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Article

Grinding and crushing techniques in Africa Proconsularis

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Abstract

This article addresses the lack of literature on grinding and crushing techniques and its equipment in Africa Proconsularis. A new typology is presented, along with their geographical distribution. The types of stones used are also discussed, in relation to provenance, suitability and technological innovations. The conclusion questions what we know and what future research needs to address.

يغطي هذا المقال النقص الحاصل في الأبحاث العلمية والمعرفية حول تقنيات الطحن والسحق ومعداتها في أفريقيـــــا البروقنصلية. كما يتضمن تصنيفات جديدة لهذه المعدات وتوزيعها الجغرافي وكذلك أنواع الصخور المستخدمة و ملائمتها التقنية مع طبيعة العمل المخصص لها (رحي القمح أو الزيتون). إذا هذا العمل يقدم نظرة جديدة للتقنيات القديمة المستعملة و يطرح مناهج جديدة للبحث المستقبلي.

Introduction

Usually, the history of techniques in Africa Proconsularis is a 'parente pauvre',[1] despite many studies having dealt with the ancient African economy's two main sectors: cereals and olive. For wheat, research has focused on the value of African production and its role in supplying the *Urbs* as part of the Annona, with all the administrative system that goes with it. For olive oil, the situation is different since there has been considerable research that has dealt with the pressing techniques, equipment and impact this product has had on the Roman economy. However, within a number of these studies on olive pressing, particularly those that focus on the production process, references to the equipment used to crush the fruit, are often mired by inconsistency and errors in the use of specific nomenclature.[2]

In Africa proconsularis,[3] artefacts of grinding and crushing seem to be very important and attractive. More than 1,300 pieces have been identified,[4] divided into nine classes whose typology and distribution vary greatly over time and space.

Typo-chronological report

In order to attempt a typo-chronological classification of the different tools used for grinding and crushing cereals and olives that exist in Africa Proconsularis, we are initially faced with great morphological and technical diversity. From linear motion objects to hydraulic machines, grinding and crushing equipment have a long history of use in the ancient, and more recent, world. The evidence from Africa Proconsularis shows that a large variety of existing types of grinding and crushing equipment was in use, unlike other regions in the Roman world, which have a more conservative and distinctly regional range. However, regional variations also exist for the forms in use in Roman N. Africa, which include regional adaptations concerning the material, form and technique of use, resulting in a sort of 'Africanity' of these tools. The purpose of this article is to present the first chronological and geographical appearance of certain types of querns and millstones, and to investigate the technical transition between unidirectional and rotary movement. However, in order to do that, the different types of these techniques attested in Africa Proconsularis are listed and described below (Figure 1).

1. Unidirectional quern: we have counted 65 saddle querns (between pounder rubber, tall mortar, shallow mortar and saddlestone-metate variety) and 30 artefacts of Olynthus querns.
2. Hand rotary querns: 78 *metae* (lower stone) and 121 *catilli* (upper stone). The diameter of African rotary querns is between 27–42/46 cm and it's about 5–17 cm in width. The grinding surface rarely surpasses 17°.
3. Rotary millstones (animal or man-driven mills): it was the most findable type with 400 artefacts (269 *metae* and 131 *catilli*). This type measures between 27–60 cm in diameter and 23–113 cm in height.
4. Hydraulic rotary millstones.
5. Mortars: We have counted 140 artefacts between small objects for daily use and the big mortar. This big instrument was intended mainly for grain crushing, especially wheat and barley.
6. Kneading machines: 9 machines used in bakeries.
7. Roller for olive crusher: we have identified 136 instruments. The height varies between 57 and 160 cm.
8. Olive press with hemispherical mills: It's called also *trapetum*. This machine is composed of two elements, *mortarium* (42 artefacts) and *orbis* (60 artefacts).
9. Olive press with cylindrical mills : we have counted 175 presses and 122 mills.

The earliest and simplest method of milling grain involved the use of simple querns composed of two parts: a lower stone in the form of a slab, and a mobile upper one called handstone or rubber. A number of quern types have been identified, the most important of which is almond-shaped,[5] found mainly in Carthage and Kerkouane. This type is also attested in Monte Sirai (Sardinia), Algeria and Morocco.[6] Moreover, the examples of those found

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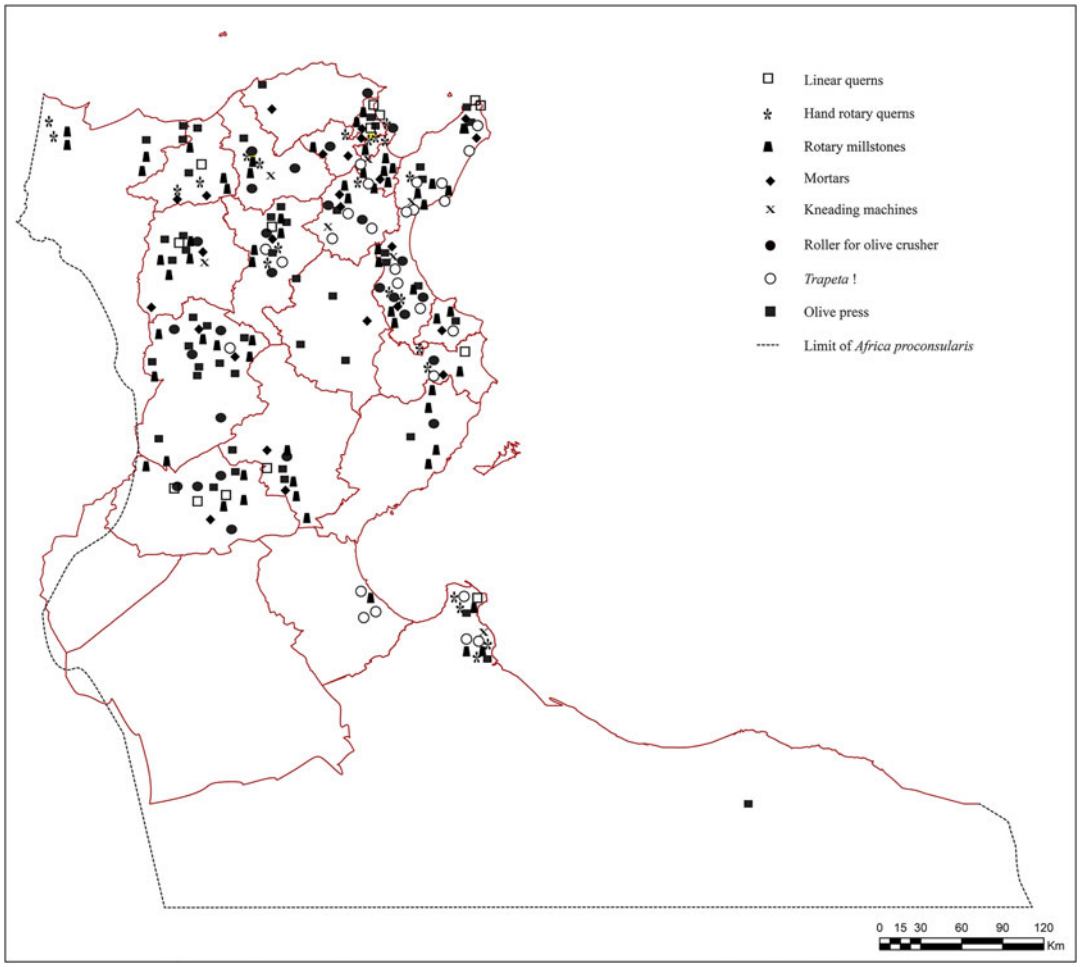


Figure 1. Map of typo-geographical distribution of grinding and crushing techniques in *Africa proconsularis*.

in Carthage, seem to be carved in the ignimbrite rhyolite from Sardinia. This is based on macroscopic identification and comparison with other objects of the same lithological nature. The excavations of a Punic tomb, located on the eastern flank of the Odeon in Carthage, brought to light a small ivory figurine, which represents 'une femme accroupie en train de broyer le grain ou de pétrir le pain',[7] making use of a similar type of hand quern.

This type of saddle quern, which is known in a variety of shapes, is also attested in the interior of the territory. Twelve pieces were discovered at the site of Althiburos, some of which were made of volcanic rock, with dates spanning from the 8th century BC to the Augustan period.[8] The shift from linear to rotary quern types was slow and gradual, initially adopting a semi-rotary motion, known as Olynthus mill.[9]

It seems that the spread of this lever-operated type was not universal, as its distribution appears limited to the coastal areas of Africa Proconsularis. In Kerkouane, M.-H. Fantar inventoried 29 querns of varying types. These included 03 saddle querns, 25 'Olynthus mills', and 01 manual rotary mill. Several of these objects were not 'en rapport direct avec un contexte archéologique précis',[10] since they were collected mostly as surface finds.[11] We note that until the middle of the third century BC, when the site was abandoned according to J.-P. Morel,[12] the hopper mill remained the most widely used tool for grinding despite the remarkable persistence of saddle querns. From the examples illustrated, we can deduce that the diffusion of this milling technique did not spread into the far west of the Mediterranean basin, nor beyond the Tunisian coasts, in to the interior of Africa.[13] Ultimately, we can identify the limit of the distribution area of the so-called Olynthus mills, which seems to pass through the Hérault valley to the north and the Tunisian coasts to the south, consequently intersecting the area of Greek influence in the western Mediterranean basin.

Rotary querns are much rarer. This may be a result of the slow diffusion of this type in the Mediterranean from Iberia, as L. Jaccottey had shown for southern Gaul,[14] or that the region was more open to Hellenistic influence than further west. The technical transition to the rotary type itself poses a problem, whether chronological or material. First, we do not have a sufficient collection on which to establish reliable interpretations. It should be remembered that the oldest manual rotating querns were discovered in Nord-east of Spain, in the excavations of the Iberian site of Alorda Park (16 *catilli* and 6 *metae*).[15] The oldest example is a *catillus* which comes from a context of the mid-5th century BC, dated on the basis of Attic pottery.[16] The oldest *meta* is found in a context that dates from the second half of the 5th century BC.[17]

In 2001, Morel published an article in which he claimed that during a development-related excavation on the Byrsa Hill, a Punic tomb had been unearthed.[18] One of the finds included a piece of volcanic stone that was lodged between the sealing slab and the doorframe of the tomb's opening. The excavator noted that it was 'donc en place depuis que la tombe avait reçu son unique défunt et que le puits avait été colmaté'.[19] The funerary furniture of this tomb suggests a date from the last quarter of the 6th century BC or later.[20] Morel interpreted this worked stone as a fragment of a hand rotary *meta* 'récupérée pour bloquer

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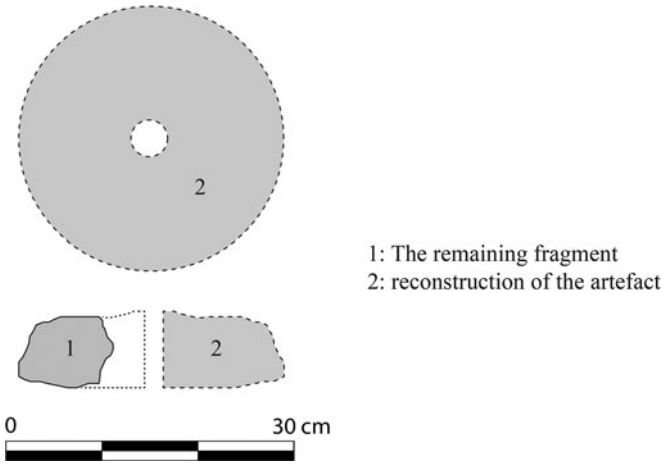


Figure 2. Possible reconstruction drawing of the so-called Carthage quern.[68]

la porte de la tombe'.[21] According to his assertion, this object is part of a lower quern measuring c. 30 cm by 8–9 cm[22]. This interpretation of the volcanic *meta* fragment has, however, been questioned by several researchers, either because the fragment of the so-called quern is very small, making it difficult to identify[23]; or the photo published in the article is insufficient to observe further details.[24] Attempts to relocate and re-examine the artefact have also been unsuccessful.[25] In spite of this, according to D. Peacock[26] and J.-P. Brun[27] 'Jean-Paul Morel est un connaisseur dans ce domaine', prompting us to accept Morel's original interpretation until new evidence comes to light. But in the absence of literary or archaeological evidence, it still remains hypothetical, because one can think that this artefact was the subject of an importation especially since this type did not know a great spread on the Carthaginian territory (Figure 2).

Either way, it is believed that the transition from the unidirectional (i.e. saddle querns or Olyntus mill) to rotary querns took time. This is supported by the evidence from Kerkouane and Carthage, where rotary querns have been identified, alongside hopper millstones, sometimes in considerable numbers. In fact, the first appearance of rotary grinders in Greece dates to the 1st century AD, whilst also continuing to use the Olynthus mill until that time.[28] Likewise, in Althiburos saddle querns continued to be used for milling grain until the end of the 1st century BC.

It seems that, until the Augustan period, Africa Proconsularis imported rotary querns from Sardinia and Pantelleria, as indicated by the only two dated pieces and the concentration of volcanic material from Carthage.[29] On the other hand, the diffusion of this type within the Carthaginian territory remained weak for several reasons. To this, it is added that the art of carving rotary materials was probably not known to Africans. Inside this territory, they used models of Neolithic origin. It was not until the Roman period that local artisans learned to cut grinding stones that imitated imported models, particularly Pompeian-style mill; the new technique widely used in Italy. It is possible that this Italian influence can explain the wide distribution of this last type in comparison with the rotary querns. We can trace the coexistence and spread of the artefacts by the presence of four types of mills in Punic levels at Byrsa, all within the same stratigraphic context dating from the 2nd century BC. These mills included the lower stone of a saddle quern;[30] a fragment of a hopper rubber;[31] a rotary quern;[32] and three millstones of the Morgantina type.[33] The presence of several typologically different millstones in the same context suggests that morphological difference does not necessarily translate into chronological changes, and that the appearance and diffusion of a certain type does not cause the abandonment of the type which precedes it. A similar case can be observed in Sicily, where three types of grinding stones coexist. These include hopper mills, biconical millstones and the cylindrical type.[34]

In the Roman period, there is scant dating evidence for Pompeian mills. The only two examples with sufficient dating evidence date back to late antiquity. These include a 4th century *meta* from the Oued R'mel;[35] and a 5th century *catillus* found in *Musti*.[36] However, according to our study,[37] the large number of this type prompts reflection on the location, and probably the replacement of manual rotary querns.[38] Our corpus[39] also includes two small *metae*[40] whose dimensions are similar to the manual type, with a diameter of 44 cm and a height of 28 cm. Due to the small size of this mill, we can only speculate on how this form functioned, and how much flour it might have been produced. However, Pompeian-mills domination did not last very long, as seen by the shift in late antiquity and especially medieval period, to a return of manual tools with hemispherical and flat types.

The introduction of hydraulic-powered mills parallels the increase in cereal production, and especially the increased demand for processed product (bread flour). The two known examples of hydraulic-powered mills from Chemtou and Testour, date to the 4th century.[41] However, it is quite evident that the natural geography of this African territory did not favour the uptake of this type in this region since it requires a flow of water that is lacking in N. Africa. In addition, this type of technique requires a certain investment in knowledge and equipment[42] that inhabitants in the countryside where unlikely to possess. But in reality, as has been shown,[43] the construction of these watermills in arid regions is technically possible, as long as one can exploit the minimal natural and topographical conditions to build rustic models, without sophisticated gears.

For olive crushing machines, the spatial distribution is more clearly marked by the two geographical areas where historical and human factors have played an essential role in the introduction and the spreading of this technique. On the one hand, tools of oriental origin, trapeta and rollers, were especially represented in the part most affected by Greek influence (coastal part); whilst on the other hand, newer techniques, probably of Roman origin, are associated with agricultural settlements dating to the High Empire. Whether in Carthage, Cap Bon, the Sahel, Dougga or in the Numidian towns, all the olive-mills found and listed belong to the types that have a central hole, already attested in the East,[44] except for a few artefacts where we note the presence of olive-mills with a *columella*. This last type, and as we had deduced, is very widespread in western Byzacene, and in particular the High Steppes. This result of the typo-chronological distribution of the olive-mills is in fact only a reading of numbers and data that were available. But the potential discovery, for example, of trapeta or orbes within the territory may require a revision of these ideas.

Geographical distribution

Our study area does not constitute a homogeneous geographic and climatic unit: mountains, forests, wetlands, sometimes subhumid (the extreme north-west of Tunisia), but also semi-arid steppes and areas close to the desert. Did these geographic and climatic factors constitute a natural barrier that influenced the choice of adopting some milling techniques over others?

In general, there is an imbalance in the spatial distribution of grinding tools between coastal regions and urban sites on the one hand, and the interior of the country and rural sites on the other. The density of millstones decreases eastwards from the Tunisian coastline and southwards for the Algerian territory of Africa Proconsularis. The regression does not only concern the number

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N°	Site	Ignimbrite ryholite	Grey lava	Black lava
-1-	Carthage	02	01	03
-2-	Ksar Said	01	--	--
-3-	Kerkouane	--	28	--
-4-	Zama	--	01	--
-5-	Mahdia	--	--	02
-6-	Althiburos **			
-7-	Djerba			01

Figure 3. Distribution of volcanic linear artefacts.

of artefacts, but also the shape and technique of the mills. *Metae* and *catilli* with 'des formes canoniques' are found in the sites of Utica, Carthage, Oudhna, and El Jem, many of which are made of volcanic rock[45] (Figures 3–5). On the other hand, in the countryside, millstone types appear more uniform, and without noticeable variation. The essential function of these tools is thus to grind the grains, for domestic use or for artisanal production. Likewise, the hopper mills of Greek origin did not exceed the Punic sites (Carthage and Kerkouane) in their spread. In contrast, the west side of Africa Proconsularis, and almost all western parts of Roman Africa lack this type of mill. Another type deserves special mention: the *catillus* of type 364.[46] Attested in the excavations of Delos of 1937–1938,[47] as well as in the mines of Laurion,[48] this *catillus* (Figure 6) with its small lateral notches carved in volcanic rock is only found in Carthage and at Thysdrus.

This distribution marks the presence and the limits of Greek influence in the western Mediterranean, which can also be found in the geographic distribution of *trapeta*. Despite the

N°	site	Ignimbrite rhyolite	Grey lava	Black lava
-1-	Utique	01	02	--
-2-	Carthage	30	04	--
-3-	Ksar Said	06	01	--
-4-	Annaba	03	01	--
-5-	Oudhna	09	--	--
-6-	Dougga	24	--	06
-7-	Nabeul	01	--	--
-8-	Hammamet	01	01	--
-9-	Pupput	02	01	--
-10-	Enfidha	--	02	--
-11-	Sousse	03	03	--
-12-	Zama	04	--	--
-13-	Kef	02	--	--
-14-	Lamta	01	--	--
-15-	Monastir	--	--	01
-16-	El Jem	--	07	01
-17-	Gabes	--	03	--
-18-	Gigthis	--	--	01
-19-	Zarzis	--	02	--
-20-	Djerba	--	04	--

Figure 5. Distribution of volcanic millstones.

N°	Site	Ignimbrite ryholite	Grey lava	Black lava
-1-	Carthage	09	04	04
-2-	Oudhna	02	--	01
-3-	Dougga	05	--	06
-4-	Souk El Ahras	--	--	01
-5-	Sousse	--	02	01
-6-	Zama	02	01	--
-7-	Mahdia	--	--	02
-8-	El Jem	--	02	01
-9-	Gabes	--	--	01
-10-	Gigthis	--	08	--
-11-	Zarzis	02	01	--
-12-	Djerba	--	13	--

Figure 4. Distribution of volcanic querns.

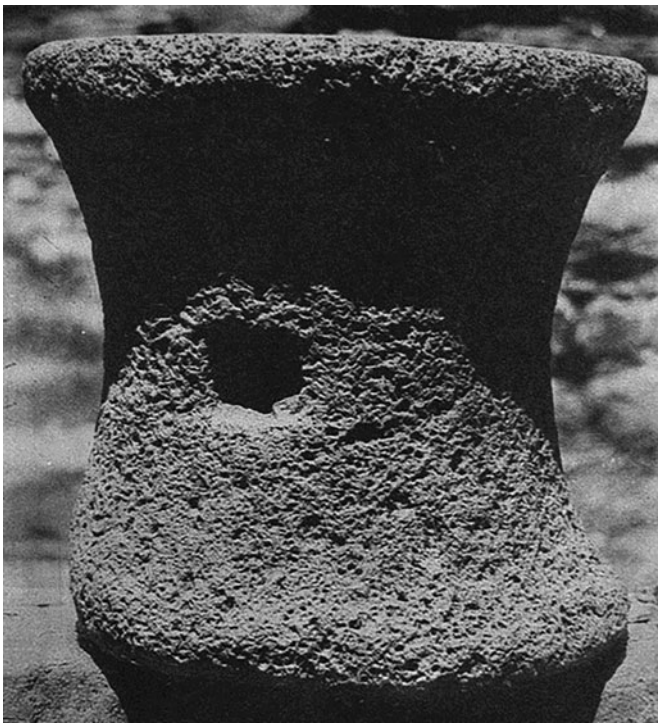


Figure 6. Catillus from Delos.[69]

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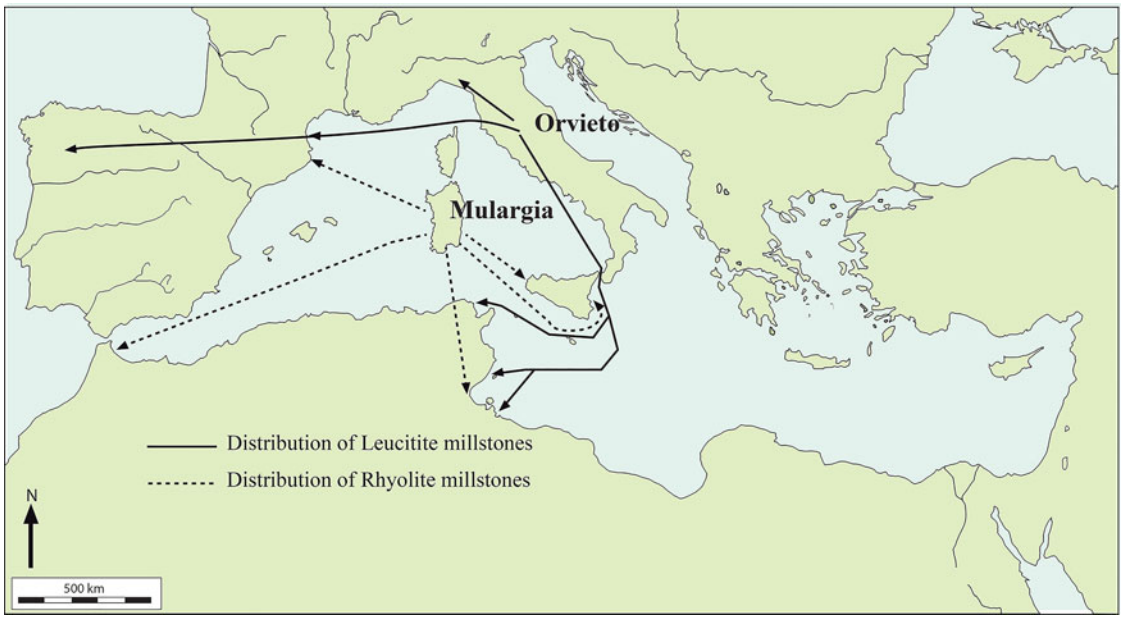


Figure 7. Map showing the distribution of Rhyolite and Leucitite millstones.[70]

discovery of some elements in the interior of the country, the *trapetum* characterizes the regions which were in contact with Mediterranean influences, even though these machines were adapted to local dimensions and African materials. Can we think to the role of the Romanized Africans in the adoption of new techniques, especially with roman domination over the fertile lands and the creation of new towns and colonies? Was this a technical choice, rather a technical adoption of a certain type, in relation to the crushing efficiency and the 'alleged' quality of the product?

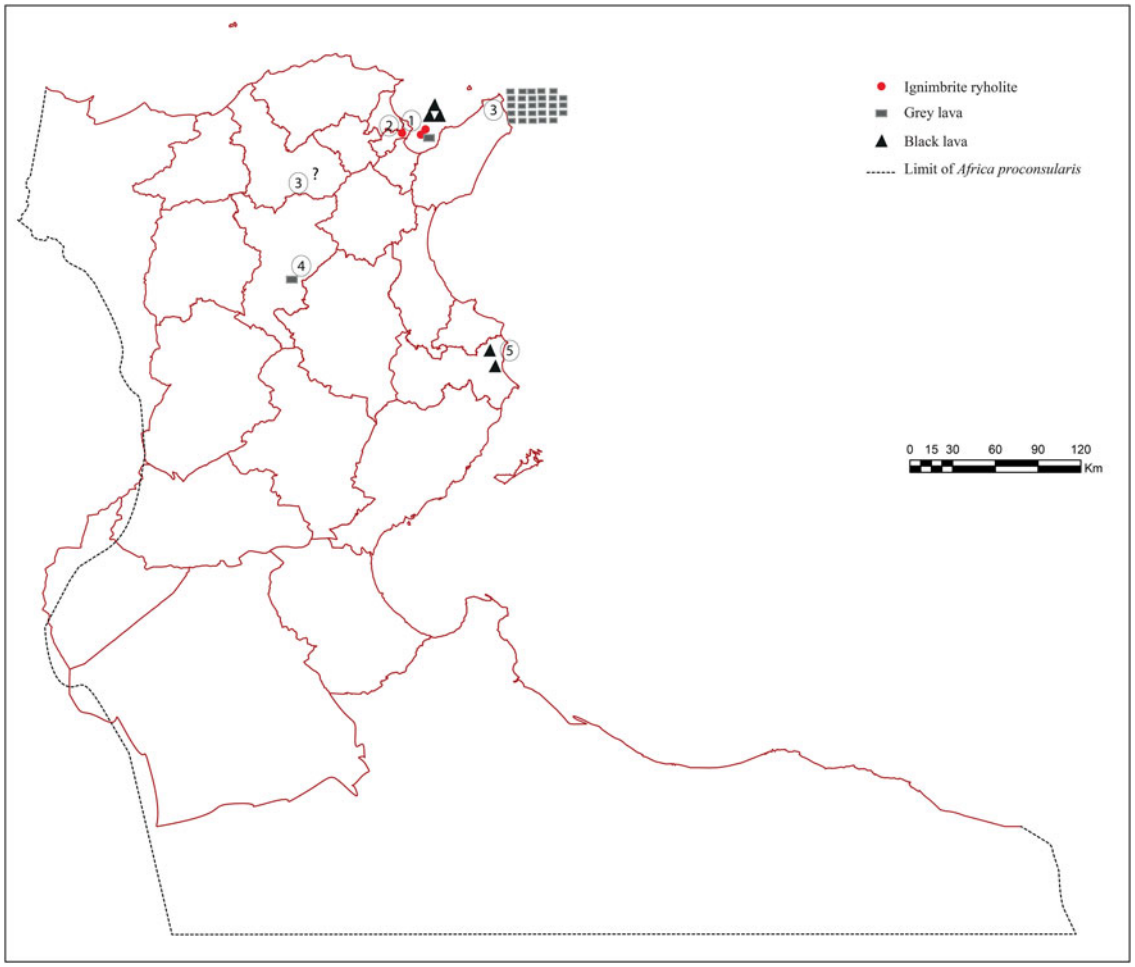


Figure 8. Map of distribution of volcanic linear artefacts.

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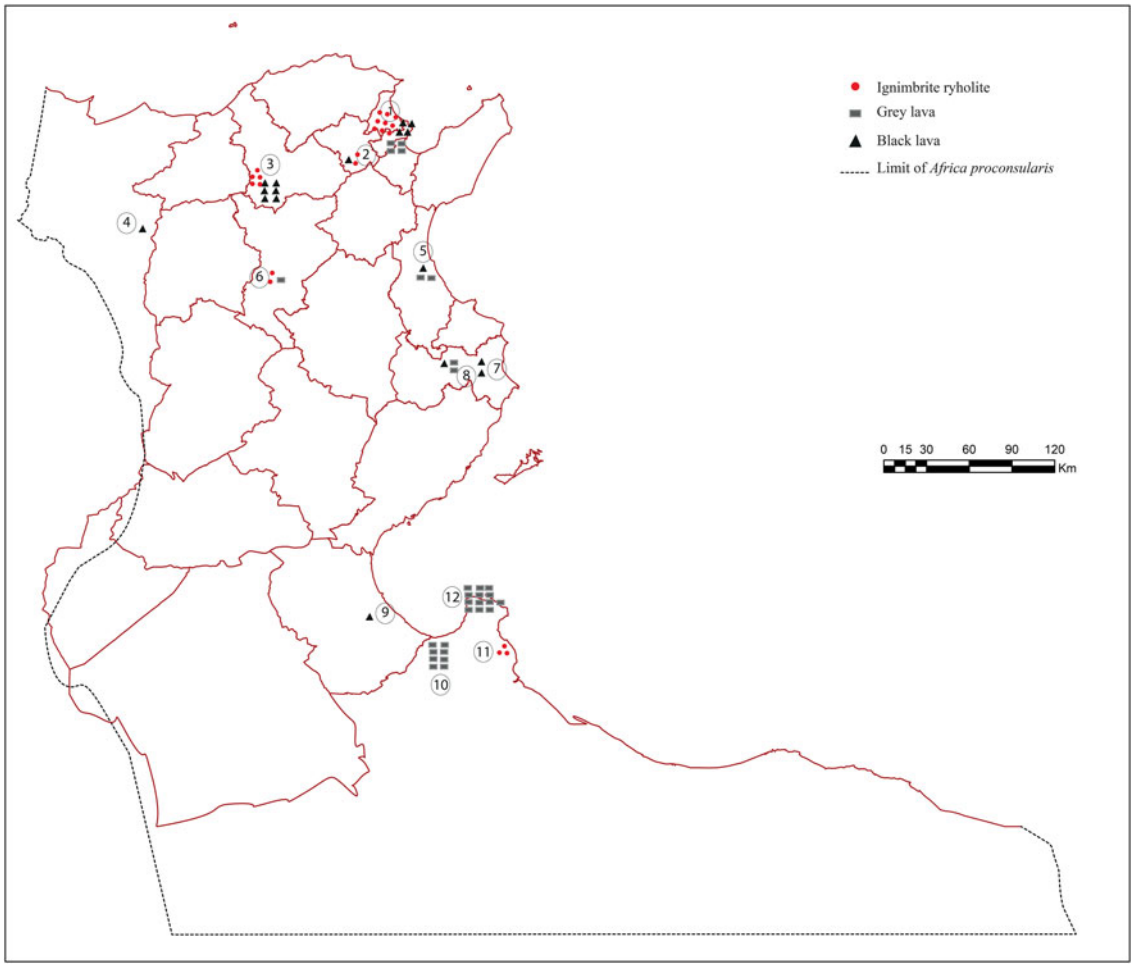


Figure 9. Map of distribution of volcanic querns.

Another remark concerns the rarity and sometimes the absence of querns in the interior of Africa Proconsularis, especially in rural sites, some of which have been well studied and surveyed. On the other hand, millstones are quite abundant in these sites, where olive production is also documented, certainly in connection with the need to feed many people and employees. Absence of documentation does not mean absence of these types in rural sites where the need to grind grain remained vital; instead the scarcity of finds is possibly due to agricultural and urban destruction, as well as to the reuse and migration of these 'portable' tools. The same is possible for mortars and mixing machines (i.e. kneading machines), which are not found in the far west of Africa Proconsularis, despite their usefulness for daily or seasonal tasks. Finally, it should also be noted that this spread of artefacts is not only determined by technical or geographical choices, but also in relation to the nature of the type of material used and the proximity and availability of suitable raw materials.

Rocks and the origin of the grinding stones

The type of stone used is evaluated by the resistance to wear caused by repeated grinding; by its aesthetic appearance, particularly the colour;[49] as well as by its cost of extraction and transport, in particular when the quarry is located far away. Since the Neolithic period, two types of rocks have been associated with making grinding tools; volcanic (local or imported) and sedimentary rock. In Africa Proconsulairs, according to our study, it appears that volcanic rocks were used since prehistory, becoming increasingly popular during the Roman period. In all ancient mediterranean cities, we can detect artefacts in basalt rocks whose origin varies according to the geographical location of these cities and their proximity to volcanic deposits. These volcanic rock artefacts have been the subject of a 'transcontinental'[50] transfer or trade. The archaeological evidence of this movement of raw materials dates back to the 4th century BC, when a boat loaded with forty-two hopper mills and a mill of Morgantina-type (*meta* and *catillus*), probably from Nisyros,[51] was wrecked off Mallorca. A second Greek ship from the same century (c. 290 BC) was discovered on the coast of Kyrenia (Cyprus). In addition to the 375 amphorae and sacks of almonds, the wreck also contains 29 Olynthus mills.[52]

A number of factors controls the production and the trade of volcanic millstones. Generally, to cut and to shape mills, we look for non-friable hard rock. However, lighter rock types were preferred, which would not constitute too heavy a burden during transport and trade. Sources of volcanic rock are numerous in the Mediterranean Basin, however, the most popular types of rock used during the Roman period appears to have been rhyolite from Mulargia, in central Sardinia, and leucitite from Orvieto in north-central Italy. According to Williams-Thorpe, these were the most widely transported rock types, where evidence of Sardinian rhyolite from Tetouan in northern Morocco, shows a travel distance of 1,350 km from its source, whilst a distance of 1,500 km is recorded between the source of a Leucitite millstone and its findspot in Astorga in Spain (Figure 7).[53]

In Africa Proconsularis, the earliest imported millstones known date to the 4th century BC, and come from the El Sec shipwreck (Mallorca), which was loaded with a consignment of

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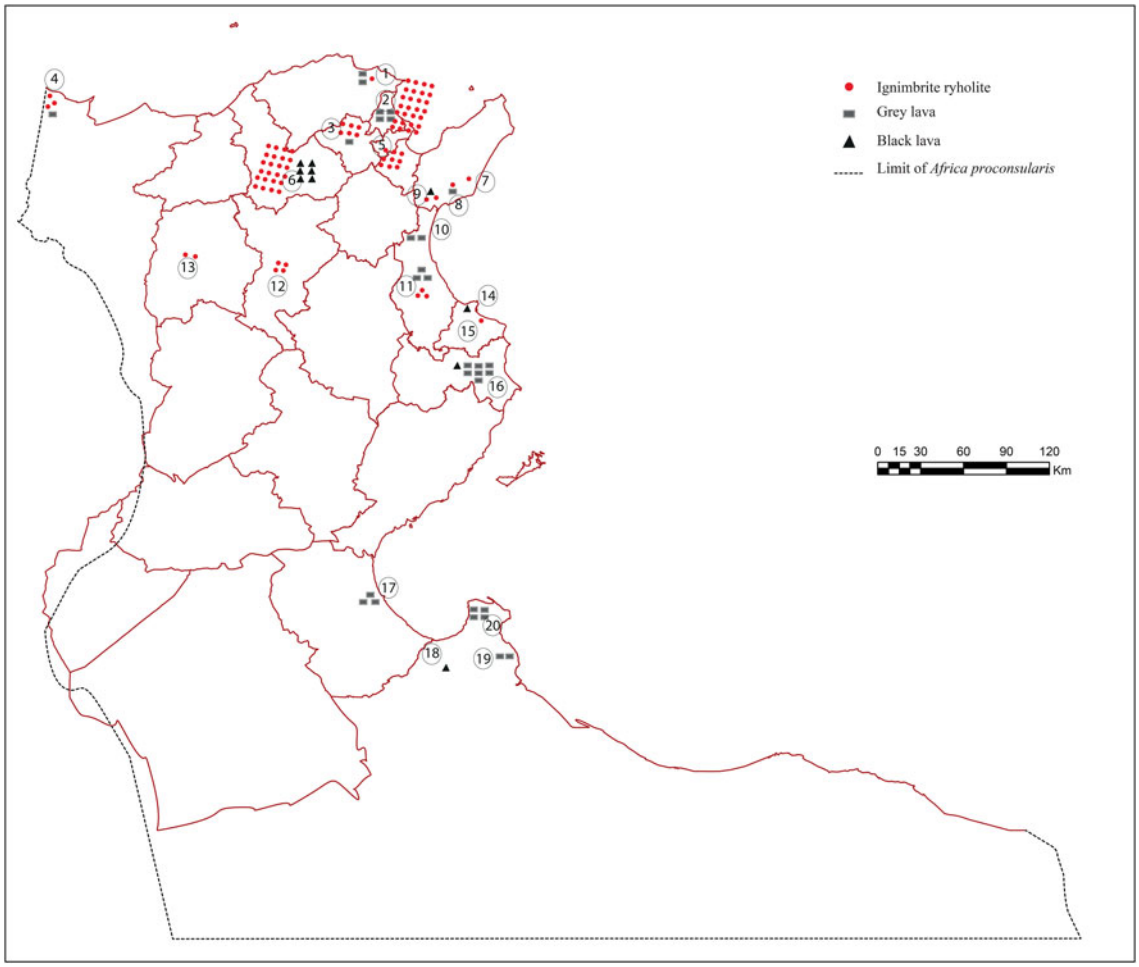


Figure 10. Map of distribution of volcanic millstones.

Morgantina mills in the port of Carthage during its second stopover from Pantelleria.[54] This type of mill, which was widespread in the Punic world, was also discovered in Carthage in an artisanal context dating from the 2nd century BC,[55] that is to say even before the *pistrinae* or bakery mills of Pompeii. The importation and use of millstones made of volcanic rocks continued and extended in Africa until the 5th century, with the *catillus* found at Mustis.[56]

A recent morphological and spatial study[57] has shown that out of 146 documented millstones,[58] volcanic millstones are concentrated mainly in cities near coastal regions (74%), whilst the remaining 26% were located in inland cities, including at Dougga (41 examples), Zama (8 examples), Kef (2 examples) and Souk el Ahras (1 example). This distribution can be partly explained by the proximity of these coastal regions to several major volcanic outcrops, primarily in Sicily,[59] Pantelleria, Sardinia and Etruria, in addition to the relative ease of maritime access between these areas[60] (Figures 8 and 9).

	Tunisian territory of *Afr. Pro*	Algerian territory of *Afr. pro*	Total
Lava	58	1	59
Lumachelle	43	2	45
Limestone	14	12	26
Fossiliferous stone	8	-	8
Sandstone	6	24	30
Conglomerate stone	4	27	31
Total	133	66	199

Figure 11. Lithological distribution of African rotary querns.

	Tunisian territory of *Afr. pro*	Algerian territory of *Afr. pro*	Total
Lava	117	05	122
Limestone	25	14	39
Fossiliferous stone	22	--	22
Lumachelle	08	--	08
Granite	13	--	13
Sandstone	07	01	08
Conglomerate stone	0	13	13
Total	192	33	225

Figure 12. Lithological distribution of African millstones.

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Figure 13. Brown vesicular lava (Musuem of Carthage).



Figure 15. Black lava (Museum of Jerba).

At this point, we should mention the importance of seaports and river navigation in the distribution of mills, especially the Pompeian mills. This is the case with the role played by the Tiber valley in Italy in transporting the mills from the Santa Trinita quarry to Pompeii,[61] or the role of the Rhône in Gaul with the concentration of mills made from volcanic rocks in the Narbonne region. Carthage had undoubtedly benefited from its geographical position in the Mediterranean with its maritime commercial network well suited to import millstones from different sources.

The diffusion of volcanic millstones in Africa Proconsularis illustrates the theme of circulation across the Mediterranean (Figure 10). It supports the idea of a geographical limit of each quarry, a limit conditioned by natural boundaries and proximity of source material, and technical ability in relation to the capabilities of maritime navigation. However, it also brings to highlights the commercial relationship between two parts of the Mediterranean; that of the eastern and western parts of the basin. Other than the millstones from El Sec shipwreck, which



Figure 14. Red lava (Musuem of Carthage).



Figure 16. Grey vesicular lava (site of Gightis).

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came from Nysiros, or those from the wreck of Mahdia,[62] there are no recorded millstone examples of eastern origin in the western basin of the Mediterranean. It is true that we know very little about the trade in the East apart from amphorae; however, it is not unreasonable to speculate that if Dressel 1, Lamboglia 2 and Dressel 22 amphorae, both typically western Mediterranean amphorae, are well distributed in the east, then why not mills? Theoretically it is possible, but archaeologically, the discoveries and studies in this field have yet to yield concrete data: O. Williams-Thorpe and R. Thorpe have concluded in their study on the provenance of millstones in the Eastern Mediterranean that all the documented millstones originate from eastern sources, and that these millstones never travelled westwards, beyond the island of Cyprus.[63]

One can also explore the limits of this 'trade' in the substitution of the volcanic rock with locally sourced sedimentary rock. Whether in relation to a supply problem[64] or to the high cost of these imported raw materials, Africans, especially those in the interior of the country appear to have resorted to using other types of rock to manufacture millstones, making use of the fossiliferous limestone, which widespread in Africa Proconsularis, and offered a good lithological replacement (Figures 11 and 12).

This phenomenon of adapting millstones by using locally sourced stone reflects a technical evolution: the mills made in volcanic rock (Figures 13–16), which were well diffused during the 1st and the 2nd century BC are replaced by those manufactured from sedimentary rock in a new morphology. The choice of this type is historical and technical. Imported manual querns and models had until then a standardised general morphology consisting of a cylindrical shape with receptacle, with horizontal active faces or most often concave. But the performance of the work on these parts, as well as the quality of the ground product were not, as it seems, satisfactory, in the sense that the inclined profile of the active face causes the grains to escape before being fully crushed. Thus, with the decline of the artisanal activity of the production of flour, and in order to increase the speed of rotation of the millstones and save more time, users and of course artisans have observed that the wider the grinding mills, the more the grinding capacity can be increased, and the heavier the grinding mills, the finer the flour would become.[65] This explains the orientation towards flat sedimentary millstones.[66] Moreover, in our catalogue, it was noted that all the artefacts of this flat type[67] (*catilli* type 280) are made of non-volcanic rocks.

Conclusion

The grinding and crushing tools in Africa Proconsularis have known a technical evolution that appears to parallel other regions bordering the Mediterranean, both during the Hellenistic period or under the Roman Empire. This territory has received, through its maritime connections, all the available types known elsewhere, but sometimes with a kind of African adaptation, which has given rise to local original types. Nevertheless, the question that arises and remains unanswered is whether Africa can be attributed with the origin of the invention and diffusion of manual rotary querns. Despite the few small indications, we are really far from answering this, and we will be satisfied with the results already acquired in this regard. With this, we are very optimistic that a future excavation and prospecting project could give good results and this for two reasons. Firstly, Africa Proconsularis has never been a field of research for this type of artefacts and that systematic excavations and well-targeted prospecting in very specific places (oil mills, ancient sites and cities) will be able to provide more information and clues in everything concerning the grinding or extraction operation. Likewise, Africa Proconsularis includes a wide variety of instruments, which suggests the experience of African artisans in this field.

Notes

1. Amouretti 1987, 9.
2. Recent doctoral research has demonstrated that there is a persistent terminological gap used to distinguish the differences between types of pressing equipment, for example, between *trapeta* and *molae olearia*e. See Souissi 2022, Vol. II, 14, 112–113.
3. See the map of the distribution of these artefacts, Figure 1.
4. However, the number is constantly increasing with new discoveries.
5. Type 172 according to our typology. See Souissi 2022, Vol I, 32.
6. Fantar 1985, II, 171–172, note 364.
7. Merlin 1917, 143.
8. Sanmarti *et al.* 2016, 125.
9. Alonso 2002, II, 113: this type has many naming as the *Olynthus* mill, lever-operated type or the hopper rubber.
10. Fantar 1985, II, 171.
11. *Idem.*
12. Morel 1969, 513.
13. We should note in this regard the fragment found in Djerba, an island which played a commercial and maritime role during Antiquity.
14. Jaccottey *et al.* 2013, 413.
15. Alorda Park Team 2002, 155.
16. *Ibid.*, 167.
17. *Idem.*
18. Morel 2001, 241.
19. *Ibid.*, 242–243.
20. *Ibid.*, 245.
21. *Ibid.*, 243.
22. During our reconstruction of this so-called *meta*, we chose a pierced type, in parallel with the oldest model in the Alorda Park collection. Alorda Park team, 2002, 159, Figure 3; 167.
23. Jaccottey *et al.* 2013, 407.
24. Peacock 2013, 55.
25. The fragment has since been misplaced, and attempts to contact the excavator have been unsuccessful.
26. Peacock 2013, 55.
27. It was during one of our meetings with our PhD thesis director that I had this testimony.
28. Wefers 2011, 69.
29. See Figures 3–5.
30. Lancel 1982, 164, note n°13, Figure 203–204.
31. *Ibid.*, 102–103, Figure 121.a, 121.b.
32. Ferron et Pinard, 1955, IX, 129, n° 323, Pl. LII.
33. We are not sure, even the excavator, that all these millstones were used contemporarily though? Or could they have been discarded at different times but ended up in the same context post-depositionally?
34. Alonso Martinez 2002, II, 119.
35. Ghalia 2005, 67–69.
36. Williams-Thorpe 1988, 261.
37. Souissi 2022.
38. In bakeries.
39. Souissi 2022, Vol I.
40. *Ibid.*, artefacts 409 and 410.
41. *Ibid.*, 317.
42. Brun et Borréani 1998, 280.
43. Souissi 2022, 294–299.
44. This central hole can be circular or square, with complete or incomplete perforation.
45. See maps of distrubition of volcanic artefacts in Figures 8–10.
46. Souissi 2022, Vol I.
47. Deonna 1938, pl. 391, 394, 396: 02 *catilli.*
48. Domergue *et al.* 1997, 54–55.
49. See Figures 13–16.
50. Lancaster *et al.* 2010, 951.
51. Williams-Thorpe and Thorpe 1990, 131.
52. Katzev 1970, 317.
53. Williams-Thorpe 1988, 284, Figure 11.
54. Williams-Thorpe and Thorpe 1990, 133.
55. Lancel 1982, 93.

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56. Williams-Thorpe 1988, 261.
57. Souissi 2022, Vol I.
58. See Maps of volcanic artefacts distribution (Figures 8–10).
59. The whole area which includes the mountains of Etna, the Hyblaean mountains and the Aeolian Islands.
60. Gluhak and Schwall 2014, 4.
61. McCallum 2010, 78–79.
62. A couple of manual querns.
63. *Ibid*., 1993, 301.
64. Particularly the challenges associated with imported volcanic material inland, and very distant from the coast.
65. Jorgensen 2002, 189–191.
66. Sedimentary millstones are heavier than volcanic ones. See Picavet 2019, 352. 'un poids en charge d'une tonne contiendra donc 40 meules manuelles romaines en roche volcanique (20 moulins) ou 32/34 meules en Grès de Macquenoise (16 ou 17 moulins)'.
67. It should be noted that even for the type 282 (four artefacts) catilli, with a concave active face, this inclination has never exceeded 6°, which could be the result of wear. See Souissi 2022, Vol. I.
68. Souissi 2022, 326, Figure 125.
69. Deonna 1938, pl. 391.
70. *Ibid*., 284.

References

Alonso Martinez, N. 2002. Le moulin rotatif manuel au nord-est de la péninsule ibérique: une innovation technique dans le contexte domestique de la mouture des céréales, *Moudre et Broyer II*, Paris: 111–27.

Amouretti, M.-Cl. 1987. La diffusion du moulin à eau dans l'antiquité, un problème mal posé. In: A. De Réparaz, (ed.), *L'eau et les hommes en Méditerranée, Actes du colloque du G.I.S 1984*. CNRS, Paris: 13–23.

Brun, J.-P. and Borréani, M. 1998. Deux moulins hydrauliques romains en Narbonnaise (*villae* des Mesclans, La Crau, et de Saint-Pierre, Les Arcs, Var). *Gallia* 55. CNRS Editions. Paris: 279–326.

Deonna, W. 1938. *Exploration archéologique de Délos*. Le mobilier Délien, Paris.

Domergue, C., Béziat, D., Cauuet, B., Jarrier, C., Landes, C., Morasz, J.-G., Oliva, P., Pulou, R. and Tollon, F. 1997. Les moulins rotatifs dans les mines et centres métallurgiques antiques. In: D. Meeks and D. Garcia (eds) *Techniques et économies antiques et médiévales: le temps de l'innovation, Colloque international d'Aix-en-Provence*, Mai, Paris: 48–61.

Équipe d'Alorda Park 2002. Les meules rotatives du site ibérique d'Alorda Park, *Moudre et Broyer II*, Paris: 155–75.

Fantar, M.-H. 1985. *Kerkouane, Cité Punique du Cap Bon (Tunisie)*.

Ferron, J. and Pinard, M. 1955. Les fouilles de Byrsa: 1953–1954. *Cahiers de Byrsa V*.

Ghalia T., 2005, La villa romaine de Demna-Wadi El Rmel et son environnement. Approche archéologique et projet de valorisation, *Africa, nouvelles series, Séances scientifiques III,* 2005, p. 53-86.

Gluhak, T.M. and Schwall, C. 2014. Provenance analyses of the volcanic rock grinding stones from the Greek colony of Selinunte, Sicily (Italy): Constraints and possibilities. *Archaeometry*, 57, issue 2, 2014, p. 246-268.

Jaccottey, L., Alonso, N., Defressigne, S., Hamon, C., Lepareux-Couturier, S., Brisotto, V., Galland-Crety, S., Jodry, F., Lagadec, J.-P., Lepaumier, H., Longepierre, S., Robin, B. and Zaour, N. 2013. « Le passage des meules va-et-vient aux meules rotatives en France », S. Krausz, A. Colin, K. Gruel, I. Ralston, T. Dechezleprêtre (eds) *L'âge du Fer en Europe Mélanges offerts à O. Buchsenchutz, Ausonius Editions. Collection Mémoire32. Bordeaux*: 405–20.

Jorgensen A.B. 2002. Investigations of Danish rotary quern from the iron age: Archaeological evidence and practical experiments. *Moudre et Broyer II*. Paris: 183–96.

Katzev, M.L. 1970. Resurrecting the oldest known Greek ship. *National Geographic* 137(6): 842–57.

Lancaster, L.C., Sottili, G., Marra, F. and Ventura, G. 2010. Provenance of lightweight volcanic stones used in ancient roman concrete vaulting: evidence from Turkey and Tunisia. *Archaeometry* 52(6): 949–61.

Lancel, S. 1982. *Mission archéologique française à Carthage Byrsa II, Rapports préliminaires des fouilles (1977-1978)*. Rome.

McCallum, M. 2010. The supply of stone to the city of Rome: a case study of the transport of Anician building stone and millstone from the Santa Trinità Quarry (Orvieto). In: C.D. Dillian and C.L. White (eds) *Trade and Exchange: Archaeological Studies from History and Prehistory*. Springer. New York: 75–94.

Merlin, M. 1917. *Note sur des tombeaux puniques découverts à Carthage*. B.A.C., Paris: 131–53.

Morel, J.P. 1969. Kerkouane, ville punique du cap Bon: remarques archéologiques et historiques. *Mélanges de l'école française de Rome* 81(2): 473–518.

Morel, J.-P. 2001. Aux origines du moulin rotatif? Une meule circulaire de la fin du VIe siècle avant notre ère à Carthage. In: J.-P. Brun and Ph. Jockey (eds) *Techniques et sociétés en Méditerranée*, Paris: 241–50.

Peacock, D.P.S. 2013. *The Stone of Life. Querns, Mills and Flour Production in Europe up to c. AD 500*. Southampton Monographs in Archaeology New Series 1, Southampton.

Picavet, P. 2019. *Les meules rotatives de la fin de l'Âge du Fer au haut Moyen Âge entre la Seine et le Rhin*, Thése de doctorat dirigée par William Van Andringa et Jean-Pierre Brun, Lille.

Sanmarti, J., Lopez, A. and Alvares, R. 2016. Les objets lithiques, *Althiburos II, L'aire du Capitole et la nécropole méridionale: études*. Tarragona: 275–86.

Souissi, S. 2022. *Meules et Mouline en Afrique proconsulaire*. Archeopress, Oxford (in press).

Wefers, S. 2011. Still using your saddle quern? A compilation of the oldest known rotary querns in Western Europe. In: D.P.S. Peacock and D. Williams (eds) *Proceedings of the colloquium Bread for the People*, Rome, Italy, November 2009, British Archaeological Repots, International Series. Archaeopress, Southampton: 67–76.

Williams-Thorpe, O. 1988. Provenancing and archaeology of Roman millstones from the Mediterranean area. *Journal of Archaeological Science* 15(3): 253–306.

Williams-Thorpe, O. and Thorpe, R.S. 1990. Millstone provenancing used in tracing the route of a fourth-century BC Greek merchant ship. *Archaeometry* 32(2): 115–37.

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