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IRON AGE AGRICULTURE IN THE NEGEV HIGHLANDS? METHODOLOGICAL AND FACTUAL COMMENTS ON BRUINS AND VAN DER PLICHT 2017A (*RADIOCARBON* VOL. 59, NR. 1)

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ABSTRACT. This is a reply to a rejoinder to our work in the Negev Highlands (Shahack-Gross and Finkelstein 2015) recently published by Bruins and van der Plicht in this journal (2017a). It addresses archaeological method and practice related to the way evidence for the timing of dry farming in the arid Negev Highlands, Israel, has been obtained. We highlight issues related to phytolith assemblages and livestock dung found in Negev Highlands sites as an indicator for presence/absence of cereal crops, and briefly discuss methods with which terraced agricultural plots in the region have been dated. We touch upon issues at the core of the scientific method, especially the need for proper controls and the importance of reporting full sets of data. Based on the new data presented by Bruins and van der Plicht (2017a, 2017b) we propose an alternative interpretation for their dating of a single terrace at Horvat Haluqim.

KEYWORDS: Iron Age, Negev Highlands, OSL, radiocarbon, terrace agriculture.

INTRODUCTION

In recent years, we carried out geoarchaeological investigations at two Iron Age sites in the Negev Highlands—Atar Haroa and Nahal Boqer. Based on the results, and contrary to past theories, we concluded that the inhabitants did not conduct dry farming (Shahack-Gross and Finkelstein 2008, 2015; Shahack-Gross et al. 2014). In a rejoinder published in this journal, Bruins and van der Plicht (2017a) criticize our work, and based on their work in a terraced plot near Horvat Haluqim located close to the sites where we worked, argue that terrace agriculture in the region did take place during the Iron Age and even earlier.

Bruins and van der Plicht base their hypothesis on seven radiocarbon (^{14}C) determinations from bone and charcoal samples collected along a fill behind one terrace, microarchaeological data on materials in the fill, and ostensible evidence in the debris for manuring and plant growth. We have no argument with Bruins and van der Plicht that terraced wadis in the Negev Highlands have been utilized for agriculture; we differ on the question of timing.

Bruins and van der Plicht (2017a) argue that:

1. Our reconstruction of the subsistence economy of the Atar Haroa and Nahal Boqer sites is based on sediments "interpreted as dung" and on phytolith assemblages which are "problematic." This is a critique on our methodology and ability to understand archaeological materials, their taphonomy and formation processes.
2. We conducted our research in rooms and courtyards in settlement sites, hence we cannot determine the chronology of terrace agriculture.
3. We extrapolate our results from two sites to an area of 2000 km^2.

Below we address these arguments and point to flaws in Bruins and van der Plicht's work.

Dung and Phytoliths

Bruins and van der Plicht assert that our study used unreliable materials (dung and phytoliths). They preferred to ignore the vast amount of controls we used in our studies: a) modern dung

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of animals grazing in the Negev Highlands at different periods of the year; b) sub-recent dung from a winter Bedouin occupation; c) dung from an Early Islamic period site, showing foddering on cultivated cereals; and d) geochemical tests on the state of preservation of the phytolith assemblages that we studied (Shahack-Gross and Finkelstein 2008; Shahack-Gross et al. 2014; Cabanes and Shahack-Gross 2015).

Moreover, Bruins and van der Plicht selected studies that support their theory and ignore others. Note that one of us—Shahack-Gross—has intensively worked on the identification of dung deposits using various lines of evidence (some of which developed by her; see Shahack-Gross 2011) and on site formation processes (Shahack-Gross 2007, 2017). In addition, Shahack-Gross devoted a systematic study to understanding the taphonomy of phytolith assemblages and developed criteria by which the reliability of phytolith assemblages can be evaluated (Cabanes et al. 2011, 2012; Cabanes and Shahack-Gross 2015). Based on these studies, we felt confident to state that there is no preservation bias in the Negev Highlands assemblages that we studied (Shahack-Gross et al. 2014; Shahack-Gross and Finkelstein 2015).

We took care to collect control sediments outside the studied sites—a basic scientific requirement not practiced by Bruins and van der Plicht. Contra the assertion of Bruins and van der Plicht (2017a:14), that concerning the Negev Desert, "hardly anything is known about phytolith transport by dust, in both quantitative and qualitative terms," we showed that phytolith concentrations in the region's wind-blown sediments (local loess) are negligible.

Bruins and van der Plicht did not include information on phytolith morphologies in the dung manure they identified. Marta Portillo and R M Albert, the researchers who conducted the analyses for them, are experts on the subject. Albert informed us that: "we made very clear [to Bruins] that we did not agree with the interpretation as agriculture based on phytoliths… there is no evidence of agriculture in the phytoliths" (personal communication).

To conclude this point, we stand behind our initial interpretation, that the low concentrations of phytoliths in dung deposits and dung pellets in the two Iron Age sites that we have investigated indicate that livestock grazed on the natural, phytolith-poor vegetation typical of the Negev Highlands. From this, and based on comparison to phytolith assemblages in the better-watered areas to the north, we concluded that there is no evidence for agricultural practice in the Negev Highlands during the Iron Age. Actually, the fact that the dung-dominated terrace manure identified by R M Albert and dated to the Iron Age by Bruins and van der Plicht did not include evidence for cereal agriculture, lends support to our conclusion (see more in the addendum below).

Dating Terraced Plots

We did not study sediments from terraced plots. We adhere to the results of a large-scale and systematic study of terraces carried out by Avni et al. (2012, 2013). They showed that the vast majority of OSL ages obtained from a number of terraced fields across the Negev Highlands, even those close to Iron IIA sites, yielded ages that range between the 4th and 11th centuries AD (only one or two samples provided dates in the Iron Age). Avni et al. (2013) concluded that the practice of terrace construction in this region does not predate the Roman period.

This brings us to the question, what is the most suitable methodology for dating terrace construction and use—radiocarbon or OSL? Bruins and van der Plicht support the former, arguing that sediment accumulation behind terraces captures datable materials that define terrace use-life. This might have been acceptable had the authors showed that they date a laminated rather than homogenous fill [which they fail to show even via micromorphology (Bruins and van der Plicht

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2017a; but see Bruins and van der Plicht 2017b and our addendum below)]. Therefore, the seeming development in age along the dated profile of sediments presented by Bruins and van der Plicht (2017a: Table 1), cannot be evaluated from a sedimentological point of view. For these reasons and more (below), in the case of terraces, we, as well as other researchers (e.g., Avni et al. 2012, 2013; Davidovich et al. 2012; Gadot et al. 2016), opt for OSL dating.

How then, can one explain the Bronze and Iron Age radiocarbon determinations reported in the terrace fill at Horvat Haluqim?

Bruins and van der Plicht report on the practice of manuring, an important contribution to the study of ancient terrace management. Yet, they fail to consider the possibility that the bone and charcoal fragments they collected had been brought to their final resting location in later times from the adjacent Iron Age site of Horvat Haluqim. We refer to manuring the fields with old Iron Age deposits. In their rejoinder, Bruins and van der Plicht allude to several radiocarbon determinations from the terraces near Horvat Haluqim, that fall in the Early Islamic period. Regrettably, in none of their publications do they present the data: how many such dates have been obtained, from where and in what relation to dates pertaining to other periods? We suspect that these unpublished ages come from the same plot that provided the Iron Age dates. If this is the case, and if the samples that gave Early Islamic dates come from the upper part of the probe, it would mean that the terrace was constructed and the plot prepared (with imported Iron Age sediments?) in the Early Islamic period. Note that the late-Byzantine to Early Islamic was the peak prosperity period in the Negev Highlands, including vast areas devoted to terrace agriculture (e.g., Rubin 1990; Avni 2008). The nearby Byzantine/Early Islamic site of Wadi el-Mustayer, which was studied by us, provides clear-cut evidence for vast terrace construction at that time, and dung deposits from this site contain high phytolith concentrations, with phytolith morphotype evidence for animal foddering on cereals (Shahack-Gross et al. 2014).

Overall, the lack of lamination to testify for slow sediment accumulation within the terraces, coupled with dung remains, and the range of radiocarbon dates that apparently ends around the Early Islamic period, seem to indicate that what Bruins and van der Plicht dated is a mixed sediment. In our opinion, sediment to fill up the terraces was brought from nearby sources, including the Iron Age settlement that had already been abandoned at the time when terrace construction took place.

All this shows that the basic approach of Bruins and van der Plicht is erroneous from the outset, and that OSL should remain the preferred method to determine the chronology of terraced fields. Incidentally, a somewhat similar assumption regarding terrace construction in the Judean Highlands in the Iron Age has recently been tested by OSL dating. The study showed that in this case too terraces date not earlier than the Hellenistic period despite proximity to Iron Age sites (Porat et al. in press).

On Extrapolation

Bruins and van der Plicht criticize us for extrapolating our results from two sites to the entire area of the Negev Highlands. At the same time, they extrapolate their results from a single terrace, over the same entire region.

CONCLUSION

Bruins and van der Plicht put all their eggs in one basket (a single terraced plot), do not use controls and comparisons, and do not report the full sedimentary (i.e., soil profiles),

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radiocarbon, and seemingly even phytolith data. The samples that they radiocarbon-dated probably come from sediment that was transported to the plot from the nearby Iron Age site. To differ, our systematic project at Atar Haroa and Nahal Boqer, coupled with our recent, soon to be published study of a nearby open-air water cistern using OSL dating (Junge et al. forthcoming) and the results of Avni et al. (2012, 2013), supplies strong testament for the absence of crop agriculture in the Negev Highlands during the Iron Age.

ADDENDUM

In their response to this letter, Bruins and van der Plicht (2017b) address some of the concerns raised above. We thank them for presenting additional data and for the stimulating discussion.

Bruins and van der Plicht state that "the total agricultural area in the Negev Highlands during the Iron Age must have been smaller than the 4000 hectares mapped by Kedar (1967)" and that Iron Age herds "were even more dependent on natural vegetation as compared to the people who lived in the region during the Byzantine period, or the Bedouin in recent times…" (Bruins and van der Plicht 2017b: 1234). The comparison to Bedouin activity is telling; had evidence for this assertion been presented, it would describe *opportunistic* rather than *subsistence-based* cultivation. Our detection of cereal phytoliths in Byzantine/Early Islamic livestock dung showed that agriculture was practiced on a large enough scale to be identified as a component in the subsistence base (Shahack-Gross et al. 2014), while we see no evidence for agriculture being a significant component in the Iron Age subsistence base.

The phytolith data provided by Bruins and van der Plicht (2017b) is partial. First, only one sediment sample was studied from the supposed Iron Age dated level in the thick accumulation of the terrace fill. Second, for better evaluation of the data the percentages of the phytolith morphotype groups given by Bruins and van der Plicht should be associated with their concentration. The latter is found in Bruins and van der Plicht's rejoinder (2017a: Table 2). Taken together the data show that the phytoliths in this sample derive from dung; the overall characteristics of this sample are similar to dung samples which we studied at Atar Haroa and Nahal Boqer (Shahack-Gross and Finkelstein 2008; Shahack-Gross et al. 2014). Furthermore, the presence of grass phytoliths from the fetucoid family (Bruins and van der Plicht 2017b: 1236) **does not** indicate wheat or barley. Proving the existence of wheat or barley requires specific advanced phytolith analysis. Third, the example of a single multicellular phytolith (Bruins and van der Plicht 2017b: Figure 1) does not contribute to the discussion about cereal cultivation as the absolute quantities of such phytoliths cannot be obtained from thin sections. We therefore agree with Albert's conclusion as cited by Bruins and van der Plicht (2017b: 1235), that more phytolith analyses should be carried out at Horvat Haluqim.

As for evidence for sediment aggradation, as noted by Bruins and van der Plicht (2017b), the thin section represents young deposits, not the supposed Iron Age sediments which are the focus of this discussion. It can be understood that crusts are not present in the relevant sediment levels. Bruins and van der Plicht raise the possibility of breakage and obliteration of sediment crusts due to periodic desiccation, bioturbation, and possible agricultural practices such as ploughing and tilling. This is a valid hypothesis that should be tested in future studies.

In summary, we are willing to accept the possibility of limited, opportunistic (rather than subsistence-based) cereal cultivation in the region during the Iron Age, but evidence for this has not been presented so far. The discussion between Bruins and van der Plicht and us highlights issues that require further research, namely phytolith analysis and micromorphology of terraced fields. One of us (RSG) is currently taking part in a project that studies the collapse of the Byzantine system in the

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Negev (directed by G Bar-Oz, University of Haifa), which includes the study of phytoliths and micromorphology in terraced fields, and involves dating using both radiocarbon and OSL.

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