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# Wheel Fashioned Ceramic Production during the Third Millennium BCE in the Southern Levant: a Perspective from Tel Yarmuth

Valentine ROUX

## INTRODUCTION

In the Southern Levant, although the wheel coiling technique (shaping coiled roughouts on the wheel) appears by the second half of the fifth millennium, it does not become predominant before the second half of the second millennium BCE. In other words, it took 3000 years for a technique presenting techno-economic benefits (rapidity of the fashioning, regularity of the end product), but also a high learning cost (difficulty in learning the skills involved), to be widely adopted. Between the fifth and the second millennia BCE, this technique disappeared (and reappeared) twice, once after the collapse of the Chalcolithic societies, in the middle of the fourth millennium BCE, and once after the collapse of the first urban societies, at the end of the second millennium BCE. In a previous study, I suggested that the disappearance of the wheel coiling technique by the end of the Late Chalcolithic period could be explained in terms of the context of production and transmission of the craft (Roux 2003, 2008): the technique was restricted to the manufacture of ceremonial vessels, and, as suggested by our data, was probably in the hands of only a few craftsmen<sup>1</sup> attached to a politico-religious elite. Once the politico-religious elite and its demands disappeared, the transmission of the craft stopped.

During the first half of the third millennium BCE (Early Bronze [hereafter EB] II and III), the potter's wheel is back and supposedly extensively used, the rise of urbanization supposedly promoting techniques to speed up craft production. However by the EB IV period, just as at the end of the Chalcolithic period, the wheel coiling technique again fell into oblivion. This raises the question of the context of production of wheel made ceramics during the EB III period, and specifically, to what extent was the wheel coiling technique in the hands of a limited number of craftsmen with a specific status like that of the Chalcolithic potters using the wheel. In order to explore these issues, analysis was undertaken of the EB III ceramic assemblage of Tell Yarmuth, a fortified urban centre located in southwestern Canaan, in the central Shephelah, among the major EB III sites of the southern Levant (Miroschedji 2000a, 2000b, 2003, 2006). On this site two tournettes have been discovered in situ (Miroschedji 2000b), attesting the use of rotary instruments to produce ceramics. Before presenting and discussing the results of our study, I outline the methodology followed, review technological definitions, and indicate the southern Levantine technological background of the Yarmuth potter's wheels.

1. One of the arguments was quantitative: three craftsmen, each making 10 bowls a day, 200 days a year, over 200 years, can produce 1,200,000 bowls (i.e., 10 million sherds if each bowl gives 10 sherds). The archaeological figures are much lower and therefore very consistent with the hypothesis of a few craftsmen in charge of the wheel fashioned vessels.

## METHODOLOGY, TERMINOLOGY, AND TECHNOLOGICAL CONTEXT

**Methodology: a classification aimed at highlighting organization of the ceramic production**

Classification of ceramic assemblages is usually based on both morphological and stylistic features and fabrics. Morphological and stylistic features are supposed to indicate such phenomena as archaeological chronologies, intended functions, and social status of consumers. Combined with fabrics, they can indicate centers of production and distribution networks (e.g. Orton et al. 1993 ; Rice 1996). When aimed at characterization of modes of ceramic production or reconstruction of techno-economic systems, such a classificatory procedure is limited. Indeed, the same morphological type can be produced by different social groups (whatever the nature of these social groups) or different morphological types can be produced by the same social group. In this regard, single morphological attributes are not relevant, although admittedly when there is a close correlation between morphological types, technological features, and fabrics, definable as discrete groups or “wares” identifiable with the naked eye, distinct traditions attributable to different groups of producers are in effect revealed (e.g., Gray Burnished Ware, Khirbet Kerak Ware, Metallic Ware, etc.). However, when morphological types comprising numerous sherds whose fabric or technological attributes do not permit the definition of discrete groups with the naked eye, random sampling of fabric is conducted within the morphological classes. Such random sampling is aimed at identifying the provenance of the production (where the ceramics have been made) and thus groups of producers. The problem is that most of the time only a limited number of sherds<sup>2</sup> are sampled within large morphological classes (e.g., bowls, jugs, etc.) without control of their representativeness in terms of clay sources. We are then in a situation where it is difficult to assess the possible various groups of producers at the origin of the studied assemblage.

An alternative to the approach outlined above is classification of ceramic assemblages according to *chaînes opératoires* – the modalities according to which raw material is transformed into finished product (Creswell 1996). Each *chaîne opératoire* is considered to correspond to a technological group, i.e., groups of sherds expressing recurrent technological practices. When technological groups do not correspond to distinct functional groups, it indicates that the *chaînes opératoires* do not vary according to the function of the vessels, and, in this regard, can be considered as representative of social groups or communities of practice (Gosselain 2008), given universals pertaining to the mechanisms of learning and transmission of technical tasks (e.g. Gosselain 2000 ; Roux 2007 ; Shennan 2002 ; Stark 1998). Briefly, these mechanisms explain that once skills are learned through apprenticeship, they are embodied and put into action according to a social agenda, here the range of morphological types to be produced according to the skills learned for this purpose. In other words, they explain why ethnographic data have never offered even a single example of a person using different techniques at random for producing the same range of functional objects. When sorting sherds on the basis of *chaînes opératoires*, the advantage is that the groups of producers and the range of products they manufacture are not only rapidly highlighted, but more importantly, they are highlighted according to a quantitatively controlled procedure. In effect, each sherd, even shapeless sherds, can be attributed to a *chaîne opératoire* or technological group, as long as it presents legible surface features and/or microfabrics. From this, a better control of the proportion of each technological group within an assemblage is achieved.

In order to identify the different *chaînes opératoires* present in a ceramic assemblage, first, each sherd is examined in terms of manufacturing methods and techniques, tools, gestures, quality and ‘know-how’. For this purpose, surface features, visible on both the outer and inner faces of the clay walls, are recorded. Manufacturing methods, techniques and tools are identifiable on the basis of diagnostic attributes highlighted through experimental and/or ethnoarchaeological studies, i.e., univo-

2. The limited sampling of sherds for making thin sections and therefore identifying sources of clay is often a matter of cost (money and time consuming analyses).

cal attributes given energetic constraints acting upon the mechanical behavior of the clay (e.g., Ali 2005; Courty and Roux 1995; Roux and Courty 1998; Gelbert 2003; Rye 1981); gestures are indicated by the orientation of the visible forming and/or finishing surface features; quality is expressed by the surface aspect of the clay walls; know-how is suggested by the regularity of the wall and rim morphology.

Second, within each technical entity, the petrographic attributes of the sherds are examined in order to sort them out according to clay preparation techniques and clay sources (Roux and Courty 2005). The final products of such a classification are “techno-petrographic groups”, i.e., technical groups characterized by petrographic attributes. They reveal *chaînes opératoires*, from the place of extraction of the raw material to the firing, and in this regard, units of production. The morphological classification is done within each techno-petrographic group. Classifying the morphological types at the end of the general classificatory procedure enables one to assess the possible co-variation between the *chaînes opératoires* and the morphological types.

### Wheel forming techniques and methods

Two main forming techniques, i.e., physical modalities through which the raw material is transformed, use the rotary kinetic energy (henceforth RKE) for transforming clay material into a vessel, the *wheel coiling technique* and the *wheel throwing technique*.

The *wheel coiling technique* consists of combining the coiling technique for making a roughout, i.e., hollow volume which does not present the final geometric characteristics of the vessel, and the wheel shaping technique for making a preform, i.e., a vessel with its final geometric characteristics but which has not been subjected to finishing techniques. The combination of coiling and wheel shaping techniques depends on what stage rotary kinetic energy (RKE) is used for transforming clay walls. Four methods, i.e., the series of operation involved in production, have been distinguished (Roux and Courty 1998):

Method 1: coils are built, joined and thinned by discontinuous pressures, without the help of RKE. Shaping is done with the help of RKE.

Method 2: coils are built and joined by discontinuous pressures, without the help of RKE. Thinning and shaping the body is done with the help of RKE.

Method 3: coils are built by discontinuous pressures, without the help of RKE. Joining the coils, thinning and shaping the body is done with the help of RKE.

Method 4: Forming and joining the coils as well as thinning and shaping the body are done with the help of RKE. In this method, the coil is set on the wheel and then thinned and shaped with the help of RKE. A symmetrical platform is fashioned, upon which is laid the next coil. Joining the two coils is done with the help of RKE.

The *wheel throwing technique* consists in using the RKE to transform a mass of clay into successively a roughout and a preform. The manufacturing process is entirely mechanized and the different operations are exerted in synergy through the use of RKE. A considerable gain of time follows: 3 minutes for wheel throwing against 20 minutes for wheel coiling small bowls.

These different fashioning techniques produce very similar finished products. However, these similar finished products can be differentiated on the basis of the combined study of surface features and microfabrics. Significant surface features include specific morphology of grooves, rilling, ridges and walls while significant microfabrics include specific structural patterns, air voids, particle orientation and joins (Courty and Roux 1995; Roux and Courty 1998).

Skills involved in fashioning a pot with RKE are radically different from the ones involved in fashioning a pot without RKE, whatever the technique used, wheel coiling or wheel throwing. In particular, those skills imply the development of specific bimanual coordination through lengthy apprenticeship and repeated practice (Gelbert 1997, Roux and Corbetta 1989, 1990).

As far as the wheel is concerned, the wheel coiling technique does not need the wheel to rotate at a speed beyond 80 revolutions per minute (henceforth: rpm) whatever the size of the vessel. In the case of the wheel throwing technique, the wheel needs to turn at a speed of at least 150 rpm in order

to resist to the pressures of the potter's hand when centering the lumps of clay. When wheels cannot exceed 80 rpm, they are called "tournette", i.e., an instrument revolving around an axis but whose speed is quickly slowed down when centering lumps of clay (Roux and Miroschedji 2009). The potter's wheel corresponds to an instrument whose speed is not slowed down by the potter's pressures while centering lumps of clay.

### The wheel coiling technique in the southern Levant during the fifth-fourth millennia BCE

In the Southern Levant, during the second half of the fifth millennium BCE, vessels were not wheel thrown but wheel coiled according to Method 2 outlined above (Roux and Courty 1998; Roux 2003). The succeeding period witnesses considerable changes. In particular, EB I ceramic assemblages attest the fact that, surprisingly, the wheel coiling technique was no longer in use, except for a short period of time over a small geographical area, southwestern Canaan. In this area, during the EB IA, some open bowls are still wheel coiled according to the same method used previously (Braun and Gophna 2004; Golani 2004; Yekutieli 2001; Yekutieli and Gophna 1994). However, this continuity did not last. In the EB IB, the wheel coiling technique seems to have disappeared completely. Indeed, even though the wheel was still in use, it is used henceforth as a simple rotary device, for finishing operations only, as shown by the technological studies conducted by Charloux on the ceramic material found at Tell el-Fâr'ah North (Charloux 2002), Megiddo and Tel Yarmuth (Charloux 2006), and by our own observations of the ceramic material from various sites (Beth Shean, Erani C, Hartuv). Ceramics can exhibit string cut marks on the outside of the base, but there is no transformation of their clay walls with the help of RKE. At Fâr'ah, a very limited number of vessels were finished on the wheel (only 6.3 % of the vessels; 36 out of 575).

Skills involved in smoothing a pot with RKE and skills involved in fashioning a pot with RKE are radically different. In the first case, it is enough to apply the hand to the clay walls while the wheel is rotating, whereas in the second case, specific bimanual coordination has to be developed through lengthy apprenticeship and repeated practice (Roux and Corbetta 1989, 1990). From this point of view, the EB IB ceramic assemblages reveal that some EB IB potters used the wheel but, unlike their Late Chalcolithic predecessors, they did not develop the skills necessary for fashioning vessels with the help of RKE.

#### ANALYSIS OF THE TEL YARMUTH EB II-III CERAMIC ASSEMBLAGE

In order to understand the organization of wheel made ceramic production at Tel Yarmuth during the third millennium BCE, ceramics formed with the help of RKE have been characterized qualitatively and quantitatively. However, no petrographic examination has been conducted. The technological analysis proposed here is therefore limited to an analysis of the manufacturing operations. Information about clay sources must await further studies.

All the ceramics dated from EB II-III and excavated in the different areas (B, C, G, H) of Tel Yarmuth (Fig. 1) have been examined (except for area J which was under excavation<sup>3</sup>), totaling around 30,000 sherds (diagnostic sherds + sherds intended for conservation). At Tel Yarmuth, the EB III period has been dated ca. 2700 – 2300 BCE, encompassing around 400 years (Miroschedji 2000c). It has been subdivided into three phases, A, B and C, on the basis of the stratigraphy and the evolution of the ceramics (Miroschedji 2000a, 2000c, in press). The different areas excavated have revealed structures with different functions: Area C has revealed, for the EB IIIA phase, domestic habitations and a small public building; for the EB IIIB phase, a large public building whose techniques of construction belong to palatial architecture; for the EB IIIC, in area B, two successive palatial build-

3. Area J corresponds to a terrace south-east of the palace B and has revealed houses; the sherds excavated before 2005 have been examined but, given the small body of data, they are not here considered.

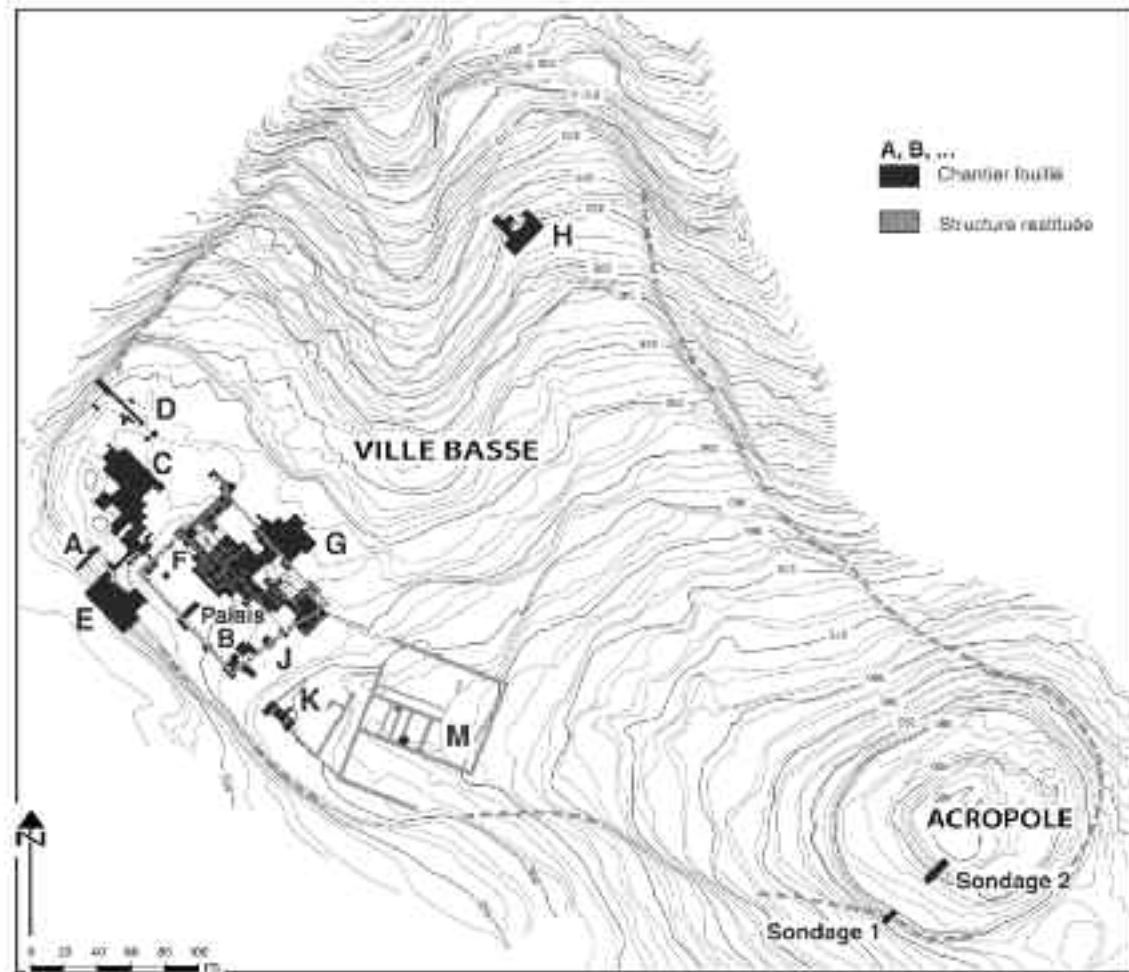


Figure 1. Tel Yarmuth. Location of the different excavated areas (after Miroschedji 2000b).

ings (Palace B1 and Palace B2) (Miroschedji 2000b). Area G, situated alongside the palace B1 is characterized by domestic habitations. Area H is a habitation area located in the southern part of the site. Occupation of Areas C, B and G, started in the EB IB. Occupation of Area C ended by phase EB III B (Miroschedji 2000a).

### Identification of wheel forming and finishing techniques

The vessels made with RKE (and whose shapes are described hereafter) present clear diagnostic attributes of the use of RKE: concentric parallel striations, stretched walls, string cut marks on the base, sub-parallel organization of the constituent elements of the clay material (poral system and coarse fraction) and elongation of fissures. Vessels displaying only concentric parallel striations on the external walls of the vessels, but no other features diagnostic of the use of RKE and/or of a tournette revolving around an axis (such as the string cut mark or specific organization of clay components) have been considered as fashioned without RKE. In effect, concentric parallel striations alone can be obtained by smoothing the clay walls while either turning around the pot or revolving the pot by a simple movement of the hand, the pot resting on a support enabling rotation (lubricant like slip on a wooden plank, concave base of a broken jar, etc.).

The vessels made with RKE are all wheel coiled: roughouts were first coiled, then thinned and/or shaped on the wheel. The wheel coiling technique is visible on numerous vessels which exhibit diagnostic features such as joins of coils visible on the surface and in section (Fig. 2). Two fashioning

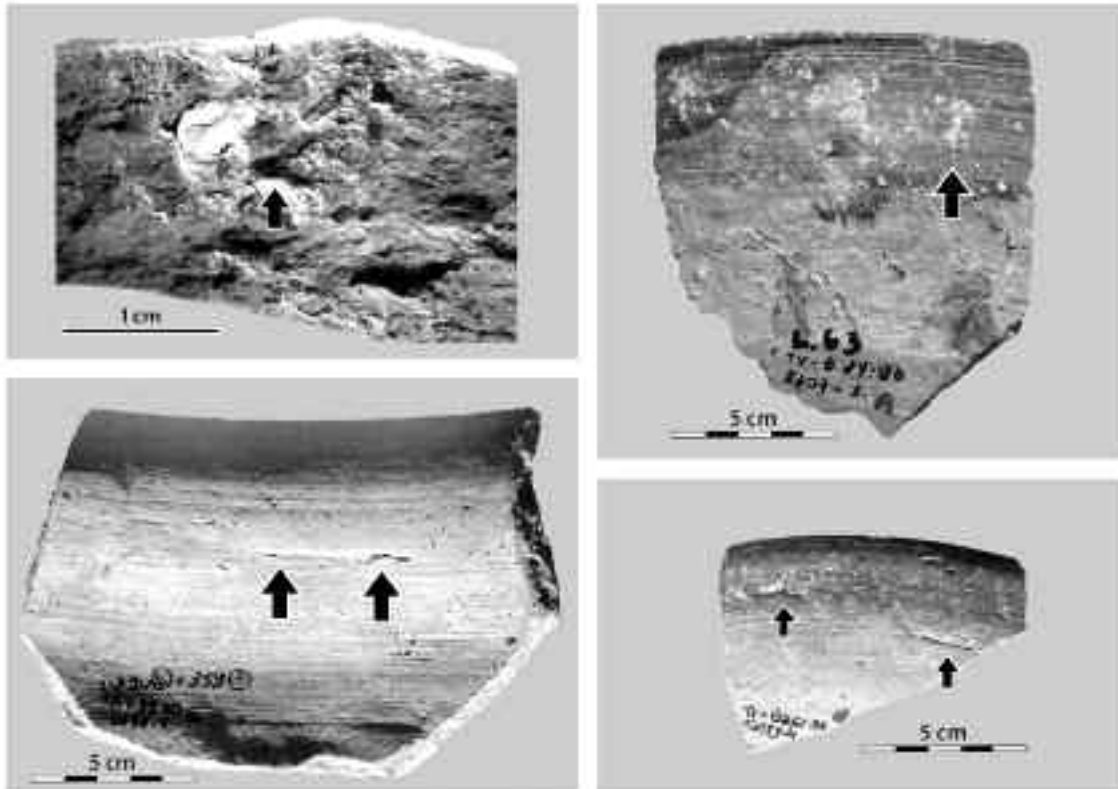


Figure 2. Diagnostic attributes of the wheel coiling technique: joints of coils, parallel striations, stretching of the clay walls.

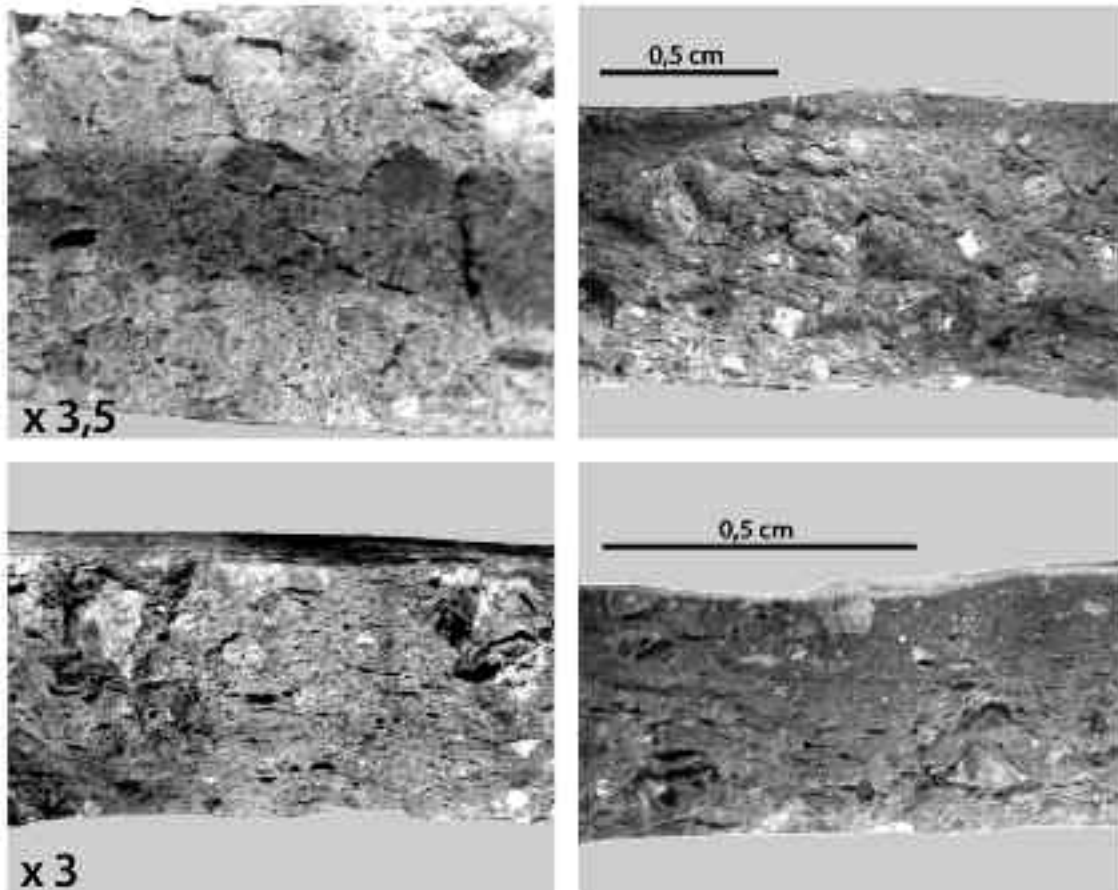


Figure 3. Diagnostic attributes of the wheel coiling methods. The more the quantity of RKE applied to the clay walls, the strongest the compression and the more subparallel the different components of the clay fabric (poral system and coarse fraction) (below, right and left as compared to weakly compressed clay walls, above, right and left).

methods have been identified, Method 1 and 2 outlined above. In Method 1, pressures applied with RKE slightly modify the morphology of the walls which have already been thinned by discontinuous pressures. In Method 2, pressures with RKE strongly modify the wall surface in order to erase join patterns and thin the walls. This variability of pressures is mostly visible in the organization of the coarse fraction and voids. The stronger the pressures with RKE, the more sub-parallel the general organization of these constitutive elements (Fig. 3).

At Tel Yarmuth, the vessels made with RKE present two main qualities of fashioning on the basis of the way the clay material has been prepared and the way the clay walls have been regularized:

1. a low quality marked a) by a weak preparation of the clay as shown by the air voids and the weak integration of the coarse fraction to the fine mass, b) by a superficial finishing of the clay walls with RKE.

2. a high quality marked a) by a fine preparation of the clay as shown by the low porosity of the clay material, b) by a strong transformation of the clay walls with RKE as shown by the stretching and regularity of the walls.

On the basis of the wheel coiling methods and the quality of fashioning, four technological groups have been distinguished, corresponding each to a specific *chaîne opératoire*.

1. The first *chaîne opératoire* is characterized by the following forming operations. The roughouts were coiled, the coils were joined and the preforms shaped by discontinuous pressures. Then, they were finished on the wheel (Method 1). While still humid, vessels were detached from the wheel with a string as shown by the string cut striations on the external bases. The clay walls were hardly transformed by RKE. Some specimens do not even attest of any transformation with RKE; in many cases, the string cut base is the main diagnostic attribute for ascertaining the use of a tournette while forming the vessel. Generally speaking, the vessels made according to this *chaîne opératoire* are not carefully manufactured. First, the clay has not been prepared carefully as shown by the air voids and the weak integration of the coarse fraction to the fine mass. They have not been either carefully shaped on the wheel as shown, for example, by the clay surplus around the base as well as by the lack of regularization of the walls. Some vessels are slipped on the internal face, but in general, there are no decorative operations. The vessels made according to this *chaîne opératoire* are mainly flat base bowls with a simple rim (e.g., Miroshedji 2000c, fig. 18.8:1), deep bowls and small jugs<sup>4</sup>.

2. The second *chaîne opératoire* comprises vessels made by coiling, and shaped on the wheel (Method 1). Once detached from the wheel, the bowls are left to dry to leather hard and then shaved, slipped and/or burnished. Preparation of the clay and quality of the fashioning are rather poor. This group comprises mainly open vessels, either bowls with a simple rim (hemispherical bowls, e.g., Miroshedji 2000c, fig. 18.5:1), or a profiled rim (*écuelles*, e.g. Miroshedji 2000c, fig. 18.3:5, 7), or platter bowls with a simple (*jatte*, e.g., Miroshedji 2000c, fig. 18.8:8) or profiled rim.

3. The third *chaîne opératoire* comprises vessels made by coiling, then thinned and shaped on the wheel (Method 2). They are also shaved or turned when leather hard. This *chaîne opératoire* is different from the second one in that RKE has been used not only for shaping the clay walls, but also for thinning them which corresponds to Method 2. Such a method is inferred from the degree of compression which is stronger than for Method 1 and which results in a tighter sub-parallel structure and a stronger stretching of the clay walls. Vessels made according to Method 2 are usually more carefully fashioned than the vessels made according to Method 1. Clay is also better wedged. This group includes mainly bowls with simple and profiled rims (e.g., Miroshedji 2000c, fig. 18.3:6), but also deep carinated bowls (e.g., Miroshedji 2000c, fig. 18.5:6).

4. A fourth *chaîne opératoire* has been observed. Vessels are made by coiling, then thinned and shaped on the wheel (Method 2). Bases and necks are compressed while the wheel is rotating, indicating an application of two hands and therefore the use of bimanual skills. No shaving or turning

4. Flat base bowls with a simple rim correspond to types 04, 05, 10 and jugs to types 03, 06 as defined in Miroshedji's provisional typology.



follows. Clay is fine and well prepared. This group is mainly made of stump-base jugs (e.g., Miroshedji 2000c, fig. 18.6:3) or pots.

### Fashioning techniques and morphological types

The main morphological types fashioned with RKE are found throughout the EB III (Table 1). Some types are already present by the EB II which is present in Areas C, B and G. During the EB II, wheel made vessels include slipped and/or polished profiled rim bowls, slipped bowls with a flat base, and slipped and polished jugs. During the EB IIIA, the wheel made vessels include the same types and subtypes that appear during the EB II except for the non-slipped flat base bowls<sup>5</sup> and the stump-jugs which appear at this time. During the EB IIIB, there is an increase in the number of subtypes which are wheel made. In the EB IIIC most of the wheel made subtypes remain the same except for the stump-jugs which are no longer present. In summary, there is a strong continuity throughout the EB III in the main morphological types made with RKE – simple rim bowls, profiled rim bowls, jugs and platter-bowls.

Wheel fashioned vessels	EB II	EB IIIA	EB IIIB	EB IIIC
Bowls with a profiled rim (flat or hemispherical)	01 (small), 11B1 (flat base), 11B2	11B1, 11B2, 12	01, 11A, 11B1, 11B2, 11C1, 11D, 12 (flat base)	01, 11A, 11B1, 11B2, 11C
Carinated bowls			09B, 09	
Hemispherical Bowls with a simple rim		02A	01, 02A, 02B	02A, 02B
Flat base bowls with a simple rim	03A1	03A1, 04	03, 04, 04C	03, 04, 04C, 05, 10
Jugs	14	15		03, 06, 12
Stump-base jugs		19A, 19B, 19C	19A	
Platter-bowls with a simple rim				01A
Platter-bowls with a profiled rim		21B		

Table 1. Morphological types made with RKE throughout the EB III period (correspondence with Miroshedji's provisional typology).

These different morpho-stylistic types are also made without RKE. In this regard, there is no relationship between technique and morphological type. Hemispherical bowls with a simple or profiled rim, carinated bowls, jugs, and platter-bowls are also made without RKE. One exception could be the flat base bowls with a simple rim<sup>6</sup>. Whenever the base remains, one sees traces of the string cut. In this regard, we can suppose that all the flat base bowls with a simple rim could have been fashioned on a tournette.

The vessels made without RKE are formed according to *chaînes opératoires* that are similar to the ones described for the vessels made with RKE: a) coiling, shaping, smoothing; b) coiling, shaping, smoothing, shaving when leather hard. Preparation of the clay varies in quality and constituents.

5. Type 04 according to Miroshedji's provisional typology, fig. 18.8:1, Miroshedji 2000c.

6. Type 04 according to Miroshedji's provisional typology, fig. 18.8:1, Miroshedji 2000c.

### Quantitative data

The percentage of wheel made vessels has been assessed for the different areas excavated. The total number of diagnostic sherds have been counted and the Minimum Number of Individuals (hereafter: MNI) calculated, here corresponding to the number of rims<sup>7</sup>. At Tel Yarmuth, the number of wheel fashioned vessels is very low. It represents only 0.6% of the assemblage and less than 3% of the MNI (Table 2).

Areas	EBII	EBIIIA	EBIIIB	EBIIIC	TOTAL
Area B	-	3,22% (1/31)	3,34% (24/718)	2,08% (37/1778)	2,08%
Area G	-	1,53% (2/130)	10,4% (14/134)	6,89% (52/754)	6,67%
Area H	-	100% (2/2)	3,44% (3/87)	2,51% (11/437)	3,04%
Area C	0,57% (7/1220)	4,17% (17/407)	0,82% (3/363)	-	1,35%
TOTAL	0,57 %	3,85%	3,37%	3,36%	

Table 2. Percentage of wheel coiled vessels distributed according to phase as compared as to the Minimum Number of Individuals, here defined in terms of number of rims.

In order to test to what extent these very low figures were not due to a bias in the selection of the diagnostic attributes, we checked the number of wheel made ceramics among the sherds freshly excavated and not yet sorted. Whatever the area (B or J), it appeared that the proportion of wheel made ceramics was very low, less than 1% (Table 3). This confirms the low figures obtained on the basis of the total number of diagnostic sherds.

This low number is found throughout the entire EB III period (Table 2). This indicates that during the entire period encompassed by the EB III, fashioning with RKE was minimal.

Sherds > 3cm <sup>2</sup>	% vessels made with RKE
Area Ba	0.63% (9 out of 1427)
Area Bb	0.77% (12 out of 1549)
Area Ja	0.51% (8 out of 1542)

Table 3. Percentage of wheel coiled vessels as compared as to the total number of sherds excavated during two weeks.

Simple and profiled rim bowls appear as the main morphological types made with RKE throughout the EB III (Fig. 4). Within each morphological category, the proportion of wheel shaped ceramics is always minimal, as illustrated in Area B (Fig. 5). Thus, as an example, wheel made simple rim bowls with a slip on the internal face, constituting an important part of the wheel made vessels, represent only 4.54% of this morphological type (which is made mostly without RKE). When assessing, per phase, the proportion of wheel fashioned ceramics within each main morphological type, the

7. Bases, handles and body sherds are not included in the MNI.

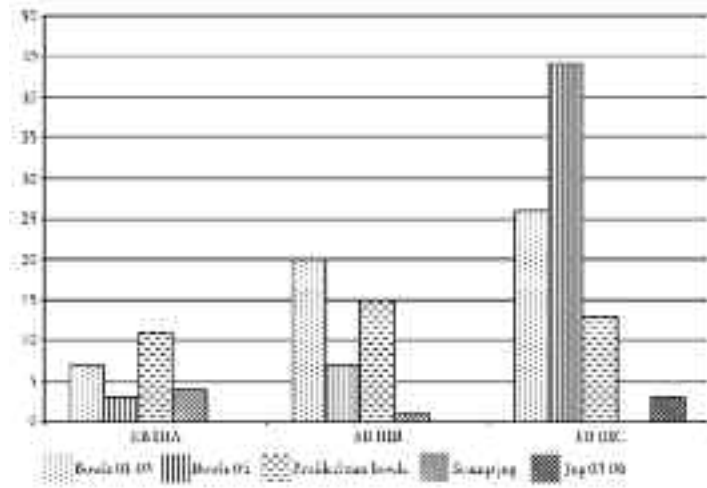


Figure 4. Number of wheel coiled vessels per main morphological categories (hemispherical simple rim bowls (types 01 to 03), bowls with a flat base and string cut traces (type 04), profiled rim bowls, stump jugs, jugs with a flat base and string cut traces (types 03-06).

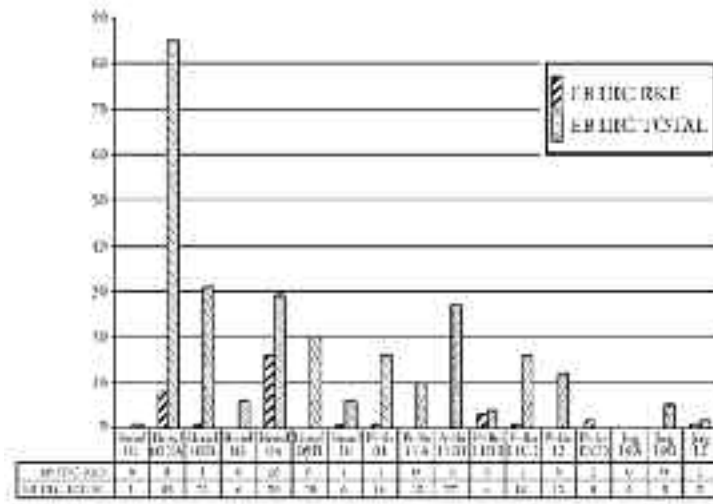


Figure 5. Proportion of wheel coiled vessels per morphological categories, area B, EB III C phase.

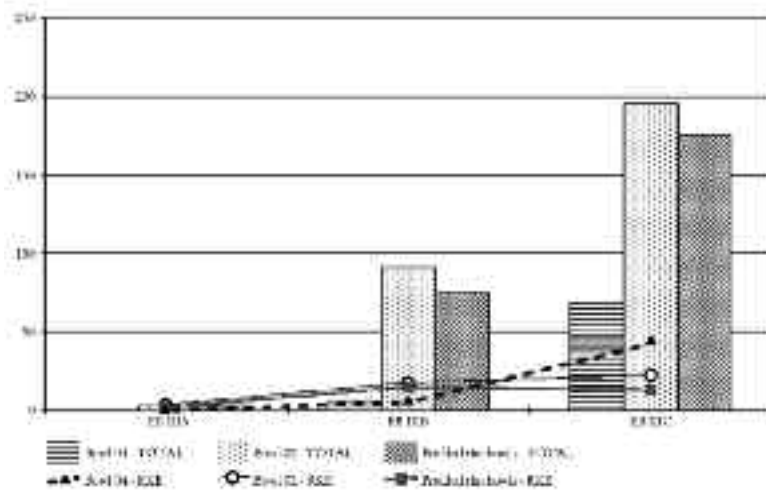


Figure 6. Proportion of wheel coiled vessels per main morphological categories distributed according to phase, all areas considered.

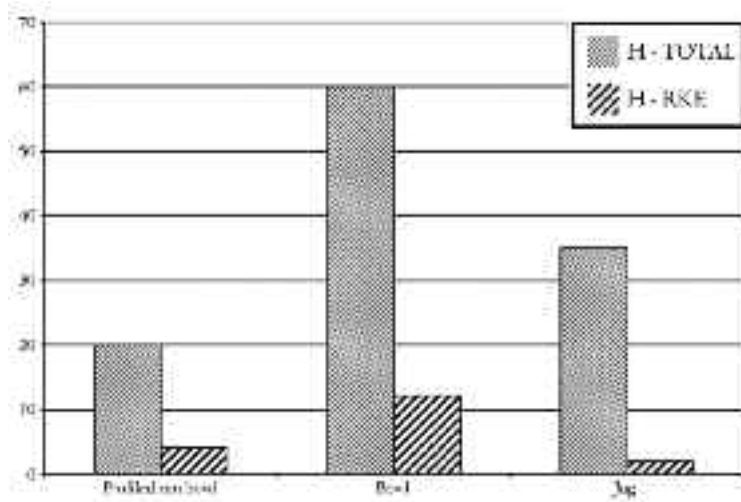


Figure 7. Percentage of wheel coiled vessels per main morphological categories, Area H.

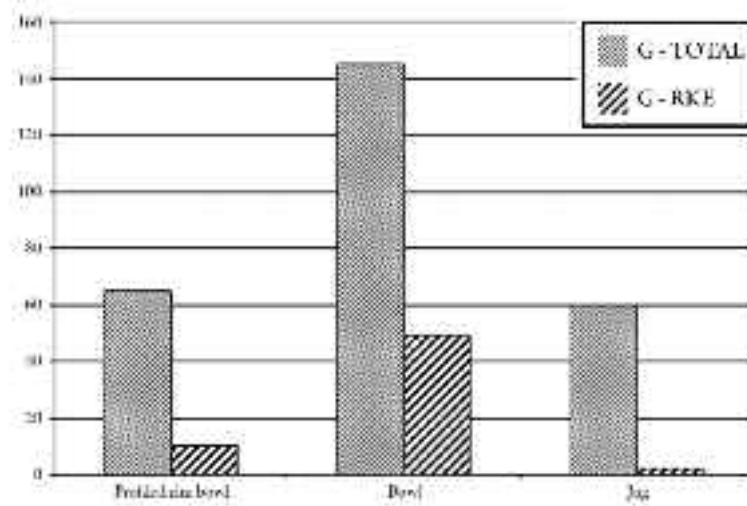


Figure 8. Percentage of wheel coiled vessels per main morphological categories, Area G.

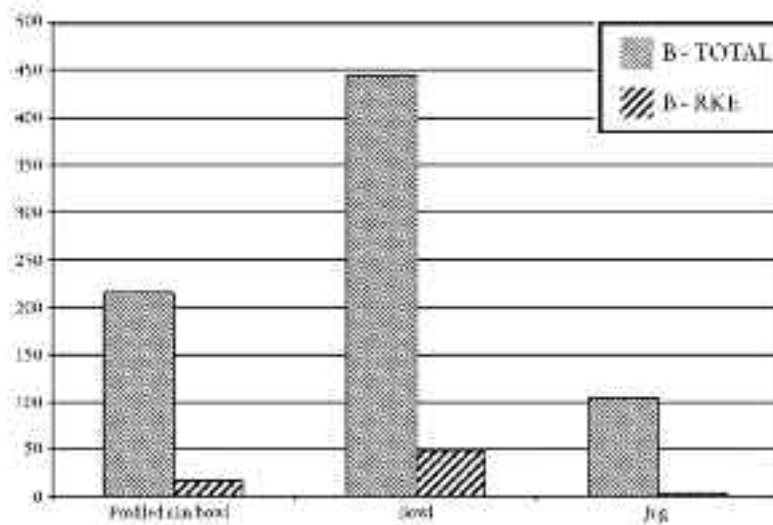


Figure 9. Percentage of wheel fashioned vessels per main morphological categories, Area B.

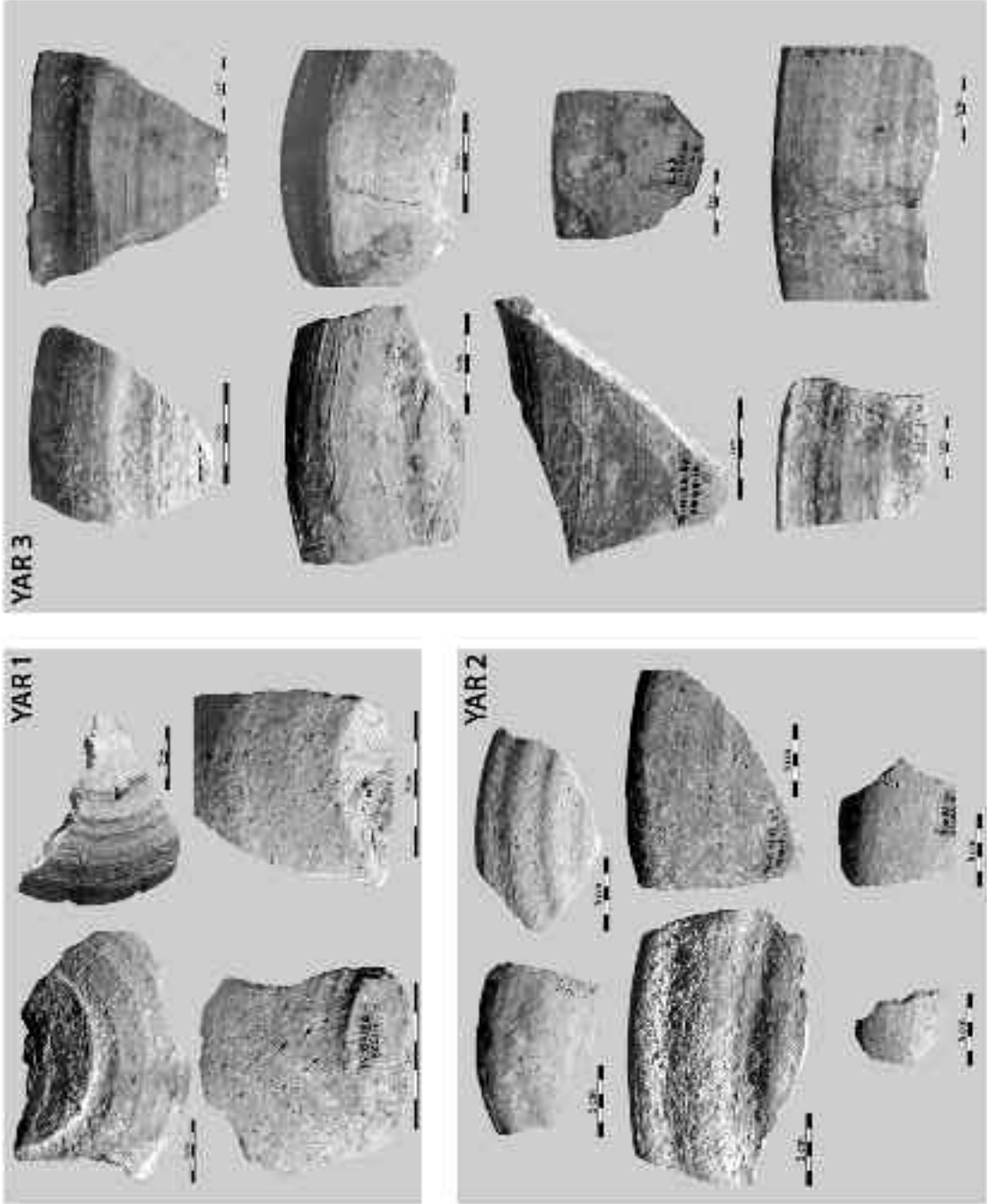


Figure 10. The three wheel coiled ceramic groups identified at Tel Yarmuth.

increase in wheel fashioned ceramics during the EB IIIC phase appears to be proportional to the general increase of number of ceramics (Fig. 6). Hence, it does not reflect a significant increase in wheel fashioned production. On the contrary, it shows that the continuity in wheel made production, outlined above on the basis of morphological types, is also found in the quantity manufactured.

### Spatial data

In order to better understand the functional differences between the vessels made with RKE and without RKE, we examined the spatial distribution of the vessels. Given the different functions of the buildings excavated, we supposed that those living in a palace and those living in domestic dwellings corresponded to different categories of inhabitants. A differential spatial distribution of the wheel fashioned ceramics according to these categories of inhabitants could therefore reveal specific “functions”.

Figures 7, 8 and 9 show that, in fact, there is no significant differential distribution of the wheel made ceramics across the site. They are distributed all over the different excavated areas, in the public buildings like Palace B, in the habitation areas next to the Palace B (area G), and farther away (area H). Moreover, they are found side by side with non-wheel fashioned ceramics belonging to the same morphological types. In this regard, spatial data do not suggest any relationship between the use of the wheel coiling technique and the status of those who used them, i.e., the function of the vessels.

Similarly, among the wheel made ceramics the different *chaînes opératoires* highlighted present no specific distributions. They are found side by side such that the unslipped or slipped flat base bowls<sup>8</sup> made according to Method 0-1 are found in the same areas as the slipped profiled rim bowls or the jugs made according to Method 2. The simple rim bowls are found over all the excavated areas, perhaps to be explained by their hypothetical function as lamps if we consider that most of them retained traces of soot on their rims.

## DISCUSSION

### Technological groups and groups of producers

Throughout the EB II-III, there is strong continuity in the production of the wheel fashioned ceramics, both in terms of the morphological types, and in the low number of exemplars per type. This allows us to consider the wheel fashioned ceramics globally and to propose for the EB II-III period at Yarmuth, on the basis of the *chaîne opératoire* and the skills involved, three main technological groups. These three technological groups have been designated YAR1, YAR2 and YAR3 and correspond respectively to the *chaînes opératoires* 1, 2 and 3, 4 (Fig. 10). They could indicate different groups of producers.

Group YAR1, made according to Method 1, is quantitatively the most important and probably the most homogeneous in terms of correlation between shape and technique. This is the only group which includes one type of vessel made apparently exclusively on the wheel (bowls with a simple rim and string-cut base, e.g., Miroschedji 2000c, fig. 18.8:1). The *chaîne opératoire* corresponding to YAR1 applies mainly to bowls (shallow and deep), but also to other vessels, like ledge handle jars (Miroschedji 2000c, 18.9:5), pots (medium size restricted vessels or jugs) and the tetrapod platter (Charloux 2006; Miroschedji 2000c, fig. 18.9:1). Tetrapod platters have been found only within the compound of Palace B. According to petrographic examination by Y. Goren, these vessels were imported to Yarmuth from the southern Coastal plain, somewhere south of Ashkelon (Miroschedji 2000c: 332). More petrographic data are needed here to assess the homogeneity of group YAR1 in terms of clay sources and then propose hypotheses about its origin.

8. Types 04 and 04c as defined by Miroschedji's provisional typology, fig. 18.8:1, Miroschedji 2000c.

Groups YAR2 and YAR3 include the vessels made according to the *chaînes opératoires* 2, 3 and 4. These vessels have been lumped together due to the similarity of the *chaînes opératoires* characterizing their manufacture. They are formed by wheel coiling and shaving. They are comparable to the one used for making some of the platters whose rims display parallel striations, indicating a smoothing with a rotary movement. Such a rotary movement could have been produced with the help of the tournette even though no structural modification indicates the use of RKE. Indeed, the fashioning of rims implies a tensile stress that obliterates features diagnostic of forming techniques (Courty and Roux 1995).

Quality varies between groups YAR2 and YAR3 as expressed by the low quality vessels belonging to the *chaîne opératoire* 2 and the high quality vessels made according to *chaînes opératoires* 3 and 4. Among the latter, vessels present a technological variability visible a) in the tools used for shaving, the way these tools have been used, and b) in the degree of hygrometry at which the clay has been thinned, shaped and shaved. One jug, made according to *chaîne opératoire* 4, has been identified as originating from Lebanon (dated EB II), while a stump-jug is possibly from the Shephelah<sup>9</sup>. These data suggest that YAR2 and YAR3 vessels could have been manufactured by different potters originating from Yarmuth as well as from outside Yarmuth, although most of them belong to the same cultural area, taking into account the similarity of shapes and decor with the local production.

Given the small number of vessels forming the YAR3 group, it could be that the vessels whose fabrics are local were made by the potters who made also the YAR2 vessels.

As far as skills are concerned, YAR1 vessels could have been shaped with unimanual skills, one hand pressing the clay walls and therefore transforming them more or less strongly, the other hand rotating the wheel. This holds also for YAR2 vessels. YAR3 vessels could have been thinned and shaped either with unimanual or bimanual skills. Ethnographic data and experiments show that closed vessels (e.g., jugs) can be shaped on the wheel with unimanual skills, the thinning of the coils occurring as they are laid. Bimanual skills suppose more elaborate skills than unimanual, a better control the transformation of the clay walls as well as a different functioning of the tournette whose rotation would have necessitated a helper. In fact, the limited number of vessels made on the tournette leads us to suppose that, during the EB II-III period, the vessels were mainly manufactured with unimanual skills.

Whatever the case, the technological ceramic groups highlighted here can be interpreted in terms of a distinct social community as compared to the social groups making the pottery without RKE. The skills involved in vessels made with and without RKE are different, suggesting different transmission networks. These skills were not restricted to specific categories of objects. Hence the hypothesis according to which the wheel coiling technique was not restricted to specific functional categories of vessels, and that the manufacture of similar morphological types was in the hands of different groups of potters following different technological traditions applied to the same morpho-stylistic types of vessels.

### Modes of production of the wheel coiling technique

The potters making vessels with RKE were limited in number throughout the EB III as shown by the low number of wheel made ceramics. We can suppose they were specialized given the skills necessary for mastering the use of RKE. Here, the hypothesis is that any craft involving skills long to learn in a techno-economic context of multiple activities cannot be learnt by all the members of the community, but only by a few of them (Roux 1990). Some of these craftsmen may have been attached to the palace. Indeed, the first tournette was found in the hypostyle room of Palace B1. Archaeological evidence shows that the tournette and part of the ceramic material were stored on an upper first floor from which they fell. The second tournette was found outside of the palace, in the immediately preceding level, but dated also from the EBIII (Miroschedji 2000b). The context of discovery suggests that it is not a domestic one. If we consider that the provenience of the tournettes indicates the place

9. Identifications made by Yuval Goren.

where the potter was working, and that this place in turn is indicative of the status of the potter, we can then suppose that the potters using the wheel were attached to the palace.

The rationale for the hypothesis according to which the potters using the wheel coiling technique had a specific status is also the following. In the course of the EB III, there was no increase in the demand for wheel fashioned ceramics, and the use of RKE distinguished neither the function of the vessels nor the categories of the consumers. In other words, the demand was for morphological types, not for technical ones. Now, contrary to Chalcolithic potters, the EB III potters using the wheel were not specialized in the manufacture of a single morpho-functional type of pots (Roux 2003). However, the potters who were not using the wheel, and who were in the majority, did not borrow the wheel coiling technique. Let us recall that the wheel coiling technique presents a high learning cost, not to mention the high cost of acquiring the tournette, which was not made locally. High learning cost can be reduced by learning the craft when young (Shennan and Steele 1999). The non-borrowing of the wheel coiling technique and, in this respect, the non-training of young potters to the wheel coiling technique, even though this technique was used for a range of vessels also made without RKE, suggests that during the EB III period RKE ceramic production was in the hands of a group of potters having a specific status as compared to the potters not using the wheel.

The size of the potters' groups using the wheel remained limited. It looks as if the dissemination of the tradition did not follow the "classic" mode of family transmission (from adults to children) which favors the expansion of a group given the demographic growth factor. One can then wonder to what extent there were limitations on transmission of the craft given the socio-economic status of the potters (specialized potters' groups whose size is constrained by its status).

Although the EB III period is a period of urbanization and despite the techno-economic advantages by the wheel coiling technique over the coiling technique, the use of the wheel coiling technique appears then to respond mainly to social factors (use of RKE in the hands of a limited number of potters having a specific status) and not to economic ones.

## CONCLUSION

At Tel Yarmuth, during the EB III, qualitative and quantitative data suggest that the wheel coiling technique was in the hands of specialized potters, distinct from the ones making the non-wheel fashioned ceramics. These potters were very few and transmission networks of the wheel coiling technique were limited in size. Contrasting with Chalcolithic potters, EB III potters produced vessels belonging to different functional categories, comparable to the ones made without RKE. However, they may have had a specific status as compared to the potters not using the wheel. This specific status constrained the growth of the producing group. As a result, and given general economic conditions, their number never grew. As for the Chalcolithic period, the technological system was fragile, sensitive to historical dynamics and therefore susceptible to extinction (Roux 2008). In this respect, the fact that wheel coiling disappeared at the same time as the collapse of the urban system is no surprise.

Further researches are now to be conducted at a macro-regional level in order to better understand the production system of the different groups of vessels made on the wheel. Petrographic analyses are also needed to specify the different modes of production of the wheel fashioned ceramics. Large-scale technological analysis in collaboration with petrography is, in fact, the prime agenda of ceramic studies (Graham and Baird 2000) if one wants to begin to get a clearer view of the evolution of modes of production and distribution of ceramic vessels over the southern Levant.

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