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RESEARCH ARTICLE

State of the (t)art. Analytical approaches in the investigation of components and production traits of archaeological bread-like objects, applied to two finds from the Neolithic lakeshore settlement Parkhaus Opéra (Zürich, Switzerland)

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Abstract

The site of Parkhaus Opéra is located on the north-eastern shore of Lake Zürich (Switzerland) and was documented during a rescue excavation in 2010 and 2011 by the Office for Urbanism, City of Zürich. Two charred bread-like objects were found in late Neolithic Layer 13 of the pile-dwelling, and are investigated using a novel set of analyses for cereal-based foodstuffs. Tissue remains of barley and wheat were identified, as well as a schizocarp of celery (cf. *Apium graveolens*), providing the first evidence for the use of bread condiments in the Neolithic. Cereal particle sizes were recorded and used to draw conclusions regarding milling and sieving of the raw material. Gas bubbles in the charred objects were measured in order to evaluate possible leavening of the dough. The outcomes of this research significantly advance the understanding of the production traits of cereal-based food during the Neolithic. The analytical techniques proposed by this study open up new possibilities for systematic and consistent investigations of cereal-based archaeological foodstuffs.

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Introduction

Is bread as old as cereal cultivation, or was it the outcome of a progressive development that culminated with the flourishing of the major civilisations of Classical Antiquity? Was prehistoric bread always the same culinary product that we know today, or that we can deduct from historical records? What was the role of bread in everyday alimentation? Has it always been as essential as it is regarded today in the western World? How should bread be defined after all, and where do we draw the line between bread and other cereal products created in the past?

As we know today, the scientific investigation of actual archaeological finds must always play a key role in the process of answering such questions [1–3]. It is such research which demonstrated the Upper Palaeolithic beginnings of (wild cereal) food processing as in Ohalo II [4–6], and the processing of cereals at Catalhöyük from the earliest Neolithic onwards [7]. The first "bread" finds from the Swiss Cortaillod culture [8] resulted in the scientific consensus that bread-making has been a part of central European food culture since the Neolithic. Most details in the history and development of bread-making are however still unclear in many aspects.

Regardless, no typology or standardised terminology exists for archaeological finds of cereal preparations. The habit of equalling archaeological finds to their presumptive modern counterparts has a long tradition. Widely used terminology such as Pumpernickel [9], cakes [10, 11], dumplings [11], or noodles [11–13] usually only consider the objects' shapes and not the *chaînes opératoires* of their production. When referring to supposed "bread" finds in archaeology, very general definitions seem to be more appropriate. One definition may be that bread is a processed (and usually, but not always, cereal-based) foodstuff made of a variety of solid and liquid ingredients, optionally fermented, but eventually dried or cooked/baked [14, 15]. Such a broad definition of bread, if applied to present time, would encompass nearly all bakery and pastry products imaginable. There are also narrower definitions, some implying fermentation when using the term "bread", opposing it to unfermented flat bread [16].

In light of this background, the aim of this study is to propose a standardised approach to record the parameters for archaeological "bread" finds. Morphological descriptions of prehistoric bread-like objects will be integrated with the microscopic analysis of their plant content. Moreover, procedures from material analysis will be applied to gain additional qualitative data on the components, as well as quantitative data on grinding and baking traits. The ultimate goal of this approach is the identification of (1) ingredients of the cereal products in order to link archaeobotanical crop spectra with actual food consumption, and also of (2) technological aspects of cereal processing in order to gain insight into the qualities of the products, the time invested in their production, and consequently their value and significance for a society [17–19].

As a case study illustrating this approach we selected two Late Neolithic finds of possible bread buns from the site of Parkhaus Opéra, Zürich, Switzerland, which are extraordinary due to their excellent preservation and precisely recorded find context. By using them as a link between archaeobotanical plant macroremains of cereals and actual culinary practices, we seek to expand the knowledge of local food culture in the lakeshore dwelling.

Additionally, we suggest that the development of an up-to-date classification scheme for archaeological finds of cereal products is a desirable goal for future research–in particular against the background of the artefactual character of bread [3]. For the time being, we suggest the use of more general terms for archaeological finds containing processed cereals. The current research combined with approaches followed within the scope of the ongoing EU Horizon 2020 project PLANTCULT (ERC-2015-CoG 682529) [20], will be used as the basis for a typology of bread remains.

Taphonomy of cereal products

Most cereal products are the results of intentional removal or breaking down of the various types of plant tissues in the grains to varying degrees. The applied techniques include one or several processes in various sequences such as crushing/grinding/milling, sieving, soaking, boiling, fermenting, or baking/roasting, leading to improved palatability and digestibility (see short overviews in [14, 21, 22, 23]). However, these processes also greatly lower the resistance of these products to microbial decay as well as reducing their stability in water, which is why

even under otherwise favourable waterlogged conditions, these objects will quickly disintegrate [3]. This explains why the preservation of waterlogged bread and other processed cereal objects is unknown until today. The only documented suspected waterlogged bread find from Ipwege, Lower Saxony [24], later turned out to be a bread-like idol consisting of mostly beeswax [25, 26].

Desiccated bread finds have indeed been recorded since the 19th century [3], but are limited to extremely dry conditions in arid climates as documented by finds in Egypt [27] and Xinjiang, China [11, 28]. Cases of bread-like objects preserved by permafrost are unknown from the literature so far. Given the altogether unstable nature of cereal products in wet environments as mentioned above, for the time being we presume that archaeological cereal preparations (including breads) outside arid climates only preserve in a charred state.

Charred bread-like objects are not commonly found in prehistoric settlements. Among these, only lakeshore dwellings have resulted in relatively high numbers of intact finds of larger objects of cereal origin, including other equally rare and fragile remains such as complete cereal ears. As charred plant material is highly susceptible to mechanical stress [29], it is suggested that the deposition in water and gentle processes of sedimentation may play a major role as a selective force in the preservation of bread-like objects, not only by reducing predepositional fragmentation but also by minimizing post-excavational fragmentation by recovery techniques such as flotation [30].

There is also a seemingly high incidence of bread finds from ritual depositions in funerary contexts [16, 21, 31–35]. This may indeed emphasize a particular role that these bread-like objects may have played in burial rites [36], but may also just be the consequence of intentional (and careful) deposition, which therefore reduced the chance of shattering these fragile charred objects. Well-known *in situ* finds of intact breads in burned down Roman bakeries such as in Pompeii [37] or Carnuntum [38]–contexts where the objects did not undergo mechanical stress after charring–could also favour this hypothesis.

Research history of archaeological bread-like objects

Some of the earliest attempts to identify the components of archaeological bread date back to the late nineteenth/early twentieth centuries, when the first lakeshore dwellings were excavated, as documented for sites such as Wetzikon-Robenhausen at Lake Pfäffikon [9, 39], or Station See at Lake Mondsee [40]. Despite the fact that histological knowledge at the time allowed for the identification of cereal bran under transmitted light (e.g. [41–43]), analysis of charred cereal products requires either a reflected light microscope with magnifications of 200-fold or more, or sometimes an SEM–both of which were not available at the time. Heer [9] leaves no doubt that several "breads" from Lake Pfäffikon must have been made of millet, without expanding upon the reasons for this conclusion. Hofmann [40], although favouring the same idea for the Lake Mondsee bread objects, at least concedes they might contain virtually any cereal given they had been thoroughly dehusked and finely ground. Although re-examination of such finds is still clearly needed, the "millet breads of Robenhausen" are still being cited uncritically (e. g. [36]).