Early Pottery in South China

TRACEY L-D LU

INTRODUCTION

IN THIS PAPER, "early pottery" is defined as ceramics dated to approximately 10,000 years ago or earlier, which have been discovered from the Japanese Archipelago, the Russian Far East, the Yellow and the Yangzi River Valleys, to South China (Tables 1 and 2). Pottery discovered in the Japanese Archipelago are dated to between 15,000 and 12,000 years ago (Tsutsumi 2000), or even up to 17,200 B.P. (Kuzmin 2006); those found in the Russian Far East are dated between 13,300 and 12,300 years ago, or 16,500–14,100 B.P. (Kuzmin 2006; Zhushchikhovskaya 1997). Potsherds found in North China are dated to between 12,000 and 10,000 years ago (Guo and Li 2000; Zhao et al. 2003), those found in the Yangzi River Valley are dated probably up to 18,000 years ago (Boaretto et al. 2009), and pottery found in South China is dated to approximately 12,000 years ago (Institute of Archaeology CASS et al. 2003). It seems that pottery was manufactured by different groups in different natural and cultural contexts at the end of the Pleistocene or the beginning of the Holocene[1] in various places of East Asia, although it is not clear whether pottery was invented in one center or in multicenters.

There are many hypotheses on the origin of pottery, including the "architectural hypothesis," the "culinary hypothesis," which proposes that pottery was invented for cooking cereals and/or shells, the "resources intensification" hypothesis, and the "social/symbolic elaboration" theory (Rice 1999:5–14). However, prehistoric pottery manufactured in different natural and cultural contexts usually differs in terms of morphology, function, and symbolic meanings. Thus, it is necessary to carry out an in-depth and contextualized analysis in order to understand the impetus for, and the consequences of, this technological development in different regions.

In North China, potsherds dated between 12,000 and 10,000 years ago have been found in three archaeological sites, namely Hutouliang and Nanzhuangtou in Hebei Province, and Donghulin near the present Beijing City (Table 1; Guo and Li 2000; Yan 2000; Zhao et al. 2003). Detailed reports of these sites have not been published. However, based on available data, the archaeological assemblages of the three sites apparently are not the same.

Tracey L-D Lu is a Professor in the Anthropology Department of The Chinese University of Hong Kong Shatin, N.T. Hong Kong.

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Table 1. Early Pottery Found in the Yellow and the Yangzi River Valleys

Site	Location	Type of vessel	Forming methods	Thickness of walls	Inclusions	Color	Decoration and marks	^{14}C date (B.P.)*	Associated archaeological discoveries	Sources
Hutouliang	114°9′E, 40°10′N	Potsherds only, flat bottom	No data	No data	Sand	Yellowish red	Plain or nail-pressed mark	11,870 ± 1720**	Flaked stone tools, microblades	Guo and Li 2000; Tang 1997
Donghulin	115°54′E, 39°37′N	Potsherds, pot?	Slab building?	No data	Crushed quartz	Brownish red	Mainly plain, occasionally with relief	10,350–9960	Flaked and ground stone tools, bone implements, animal remains and shells, burial, hearths	Zhao et al. 2003
Nanzhuang-tou	115°36′E, 39°N	Pot and jar, some with charcoal	No data	0.8–1 cm	Crushed shell and quartz	Gray or brown	Cord-mark, relief, occasionally incision	10,500–9700	Stone, wood and ground organic artifacts, animal bones and shells	Guo and Li 2000

(Continued)

Xianren-dong, Diaotong-huan	117°13′E, 28°44′N	Potsherds, round- and flat-bottom vessels	Slab building, then coiling	0.7–1.2 cm	Crushed, un-sieved quartz or feldspar	Dark, reddish or grayish brown	Marks of plants, notching lips, and punctu-ating from the inside out	13,500–11,800[#]	Stone and bone artifacts, rice phytolith, and shells	MacNeish et al. 1998; Zhang 2000
Yuchanyan	111°30′E, 25°30′N	Potsherds recon-structed to a *fu*	Slab building?	Up to 2 cm	Charcoal, crushed quartz and sand	Mixed dark brown and red	Cord-mark on interior and exterior sides	13,503–11,252, or approxi-mately 18,000?	Stone and bone artifacts, rice, animal bones, and shells, etc.	Boaretto et al. 2009; Yuan 2000

* Calibrated by applying Calib3 program (Stuiver et al. 1998). ** This is a thermoluminescence date, tested by the laboratory in the Chinese University of Hong Kong (Tang 1997). # Dates suggested by MacNeish et al. 1998.

Table 2. Early Pottery Found in South China

Site	Location	Type of vessel	Forming methods	Thickness of walls	Inclusions	Color	Decoration and marks	Absolute date (B.P.)*	Associated archae- ological discoveries	Sources
Niulan-dong	113°27′E, 24°20′N	Potsherds, round-bottom *fu* and pot?	Hand pinching?	0.3–1.1 cm	Crushed quartz and sand measured up to 0.9 cm	Dark brown to black	Cord-mark or plain	10,000–9000	Stone and bone artifacts, rice phytolith, and shells	Yingde City Museum et al. 1999
Miaoyan	110°16′E, 25°16′N	Plain potsherds	No data	No data	Charcoal and coarsely crushed quartz	Grayish brown	Plain; some bear charcoal residue on the surface	Circa 15,000?	Flaked pebble tools, shells, and animal bones.	Chen 1999
Zeng-piyan	110°15′E, 25°18′N	Potsherds, round-bottom *fu* only in phase I; *fu* and pot in phase II	Pinching/ drawing	Up to 2.9–3.6 cm at the early stage	Crushed calcite and quartz of varying sizes	Grayish brown	Cord-mark on interior and exterior; appliqué and incision later occurred	12,000–10,000	Stone and bone artifacts, burials, and shells	Fu 2004; Institute of Archaeology CASS et al. 2003

(Continued)

Dayan	110°14′E, 25°17′N	Fired clay and plain potsherds; a round-bottom *fu*.	Pinching	2–3 cm	Crushed calcite and quartz of varying sizes	Red or grayish brown	Plain; one bears charcoal residue on the surface	Circa 12,000–10,000	Flaked pebble tools, ground bone artifacts, burials, shells.	Fu 2004
Liyuzui	109°24′E, 24°18′N	Potsherds, one vessel foot	No data	0.2–0.9 cm	N/A	Red and black	Cord-mark	Circa 10,000	Stone and bone artifacts, shells.	He 1988; Yuan 1993
Ding-sishan	108°30′E, 22°67′N	Potsherds, round-bottom *fu*	No data	1 cm +	Coarse calcite particles	Grayish yellow surface, dark or dark brown interior	Cord-mark and appliqué	Circa 10,000	Tektite and sandstone tools	Fu 2004

*Dates suggested by the excavators of the assemblages as radiocarbon dating in limestone areas is problematic.

Discovered on a terrace of the Sanggan River in Hebei Province, North China in the 1990s, the Hutouliang ceramics are fragments of flat-bottomed vessels fired in very low temperatures and without decoration, associated with microblades, microcores, flaked stone implements, ornaments made of shell and antler, bones of wolf, wild horse, boar, deer, ox, wild goat, and several species of rodents, as well as the remains of three hearths (Guo and Li 2000). The potsherds have been proposed to represent fragments of containers dated to around 11,000 years ago (Guo and Li 2000).

Found in the late 1980s and dated to approximately 10,000 to 9000 years ago, the Nanzhuangtou potsherds consist of two different types of pottery, although both are fired at low temperatures. The first type is crumbled and grayish with crushed tiny pieces of shell and quartz as inclusions, and cord-mark or appliqué as decorations, while the second type comprises yellowish brown potsherds of relatively more solid walls without decoration (Guo and Li 2000). Other findings at Nanzhuangtou include stone grinding slabs and rollers, ground bone arrowheads, drills, and the remains of deer, rodent, wolf, bird, fish, tortoise and shells, as well as two pits and two hearths (Guo and Li 2000). Charcoal remains have been found on the surface of some potsherds (Guo and Li 2000), indicating a possible cooking function.

Stone and organic artifacts similar to those found in Nanzhuangtou, plus flaked stone tools and shells, large quantities of deer bones and shells, traces of a hearth, and a burial, were found in Donghulin in the 1990s (Zhao et al. 2003). Probably built by slab building with quartz grains as tempering agent, the plain Donghulin potsherds have been dated to approximately 10,000 years ago (Zhao et al. 2003).

Apparently, potsherds found in the above three sites in North China are associated with two different stone toolkits. While the Hutouliang pottery is associated with the microblade tradition dated from the terminal Pleistocene to the Middle Holocene in North China, the Japanese Archipelago, and Northeast America (i.e., Gai 1991; Smith 1974), the Nanzhuangtou and Donghulin potsherds are discovered together with grinding slabs and rollers, as well as other stone and organic implements, but *without* the microblades. Obviously, early pottery was produced by prehistoric groups using different toolkits, although it is not clear at this stage whether the different toolkits indicate different subsistence strategies.

A similar phenomenon can also be observed in Japan, where early pottery decorated with appliqué is associated with two major lithic traditions, namely the microblade tradition and the bifacial-flake tradition, the latter sometimes with edge-ground axes (Ikawa-Smith 1976: 513). In North China's context, the microblade tradition is a toolkit primarily for hunting-gathering activities, but microblades with grinding slabs and rollers may indicate a broad spectrum subsistence strategy with the possibility of developing into cereal cultivation (Lu 1998). However, while the Hutouliang lithic assemblage seems to suggest that the group primarily lived on hunting and gathering, the presence of pottery, if really serving as a storage facility, might suggest a certain degree of sedentism. As the Hutouliang excavation report has not been published, further discussion is not possible at this stage.

Grinding slabs and rollers, on the other hand, were often used by people collecting and/or cultivating grass seeds in prehistoric North China (Lu 1999, 2006).

Although details of the Nanzhuangtou and Donghulin sites are not yet available, the toolkits found in the two sites suggest that grass exploitation might have been part of the subsistence strategies, while the burial at Donghulin with grave goods indicates the possibility of sedentism.

Early pottery has also been found in Xianrendong and Diaotonghuan in Jiangxi Province, Yuchanyan in Hunan Province, and Shangshan in Zhejiang Province, all located in the Yangzi River Valley (Table 1; Jiang and Liu 2006; Yan 2000). The potsherds of Xianrendong and Diaotonghuan are dated to more than 12,000 years ago (Zhang 2000), the Yuchanyan potsherds, previously dated to between 12,320 ± 120 and 14,810 ± 230 years ago (Yuan 2000), have now been dated to 18,000 years ago (Boaretto et al. 2009), and the Shangshan potsherds are dated to approximately 10,000–9000 years ago (Jiang and Liu 2006).

Xianrendong, Diaotonghuan, and Yuchanyan are all cave sites, and the stone toolkits found in these sites consist of both pebble tools and small flaked tools made of quartz, flint, and crystal. Large quantities of terrestrial animal, fish, and bird remains have been found in the three sites, as well as rice phytoliths (Yuan 2000; Zhang 2000; Zhao 1998). Zhao (1998) has argued that the early Xianrendong and Diaotonghuan occupants were rice collectors, and the succeeding occupants became rice cultivators, while Yuan (2000) also argues for rice cultivation at Yuchanyan.

Shangshan, on the other hand, is an open site located on a small mound in the Yangzi Delta. Discovered in 2001 and excavated since then, the site has yielded pits, postholes, flaked stone tools, stone balls, grinding slabs, and pottery vessels with rice husks as inclusions (Jiang and Liu 2006). It has been argued that Shangshan was a sedentary site and rice was domesticated (Jiang and Liu 2006). It seems that early pottery found in the Yangzi River Valley were produced and used by prehistoric groups, who were probably rice collectors and/or cultivators.

While early pottery found in the Yellow and the Yangzi River Valleys might have facilitated grass seed processing and consumption, which in turn accelerated extensive grass-seed collection as a prelude to cultivation (Lu 1999, 2005), pottery found in the Russian Far East might have related to fishing and fish oil processing, and those found in the Japanese Archipelago might have been used for cooking various food ingredients and processing nuts (Ikawa-Smith 1976; Tsutsumi 2000). In summary, early ceramics were manufactured and used, more or less contemporaneously, by groups living on diversified subsistence strategies in geographic regions from cold-temperate, temperate, and subtropical to tropical ecozones in prehistoric East Asia after the Last Glacial Maximum, and served various functions (Lu 2005), manifesting the diversity of human cultures adapting to different environments.

It is also worth noting that the early pottery in North China and the Japanese Archipelago occurred after the florescence of the microblade tradition, the latter exemplifying not only a technical development of efficiently utilizing natural resources for tool making, but also a broad-spectrum subsistence strategy, including the collection of nuts and/or wild grasses, in the period between the terminal Pleistocene and the early Holocene (Ikawa-Smith 1976; Lu 1999, 2005). In North China, early pottery is also associated with grinding slabs and rollers. All these are important cultural changes in the transitional period from the terminal Pleistocene to the early Holocene in East Asia (Lu 1999, 2005). Further, the occurrences of early pottery in so many geographically and climatically different regions in East Asia may suggest prehistoric human diaspora and/or cultural exchanges, which is an issue requiring considerable in-depth typological studies and NAA analysis of pottery in the future.

Undoubtedly, early ceramics found in all the above sites are very important, and those found in the Yellow and the Yangzi River Valleys might have related to the origin of agriculture. However, details of the aforementioned archaeological sites in the Yellow and the Yangzi Valleys have not been published. Therefore, this article will focus on the natural and cultural contexts, the chronology, and the characteristics of the early pottery found in South China dated to approximately 12,000–10,000 years ago, and the driving force and significance of the origin of pottery in respect to the prehistoric cultural developments in South China and adjacent areas. Although pottery in South China may not be the earliest in terms of absolute dates, it illustrates the process of the origin and development of pottery in the prehistoric epoch in this region in terms of both manufacturing technique and typological evolution. Thus an analysis of the early pottery in South China will provide new insights for our understanding of the origin and development of pottery in East Asia.

THE NATURAL CONTEXT

In this article, South China refers to the present administrative areas south of the Five Mountain Range, consisting of the present Guangdong, Guangxi, Fujian, and Hainan Provinces, and the two special administrative regions of Hong Kong and Macau (Zhang and Fu 1997) (see Fig. 1). Generally speaking, this is a subtropical to tropical landmass, with a precipitation of over 1600 mm, and very rich and diversified natural resources (Zhang and Fu 1997). Geographically, both the northern and central areas of South China are hilly with limestone bedrocks and caves, but the southern part is quite flat. The Pearl River, which is the major water resource in this area, runs through the southern part of South China (Fig. 1). In the northern part, there are several small rivers and streams, like the Zi River and the Hongshui River, which are tributaries of the Yangzi and the Pearl River, respectively (Fig. 1). These rivers are channels for human diaspora and cultural exchange within South China and between South China and adjacent areas.

Since the 1980s, many scholars have been working on the prehistoric environment and human exploitation of natural resources in this area. Pollen analysis has been conducted at the Niulandong, Miaoyan, Zengpiyan, and Dingsishan archaeological sites, as well as in other natural deposits in Guangdong, Guangxi, and Hainan Provinces (i.e., Chen 1999; Lu 2003*a*; Yuan et al. 1999; Zheng 2000). Stalagmitic analysis has been conducted in several caves in northern South China. Animal remains discovered in several caves also provide useful information.

The results of these analyses indicate that, after the Last Glacial Maximum, the climate in South China gradually became mild and warm (Liu 1997; Lu 2003a, 2008; Zheng 2000). There was a sudden cool change at around 11,000 years ago comparable to the Younger Dryas in Europe, but the temperature increased and reached a similar level to that of the present by 10,000 years ago (ibid.). Evergreen and deciduous trees, various species of fern, and the grass family have been found in both natural and archaeological deposits dated from 12,000 years on-

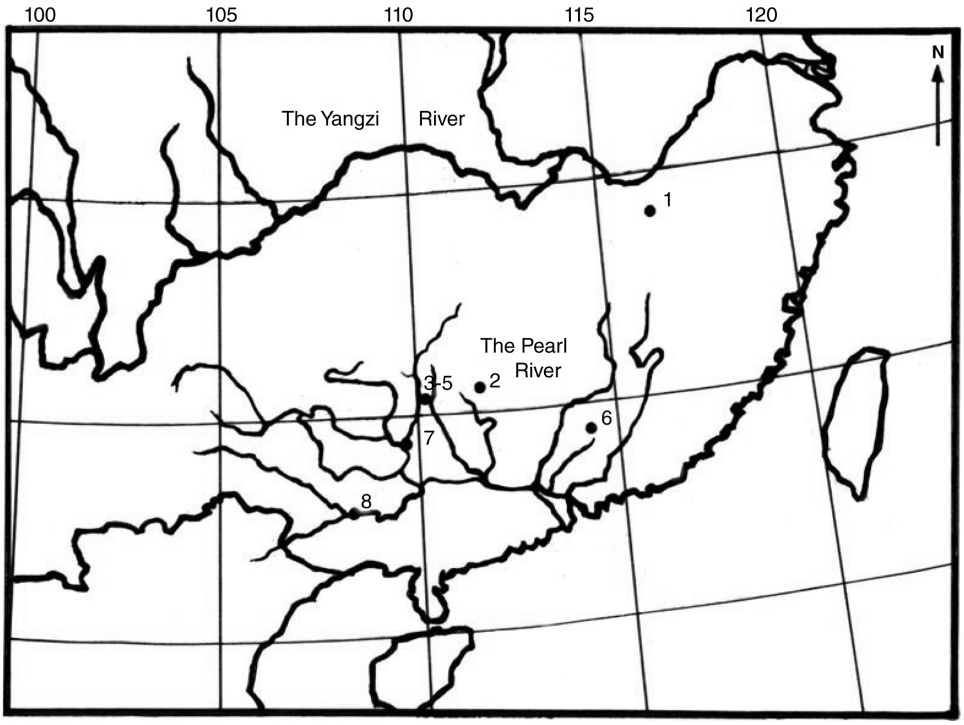

Fig. 1. Archaeological sites mentioned in the text: 1. Xianrendong, Diaotonghuan; 2. Yuchanyan; 3–5. Dayan, Zengpiyan, and Miaoyan, all in the present Guilin City; 6. Niulandong; 7. Liyuzui; 8. Dingsishan.

ward, many of which bear edible seeds, nuts, stems, leaves, or roots, or can be used for medical treatments or textile manufacturing (Lu 2003*a*, 2008; Zheng 2000).

Remains of tubers, including taro [*Colocasia* sp. (L.) Sohott], have been discovered in cultural deposits dated from 12,000 to 7000 years ago in the Zengpiyan cave by flotation and starch residue analysis, although a more precise identification of wild or domesticated species is not feasible (Lu 2003*b*; Zhao 2003). Flotation and pollen analysis suggest that there were more than 20 genera and/or species of plants, including Asian plum (*Prunus mume* Sieb et Zucc), *Alchornea*, hickory (*Carya* sp.), wild grape (*Vitis* sp.), Castanopsis, bamboo (Bambuscideae), legumes (Leguminosae), crucifers (Cruciferae), several other species of the grass family (Gramieae), pine (*Pinus* sp.), acorn (*Quercus* sp.), soapberry and soapnuts (*Sapindus* sp.), tree ferns (*Cibotium* sp.), and a few species of ferns available to prehistoric peoples (Lu 2003*b*, 2009*a*; Zhao 2003). These plants would have provided edible parts, being tubers, fruits, leaves, or seeds, in different seasons to prehistoric people in South China.

Zooarchaeological studies conducted at Niulandong, Miaoyan, and Zengpiyan also manifest very rich animal species in the region. Based on published data, the most commonly found species in archaeological deposits in South China are several species of deer and freshwater shellfish (Yingde City Museum et al. 1999; Institute of Archaeology CASS et al. 2003; Zhang et al. 1999) (Table 3). At

Table 3. Fauna of the Terminal Pleistocene in Northern South China

SPECIES	ENGLISH NAME	ZENGPIYAN I	ZENGPIYAN II	MIAOYAN	NIULANDONG	HABITAT AND CHARACTERISTICS
Invertebrate						
Unionidae	Freshwater clams					Rivers, streams, and ponds
Unio douglasiae		+	+	+		
Cuneopsis subceltiformis sp.				+		
Cuneopsis zhenpiyanensis sp.				+		
Lamprotula obovata sp.				+		
Lamprotula leai		+	+	+		
Lanceolaria grayana		+	+	+		
Lanceolaria fruhstorferi				+		
Pseudodon resupinatus				+		
Margaritiana sp.		+	+			
Corbiculidae	Clams					
Corbicula obtruncata		sp.	sp.	+		
Corbicula oabunca				+		
Viviparidae	Freshwater shells					
Cipangopaludina chinensis		+	+			
Cipangopaludina chinensis fiuminalis		+	+	+		
Cipangopaludina chinensis longispira		+	+	+		
Bellamya sp.		+	+	+		
Viviparus sp.		+		+		
Decapoda	Crab		+			Rivers, streams, and ponds
Total intertebrate		10	10	14		
Vertebrate						
Pisces	Fish	+	+			Rivers, streams, and ponds
Cyprinidae	Carps	+	+			
Chelonia						
Trionychidae	Softshell turtles	+	+			Rivers, streams, ponds, and wetland

(Continued)

Aves	Birds	+	+			
Ardeidae						
Ardea sp.	Heron		+			
Anatidae						
Anser sp.	Goose		+			
Phasianidae		+				
Gallus sp.	Wild chicken		+			
Phasianus sp.	Pheasant		+			
Corachformes						
Eurystomus cf. *orientalis*	Eastern broad-billed roller	+				
Aves indet.			+			
Mammalia	Mammals					
Insectivora	Insectivores					
Crociduras sp.					+	Rivers, streams, ponds, and wetland
Chiroptera	Bats					Caves
Ia io					+	
Hipposideros armiqer					+	
Primates						
Hylobates sp.	Gibbon				+	Subtropical forest, lowland, and hills
Macaca mulatta	Short-tail macaque	sp.	sp.		+	" "
Rodentia						
Apodemus	Field mouse				+	Various: steppe, dryland, etc.
Microtus brandtioides					+	
Micromys cf. Minutus	Eurasian harvest mouse				+	
Rattus sp.	Rat	+	+		+	Human commensal
Rattus cduardsi			+			
Niviventer fulvescens	Chestnut white-bellied rat				+	
Hystrix brachynra subristata		+	+	sp.	+	Subtropical area

(Continued)

TABLE 3 *(Continued)*

SPECIES	ENGLISH NAME	ZENGPIYAN I	ZENGPIYAN II	MIAOYAN	NIULANDONG	HABITAT AND CHARACTERISTICS
Atherurus sp.	Rat			+	+	
Rhizomys sinensis	Bamboo rat	+	+	sp.	sp.	Subtropical bamboo stands
Leporidae						Various: steppe, forest
Lepus sp.	Hare	+	+	+	+	
Mammalia	Mammals					
Carnivora		+	+			
Canidae						
Ailuropoda melanoleuca fovealis	Giant panda				+	Bamboo and forest
Ursus thibetanus	Black bear			+	+	Moist deciduous forest
Arctonyx collaris	Hog badger	+		+	+	Forest up to 3500 m elevation. Weight 714 kg
Viverra sp.	Oriental civet				+	Forest, bush/meadows. Weight 5–11 kg.
Lutra sp.	River otters				+	Freshwater rivers and streams
Panthera tigris	Tiger			+	+	Forest to savanna.
Panthera sp.	Leopard				+	Various
Vulpes sp.	Fox				+	Hilly/forest areas
Mustela sp.	Polecat	+	+		+	Steppe
Viverricula malacensis fossilis	Rasse				+	Forest, bush/meadows. Weight 2–4 kg
Paguma sp.	Masked palm civet				+	(Sub)tropical forest
Felis temmincki	Gold cat				+	Various
Felis microdus	Small wild cat	sp.	sp.	sp.	+	
Nyctereutes procyonoides	Raccoon dog	+	+	+	sp.	River valley, forest, and steppe
Meles meles	Badger	+				Forest and densely vegetated areas
Artiodactyla						
Bovinae						
Bubalus sp.	Buffalo	+		+	+	Moist bush/forest
Bison sp.	Ox				+	

(Continued)

Cervus unicolor	Sambar			+	+	Various. Prefer wooded area. Weight 109–260 kg
Cervus nippon	Sika deer			+	+	Forest/grass. Weight 26–33 kg
Cervus sp. A	Large deer	+	+			Woodland of temp.–subtropical. Weight 45–109 kg
Cervus sp. B	Medium-sized deer	+	+			
Cervus sp. C	Small-sized deer 1	+	+			
Cervus sp. D	Small-sized deer 2		+			
Lijiangocerus speciosus	Lijiang deer			+		
Hydropotes sp.	Chinese water deer				+	(Sub)tropical river/lakeside or grassy mountains
Pseudaxis sp.					+	
Muntiacus muntjak	Muntjac			+	+	Forest/dense vegetated areas with water
Caprinae indet.				+		
Capricornis sumatraensis	Sumantra serow	+			sp.	Rugged mountains/forest ridge/bush
Sus scrofa	Wild boar				+	Forest
Sus sp.		+	+	+	+	
Total vertebrate		23	24	16	37	
Total species		33*	34*	30**	37***	

Sources: Chen 1999; Institute of Archaeology CASS et al. 2003; Zhang et al. 1999.
* Only species found in the first and second phases of Zengpiyan are listed here. A total of 47 species of shell, 20 species of bird, 37 species of mammal, plus fish, etc., have been found in the whole stratum at Zengpiyan, totaling 108 species.
** There are four layers in Miaoyan but the cultural chronology is not reported. The species listed here are from the whole stratum.
*** Only mammals have been reported for the Niulandong Cave.

Table 4. Comparing Pottery Vessels and Associated Archaeological Remains in the Yangzi River Valley and South China

The Yangzi River Valley			South China		
Sites/Date	Pottery Types	Associated Archaeological Remains	Sites/Date	Pottery Vessels	Associated Archaeological Remains
Xianrendong Cave, pre-ceramic, 18,000–14,000 B.P.?	Not present	Flaked pebble tools, small lithic flakes, pierced shell and ground bone implements	Dayan Cave, Phase I; Upper Palaeolithic, 15,000 B.P.?	Not present	Flaked unifacial pebble tools, small amount of animal bones and freshwater shells
Xianrendong, 13,000 B.P.? Transitional?	No restorable vessels	Pebble and small lithic flakes, ground bone and pierced shell tools, rice phytolith, shells, animal bones, etc.	Dayan Phase II, 13,000–12,000 B.P.; transitional period	Two pieces of fire clay	Pebble tools, ground bone and pierced shell tools, shells, wild animal bones, two flexed burials without grave goods
Yuchanyan Cave, 13,000–12,000 or 18,000 B.P.?	Round-bottom *fu*, walls up to 2 cm thick; inclusions—charcoal and quartz; cord-mark on interior and exterior	Pebble and small lithic flakes, ground bone and pierced shell implements, rice husk and phytolith, shells, animal bones, etc.	Dayan, Phase III, Zengpiyan Phase I, Miaoyan, 12,000–11,000 B.P.?	Round-bottom *fu* by hand pinching, walls up to 3.6 cm thick; cord-mark "wiped out"	Pebble tools, ground bone and pierced shell tools, shells, wild animal bones and plants; rice phytolith
Shangshan, open site, Zhejiang, 10,000–8000 B.P.?	*Fu*, pot, big basins with flaring up from a small and flat bottom; some with cord-mark, stamping, and incision	Flakes and pebble tools, some ground tools; remains of pile holes, rice phytolith, grains, etc.	Zengpiyan Phase II, Dingsishan Phase I, 10,000–9000 B.P.	*Fu* and/or round-bottom pot; slab building; inclusion-calcite; cord-mark; appliqué and incision	Pebble tools, ground bone and pierced shell tools, shells, wild animal bones; tektite flakes found in Dingsishan

(Continued)

Pengtoushan and Bashidang 9000–8000 B.P.	Plant as inclusion; *fu* and round-bottom pot, stand, plate, bowl, basin, dish, and tripod vessels; hand pinching and slab building	Flaked and ground stone tools, rice grains, domesticated (?) pig, ox, and chicken, wild animal and fish bones, houses/village, burials with stone or pottery as grave goods; protective ditch	Dayan Phase IV, Zengpiyan Phase III, 9000–8000 B.P.	*Fu* and/or round-bottom pot; calcite and quartz as inclusions; cord-mark; appliqué and incision; relatively high firing temperature	Pebble tools, occurrence of ground stone axe and adze, ground bone and pierced shell tools; wild animal bones and freshwater shells
Zaoshi and Hujiawuchang 8000–7000 B.P.	Fine pottery; white, grayish white, and painted pottery; plate with ring foot, pots, *fu*, basin, dish, bowl, lid and stand	Ground stone axes, knives, adzes, chisels; rice remains, domesticated (?) pig, water buffalo, goat; wild animal and fish bones, shells, houses; kiln?	Zengpiyan Phase IV, Dingsishan Phases II and III, 8000–7000 B.P.	*Fu*, round-bottom pot; techniques similar to previous ones; walls thinner; only cord-mark present	Pebble and ground tools, ground bone and pierced shell tools; wild animal bones and shells; four squatting burials without grave goods but with stones (Zengpiyan); various burials at Dingsishan with limited grave goods
Tangjiagang 6600–6200 B.P.	*Fu*, pot, urn, basin, plate, high-footed cup, bowls, tripod vessel, stand and lid	Flaked and ground stone axes, adzes, chisels, spades, abraders, spindle whorls; burials with pottery as major grave goods	Dayan Phase V, Zengpiyan Phase V, 7000–6000 B.P.	Fine pottery; *fu*, pot, plates with ring foot, bowls, basins, stands	Ground stone tools; eight flexed burials with stone, bone, and shell tools as grave goods in Dayan; no pottery buried with the dead
Daxi 6400–5300 B.P.	Fu, pot, jar, basin, bowl, plate, etc.	Open sites; ground stone tools; houses, burials with grave goods	Dingsishan Phase IV, Xiaojin Phase II, 6000–5000 B.P.	Grayish white ceramic	Domesticated rice. Well-ground stone tools. Rice grains and phytolith

Sources: Fu 2004; Hunan Institute of Archaeology 1993, 1999; Jiang and Liu 2006.

Miaoyan, more than 65 percent of animal bones are remains of several species of deer, dominated by sika deer and sambar (Zhang et al. 1999: 187). The quantity of shell remains increased substantially in Dayan, Zengpiyan, and other deposits dated to after 12,000 years ago, suggesting that shellfish became an important food resource for human beings (Table 4). It seems that there were abundant terrestrial animals and freshwater shellfish as resources for people living in South China after the Last Glacial Maximum.

To summarize, the natural context of early pottery in South China was a subtropical to tropical environment with rich and diversified natural resources. The prehistoric residents in this area could have exploited plant and animal species living in different habitats and available in different seasons. Based on the author's experiments, if a person relied on plant roots (taro, yam, and bamboo shoots, etc.) and shellfish as his/her staple food, he/she only needed to spend about 2–3 hours daily on subsistence activities, and any return from hunting would be an extra bonus (Lu 2006). It seems that people living in South China from the terminal Pleistocene to the early Holocene were "affluent foragers" supported by abundant and relatively easy access to diversified natural resources, the seasonality of which would have been quite stable.

THE ARCHAEOLOGICAL CONTEXT

Based on archaeological discoveries to date, the peopling of South China can be traced back to at least the Pleistocene era (Xie 2006). The archaeological remains dated from the Middle to the Upper Pleistocene in South China are characterized by pebble tools made by direct percussion (He 1988), which belonged to the pebble tool industry in the vast areas from the Yangzi River Valley to mainland Southeast Asia and lasted well into the Holocene in South China.

Archaeological data presented in this article come primarily from several archaeological sites discovered since the 1980s, and dated from the terminal Pleistocene to the early Holocene in South China, namely the cave sites of Dayan, Liyuzui, Niulandong, Miaoyan, and Zengpiyan in the north, and the shellmidden site Dingsishan in the south (Table 2). All of the cave sites are situated in hilly areas, whereas Dingsishan is located on top of a terrace along the Yong River near the present Nanning City, Guangxi Province. Based on the stratigraphies and findings of these sites, a chronology of the local archaeological cultures in this area can be proposed.

The terminal Pleistocene of about 15,000 years ago can be illustrated by the bottom deposit of Dayan, in which unifacial pebble tools produced by direct percussion and a small amount of animal bones and freshwater shells have been discovered. In the succeeding layers dated to between 13,000 and 12,000 years ago, pebble tools still dominated, but grinding occurred as a new technique and was initially used to produce bone and shell implements, associated with two pieces of fired clay. A small amount of animal bone and shell have also been found. This phase is defined as a transitional period from the Palaeolithic to the Neolithic, characterized by the occurrence of grinding techniques and fired clay (Fu 2004). Flaked pebble tools and ground bone and pierced shell implements have been found in layers dated to 12,000 and 10,000 years ago in both Dayan and the bottom layer of Zengpiyan, as well as substantial amount of animal and shell remains, and early pottery (Fu 2004) (Table 2).

Thus the toolkit associated with early pottery in South China and adjacent areas consists of pebble tools, ground bone tools, and pierced shell implements. This toolkit dominated the prehistoric cultures in this region from approximately 12,000 to 7000 years ago (Table 4). The author's preliminary use-wear analysis indicates that the bone drills might have been used to deal with plant and other soft materials (Lu 2003*c*). Meanwhile, the occurrence of pierced shell implements is also worth noting. Based on ethnographic data in Japan, MacNeish proposed that the pierced shell implements might have been used to cut grass, even rice (MacNeish 1998 : 19). Recently, rice and millet remains, as well as shell reaping knives, have been found in Taiwan, and a similar function has been assigned to the shell knives (Tsang 2005). Rice phytoliths have been found in Zengpiyan and the early phases of Dayan, but it remains unclear whether rice was collected for food or for other purposes, and the function of the pierced shell implements requires further investigation. Nevertheless, these new implements must have been made in that period to meet new demands for subsistence strategies and/or other purposes.

Remains of plants, nuts, and animal bone indicate that the prehistoric groups at this time were mainly hunters and gatherers (Fu 2004; He 1988; Yuan 2000). Two burials have been found in Phase II of the Dayan assemblage, contemporaneous to the fired clay (Fu 2004). No grave goods have been discovered. On the other hand, several natural stones had been placed on the skull and the limbs of the dead (Fu et al. 2001), which may indicate some beliefs or rituals not comprehensible to us at present. This type of burial has also been found in Zengpiyan dated to 8000–7000 years ago (Table 4).

Grave goods did not occur in the Guilin area in South China until around 7000–6000 years ago (Table 4). Whether the presence of grave goods indicates reduced mobility, conceptual changes about death and afterlife, or the emergence of the notion of private ownership, or all of the above; and whether such changes were the results of local development or cultural contact with other areas, remain unclear. Whatever the case, no grave goods have been found prior to 8000 B.P. in the Guilin area. While grave goods have been found in Phase V of the Dayan assemblages, which is dated to about 7000 years ago, the quantity and quality of these grave goods between burials are not significant.

Further, archaeological data to date suggest that the toolkits and other remains found in South China from 12,000 to 7000 years ago were without much change except the occurrence of ground stone tools (Table 4), although the techniques of making these tools as well as making pottery somehow developed during this long span of time. In Dayan and Zengpiyan, no special treatments, decorations, or any other special labor/efforts have been detected on any stone or organic implements dated prior to 7000 years ago. Thus, none of them can be identified as bearing special meanings or symbols, which, if present, may indicate the existence of individuals holding special social status. The artifacts found in Dayan and Zengpiyan seem to have been produced by regular methods including direct percussion and/or grinding, and have been used for practical purposes by members of these groups. Therefore, there seems to be no visible evidence for the occurrence of stratified societies in South China before 7000 years ago, when early pottery was manufactured in this region.

In summary, the above archaeological data indicate that, up to the Middle Holocene or 7000 years ago, the prehistoric societies in northern South China were not stratified, and the early pottery dated to between 12,000 and 10,000 years ago was made by egalitarian societies living in caves and subsisting through hunting and gathering.

EARLY POTTERY IN SOUTH CHINA

The origin and development of pottery from fired clay to shaped vessels in prehistoric South China can be best illustrated by the stratigraphy and associated discoveries in Dayan and Zengpiyan (Table 4). As mentioned above, two pieces of fired clay have been found in Phase II of the Dayan assemblage, one piece being cylindrical and another one dish-like with a concave surface (Fu 2004). Although not vessels, they apparently had been manipulated by human beings into certain shapes and had been fired. Details of these two pieces have not been published, but they apparently manifest an attempt to combine clay, water, and fire to produce a new material, and should be viewed as a prelude to the origin of pottery.

After the occurrence of the two fired clay objects, potsherds occurred in Phase III in Dayan and Phase I in Zengpiyan, representing the earliest ceramics in South China to date. Pottery of this initial period is characterized by very thick and crumbled walls up to between 2.9 and 3.6 cm, with un-sieved, often coarse, crushed calcite or quartz as tempering agent, and a cracked surface without intended decoration (Fig. 2). The potsherds are built by hand-pinching, and were fired in temperatures of approximately 600–700 °C, with the earliest ones found in Zengpiyan fired at probably below 250 °C (Fig. 2; Wu et al. 2003). The earliest pottery is often plain, but traces of pressed marks of plant stems have been found on certain parts of the surface, which might have been remains of the "wiping off" or "smoothing off" efforts made by the prehistoric potters' hands, signs that these marks were not intended decoration. All of these characteristics indicate a very initial stage of pottery manufacturing. Based on cross-comparison between potsherds found in the Yangzi River Valley and those in South China, as well as results of radiocarbon dating, the early pottery manufactured in South China is dated to approximately between 12,000 to 11,000 years ago (Institute of Archaeology CASS et al. 2003).

The quantity of potsherds found in this early stage is often very limited, and only one type of round-bottom pot can be reconstructed, known as a *fu* or pot in Chinese archaeology (Fig. 2; Institute of Archaeology CASS et al. 2003). To date, this type of vessel is the dominant utensil found in all the aforementioned archaeological assemblages by 7000 years ago in South China. It was not until around 7000–6000 years B.P. that other types of pottery vessels occurred in South China, such as jars, plates with a high ring foot, basins, and bowls, the latter three usually used for serving food. This typological assemblage is quite different from that in the neighboring Yangzi River Valley, where *fu* also occurred by 12,000 years ago or earlier as the only vessel (Yuan 2000), but various pots, bowls, dishes, and plates occurred by 8500 years ago (Pei 2000). This ceramic monomorphism in South China will be discussed further in the following sections.

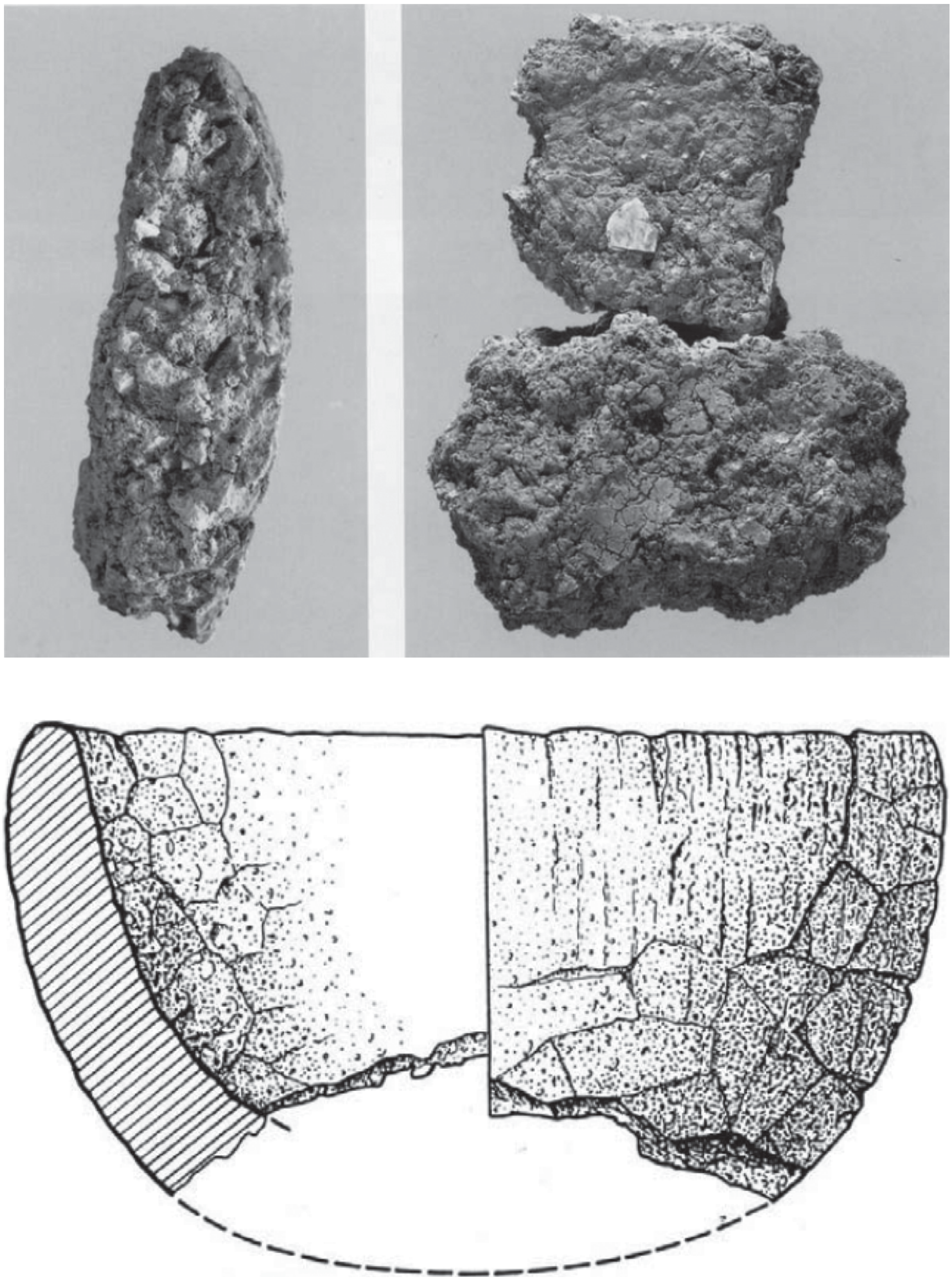

Fig. 2. Early pottery found in Zengpiyan, South China. *Top*: potsherds found in Zengpiyan dated to approximately 12,000 years ago (not to scale). *Bottom*: restored *fu* found in Zengpiyan dated to approximately 12,000 years ago (scale–1 : 3). (Courtesy of Institute of Archaeology CASS et al. 2003)

While potsherds found in Phase III in Dayan and Phase I in Zengpiyan (Table 4) represent the initial phase of pottery manufacturing in South China, potsherds from the ensuing Phase II of the Zengpiyan assemblage bear some advanced characteristics. Slab building occurred as a new technique for vessel construction in this period, and became the major technique for pottery manufacturing in the succeeding Neolithic cultures in the region. The pottery walls were often thinner, and the grains of the tempering agent became smaller, although crushed calcite was still the major material of the latter. The concept of decoration also made its appearance during this period, as the marks on pottery surfaces were no longer "wiped off" by the potters; further, they seem to be in a relatively regular pattern.

Potsherds with similar characteristics have also been found in other areas in northern Guangdong and southern Guangxi, such as in the Niulandong and Dingsishan sites (Fig. 1), representing the second phase of ceramic development in South China. Low relief was present in Dingsishan (Table 4) as a clear indication of decoration. However, when comparing these potsherds found in South China to those found in the Pengtoushan and Bashidang assemblages in the middle Yangzi River Valley, the former still have thicker and more crumbled walls, the inclusions are coarser, and the firing temperature lower. Based on cultural comparison and radiocarbon dating, the second phase of ceramic development in South China should be between approximately 10,000 and 9000 years ago.

In summary, archaeological data to date suggest that pottery was manufactured in South China by 12,000 years ago. As the process from fired clay to shaped vessels is clearly illustrated in Dayan, and the potsherds found in Dayan and Zengpiyan bear the most "primitive" characteristics of ceramics, it seems that South China is one of the places where pottery was indigenously made.

After its initial appearance, pottery manufacturing expanded to adjacent areas, and the techniques developed further in the ensuing Neolithic cultures, illustrated by relatively thinner walls, the application of the slab building method, sieved inclusions, comparatively higher firing temperature, and probably the initial occurrence of decoration. However, the typological diversity and technological development of pottery in South China seem to have differed from that in the Yangzi River Valley until 7000 years ago, when the cultural influences of the latter seem to have arrived in South China (Table 4). While different ceramic developments in terms of typological diversity, decoration motifs and manufacturing techniques in South China and the Yangzi River Valley further suggest that pottery was made independently in South China, the causes of this difference should be examined further.

DISCUSSION

Undoubtedly, the origin of pottery is a significant technological development. It may also indicate changes in other aspects of prehistoric cultures. Recent archaeological discoveries in South China have provided novel information to help us understand not only the chronological origin and development of pottery, but also the impetus, the manufacturing process, and the natural and cultural contexts of this event. Meanwhile, more questions arise from these new discoveries.

Chronology

In South China, the majority of early potsherds are from cave sites, and all of the cave sites are located in limestone areas, which is problematic for radiocarbon dating. Samples from all the sites listed in Table 4 have been subjected to ^{14}C dating, and some of the results have been published (Table 5), but many of them are not convincing. For example, a shell sample from trench No. 5, Layer 3 [T5 (3)] in Niulandong gave a result of 16,000 years B.P., but a bone sample from the same layer only yields an absolute date of 7910 years B.P. (Table 5). Similar discrepancies can be observed in other dates that were run on bones and shells in Niulandong (Table 5). In another site, Miaoyan, dating was run on shell samples only, and some of the dates are not in sequence. While three samples from Layer 2 produce a time range between 13,547 and 12,707 years B.P., one sample from the underlying Layer 3 gives a younger date of 12,630 B.P. (Table 5).

Radiocarbon dating in limestone areas has been troublesome since its first application. In an attempt to solve this problem, the laboratories of the Institute of Archaeology CASS, and the Archaeology Department, Beijing University conducted detailed sample gathering and testing in South China in the mid-1980s. The outcome is that ^{14}C dates run on freshwater shells often produce much older readings than the true age of the samples, mainly due to the "contamination of dead radiocarbon" (Yuan 1993). On the other hand, dating on grass, charcoal, and bones of animals fed on terrestrial resources may be close to their true ages; however, dating on bones of animals fed on water resources is also problematic (Yuan 1993). As the researchers were not certain about the standard differences between results tested on shells and that on other materials, no fixed value of adjustments were provided, although it was proposed that dates on shell samples could be a few hundred to 2500 years older then they actually were (Yuan 1993). Up to that time, there were no reliable solutions for the problem of radiocarbon dating in limestone areas (Yuan 1993).

As discussed above, the dates' testing on shells in Niulandong is more than 7000 years older than that on bones, which means that the deviation on shell samples could be much greater than 2500 years if the dates on bones are to be trusted (Table 5). Further, not all bones are reliable. As large amounts of shell have been found in all of the cave sites in South China, it is highly probable that freshwater shellfish were a staple food of prehistoric human groups living in limestone areas from the beginning to the Middle Holocene. Based on the aforementioned research outcome, bones of humans ingesting freshwater species can be problematic, as they tend to yield dates older than their true age. On the other hand, terrestrial animal bones may be more reliable (Yuan 1993).

Given the relative reliability of radiocarbon dates run on terrestrial animal bones, the six dates from Layers 3–8 in Trench No. 5 in the Niulandong assemblage may be accurate. These six dates and their corresponding layers are consistent, and the dates are in a good sequence (Table 6). However, with the uncertainty of dating in limestone areas in mind, the excavators of Niulandong proposed that Phase I belonged to the Upper Palaeolithic epoch, and should be between 12,000 and 11,000 years ago; Phase II should be Mesolithic and dated between 11,000 and 10,000 years ago; and Phase III should be Neolithic and dated between 10,000 and 8000 years ago (Yingdeshi Bowuguan deng 1999). As

Table 5. Radiocarbon Dates of Some Archaeological Sites in South China (half-life 5730)

site	cultural phase or layer	testing samples and methods: bone	testing samples and methods: shells	lab. and ^{14}C dates b.p. (un-calibrated)	source
Niulandong	Phase I	T5 (7) animal bone, conventional		KWG, 10,780 ± 220	Yingde City Museum et al. 1999
		T5 (8) animal bone, conventional		KWG, 11,320 ± 240	Ibid.
		T7 (3) animal bone, conventional		KWG, 12,410 ± 250	Ibid.
	Phase II	T5 (5) animal bone, conventional		KWG, 9320 ± 110	Ibid.
		T5 (6) animal bone, conventional		KWG, 10,320 ± 200	Ibid.
			T1 (6) shell, conventional	BK, 18,105 ± 200	Ibid.
	Phase III(1)	T5 (3) animal bone, conventional		KWG, 7910 ± 100	Ibid.
			T5 (3) shell, conventional	KWG, 16,780 ± 300	Ibid.
		T5 (4) animal bone, conventional		KWG, 8940 ± 100	Ibid.
		T9 (3) bone, conventional		KWG, 8150 ± 120	Yingde City Museum et al. 1999
			Locality 2, shell, conventional	BK, 15,560 ± 150	Ibid.
			T1 (4) shell, conventional	BK, 16,235 ± 100	Ibid.
			T3 (2) shell, conventional	BK, 17,525 ± 200	Ibid.
			T9 (3) shell, conventional	KWG, 14,560 ± 350	Ibid.
	Phase III(2)	T9 (2) bone, conventional		KWG, 7460 ± 100	Ibid.
			Locality 1, shell, conventional	BK, 10,440 ± 100	Ibid.
			Locality 3, shell, conventional	BK, 9310 ± 80	Ibid.
			T1 (1) shell, conventional	BK, 11,870 ± 100	Ibid.
Miaoyan	Layer 6		Shell, method unknown	BK, 20,920 ± 430	Chen 1999
	Layer 5		Shell, method unknown	BK, 18,140 ± 320	Ibid.
			Shell, conventional	ZK, 17,238 ± 237	Ibid.
	Layer 4		Shell, method unknown	BK, 13,710 ± 270	Ibid.
	Layer 3		Shell, method unknown	BK, 12,630 ± 450	Ibid.
	Layer 2		Shell, method unknown	BK, 12,730 ± 370	Ibid.
			Shell, conventional	ZK, 12,707 ± 155	Ibid.
			Shell, conventional	ZK, 13,547 ± 168	Ibid.

(Continued)

Liyuzui	Phase I		Shell, conventional	PV, 7820 ± 100	Yuan 1993
	Phase II, upper	Human bone, conventional		PV, 10,510 ± 150	Ibid.
		Human bone, conventional		PV, 11,450 ± 150	Ibid.
	Phase II		Shell, conventional	BK, 12,880 ± 220	Ibid.
			Shell, conventional	PV, 18,560 ± 300	Ibid.
			Shell, conventional	PV, 21,020 ± 450	Ibid.
	Phase II, lower		Shell, conventional	BK, 23,330 ± 250	Ibid.
Dingsishan	Phase II		Shell, conventional	ZK, 10,365 ± 113	Fu 2004

Abbreviations of laboratories: BK—Laboratory of Archaeology Department, Beijing University; ZK—Laboratory of Institute of Archaeology, Chinese Academy of Social Science; PV—Laboratory of Institute of Vertebrate Palaeontology and Palaeoanthropology; KWG—Laboratory of the Guangzhou Geographic Research Institute.

Table 6. ^{14}C Dates from Trench No. 5 of Niulandong, Guangdong

STRATIGRAPHIC UNITS	RADIOCARBON DATES (B.P.)	CALIBRATED DATES (B.P.)*	CULTURAL PHASE
T5 (8)	KWG, 11,320 ± 240	13764–13022	Phase I
T5 (7)	KWG, 10,780 ± 220	13004–12633	Phase I
T5 (6)	KWG, 10,320 ± 200	12777–11693	Phase II
T5 (5)	KWG, 9320 ± 110	10685–10288	Phase II
T5 (4)	KWG, 8940 ± 100	10215–9895	Phase III (1)
T5 (3)	KWG, 7910 ± 100	8994–8592	Phase III (1)

* Using Stuiver et al. 1998a, Calibration Program 4.3 at http://depts.washington.edu/qil, calibrated by the author.

potsherds have been found in Phase III, its presence in the present Guangdong Province, or eastern South China, can be dated to 10,000 years ago. These dates may also serve as a reference for other archaeological remains in South China. Based on structural analysis, potsherds found in Niulandong might have belonged to the second phase of early pottery in South China, contemporaneous to that found in Phase II of the Zengpiyan assemblage. The radiocarbon dates in Niulandong are consistent with this proposal.

When carrying out excavation at Zengpiyan in 2003, we designed the sampling strategy to collect three sets of samples—charcoal, bone, and shell—from narrow cross sections of the stratigraphy for ^{14}C dating in order to tackle the problem of dating in limestone areas, and we planned on sending the samples from the same layers to two to three laboratories for testing to compare the results. However, this plan could not be fully implemented due to the insufficiency or poor quality of bones found in many cultural layers at Zengpiyan. Eventually, only samples of charcoal and shells have been dated, and the results and corresponding cultural layers and depth are listed in Table 7.

While these ^{14}C dates illustrate a chronological framework for the Zengpiyan archaeological assemblage from approximately 12,000 to 7000 years ago, there are still problems. The first one is the discrepancy between the stratigraphic depth and the ^{14}C dates of some samples. For example, a charcoal sample from Layer DT6 (27) tested by the laboratory of the Australian National University yields a reading of 10,520 ± 280 years ago, but another charcoal sample tested by the same laboratory from the layer beneath, DT6 (28), yields a much younger reading of 9130 ± 160 B.P. (Table 7). The results of some shell samples have the same problem. For instance, the reading of two shell samples in Layer DT4 (25) are much older than the shell sample from Layer 26 below (Table 7). Shells from Layer DT6 (27) at the depth of 246–212 cm yield a chronological reading of 10,996 ± 68 years bp, but another two samples from DT4 (20) at the depth of 144–135 cm provided dates of almost the same age (Table 7). The second problem is the discrepancy between dates resulting from shell samples and charcoal samples. It is apparent that the dates obtained on shells are about 1000–2000 years older than the majority of the charcoal samples (Table 7). If the dating results on charcoal are more reliable (Yuan 1993), then the dates on shells are not accurate.

The above problems are not unique in Zengpiyan, as the recent ^{14}C results at Yuchanyan (Boaretto et al. 2009) show similar problems. For instance, two charcoal samples from Layer 3E of about 254 cm deep in Yuchanyan are dated to 11,855 $\pm$ 50 and 12,735 $\pm$ 70 B.P. respectively, which are almost the same or even younger than the dates obtained on charcoal and bone samples from about 129 to 217 cm deep. Further, the charcoal sample RTB 5471 from the deepest layer at 305–314 cm of T5 is dated to 12,825 $\pm$ 50 B.P., which is at least 2000–5000 years younger than several samples (Nos. RTB 5115, 5463, 5464, 5465, 5466, and 5470) from layers at a depth of around 252 to 264 cm (for the original data, please see Table 3 in Boaretto et al. 2009). The author of this paper is not a ^{14}C dating expert and cannot provide a full analysis of this methodological issue, but it is obvious that samples dated on charcoal and/or bones in limestone areas are not without problems, and that ^{14}C dating in limestone areas of China requires much more study.

In addition, it must be emphasized that the archaeologists' ability to recognize different cultural layers and deposits is essential for the reliability of absolute dates, particularly in caves. The stratigraphy of cave deposits can be very complicated, as deposits of different periods could have been accumulated at different locations at the same horizontal level (or similar depth), as prehistoric peoples of different times might have occupied varying locations inside the cave. If such differences have not been detected during excavation and sample gathering, it is possible that the samples perceived from the same cultural layer might in fact have been from different periods. Consequently, absolute dates tested on these samples could be misleading. To reduce possible errors, sample gathering for absolute dating should be conducted within a narrow cross section of one trench, and samples should be collected from as many layers as possible within this cross section.

Therefore, in addition to radiocarbon dating, typological and structural analysis of artifacts integrated with cross-cultural comparison, particularly on pottery items, are also necessary for establishing the chronology of both ceramics and archaeological cultures in limestone areas. The tentative chronology listed in Table 4 is primarily based on comparisons between pottery found in South China and in the Yangzi River Valley, particularly in open sites along rivers, such as the Pengtoushan and Bashidang sites (Table 4). The major criteria of such analysis and comparison are pottery structures, formation methods, the thickness of walls, materials, and processing techniques of the tempering agents, the presence or absence of intended decoration, firing temperatures, and other attributes that may indicate different stages of pottery development. If similar attributes are found in archaeological sites in both the Yangzi River Valley and South China, these sites may be dated to similar periods.[2]

The Impetus for the Origin of Pottery

As mentioned in the introduction of this article, several theories and hypotheses have been proposed concerning the origin of pottery (Ikawa-Smith 1976; Lu 1999; Rice 1999; Tsutsumi 2000). The occurrence of pottery in north China and the Yangzi River Valley might have been related to wild grass collection and exploitation (Lu 1999), as early pottery found in the Yangzi River Valley (Xianrendong and Yuchanyan) was in association with rice remains. Whether this is also the case in South China (Niulandong and Zengpiyan) requires further study (Tables 1 and 2), as recent phytolith analysis conducted at Zengpiyan and Dayan

Table 7. Radiocarbon Dates of Zengpiyan (half-life 5568)

Depth (cm)	Layers in grid DT4	Layers in grid DT6	Layers in grid BT3	Layers in grid BT6	Material and method	Lab. and ^{14}C dates (B.P.)	Material and method	Lab. and ^{14}C dates (B.P.)	Calibrated B.C. (68.2%)	Cultural phase
					Charcoal		Shells			Phase I
310–280		DT6 (32)					Conventional	ZK, 11,255 ± 75	11,272–11,140	
300–264		DT6 (31)					Conventional	ZK, 11,596 ± 91	11,602–11,381	
298–252	DT4 (31)						Conventional	ZK, 11,000 ± 112	11,084–10,915	
	DT4 (31)						Conventional	ZK, 11,235 ± 141	11,272–11,140	
	DT4 (31)				AMS	BA, 9380 ± 170			9150–8950	
274–245		DT6 (29)			AMS	BA, 11,960 ± 240			12,400–11,500	
263–236		DT6 (28)					Conventional	ZK, 11,575 ± 112	11,599–11,350	
		DT6 (28)					Conventional	ZK, 11,438 ± 85	11,422–11,274	
		DT6 (28)			AMS	BA, 9380 ± 180			9150–8950	
		DT6 (28)			AMS	BA, 9440 ± 280			9150–8950	
		DT6 (28)			AMS	ANU, 9350 ± 250			8900–8250	
		DT6 (28)			AMS	ANU, 9130 ± 160			8650–8200	
245–221	DT4 (30)				AMS	BA, 9770 ± 130			9400–9050	
246–212		DT6 (27)			AMS	ANU, 10,520 ± 280			10,950–10,000	Phase II
		DT6 (27)					Conventional	ZK, 10,996 ± 68	10,999–10,908	
228–214		DT6 (25)					Conventional	ZK, 10,944 ± 132	11,051–10,875	
226–202		DT6 (24)			AMS	ANU, 9060 ± 220			8600–7850	
232–208		DT6 (21)					Conventional	ZK, 10,553 ± 93	10,770–10,446	
217–188		DT6 (19)			AMS	ANU, 8770 ± 210			8200–7600	
215–202	DT4 (28)				AMS	BA, 9490 ± 190			9200–8600	
208–196		DT6 (16)			AMS	ANU, 9270 ± 220			8850–8200	
202–180	DT4 (27)				AMS	BA, 9180 ± 100			8530–8490	Phase III
206–167	DT4 (26)						Conventional	ZK, 10,571 ± 63	10,802–10,453	
	DT4 (26)				AMS	ANU, 9730 ± 60			9280–9140	
	DT4 (26)				AMS	BA, 9210 ± 240			8800–7900	

(Continued)

198–175		DT6 (15)					Conventional	ZK, 10,828 ± 99	10,951–10,836	
197–190	DT4 (25)						Conventional	ZK, 10,799 ± 83	10,927–10,833	
	DT4 (25)						Conventional	ZK, 11,093 ± 85	11,132–10,983	
176–148		DT6 (13)			AMS	ANU, 9490 ± 230			9250–8550	
172–157	DT4 (24)				AMS	BA, 8460 ± 290			7950–7050	
169–165	DT4 (23)				AMS	BA, 10919 ± 84			10,941–10,727	
165–148	DT4 (22)						Conventional	ZK, 10,599 ± 100	10,847–10,451	
196–162	DT4 (21)						Conventional	ZK, 10,610 ± 82	10,846–10,460	
	DT4 (21)				AMS	BA, 10,160 ± 80			10,150–9600	
144–135	DT4 (20)						Conventional	ZK, 10,863 ± 77	10,943–10,870	
	DT4 (20)						Conventional	ZK, 10,975 ± 84	11,025–10,902	
	DT4 (20)				AMS	BA, 8970 ± 80			8270–8160	
163–149	DT4 (19)						Conventional	ZK, 10,755 ± 70	10,903–10,807	
	DT4 (19)				AMS	BA, 9040 ± 150			8450–8150	
141–132	DT4 (18)				AMS	BA, 8890 ± 160			8260–7800	
149–131	DT4 (17)						Conventional	ZK, 10,628 ± 59	10,845–10,698	
	DT4 (17)						Conventional	ZK, 10,949 ± 104	11,026–10,883	
	DT4 (17)				AMS	BA, 8870 ± 80			8210–7940	
142–133	DT4 (16)				AMS	BA, 9070 ± 250			8650–7800	
158–122		DT6 (11)					Conventional	ZK, 10,738 ± 102	10,904–10,744	Phase IV
131–124	DT4 (15)						Conventional	ZK, 10,633 ± 56	10,843–10,710	
	DT4 (15)				AMS	BA, 9010 ± 80			8290–8160	
124–98	DT4 (14)				AMS	BA, 6500 ± 120			5610–5590	
115–62	DT4 (13)						Conventional	ZK, 10,588 ± 56	10,817–10,461	
	DT4 (13)				AMS	BA, 9010 ± 150			8450–7900	
	DT4 (13)				AMS	ANU, 9570 ± 280			9800–8450	
				BT2 (13)			Conventional	ZK, 10,095 ± 70	10,004–9495	
112–59	DT4 (12)				AMS	BA, 9040 ± 100			8420–8390	
	DT4 (12)						Conventional	ZK, 10,640 ± 150	10,881–10,448	
	DT4 (12)				AMS	BA, 8740 ± 170			8200–7550	
81–38				BT2 (6)			Conventional	ZK, 8998 ± 74	8292–7994	Phase V
49–26			BT3 (7)		AMS	BA, 8790 ± 170			8200–7600	
			BT3 (7)				Conventional	ZK, 8538 ± 63	7597–7536	

(Continued)

Table 7 *(Continued)*

DEPTH (cm)	LAYERS IN GRID DT4	LAYERS IN GRID DT6	LAYERS IN GRID BT3	LAYERS IN GRID BT6	MATERIAL AND METHOD	LAB. AND ^{14}C DATES (B.P.)	MATERIAL AND METHOD	LAB. AND ^{14}C DATES (B.P.)	CALIBRATED B.C. (68.2%)	CULTURAL PHASE
43–25			BT3 (6)				Conventional	ZK, 8342 ± 64	7501–7340	Phase V
48–32			BT3 (4)				Conventional	ZK, 7783 ± 61	6677–6561	
21–12				BT2 (5)			Conventional	ZK, 8602 ± 68	7709–7573	
18–9			BT3 (5)				Conventional	ZK, 7979 ± 65	7043–6781	
42–31			BT3 (2)				Conventional	ZK, 1655 ± 35	A.D. 344–427	Historic
43–37				BT2 (3)			Conventional	ZK, 717 ± 41	A.D. 1259–1298	
36–12				BT2 (2)	AMS	ANU, 1010 ± 90			A.D. 960–1160	

Source: Institute of Archaeology CASS et al. 2003.

in Guangxi, and another site—Xiantouling—in Guangdong, seems to suggest that rice was exploited in South China as fuel when early pottery was produced (Lu 2009*a*, *b*).

On the other hand, shells have been found in association with early pottery in many archaeological sites dated to the early Holocene from the Yellow and the Yangzi River Valleys to South China, except for the sites of Hutouliang and Dingsishan (Tables 1 and 2). Potsherds found in all the sites are reconstructed to conform to the round-bottom *fu*, except the potsherds found in Hutouliang, which appear to represent a flat-bottom vessel probably used for storage (Guo and Li 2000).

Based on our observation and a cooking experiment, a flat-bottomed pot can stand stably on the ground, and would be ideal for storage. However, it is very hard for a vessel to remain balanced when placed over stones of different height for cooking, as the flat bottom cannot adjust well to the different heights of supporting stones. Further, if the vessel was not constructed properly, the joint between the flat base and the body could shrink and crack when heated. On the other hand, the round-bottom *fu* cannot remain stable on the ground, and therefore it is not very convenient for storage. However, its hemispherical bottom can adjust to stones of different heights and remain balanced when placed over stones for cooking, and its round structure prevents it from easy cracking when heated by fire. As charcoal residues are often found on the exterior bottom of *fu*, it seems that the major function of *fu* is cooking.

If this is the case, then the dominance of *fu* in early pottery vessels found in different environments and prehistoric cultures in South China may indicate that the need for cooking was the primary impetus to the origin of pottery, similar to that in Japan (Aikens 1995; Ikawa-Smith 1976; Lu 2001).

It is notable that shell remains are absent in archaeological deposits dated from the Middle to the Upper Pleistocene, but small quantities of shells have been found in deposits dated toward the Holocene, and the majority of archaeological sites dated from the early to the Middle Holocene in South China contain large quantities of shells (Tables 2 and 4). Clearly, from approximately 12,000 years ago, shells became one of the major food resources for the local inhabitants. Meanwhile, pottery also occurred approximately in the same time framework. Is this a coincidence? Does the occurrence of pottery have any relation to shell consumption? To examine this issue, we need to know how shellfish is consumed.

Several species of freshwater shellfish are still consumed in contemporary South China, and are considered to be a tasty dish. Today, shellfish is cooked in various ways (boiling, steaming, stir-frying, etc.) and the flesh is either sucked out or picked out by using a small stick, or for clams, chopsticks. According to the author's experiments, when shellfish are alive, they can quickly withdraw inside their shells when touched, so it is impossible to either suck or use a stick to pick the flesh out. If one wants to eat an uncooked freshwater shellfish, one has to crush the shell. When doing so, it is unavoidable that both the shell and the flesh are broken into small pieces, and it is troublesome to retrieve and consume the latter. Furthermore, there are various parasites in freshwater shellfish, among them schistosomes (i.e., tiny flatworms living in the blood of mammals and birds), which cause human schistosomiasis, a condition that could readily be fatal in prehistoric periods. Uncooked or not fully cooked shellfish can also cause diarrhea or other digestive problems. In effect, shellfish must be cooked before consuming them in substantial quantities.

Another relevant issue is how shellfish might conceivably have been cooked in pre-modern times. Unlike animal meat, shellfish cannot be hung and baked over fire. Unlike grass seeds, shellfish cannot be ground and baked on stone slabs. The most efficient and easiest way to cook shellfish is to put them into a container and boil them with water. Apparently, the need to consume freshwater shellfish from the terminal Pleistocene to the early Holocene in South China demanded the creation of a new instrument, a cooking vessel, which could withstand fire and contain water and shellfish at the same time. It is highly possible that such a requirement for shellfish processing was the impetus for the origin of pottery in this region, although other subsistence-related needs such as food and water storage and cooking other types of food cannot be ruled out (Lu 2001).

According to archaeological data found in Dayan and Niulandong, the majority of shells found in deposits without pottery had been crushed, while the majority of those found in association with fired clay or potsherds remained intact. This clearly indicates a change in shellfish consumption along with the occurrence of pottery. The small amount of crushed shells found in Phase I of the Dayan site may indicate an initial attempt to exploit shellfish at the terminal Pleistocene by breaking the shells and picking the flesh out. During the transitional period of approximately 13,000 to 12,000 years ago, shellfish was consumed in substantial quantities and the means of consumption seems to have changed, as shells found in this period were intact (Institute of Archaeology CASS et al. 2003; Lu 2001). Our experience indicates shellfish must be cooked before being eaten. The occurrence of pottery and intact shells in the same archaeological layers in Dayan and Zengpiyan dated to 12,000 years ago indicates that pottery was used for cooking shellfish in South China (Institute of Archaeology CASS et al. 2003; Lu 2001), as well as for other functions.

In South China, particularly in areas inhabited by minorities, bamboo culms (i.e., the jointed hollow stems of the plant) are still used to cook rice, meat, fish, and other dishes. The culms are first cut down, then cut into sections at each joint end. Food ingredients and water are placed into the hollow culms and sealed with clay if needed. The bamboo culms with the ingredients inside are then placed over fire. When the cooking is finished, the bamboo culm is often charred and has to be discarded. Theoretically, shellfish can be cooked in this way, but only a limited amount can be cooked each time, and the labor cost from chopping down bamboo culms to cut up sections is also considerable, as each section can only be used once. Although ethnographic data can only be taken as a reference, and we cannot tell whether shellfish was actually cooked in prehistoric South China in bamboo culms based on the current archaeological evidence, we can however argue that it is inconvenient and too labor-intensive to use bamboo culms for shellfish cooking and that pottery is a much more technologically efficient choice.

The appearance of pottery technology seems to have accelerated the consumption of shellfish, as large quantities of shells and pottery have been found in many archaeological sites in South China and adjacent areas from approximately 10,000 years ago. The major reason for such popularity of shellfish consumption could be the efficiency of shellfish gathering. The author's experiment in South China suggests that more than 340 shellfish can be gathered in 20 minutes, or more than

1000 shellfish in one hour; from which about 460 grams of shellfish flesh can be obtained, which can provide 322 kcal of energy (Lu 2006). Apparently, the return of shellfish gathering is quite high, and with a ceramic cooking vessel, shellfish became a very attractive food in prehistoric South China.

Of course, shellfish would not have been the only item cooked in pottery vessels in South China. Many food ingredients need to be cooked before consumption, but some of these ingredients such as taro, yams, or animal meat, can be baked over fire and do not necessarily require a cooking utensil. Grass seeds could be another ingredient that requires a cooking vessel in China's context (Lu 1999), but not many grass seeds have been found in archaeological deposits in South China, indicating that this type of food was probably not favored due to the extremely low return of harvesting (Lu 2006). On the other hand, the cooking *fu* found in the Yangzi River Valley might have been used to cook rice, as rice remains have been found in these sites (Table 4) (Lu 1999).

The Occurrence of Intentional Decoration

In South China, the earliest pottery was plain, without decoration. However, cord-marking soon appeared in this region. An experiment with pottery manufacturing was conducted in South China from 2000 to 2002 in order to investigate the techniques and process of making pottery. Preliminary results of this experiment reveal that clay near Dayan, Zengpiyan, and Dingsishan in Guangxi can be used to make pottery, and calcite and quartz as tempering agents are easily located in limestone areas (Institute of Archaeology CASS et al. 2003). According to the experiment, the walls of vessels built by hand pinching and with coarse inclusions are often very thick and uneven; a further forming step is thus required to shape and firm the walls. This can be done by using a small pebble and a wood or bamboo rod tightly wrapped by twisted grass stems (Fig. 3). The potter holds the pebble inside the vessel in one hand, and the grass-wrapped rod outside the vessel in another hand, then evens out and modifies the walls by rolling the rod on the surface, while using the pebble inside the vessel to support the wall against the pressure (Institute of Archaeology CASS et al. 2003). The experiment suggests that using a grass-wrapped stick may be a necessary component of pottery manufacture by hand pinching.

Since this is not a decorative process, the potter can roll the rod toward various directions at his/her discretion, or the potter can roll the rod more than once at any point, leaving a multi-directionally pressed cord-mark on the surface. The marks produced by the experiment often overlap with each other and without observable patterns, and appear exactly the same as those observed on the surface of the early pottery dated to about 12,000 years ago found in Dayan and Zengpiyan (Institute of Archaeology CASS et al. 2003; see Fig. 3).

Why was it necessary to use grass stems to wrap the wood or bamboo rod in this process? According to the experiment, a wood or bamboo rod without grass stems was too smooth and was often sticky on the surface of the damp vessel. It is comparatively difficult to roll such a rod freely on the vessel surface; further, the rod may stick off the surface clay and reduce the strength of the wall (Institute of Archaeology CASS et al. 2003). These problems were solved by using a rod wrapped by twisted grass stems, as the latter reduced the size of the interface

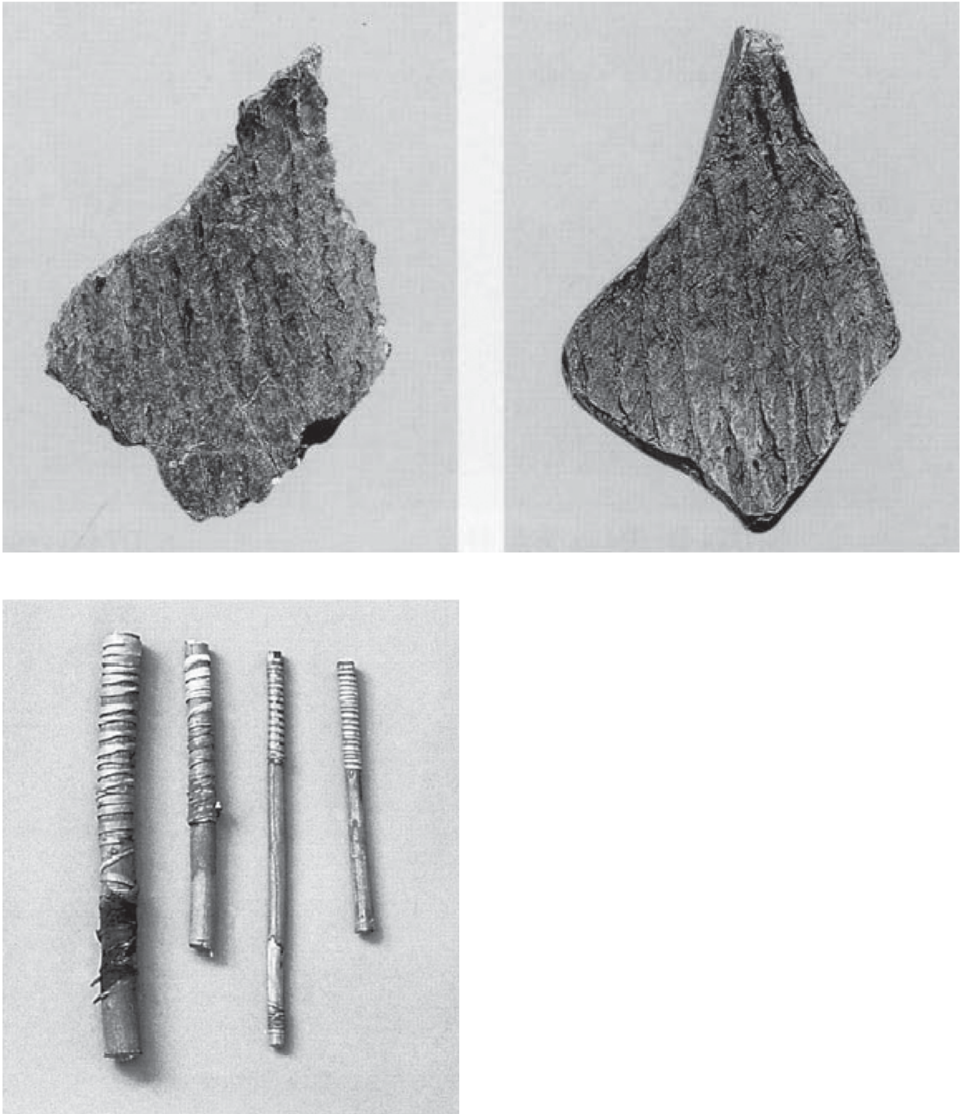

Fig. 3. "Cord-mark" as remains of pottery formation process. *Top left*: potsherd dated to approximately 10,000 years ago with flattened marks; *Top right*: replica produced by manufacturing experiment (not to scale). *Bottom*: wood rods wrapped by twisted grass stems and used for pottery manufacturing experiment (not to scale). (Courtesy of Institute of Archaeology CASS et al. 2003)

between the wet clay and the rod, and facilitated better movement of the former. MacNeish hypothesized that the rod was probably dampened when used on the vessel (MacNeish et al. 1998:24). However, the experiment indicates that dampening is not required (Institute of Archaeology CASS et al. 2003).

As mentioned above, it has been observed that such marks on the surface of the earliest potsherds in South China had often been wiped or smoothened by human hands, suggesting that the potter had no intention of letting the mark remain

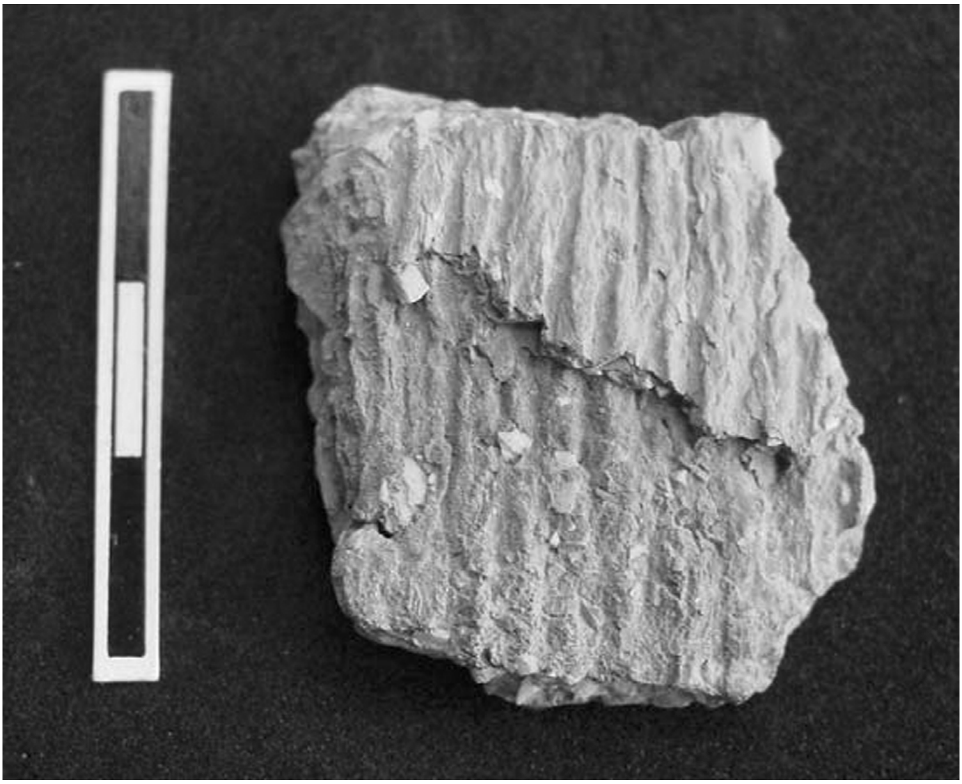

Fig. 4. A piece of pottery built by slab building, with flattened "cord-mark" presses on the surface of two overlying slabs. (Courtesy of Institute of Archaeology CASS et al. 2003)

visible after the completion of the process (Institute of Archaeology CASS et al. 2003). In addition, such cord-marks shows no observable patterns, and reveal no cognitive intention or efforts for aesthetic presentation. Further, this type of cord-marking has been observed on both the interior and the exterior of the vessels, and on both sides of the clay slabs when slab building was used to construct vessels (Institute of Archaeology CASS et al. 2003; Fig. 4). All these manifestations of cord-marking on the earliest pottery found in South China appear to not represent intentional decoration, but instead are likely the remnants of a manufacturing process used to strengthen the walls of the vessels.

Cord-marking, however, did eventually become a major decorative motif. On the surface of pottery dated to between 10,000 and 9000 years ago in South China, there are no traces of potters' hands for wiping or smoothing the cord-marks. Furthermore, the cord-marks dated to this period are better organized and they present certain patterns and directions, although some of them are still multi-directional (Fig. 5). The experiment suggests that cord-marking found in Phase II of the Zengpiyan assemblage was probably still produced by rolling rods wrapped by grass stems, but the aforementioned phenomenon seems to suggest that the potters in this period intended to keep the marks, and began to convert the mark into a purposeful decoration (Institute of Archaeology CASS et al.

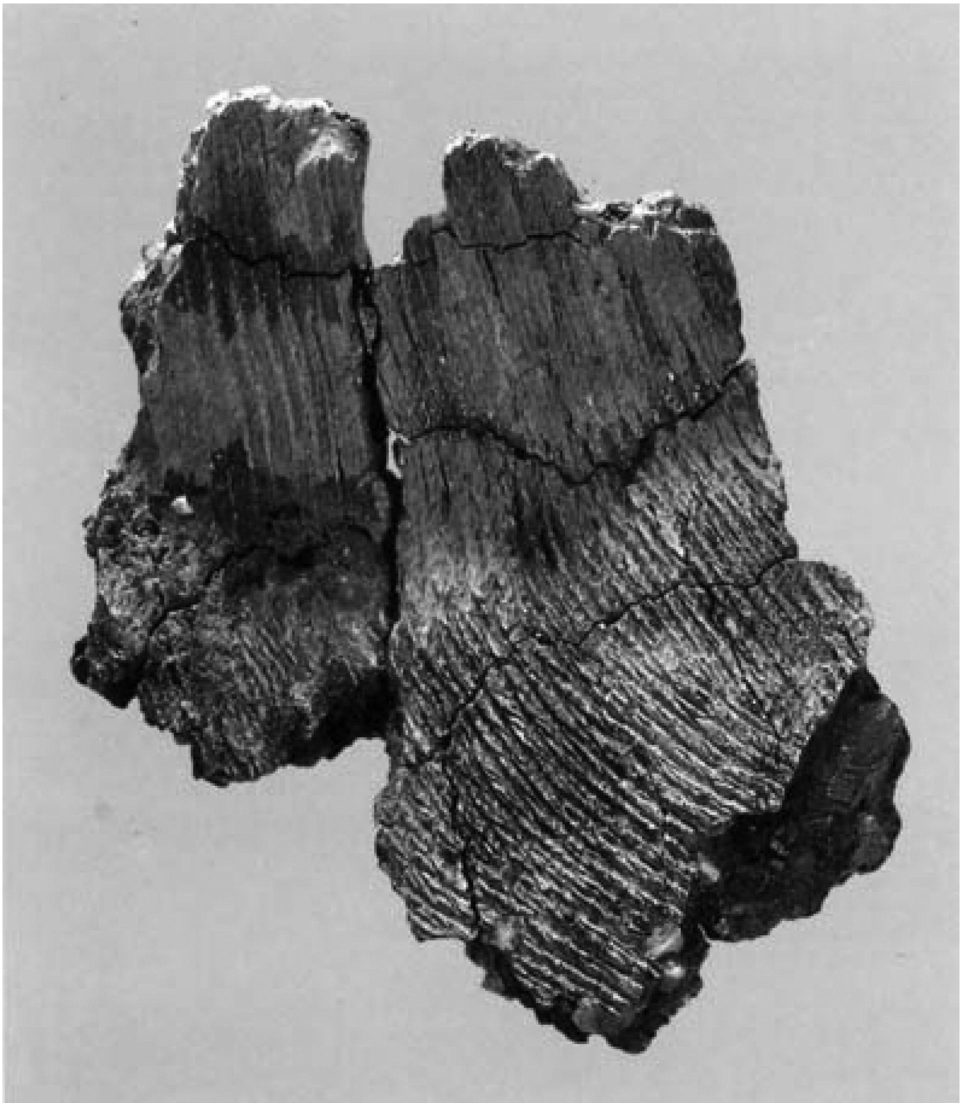

Fig. 5. Potsherds with non-flattened cord mark found in Zengpiyan, phase II, dated to approximately 11,000–10,000 years ago (scale–1:1.6). (Courtesy of Institute of Archaeology CASS et al. 2003)

2003). According to the author's observation, some decoration motifs such as the basket or the straight line motifs found in Neolithic cultures dated to the Middle Holocene in South China are developed from regularizing and re-patterning cord-marks, although the construction method might have differed significantly from that of the earliest pottery.

Therefore, marks on the pottery surface dated to different periods may be able to tell us more about the cognitive aspect of prehistoric human beings with respect to the occurrence and development of aesthetic presentation and decoration for pottery. The cord-marking found on the surface of the earliest pottery in

South China is not a decoration but remains of a manufacturing process. However, such remains were converted into decorative motifs in the succeeding Neolithic cultures, and were probably the base from which more ceramic decorative motifs developed sometime after 10,000 years ago in South China.

Mobility, Subsistence Strategies, and the Development of Pottery

The archaeological data seem to suggest very stable cultural development in Dayan and Zengpiyan (Table 4). Further, this seemingly stable cultural development is not only found in the two cave sites. To date, dozens of archaeological sites and finding places dated from the terminal Pleistocene to the early Holocene have been located in South China, and thousands of artifacts have been discovered. Generally speaking, these artifacts can be classified into a few categories, namely flaked pebble stone tools, ground stone tools, ground bone implements, pierced shell implements, and pottery. The tools/implements found in these archaeological sites are quite similar to each other in terms of raw materials, manufacturing techniques, and typological variety. The majority of tools were made of river pebbles, terrestrial animal bones, or freshwater shells. Based on observation and archaeological experiments, the stone tools at Zengpiyan and Dingsishan were made by direct percussion and/or grinding; bone implements were made by splitting animal long bones and then grinding; shell implements were made by direct percussion, piercing, and grinding (Lu 2003*c*). Although technical refinement and variations in typological assemblages have been observed, no significant changes are visible in cultural remains dated from 13,000 to 8000 years ago except for the occurrence of ground stone tools (Table 4).

This stable cultural sequence differs significantly from that in the neighboring Yangzi River Valley, where rice farming occurred by 8500 years ago in association with sedentary settlements and diversified pottery (Table 4), some of the latter elegantly decorated and of possible use for special functions. The typological variety of pottery during this period was contrastingly very limited in South China (Table 4). After its initial occurrence, *fu* remained a dominant vessel type in South China from approximately 12,000 to 8000 years ago, whereas various types have been found in the adjacent Yangzi River Valley (Table 4). While typological monomorphism is expected at the beginning of production of new materials or items, the dominance of a single vessel for such a long period of time in South China is quite unusual. It seems that cooking remained the basic function of pottery in South China for 4000 years, but other factors might also have played a role.

Comparing the sequences of the origin and development of pottery in the Yangzi River Valley with that of South China (Table 4), it is obvious that there were similarities in the two regions in the initial stage. Pottery appeared approximately at the same time in both regions, and the remains were all found in cave sites, associated with pebble tools, ground bone tools, and pierced shell instruments (Table 4). Remains of animal bones and shells found in both regions indicate similar subsistence strategies in both areas. Even the earliest pottery type was similar, being the round-bottom *fu* (Table 4), indicating similar requirements for pottery in the two regions. However, some prehistoric groups in the Yangzi River Valley became rice farmers by approximately 8500 years ago (Table 4).

These groups moved to river terraces, became sedentary, built houses and protective ditches surrounding the houses. For them, vessels not only for cooking but also for serving food and even ritual activities may have been needed.[3] Thus, a wider variety of pottery items was made to satisfy these needs. Furthermore, food surplus provided by agriculture and a sedentary life might have facilitated labor division and the gradual professionalization of craftsmanship, which enabled the development of pottery manufacturing techniques, particularly involving the creation of fine and delicately made vessels, as well as the building of kilns to fire white and light-colored pottery. An experiment conducted in Hong Kong indicates that light-colored pottery cannot be produced without a kiln (Wong 2007). Although the social structures of the farming societies in the Yangzi River Valley remain unclear due to the unavailability of archaeological data relevant to this issue, some degree of specialization of craft production might have developed there judging from the high level of ceramic craftsmanship.

In contrast, the prehistoric groups living on rich resources in South China remained foragers until the Middle Holocene (Table 4) (Lu 2008). The majority of them still lived in caves, and, judging from unearthed ecofacts, their subsistence strategies seem to have remained little changed. Their primary need for pottery also seems to have remained focused on cooking, indicated by the dominance of cooking *fu* (Table 4). Furthermore, as foragers tended to be mobile, their lifestyle might have hindered the development of more sophisticated pottery styles and manufacturing techniques, as pottery is easily broken when frequently transported and the construction of permanent facilities such as kilns may not be technologically known and/or attractive to mobile groups. Specialization in craft production is not evident from the archaeological evidence, judging from not only the nature of the vessels produced in this area before 7000 years ago, but also the overall archaeological evidence (discussed above) suggesting that the society represented in South China was largely egalitarian.

It was not until approximately 7000 to 6500 years ago that new types of pottery vessels, along with burials containing grave goods, occurred in South China (Table 4). The shapes of these new vessels, along with their decorative motifs such as incision and perforation, are morphologically similar to those found in the Yangzi River Valley. This similarity strongly suggests cultural exchanges between the Yangzi Valley and South China in this period, with the influences largely from the former to the latter.

In summary, the ceramic development in South China seems to have differed significantly from that in the Yangzi River Valley by approximately 7000 years ago in terms of typological diversity, range of functions, manufacturing techniques, and decoration motifs. These differences might have been related to varying paths of prehistoric cultural development in the two regions involving differing subsistence strategies, mobility, and social structures. There might have been various reasons for the different trajectories of cultural development in South China and the Yangzi River Valley from approximately 12,000 to 7000 years ago. Based on current data, resource differences in terms of seasonality, accessibility, and diversity in the two regions, as well as the fluctuation of local climates and different local cultures might have caused this cultural diversity (Lu 2003*a*, 2006), but more studies are required on this issue.

Pottery and the Definition of Neolithic in South China's Context

V. Gordon Childe defined pottery as one of the essential elements of "Neolithic," with other features including agriculture, sedentism and ground stone tools (1951). According to this definition, many archaeological assemblages found in China and the mainland and coastal areas of Southeast Asia cannot be called Neolithic cultures at all, as they are neither sedentary nor agricultural societies, although possessing pottery and ground stone tools. So how can we define these archaeological assemblages if they cannot be called "Neolithic"? Can they simply be called hunting-gathering cultures? The latter nomenclature may be just as problematic as Childe's concept of "Neolithic" for several reasons.

First, both archaeological study and ethnographic data in South China suggest that foraging and farming are not exclusive subsistence strategies. When conducting our survey in northern Guangxi in 2000, we were informed that the local minorities were still hunters and gatherers in the 1980s while cultivating rice, yam, and taro, because farming could not provide sufficient food. While modern ethnographical data can only be taken as a reference point, the discovery of large quantities of wild animal bones, fish remains, nuts and seeds of wild plants in prehistoric farming societies such as the Cishan, Peiligang, Jiahu, Pengtoushan, Bashidang, Tianluoshan, and Hemudu assemblages in the Yellow and the Yangzi River Valley (Lu 1999, 2006) clearly manifests the coexistence of hunting, gathering, and farming. Archaeological experiments also indicate that farming in its initial stage could not provide sufficient food; thus, foraging was still necessary for early farmers (Lu 2002, 2006). It is probably more accurate to say that some prehistoric groups were farmers and hunters and gatherers, while others were solely hunters and gatherers.

The second problem is that by defining an archaeological assemblage as a hunting-gathering culture, the chronological and cultural characteristics become blurred. Hunting-gathering existed as a subsistence strategy from the early Palaeolithic to the present in different areas and different groups. Although the contents and techniques have been changing, the basic characteristic of this strategy—relying on natural resources to survive—has remained. By defining an assemblage as a hunting and gathering culture, one cannot tell whether it is dated to the Pleistocene or the Holocene, and whether pottery or ground stone tools were produced. As many groups from the early Palaeolithic to the end of the Neolithic can be defined as hunters and gatherers, this definition would have lost its chronological meaning, and this temporal component is a very significant implication of the traditional use of the term Neolithic.

Apparently, agriculture, sedentism, ground tools, and pottery did not occur simultaneously in China. Pottery is an important cultural hallmark of the transition from the Pleistocene to the Holocene in China, but other hallmarks include shellfish and rice gathering, and the occurrence of grinding techniques first applied to bone tools, then to lithic tools. Thus, archaeologists in Vietnam and China often described prehistoric cultures with pottery and ground stone tools as Neolithic.

The debate on the definition of Neolithic, however, may well be an attempt to fit the prehistoric cultural development in some areas of China into a universal model. Whether there is such a universal model in terms of cultural development in human societies is another theoretical question for discussion beyond the scope of this article. But it can be argued that human beings, living in prehistory or the present, adapt to different natural environments and develop different cultures, not only as modes of adaptation, but also as a continuity of their cultural traditions. The consequence is a rich cultural diversity from prehistory to the present. It is probably unjustified, unnecessary, and impossible to try to fit cultural developments occurring in different regions into one model.

CONCLUSION

In summary, early pottery found in South China dated to approximately 12,000 years ago was manufactured by affluent, but egalitarian foragers. Its occurrence in association with shell remains indicates significant changes in technological and subsistence strategies at the beginning of the Holocene, with the consumption of freshwater shellfish being a new cultural development. The occurrence of pottery, together with ground bone and shell implements, as well as a large amount of shell remains, signals an important cultural transition in this region. It is probably with the aid of pottery as a cooking tool and storage facility that the prehistoric population in South China significantly increased their ability to exploit shells and other resources as food, which might have gradually changed their mobility patterns and other aspects of life. At approximately 6000 yeas ago, rice farming appeared in South China, associated with further changes in ceramic technology and other cultural developments in this region. These new developments might have been the result of cultural contacts and exchanges with the Yangzi River Valley.

As discussed previously, there are still many questions that remain with respect to the origin and development of pottery in South China, the Yangzi River Valley, and North China. Further and more in-depth archaeological research will provide essential information for us to better understand the prehistoric cultures in China, which will also provide useful references for archaeological studies in both East and Southeast Asia.

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ENDNOTES

1. There are different opinions about the beginning of the Holocene. In this paper, the date of 12,000 B.P. is adopted as the beginning of the Holocene.
2. This approach is of course not ideal, as archaeological assemblages containing similar items may belong to different ages, so radiocarbon dates are also taken as references.
3. Judging from pottery motifs found in the Zaoshi assemblage, it has been proposed by scholars in the middle Yangzi Valley that sun worship might have existed there as early as 7800 years ago (Hunan Institute of Archaeology 1999).

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ABSTRACT

Potsherds of thick walls with coarse inclusions have been found in several archaeological sites in South China, associated with flaked or ground stone tools and ground organic implements. This paper focuses on the natural and cultural contexts, the chronology, and the characteristics of the early pottery found in South China, as well as the impetus to the origin of pottery and several related issues. It is argued that the earliest potters in South China were affluent foragers, who lived on diversified natural resources and were members of egalitarian societies. The earliest pottery in this region is tentatively dated to approximately 12,000 years ago, characterized by thick, crumbled walls built by hand pinching and without decoration. Although potsherds found in South China may not be the earliest in terms of the absolute dates, they represent the very beginning of pottery manufacturing as a technological invention from the terminal Pleistocene to the early Holocene in southern East Asia. Based on current archaeological data and the results of multi-disciplinary analyses, it is argued that South China seems to have been an area for the origin of pottery, which might have been associated with subsistence strategy changes. Furthermore, there might have been cultural exchanges between the prehistoric potters in South China and those in adjacent areas. Keywords: South China, pottery, terminal Pleistocene, early Holocene, foragers, subsistence strategies, exchange, ethnoarchaeology.