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VISUALIZATION AND COLLABORATIVE PRACTICE IN PALEOETHNOBOTANY

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Paleoethnobotany lends unique insight into past lived experiences, landscape reconstruction, and ethnoecological connections. A wide array of paleoethnobotanical methodologies equips us to negotiate complementary understandings of the human past. From entire wood sea vessels to individual plant cells, all sizes of botanical remains can be addressed through the tools available to an archaeobotanist. As paleoethnobotanical interpretation is interwoven with other threads of information, an enriched vision of the relationships between landscape and people develops.

Collaboration is a necessary component for archaeobotanical analysis and interpretation. Through collaboration we make the invisible visible, the unintelligible intelligible, the unknowable knowable. We increase visibility through intra- and interdisciplinary engagements, descendant community collaborations, complementary approaches, and technological innovations. We improve intelligibility through targeted visualizations for scholars, students, and the broader public, using charts, graphs, models, images, and artistic reconstructions. We approach the unknowable through historical documentation, ethnographic analogy, and iconographic representation to understand how plants and their remains were viewed and negotiated in the past. Moreover, we attempt to preserve the past for the future, by archiving botanical multiplicity, preserving material heritage, making materials digitally accessible, and critically engaging with issues of botanical diversity, ecological sustainability, and food security.

Here, we draw on examples from the lab and the field to demonstrate how collaboration has made it possible to access disparate landscapes and their ethnobotanical stories. We consider the following questions: How is our view of plants and plant practices formulated and reformulated through cooperative efforts? What shared practices and modes of visualization improve cross-pollination, both between sister disciplines and within our own? What are our paleoethnobotanical contributions to a shared vision of archaeology?

Methodologies, Practices, and Multi-Proxy Understandings

There are many methodologies within paleoethnobotany that lead to distinct yet complementary pieces of information, whether due to scale of residue (chemical to architectural) or the technology available (hand loupes to full laboratory facilities). The limits of archaeobotanical analysis are constantly expanding as the accessibility and capabilities of technology improve. This is true for microscopes and software, which make it possible for a paleoethnobotanist to capture and enhance the smallest of cellular structures, and for telecommunications and digital records, which are expanding the possibilities for deciphering archaeobotanical material and for collaborating with distant stakeholders. Improvements in technology are an integral part of the exciting future of paleoethnobotany, which includes collaboration between many individuals and resources to help archaeobotanical research reach its fullest potential.

The recovery of multiple lines of archaeobotanical evidence has increased dramatically with technological advancements, higher volumes of research, and information sharing. Complementary approaches are becoming increasingly critical to address the full spectrum of plants and plant practices in the past. The use of multiple scales of plant data—from those visible to the naked eye to those a hundred times smaller—has in many cases revealed plant taxa invisible at one or several scales. Moreover, the visibilities of certain taxa are directly related to the taphonomic processes that filter the archaeological record. Macrobotanical analysis often pertains to carbonized plant remains, while phytolith analysis utilizes microfossils of plants that may or may not have been carbonized. Starch grain analysis incorporates plant remains that may be difficult to identify once carbonized, such as roots and tubers. Palynological analysis incorporates the pollen grains of plants that may not produce diagnostic phytoliths or starch grains. Chemical analyses, including isotopes, DNA, trace elements, lipids, and proteins, allow us to see what cannot be seen even through the use of microscopy.

The use of a combination of archaeobotanical analyses ensures a more complete picture of plant species growing near an

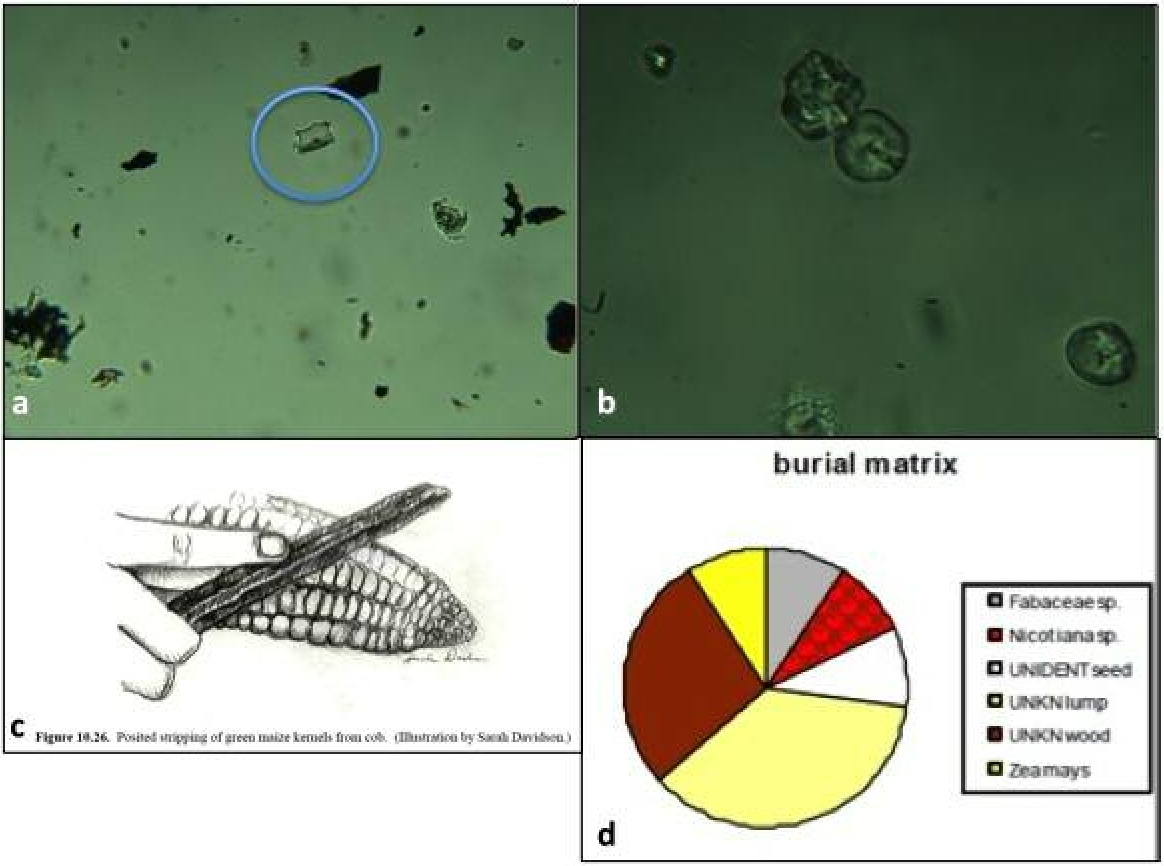

Figure 1. Visual representations of maize (Zea Mays): (a) photograph by Jessica Herlich of a maize cob phytolith (40x magnification); (b) photograph by Jessica Herlich of a maize kernel starch grain (40x magnification); (c) illustration by Sarah Davidson of green maize stripping (in Morell-Hart 2011); (d) pie chart of maize residues as compared with other residues in burial contexts (in Morell-Hart 2011).

archaeological site and utilized by an ancient community. Phytoliths, macrobotanical remains, pollen, and starch grains can be recovered from sediments, making it possible to get a larger picture of plant use at a site by viewing it at the stratigraphic and chronological level as well as in terms of spatial, intrasite relationships. Microbotanical remains can also be removed from the cracks and crevices of artifacts. Such residue analysis provides a specific view of plant use that can be expanded to answer larger questions related to artifact use and practices occurring at a site (Pearsall 2008; Piperno 2006).

Actively drawing together different botanical elements, Herlich's research in coastal Virginia and at shell midden sites connects macrobotanical residues from flotation samples, phytoliths from sediments, and phytoliths and starch grains from artifacts. These data address landscape use and design and seasonal mobility among Algonquian groups from ca. A.D. 1–1600. The focal shell midden is at the Kiskiak site in Yorktown, Virginia, an excavation directed by Martin Gallivan at the College of William and Mary. Through a combination of archaeobotanical data and historical accounts, Herlich's project addresses the various practices and gendered labor divisions occurring at coastal sites. These activities are connected to landscape through the idea of the taskscape, or a dynamic landscape comprised of tasks occurring together or separately (Ingold 2000; Moore and Thompson 2012). The study demonstrates through archaeobotanical remains how Algonquian coastal sites were revisited and continued to play a role in community life as persistent places over time (Gallivan 2011; Schlanger 1992; Moore and Thompson 2012). The use of multiple lines of botanical evidence has allowed for the visualization of past practices.

Visualization, Collaboration, and Identification

Visual depictions are generally considered the most productive way of representing seeds and other archaeobotanical remains (Goddard and Nesbitt 1997:13). While there are many terminologies utilized by archaeobotanists for the purposes of plant identification, there can be misinterpretation and vagueness in these verbal depictions. Therefore, it is the physical image of the seed or other plant part (Figure 1) that becomes the most reliable medium with the greatest potential for communication and collaboration between archaeobotanists (Goddard and Nesbitt 1997:13). Photographs and illustrations are important tools for identifying plant remains as well as sharing information between paleoethnobotanists. Both serve as a useful means for capturing the detail of small objects, but archaeobotanists have traditionally preferred illustrations for capturing the three-dimensionality of seeds (Goddard and Nesbitt 1997:13–14).

Different types of microscopes provide paleoethnobotanists with a variety of visual opportunities. Reflected light stereo-microscopes enhance the view of carbonized plant remains that can be seen with the naked eye. When botanical residues are magnified (5x–50x), a paleoethnobotanist can see subtleties in morphology that make it possible for plant identification to the family, genus, or species level (Pearsall 2008). Carbonized remains may be difficult to identify with simple stereoscopic magnification, but paleoethnobotanists have found that with more advanced techniques, such as scanning electron microscopy (SEM), more accurate identifications are possible. Transmitted light microscopy, with magnifications of material up to 1000x, is the means by which the archaeobotanist can study microremains of past plant remains, making it possible for residues from artifacts and microfossils present in archaeological sediments to become visible. Such residues include phytoliths, starch grains, and pollen, along with other residues that may be fungal spores or diatoms (Pearsall 2008). For both transmitted light and reflected light microscopy, camera attachments allow for magnified images to be captured, shared, and compared with those in other samples and collections. There is also enormous potential in the area of digital video capture to illuminate the three-dimensionality of macroremains and microremains and share this view with others through video clips or even GIFs.

Beyond the technical elements, visualization is best realized through successful partnerships across subdisciplines, disciplines, and stakeholding communities. Interdisciplinary involvement includes the sciences (e.g., biology, environmental science, and occasionally, chemistry) as well as the social sciences and humanities (e.g., archaeology, anthropology, and history). This cross-disciplinary knowledge requires extensive education and often necessitates work with various specialists. Collaborative efforts between fields have led to innovative applications, including the incorporation of previously "invisible" lines of evidence such as phytoliths (drawn from fields such as ecology and botany), first analyzed by botanists in the mid-nineteenth century and utilized in ecological research (Piperno 2006:3). Paleoethnobotanists, such as Dolores Piperno and Deborah Pearsall, identified the significance of applying phytolith analysis to archaeological sites and to research questions related to plant domestication and paleoecology. The collaboration between archaeobotany and other disciplines has led to mutual benefits in such fields as conservation biology and ecology by providing further insight into past environmental conditions and landscapes (e.g., Lightfoot et al. 2013; Rick and Lockwood 2013). Such partnerships between academic disciplines extend beyond data sharing, theoretical frameworks, and applications of techniques. Archaeobotanists housed in anthropology departments often work with a variety of outside academic departments, sharing equipment and resources necessary for their analyses. Generous external disciplines have traditionally included chemistry, environmental sciences, and biology, where microscopes, fume hoods, sonicators, centrifuges, and chemicals are more readily available. This sharing of resources often leads to other sorts of collaborations, as we have experienced in the Keck Environmental Field Laboratory at the College of William and Mary. This collaboration includes working with resources and equipment so as to train students in paleoethnobotany, which merges topics relevant to both anthropology and environmental studies. Another example of collaboration and shared resources has been the involvement of archaeologists from Naval Facilities Engineering Command (NAVFAC) Atlantic in facilitating the archaeology and archaeobotanical analysis at Kiskiak.

Reference materials are a critical element of archaeobotany, and a functional collection of reference materials involves interdisciplinary collaboration as well as work with an extended network of experts in various types of species and plant anatomy identifications (Figures 2 and 3). For each specialty within archaeobotany (pollen, macrobotanical, phytolith, and starch grain), there is a unique subset of materials necessary for an archaeobotanist to properly identify archaeological material. Traditionally, there has been a heavy focus on physical specimens as well as the use of various reference volumes. Almost every part of a plant can be evaluated archaeobotanically, depending on the technique, but such work requires access to multiple anatomical portions of plant samples. Access to seeds and nuts is necessary for macrobotanical work, while access to inflorescences, roots, tubers, and various other plant parts is necessary for microbotanical analyses.

Archaeobotanists develop an expertise typically at a regional level and might collaborate with local botanical experts, botanical societies, and botanical gardens for access to archival collections as well as assistance in identification of species and direction for

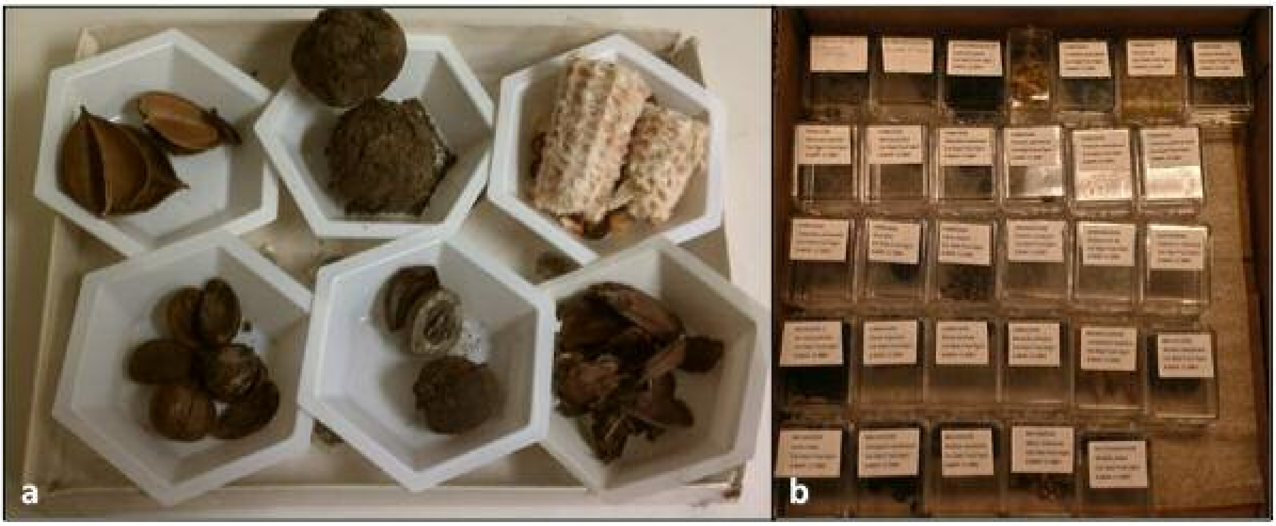

Figure 2. Identification through modern reference materials: (a) modern reference botanical samples from Virginia; (b) modern reference seeds from CDFA Bulk Seed Collection.

locating areas for modern collection. Herbaria and seed banks are other means by which archaeobotanists might obtain resources for reference collections and gain familiarity with seed and plant morphologies characteristic of their study regions.

Despite the benefits of photographs and images, as noted above, a physical example of a specimen is typically the most productive method of identification. Archaeobotanists usually archive in their collections a dried sample of a plant specimen and a charred sample of the same specimen in order to observe the effects of charring and to draw more accurate comparison between modern and archaeological materials.

However, being able to examine physical examples is not always possible. Digital technologies have made it easier to eliminate unknowns in archaeological samples through digital archives and collaboration between researchers. Communication between archaeobotanists to confirm and check various identifications is a crucial resource and component of collaboration. In Herlich's research, archaeobotanist Linda Perry, Executive Director of the Foundation for Archaeobotanical Research in Microfossils (fossilfarm.org), and archaeobotanist Justine McKnight are examples of archaeobotanists and collaborators that regularly provide helpful advice and support. Email listservs and forums have become media through which photos of various archaeobotanical images can be shared between a large collective of experts, as evidenced by the phy-talk listserv run through Brigham Young University and the Archaeobotany listserv run through the UK (https://www.jiscmail.ac.uk/). Online resources of seed images also serve as tools for plant identification but have limitations due to the volume of species throughout the world and the laborious process of digitizing and making accessible a comprehensive collection of seed images and information. Websites such as the University of Missouri (http://phytolith.missouri.edu/), paleobot.org, and Colorado State University's Seed Images are several directions taken by archaeobotanists to share visual resources and collaboratively identify and interpret archaeobotanical remains.

Paleoethnobotanical interpretations are constructed and visually rendered through a variety of media and software. At the empirical level, we attempt to visualize our data in a variety of ways, and then present our results to a myriad of publics. Charts, graphs, models, images, and artistic reconstructions (Figure 1) are all well-established means of both structuring and conveying information (as noted in Deufemia et al. 2012; Miller 2011; Pearsall 2008). Geographic Information Systems (GIS) have also proven useful for various types of analysis and visualization (e.g., Hallisey 2005; Llobera 2011; Morell-Hart 2011) but are still vastly underutilized. For pedagogical purposes, many different modeling techniques have been appropriated and manipulated to train students in the methods of paleoethnobotany (Pearsall 2008). Different physical visual aids are critical to paleoethnobotanical analysis, and visualization is critical to interpreting the past and communicating findings.

Interpretations and Implications

Presenting our interpretations to broader publics represents its own set of challenges in paleoethnobotany, and a variety of meth-

Figure 3. Collaboration in paleoethnobotanical analysis: reference material collection with Beth Chambers, Herbarium Coordinator at the Herbarium at the College of William and Mary, and Robert H. Floyd, Natural Resources Specialist from the DPW Environmental & Natural Resources Division, Fort A.P. Hill (a) Tuber collection at Meadow Creek Pond, Fort A. P. Hill, Virginia; (b) American Lotus (Nelumbo lutea) at Fort A. P. Hill; (c) Beth Chambers in the College of William and Mary Greenhouse.

ods have been utilized to overcome these challenges—even comics have been used to represent plant use in the past (e.g., Zapatero 2005). Archaeological interpretation presents a set of difficulties well covered by other authors, many of whom have signaled caution in terms of visual representation and artistic reconstruction (Cochrane and Russell 2007; Moser 2001; Rudwick 1992). In paleoethnobotany, as with other specializations, we do not wish to introduce erroneous or misleading data but do want to humanize plant use and attempt to populate the past with actual people (following Carlson et al. 2010). This is something that Morell-Hart endeavored in her own research (2011), by working with illustrator Sarah Davidson to incorporate representations of people engaging with plants in a variety of ways, while simultaneously trying to leave out as many unknown details as possible—including age and gender (similar to Gifford-Gonzalez 1993). With human-plant interactions, as with other types of practices represented, how we populate the past in our narratives and visual reconstructions can have enormous impact on the present (Cochrane and Russell 2007; Moser 2001).

Although challenges to traditional 2-D reconstructions of plant practices have been made (e.g., Perry 2009), most representations continue to focus on visual media. Images can go far beyond simple representations and reconstructions (Back Danielssen 2012 et al.). Moreover, "visualization" can occur through non-visual means (similarly to Ouzman 2001) to represent a multitude of plant properties in the past and in the present, including touch, taste, and even sound. Understanding and representing these properties through a variety of means has been attempted through efforts at recreating meals, reconstructing ecologies, and building other sorts of multi-sensory experiences.

Once archaeobotanical data are recorded and synthesized, the archaeobotanist's next task is to assess how this information connects with the archaeological and historical interpretations of their contexts. How do we "collaborate" with texts, ethnographic analogies, and iconographic representations of plants during the interpretive process? The many views through which archaeobotanists observe and record archaeobotanical remains have led to a larger visual projection and depiction of human-environmental relationships in the past. There are a variety of resources potentially at the disposal of an archaeobotanist to make this vision clearer: historical documents, ethnographic texts, oral histories, and collaboration with descendant and stakeholder communities. Often archaeobotanical contexts do not have living sources or documentary materials associated with the same historical contexts, and this leads to dialogue and negotiation between later texts and ethnographies, carefully navigated through application of analogies and judicious use of the direct historical approach (Wylie 1985). Without this collaboration between archaeobotanical data and various sources, archaeobotanical analysis would be static—a list of plants unincorporated into the anthropological realm.

As we look toward the future, we seek to preserve the past, both physically and digitally, and incorporate our findings into academic and public realms. Beyond the large body of archived reference materials previously mentioned— various parts of modern plants, at different scales, from the chemical to the macro— paleoethnobotanists have made great efforts to archive ancient materials for posterity. We have many ways of documenting and sharing our efforts, through a variety of media, both physical and virtual. In this way, we help to contribute to archaeology's greater goal of shifting our work in the public eye away from object fetishization and toward subject interpretation and shared information.

The rewards of collaboration go beyond disciplinary endeavor and dissemination of results. Paleoethnobotanical work has been incorporated into a wide array of public interests and even public policy. Critical efforts have been directed toward several key areas, increasing the visibility of paleoethnobotanical interpretation. Efforts to preserve and promote botanical and cultural diversity have incorporated paleoethnobotanical materials, from interpretive centers to agricultural practices (e.g., Cummings 2008). Similarly, ideas about ecological sustainability and food security have been impacted by understandings of ancient plants and ethnobotanical practices in public policy and non-profit sectors (e.g., Spielmann et al. 2011). Even ancient seeds themselves have been sprouted and grown (e.g., S. Ben-Yehoshua and L. Ben-Yehoshua 2012).

One model project that has managed to accomplish all of the above is the Native Seeds Project. This non-profit organization, based in Tucson, Arizona, "promote[s] the use of ... ancient crops and their wild relatives by gathering, safeguarding, and distributing their seeds to farming and gardening communities" (Native Seeds 2015). Such efforts contribute to food security by widening diversity and distributing collections (and thus mitigating risk), to ecological sustainability by incorporating a variety of locally appropriate propagation techniques, and to cultural preservation by distributing knowledge of archaeological findings, oral histories, and written narratives. Although our work encompasses a diverse array of endeavors, as archaeologists we strive to build such collaborations with an eye to the benefits that contribute to a shared future and a shared vision.

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