Detecting cultural formation processes through arthropod assemblages: a conceptual model for urban archaeological waste-/cesspits
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INTER-SECTION

Innovative approaches by Junior Archaeological Researchers

II

INTER-SECTION
15 December 2016
Volume II

www.inter-section.nl

COLOFON

INTER-SECTION
Innovative Approaches by Junior Archaeologists
Volume 2
15 December 2016
ISSN Printed version: 2452-266X (200 copies)
ISSN Online version: 2452-2678
Cover photo: www.frogwell.com

Einsteinweg 2
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Layout and Editor of Illustrations
Joanne Porck

Printer
Drukkerij de Bink

Faculty of Archaeology

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DETECTING CULTURAL FORMATION PROCESSES THROUGH ARTHROPOD ASSEMBLAGES

A CONCEPTUAL MODEL FOR URBAN ARCHAEOLOGICAL WASTE-/CESSPITS

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Abstract

Archaeologists encounter cultural deposits on a daily basis. One possible method for demonstrating formation processes, and potential contextual re-positioning of particular deposits is by looking at arthropod remains. Many members of this phylum are likely to be preserved in the archaeological record due to their sturdy chitinous exoskeletons. They are highly abundant in practically any habitat, which makes them very suitable for formational reconstructions. This article proposes a conceptual model to link arthropod assemblages to cultural formation processes. By defining the systemic contexts as domestic, peridomestic and natural, and the archaeological context as an urban archaeological pit containing waste, the movement of deposits can be traced through the ecological implications of the present arthropod remains. The distance between the original systemic context and the archaeological context defines four different sub-assemblages. These are then further divided into groups that show the relationship with human activities to separate the natural from the cultural formation process and indicate the type of deposit based on synanthropicity. Furthermore, a number of niche groups are distinguished to indicate the material contents and characteristics of a deposit. Reconstructing the origins and characteristics of these deposits allow for a better understanding of site formations and the functions of pits. Especially when there is no visible stratigraphic succession at the time of excavation, high resolution ecological information can shed light on the stratigraphy of a pit.

Keywords

archaeoentomology, insects, synanthropic species, cultural formation processes, systemic contexts

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Introduction

At the base of the interpretation of archaeological features lies the understanding of their formation and taphonomy. These processes are either of cultural or natural cause, and can be referred to as C-Transforms and N-Transforms (Schiffer 1987), which can be very difficult to pinpoint. In many features there is an accumulation of deposits from different origins, which may result in a stratigraphy that is not clearly visible. This makes an interpretation of these features in the field difficult, if not impossible at times. The less 'attractive' a feature is, the less attention it would get due to limitations in budget and time. Especially pits that contain rubbish or sewage are likely to be overlooked (Smith 2013, 526). This is unfortunate, as the identification of these cultural deposits can provide many insights into activities such as waste-management, consumption patterns, house maintenance, (personal) hygiene, but furthermore on the successive uses of a feature.

Whether cultural or natural, it is likely that arthropods are silent witnesses that hitchhiked along with the deposits. Arthropods, like beetles and mites, are largely abundant in any habitat (Robinson 1996, 5). Their sturdy chitinous exoskeletons allow them to be preserved in the archaeological record. The use of these remains and their ecological implications are a useful way to separate the cultural from the natural formation processes, but they are often neglected in archaeological research (Elias 2010). In the search for anthropogenic activities, those arthropods that are known to interact with and benefit from humans and man-made environments form great indicators. These species are called synanthropes. For example, the grain weevil *Sitophilus granarius* cannot survive without indoor stored grains (King *et al*. 2014), and forms an indication for grain storage, consumption and waste-disposal.

Using ecofacts, or 'culturally relevant nonartifactual data' (Binford 1964, 432), as indicators for C-transforms is in sharp contrast with Schiffer's pioneering work on formation processes, where he considers ecofacts solely as natural formation processes (Schiffer 1987, 290-291). Since then, people have argued against this, showing that ecofact assemblages can well be a cultural formation process (Welinder 1991). The aim of this article is not to define which arthropod groups are indicators for a certain activity or feature as with indicator packages (*sensu* Kenward and Hall 1997), nor to describe species associations from urban deposits like Carrott and Kenward (2001) have done, but to create a preliminary arthropod-based model for understanding cultural formation processes, using an urban archaeological rubbish/cesspit as example. Urban in this sense refers to a human society where people occupy permanent domestic dwellings, with properties linked to those dwellings.

The trajectory of a deposit from the context of origin to the moment of final deposition can be described as the transition from systemic to archaeological context (*sensu* Schiffer 1972). In the example of the rubbish/cesspit, this feature is considered the archaeological context, and the conceptual systemic contexts are defined using concepts as described in Robinson's work on urban entomology. Conceptual systemic origins and synanthropicity are used to make cultural formation processes visible, by a number of subdivisions of the overall arthropod assemblage.

Between natural and cultural formation processes: defining systemic and archaeological contexts

The difference between a natural and a cultural formation process lies in the movement from the systemic to the archaeological context. In order to define move-

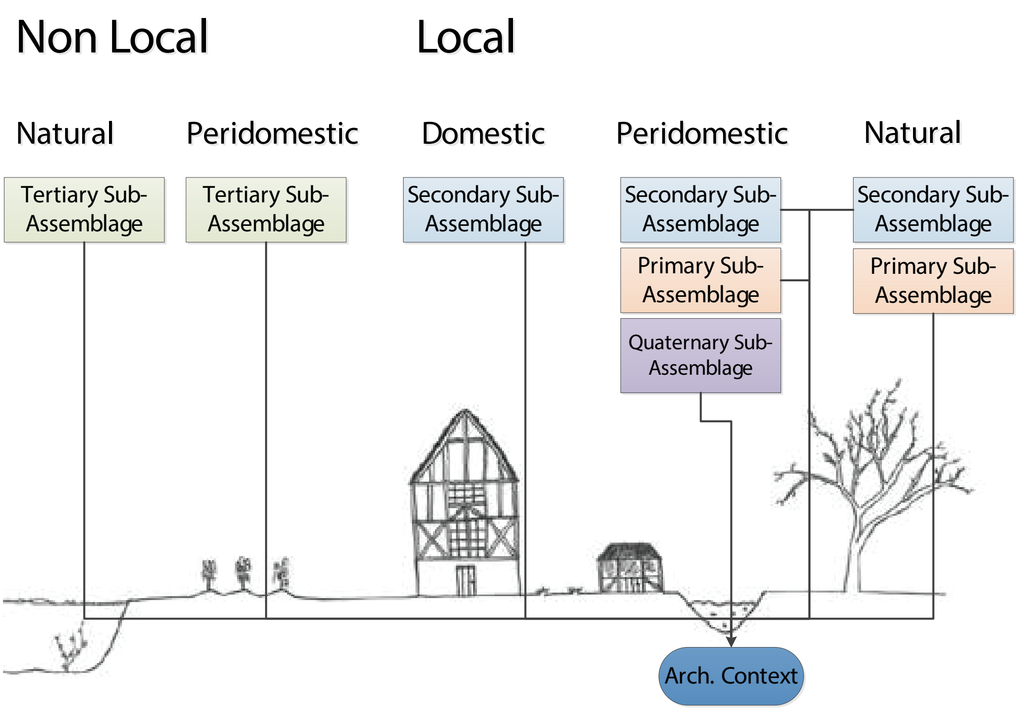

Figure 1. Representation of the sub-assemblages and their trajectories from systemic contexts of origin towards the archaeological context.

ment, i.e. a transform, the contexts need to be defined. Robinson (1996, 85-88) distinguishes a domestic, peridomestic and natural environment. For practical purposes, the peridomestic and natural areas here are subdivided into a local and a non-local area, to distinguish autochthonous from allochthonous taxa (figure 1). The domestic area is the local dwelling that is attached to the local peridomestic area. A house in an urban setting would have a property where activities take place that are linked to those in the home. For example, food preparation and consumption results in waste that may be deposited in features in the garden. There are many possible peridomestic features, such as a vegetable plot or a cesspit, or buildings such as stables, which are never domestic dwellings themselves. The local natural area encompasses the natural features in close proximity to or overlapping the peridomestic area. The non-local natural area is located elsewhere, and may be represented through imported natural resources. The non-local peridomestic area is any peridomestic area not directly attached to the home, and may be represented through imported cultivated resources. These make up five conceptual systemic contexts, while the archaeological context is the waste- or cesspit, a peridomestic feature. The possible movement of arthropods, whether as individuals or within a deposit, between these systemic contexts towards deposition is represented in figure 2, also showing the different trajectories of N- and C-transforms.

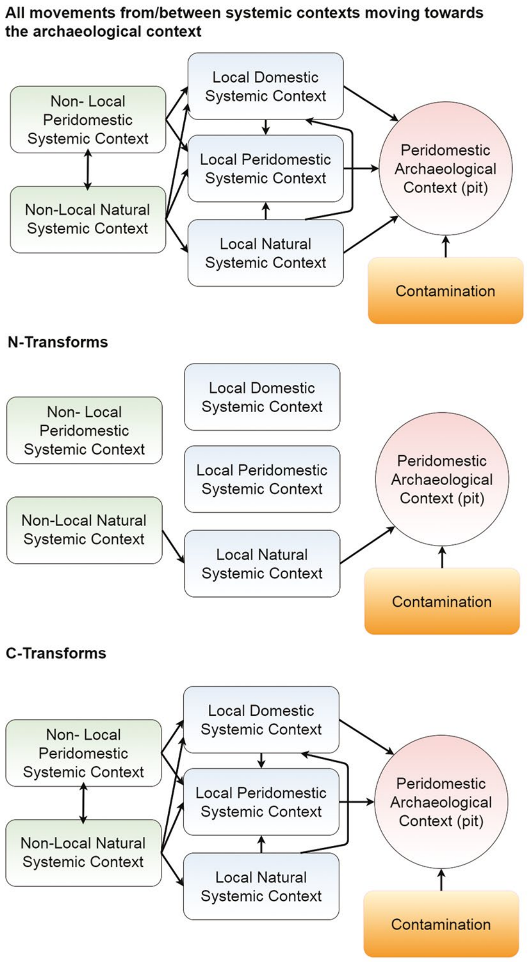

Figure 2. Assemblage movement from and between systemic contexts towards deposition and the distinction between N- and C-transforms.

The assemblage movement from and between the systemic contexts will ultimately result in deposition in the archaeological context. Therefore, the arthropod assemblage of a pit is an accumulated mixture of assemblages. In order to separate these, the overall assemblage is subdivided into four sub-assemblages.

Sub-assemblages: a division based on systemic context origin

Separating species communities allows for a better understanding of a deposit, but it will also make interpretation of the relative abundance of species possible, as there may have been a natural or anthropogenic selective process that resulted in over- or underrepresentation of species. Dumping a weevil-infested bag of grain into a pit will make a vast majority of the sample grain weevil, while this is solely based on one event, possibly blurring out other less abundant species. Although it is useful to identify an event, the superabundance of a taxonomic group might overshadow the ecological implications of smaller groups, for example statistically or in a visual representation.

The four sub-assemblages are based on the original systemic contexts, and have travelled a certain relative distance before deposition. Faunas originating from a non-local source need to pass through the local area before reaching the archaeological context (figure 1). The sub-assemblages are subdivided into synanthropic and natural groups, showing what the relationship in regards to human activity is. In a local systemic context, the ecological implications of taxa can indicate the intermediate actor of deposition, either a natural cause or an anthropogenic one for synanthropic taxa. This does not necessarily account for non-local faunas because a direct importation from a non-local source to the local peridomestic area is likely to be an anthropogenic activity. The sub-assemblages with ecological groups and the depositional implications is given in table 1.

Sub-assemblage	Synanthropicity	Depositional implication
Primary sub-assemblage	Synanthropic	Independently deposited due to attractive circumstances in and around the archaeological context.
	Natural	Independently deposited, but incidentally.
Secondary sub-assemblage	Synanthropic	Deposited through an anthropogenic activity.
	Natural	Deposited through a natural activity.
Tertiary sub-assemblage	Synanthropic	Deposited through anthropogenic activity with a minimum of one previous systemic context.
	Natural	Deposited through anthropogenic activity with a minimum of one previous systemic context.
Quaternary sub-assemblage		Contamination from neighbouring sediments / deposits and modern faunas.

Table 1. An overview of the four sub-assemblages with the depositional implications of the synanthropic and natural groups.

The primary sub-assemblage encompasses all taxa that have independently deposited themselves. This is the fauna that was effectively alive at the time of deposition. The synanthropic group includes the fauna that was attracted to specific circumstances in and around the pit at the time. This forms an indication of the presence of certain materials in a specific state, such as water, carrion, or excrements. The natural group deposited itself by accident, meaning that there are no beneficial factors for them, with the pit becoming their death trap. This group can be considered background fauna (*sensu* Kenward 1978) from the local natural area, like carabid beetles that wandered into a cesspit.

The secondary sub-assemblage indicates that there is either a natural or anthropogenic intermediary depositional actor between the systemic and archaeological context on a local level. The taxa in this sub-assemblage are not necessarily alive during deposition or able to survive inside the archaeological context. The synanthropic group includes the taxa that are either moved from their systemic context in the domestic or peridomestic area by anthropogenic action, for example the disposal of straw flooring. All other deposits which have occurred without involvement of people are included in the natural group, such as arthropods deposited through illuviation or bird pellets (Kenward 1978, 7).

The tertiary sub-assemblage encompasses the taxa that were imported from a non-local natural or peridomestic source. These deposits have had at least one intermediary systemic context. Both the synanthropic group and the natural group would have been imported by humans, before being brought into the (peri-)domestic area, as migrating faunas from a non-local natural source would become part of a local area first. These natural faunas could only be differentiated from one another if the ecological circumstances differ greatly, for example through niche modelling. The synanthropic group is likely to include agricultural pests, being imported along with fresh produce from a non-local peridomestic source. The natural group could contain either intentionally or unintentionally imported arthropods from a natural source through anthropogenic activity. Intentionally imported taxa could include edible crustaceans, whilst the unintentionally imported taxa could be any species that lived or are living in or on imported natural resources (Kenward 1978, 11-12). This could be inhabitants of imported wood, but also older sub-fossils present in peat.

The quaternary sub-assemblage represents contamination in the form of remains from neighbouring deposits or sediments, or modern arthropods. This assemblage may not hold information on the past environment or human actions, but may originate from other contexts, for example due to the collapse of a wall or mixing due to flooding, or a more recent taphonomical process, such as ploughing, and became part of the current archaeological context.

Visibility of C-transforms through synanthropes: commensals and pests

Biological and ecological data is needed to trace the meaning of the sub-assemblages. Synanthropic species and communities have proven useful to reconstruct human activities (King 2014, Forbes and Milek 2014). However, in separating the natural from the cultural formation processes in a pit that forms an accumulation of deposits, understanding synanthropic ecologies and species associations is a helpful aid. The applicability and potential of synanthropic ecological data to determine specific anthropogenic actions is presented in a case study on Icelandic turf buildings (Forbes and Milek 2014, 197-198). Nowadays, insect ecological data can be easily accessed through the *BugsCEP* database, which is still being improved (Buckland 2014).

On a somewhat larger ecological scale than species communities, a differentiation is made between commensals and pests. The commensals are those synanthropes that benefit from man-made environments without causing any harm or nuisance. If humans deposit their cess in the back of the garden, any dung beetles that may be attracted to that will not have any negative influence on the people's daily lives. Pests on the other hand do inflict damage on humans directly, to their food resources or possessions (Robinson 1996, 56). The more stenotopic, or confined to a small range or environmental conditions, the present species are, the more detailed the information is that we can retrieve from the remains. The aforementioned *Sitophilus granarius* can only thrive on stored grains, while the blind and wingless beetle *Aglenus brunneus* has been found in different anthropogenic habitats with organic components (Kenward 1975, Buckland *et al*. 2009). Many *Staphylinidae* beetles are likely to occur in human environments to hunt other arthropods, but are eurytopic and unsuitable for the reconstruction and differentiation of deposits (Kenward 1978, 5-6). Also peridomestic pests can be encountered (Robinson 1996), feeding on crops or occurring on livestock as parasites. Parasites do not directly affect the produce, but can be a nuisance to their hosts. Some are seemingly peridomestic, such as *Damalina ovis* or the sheep louse, forming an indicator for the presence of sheep, whilst *D. bovis* points archaeologists in the direction of cattle presence (Smith 2012, 55-56). Correct interpretation is not too easy, as these species are more likely to have occurred on the hides than on the animals themselves (Smith 2012, 55-56). Although these are then not an indication for the presence of live animals, they can form an indication for the processing of hides and carcasses, possibly in the domestic area.

The commensals and pests are all part of larger communities, which may or may not be observed in the archaeological record, depending on the selective process of deposition and over- or underrepresentation as well as post-depositional taphonomic processes. Figure 3 gives examples of such faunal groups, as can be observed in waste/cesspits and where they would fit in the grand scheme of deposit origins.

Archaeological applicability and future prospects

Understanding depositional trajectories allows understanding of 'invisible' stratigraphies and functions. A pit may have gone through successive phases of use during its life-span on which arthropod remains can shed new light. Also, as a part of an interdisciplinary research, it can be of aid to simply reconstruct the function of a pit in the first place. The identification of features in the field is not always done correctly, for which manure pits as found in Dutch medieval contexts form a great example. A vast number of relatively shallow, rectangular features with organic fillings are described as manure pits, but differ greatly in arthropod composition (Aerts, in prep.), thus indicating different characteristics and function. Interpreting and describing manure pits as seemingly uniform has caused confusion, but can be avoided through a more in-depth analysis (Aerts, in prep.). An interdisciplinary specialist study would help prevent such misinterpretations from seeping into the academic and grey literature, allowing archaeologists to do better research. It provides researchers with a more objective toolkit to interpret features. Arthropod remains can indicate the importation of resources, and which materials were discarded, how and where. They can help understand in what state the deposited materials

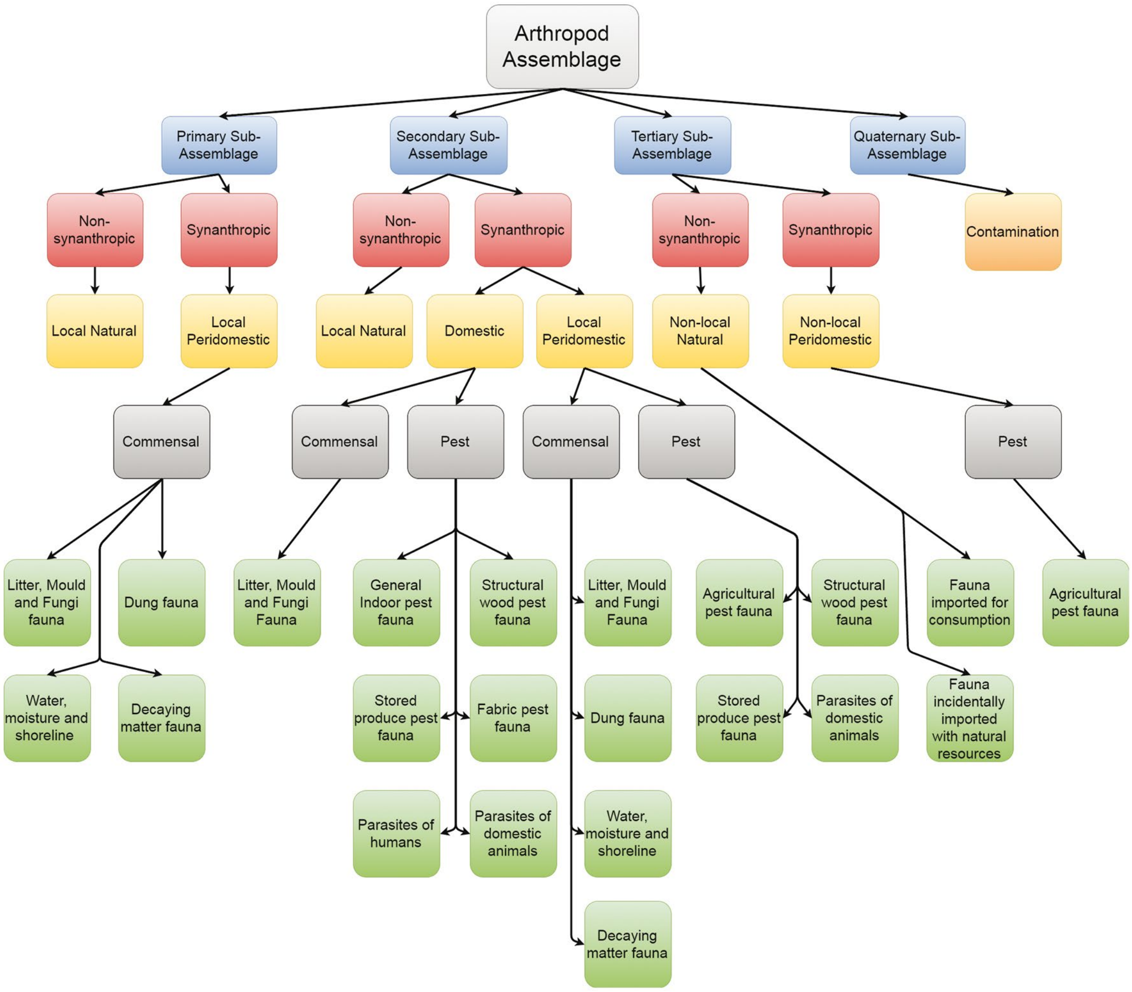

Figure 3. The overall proposed subdivisions of an arthropod assemblage.

were at the time of deposition, and explain why they were discarded. It can also provide information on the circumstances under which this happened, what the state of the feature was, for example open, closed, waterlogged or dry. Specific faunas can help to place a feature in a wider environmental context and understand its taphonomy. Overlaps in systemic contexts and ecological ranges of the arthropods will form limitations to some extent, and need to be dealt with cautiously through the correct use of modern habitat data. Ecological niche modelling can be a useful tool, if we can statistically deal with the differences in representation of taxa from different origins. It would be a step closer to a better understanding of our archaeological features, and a step towards a more fine-tuned cooperation between fieldwork and lab work.

Conclusion

This article has shown on the basis of a conceptual model that it is possible to trace deposit movement from systemic to archaeological context through arthropod remains, and how these movements indicate formation processes. It has also shown that synanthropicity is a way to differentiate the natural from the cultural transforms, as well as utilising arthropod ecologies to distinguish allochthonous from autochthonous faunas.

Pinpointing cultural formation processes through arthropods does not only refute Schiffer's theory that ecofacts are only indicators of natural formation processes, but it also has a practical applicability. Tracing C-transforms provides information on the anthropogenic (successive) uses and impact on an archaeological feature. This implies more precise interpretations of archaeological features and better (future) research by studying insects, arachnids and other arthropods.

Acknowledgements
I would like to thank the following people, without whom this paper could not have been realised: the editorial board of *INTER-SECTION*, for giving me this opportunity and their full support, Drs. Tom Hakbijl (Naturalis Biodiversity Center) for sharing his knowledge with me, Dr. Roos van Oosten (Leiden University), for always willing to discuss and correct my writing, and my anonymous peer reviewer for providing me with great feedback. I also want to thank my friends who read the paper in various stages to help me improve my writing, you know who you are.

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ISSN Printed version: 2452-266X (200 copies)
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