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# Middens, currents and shorelines: Complex depositional processes of waterlogged prehistoric lakeside settlements based on the example of Zurich-Parkhaus Opéra (Switzerland)

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ABSTRACT

Circumalpine lakeside settlements have been declared Unesco world heritage in 2011. Their importance is mainly due to waterlogged preservation of organic material and hence the outstanding potential of these sites for performing detailed archaeological studies of prehistoric societies. However, the details of the taphonomic processes (depositional environment, development of anoxia, lateral or vertical displacement of objects, etc.) have rarely been studied. Consequently, interpretations based on find distributions or comparisons of find densities remain difficult. Zurich-Parkhaus Opéra is a large-scale excavation of waterlogged Neolithic settlement deposits. Eight settlement phases of the late fourth and early third millennium BC were documented and dated using dendrochronology as well as six settlement layers, two of which showed excellent organic preservation. Based on a large number of sediment samples we conducted a multidisciplinary study in taphonomic processes influencing these layers. Our results indicate that a multi-indicator approach can provide detailed information on formation processes of waterlogged cultural layers. We found that 1) aquatic invertebrate remains and geotechnical calculations gave evidence for continuous shallow water conditions and eutrophic/anoxic deposition environment during occupation of the site. 2) Position and distribution of finds and loam patches indicate that disposal of household waste was focused on middens, which were still intact. 3) High variability in sediment contents (both spatially and in terms of state of preservation) is due to different factors such as oxygen depletion, deposition rate, erosion and enrichment of different materials, while all factors can affect each other resulting in highly complex formation processes.

## 1. Introduction

Prehistoric lakeside or wetland settlements with waterlogged deposits are common around the Alps. They have been the focus of archaeological research since the 19th century and form part of the Swiss national identity (Kaeser, 2004). However, similar sites exist in a much wider regional context. In Europe, wetland sites have as well been found e.g. on the Balkans (e.g. Chrysostomou et al., 2015; Todoroska, 2016; Naumov, 2016), the Baltics (e.g. Menotti et al., 2005) or Poland (e.g. Pydyn and Gackowski, 2011; Czebreszuk et al., 2010), but they also occur in other non-European regions (Menotti and O'Sullivan, 2013).

Large-scale excavations of coherent areas in such sites are rare, due to their high costs and complexity. Particularly, systematic interdisciplinary studies of the finds and sampled material are needed, since only under these conditions can such organically preserved settlement deposits be fully exploited for developing palaeoeconomic and -ecological studies e.g. concerning land use and the development of cultural landscapes (Jacomet et al., 2016) or for producing reconstructions of past social history (e.g. Röder et al., 2013; Schibler and Jacomet, 2010). In this paper, we discuss recently excavated finds and analysed samples from the large scale excavation of Neolithic settlements at Zurich Parkhaus Opéra (Switzerland). Based on the detailed findings from this site

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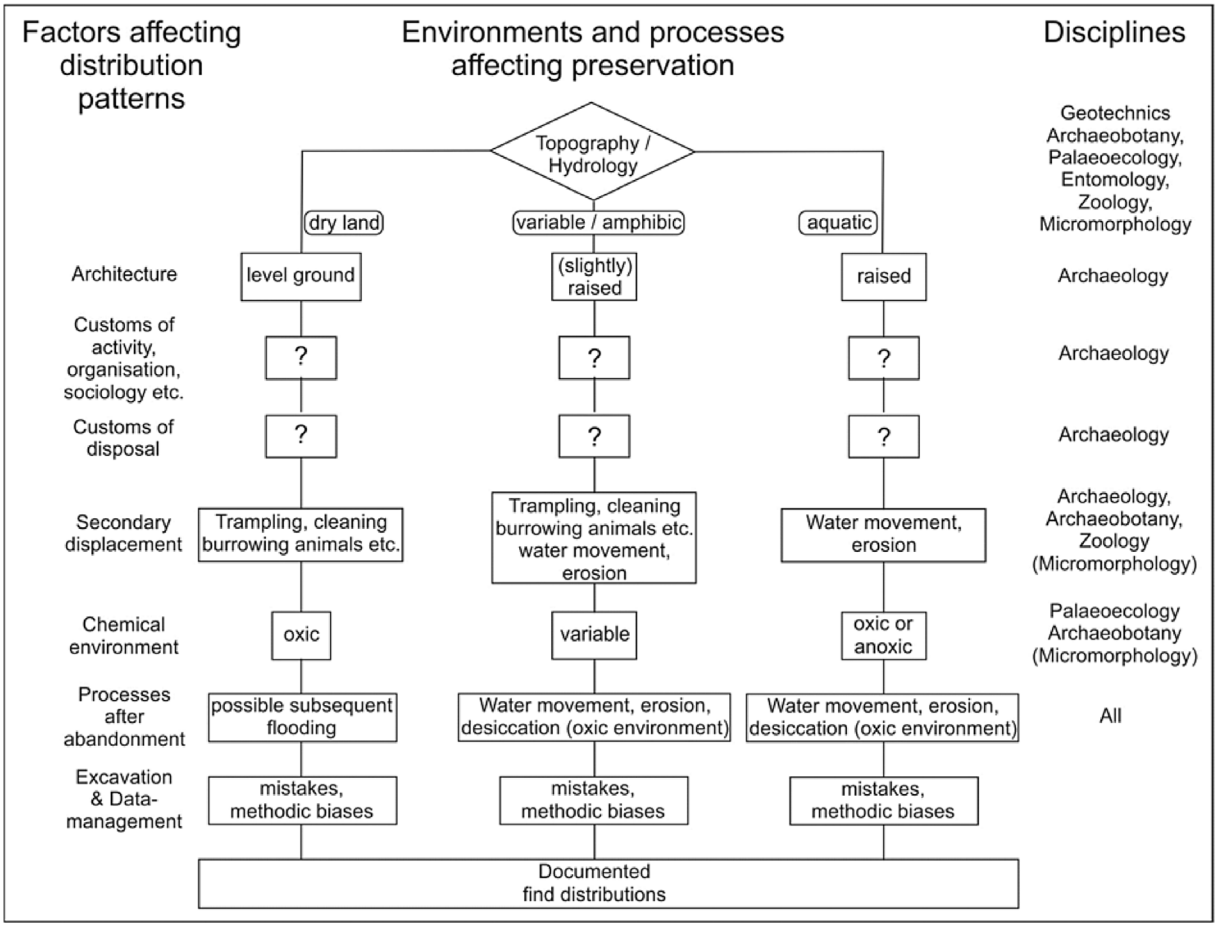


**Fig. 1.** Environments and processes determining and influencing find distributions in lakeside settlements and the disciplines that can contribute to their reconstruction.

we first try to identify the most important taphonomic processes that influenced layer genesis of these deposits and more generally affect preservation state and find distributions in prehistoric lakeside settlements.

The interpretation of rich datasets such as those obtained at our study site requires a thorough understanding of the particularly complex site formation processes in lakeshore environments.

Formation processes have been studied for decades (Schiffer, 1987), but mostly for sites on mineral soils. However, in wetland archaeology there have been a number of studies and sites for which these questions have not been answered in detail (e.g. Eberli, 2002, 87), where contradictions between disciplines led to discussion (e.g. Dieckmann et al., 2006, 198) or where results from some disciplines were not fully integrated into archaeological theories (e.g. Joos et al., 1980). The difficulties that cultural layers in lakeside settlements pose for research and interpretation gave rise to intense debate (see Dieckmann et al., 2006, 207–219; Bleicher, 2015) and were part of the reasons, why in some cases analysis and publication of the layers was delayed for decades (e.g. Ebersbach, 2015, 11).

In the past, taphonomic studies of waterlogged deposits at former lake shore settlements mostly focused on plant and animal remains or micromorphology of sediment structures (Jacomet, 1985; Brombacher and Hadorn, 2004; Deschler-Erb and Marti-Grädel, 2004; Ismail-Meyer, 2014; Steiner et al., 2018). Some of these studies aimed at high (micro-) stratigraphical resolution although only for a very limited area of the examined archaeological sites. In contrast, at Zurich-Parkhaus Opéra we focused on a combined examination of high-resolution stratigraphic analyses at several profile monoliths and extensive sediment scatter samples (according to Lennstrom and Hastorf, 1992) of large volume, which we call in the following text surface samples (for details see Steiner et al. 2017). These were systematically extracted from archaeological deposits across a large section of the excavated area. The analyses were supported by geotechnical calculations and detailed spatial analyses of find distributions.

### *1.1. General considerations on taphonomy in wetland sites and aims of this paper*

Reconstruction of cultural customs are the original aim of archaeology but this relies on the clarification of all other processes. Numerous factors determine both distribution patterns of objects in settlements and whether these are preserved or not. Regarding lakeshore settlements, these factors have been conceptualised as a series of processes at four levels or stages during layer formation (Bleicher, 2013). For the present study this concept has been expanded by including the topographical and chemical environment. Factors affecting distribution patterns are different in various environments (Fig. 1).

The depositional environment is crucial for wetland taphonomy, as it determines whether organic material is preserved. It is characterized by local physical and chemical factors, the most important of which are