Review Article: Archaeoentomology

When Entomological studies meet Archaeology: archaeoentomology an old, new discipline for investigation of the Past

Stefano Vanin

Department of Earth, Environmental and Life Sciences (DISTAV), University of Genoa, Genoa, Italy; National Research Council, Institute for the Study of Anthropic Impact and Sustainability in the Marine Environment (CNR-IAS), Genova, Italy.

Abstract

Due to their widespread distribution and their ability of colonizing all the terrestrial and freshwater ecological niches, insects represent a good candidate in archaeological investigation to derive further levels of knowledge. Archaeoentomology is the discipline devoted to this aim. In addition, a more specific discipline, funerary archaeoentomology focus its attention to the funerary context in order to reconstruct the funerary practices and obtaining specific information about rituals, bodies' transfer and sanitary conditions. In this review the potentialities and the limits of this disciplines are described.

Key words: Insects, Diptera, mummies, burial, decomposition

Insects, with more than 1,300,000 described species, represent about the 75% of the known animals and are present in all the terrestrial and freshwater environments of our planet. Only the deepness of the oceans is not inhabited by insects, however crabs and shrimps belonging, as the insects, to the phylum Arthropoda are the "citizens" of that obscure, dark environment. Due to their high number, worldwide distribution, high rate of reproduction and elevate adaptability insects are quite common in all the anthropic environments where they can found microhabitats similar to their natural environments and benefit from their facultative or obligate association with humans (King, 2014). Our species, *Homo sapiens*, has been and is strongly affected by insects at different level: i) public health, insect are vectors of several pathogens and among them malaria, counting 627,000 deaths in 2020 (WHO, 2021); ii) economy, pollination of a high variety of edible plants is done by insects such as the small biting midges in the genus *Forcipomyia* (Diptera, Ceratopogonidae) pollinating the cacao tree. Insects also have an important economic impact destroying or affecting the quality of edible plants, seeds, cheeses, dry fishes, etc., with an economical lost evaluated in more than 700 billion dollars per year; iii) waste recycling, the necro-mass of animals and plants and the excrements of animals are transformed and recycled by insects and other arthropods - the problem created introducing livestock in Australia where scatophagous insects were not present is one of the most illuminating example of the importance of insect in "organic waste" cycling; iv) culture and symbolism, insects played an important roles representing obscure forces (Beelzebub is the king of flies) or richness and power (honey bees are represented in a lot of family stemmas such as the Napoleon one). This has happened not only in the past but also nowadays where several companies are using images and names of insects and other arthropods in their brands and models (for example among the motorbike the Piaggio's Vespa and the Honda's Hornet).

The relationship between human environments, human goods and insects if correctly investigated may provide a further level of information to better reconstruct past environmental and climatic conditions, landscape usage and cultural practices (Kenward, 1978). The discipline devoted to this aim is

called Archaeoentomology. This discipline deals with the study of synanthropic insects and other arthropods recovered during archaeological excavations, whereas another discipline paleoentomology focus on the study of insect remains collected from natural environments free from any kind of anthropic activity (Ashworth et al., 1997).

More in general, as suggested by Kenward (2009) archaeoentomology can be considered a branch of the environmental archaeology which is a large interdisciplinary subject involving other disciplines as geology, geography, climatology, biology, history, and anthropology, all collaborating and providing information field-specific in order to draw a scenario as much accurate and complete as possible about the human past (Kenward, 2009).

The first usage of insects in for the interpretation of past environments had its beginnings in Egypt in 1842 when Reverend Hope described the diet of mummified ibis from the insects found in their gut (Panagiotakopulu, 2001). Since that the discipline has developed in different ways across the world, with entomologists and archaeologists of some countries more sensitive to the discipline and others, from other countries, more indifferent. Anyway, it is worth of mentioning that the attention to insects from archaeological contexts has shown a significant increase in the last decades.

The utility of the entomological approach in the archaeological context is related to the fact that: i) insects are the most ecologically diverse group of animals, capable to survive in a large variety of habitats with the most diverse environmental/climatic conditions (Buckland et al., 2014). Some species are cosmopolite and adapted to different habitat in contrast other species are quite specific in term of habitat and distribution; ii) insects did not evolve in the last 2 million years (Forbes et al., 2013; Buckland et al., 2014). The information about the ecology of populations of insects living today can be used for reconstructing the past specially to derive: past climate and environments, both terrestrial and marine (Ashworth et al., 1997; Buckland et al., 2016); human diet (Panagiotakopulu, 2001); agricultural practices, food storage even through the study of stable isotopes accumulated in the exoskeleton (King, 2012); commercial trades (Panagiotakopulu, 2003); human living conditions and attitudes to hygiene (McCobb et al., 2004; Panagiotakopulu, 2004); permanence of settlements (Panagiotakopulu et al., 2007; Panagiotakopulu & Buchan, 2015) and funerary practices (Huchet, 1996; Giordani et al., 2020).

A very peculiar branch of archaeoentomology has been developed in 1996 by Jean-Bernard Huchet transferring the methodology and the knowledge about human colonization typical of forensic entomology to funerary contexts of archaeological interest. Records of insects from Egyptian mummies date back in the 17th century when Vallisneri described and sketched puparia of flies, potentially in the family Fanniidae from a mummy (Benecke, 2001).

Different groups of insects can be collected from a funerary context, each of them, if correctly identified and correctly interpreted may provide a specific kind of information:

- Insects associated to the corpse remains - and strictly associated to the decomposition process as members of one of the "successional waves"- (Fig. 1). Among these insects Huchet (2014) recognizes also two additional categories: i) pre-depositional phase insects, necrophagous insects colonizing corpses shortly after death in a time period prior to burial

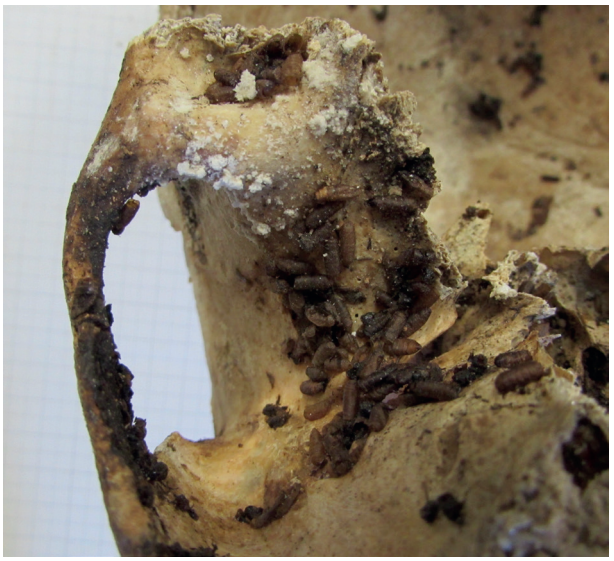

Figure 1. Puparia of *Hydrotea* (Diptera, Muscidae) on a skeletonized skull from the putridarium of Azzio (Northern Italy) (for further information see Pradelli et al., 2019).

– mainly Diptera in the family Calliphoridae and ii) post-depositional phase insects, specialized in colonizing underground corpses such as Diptera in the family Phoridae or among the Muscidae the genus *Hydrotaea* (Giordani et al., 2018). This distinction is essential to reconstruct the taphocenosis (i.e. the assemblage of cadaveric organisms) post facto, as the biodiversity of the entomofauna of buried corpses is different and reduced when compared to the community colonizing an exposed body (Pradelli et al., 2019);

- Taxa associated with offerings such as clothes, ornaments, personal artefacts, or vegetal matter;
- Taxa resulting from subsequent contaminations. In archaeological material stored in collections and museums also the so-called museophagous insects can be found (Vanin et al., 2021);
- Human and other animals – often used as offerings - ectoparasites such as lice, fleas, etc. that can be vector of pathogens (Amanzougaghene et al., 2016);
- Environmental indicators, taxa associated with the primary deposition site/s. These insects can be associated to specific habitat, or to specific locations. Their presence on the body can be occasional or due to a passive transport.

The first step for any interpretation and deduction based on insects is the correct species identification done by a specialist. The identification of archaeological material is mainly done using a morphological approach being the DNA analysis of ancient insect still difficult and in most of the cases useless. However, the very first step in an archaeoentomological investigation is the correct collection of the insects, whole specimens, or fragments of them. Due to their small size the collection is not always simple and easy to perform, and it has to be scheduled before the starting of the digging process where also the size of the tools used for sieving the soil is defined. In this way the majority of the specimens will be properly collected, identified and interpreted.

Entomologists working at the Natural History museums or in other scientific organization (eg.: University) may be helpful to carry this kind of analysis, till now underestimated and not fully explored in its potentiality.

References

Amanzougaghene, N., Mumcuoglu, K. Y., Fenollar, F., Alfi, S., Yesilyurt, G., Raoult, D., & Mediannikov, O. (2016). High ancient genetic diversity of human lice, *Pediculus humanus*, from Israel reveals new insights into the origin of clade B lice. *PLoS ONE, 11*, e0164659. https://doi.org/10.1371/journal.pone.0164659

Ashworth, A. C., Buckland, P.C., & Sadler, J.P. (1997). *Studies in Quaternary Entomology: An inordinate fondness for insects*. Chichester, John Wiley & Sons, 305.

Benecke, M. (2001). A brief history of forensic entomology. *Forensic Science International*, *120*(1-2), 2–14. https://doi.org/10.1016/S0379-0738(01)00409-1

Buckland, P.I., Buckland, P.C. & Olsson, F. (2014). *Paleoentomology: Insects and other arthropods in environmental archaeology*. In*:* Smith, C. (Ed.) Encyclopedia of Global Archaeology. Springer, New York.

Buckland, P.C., Buckland, P.I. & Panagiotakopulu, E. (2016). Caught in a trap: Landscape and climate implications of the insect fauna from a Roman well in Sherwood Forest. *Archaeological and Anthropological Sciences*, *10,* 125–140. https://doi.org/10.1007/s12520-016-0338-8

Forbes, V., Dussault, F. & Bain, A. (2013). Contributions of ectoparasite studies in archaeology with two examples from the North Atlantic region. *International Journal of Paleopathology*, *3*, 158–164. https://doi.org/10.1016/j.ijpp.2013.07.004

Giordani, G., Grzywacz, A. & Vanin, S. (2018). Characterization and identification of puparia of *Hydrotaea* Robineau-Desvoidy, 1830 (Diptera: Muscidae) from forensic and archaeological contexts. *Journal of Medical Entomology, 56*(1), 45–54. doi: 10.1093/jme/tjy142

Giordani,G., Erauw, C., Eeckhout, P. A., Owens, L. S. & Vanin S. (2020). Patterns of camelid sacrifice at the site of Pachacamac, Peruvian Central Coast, during the Late Intermediate Period (AD1000–1470): perspectives from funerary archaeoentomology. *Journal of Archaeological Science*, *114*,105065. https://doi.org/10.1016/j.jas.2019.105065

Huchet, J.B. (1996). L'Archéoentomologie funéraire: une approche originale dans l'interprétation des sépultures. *Bulletins et Mémoires de la Société d'Anthropologie de Paris, 3-4*, 299–311. https://doi.org/10.3406/bmsap.1996.2450

Huchet, J.B. (2014). *Étude archéoentomologique.* In: Péchart, S., Arnaud, M. (Eds.). Vol. 2

Rapport final d'opération, "Etudes spécialisées". (pp. 323-334). Service Archéologique de Reims Métropole.

Kenward, H. (2009). *Northern regional review of environmental archaeology: Invertebrates in archaeology in the North of England: Environmental studies report*. English Heritage Research Department unpublished report series, Swindon.

Kenward, H.K. (1978). The Analysis of Archaeological Insect Assemblages: A New Approach. *Archaeology of York 19/1*. Council for British Archaeology for York Archaeological Trust, York.

King, G. A. (2012). Isotopes as paleoeconomic indicators: New applications in archaeoentomology. *Journal of Archaeological Sci-*

ences, 39, 511–520. https://doi.org/10.1016/j.jas.2011.10.006
Mccobb, M.L.E., Briggs, D.E.G., Hall, A.R. & Kenward, H.K. (2004). The preservation of invertebrates in 16th century cesspits at St. Saviourgate, York. *Archaeometry, 46*, 157–169. https://doi.org/10.1111/j.1475-4754.2004.00150.x
Panagiotakopulu, E. (2001) New records for ancient pests: Archaeoentomology in Egypt. *Journal of Archaeological Sciences, 28*,1235–1246. https://doi.org/10.1006/jasc.2001.0697
Panagiotakopulu, E. (2003). Insect remains from the collections in the Egyptian Museum of Turin. *Archaeometry, 45*, 355–362. https://doi.org/10.1111/1475-4754.00113
Panagiotakopulu, E. (2004). Dipterous remains and archaeological interpretation. *Journal of Archaeological Sciences, 31*, 1675–1684. https://doi.org/10.1016/j.jas.2004.04.008
Panagiotakopulu, E. & Buchan, A.L. (2015). Present and Norse Greenlandic hayfields – Insect assemblages and human impact in southern Greenland. *The Holocene, 25*, 921–931. https://doi.org/10.1177/0959683615574585
Panagiotakopulu, E., Skidmore, P. & Buckland, P. (2007). Fossil insect evidence for the end of the Western Settlement in Norse Greenland. *Naturwissenschaften, 94*, 300–306. doi: 10.1007/s00114-006-0199-6
Pradelli, J., Rossetti, C., Tuccia, F., Giordani, G., Licata, M., Birkhoffc, J.M., Verzeletti, A. & Vanin, S. (2019). Environmental necrophagous fauna selection in a funerary hypogeal context: the putridarium of the Franciscan monastery of Azzio (Northern Italy). *Journal of Archaeological Sciences Report, 24*, 683–692. https://doi.org/10.1016/j.jasrep.2019.02.028
Vanin, S., Azzoni, M., Giordani, G. & Belcastro, M.G. (2021). Bias and potential misinterpretations in the analysis of insects collected from human remains of archaeological interest. *Archaeological and Anthropological Sciences, 13*, 201. https://doi.org/10.1007/s12520-021-01458-2
WHO, 2021 *World malaria report 2021*. Geneva: World Health Organization, Licence: CC BY-NC-SA 3.0 IGO.

Correspondence:
Stefano Vanin
Department of Earth, Environmental and Life Sciences (DISTAV), University of Genoa, Genoa
Email: stefano.vanin@unige.it; stefano.vanin@gmail.com