Paleoethnobotany

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Paleoethnobotany refers to the scientific study of the interaction between humans and plants in the past; this includes the study of human impacts on the environment, how the environment directed human practice, and cultural uses of plants. It is simultaneously a subfield of archaeology and ethnobotany, which, in turn, are subfields of anthropology (in the American academic system) and botany or the plant sciences, respectively. In this sense, a paleoethnobotanist studies past human culture and plant life. In practice, this often consists of studying the remains of plants in archaeological sites, by a specialist, who draws upon methods and theoretical frameworks from both the biological and social sciences. In essence, paleoethnobotany is at the intersection of the interplay between living organisms and human culture. The term paleoethnobotany is also used synonymously with archaeobotany and advocates a multidisciplinary approach to studying human history. Specialists are required to mingle laboratory-produced data with historical texts, ethnographic analogies, cross-cultural comparisons, and a wide range of archaeobotanical data that are extracted from archaeological contexts, including ancient crafts made from plants, impressions of seeds and plant parts in ceramics or mudbrick, remains of plants in human paleofeces or in the stomach contents of preserved bodies, as well as artifacts or tools used to process or cultivate plants, such as grinding stones, farming tools, woodworking tools, digging sticks, loom weights or spindle whirls, and irrigation structures.

The most widely studied topic within the field relates to human paleodiet, and how humans cultivated or foraged for, harvested, and consumed plants in the past, as well as what kinds of plants they chose to eat. In addition, some of the most widely publicized questions in the field surround the topic of plant domestication—including when certain plants were domesticated, how long this process took, where the domestication process took place, and why humans initiated the process. The origins-of-agriculture debate remains one of the most lively topics of inquiry in the archaeological sciences. Indeed, the plants that were morphologically domesticated as a response to human cultural practice express the closest coevolutionary relationship to humans, and, in studying them, scholars are looking at the deepest interrelationship that humans have with plants. There is also a wide array of research topics beyond plant cultivation; these include questions relating to how humans through time have impacted the environment that they live in, often dramatically reshaping plant communities, such as in agricultural fields or managed forests. All humans continually impact the plant communities around them, reshaping entire ecosystems and altering niches. In addition, plants are used for a range of cultural purposes beyond food and drink, including architectural construction material, textile and basket production, clothing, rope, fiber, and thread, weapons, hunting equipment, fishing nets and tackle, boat construction, ornamentation and art, dyes and paints, medicine, cosmetics, bedding, kitchen and household utensils and furnishings, fuel, ritual practices, and displays of status, identity, and aesthetics.

While the field is rapidly branching out into new methodological realms, including genetics (using ancient and modern DNA; see GENETICS: ANCIENT), isotope studies (see ISOTOPES), phytochemistry, proteomics, and other biomarkers, it has traditionally focused on the morphological identification of ancient plant remains. Many scholars in the field further subdivide paleoethnobotany into two primary branches based on methodological approaches: microbotanical and macrobotanical methods. The latter deals with all archaeobotanical remains that are large enough to see with the human eye, even if the identification of these remains requires magnification, whereas

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microbotanical approaches deal with plant remains that can only be seen with high-power magnification—phytoliths, pollen, and starch grains. Both methodological branches rely on morphological identification at a microscope; however, macrobotanical studies principally use dissecting microscopes with magnifications up to 50×, whereas microbotanical approaches generally use reflected or transmitted light microscopes at magnifications up to 1,000×. The field is largely quantitative, relying on the abundance and density of specific categories of plant remains in specific archaeological contexts. These counts and ratios go beyond simple observations of presence and absence and allow the specialist to determine cultural practices relating to plant use in specific areas of an archaeological site.

Plant tissue does not readily preserve; hence the archaeological recovery of these remains only occurs when specific depositional and taphonomic processes are met. Plants are consumed by fungi, including mold, animals, including insects, and microorganisms; only when the biological deterioration of these plants is prevented will they preserve in archaeological contexts. The majority of the macrobotanical remains recovered from archaeological sites have been burnt—carbonized or charred—either accidentally, such as by storage areas catching fire, or deliberately, when used as fuel or as discarded trash in a cooking hearth, resulting in their long-term preservation in anthropogenic sediments. Plant remains that have been carbonized will no longer deteriorate (rot) at the same rate as uncarbonized remains, as carbon is largely inert and not subject to biological or chemical attack, though such remains are vulnerable to physical and chemical weathering (see Miksicek 1987). Plant parts, such as seeds and fruit structures, can be preserved through other vectors, through which chemical, biological, and mechanical deterioration is halted or slowed, such as being incorporated into an anerobic environment (e.g., permanently waterlogged conditions or deep burial), or when desiccated, exposed to the corrosion products of metals, frozen, or through mineral replacement (e.g., calcium-phosphate replacement; see FORMATION PROCESSES).

The most widely studied category of macrobotanical remains includes seeds and fruit parts, such as nut shells; other archaeological remains of plants include carbonized wood (see CHARCOAL AND WOOD ANALYSIS), pedicles, stems, textiles, and fibers (see TEXTILES), roots and underground storage organs, parenchyma tissue, and in some cases even leaves and floral structures. Carbonized macrobotanical remains are usually recovered from archaeological sites by means of a flotation/water separation system. There are several ways that excavators and specialists approach the systematic removal of botanical remains from anthropogentic sediments (for a discussion see Fritz 2005; Watson 1976); collectively, these methods are referred to as flotation. Flotation methods rely on buoyancy to mechanically separate carbonized plant remains from the soil matrix, dirt, rock, or other inorganic materials. Sieving is then used to remove all material below the target particle size.

In cases where macrobotanical remains did not preserve or as a complement to other lines of evidence, paleoethnobotanists can turn to microbotanical data, such as pollen. The study of pollen, or palynology (see PALYNOLOGY), has gone hand-in-hand with paleoclimatic studies for nearly a century. The most important use of pollen data for paleoethnobotanical purposes is to help elucidate changes in settlement patterns or possible anthropogenic impacts on vegetation cover. While pollen data are still most often used by scholars to reconstruct ancient vegetation communities, the data can also be used to understand aspects of human activities in the past. Pollen studies are sometimes conducted on sediments in archaeological sites, under the assumption that concentrations of pollen from economically significant plants may indicate processing areas or areas where flowers were concentrated, such as through a funerary offering.

Phytoliths (see PHYTOLITH ANALYSIS) are silica-based structures that form through the deposition of inorganic material inside or between plant cell walls. The particles serve the function of both providing structural support and reducing herbivory for the plant. Because the particles are inorganic, they are not subject to the same processes of biological deterioration as other plant remains and can preserve in situations where other organic material does not. However, not all plants produce the same abundance of phytoliths, nor are the same densities of these deposits produced in all parts of the plant. In many cases, the morphology of the phytoliths is distinct to a specific clade of plants, allowing phytolith experts to identify categories of plant remains in archaeological sites, even if macrobotanical remains do not preserve. One of the most significant aspects of phytolith studies is the fact that these siliceous particles form in the leaves and stems of plants, leaving a signature of plant parts that are rarely preserved as charred remains.

Starch grains (see STARCH GRANULE ANALYSIS) are small granules of carbohydrates that form inside certain parts of some plants. They are commonly found in the fruits, roots, and seeds of many plants; in some cases, starch is stored in the leaves and stems of plants as well. While it is not exactly clear how carbon-based particles preserve in archaeological contexts, they have been recovered from dental calculus, ceramic sherds, organic materials, sediments, and stone tools. Starch grains often provide a direct indication of food processing, when found on grinding stones, or food consumption, when found in dental calculus or in cooking pots and on processing tools.

All of the methods mentioned above have positive and negative aspects and, therefore, they are best implemented in unison. Macrobotanical, rather than microbotanical, studies provide the most reliable line of evidence, and, in most cases, macrobotanical remains can be identified to a more specific cladistic level, often to species. However, phytoliths can be used in cases where macrobotanical remains do not preserve. Many studies have shown that these methods are complementary and produce data that highlight different aspects of the plants used by people in the past. For example, the glumes or chaff of grain crops contain phytoliths, and, therefore, finding high densities of chaff phytoliths in one area of a site may indicate that it was a crop-processing location. In addition, starch grains on archaeological tools and grinding stones have allowed scholars to determine what the tools were used for. Integrated or multivariant datasets are becoming increasingly more prevalent in the field, producing the most holistic picture possible. In addition, ethnoarchaeology has been tied closely to archaeobotanical interpretation for many decades. For example, studying what plant remains are found in recently abandoned pastoralist campsites in West Asia has helped scholars determine what vectors ancient plants followed to ultimately end up in archaeobotanical assemblages (Spengler 2015). By studying these modern analogies, scholars can hypothesize whether specific seeds were introduced to a site as human food or if they followed another vector into the site, such as through dung or sod burning as fuel, through crop-processing to remove seeds from field weeds, incorporated into bedding or roofing material, or as seed rain—among a wide range of other possible vectors.

There are many historical overviews of the field, and the reader interested in understanding the development of paleoethnobotany should turn to sources such as Pearsall (2015) and Watson (1997). Pearsall (2015) suggests that the field was largely formalized into a system of inquiry with an article published by Volney H. Jones (1941) titled "The Nature and Scope of Ethnobotany". In this article, Jones uses a broad definition for the field, noting that it centers on the study of the interrelationship of plants and humans; he also emphasized the interdisciplinary nature of the field, which is still one of its hallmarks today. While the systematic targeting and recovery of archaeobotanical remains may only date back to the 1940s, botanists have been recording and identifying plants in archaeological sites since the nineteenth century, with Kunth's 1826 study of remains in Egyptian burials and Heer's 1866 study of plant remains from waterlogged villages in the mountains of Switzerland. Furthermore, large-scale multidisciplinary expeditions, with scientific specialists including botanists on staff, have been undertaken for over a century, such as Pumpelly's 1904 expedition to Anau in Turkmenistan. The term paleoethnobotany was first used in 1959 by Hans Helbaek; and Richard Ford's definition from 1979 is still widely used today—"the analysis and interpretation of the direct interrelationship between humans and plants for whatever purpose as manifested in the archaeological record" (Ford 1979, 286). Over the past half century, the field has moved forward with new methods and technology in the laboratory, at the excavation site, and during data interpretation. As new technology and scientific methods are introduced, the questions that archaeobotanists are asking have become increasingly complex. Research questions addressed by specialists, by definition, deal with food and ecology, which are inseparably intertwined with sociopolitical organization, ideology, and identity, exchange, kinship, adaptability, and ecosystem engineering. However, in the past few years, scholars have increasingly embraced a range of previously overlooked questions; one of the most intriguing of these is the topic of cuisine. These specialists are readily stepping beyond simple tallies of plant remains and instead discussing how the remains came together in a culinary tradition. In order to achieve this goal, they need to incorporate other archaeological artifacts, including tools and cooking pots, human osteological studies, and isotope analyses, as well as zooarchaeological data.

Plant domestication continues to be one of the most prominent areas of investigation (Langlie et al. 2014) (see DOMESTICATION), and with the incorporation of genetic approaches since mid-2000 scientists have largely rewritten what we know about the origins of our domesticated plants. For example, many specialists are looking beyond the idea of simple domestication models that rely on single centers of domestication and rapid domestication events, recognizing that many plants were domesticated multiple times and that this process may have taken several millennia. Increasing scientific investigation is also showing that the transition between hunting and gathering to farming is not a simple one and that many foragers also grew crops. Similarly, the introduction of archaeobotanical methods into parts of the world and time periods where archaeologists did not expect to find farming has been changing scholarship, notably in areas of Eurasia that were thought to be largely dominated by nomadic populations (e.g., Spengler 2015). In addition, many archaeobotanists are recognizing that questions concerning dissemination of these plants are as important as the identification of the original domestication; scholars are focusing more on plant spread and exchange. Other popular topics of investigation include human health and nutrition, plant pathologies associated with cultivation, the study of the spread of invasive species, the ramifications of deforestation, and the effects of global climate change in the long term. Furthermore, scientists are turning more towards multivariate statistics (see MULTIVARIATE ANALYSIS) and direct integration of plant and animal remains. Archaeologists acknowledge that plants are fundamental to human life and, therefore, a comprehensive picture of human societies of the past cannot be drawn without the incorporation of paleoethnobotanical methods. As a result of the developments in the field of paleoethnobotany over the past half century, specialists are readily incorporated into excavations and the data they produce are held on par with other lines of archaeological investigation.

SEE ALSO: Paleoenvironmental Reconstruction; Paleoethnobotany and Ancient DNA Analysis; Paleoethnobotany and Stable Isotopes

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