

A Study of Dog Coprolite from Late Neolithic Pile-Dwelling Site in Slovenia

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Abstract

More than 5000 years old dog's coprolite was found during rescue excavation at *Črnelnik* pile-dwelling site in Slovenia. Although human and dog diets may overlap considerably, the content of the consumed and digested food, consisting of plant and/or animal remains biologically diverse. While the investigated fossil excrement contained many fish head bones, scales and teeth of Cyprinidae family, we believe that we are dealing with an individual that had only eaten fish heads, that is why it was suggested to be of dog. Beside the origin and the daily diet of the individual together with the nutritional habits of the dog in the Late Neolithic, the analyses of coprolite provide more important information, for example: the time of year of the deposit, the environmental conditions there, the size and the health of the animal as well as care (or the status) of domesticated animal for humans. The discovery confirms again that animal dung should be an important part of archaeological investigations, specially at waterlogged sites.

Keywords

Archaeobiology, Nutrition, Late Neolithic, Coprolite, Dog

1. Introduction

Archaeobotany and archaeozoology are important natural sciences that supplement archaeological investigations. Both botany and zoology are closely connected to human activities. Nutrition supplies (for people and domesticated animals), as well as material for building activities or weapon and tool production are all connected with natural materials, both plant and animal. Archaeobiological material can be well preserved in waterlogged conditions where organic

remains are often preserved in an uncarbonised state and in large amounts. Circum-Alpine prehistoric lake-shore settlements are typical such archaeological sites. The Ljubljansko barje region in Slovenia with more than 40 pile-dwelling sites from the 5th to the 2nd millennium cal BC (Velušček, 2004) is the most southeasterly region of those sites (Figure 1).

Archaeological layers of lake-shore pile-dwelling sites are always composed of a variety of components derived from human and animal activity (Jacomet et al., 2004). Well preserved coprolites (fossil excrement remains) can often be found as well (Byrne, 1973; Akeret & Jacomet, 1997; Kühn et al., 2013). They are found whole or fragmented, uncarbonised and from various animals such as mice, sheep/goats, cattle, dogs etc. as well as from humans. Beside the daily diets of the individuals and their nutritional habits, the analyses of coprolites can provide more important information, for example: the time of year of the deposit, the environmental conditions there, the size and the health of the animal, care (or the status) of domesticated animals for humans, endoparasites if present, and finally also an exact C14 dating of the consumed plant/animal macroremains. The organic material of terrestrial plants and animals preserved in waterlogged conditions are one of the most suitable archaeological matter for radiocarbon dating. Therefore animal dung should be an important part of archaeological investigations at waterlogged sites. Goat and sheep faeces have been investigated relatively often because they are compact and, therefore, are not always destroyed by sieving (Akeret & Jacomet, 1997; Akeret et al., 1999; Kühn et al., 2013). Cattle dung is often a mixture of faeces, stable litter, fodder and material that had nothing to do with cattle management (Kühn et al., 2013). Not so often, but randomly, dog or human coprolites can be found as well, when the excavation is careful and precise (Byrne, 1973). They are compact and therefore easy to

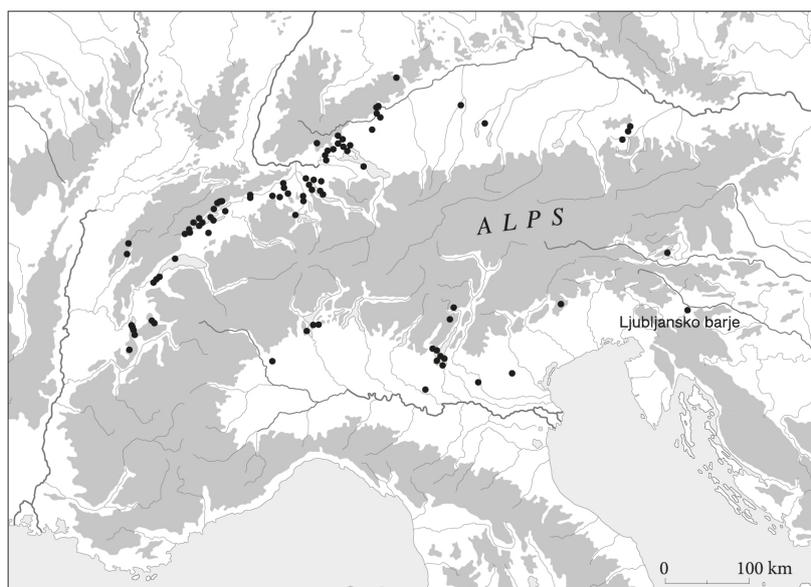


Figure 1. Geographical position of the Ljubljansko barje (longitude: 14°29"; latitude: 46°0") in the European Circum-Alpine lake-shore (pile-dwelling) sites.

recognize. While their outer structure and shape are similar to human or pig coprolites, the inner composition may differ (Byrne, 1973). While many studies have been made on goat/sheep faeces in order to investigate prehistoric management of domesticated animals and transhumance (Akeret & Jacomet, 1997; Akeret et al., 1999; Kühn et al., 2013), dog coprolites have not often been analysed, although the osteological investigations on them show that the dog was an important human companion in the Eneolithic (Bartosiewicz, 1999, 2002). The probable reason for the previous lack of study is that dog coprolites are not so often found.

2. Materials and Methods

Presumably dog or human well preserved waterlogged excrement in the cultural layer of the Late Neolithic pile-dwelling site *Črnelnik* in Slovenia was found in 2014, when the mechanical excavation of the ditch for the sewerage began (Velušček et al., 2018). Excrement of *Canis familiaris* (dog), as well as of human, mostly show an elongated, sometimes segmented shape (Jones, 1990). Well-preserved specimens are rarely found (Brönnimann et al., 2017). The one from *Črnelnik* site was dark brown, with a length of ca. 6 cm, and a width of ca. 2-3 cm (Figure 2).

The typical shape, colour and structure suggest that it is of dog or human origin (Byrne, 1973; Harrison, 2011; Brönnimann et al., 2017 and Link—<http://www.scirpus.ca/dung/mammal.php>). While the content of the consumed and digested food, consisting of plant and/or animal remains biologically diverse, the content of digested materials was investigated in the archaeobotanical laboratory by the methods of gently disaggregation and washing over 0.056 mm mesh sieve (following Jouy-Avantin, 2003). Then the macroremains caught on the sieve were sorted out and identified using a Leica MZ75 stereomicroscope with up to 50x magnification, with the aid of the reference collection of the plant remains at the Institute of Archaeology, ZRC SAZU and osteological fish bone reference collection at the Austrian Archaeological Institute. Identification atlases and keys were used as well (Schmid, 1972; Granadeiro & Silva, 2000; Capers et al., 2006).



Figure 2. The coprolite from *Črnelnik* site. Photo: D. Valoh.

3. Results and Discussion

On the first view, the coprolite showed mineralized structure, it was compact, hard and resistant to pressure, therefore it was not easy to disaggregate it. As the coprolite was waterlogged preserved, the remains caught on the sieve were mostly uncarbonised preserved. They were precisely sorted, counted and identified in wet conditions. All together, 20 ml of the organic fraction was caught on the sieve. Animal remains, mostly uncountable unidentifiable flat bone fragments and fish scales and pharyngeal teeth of the Cyprinidae family prevailed. Among plant macroremains, six taxa were identified (**Table 1; Figure 3**). Some very small fragments of charcoal were present as well.

We found out that the specimen (most probably the dog) enjoyed diverse food. The scales, teeth of fish, and uncountable unidentifiable flat—most likely skull bone remains of fish heads, prevailed (**Figure 3(a), Figure 3(b)**). Interestingly, there were, except of one individual (**Figure 3(f)**), no fish vertebrates included, indicating that the specimen only fish heads had eaten. Therefore we conclude that the excrement most likely belongs to the dog. Rare plant remains testify that the dog also enriched its menu with vegetable food as well. Jones (1986) established that less than 10 % of ingested bones survived passage through an animal's digestive system: beside some skull and cranial elements, the vertebrae survived as well. Beside the absence of the vertebrae, the absence of larger content of plant macroremains (except individual seeds; **Table 1, Figure 3(c)**) additionally convinced us that this is most probably dog's excrement. Byrne (1973) has recognized the differences between dog coprolites which contain

Table 1. The content of macroremains in the coprolite from Črnelnik site.

Number	Content
PLANT REMAINS	
4 seeds	<i>Rubus fruticosus</i> agg. (blackberry)
1 seed	<i>Linum usitatissimum</i> (flax)
3 seeds	<i>Chenopodium album</i> (white goosefoot)
1 seed	<i>Brassica rapa</i> (turnip)
1 seed	<i>Betula</i> sp. (birch)
1 frg. of fruit and 1 frg. of leaf	<i>Trapa natans</i> (water chestnut)
FISH REMAINS	
x	skull and cranial element fragments
x	pharyngeal teeth of Cyprinidae
x	scales of Cyprinidae
3 fragments	finrays
1	epihyale
1 fragment	vertebra fish unident.

x—many, not counted.

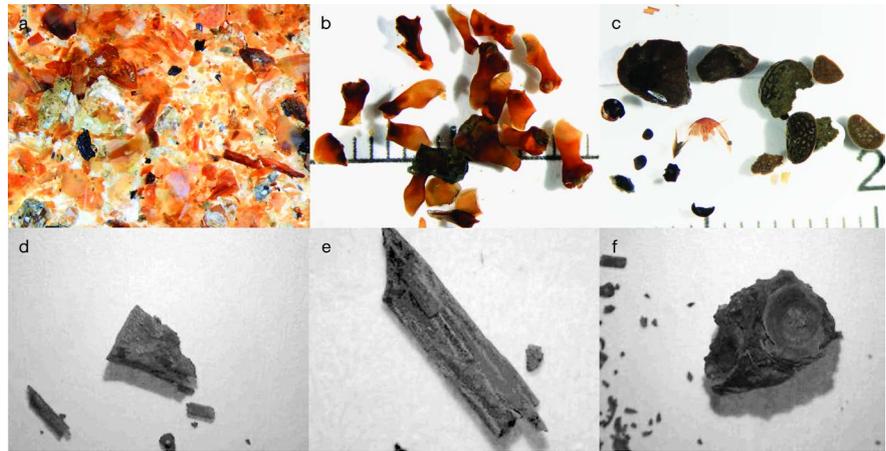


Figure 3. An example of macroremains from the coprolite, after processing in the archaeobotanical laboratory. Numerous flat fish remains, scales (a) and teeth (b), plant macroremains (c), epihyale fragment (d), finray fragment (e) and single vertebra remain (f). Photos: D. Valoh (a-c) and A. Galik (d-f).

mainly fish bone fragments, and human coprolites which contain mainly plant remains. The absence of fur or animal hair suggest that we are neither dealing with a wolf, for which larger content of hairs are typical in the excrement (Skrbinšek, 2010 and Link—

http://www.volkovi.si/wp-content/uploads/2014/10/zimsko-sledenje_navodila-koncna.pdf).

Beside nutrition habits and the diet of the individual, the preserved macroremains give also other important information. The size (the width) of the excrement suggest that the dog was some smaller than a wolf, for example, which excrement measures about 3 cm in width, smaller wolfs 2 cm, while the biggest ones up to 4 cm in width (Skrbinšek, 2010).

Another information gives the remain of birch fruit for example, which extend its seeds from the late summer till the winter time; and also other recognized seeds/fruits (i.e. of water chestnut, flax, turnip, blackberry and goosefoot) are mature in late summer or autumn, what gives the information of the deposit (excrement) period of the year and consequently the settling period, which was most probably permanent (during whole year seasons; Čufar et al., 2010; Tolar et al., 2011).

Ecological conditions at and around the site could be discussed as well. Birch and water chestnut evidence marshy ground and the existence of slow flowing river or a lake, while the others (flax, turnip and goosefoot) evidence fields and other anthropogenic areas (Kreuz & Schäfer, 2011; Tolar et al., 2011). Fishes of the Cyprinidae family, collectively called cyprinids, that includes carp, true minnow, and their relatives, is the largest known fish family with about 3000 living and extinct species in about 370 genera. Some of the fish remains are isolated pharyngeal teeth (Figure 3(b)) of typical freshwater species like rudd or roach (Kottelat & Freyhof, 2007).

Predominantly uncarbonised remains of fish heads in the coprolite indicate

organic refuse management as well. The culture of eating fishes and the importance of the lake for the neolithic economy can be illustrated at various pile-dwelling sites (Torke, 2000; Govedič, 2004; Hüster-Plogmann, 2004; Jacomet et al., 2004; Jörg, 2006; Kottelat & Freyhof, 2007; Galik, 2009). One of the explanations could be that humans ate fish bodies, while the heads were thrown to dogs (Ewersen & Schmölcke, 2013), very likely even before roasting, while the fish remains were uncarbonised preserved. More evidences (with more dog coprolite investigations) should be performed to confirm this hypothesis. Additionally, the care (and the status) of domesticated animal for humans could be discussed. It seems that dog's master knew that fish heads are safer food for his dog than fish bodies (with lots of peaked bones), what leads to a suspicion that humans took care for dogs, what consequently prove that the dog had an important status for humans (Bartosiewicz, 2002; Ewersen & Schmölcke, 2013; Janssens et al., 2018).

4. Conclusions

Coprolites of *Canis familiaris* (dog) as well as of human are regularly reported in various archaeological contexts (Macphail, 2000; Ismail-Meyer & Rentzel, 2004 and etc.), but rarely as completely preserved specimens. Therefore dog faeces from the Črnelnik site is valuable and remarkable find that has been worthwhile to investigate. We assume we are dealing with the coprolite of dog origin, because uncarbonised remains of fish heads (teeth, scales and flat bones) of Cyprinids were mainly preserved (Figure 3). It would make sense to re-excavate at the Črnelnik site, not only for the possibility of obtaining some more coprolites that are possibly abundant at that site, other archaeological and archaeobiological investigations could also be carried out at the same time, since other very interesting finds have been found at this site (Velušček et al., 2018). The investigation of only one well preserved coprolite sets out to explore the possibilities of coprolite analysis in wetland prehistoric archaeology. The presented initial strategy of investigating macroremains content in the waterlogged faeces is going to be the basis for future researches of newly excavated material (possibly dog or human coprolites) in Slovenia (Ljubljansko barje), as well as at other wetland sites. If more material (i.e. coprolites) available, different possible means of extracting data could be performed, beside plant and animal macroremains, also parasites (which beside biological origin of the sample, brings with it information that relates to many domains: primarily, palaeopathology and sanitary conditions, but also palaeodietetics, organic refuse management and cultures; Bouchet et al., 2003; Le Bailly et al., 2003, 2005), micromorphology (Macphail, 2000; Akeret & Rentzel, 2001; Ismail-Meyer & Rentzel, 2004; Brönnimann et al., 2017), pollen (Martin & Sharrock, 1964; Horrocks & Irwin, 2003), C14 dating, DNA extraction (Iñiguez et al., 2003) as well as biomarkers (such as lipids and stable isotopes which evidence totally digested food such as dairy products; Gill et al., 2009). All the investigations are intended to provide a range of information about past life in the pile-dwelling settlements, not only about the diet. If more

canine coprolites investigated, cultural heritage could be discussed as well, for example why the hunter-gatherers kept dogs; were they domesticated dogs and kept only for particular purposes such as helping with hunting, or were they regarded also as pets, and how were they kept, fed and what care or importance were they given (Ewersen & Schmölcke, 2013; Janssens et al., 2018)?

The presented research is the first investigation of coprolites in Slovenia, the most southeasterly region of Late Neolithic circum-Alpine lake-shore sites, where such finds are not rare. It has an important impact for the development of new research directions there, and on the other hand, it contributes to the database which is already available from comparable prehistoric waterlogged contexts in Europe (Bouchet et al., 2003; Le Bailly et al., 2003; Kühn et al., 2013; Maicher et al., 2017 and Link—<http://www.scirpus.ca/dung/mammal.php>). While this type of find material is scarce and hard to obtain, and therefore only rarely investigated, each analysis of it counts and is original and exceptional.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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