Apollo's necklace

Or: How did ancient pottery end up on agricultural fields?

Bernhard Lucke

Abstract Scatters of off-site pottery can be found on many agricultural fields, which is a long-standing enigma, as they are not connected with archaeological sites. There are growing indications that they came to the fields in the context of manuring, but the exact pathways are still unknown. It proved very difficult to understand distribution patterns as most models consider the pottery a by-product of garbage treatment that got accidentally to fields. However, the application of pottery to soils might have happened intentionally, i.e. the pottery itself could be a soil amendment. Ceramic sherds may improve soil properties and support the establishment of soil microbiomes that are beneficial for plant growth. The necklace of my barber's dog Apollo shows that pottery can be used to reduce parasites of domesticated animals. This suggests that there might be much more to discover with regard to the presence of ancient pottery on agricultural fields.

Keywords off-site pottery carpets, ancient land use, manuring, soil microbiome, dung

Introduction

Archaeological sites are characterized by their material culture, i.e. artifacts that accumulated in ruins and other places of human activity. Excavations aim to locate and define sites by their material culture, and to establish chronological orders of the most frequent type: pottery, whose characteristics may permit dating the site. However, this requires relatively well-preserved material of sufficient size and stylistic type ("diagnostic sherds"), whereas small fragments of everyday vessel bodies ("body sherds") are of limited value (and thus often not met by enthusiasm in archaeological research). This is not only connected with poor stylistic features preserved by body sherds, but also due to a potential difference of pottery used for everyday activities compared to more fashionable, highly decorated vessels. While the latter can mostly well be dated, ceramic styles of everyday material may not have changed significantly during long time periods which limits their potential interpretation.

Pottery is not only found within former settlements: it is also present in the open landscape, i.e. in areas which were presumably used as agricultural fields. These off-site pottery scatters, or carpets if involving huge amounts of material, mostly consist of small, worn body sherds. Off-site pottery data collected from fieldwalking has tradi-

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tionally been used to identify 'sites' (high-density pottery concentrations) and to distinguish crudely between arable and non-arable zones on the basis of the presence or absence of low-density pottery scatters (see the recent review on the history of offsite archaeological surveys by John Bintliff[1]).

Off-site pottery scatters: evidence of manuring?

Although initially understood as markers of "sites", the interpretation of off-site pottery scatters changed when research attempted to understand how ancient settlements interacted with their surrounding environment. Tony Wilkinson's surveys to map the distribution of off-site pottery scatters around ancient tells in Mesopotamia found distribution patterns in form of "halos", i.e. amounts that depended on distance from the respective site[2]. This was interpreted as resulting from the intensity of ancient land use activity, with manuring as the most plausible explanation of how pottery terminated its life cycle as garbage sherds in the soil of agricultural fields.

Critics argue that the practice of *Sabakh,* i.e. the recent mining and re-distribution of phosphorus-rich archaeological sediments from tells to fields, in order to improve soil quality, could explain such artifact scatters. However, this would imply that multi-period sherd scatters would be encountered, including poorly worn material with rather fresh edges, and including large sherd sizes, which is mostly not the case (see the comprehensive discussions of *Sabakh* by Tony Wilkinson[3] and John Bintliff[4]).

Critics of the manure theory further doubt whether sufficient manure and incorporated pottery could have been produced on ancient farms to account for partially massive offsite sherd carpets[5], and argue that multiple reasons other than manuring could explain how pottery sherds were deposited on fields. These include non-residential buildings and activity areas, storage sheds, field buildings, animal pens, beehives, gardens, and perhaps also vast spread of shacks built by the poor during times of population peaks[6], as well as post-depositional processes, such as erosion, or the 'smearing' of artifact clusters by plowing. However, such patterns should be reflected by irregular distribution of pottery densities, and it has to be noted that off-site pottery scatters or carpets are not present everywhere. Yet, many off-site pottery scatters show changing densities depending on distance from a settlement. This implies that areas close to ancient sites were used more intensely, e.g. as gardens, whereas areas further afar were used more extensively, e.g. for the production of cereals. Such patterns support a connection with manuring. As well, it has become increasingly clear

1 Bintliff 2023.
2 Wilkinson 2003.
3 Wilkinson 2003.
4 Bintliff 2023.
5 Alcock et al. 1994.
6 Pettegrew et al. 2001.

that the distribution of pottery scatters cannot be explained with soil erosion or mass movements[7].

But even if the manure hypothesis is accepted, the question remains what exact kind of activity led to the deposition of pottery somewhere in the countryside. The most reasonable explanation seems that discarded pottery came as garbage to middens, was mixed with other organic remains, and applied as compost onto agricultural soils. This would be in agreement with reports by ancient authors about the use of certain excrements and organic garbage for the preparation of specific manure[8]. However, our understanding of these processes remains largely on a theoretical level. It could rarely be determined which ancient agricultural strategies were applied and possibly connected with deposition of pottery scatters.

Jones[9] investigated medieval land use patterns, combining archaeological and textural evidence from the English Midlands. He was able to distinguish infield and outfield cultivation, assarts, and demesnes due to different ceramic signatures that these left on the ground. He also found that shifts from distinct plots marked by light ceramics cover to denser carpets were associated with the establishment of open field strip blocks, probably manured by many families[10]. In contrast, fields belonging to the ruling class did not show high amounts of pottery. This might perhaps be explained by huge amounts of dung that were available to these landowners as they possessed large flocks, so there was no necessity to apply household garbage. If true, pottery scatters might be interpreted not only as indicators of manuring, but also of past land ownership structures. Pottery scatters might therefore testify to manuring activities of the peasantry and the re-use of household garbage.

Agriculture, irrigation, and animal husbandry in the context of pottery scatters

An intensive survey of off-site pottery scatters at three sites in northern Jordan systematically mapped sherd densities in the context of soil properties and remains of irrigation features (fig. 1)[11]. The selected sites included Gadara/Umm Qeis, a city where rain-fed agriculture on a fertile basalt plateau was possible, and Abila/Queilbeh, a place close to the transition to the steppe, but where rain-fed agriculture would still have been possible on clay loams of a limestone plateau. The last site, Umm el-Jimal (ancient name unknown), was situated in the basalt steppe, covered by deep and potentially very fertile desert loess, but beyond the precipitation zone that would have permitted rain-fed agriculture. Thus, it was possible to compare off-site pottery

7 Bintliff 2023.
8 Colum. de arboribus.
9 Jones 2004.
10 Jones 2012.
11 Lucke et al. 2019.

Fig. 1 Intensive survey of fields surrounding the site of Abila, northern Jordan (B. Lucke)

scatters of very different environments, but separated by only small distances of about 30–50 km.

Contrary to the initial hypothesis of the survey, ancient irrigation proved less significant near the steppe site Umm el-Jimal than at the two other sites. The loess soils surrounding this site were nearly completely devoid of any material culture. Only some small terraces near valleys, probably fed by diverted runoff, yielded petty amounts of pottery and sediments. Remains of rounded structures near these terraces might point to husbandry activities, which means that the area could have been used mainly for raising animals. This could be in agreement with the modern name of the place, which means 'mother of camels'. In contrast, relatively large amounts of small body sherds were encountered inside the ancient settlement, in open spaces whose purpose has so far remained unknown. As many large water storage systems had been constructed in the city, fed by diverted runoff during winter floods in the valleys, these areas might have been used as cultivated, irrigated gardens[12].

While Abila showed a transitionary pattern of strongly varying pottery concentrations (fig. 2), the largest sherd carpets, as well as most extensive and sophisticated remains of irrigation canals, were found at the best-watered site of Gadara/Umm Qeis. There, sherd concentrations fit the halo model by Tony Wilkinson, slowly diminishing with increasing distance to the city.

12 Lucke et al. 2019.

Fig. 2 First evaluation of pottery collected from fields surrounding the site of Abila, northern Jordan (B. Lucke)

Therefore, it was concluded that the manuring hypothesis most likely explains the pottery distribution in northern Jordan, too, apparently modified by the availability of irrigation water which limits the possible intensity of cultivation. Still, however, the question remains how and where this manure was collected, perhaps treated, and applied. In this context, the collection of approximately 50,000 sherds during the survey may in the future allow for more detailed analyses of pottery type distribution patterns, which could be combined with specific soil analyses. For example, there are indications that some areas of the rather complex situation at Abila are characterized by unexpected high concentrations of faeces biomarkers in the soils which indicate the presence of pigs. These correspond to elevated amounts of pottery[13], which suggests that the raising of pork may have been part of the (at least pre-Islamic) land use history of this semi-arid region.

Apollo's necklace

It was my barber's dog Apollo (fig. 3) who made me aware that there could be more to discover about pottery on fields, and that one might have to take a more experimental approach instead of focusing only retrospectively on recovered sherd amounts and

13 Preliminary interpretation of unpublished material, presented at the annual meeting of the Working Group Geoarchaeology in Germany, 2021.

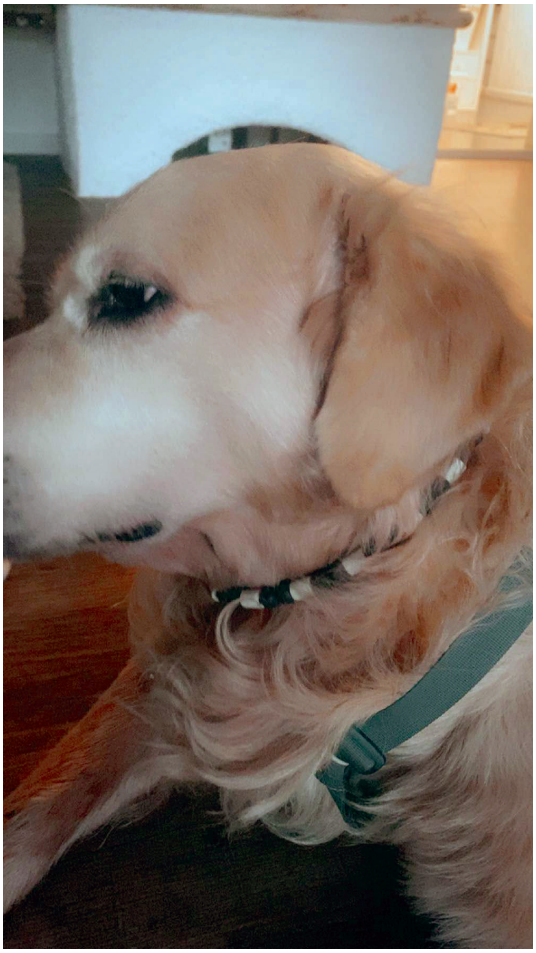

Fig. 3 My barber's dog Apollo, wearing his necklace (A. Rudloff)

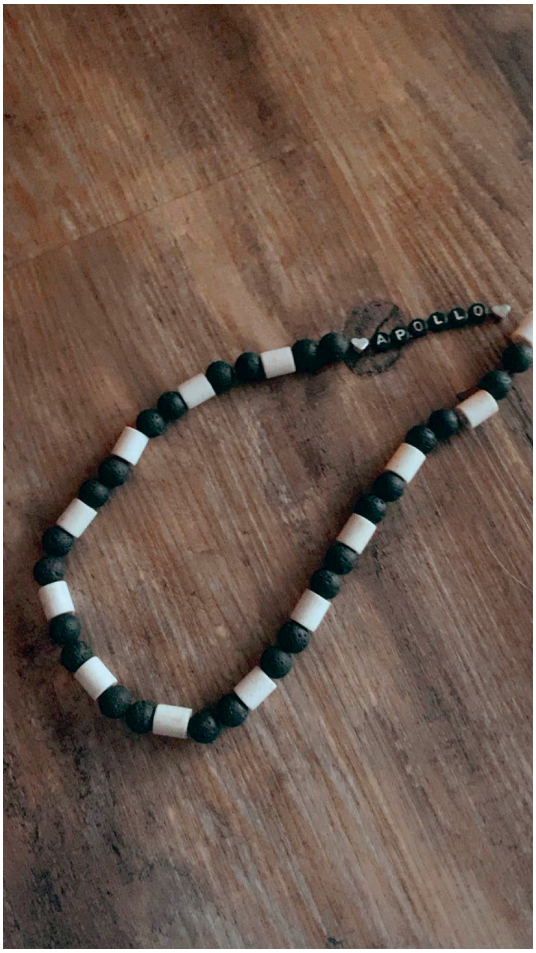

Fig. 4 Apollo's necklace, made of small ceramic pipes (A. Rudloff)

their distribution. Apollo is an old dog that would sometimes rest, or play with children, in the barber's shop while clients were taken care of. Someday, I noticed that the dog wore a necklace made of ceramic pipes (fig. 4). This necklace is supposed to serve as protection against ticks and other parasites such as mites, and apparently also has a positive impact on the fur, improving its structure and reducing the amount of falling hair. My barber further reports that the necklace needs once a month to be washed in water and then be left in the sun for about 24 hours, as its positive effects would otherwise diminish.

If such impacts of ceramics on domesticated animals prove true, this could mean that the application of pottery on fields may not only have happened accidentally as a by-product of manure preparation out of collected garbage. Instead, it might have served more specific purposes, such as protection against parasites and pests, or improving soil properties.

A quick search of reports regarding pottery necklaces for dogs in the internet reveals a split picture. Some dog owners doubt that there is any positive effect, but there

is a huge number of positive statements that agree with the report of my barber. As usual with products related to health, it is well possible that magical beliefs (also called: placebo effect) play a role for positive perceptions of certain treatments, and may even have an objective (psychology-based) impact. However, I do not believe that animals strongly react to beliefs of their owners, and that products with little positive effect would sell badly. Considering the apparently strongly growing numbers of ceramic necklaces sold for dogs, it seems adequate to look deeper into the matter.

Effects of pottery in cultivated soils: magical imagination, or true?

Ceramic necklaces for dogs are marketed as useful due to "effective microorganisms" (EM), which are supposedly included in the clay pipes. This approach belongs to the alternative agriculture movement and is based on the idea that it is the composition of the microbiome which determines e.g., whether nutrients become available to plants, or whether pests can develop[14]. Teruo Higa conducted experiments of incubating soils with microorganisms[15] and claimed in 1980 to have found an optimal mixture which would promote healthy plant growth. This has developed to an organic farming industry, which, among other products, markets clay pipes that are supposed to carry beneficial microorganisms[16]. The wetting and warming by infrared radiation of the pipes once a month is supposed to nourish and re-activate these microorganisms. They are supposed to induce a microflora on the fur which is repellent to ticks and other parasites, but beneficial for skin and hair.

Although there is a significant number of academic reports of respective companies available, which describe procedures and results of EM treatments[17], independent, peer-reviewed studies on the subject are rare. A small study conducted by the Agroscope Reckenholz-Tänikon Research Station ART in Switzerland, published in conference proceedings, found that EM additions to soils were effective for some crops, but only because they were combined with a significant additional supply of nutrients[18]. This was concluded from comparison with EM additions that were subjected to autoclave treatment, yet showed similar positive effects on crop yields. Autoclave treatment is supposed to devitalize microorganisms, as it subjects them to a pressurized saturated stream at 121 °C for about 1 hour, which is expected to kill or at least strongly reduce any living organisms[19]. Although some microorganisms might perhaps survive such treatment, it seems likely that the "optimal mix" of Teruo Higa would at least be severely reduced[20].

14 Habernern 1992.
15 Higa – Parr 1994.
16 EMRO 2023a.
17 EMRO 2023b.
18 Mayer et al. 2008.
19 Garibaldi et al. 2017.
20 Cowan 2004.

EM of ceramic necklace pipes, however, are mixed with clay and burnt to ceramics at temperatures of 900–1200 °C. This heat would usually be considered sufficient to eliminate any living microorganism, unless there are properties of ceramics that we still have not fully understood. It should be mentioned that the soil microbiome is still largely a black box which is methodologically very challenging to investigate. If we discard a potential direct role of living microorganisms that may have been incubated by a ceramic necklace onto a dog's fur, then the reported positive effects are either products of imagination, or there is an unknown effect of the pottery itself. Is it possible that similar mechanisms could have positive impacts on crop yields, if pottery sherds are added to soils?

The negative perception of the particular use of EM in anti-parasite necklaces for dogs should not be confused with a general dismissal of the potential role of the microbiome: there is no doubt that microbial soil amendments can be very beneficial for plant growth. They were found to significantly improve the fixing of nitrogen from the atmosphere, the solubility of phosphorus and potassium, and fixation of soil pollutants[21]. Among others, clays (partly in form of ceramics) have proven effective inorganic carriers of microbial inoculants as they provide protective microhabitats for bacteria which are not accessible to predators, and minimize desiccation. Bacterial cells and clay surfaces may interact positively[22], and it could be hypothesized that the heating of clay during the ceramics production process may to some degree mirror the thermal activation of biochar[23]. Even if the microbiome is destroyed during the burning process, microbial re-colonization on carrier surfaces was found to take place within only 20 days[24]. The mechanisms behind this, as well as the complex biological responses of soil animals to different amendments and their carriers, are however still largely unknown.

In this context, archaeological dark earths (Terra preta) in the Amazon basin are characterized by an abundance of ceramic sherds, which were found to directly contribute to the fertility to these soils because they release phosphorus[25]. This would mean that the pottery sherds may serve themselves as a type of manure. They also change soil physical properties as porous, non-glazed sherds can act like sponges and store water. Thumb-sized objects such as body sherds may play a positive role for soil texture, improving bulk density at least in clay-dominated soils with small pore volume, and reducing evaporation at the soil surface. The practice of irrigation by buried clay pots is known to have been practiced in China for more than 2000 years, and is considered one of the most effective traditional methods of irrigation (in particular in regions with water deficit)[26]. Although there is no evidence that pottery carpets on fields stem from buried clay pots, it seems at least worth investigating the potential

21 Bamdad et al. 2022.
22 Bamdad et al. 2022.
23 Sajjadi et al. 2019.
24 Bamdad et al. 2022.
25 Valente – Costa 2017.
26 Bainbridge 2001.

role of sherds for plant-available water in soils, as subsurface ceramics have been found effective for irrigation[27].

The importance of the soil microbiome might even go further as it has been found to interact significantly with human health. It is relevant for nutrients supply and may enhance the immune system[28]. Clays, in this context, were found not only to be potential carriers of microbiota, but to also have antibacterial properties that kill certain bacteria within 24 hours. The consumption of soil with food, in particular clay, might have been more significant for human health than previously thought[29].

Last but not least, it is worth to consider the process of pottery production, as there might be a connection of animal dung with pottery that has some relevance for the management of soils. Sillar found dried animal dung the most important fuel for open-fire pottery production in the Andes, where complex mixtures of certain dung from different animals were assembled in order to achieve optimal firing. Dung was even used as temper for pottery, and sometimes the production site plowed into the fields when the process was terminated, as this was considered beneficial for agriculture. With regard to the proposed preparation of manure from household garbage and other organic remains, it should not be forgotten that animal dung was most likely one of the most important ingredients. Sillar describes vividly how dung, and not milk or wool, is the most important animal produce for various Andean communities as it can be used both as fuel and for manuring[30]. In this context, it seems likely that the remains of burnt dung were collected for manure preparation, and it remains to be investigated whether past production chains between dung, manure and pottery may provide further insights regarding the presence of ancient pottery on agricultural fields.

Summary and conclusion

The presence of ancient ceramic body sherds on agricultural fields is a long-standing enigma. There are growing indications that they came to the fields in the context of some kind of land management practice, in particular manuring, but the exact mechanisms and pathways are still unknown. Research has so far looked retrospectively at the issue, i.e. it has been attempted to find patterns and construct a logic from amounts and spatial distributions encountered on soils. However, this is based on modern-minded premises which mostly look at soils in mechanist models. There, the pottery is only a by-product that got accidentally to fields, when pottery-containing garbage was mixed with other refuse to prepare manure.

However, it seems possible that the application of pottery to soils might have happened intentionally, and that the pottery itself is a soil amendment. As well, there

27 Cai et al. 2017.
28 Brevik et al. 2020.
29 Oliver – Brevik 2023.
30 Sillar 2000.

could be a connection of pottery and the most important source of ancient manure, which is animal dung. The latter could have played a role for the production of some of the pottery, and was probably still used for manuring after burning. In addition, ceramic sherds may improve soil properties and support the establishment of soil microbiomes that are beneficial for plant growth. As pottery is even used to reduce parasites of domesticated animals, it seems possible that a whole cosmos of forgotten, but specialized use of pottery in ancient agriculture awaits discovery.

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