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Stone age disease in the north – Human intestinal parasites from a Mesolithic burial in Motala, Sweden

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ABSTRACT

Eggs from an intestinal parasite has been found in a burial radiocarbon dated to 5210-4840 cal BC in Motala, east-central Sweden. The two helminth eggs are identified as *Trichuris trichiura* (human whipworm). Control samples from the cemetery site were all negative and confirmed that there was no evident contamination of younger material. This discovery raises new questions concerning the early geographical spread and timing of parasitic diseases among hunter-gatherer societies in northern Europe, and in the temperate zone of the northern hemisphere. Whipworm infection (Trichuriasis) is perhaps the disease most associated with crowding and poor sanitation, and as it manifests itself in the youngest dated burial, it could be a contributing factor to the final abandonment of the Mesolithic settlement. Also, parasite eggs found in a soil sample from the Neolithic Alvastra pile dwelling could indicate the continued presence of the *Trichuris* parasite in east-central Sweden. Generally, parasite ecology can aid in reconstructing human behaviors that include aspects of sedentism, mobility, food preferences, hygiene and other social practices.

1. Introduction

Very little is known about the spread of intestinal parasites during the Mesolithic in general, and in Scandinavia, no finds of parasite eggs seem to be previously reported from any Stone Age sites. From northern Europe, only Dark (2004) have reported finds of parasites from Mesolithic contexts at Goldcliff, England. *Trichuris* eggs of unknown species were found in pollen samples from an intertidal peat deposit with traces of human activity dated between 5600–5200 cal BC. The eggs were well within the size range of *Trichuris trichiura* but the lack of a more human context, such as a burial, prohibited an identification to human whipworm. The only previous studies to have reported finds of *Trichuris trichiura* of similar age, is from South Africa (10 000–7000 BP) and Brazil (8000-7000 BP; Gonçalves et al., 2003; Mitchell, 2013). This raises questions if the disease spread during the Late Mesolithic along certain migrating routes (discussed by Araújo et al., 2008b), and if the spread was associated with a change to a more sedentary lifestyle among hunter-gatherer populations.

Relatively few parasitological studies from archaeological contexts have to date been published from Scandinavia, and none from Sweden. However, earlier unpublished studies include analysis of coprolites from the Viking age town of Birka, where Sven Karlsson (Stockholm University) recovered eggs of the *Ascaris* (large roundworm) and *Trichuris* genus. Also, at the Bronze age settlement site of Apalle, parasitologist Dan Christensson of the Swedish National Veterinary Institute, found *Trichuris* eggs in a refuse pit. In Denmark, there are published reports of a few archaeoparasitological studies, such as Roepstorff and Pearman (2005), who found *Trichuris* sp. (*Trichuris suis* and *Trichuris trichiura*) as well as other parasites to be common in early medieval Viborg. And from Ribe, Nansen et al., (1977) reported finds of *Trichuris* sp., *Ascaris* sp. as well as other parasites, in culture layers of early medieval age. Research from Norway showed that *Trichuris* were present in the cold temperate region during the late medieval period (Schia, 1979). Although the number of studies is few, the general indication seems to be that the *Trichuris* parasite thrived in southern Scandinavia at least during early medieval time. This pattern was extended further north in Sweden with the investigations in the town of Nyköping, where eggs of *Trichuris trichiura* and several other parasites were found in relatively high concentrations in town contexts from the early medieval period (Heimdahl and Bergman, 2016).

Human whipworm infection is a soil-transmitted parasitic disease, one of the most common in the world, infecting several hundreds of millions of people today, mainly in tropical Asia, Africa and South America. The infection rate (prevalence rate) of human populations in third world rural areas are often between 80 and 100% (Roepstorff and Pearman, 2005). It has been discussed more recently, e.g. by Mitchell (2013), that human whipworm is an "heirloom parasite", meaning it has been present during human evolution since before modern man migrated out of Africa. But that does not mean it has infected every human population ever since. In paleoparasitological studies and

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reviews from America (Bouchet et al., 2003; Gonçalves et al., 2003; Araújo et al., 2008a, b), there has been discussion about the spread of *Trichuris trichiura* and its prehistorical distribution into northern latitudes. Geohelminths such as *Trichuris* infect hosts through eggs that need to mature in the soil and are generally considered to require humid and warm climatic conditions. Its distribution during modern-preindustrial time in northern temperate regions is less well known, since sanitary facilities and medicines developed during the industrial period, greatly reduced the disease during the 20th century in e.g. Europe and North America. It has however been suggested by some researchers that human geohelminths in general could have been almost as common in Northern Europe during pre-industrial time as today in the third world rural areas (Metsis et al., 2003). How soil-transmitted diseases like Trichuriasis affected people in the past can at present perhaps be more easily incorporated into our understanding of sedentary agricultural societies, like the majority of prehistoric and historic cultures from Neolithic time until present. But how would the lifestyle of people in a hunter-gatherer society be affected by such a weakening disease, living in a subsistence economy? In this study, we present parasitological data from the Mesolithic burials at Strandvägen and discuss their implications. Also, to further highlight the great potential of archaeoparasitology, and show that human parasites prevail in the northern environment, a small-scale study conducted on archaeological samples from the Neolithic Alvastra pile dwelling is included in this paper. Despite being in museum storage for a long time, samples of this kind can readily be used for future parasitological research.

1.1. The Strandvägen cemetery in Motala

The area of Motala, at the outflow of Lake Vättern, the second largest lake in Sweden, has been interpreted as a central place in the Mesolithic society of the region (e.g. Carlsson, 2008; Larsson and Molin, 2017; Molin et al., 2014). Three contemporary sites (Strandvägen, Verkstadsvägen and Kanaljorden) located along the river Motala Ström, comprise without comparison the largest and most complex Mesolithic settlement in east-central Sweden (Fig. 1). Excavations from 1999 until 2013 has revealed extensive settlement remains (Hagberg and Westermark, 2015), water-deposited sediment layers with refuse material, ceremonial contexts with deposited human remains (Eriksson et al., 2018; Hallgren and Fornander, 2017), and a Mesolithic cemetery (Gummesson and Molin, 2016), all dating between 6000 and 4500 cal BC, but with the majority of remains from 5600 to 5000 cal BC. The cemetery at the Strandvägen site, where the archaeoparasitological investigation was carried out, is contemporary with the adjacent settlement area, where i.a. several dwellings, hearths, cooking pits and workspaces have been investigated (Molin et al., 2018). Nineteen burials have been excavated and interpreted as Mesolithic, and 13 of them have been AMS radiocarbon dated to the Late Mesolithic period (Gummesson and Molin, 2016). The burial of special interest, burial no. 4, was of primary burial type and contained an adult skeleton in supine position (Fig. 2). The cemetery is placed in an area of sandy till, with overlaying patches of postglacial sand.

1.2. The Alvastra pile dwelling

This Neolithic site is located in the Alvastra fen, a part of a peatland complex southwest of Lake Tåkern, about 35 km southwest of Motala (Fig. 1). It has been a target of several archaeological investigations from 1909 to 1980, and some of these are reported by Browall (e.g. 1986, 2011, 2016). The pile dwelling consists mainly of well-preserved log platforms and extensive occupation remains from the middle Neolithic period (c. 3300-2700 cal BC). A large assemblage of pottery has been retrieved from the pile dwelling and have been attributed to both the Funnel Beaker Culture and the Pitted Ware Culture (Hinders, 2017). A wide range of botanical remains have also been examined during the archaeological investigations (Göransson, 1995).

2. Materials and methods

In order to examine the human remains from the Mesolithic cemetery for intestinal parasites, a total of 12 soil samples were collected from the pelvic area in 10 burials. Sampling depended heavily on the degree of preservation of skeletons and burial pit stratigraphy; in some burials the pelvic area was very difficult to locate (Fig. 2). Seven control samples were analysed from top soil layers, nearby medieval settlement remains, and from sections in the filling of pits in and around the Mesolithic cemetery. The nearby medieval remains were composed of carbonized organic material in low concentrations, such as charred cereal fragments and wood. No macroscopic uncharred organic material was found in the samples from the cemetery area, except modern vegetation (rootlets).

All material used for parasite analysis was subsampled from larger soil samples of 1–2 L. Sediments from these were also used for pH measurements, macrofossil- and charcoal analysis, and in a few cases for pollen analysis. From each soil sample, 40 ml of soil were split into two test tubes of 50 ml, and 30 ml of physiological saline solution (9 g NaCl/1 l H_2O) were added to each test tube. Samples were rehydrated for 10 days, and then centrifuged. The sediment was then disaggregated using a magnetic stirrer in 5% HCl for 15 min at *c.* 70 °C and left overnight in 2% HCl. Large particles were then removed using a sieve with 250 μm mesh size. After washing the finer fraction, it was floated in a sugar solution with a density of 1.29 g/cm^3 and centrifuged at 1500 rpm for 30 min. The flotation was repeated three times. All floated material was collected and sieved through an 18 μm mesh, and all material from the mesh was then mounted in glycerol and analysed in microscope at 100–400× magnification. Two slides were made with this material from each sample. Also, the uppermost (*c.* 5 mm) sediment heavier than 1.29 g/cm^3 was collected and sieved through an 18 μm mesh. Five slides were made with this material from each sample. Identification of parasite eggs were made using reference manuals (Garcia, 2007; Foreyt, 2001), and parasitological expertise from the Swedish National Veterinary Institute in Uppsala. During a geological consultation concerning the stratigraphy of a block sample of peaty soil, containing Middle Neolithic pottery sherds investigated by the Alvastra pile dwelling project (Jackie Taffinder, National Historical Museums), two parasite samples were extracted from the peat block. The block of soil was excavated by Otto Frödin during the 1930s (Browall, 2011), and have been in dry storage at the Museum of National History for 86 years. In a second preparation, the two samples from the Alvastra pile dwelling, and six additional subsamples resampled from different burials at the Strandvägen cemetery, were rehydrated with 0.5% trisodium phosphate for ten days, and then treated with the same method as described above.

3. Results

3.1. Burial no. 4 at Strandvägen

Of the two flotation samples analysed at the same depth as the body in Burial no. 4, only the one from the pelvic area contained parasite eggs (Fig. 3). None of the slides with sedimented material heavier than 1.29 g/cm^3 contained any eggs. The two eggs were 52 and 50 μm long and both were 26 μm in width, and interpreted as *Trichuris trichiura* based on morphology, size and archaeological context. The polar plugs were missing in both cases. In the same sample, another corroded egg-type (65 μm in length, with one flattened side) was found and initially identified as human pinworm (*Enterobius vermicularis*), but could not be confirmed as *Enterobius* sp. due to general corrosion. All other samples from the cemetery, burials as well as control samples regardless of rehydration method (NaCl solution or trisodium phosphate), contained no parasite eggs. A few of the control samples from the youngest layer,