News piece title

The importance of open access software in the analysis of bone histology in biological anthropology

Running title

Bone histology analysis online

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The coronavirus (hCoV) pandemic has had an unprecedented impact on halting research progress around the globe. With laboratories shut down and fieldwork sites out of bounds until further notice, many biological anthropologists have found themselves working remotely. Bone histology, the study of bone tissue microstructure, relies on access to a laboratory for thin section preparation. Histologists who study research questions of anthropological significance[1] have had to shift to the 'second' major phase of sample examination – histology image analysis. Several research groups around the world routinely use the open access ImageJ 1.x[2], ImageJ2[3], or Fiji[4,5] software packages which allow to collect a range of quantitative and qualitative data. Researchers have used this software tools to identify sample regions of interest through the ImageJ overlay function[6], collect counts of secondary osteons, Haversian canals, and osteocyte lacunae[7], or measure the area, length, or perimeter of bone microstructures[8,9]. However, bone histological analysis is not yet routinely included in fossil or more recent anthropological examination toolkits. This is partly due to its invasive nature, but also because of limited training. As part of a project funded by the Australian Research Council, a recent online workshop series introducing early career researchers to bone histology image analysis was conducted. Opened to prospective participants globally, capacity of 300 was reached within five days of advertisement. Participants from 40 different countries in North and South America, Europe, Asia-Pacific, the Middle East, and Africa signed up to study and practise analysing bone histology with application to fossil, archaeological, and forensic bone samples.

Workshop series

The workshop, conducted online from the Australian National University in Canberra, consisted of six sessions that ran between 17 May and 24 June 2020. Each week focused on a different topic (Figure 1). Each participant was given access to sample images of human bone through a dedicated workshop website, so that they could practise the weekly demonstrations in their own time and at their own pace. The workshop sessions were short and concise (30 minutes each week) on the pedagogical basis that short-term learning may lead to long-term recall[10], and facilitate "Self-Regulation"[11] in learning strategies which rely on time and space flexibility. This learning style seems to be particularly important during the current hCoV pandemic restrictions.

Participants in each session were briefly introduced to the core concept behind the interpretative value of bone histology data, which was followed by a short technical demonstration of how to undertake measurements in ImageJ v. 15.2 (Figure 1). Week 1 introduced the software, and discussed differentiating young and adult human cortical bone matrices, with the goal of demonstrating how such analyses can aid in the reconstruction of a chronological age of an individual[12]. In Week 2, estimates of secondary osteon densities and their relationship to bone remodelling were discussed with the aim to highlight their utility in investigating behaviour and diet[13,14]. Week 3 included measuring the area of Haversian canals and secondary osteons revealing how these measures can be used to infer the rate at which a bone multi-cellular unit remodels bone[15]. In Week 4, osteocyte lacunae and their canaliculi were evaluated, demonstrating that they can be used to understand bone remodelling, function, and disease[16]. The Week 5 session wrapped up the series by discussing collagen fibre orientation within individual secondary osteon lamellae to illustrate how osteon 'morphotypes' can give insights into tensile or compressive properties of bone[17]. The final session was an open forum where participants at different career stages discussed their current or future projects. A range of levels, from masters to post-doctoral programs, were represented. Applications that included reconstructing life histories from fossil bone or health and disease in Holocene human populations were apparent. Those who work in industry or professional settings (e.g. forensic analyses centres) also benefited from the discussion.

Importance of open access software

The series could not have been delivered had the ImageJ/Fiji software not been available for free download and use. The only logistical requirement necessary to deliver the workshop series successfully was that the participants had access to a laptop/ PC with an internet connection. The hundreds of participants from around the world connected online, including departments with limited infrastructure and countries where biological anthropology is not a part of the university curriculum. The open access movement has long now promoted its practice to support the breaking down of geographical and institutional boundaries in generating research[18]. Van Krogh and Spaeth[18] (p. 236) identified that the "open source software phenomenon", amongst other benefits, has a positive impact on society through innovation. Indeed, several participants in the workshop series expressed their interest in incorporating histological analysis into their research program. This, ultimately, will lead to the creation of new knowledge in the future. The hCoV pandemic restrictions have certainly highlighted that the open access practice is now more important than ever. Although anthropologists have been locked out of laboratories around the world, microscopic analysis can continue collaboratively as we connect through free online platforms.

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Data availability statement

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Figure caption

Figure 1. A combination of screenshots from the online workshop sessions 1-5. In Week 1 participants practised how to differentiate younger from older bone (A). In Week 2 participants estimated secondary osteon densities (red dots in B). Week 3 focused on measuring the area of secondary osteons and Haversian canals (C). Week 4 centred on osteocyte lacunae and canaliculi (red dots in D). In Week 5, secondary osteon 'morphotypes' showing different collagen orientation patterns were studied (E: alternating dark and bright, and F: bright).

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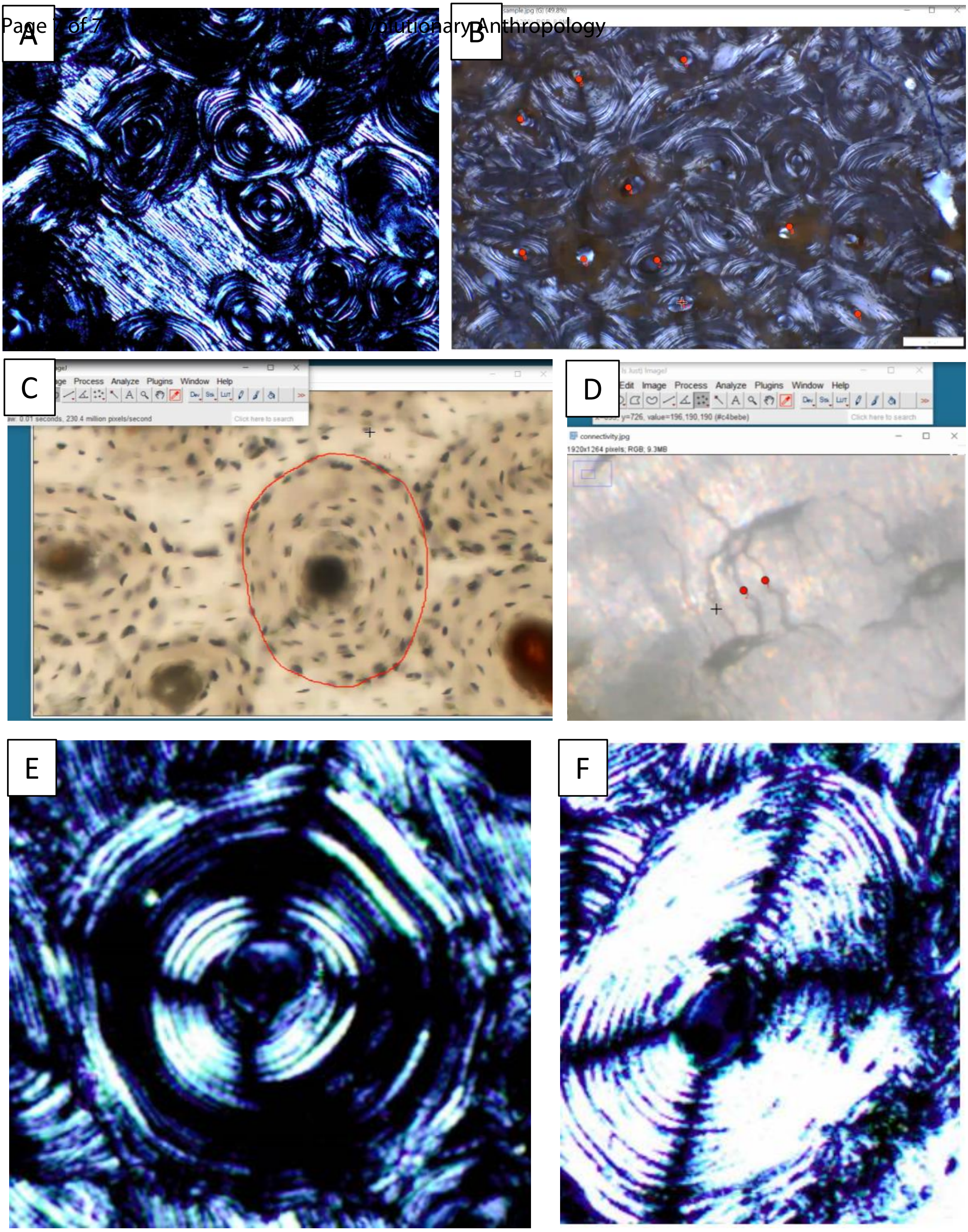
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