



Multicomponent analyses of a hydatid cyst from an Early Neolithic hunter–fisher–gatherer from Lake Baikal, Siberia

Andrea L. Waters-Rist ^{a,*}, Kathleen Faccia ^b, Angela Lieveise ^c, Vladimir I. Bazaliiskii ^d, M. Anne Katzenberg ^e, Robert J. Losey ^f

^a Faculty of Archaeology, Leiden University, PO Box 9515, 2300 RA Leiden, The Netherlands

^b Department of Archaeology and Anthropology, University of Cambridge, United Kingdom

^c Department of Archaeology and Anthropology, University of Saskatchewan, Canada

^d Department of Archaeology and Ethnography, Irkutsk State University, Russia

^e Department of Archaeology, University of Calgary, Canada

^f Department of Anthropology, University of Alberta, Canada

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ABSTRACT

Calcified biological objects are occasionally found at archaeological sites and can be challenging to identify. This paper undertakes the differential diagnosis of what we suggest is an *Echinococcus granulosus* hydatid cyst from an 8000-year-old mortuary site called Shamanka II in the Lake Baikal region of Siberia. *Echinococcus* is a parasitic tapeworm that needs two hosts to complete its life cycle: herbivores and humans are intermediate hosts, and carnivores such as dogs, wolves, and foxes are definitive hosts. In the intermediate host the *Echinococcus* egg hatches in the digestive system, penetrates the intestine, and is carried via the bloodstream to an organ, where it settles and turns into an ovoid calcified structure called a hydatid cyst. For this object, identification was based on macroscopic, radiographic, and stable isotope analysis. High-resolution computed tomography scanning was used to visualize the interior structure of the object, which is morphologically consistent with the *E. granulosus* species (called cystic *Echinococcus*). Stable isotope analysis of the extracted mineral and protein components of the object narrowed down the range of species from which it could come. The stable carbon and nitrogen isotope ratios of the object's protein, and stable carbon isotope ratio of the mineral, closely match those of the likely human host. Additionally, the $\delta^{13}\text{C}$ protein-to-mineral spacing is very low, which fits expectations for a parasitic organism. To our knowledge this is the first isotopic characterization of a hydatid cyst and this method may be useful for future studies. The hydatid cyst most likely came from a probable female adult. Two additional hydatid cysts were found in a young adult female from a contemporaneous mortuary site in the same region, Lokomotiv. This manuscript ends with a brief discussion the importance of domesticated dogs in the disease's occurrence and the health implication of echinococcal infection for these Early Neolithic hunter–fisher–gatherers.

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1. Introduction

During excavation of a 7000 to 8000-year-old Early Neolithic cemetery called Shamanka II (Weber et al., 2006), located on the southern tip of Lake Baikal, Siberia, Russian Federation (Fig. 1), an ellipsoidal calcified biological object was found in the abdominal area of a human skeleton. The term calcification refers to the deposition of calcium phosphate salts in tissues (whereas, the term

ossification indicates calcium deposition in a collagen matrix). About the size of a chicken egg, this ovoid and hollow object (Fig. 2; described in more detail below) was found in grave 23 with individual 2 (Fig. 3), amidst many grave goods including animal bones, implements, and ornaments. Initial examination of the object resulted in suggestions that it may be an organ cyst (e.g. ovarian or renal), a teratoma, a calcification of any number of normal or pathological structures (e.g. gallbladder, ovary, appendix, lymph node, fibroma, neoplasm, lipoleiomyoma, etc.), or a parasitic hydatid cyst that forms from infection by the tapeworm *Echinococcus granulosus*. Therefore, various methods were employed to identify the object and its possible significance in the lives of Early Neolithic foragers.

* Corresponding author. Tel.: +31 (0)71 527 1685.

E-mail addresses: a.l.waters@arch.leidenuniv.nl, awaters89@hotmail.com (A.L. Waters-Rist).

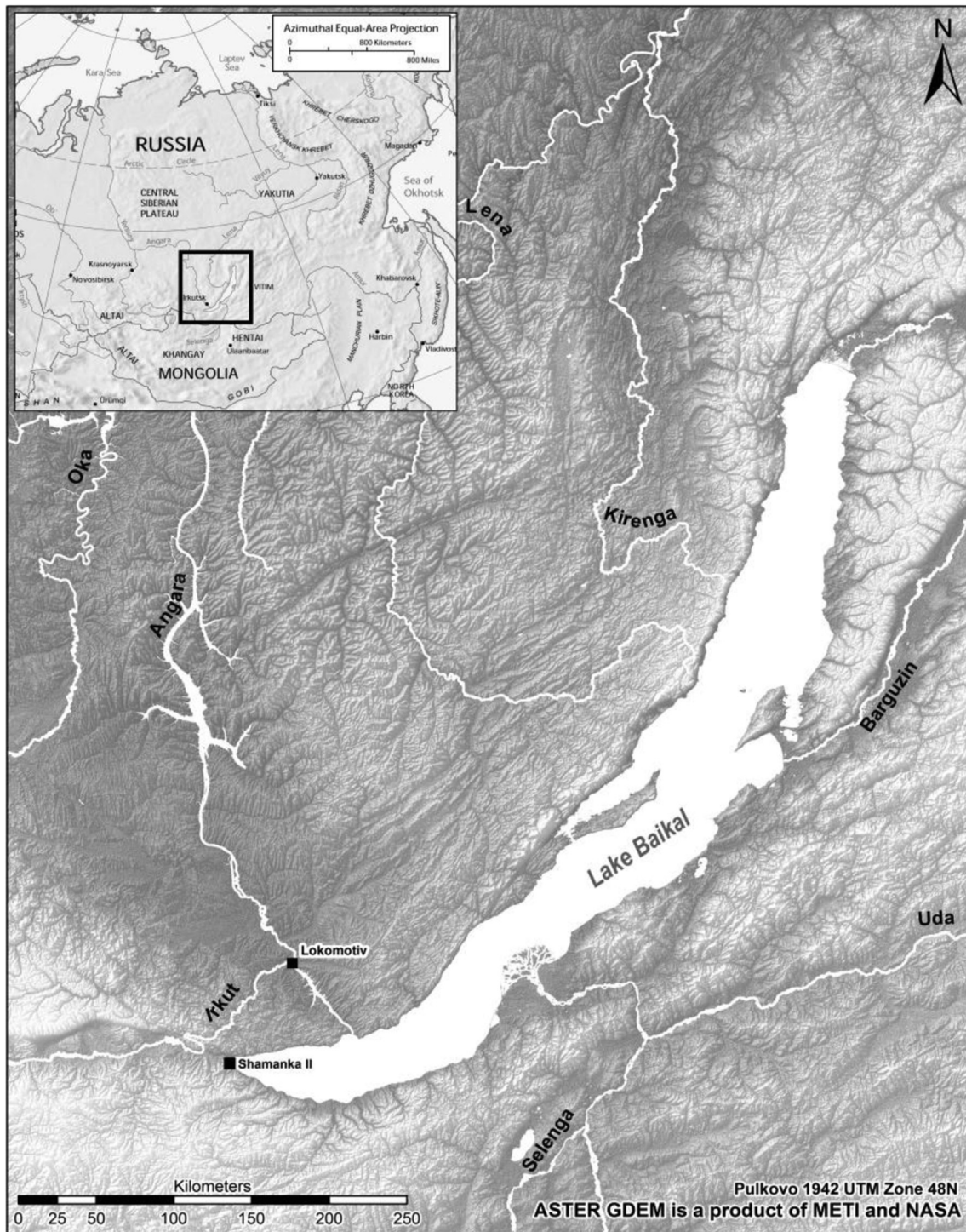


Fig. 1. Map of Lake Baikal showing the location of the mortuary sites Shamanka II and Lokomotiv, Siberia.

Two methods were applied to identify the object¹ and, in the case of it being parasitic, the host organism. First, high-resolution computed tomography (CT) scanning was undertaken to discern

the structure of the object's interior. Second, stable isotope analyses of the protein and mineral component was undertaken to narrow the range of species from which it could derive. To our knowledge this is the first isotopic characterization of this type of calcified object. Two similarly shaped calcified biological objects were found at a nearby contemporaneous site called Lokomotiv, making it possible these Early Neolithic hunter–fisher–gatherers were similarly affected.

¹ The extensive handling of the object, and its antiquity, made the success of aDNA analysis very unlikely. Additionally, a significant portion of the object would need to be destroyed. Thus, aDNA extraction and analysis was not attempted.

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