

INTERDISCIPLINARY RESEARCH ON URNS FROM THE CARTHAGINIAN TOPHET AND THEIR CONTENTS

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ABSTRACT: Six urns excavated at the tophet of Carthage and now in Dutch public collections are described. The cremated bones and the charcoal in these urns have been studied in detail. Some other remains in the urns turned out to be later, some even subrecent additions. The cremated bones from five of the six urns have been dated, using the bio-apatite fraction. A short summary of the scope and limitations of radiocarbon dating is added.

KEYWORDS: Carthage, tophet, chronology, physical anthropology, cremations, wood species, identification, radiocarbon dating, bio-apatite.

1. INTRODUCTION

Dutch public collections contain a respectable number of pots, which originate in one single, well-defined archaeological context: the tophet of Carthage, the place where the cremated remains of thousands of children had been buried in a ritual way (fig. 1). The present contribution is a preliminary archaeometrical report on the contents of six of these cremation urns. A coherent publication of these pots and of their contents is in preparation.¹ The hotly debated question whether the children buried in the tophet were murdered ritually or just died from natural causes, is complicated and extensive.² In the present context this subject will not be discussed in detail.

2. ARCHAEOLOGICAL COMMENTS [R.F.D.]

2.1. Provenance

Nineteen vessels and fragments from the tophet of Carthage can be found in the collections of the Rijksmuseum van Oudheden in Leiden (RMO) and the Allard Pierson Museum in Amsterdam (APM). The

vases in Leiden were bought on the 20th of February 1952 from Mr. G.A.H. Bisseling in The Hague³, who had acquired them in Carthage. The vases in Amsterdam were once in the collection of Mr. A.W. de Groot and Mr. R. Leuven (Utrecht) and had been on loan to the archaeological collection of the Archaeological Institute of the State University of Utrecht during the Seventies and Eighties. They were donated to the Allard Pierson Museum in 1990, after the closure of the Archaeological Institute in Utrecht.⁴

Also the pieces in Amsterdam had been acquired in Carthage; they are said to have come from the 'Sanctuary of Tanit in Salammbô', one of the common names to designate the tophet. It remains unclear, however, in which part of the tophet they were discovered. Most of the pieces in Leiden were said to have been found in the 'Temple of Tanit, Carthage', thus sharing the provenance with the vessels in Amsterdam. Excavations in the tophet started in 1922 and have continued with intervals till the end of the 1970s (Lancel, 1995: pp. 227–248). The Leiden and Amsterdam urns may have been found during one of these excavations. Three of the Leiden pieces, two urns and one lid, give some clues as to their original position within the tophet (see e.g.



Fig. 1. Carthage, tophet excavations of Kelsey in 1925 (after: Khun de Prorok, 1926a: p. 48).

below). In the context of the present contribution, six of these 19 vessels and their contents are discussed.

2.2. A jug from Kelsey's excavations

One of the urns in Leiden, the one-handled jug Cat. No. 3 (fig. 5), allows for a better reconstruction of an exact location within the tophet area. Its entry in the Leiden museum's registers gives the 'burial plot of Tanit' as the provenance, again differing from the entries of the other vessels. An original registration label found inside indicates that it was found in the 'Sanctuary of Tanit'. Such labels were used by the American mission in 1925, directed by Francis W. Kelsey. This excavation was mainly financed by the flamboyant 'Count' Byron Khun de Prorok (fig. 2), an American of Hungarian origin, who had bought the plot of land, where in 1922 François Icard and Paul Gielly started the first regular excavations in the tophet.⁵ Although the excavation never reached the stage of final publication, a very good preliminary report appeared already in the following year (Kelsey, 1926) and the British archaeologist Donald B. Harden published the pottery some years later.⁶ According to the *Journal with Inventory of Objects Found*, of which Brien Garnand (Chicago) kindly

provided us with copies of the relevant pages, number S 1466 (our Cat.No. 3; fig. 5) was excavated on Wednesday April 15, 1925 together with some 73 urns.⁷ This date is also indicated twice on the loose label found in the urn ('april 15' and '15'), thus confirming the fact that urn and contents do belong together. Garnand suggests that the stamped number '27' on the back of the label probably is the preliminary number given to the urn on that day (they assigned numbers on a daily basis).⁸ The location number written on the label is 316, which corresponds to the location of the preceding and following urns (S 1463, S 1464, S 1465, S 1469, S 1470, S 1471). As Garnand informs us, location numbers would have meaning only as a point on the site plan, not as a specific locus or a particular stratum. These numbers are referred to in the *Journal with Inventory of Objects Found*, though. The depth ('elevation') at which the preceding two urns S 1464 and S 1465 were found is 0.75 (meter), presumably calculated from the ground level, i.e. the level on which the first *stelae* stood.

After the excavation the 2000-odd urns from the Kelsey excavations (cf. fig. 2) remained in the private museum on the site, which was formed by the American expedition in 1925.⁹



Fig. 2. Urns from the Carthaginian tophet, Kelsey excavation 1925; B. Khun de Prorok in the centre (after: Khun de Prorok, 1926a: p. 72).

2.3. Stratigraphy and chronology of the tophet of Carthage

The conventional tripartite dating scheme of the Carthaginian tophet was first adopted by the American and British excavators of the Kelsey mission.¹⁰ Based on three general stratigraphical layers, initially called Level 1, 2 and 3, but later Tanit I, Tanit II and Tanit III, they developed a chronological framework which spans the whole period of Carthage's existence. The basis for the dating was formed by few imported Greek pottery vessels found in the different layers, as well as the comparison of the urns from the tophet with urns found in import-dated graves elsewhere in Carthage. Recent American excavations on the site allowed for a refinement and a further subdivision of the conventional stratigraphy and absolute dates (Stager, 1992: p. 73; Stager & Greene, in prep.). The excavators distinguished nine phases in the stratigraphy, but the publication of these in relation with the pottery found in them is still in preparation. Therefore, the slightly adapted old tripartite scheme is used here, provided with the new general absolute dates of the recent American excavations: Tanit I (750–600

BC), Tanit IIa (600–400 BC), Tanit IIb (400–300/250 BC), and Tanit III (300/250–146 BC).

2.4. Postdepositional processes

After the burial of an urn in the tophet precinct, more or less loosely sealed with a plate, various processes affected the preservation of the contents of the urns. Apart from the regular deterioration of organic materials in the Carthaginian soil, it could be shown in different instances in the Leiden and Amsterdam sample that the only partly filled containers had collected water in periods of heavy rainfall. The calcareous deposits on the interior of some urns indicate the waterlevels, which may even be oblique due to the urn's position in the ground.

Also after excavation, the urns and their contents had been subject to various sorts of treatment. The contents of the Leiden pottery containers had already been washed and screened after their discovery in Carthage. Perhaps because of the earlier screening, no 'valuable' artifacts, such as scarabs or the like have been recorded in these urns, although such original offerings should not necessarily have been included in antiquity. After the cleaning of the contents of these Leiden pieces, the urns would have been stored away for some time in Carthage, probably in a small depository on the site itself. This could explain how supposedly recent charcoal got included in one of the urns (see below). The finding of modern wood scrapings in some of the Leiden urns can probably be related to the shipment of the urns at the time of acquisition. The fact that upon study even some waste paper and matchsticks were found in a few of the Leiden urns is caused by the fact that the remains lay loose in the urns, which stood unsealed in the museum's storerooms. The find of a 'Mediterranean' ant in one of the Amsterdam amphorae is probably explained by the storage conditions on the site in Carthage (see below).

2.5. Archaeological comment on the six urns

The discussion of the six urns containing the cremation remains follows more or less in the order of classification established in 1937 by D.B. Harden, which is still unsurpassed in its morphological, technological and typo-chronological details. Harden starts his classification from morphological distinctive criteria, which can be traced back to differences in potting technique. He keenly distinguishes different clays and surface treatments. Decoration plays only a minor role in his classification. The basics of it are as follows: he starts from the three major stratigraphical groups (Tanit I, II and III), within which he discerns different pottery shapes, referred to as A, B, C, etc. The classes may have been subdivided in

subclasses a and b, mainly on the basis of the shape and technical details of the base. A further division is made on the basis of rim shape, the way the neck is joined to the body, etc.; these varieties are indicated as i, ii, iii, etc.

Given the fact that the pottery in the tophet served very particular ends, the repertoire of shapes is rather limited, mainly consisting of amphorae, jugs, 'cooking pots', and every shape that could have served as a lid. Although some of the pottery shapes in the tophet must have been made especially for the ritual of burying cremated remains, most shapes are encountered both in settlement and funerary contexts. Therefore, reference is made to other typologies of Carthaginian and Phoenician/Punic pottery. In an attempt to trace the development of the ovoid and carinated shapes in the Phoenician amphora repertoire, some of the urns from the tophet have been recently discussed (Docter, 1997: § VII.2.1; § VIII.2.3). Throughout the series of these amphorae and 'urns' a general shift in decoration can be distinguished, which is based on the gradual disappearance of the more accomplished of the five different decoration schemes:

1. Bichrome or red slip decoration in zones with geometrical patterns in the reserved handle zone;
2. Bichrome decoration in zones;
3. Red slip decoration in zones;
4. Horizontal line decoration;
5. Plain ware (no painted decoration).

The occurrence of these schemes is chronologically distinctive, although a certain overlap is evident.

2.5.1. *Bichrome ware amphora of Tanit I*

Leiden, Rijksmuseum van Oudheden, G 1952/2.7 (fig. 3).

Dimensions: Height 22.1 cm. Diameter (mouth) 11.1 cm, (belly) 21.6 cm, (base) 7.1 cm. Capacity 3.73 litre.

Condition: intact; few flakes from handle and body; decoration worn off.

Clay: well-fired, reddish yellow (5 YR 7/6); inclusions: rounded quartz mff3 (numerous, very fine, <0.2 mm), limestone particles mgl (few, large, 1.0–1.5 mm).

Surface: very pale brown (10 YR 8/3), scum; red slip on rim, shoulder, zone on belly, metopes in handle zone and horizontal lines on handles, weak red (10 R 5/4); black paint, lines bordering red slip zones on shoulder and belly.

Surface smoothed.

Contents not in situ, washed: cremated remains of 1 child, 6–9 years, 1 lamb and 1 unknown animal (young dromedary?); 17 fragments of carbonised wood.

Bibliography: Docter, 1997: table 62.A, No. 10.

The amphora can be assigned to a shape, which occurs in the oldest stratum of the tophet, Tanit I, conventionally dated to the second half of the 8th and the 7th century BC. With its bichrome decoration and additional painting in the reserved handle-zone it is typical of Harden's class I A. More specifically, it belongs to variety iii, which has a "low, beaded lip, no neck, ovoid body" (Harden, 1937: pp. 65–67, fig. 3c, d). All Class IA amphorae stand on low base-rings with a central knob on the underside. The handles are either round, 'sausage-shaped' or slightly elliptical. On the typological basis of both formal and decorative elements, the amphora Cat.No. 6 has recently been attributed to sub-class Carthage 5 A 1 (Docter, 1997: table 62.A, No. 10).

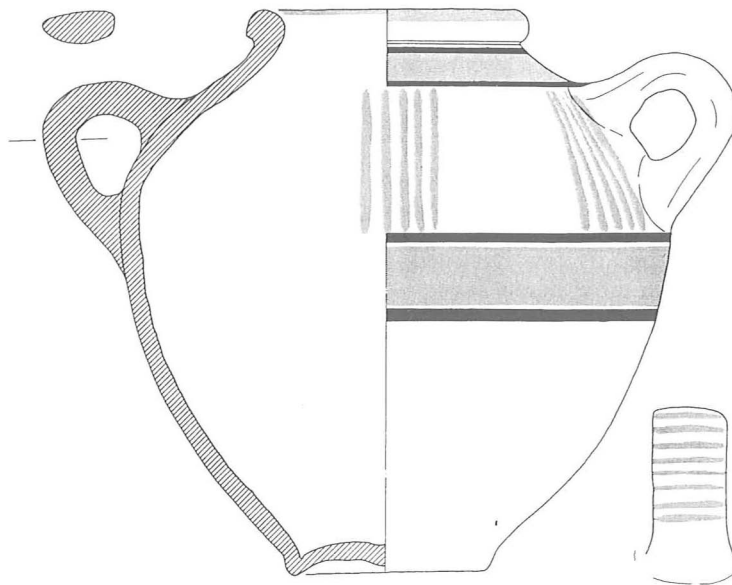


Fig. 3. Amphora Tanit I, Leiden RMO G 1952/2.7 (drawing Ch. Briese).

2.5.2. Neck-amphora of Tanit IIa

Leiden, Rijksmuseum van Oudheden, G 1952/2.2 (fig. 4).

Dimensions: Height 21.7 cm. Diameter (mouth) 10.5 cm, (belly) 16.0 cm, (base) 7.4 cm.

Condition: intact; surface slightly worn and partly flaked.

Clay: well-fired, light red (2.5 YR 6/8) with red core (2.5 YR 4/8–5/8); inclusions: rounded quartz and limestone particles mff3 (numerous, very fine, <0.2 mm), limestone and black particles mgI (few, large, 1.0–1.5 mm).

Surface: very pale brown (10 YR 8/3), scum; red slip on rim, red (10 R 5/8); black paint, three lines on belly and two on neck. Lower half of body, below handles, burnished horizontally, matt; rim and neck above handles smoothed horizontally, shining. Contents not in situ, washed: cremated remains of 1 new-born.

The neck-amphora belongs to Harden's class II D ("ovoid amphorae with tall neck and vertical handles joining middle of the neck and shoulder"; Harden, 1937: pp. 71, 74–75, fig. 4r). The bases of this type are concave with a central knob; the handles are cylindrical, elliptical or 'sausage-shaped' in section. Amphorae of this class show a characteristic ridge (or 'step') halfway up the neck where the handles are attached. The Leiden piece can be attributed to Harden's first variety of the class (i), which apart from the "thickened, overhanging lip, tall, vertical neck with step or ridge half-way up" is characterised by an "angular junction of neck and shoulder".

With regard to the dimensions of the Leiden piece, something more can be said. The two pieces mentioned by Harden (1937: p. 75) in the heading of class II Di are rather large versions, having heights of 27.9 and 30 cm respectively. The Leiden amphora is with only 20.7 cm relatively small and seems in this respect to find better comparisons in the one-handed jugs of Harden's closely related class II E. In her recent classification of Carthaginian pottery, M. Vegas does not mention this shape, probably because of its apparent absence in settlement contexts. In the light of their close relationship, it is not unlikely that at least part of the fragmentary material, which Vegas listed as belonging to the one-handed shape 24.1 (Vegas, 1999: pp. 159–161, fig. 56), actually belongs to two-handed versions.

In the tophet, the majority of the class belongs to the first part of the Tanit II stratum (IIa; Harden 1937: p. 87), which is conventionally dated between 600 and 400 BC.

2.5.3. One-handed jug of Tanit IIa

Leiden, Rijksmuseum van Oudheden, G 1952/2.6; on base in black ink S 1466; on loose label "Sanctuary of Tanit. Date april 15. Location 316, 15; Serial N°"; on the back of label "27" (fig. 5).

Dimensions: Height 19.6 cm. Diameter (ovoid mouth) 9.4–10.14 cm, (belly) 15.5 cm, (base) 7.7 cm.

Condition: intact; two large chips from wall, where large limestone particles have expanded.

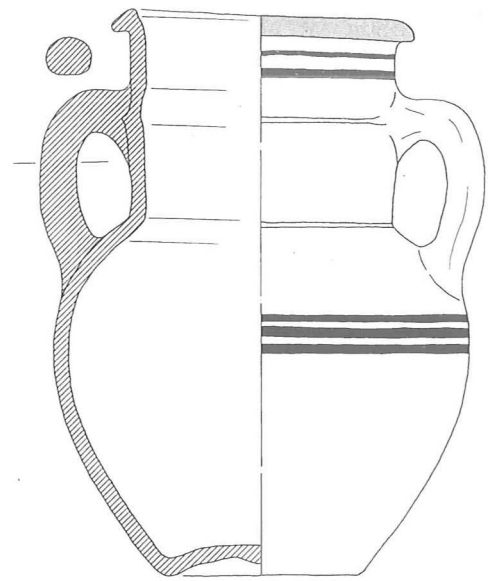


Fig. 4. Neck-amphora Tanit IIa, Leiden RMO G 1952/2.2 (drawing Ch. Briese).

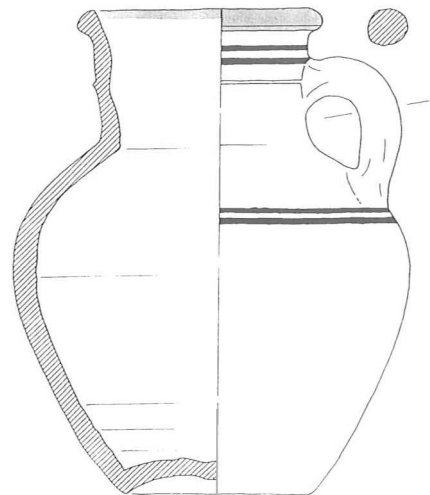


Fig. 5. One-handed jug Tanit IIa, Leiden RMO G 1952/2.6 (drawing Ch. Briese/M.A. Los).

Clay: well-fired, light red (2.5 YR 6/8); inclusions: rounded quartz mff3 (numerous, very fine, <0.2 mm), limestone particles mgI (few, very large >1.5 mm, two even 9 mm).

Surface: white (10 YR 8/2) — very pale brown (10 YR 8/3), scum; decoration: matt reddish gray paint (5 YR 5/2); red slip on rim, red (2.5 YR 5/6), burnished horizontally.

Surface smoothed.

Bibliography: Ch. Briese, in: Gehrig & Niemeyer, 1990: p. 205, cat. 179.

Contents not in situ, washed: cremated remains of 1 new-born and 1 lamb.

The jug belongs to Harden's class II E: "one-handed, ovoid jugs with vertical, stepped necks" (Harden, 1937: pp. 71, 75–76, fig. 4s–u, esp. fig. 4s). These jugs develop from the 'neck-ridge jugs' of the Levant. Their bases are concave with a central knob on the underside; the handles may be either cylindrical or elliptical in section. In the classification of P. Cintas this jug is listed as shape 93 (Cintas, 1950: p. 95, pl. 7,93). In the recent classification of Carthaginian pottery by M. Vegas the shape occurs as number 24,1 (Vegas, 1999: pp. 159–161, esp. fig. 56,7–8). Fragments of the shape occur regularly in settlement contexts from the 7th century BC onwards. Two excellent parallels discussed by M. Vegas were found in a pottery production area and are dated within the 6th and 5th centuries BC (Vegas, 1999: p. 160, fig. 56,7–8).

In the tophet, jugs of this variety are only found in the first part of the Tanit II stratum (IIa; Harden, 1937: p. 87), which is conventionally dated between 600 and 400 BC.

2.5.4. Plain ware amphora of Tanit II

Amsterdam, Allard Pierson Museum, 12.499/1 (fig. 6).
 Dimensions: Height 20.0 cm. Diameter (mouth) 9.4 cm, (belly) 15.7 cm, (base) 7.6 cm.
 Condition: almost complete, part of rim and shoulder missing; 6 small fragments of rim broken and mended.
 Clay: well-fired, reddish yellow (5 YR 6/6); inclusions: rounded quartz mff3 (numerous, very fine, <0.2 mm).
 Surface: plain, reddish yellow (5 YR 6/6) — pink (7.5 YR 7/4), scum; traces of red slip on base, red (10 R 5/6); calcareous incrustations on lower half of body (post-depositional).
 Contents in situ: cremated remains of 3 new-borns and 1 lamb; 1 base sherd of plain ware plate, originally used as lid (?), 1 small wall sherd of local closed vessel, 13 small limestone fragments.

At first sight, the amphora belongs to Harden's class II C: "low-bellied, usually piriform, amphorae with plain lip and angular or convex shoulder; vertical handles on shoulder" (Harden, 1937: pp. 71–73, fig. 4e–h). The class is divided in four subclasses on account of the shape of the base. The Amsterdam piece belongs to subclass a, which is characterised by a "concave base with central knob on under side". It would have belonged to the third variety (iii), which has a "beaded lip, plain, angular shoulders". Remarkably, the knob in the Amsterdam amphora is virtually absent; moreover, there is a tendency towards a flat base. There are more anomalies in the Amsterdam amphora. Although the largest diameter lies at a rather low point, and would thus allow an attribution to class II C, the heavy curve below the shoulder carination rather points in the direction of examples of class II F (see below). Perhaps it represents an intermediate stage in the development of such plain ware amphorae.

Harden (1937: p. 73) remarked that some ex-

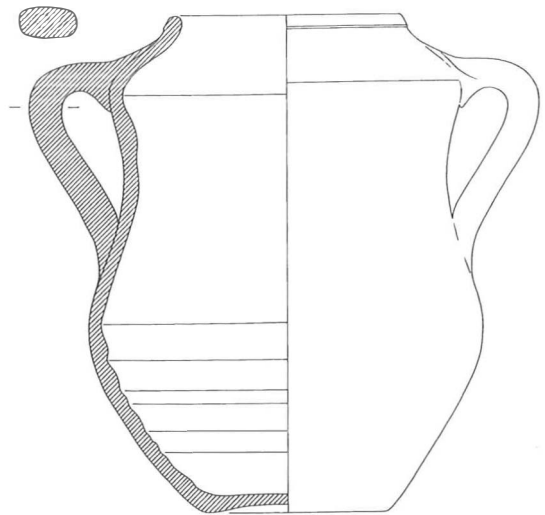


Fig. 6. Amphora Tanit II, Amsterdam APM 12.499/1 (drawing Ch. Briese / M.A. Los).

amples of class II Ca had been decorated with red horizontal bands or purplish-black horizontal lines. Although the Amsterdam amphora is a plain ware version of the class, traces of red slip below the base may be an indication of the fact that it was made and fired at the same time and probably in the same kiln as painted vessels, perhaps even painted versions of the II Ca class.

Amphorae of class II Ca normally belong to the first part of the Tanit II stratum (IIa; Harden, 1937: pp. 72, 87), which is dated between 600 and 400 BC. Since the Amsterdam amphora shows a tendency towards examples of class II F, which predominantly occur in the second part (400–300/250 BC), a date in the first half of the 4th century BC is likewise possible.

2.5.5. Plain ware amphora of Tanit IIb

Amsterdam, Allard Pierson Museum, 12.500 (fig. 7).
 Dimensions: Height 17.0 cm. Diameter (mouth) 8.2 cm, (belly) 13.6 cm, (base) 6.4 cm.
 Condition: almost intact, one handle missing, small hole in wall.
 Clay: well-fired, light red (2.5 YR 6/6); inclusions: rounded quartz mff3 (numerous, very fine, <0.2 mm), limestone particles and vacuoli mff2 (many, very fine, <0.2 mm).
 Surface: plain, light red (2.5 YR 6/6); calcareous incrustations on lower body, diagonal line indicating position of urn after deposition.
 Flat base, string cut; surface smoothed; four shallow incised lines at the height of the lower handle attachment.
 Contents in situ: cremated remains of 2 new-borns and 1 lamb?; 2 small wall sherds of local closed vessels, worn; 4 small limestone fragments; 4 fragments of carbonised wood; sand.

The second plain ware amphora in Amsterdam certainly belongs to Harden's class II C, albeit to sub-

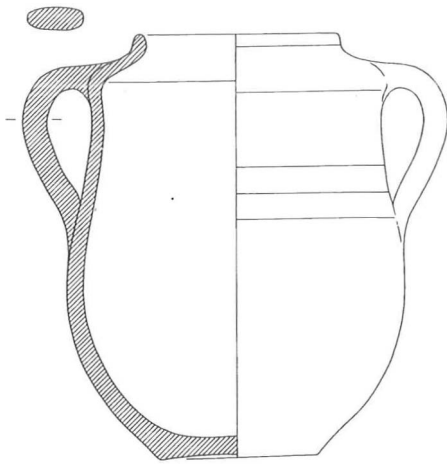


Fig. 7. Amphora Tanit IIb, Amsterdam APM 12.500 (drawing Ch. Briese/M.A. Los).

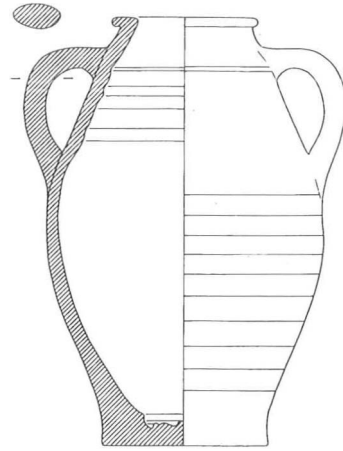


Fig. 8. Amphora Tanit III, Leiden RMO G 1952/2.12a (drawing Ch. Briese/M.A. Los).

class b, which is characterised by a flat base (Harden, 1937: pp. 71, 73–74, fig. 4i–j, esp. fig. 4j). Handles are either flattened elliptical or ‘sausage-shaped’ in section. The clay is usually fired buff or brown, but occasionally pink or red tones occur. All examples of the class are undecorated (plain ware).

Such amphorae are found in levels belonging to the second part of the Tanit II stratum (IIb; Harden, 1937: p. 87), dated between 400 and 300/250 BC.

2.5.6. Plain ware amphora of Tanit III

Leiden, Rijksmuseum van Oudheden, G 1952/2.12a (fig. 8).
Dimensions: Height 17.1 cm. Diameter (mouth) 5.8 cm, (belly) 11.0 cm, (base) 6.7 cm.

Condition: intact; slight surface damage below handle.

Clay: well-fired, white (2.5 Y 8/2); inclusions: rounded quartz mmf2 (many, medium sized 0.2–0.5 mm).

Surface: plain, white (2.5 Y 8/2) scum, in patches darker, light brownish gray (2.5 Y 6/2).

Base string cut; irregular clay lumps on base.

Contents not in situ, washed: cremated remains of 2 new-borns and 1 lamb.

The amphora can be attributed to a Tanit III class: Harden’s class III C “oval amphorae with vertical handles”, variety ii “flat, beaded lip, angular shoulder, oval body, flat base, handles flattened-elliptical in section” (Harden, 1937: pp. 80–82, fig. 6f–h, esp. fig. 6g). “These vases have their greatest diameter at or near the middle and the shape is closely parallel to class F of Tanit II. The type is the predominant one in Tanit III, hundreds of examples having been found” (Harden, 1937: p. 81). The amphora is not very carefully made and finished. Tophet stratum Tanit III is conventionally dated between 300/250 and 146 BC.

3. THE STUDY OF THE CREMATED REMAINS [E.S.]

The contents of six urns from the tophet in Carthage, consisting of cremated remains, were studied.¹¹ The object of the physical anthropological study is to assess who have been buried here. In the light of the archaeological and historical context and the theories on child sacrifice in this period, the research questions are as follows.¹² Do the urns contain human or animal bones or both? What is the age of the individuals? Is there one or are there more than one individual present per urn? What could have been the cause of death?

3.1. Material and methods

Because of the process of cremation, the collection of the burnt bones, and the deposition in an urn, the bones are fragmented and incomplete. The weight, fragmentation and the inventory of the bones present are an indication for the completeness and thus offer the possibilities for the physical anthropological study. The colour of the bones gives an indication for the burning temperature (Wahl, 1982). The cremated bones are described according to the following skeletal parts: the neurocranium (part of the skull where the brains are situated), the viscerocranium (facial part of the skull), the axial skeleton (ribs, vertebrae, pelvis etc.), and the extremities (arms, hands, legs, feet). The weight, fragmentation and colour of the bones have been recorded per skeletal part (see below). Indications for the minimum number of individuals are the presence of more than one specific bone and/or age differences represented by the bone material. The age at death is assessed by

Table 1. Results of the physical anthropological study.

Urn	Weight (g)	No. of individuals	Age at death	Animal bone
APM 12.499/1	47	3	Ind.1 = new-born Ind.2 = new-born Ind.3 = new-born	lamb
APM 12.500	62	2	Ind.4 = new-born Ind.5 = new-born	lamb?
RMO G 1952/2.2	47	1	Ind.6 = new-born	
RMO G 1952/2.6	56	1	Ind.7 = new-born	lamb
RMO G 1952/2.7	123	1	Ind.8 = 6–9 years	lamb + unknown
RMO G 1952/2.12	88	2	Ind.9 = new-born Ind.10 = new-born	lamb

the dentition (Ubelaker, 1984) and the development of the skeleton (Krogman & Isçan, 1986). The contents of the two urns in Amsterdam were excavated layer by layer in order to establish whether there was a specific deposition sequence.

3.2. Results

The six urns contained the remains of ten individuals in total (table 1). In spite of the incompleteness, as can be seen by the low weight of the cremated remains, it has been possible to assess the age of all the individuals. Only children were buried here, eight of which were new-borns and one a child of older age (individual 8). Two urns contained several individuals. Obviously they were cremated together, as their remains were assembled and buried in the same vessel. Whether these children were siblings remains uncertain, but it is difficult to imagine twins or even triplets being cremated. Five of the six urns contained animal bones as well, belonging almost exclusively to new-born lambs. No other burial gifts were present. The contents of the urns APM 12.499/1 and 12.500 were studied layer by layer but revealed no sequence of deposition. The colour of the bones varies from brown, black, blue greyish to white. This means that the burning degree is rather variable, 0–c. 800°C.

3.3. Discussion

All the urns contained cremated remains, which belonged to children. These children, except one, were new-borns. It has not been possible to detect the cause of death. Whether it was a natural one or a child-sacrifice cannot be determined from the bones.

In North-West European cemeteries with cremation graves, which are contemporary or of a later date (Iron Age and Roman times, e.g. Valkenburg, Spijkenisse), the graves of new-borns are missing because they were not cremated but buried and therefore have often not preserved. The prevailing explanation is

that stillborns had not yet achieved a status in society and were, thus, buried instead of cremated; burial being less energy consuming than cremation. A cremation ritual consists of a series of actions: the collection of wood, the building of a funeral pyre, the cremation itself, the collection of the cremated remains and the burial of the remains in a vessel. The children of Carthage had been cremated, which would have been an exception in the case of natural deaths. The presence of the new-born lambs indicates that all these children died at approximately the same time of the year, that is to say during the same season, early in the New Year. If these children had died a natural death, surely this would not have occurred only in the beginning of the new-year, but all year round.

As for the cause of death there is only circumstantial evidence, consisting of the archaeological and historical context and the seasonality that is evident from the animal bones in the graves. Especially the seasonality of the burials is more indicative of child sacrifice than natural death.

3.3.1. *The cremated remains in urn APM 12.499/1* (fig. 6, table 2)

Age at death: The remains represent three individuals because there are three specific bones present (the right Pars Petrosa). It is not possible to separate all the bones according to a specific individual as all three individuals are the same age. According to the teeth and the robustness all three individuals are new-borns.

3.3.2. *The cremated remains in urn APM 12.500* (fig. 7, table 3)

There are two individuals present (skull-base). It is not possible to separate all the bones according to a specific individual as both individuals are the same age. According to the teeth and the robustness both individuals are new-borns.

Table 2. Description of the cremated remains of APM 12.499/1.

Skeletal part	Weight	Fragmentation(cm)	Burningdegree	Parts of bones present
Neurocranium	19	1-4	0-4	os pariëtale, sphenoid, 3× right pars petrosa, L-pars petrosa
Viscerocranium	3	1-3	3-4	mandibula, mixilla, teeth, orbita,
Axial skeleton	6	1-2	3-4	vertebrae, costae, scapula
Extremities	16	1-6	2-3-4	femur, tibia, fibula, ulna, phalanges, metacarpals
Residue	3	<1		
Animal bone	3	1	3-4	lamb

Table 3. Description of the cremated remains of APM 12.500.

Skeletal part	Weight	Fragmentation (cm)	Burningdegree	Parts of bones present
Neurocranium	18	1-4	3-4	sphenoid, L-pars petrosa, L-incuspariëtale, frontale
Viscerocranium	3	1-2	3-4	teeth (11×)
Axial skeleton	22	1-3	3-4	vertebrae, costae, scapula (2×), clavícula
Extremities	9	1-3	3-4	femur, tibia, humerus, radius, ulna, phalanges, metacarpals, metatarsals
Residue	10	<1		
Animal bone	1	1	4	lamb?

3.3.3. *The cremated remains in urn RMO G 1952/2.2* (fig. 4, table 4)

Age at death: According to the dentition, this individual is new-born.

3.3.4. *The cremated remains in urn RMO G 1952/2.6* (fig. 5, table 5)

Age at death: According to the dentition, this individual is new-born.

3.3.5. *The cremated remains in urn RMO G 1952/2.7* (fig. 3, table 6)

Age at death: According to the dentition and the development of the post cranial skeleton, this individual is c. 6-9 years old. This relatively high age is quite exceptional within the tophet of Carthage.

3.3.6. *The cremated remains in urn RMO G 1952/2.12a* (fig. 8, table 7)

Age at death: There are two individuals present (2× left and 2× right pars petrosa). It is not possible to separate all the bones according to a specific individual as both individuals are of the same age. According to the teeth and the robustness both individuals are new-borns.

4. AN ANT IN URN APM 12.499/1 [T.H.]

In the amphora (APM 12.499/1; fig. 6) an insect head was found. By comparison with specimens in the collection of the Zoological Museum Amsterdam and using the key of Bernard (1968), it could be identified as a *Camponotus* species, subgenus *Tanaemyrmex*. Although the natural microsculpture gives the head a charcoal-like impression, it was uncharred and even some of the hairs were still in place.

Tanaemyrmex species mostly make their nests in the ground and live in many of the outdoor environments of Northern Africa. Many ants carry the remains of dead workers (ants) at some distance outside the nest, after having used the body fluids for feeding the inhabitants of the nest. It is, therefore, not unlikely that the remains of the ant were deposited into the urn by the other ants of the nest. Given the uncharred state of the head this probably happened after the deposition of the human and faunal remains into the urn, possibly in the period of excavation, or even during storage of the urn on the excavation premises.

5. CHARCOAL REMAINS FROM THE URNS [I.L.M.S.]

Two urns in the sample contained carbonised wood fragments, which were large enough to be determined, one from Leiden (G 1952/2.7; fig. 3) and one from Amsterdam (APM 12.500; fig. 7). The wood remains once formed part of the funerary pyre. The

Table 4. Description of the cremated remains of RMO G 1952/2.2.

Skeletal part	Weight	Fragmentation (cm)	Burning degree	Parts of bones present
Neurocranium	15	1-3	3-4	sphenoid, L+R pars petrosa, pariëtale, temporale
Viscerocranium	3	1-2	4	orbita, teeth, os zygomaticum
Axial skeleton	11	1-3	3-4	vertebrae, costae, scapula, clavicula, ilium
Extremities	10	1-5	3-4	femur, tibia, humerus, ulna, phalanges, metacarpals
Residue	8	<1		
Animal bone	—			

Table 5. Description of the cremated remains of RMO G 1952/2.6.

Skeletal part	Weight	Fragmentation (cm)	Burning degree	Parts of bones present
Neurocranium	10	1-3	1-4	L+R pars petrosa
Viscerocranium	2	1-2	1-4	teeth, os zygomaticum
Axial skeleton	6	1-2	1-4	vertebrae, costae, scapula, ilium
Extremities	8	1-2	1-4	femur, tibia, fibula, radius, phalanges
Residue	30	<1		
Animal bone	3	2	3-4	lamb

Table 6. Description of the cremated remains of RMO G 1952/2.7.

Skeletal part	Weight	Fragmentation (cm)	Burning degree	Parts of bones present
Neurocranium	97	1-5	1-4	sphenoid, R-pars petrosa, pariëtale, temporale, frontale, occipitale
Viscerocranium	14	1-4	3-4	mandibula, teeth
Axial skeleton	40	1-4	1-4	vertebrae, costae, scapula, ilium, ischium, clavicula
Extremities	72	1-6	2-4	femur, tibia, fibula, humerus, ulna, radius, phalanges, metacarpals, metatarsals
Residue	100	<1	2-4	
Animal bone	5	3	3-4	lamb (sheep/goat)+unknown

Table 7. Description of the cremated remains of RMO G 1952/2.12a.

Skeletal part	Weight	Fragmentation (cm)	Burning degree	Parts of bones present
Neurocranium	19	1-3	3-4	2× L- + 2× R-pars petrosa, temporale, sphenoid
Viscerocranium	5	1-2	3-4	orbita, teeth, mandibula
Axial skeleton	16	1-2	3-4	vertebrae, costae, scapula, ischium
Extremities	14	1-3	3-4	femur, tibia, fibula, humerus, ulna, radius, phalanges, metacarpals, metatarsals
Residue	3-4	<1		
Animal bone	8	2	3-4	lamb

study of these remains was a logical sequel to a more profound study done in the Eighties on the carbonised wood remains from tophet urns of the recent American excavations (Stuijts, 1990). The present results match the earlier ones and seem to confirm the general picture, which is summarised here for the sake of convenience.

In the American tophet samples only a few wood species were used on a regular basis. Especially *Olea*, *Pistacia* (cf. *Pistacia lentiscus*), *Prunus* subspecies and *Quercus* were important. A clear shift in the choice of wood can be observed over the three general periods of tophet use. Until the 6th century BC, *Pistacia* was predominant in the tophet urns, later on, *Olea* superseded it. As people preferred drawing fuel

(building wood) from as near as possible, these two suppliers of fuel must have grown in the vicinity. Species like *Cotinus*, *Cytisus* and *Ligustrum*, which together with *Pistacia* were among the native maquis vegetation, occurred in the first period exclusively. This would mean that, by the 6th century BC, part of the native vegetation had been replaced by olive yards.

Besides *Olea*, in the 4th century BC, *Quercus* was an important fuel supplier. Also *Ulmus* and *Cedrus* charcoal appear in the period. These three kinds of wood, which were not among the native vegetation, make good combustibles. In the 4th century BC, building the nearby harbours, which were to be eminently important to Carthage, was taken up. This took a lot of probably imported wood, the waste of which may have been used as fuel.

There are indications that in the 4th century BC, there was a progression of cultivated plants. Thus, much *Prunus* charcoal with thick medullar rays, tuberously coalesced *Prunus* parts and pruning traces (knobs) were found. All this points to the cultivation of such *Prunus* subspecies as almond, peach, apricot and plum.

5.1. Charcoal remains from urn RMO G 1952/2.7 (fig. 3, table 8)

Ceratonia belongs to the Leguminosae, Caesalpinia-ceae. Lacking sufficient comparisons, determination cannot be executed with absolute certainty. Alternatively, other species within the Caesalpinia-ceae could be suggested. A more likely explanation for the occurrence of *Ceratonia* would be that we are dealing here with a modern intrusion, a suggestion that seems to be strengthened by other anomalies in the contents. The radiocarbon dating of charcoal from this urn produced the rather young result of 510 ± 30 BP (GrN-24806), which can almost certainly be ascribed to the fact that *Ceratonia* fragments were included in the sample. About 20% of the charcoal originates from olive wood. Assuming that this olive charcoal is indeed contemporary with the urn and the cremated bones, i.e. c. 2450 BP, the ^{14}C age of the *Ceratonia* charcoal must have been less than 100 BP.

5.2. Charcoal remains from urn APM 12.500 (fig. 7, table 9)

The *Prunus* is hard to identify, because the material is disintegrating. This is due to the fact that it has been burnt at high temperature, obstructing the possibility of cross-section and tangential observations. Nevertheless, the determination is rather secure, because large experience has been acquired on *Prunus* in other Carthaginian samples (Stuijts, 1990). Radiocarbon dates provided of a sample from the urn fall

Table 8. Wood remains from RMO G 1952/2.7.

Species	Occurrence	Volume	Remarks
<i>Olea</i>	3×	4 ml	grown rank
cf. <i>Ceratonia siliqua</i>	10×	16 ml	

Table 9. Wood remains from APM 12.500.

Species	Occurrence	Volume	Remarks
<i>Olea</i>	1×	1 ml	fresh wood
<i>Quercus</i>	1×	2 ml	
<i>Prunus avium/padus/cerasus</i>	1×	1 ml	contains reddish brown crystals in channels and wood
Residue		1 ml	

within the so-called Hallstatt plateau (see below), but considering the curves, a general date around 400 BC would not be impossible. Also the composition of the wood used as combustible is typical for the period (see above, on the American tophet sample).

6. RADIOCARBON DATES OF THE CREMATED BONE AND WOOD REMAINS [J.v.d.P.]

6.1. The radiocarbon method

Three isotopes (i.e. species of the same chemical element but with different mass) of carbon occur in nature: The stable isotopes ^{12}C and ^{13}C , and the radioactive isotope ^{14}C (or radiocarbon). The abundance for these isotopes is 98.9%, 1.1% and $10^{-10}\%$ respectively. Radiocarbon is produced in the upper atmosphere by means of cosmic radiation: energetic particles from the cosmos producing neutrons which can produce a nuclear reaction with nitrogen, the main constituent of the atmosphere: $^{14}\text{N} + n \Rightarrow ^{14}\text{C} + p$. These radiocarbon atoms enter the global carbon cycle in the form of atmospheric $^{14}\text{CO}_2$, which in turn enters the biosphere through assimilation and the world oceans through exchange processes. The radioactive carbon isotope ^{14}C decays with a half-life of 5730 years. A stationary state of production, distribution and decay results in a more or less constant ^{14}C concentration (about $10^{-10}\%$) in atmospheric CO_2 . For living organisms, the carbon exchange with the environment ceases after death, whereupon only the decay of ^{14}C occurs. Thus the age (more precisely: the moment of death) can be determined by measuring the ^{14}C left in the sample, as is illustrated in figure 9.

The radioactive decay of ^{14}C follows an exponential law: $A(t) = A(=0)\exp(-\lambda t)$. Here $A(t)$ and $A(t=0)$

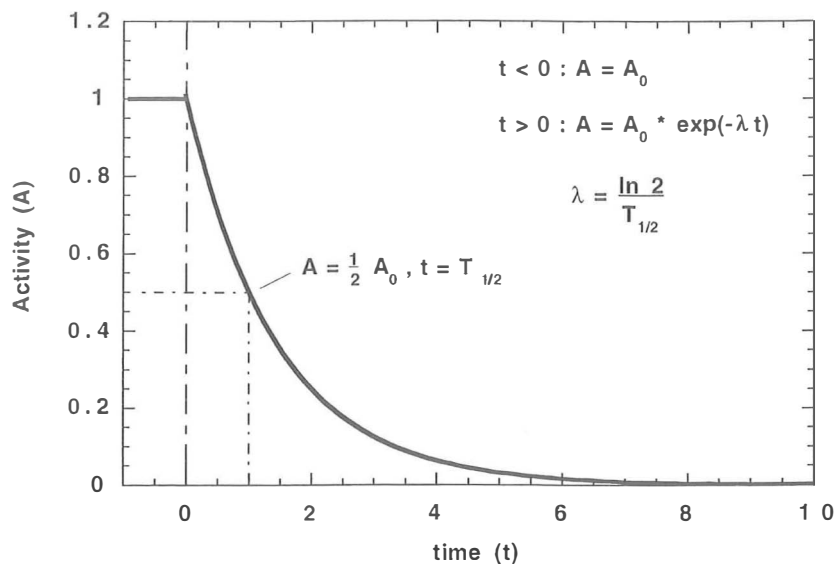


Fig. 9. Relative ^{14}C concentration in an organic sample as a function of time; before death of the organism this is constant, after death the ^{14}C concentration decreases due to radioactive decay.

are the measured and original (at time $t = 0$) radioactivity, t is the time elapsed since $t = 0$, and the so-called decay constant λ is related to the half-life $t_{1/2}$: $\lambda = \ln 2 / t_{1/2}$.

The amount of radiocarbon can be measured by two different methods: the ^{14}C radioactivity is measured by means of proportional gas counters (the so-called conventional method); the ^{14}C concentration is measured by Accelerator Mass Spectrometry (the AMS method). For both methods, the amount of radiocarbon in samples $A(t)$ is measured relative to a standard, which is chosen to be the ^{14}C radioactivity in the year AD 1950 [$A(t=0)$], which is still called 'Present'. The radiocarbon ages (t) are reported in BP, which means Before Present (Mook & Streurman, 1983).

Unfortunately, the amount of measured ^{14}C years in BP cannot simply be subtracted from 1950 in order to obtain historical ages, because of the following complications:

- The half-life of ^{14}C is not accurately known. In the early years of radiocarbon dating, a half-life of 5568 years was used (Libby, 1965). Later, the half-life was determined as 5730 ± 40 years (Godwin, 1962);
- The atmospheric ^{14}C activity is not a constant, and depends on factors such as the exchange between the major carbon reservoirs (oceans, biosphere and atmosphere), and the geomagnetic field strength and solar activity which both modulate the production of ^{14}C . These factors vary considerably through time;
- The ^{14}C concentration in a sample can be changed because of 'isotopic fractionation', which is

caused by mass dependent processes in chemical and phase transitions. For instance, during photosynthesis, $^{12}\text{CO}_2$ is taken up preferentially to $^{13}\text{CO}_2$ and $^{14}\text{CO}_2$ because of the mass differences between these molecules. This means that plants have a slightly different ^{14}C concentration than the atmosphere they grow in. Obviously, this influences a proper age determination. Fortunately the same is true for the isotope ^{13}C , which is stable so that the ^{13}C concentration, once fixed, does not change in time. This offers the possibility of making a fractionation correction. If $^{13}\text{C}/^{12}\text{C}$ is corrected into a certain agreed value, the ^{14}C activity can be corrected proportionally. The isotopic abundance of ^{13}C is quoted in terms of $^{13}\delta$, defined as the $^{13}\text{C}/^{12}\text{C}$ ratio relative to that of standard material;

- Because of these complications, the radiocarbon time scale is non-linear and is related to the historical time scale in a complicated way. The radiocarbon time scale is in fact defined by internationally agreed convention as follows (Mook & Waterbolk, 1985):
 - 1) Radiocarbon ages are reported in BP;
 - 2) They are calculated using the Libby half-life of 5568 years;
 - 3) They are calculated relative to 95% activity of the standard value (oxalic acid) which corresponds to AD 1950;
 - 4) They include a fraction correction to $^{13}\delta = -25\%$.

The original 'wrong' half-life is chosen in order to prevent dates based on different half-lives being pub-

lished. Thus, modern measurements and those published in the 1950s have the same meaning, which eases intercalibration, and ^{14}C measurements will have the same meaning regardless of laboratory and technique. Furthermore, the decay of ^{14}C since 1950 (0.1% per 8 years) for both standards and samples are automatically taken into account. The fractionation correction to $^{13}\delta = -25\text{‰}$ is chosen because this is the average value for samples such as wood, peat and charcoal. The age correction is 16 years for every 1‰ deviation from -25‰ .¹³

The ^{14}C clock is ticking differently from 'normal' physical clocks. The ^{14}C time scale is defined in BP by convention, as described above. Choices such as the wrong half-life value are not as important as it seems because of calibration, i.e. establish a relationship between the BP time scale and the historical time scale.

6.2. Calibration

In the early days of radiocarbon dating it was discovered that the ^{14}C content of the atmosphere has not been constant in time, and that the assumption of a constant ^{14}C content had led to serious dating errors (De Vries, 1958). This effect was discovered by measuring the ^{14}C activity of tree rings, which had been dated to the year by dendrochronology. It was soon recognized that dendrochronology is an excellent tool to calibrate the ^{14}C time scale for the time interval covered by absolutely dated tree-ring chronologies (i.e. the last 10,000 years). By plotting the ^{14}C ages of tree rings in BP versus their dendro-years (i.e. absolute calendar dates), calibration curves can be reconstructed (Suess, 1967).

Today several chronologies have been dated by both dendrochronology and the radiocarbon method, the most important ones representing German oak and pine (Spurk et al., 1998), Irish oak (Pearson & Qua, 1993) and Bristlecone pine (Ferguson & Graybill, 1983). All data are published in special calibration volumes of the journal *Radiocarbon*, the most recent one called INTCAL98 (Stuiver & Van der Plicht, 1998). Based on these data, a calibration curve has been composed that extends back to 9908 BC or $10,162 \pm 23$ BP (fig. 10; Kromer & Spurk, 1998). We discuss here only the tree-ring part of INTCAL98 (Stuiver et al., 1998).

The deviations from the Libby line show that the atmospheric ^{14}C concentration is not a natural constant (fig. 10). Fluctuations occur on various time scales. We distinguish three types of natural variations:

- The long-term general trend (millennia time scale); this trend can be explained by a change in the magnetic field strength of the earth, which follows the same long-term trend (Damon et al., 1989);
- Medium-term variations or so-called wiggles (on a time scale of a few hundred years; Suess, 1970); these are caused by solar fluctuations (De Jong & Mook, 1982);
- 11-year cycles: these reflect short-term variations in atmospheric ^{14}C production due to sunspot cycles (Tans et al., 1979).

These variations can be explained in terms of changing ^{14}C production. Changes of the earth's magnetic field and solar fluctuations both influence the flux of cosmic ray protons captured by the earth, which in turn directly influences the production of

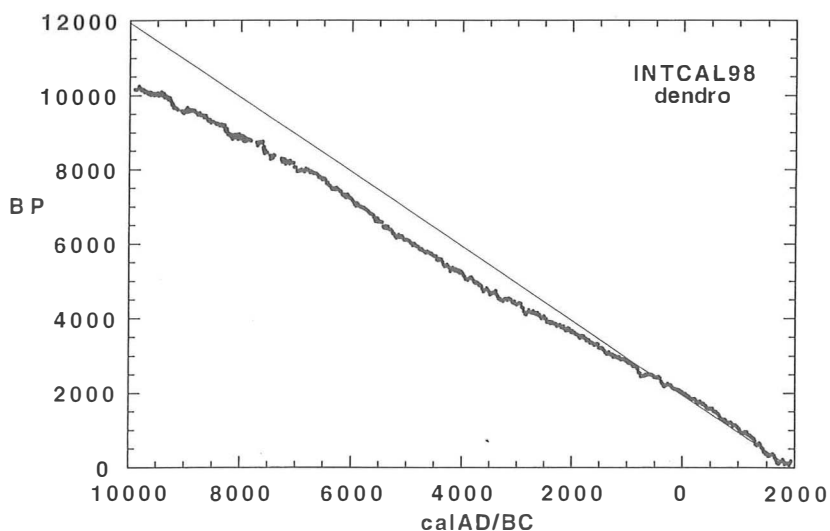


Fig. 10. Calibration data points: ^{14}C (BP, vertical) versus dendrochronology (cal BC/AD, horizontal). The solid line represents $\text{BP} = 1950 - \text{AD}$.

^{14}C , the atmospheric $^{14}\text{CO}_2$ concentration and the tree-ring radiocarbon record. The tree-ring ^{14}C record can even be used to extract short-term periodicities in solar activity, using time-series analysis.

The atmospheric $^{14}\text{CO}_2$ concentration depends not only on atmospheric ^{14}C production changes, but also on the existing equilibrium between the global carbon reservoirs (atmosphere, biosphere and ocean). Changes in this equilibrium almost certainly influence the shape of the calibration curve in the interval before the Holocene boundary. Unfortunately, this interval is too early to be covered by dendrochronologically dated tree-ring chronologies. Calibration curves based on uranium-series dates (Bard et al., 1998) and varve chronologies (Kitagawa & Van der Plicht, 1998) extend into the Upper Palaeolithic; there are inconsistencies between these records, which will not be discussed here (Van der Plicht, 1999).

Obviously to obtain historical dates, one does not simply subtract 1950 from the ^{14}C dates; this would correspond to using the straight line in figure 10 as calibration curve, thus neglecting the natural variations as apparent from the tree-ring record. Instead one has to use a calibration curve drawn through the tree-ring calibration data points. The wiggly shape of the series of calibration data complicates calibrating ^{14}C dates into historical ages. Wiggles can, for instance, cause a ^{14}C date to correspond to more than one calendar date. Furthermore, horizontal parts of the calibration curve limit the use of ^{14}C with respect to obtaining historical dates: an accurate ^{14}C date (BP) corresponds to a long range in calibrated dates (BC or AD; Van der Plicht & Mook, 1987). Unfortunately this is the case for the time range 800–400 BC, the era of large interest to the discipline of classical archaeology (Olde Dubbelink & Van der Plicht, 1989). This horizontal stretch in the calibration curve is known as the 'Hallstatt plateau' (Becker & Kromer, 1993). Geophysically, it is caused by a large increase in atmospheric ^{14}C production at c. 800 BC and which probably caused a climatic change, as observed in contemporaneous events in prehistory and palaeo-ecology (Van Geel et al., 1998).

Two aspects of the ^{14}C method are of interest for the samples from Carthage, described in this paper. First, the calibration of the ^{14}C dates into historical ages around the 'Hallstatt plateau'; and second the new possibility to date cremation remnants.

The ^{14}C radioactivity (conventional method) or concentration (AMS method) is measured on selected organic components from the material to be dated. For prehistoric bones, the datable fraction is collagen, which can be isolated using appropriate chemical treatment (Mook & Streurmann, 1983; Mook & Waterbolk, 1985). For burned bones (temperatures ~ 250°C), the ^{14}C method is problematic because of the collagen quality, if present at all; or the material is treated as other organic material (like peat, char-

coal etc.) but the presence of contaminating carbon (more recent than the age of the bone itself) can not always be excluded. Cremated bones (temperature ~600°C) were not datable by ^{14}C until recently. A new development is the dating of cremated bones by using their bio-apatite fraction (Lanting et al., 2001). This contains about 1% carbonate (originating from the food), and it appears that cremated bones contain enough of this carbonate despite obvious losses on the pyre. For AMS only 2 grams of material is needed. This development opens a new extension for applying ^{14}C in prehistory. In the course of 1999, a large test series (>100 samples) of cremated bones with known (or supposedly known) age has been dated with a success rate close to 100%. This test series includes bones ranging from recent to around 10,000 years ago.

Five samples of cremated bones from Carthage were dated by ^{14}C as part of this test program. The results are listed in table 10. Charcoal sample APM 12.500 has been dated by the conventional laboratory method as a reliability check of the cremation dating. Charcoal sample G 1952/2.7 has been dated conventionally to test the possibility of contamination of the contents of the urn with 'modern' charcoal.

The results of ^{14}C dating of the cremated bones from Carthage are a clear success: all results are well within the ranges of predicted dates. But as expected, calibration enlarges uncertainties in some cases. For two samples (GrA-13588 and 13590 from APM 12.499/1 and G 1952/2.2 respectively), the calibrated results are illustrated in figures 11A and 11B, respectively.

The date for GrA-13588 (2320±50 BP) can be calibrated very well: the date is younger than the 'Hallstatt plateau', and calibration at the steep slope in the calibration curve at 400 BC yields a narrow and precise probability distribution. Unfortunately there is a small plateau between c. 300 and 200 BC as well — therefore this region cannot be excluded in the final result. The probability ranges of the calibration can be analysed mathematically and yield the BC regions as indicated in table 10.

The date for GrA-13590 (2430±50 BP) falls exactly on the Hallstatt plateau (see fig. 11B). The calibrated results (see table 10 for the exact figures) span four centuries. This is an example of the limited use of the ^{14}C method in this time range (c. 2400 BP).

7. ACKNOWLEDGEMENTS

We have benefited from the expert advice of B. Garnand (Chicago) and J.A. Greene (Harvard) on questions relating to the Carthaginian tophet, esp. with regard to the American excavations of F. Kelsey in

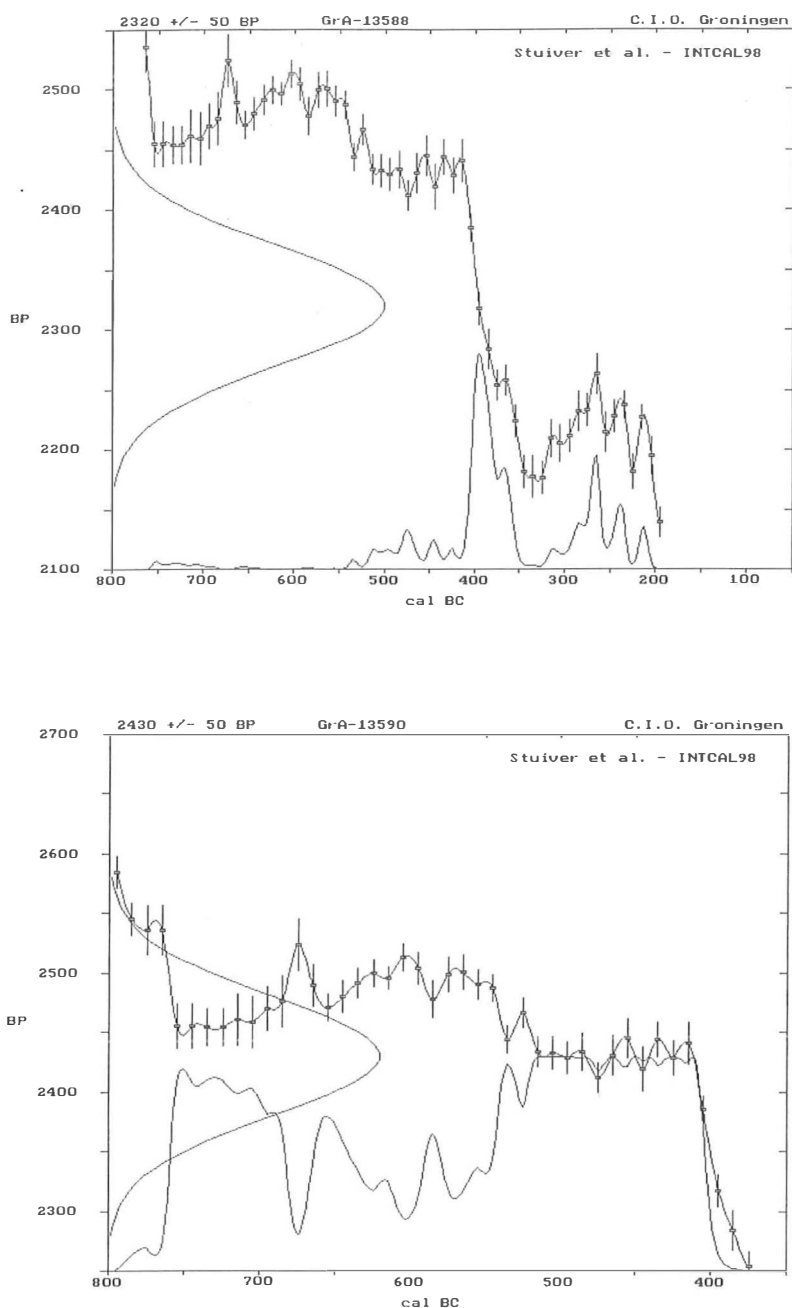


Fig. 11. Relevant part of the decadal radiocarbon calibration curve, including individual ^{14}C measurements for dendrochronologically dated wood. On the Y-axis, the Gaussian probability distribution for the radiocarbon measurements is plotted; on the X-axis, the probability distribution (non-Gaussian) for the calibrated result is plotted. (A) Calibration for 2320 ± 50 BP (GrA-13588); (B) Calibration for 2430 ± 50 BP (GrA-13590).

the 1920's and of L.E. Stager in the 1970's. We thank the staff of the APM (Amsterdam) and the RMO (Leiden) for their generous assistance; in particular thanks are due to Mr. R. van Beek, Mrs. G. Jurriaans-Helle (APM) and Dr. R.B. Halbertsma (RMO). In Groningen Mr. J. Schoneveld of the ARC Archaeo-

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Table 10. Results of the radiocarbon tests (except GrN-24806).

Laboratory number	Sample	¹⁴ C age (BP)	Calibrated age range (BC)	Expected typological date (BC)
GrA-13588	APM 12.499/1 cremation	2320±50	409–355, 287–257 245–233, 215–213	600–300/250
GrA-13589	APM 12.500 cremation	2330±50	497–495, 483–465 449–441, 411–357 287–279, 277–259 245–233	400–300/250
GrA-13590	RMO G 1952/2.2 cremation	2430±50	757–697, 541–407	600–400
GrA-13591	RMO G 1952/2.7 cremation	2460±50	759–683, 665–635 591–579, 555–553 547–483, 465–449 441–411	750–600
GrA-13593	RMO G 1952/2.12a cremation	2220±50	377–371, 363–345 323–269, 263–227 223–203	300/250–146
GrN-24805	APM 12.500 charcoal	2380±70	757–693, 541–387	400–300/250

8. NOTES

- Initially the publication was foreseen in the *OMRO* journal of the Rijksmuseum van Oudheden in Leiden, but unfortunately the journal has stopped appearing.
- See e.g. Stager & Wolff, 1984; Moscati, 1987; Moscati & Ribichini, 1991.
- Mr. Bisseling was curator of the Museum of Education (Museum voor het Onderwijs) in the Hague, the predecessor of the 'Museum'.
- See Derksen, 1990, for a concise introduction to the collection and its donation to the Allard Pierson Museum.
- On these excavations: Kelsey, 1926; Khun de Prorok, 1926a, b; Harden, 1927; Harden, 1937. See also Lancel, 1995: pp. 230–234 (Icard and Gielly), pp. 234–236 (Kelsey).
- Harden, 1927, 1937. According to B. Garnand a manuscript report on bone remains from Kelsey's 1925 excavations had been deposited in the Ashmolean Museum in Oxford sometime in the 1940s.
- In the *Journal with Inventory of Objects Found* 72 urns were registered on Wednesday April 15, numbered from S 1438 till S 1512. In between, three numbers are missing (S 1449, S 1450 and S 1466, which is now in Leiden). Elsewhere, the *Journal* mentions 74 urns found on Wednesday. Consequently, the total number of urns of that day may have been between 73 and 75.
- If one would have re-numbered urn 1 of Wednesday April 15 as S 1438, number 27 would have been S 1464. Given the fact that they skipped two numbers (S 1449 and S 1450, see previous note), one would arrive exactly at S 1466.
- A number of these urns are now in Oxford (Ashmolean Museum) and six in London (British Museum), see Harden, 1937: p. 66, note 2; also Docter, 1997: table 45, 17, 49.B, 1–2, 50.A, 7. Harden (1937: p. 66, note 2 Pl. XI, 20) indicates that already at that time one of the urns had wandered into a private collection.
- The different chronological schemes and absolute datings used by the successive excavators of the tophet are summarised by S. Brown (1991: p. 79).
- C.H. Maliepaard (AAC, Amsterdam) kindly studied the animal bones of the samples.
- Similar questions have been raised and studied from the first excavations in the tophet onwards, cf. Pallary, 1922; Benichou-Safar, 1981; and on the tophet of Tharros, Sardinia: Fedele & Foster, 1988. As B. Garnand kindly informs, the bone material from the later American excavations in the tophet are presently studied by a physical anthropologist, employing also DNA-research: Stager & Greene, in preparation.
- For a full technical account on reporting of ¹⁴C we refer to Mook & Van der Plicht, 1999.

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