0	16	37	2	
30		0	15	37	7	
38		0	9	16	2	
43		0	20	29	3	
45		0	0	5	0	
47		0	27	40	0	
	Sub Totals	0	93	206	14	Total 313
	Percent	0%	29.7%	65.8%	4.5%	
North Town						
1		0	9	28	0	
2		0	14	19	0	
	Sub Totals	0	23	47	0	Total 70
	Percent	0%	32.9%	67.1%	0%	
North Town						
4		20	10	16	0	Total 46
	Percent	43.5%	21.7%	34.8%	0%	

the frequencies from Sites KH1, KH4, and KH7 were combined as was South Town. The results of this scaling show another horseshoe with the first two dimensions accounting for 100% of the squared distance. Again we see an order from the early Nagada group (KH1, KH4, KH7) to South Town and the main part of North

Town, and finally to the northern part of North Town (N4). This latter area has by far the largest percentage of everted rims (40 %). Therefore we suggest that stylistic attributes of rims may be useful in future seriations of Predynastic pottery.

Summary

Seriation of collections of potsherds from Predynastic settlements in the Nagada region using multidimensional scaling indicates that this approach to relative dating is promising. The preliminary results indicate that the sites may be ordered into an early Nagada group consisting of sites KH3, KH7, KH4, KH1, and KH6 and a later group consisting of South Town and North Town. The later group is equivalent to Nagada II or Nagada IIcd of Kaiser. This sequence is also confirmed by radiocarbon dates and sequence dates. The seriation also suggest that South Town as well as North Town expanded horizontally from earlier occupations smaller than their present size (this has interesting implications for settlement analysis and demographic estimates). At South Town the earliest occupation was at the southwestern area. The results also indicate that South Town and North Town were for the most part contemporaneous, but an occupation post-dating South Town is noted in the northern area of North Town. A preliminary evaluation of the potential of the frequency of rim types of Rough sherds in seriation also suggests that it is a promising method. We are encouraged by these preliminary results and anticipate that further work will provide a better understanding of the history of settlements and settlement growth patterns in the Nagada region. Similar applications in other regions may also prove profitable.

Acknowledgements

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