

Terracotta vaulting tubes (*tubi fittili*): on their origin and distribution

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The use of hollow terracotta vaulting tubes (in Italian, *tubi fittili*) for the construction of vaults in Roman North Africa has long been known. First used there in the course of the 2nd c. A.D., this method of roofing enjoyed great popularity especially in Proconsularis, but scattered examples are known across a broad sweep of the North African provinces, from Banasa in Mauretania to Bu Ngem in Tripolitania.¹ The first systematic study of what David Peacock has called “these curious objects”² was made over 35 years ago by Alexandre Lézine,³ and since then our understanding of how the tubular vaults were actually built and functioned has been greatly enhanced by experiments in constructing them *ab initio* carried out at Chemtou in 1972 and at Bulla Regia in 1976, employing newly made tubes identical to those used in antiquity.⁴ Excavation reports have now begun to catalogue vaulting tubes and accord them the same treatment as that long provided for other ceramic material, including fabric description.⁵ So closely with North African sites has this particular form of vaulting been associated that it has been widely assumed to have been a North African invention.⁶ In fact, as we shall see, its earliest use occurs over 400 years before its first appearance in North Africa; and the general extent of its use outside the North African provinces, especially Italy, has not perhaps been fully realised. What the present study seeks to do, therefore, is to examine the distribution of terracotta vaulting tubes in the Roman world as a whole, and to discuss when, where, and how this method of roofing first developed.

The use of terracotta vaulting tubes in North Africa

Construction methods

Thanks to the survival of portions *in situ*, the best place to study examples of terracotta vaulting tubes is in Proconsularis, where the baths of Thelepte (Feriana) and Sufetula (Sbeitla), and private houses at Dougga and Bulla Regia, provide particularly illuminating examples of their use. The individual tubes of which each vault is composed are of standard type, cylindrical but with one end narrowing to form a nozzle-like projection, thus enabling each tube to interlock neatly with its neighbour (fig.1). The tubes are open at both ends, and usually but not invariably have lightly corrugated surfaces inside and out, made by the potter’s fingers while the tube was being fashioned on the wheel; the corrugation served to improve the adherence of the tubes to the mortar in which they were to be encased. The African tubes can vary greatly in size from 7 to 32 cm in length, and from 5 to 11 cm in diameter,⁷ although the majority are between 12 and 20 cm long.⁸ In any case any significant variations in size occur between batches rather than

1 Bu Ngem: Rebuffat 1969-70, 121-33 with pl. XXII-XXIV; Rebuffat 1974-75, 211-14 with pl. LXVI-LXVII; Rebuffat 1976-77, 44-47 with pl. XVI-XVII; Banasa: Thouvenot and Luquet 1951, 54. Brodrigg 1987, 84, uses the term *tubuli lingulati* to refer to vaulting tubes, but there is no ancient authority for the use of the term in this context (Vitruvius 8.6.8 is referring to water pipes) and I have preferred to avoid it here.

2 Peacock 1984, 246.

3 Lézine 1954.

4 Olivier and Storz 1983; Storz 1984. The technique used was the subject of an exhibition, with scale models and photographs, organised by Sebastian Storz at the Villa Massimo, Rome, in 1984, and at Kassel in 1985.

5 E.g. Hayes 1976, 103-4; Hayes 1978, 82; Peacock 1984; Dodge 1989; Christie 1991, 263-64.

6 See notes 26-27 *infra*.

7 Lézine 1954, 169, actually gives the maximum length as 23 cm rather than 32 cm — a slip of the pen since the one from Cherchell that he illustrates (170, fig.1.1) is clearly 32 cm long (and 11 cm in diameter, the maximum diameter he records: his scale is apparently not in error).

8 For example the Carthage ones published by Peacock (1984) are 14 cm and 19 cm long, while the “almost complete” example from Sabratha is 12.8 cm long (Dodge 1989, 249). At Dougga, examples in an apse opening