

Chapter 12

Hunter-Gatherer Tobacco Smoking in Ancient North America: Current Chemical Evidence and a Framework for Future Studies

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12.1 Introduction

At the time of European contact, tobacco (*Nicotiana* sp.) was the most widely exploited intoxicant in the Americas (Moerman 1998). Tobacco's popularity among humans both past and present lies in the psychotropic alkaloids it contains, including, but not exclusively, nicotine. These alkaloids cause a range of physiological effects including euphoria, increased heart rate and alertness, and suppression of hunger and thirst. In very high doses, the alkaloids of tobacco can induce hallucinations, out-of-body experiences, and color blindness, effects that were sought after by shamans, traditional doctors, and others as they relate to vision quests, medicine, and other religious practices (Siegel 1989; Wilbert 1987, p. 96). Indeed, tobacco was—and still is—widely regarded as a sacred plant or medicine by many indigenous peoples in the Americas, figuring prominently in Native traditions, religions, and rituals (Shorty 2007; Winter 2000c; Winter et al. 2000).

The chemical properties of tobacco form the basis of its long history of use among humans. A growing number of archaeologists use these very chemical properties to identify use of the plant in the past. Residue extraction methods and identification of alkaloid compounds using gas or liquid chromatography, often coupled to mass spectrometry (LC-MS or GC-MS), of pipes from archaeological contexts was recently demonstrated by Sean Rafferty. His work documents use of tobacco in the northeastern United States by at least 3000 BP through the identification of the

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biomarker nicotine in the ash content of prehistoric pipes (Rafferty 2006, 2002; Rafferty et al. 2012). Similarly, our own work in western North America demonstrates a continuous record of smoking tobacco in pipes by non-farming peoples from at least AD 860 through the historic period (Tushingham et al. 2013).

While methodological development is clearly important, so too is the development of a robust theoretical framework for future chemical studies focused on tobacco. Indeed, there are a wide range of anthropological questions that may be addressed through chemical residue analysis of tobacco and other smoke plants. Below, we outline several key research questions, with an emphasis on tobacco use, among hunting, gathering, and fishing societies in western North America. Research questions revolve around the antiquity of use, reconstruction of artifact function, manipulation and cultivation of tobacco, anthropogenic range extension, the origins of addiction and ritual activity, and applications relating to modern Native American tobacco use.

12.2 Antiquity of Use

Development of residue extraction and identification methods will give researchers the tools to better understand when and why people began using psychoactive plants, including tobacco. Such research will qualify what, if any, relationship there is between tobacco and the domestication and spread of other cultivars (e.g., Eastern Agricultural Complex plants, “three sisters” Mesoamerican domesticates: maize, beans, squash) and/or indigenous tobaccos or ritual plant complexes. More than 30 years ago, it was suggested that domesticated tobacco was cultivated around AD 1000 outside North America and was absent in the American Southwest until the historic period (Ford 1981, 1985). However, more recent work suggests a much earlier sequence, with tobacco, most likely *N. rustica*, reaching the eastern North America between 3000 and 2000 years ago (Rafferty 2006, 2002; Rafferty et al. 2012), by way of South America, and possibly *N. tabacum* spreading to parts of the southwestern United States and the Caribbean shortly thereafter (Winter 2000a, b). In these places, domesticated tobacco is thought to have been added to the suite of plants people were already farming, or spread in tandem with the rise of maize agriculture (Driver 1970, p. 106; Yarnell 1964, p. 85), though the development of different crops likely had different trajectories (Fritz 1990).

There is a growing appreciation that the development of tobacco use may have been more complex than previously imagined. For example, photogrammetric studies of tobacco seeds found at some sites in eastern North America are intriguing and suggest they more closely resemble indigenous tobacco species found in the west than domesticated *N. rustica*. Based on archaeobotanical evidence, Haberman (1984) suggests by about AD 1000 an eastern variety of *N. quadrivalvis* (var. *bigelovii*) was being cultivated in the Middle Missouri region. Likewise, Pauketat et al. (2002) present evidence that a tobacco variety such as *N. quadrivalvis* or *N. multivalvis* was used at Cahokia, a Mississippian mound center in southwestern

Illinois, around AD 1050–1100. Thus, there remains the possibility that indigenous tobaccos spread from the west, presumably through anthropogenic processes. In this scenario, these tobacco species were later abandoned in favor of the domesticated *N. rustica* from South America, or, as suggested by Haberman (1984, p. 283), the replacement of *N. rustica* by “a western tobacco, which became the historic *N. bigelovii* var. *quadrivalvis* (Pursh) East, sometime during the early expression (ca. AD 900–1100) of the Initial Variant of the Middle Missouri tradition, at which time wide-ranging trade contacts were being established by sedentary village populations with a strong emphasis on horticulture.” While there is much to understand about the timing and spread of domesticated tobaccos, even less is known about indigenous tobacco use in western North America.

While some have argued that tobacco smoking in western North America was a very recent practice brought by Euro-American traders in the contact period (e.g., Dixon 1933; Kroeber 1941, p. 14), other scholars argue that the practice has very ancient origins (e.g., de Rios 1984, p. 6; Furst 1976, p. 5–6; Heiser 1969, p. 16; La Barre 1970; Siegel 1989, p. 3; von Gernet 1989; von Gernet and Timmons 1987, p. 41; Winter 2000a; Winter and Hogan 1986, p. 120). In a model presented by Goodspeed (1954, p. 45–46), wild tobacco spread naturally into the deserts and arid zones of the southwest, Great Basin, and California by the early Pleistocene. If true, humans may have been using these tobaccos as early as Paleo-Indian times, though direct evidence for such early use is lacking.

In this scenario, the first peoples of North America, as early immigrants from Asia, may have “brought a ‘cultural predisposition’ for the use of psychoactive plants from Asia as part of their shamanistic religion” (Winter 2000a, p. 308–309). If so, tobacco could have simply been an additive to an ideological system where plants were already being used for “visions, hallucinations, and other shamanistic journeys” (Winter 2000a, p. 309). Here it is assumed that hallucinogenic plants were used to communicate with the spirit world and to produce the visions and out-of-body journeys that are commonly a part of shamanism. Though the literature emphasizes shamanism, supernatural visions, and out-of-body experiences, it is important to note these botanicals were also substances that were part of on-going medicinal practices, often due to other active ingredients within the plants.

Related to this issue is the evolution of smoking practices in North America. Tobacco use is often inferred based on the presence of archaeological pipes. This can be misleading for two reasons. First, the historic record demonstrates that Native peoples ingested tobacco in a variety of ways that are not always associated with durable artifacts or pipes (e.g., chewing with lime, smoking in organic materials such as wooden pipes, in reedgrass “cigarettes”, or in leaf wrapped “cigars”) (Adams 1990; Kroeber 1941). Second, it is not clear that the earliest smoking was necessarily of tobacco: while archaeological pipes are often assumed to have been used to smoke tobacco, we know that a staggering pharmacopeia of plants was smoked by historic groups for medicinal, ceremonial, and recreational purposes. For example, Moerman’s Native American Ethnobotany (1998) documents over 100 plant species representing 55 genera of smoke plants used throughout North America.

Among hunter-gatherer communities in western North America, the variety of smoke plants was especially high. Popular smoke plants included bearberry or kinnikinnick, which was the main alternative smoke plant to tobacco in many parts of the Pacific Northwest Coast, either smoked with tobacco or on its own. While kinnikinnick usually refers to *Arctostaphylos uva-ursi*, Kroeber (1941) points out that this is a general term that can also refer to other plants smoked in this region, including Yew (*Taxus brevifolia* Nutt.) needles, Dogwood (*Cornus* sp.) leaves, Salal (*Gaultheria shallon* Pursh) leaves, and Madrone (*Arbutus menziesii* Pursh) leaves. In California, Native smoke plants include the leaves of various species of Manzanita (*Arctostaphylos* sp.), Sagewort (*Artemisia douglasiana*), Common Mistletoe (*Phoradendron villosum* Nutt.), California Black Oak (*Quercus kelloggii* Newb.), Creeping Sage (*Salvia sonomensis*), and Sacred Thornapple (*Datura wrightii*). Thus, it is possible that smoking in pipes began with any of these other species, and was only later adapted to include tobacco.

By focusing on tobacco and/or the biomarkers of tobacco, we run the risk of overlooking other smoke plants that may have been important in the past. As a result, we could be limiting our understanding of the complexity that plants play in ritual and medicinal activities, the evolution of such activities over time, plant cultivation practices, and related human-plant dynamics (see below). The potential for the presence of other plants demonstrates that chemical studies must not only target tobacco compounds (e.g., nicotine, nornicotine) but also compounds associated with other smoke plants. Thus, it is recommended that researchers develop a list of potential smoke plants specific to their study area that draws on regional ethnography, oral histories, and research into plant ecology and past environmental conditions. Ideally this work is done in collaboration with local tribal communities, since smoke plants in the past may have been obtained via trade or people in the past may have been growing and tending plants outside their natural geographic range. Researchers should also be sensitive to the fact that they may be asking people to share proprietary information associated with such plants. Once a list is constructed, these plants should be analyzed for associated biomarkers prior to undertaking chemical analyses on archaeological materials. LC- or GC-MS analysis should then seek specifically to identify these potential biomarkers in residues associated with archaeological materials. Furthermore, discovery of compounds not previously identified may lead to interesting avenues of research where new plants not previously considered could be added to a list of smoke plants, although it can be difficult to identify specific plants without pre-identified biomarkers.

12.2.1 Ethno-Historic Distribution of Indigenous (“Wild” and “Cultivated”) Tobacco

Whether farmed, cultivated, gathered, or obtained by trade, tobacco was used by Native groups practically everywhere on the North American continent, from very mobile hunter-gatherers in the western deserts to sedentary agricultural groups in

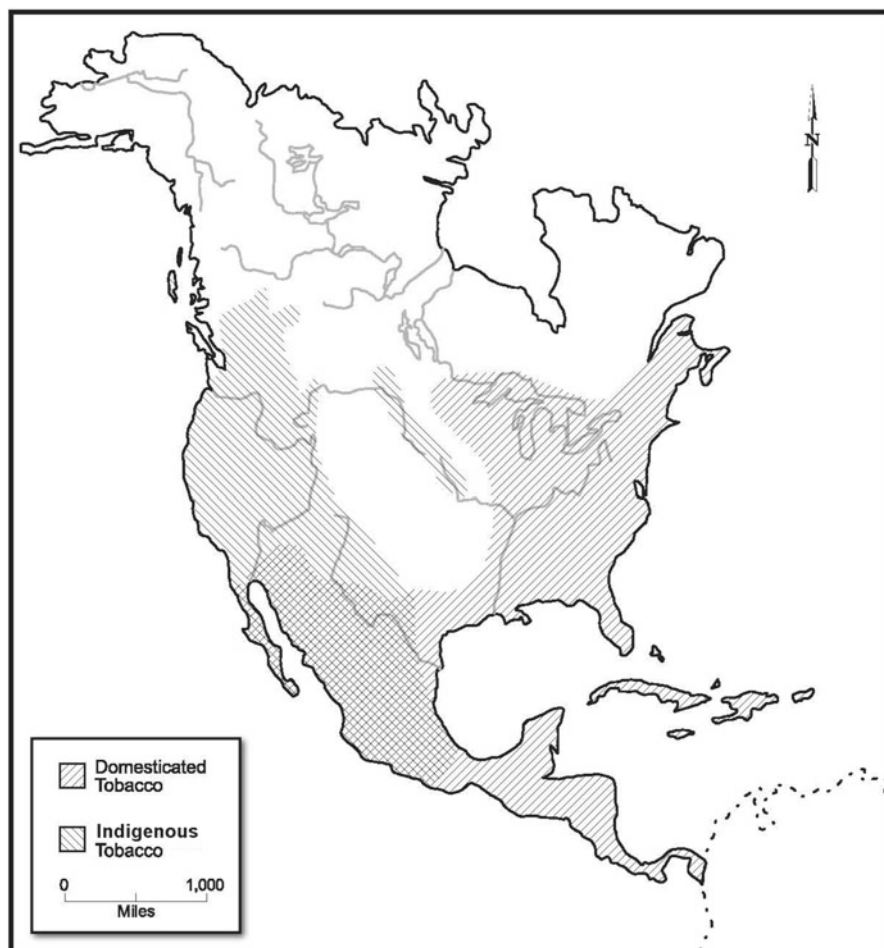


Fig. 12.1 Generalized distribution of indigenous and domesticated tobaccos in North America (Redrawn from Winter 2000a, p. 311, Map 28). Note domesticated tobaccos were likely traded further into northeastern Canada than depicted here

the Eastern Woodlands (Fig. 12.1). Of the range of species available, tobacco plants are often grouped into two broad categories: wild (also known as desert or “coyote”) and domesticated tobaccos. This is, however, a misleading dichotomy, as many of the “wild” tobaccos were in fact manipulated through selection by native groups to a degree that has been largely unappreciated, and these cultural practices likely altered several species on a genetic level, perhaps even leading to the generation of new species (cf. Goodspeed 1954, p. 9–10; Winter 2000a). We are confident that future genetic and chemotaxonomic studies on ancient, historic, and modern remains will lead to important insights into the degree of manipulation or domestication on the part of humans. In the meantime, following Goodspeed (1954), we

hereafter refer to the cultivated and “wild” tobaccos used by Native peoples in the west as *indigenous tobaccos*.

People are generally more familiar with domesticated tobaccos, which include the species *N. rustica* and *N. tabacum*, grown by indigenous farming groups throughout the eastern United States, the Caribbean, parts of the southwestern United States, and South and Central America. After European contact, these domesticated varieties of tobacco spread quickly to parts of the globe where they had never been before. For example, tobacco was brought to Europe by Spanish explorers in the early 1500s, and rapidly distributed throughout the Old World. More relevant to this chapter, tobacco was transported by Hudson Bay Company agents and other traders to northwestern North America as a trade item that was highly valued by many Native groups. Domesticated tobaccos are distinct in that, through genetic selection and modification by humans, a process that began perhaps 6000–8000 years ago in South America, the plants have much larger leaves and a higher nicotine content than the “weedier” indigenous tobaccos.

In contrast, there are many more species of indigenous tobaccos used by hunting, gathering, and fishing communities throughout the western United States and Canada. Some of these species can grow without human intervention, although there is a growing appreciation that plant management and cultivation was widely practiced by many pre-contact resident groups, a point that will be expanded upon below. Despite the absence of farmed crops (i.e., maize, beans, and squash) and agriculture, it is clear that the western North American landscape was highly managed through fire maintenance (or pyroculture) for thousands of years (e.g., articles in Blackburn and Anderson 1993). Though not in maintained plots of maize, beans, or squash, the patchwork of interconnected landcover was tended through encouragement of particular species regimes (e.g., Fowler 1996), with plant encouragement and selection for key characteristics (size, flavor, hardiness strength, etc.). Within these regimes, there is evidence for management and/or cultivation of indigenous tobaccos (Fig. 12.2). Ethno-historic sources (e.g., Kroeber 1941, papers in Winter 2000b; Moerman 1998) describe specific manners of planting, tending, and even ownership practices. This suggests that some genetic modification did occur at the hands of indigenous residents in the west, and the process of tobacco domestication should be regarded as a continuum (i.e., not simply domesticated vs. “wild”).

Furthermore, as supported historically, Native Californians commonly traded for tobacco (Davis 1961), even in places where the plant grows wild without the aid of humans (i.e., central California). That people sought to acquire exotic varieties of a plant, whose wild variety could be gathered locally, suggests the tobacco that they were trading for, and consuming, had different properties. It remains a hypothesis, but we suggest such “outside” tobacco may have been a more genetically modified variety, perhaps with a stronger nicotine content, or having other preferred chemical properties sought after by people. Thus, while not all people may have sought to invest in cultivated plots, some individuals may have specialized in maintaining small gardens of preferred varieties of tobacco and traded these plants to neighboring people. Specialized production of particular items for trade, such as obsidian

Fig. 12.2 Hunter-gatherer tobacco cultivation. Mrs. Estefana Salazar (Tubatulabal) with tobacco leaves gathered from patch, Kern County, California (1932 photo). *Courtesy of the Phoebe A. Hearst Museum of Anthropology and the Regents of the University of California—photographed by Erminie W. Voegelin, Image 3145-22*



blades or shell beads, is well documented archaeologically and ethnographically in California (e.g., Arnold 1992; Gilreath and Hildebrandt 1997), and tobacco may constitute such a product as well.

Social factors may also be involved in the distribution of tobacco. For instance, there were social sanctions against smoking tobacco that was not cultivated in northwestern California. For example, plants that grew on graves or other sacred places were deemed unfit for human use. Instead, people had to cultivate tobacco in specific patches (Kroeber 1941), including perhaps, soils that were otherwise not favorable to tobacco. These restrictions encouraged husbanding of tobacco by certain individuals. If so, selection of particular seeds for future cultivation by such gardeners could have caused pheno- and chemo-typic changes in the plant. Although difficult to demonstrate archaeologically, other social factors affecting the use, growing, and geographic distribution of tobacco might include family/group connections, and linguistic or social barriers.

12.2.2 *Anthropogenic Range Extension*

There is a growing appreciation for the varied and sophisticated ways indigenous hunting, gathering, and fishing communities manipulate their “wild” environments (e.g., Deur 2002; Deur and Turner 2005; Lepofsky and Lertzman 2008; Lightfoot et al. 2013; Winter 2000c). Tobacco cultivation in the North American west provides unquestionable evidence of plant management: cultivation practices include the preparation of plots, burning, sowing of seeds, pruning, and fertilizing soils, and demonstrates these activities were widely practiced by historic groups in California, parts of the Pacific Northwest, and the Great Basin (e.g., Deur and Turner 2005; Fowler 1996; Harrington 1932; Kroeber 1941; Moss 2005; Turner and Taylor 1972; Winter 2000c).

In certain cases, plants were cultivated, managed, or domesticated outside of their natural range. Management of indigenous tobaccos is hypothesized to have expanded their range in the western United States and possibly led to the creation of new species (Winter 2000a). In the northern Pacific Northwest Coast, where tobacco is a non-native plant, human management of these species is seen as “a special and dramatic case of geographic range extension” (Lepofsky and Lertzman 2008, p. 136). The Haida and Tlingit groups cultivated *N. quadrivalvis*, for example, a plant that does not grow naturally in their homelands and in fact was no longer found on the landscape after the introduction of domesticated tobacco by early trading partners in this area (Turner and Taylor 1972).

Human action, specifically plant management and cultivation, may have extended the range of indigenous tobaccos over time (Winter 2000a). As mentioned above, active manipulation by humans may also have led to selective breeding and genetic changes in these plants, and ultimately, the development of new species in some areas. In other words, hunter-gatherers may have domesticated tobacco, changing the plant’s ability to grow under different environmental conditions as well as altering the density and range of chemical compounds produced.

Western indigenous tobaccos are taxonomically grouped into petunioides, one of three subgenera of tobacco (the other two are rustica and tabacum) (Goodspeed 1954). At contact, petunioides were widely dispersed in North and South America, Australia, and the South Pacific Islands (Goodspeed 1954). Human cultivation and manipulation of several species used by hunter-gatherers in the west, however, likely extended their distribution. For example, *N. bigelovii*, in particular var. *multi-valvis* and var. *quadrivalvus* were widely dispersed species used in California and the Pacific Northwest at the time of contact, and it is “probable that selection was actually toward their more compact habit and greater amount of leaf tissue in proportion to stem length” (Goodspeed 1954, p. 10).

Goodspeed (1954) outlines the basic mechanisms that may have led to the spread of indigenous tobaccos: “Three major factors have been responsible for such deliberate or fortuitous extension by man as has occurred in *Nicotiana*: (1) ancient and/or modern use of certain species as sources of ritualistic or pleasurable narcotics; (2) unintentional transport of seeds, sometimes over long distances; (3) propensity of a

number of species to occupy disturbed soil” (Goodspeed 1954, p. 9). The ultimate reason for the spread of certain tobaccos may be hard to determine, and may in fact reflect a combination of the suggested mechanisms. Research investigating connections between indigenous tobaccos (wild and cultivated) remains largely unexplored. However, this may change through the application of chemical identification techniques and DNA analysis, on both archaeological artifacts and/or ancient or herbarium plant specimens.

Several authors have proposed tobacco is connected to plant domestication and cultivation in different parts of the continent. For example, according to Winter (2000a, p. 313) “tobacco use is a very ancient and far reaching cultural complex that formed or at least became part of the foundation for other kinds of plant manipulation, perhaps even agriculture.” Along the Pacific Northwest Coast, it has been hypothesized pre-contact experience with tobacco cultivation may have “set the stage” for the rapid adoption of potatoes and other historically introduced vegetable crops. Tlingit and Haida peoples were successful in these horticultural practices by simply drawing on their previous knowledge of tobacco cultivation (Moss 2005; Turner and Taylor 1972). While intriguing, this “Pacific Northwest Tobacco Mystery” (Turner and Taylor 1972) unfortunately remains unsolved.

12.2.3 The Origins of Tobacco Addiction and Ritual

Today, tobacco is used by hundreds of millions of people around the world (World Health Organization 2011), and despite being the leading cause of preventable death, nicotine dependence is a worldwide epidemic. In the United States, an estimated 29 % of Americans continue to smoke tobacco in cigarettes, pipes and cigars, and even more chew smokeless or “spit” tobacco (World Health Organization 2011). Tobacco use has had clear worldwide consequences, yet as discussed above, we know surprisingly little about the evolution of human–tobacco relationships.

When did human use develop into human need of some of these intoxicant plants (as an essential component of ritual life and/or because regular use led to physiological addiction), and how do these dynamics relate to the domestication of certain plant species? Does this have any relevance in the modern world? The attractiveness of psychoactive plants to humans is clearly related to the physiological effects they cause when ingested, and their addictive nature (Winter 2000a, p. 326). The same properties that resulted in widespread prehistoric use are the same that cause continued widespread use today.

Winter (2000a, p. 327), posits that these qualities may have led “shamans and other heavy users to domesticate a number of the wild species and expand the ranges of others.” In this scenario, after Native peoples had incorporated psychotropic plants such as tobacco, datura, and coca into their pharmacopeia, they then changed their geographic distributions, first by disturbing soils in sites where they could grow, later by burning old plants to improve the next season’s growth, third by prun-

ing and irrigating them, and finally by planting seeds. Over millennia people became increasingly dependent on tobacco and may have developed tobacco shamanism and other religious rites organized around large-scale ingestion of nicotine. This may have fostered intentional selection for increased nicotine content in tobacco (Winter 2000a, p. 315).

While this is not a testable proposition given current knowledge about ancient tobacco, techniques may be developed in the future that can ultimately produce data to address these issues. Indeed, understanding the origins and development of tobacco addiction and ritual can help us to better understand tobacco's current pull on global users: "domestication of tobacco and its widespread use by Native Americans has had profound effects upon the rest of the world. Previously used by Indians primarily as an offering and a way to communicate with the spirit world, tobacco is now ingested as a recreational, addictive drug all around the planet, with enormous economic and medical consequences" (Winter 2000a, p. 326).

12.2.4 "Tobacco Sovereignty", Colonialism, and Modern-Day Applications

Tobacco continues to be traditionally smoked and/or used as an offering by many Native peoples throughout the Americas. For example, the plant figures prominently in the annual World Renewal Ceremony of the Hupa, Karuk, and Yurok of northwestern California. Without tobacco, the ceremony is incomplete, which in traditional terms literally jeopardizes the future regeneration and well-being of the earth. Studies of past tobacco use can help document and gain perspective on the ancient nature of this ceremonial and ritual complex that continues to be an integral part of indigenous culture today (e.g., chapters in this volume by Phillips 2015; Snyder 2015; Winter et al. 2000).

At the same time, tobacco addiction is a critical health issue for Native Americans. More Native Americans than any other group habitually smoke tobacco (see discussion in Snyder 2015, this volume). Typical tobacco abatement programs approach tobacco use in black and white terms, with all tobacco use being bad, and abstinence from smoking as good. This is not the reality for many American Indians, who recognize the sacred and traditional aspects of tobacco.

Many Native communities practice "tobacco sovereignty" today (David Harrelson, personal communication, 2014), which refers to American Indians prescribing appropriate and healthy use of tobacco on their own terms. This may include, for example, development of tribal programs addressing healthy tobacco use, cessation, and/or small scale to commercial tobacco growing operations. Furthermore, many are defining traditional use practices (i.e., sacred, ceremonial, or other special use) within the terms of their own communities. This lies in great contrast with values placed on commercial tobacco smoking (unhealthy, addictive, nontraditional, colonial, large scale).

Shorty (2007) outlines several critiques of the tobacco industry, which has both a history of targeting Native Americans in their advertising and of using Native American imagery in the selling of tobacco. In an effort to better understand Native use patterns and develop successful abatement patterns, he calls for a recognition of the historical context of tobacco use and acknowledgement of its colonial past. Tribes may embark on smoking cessation programs as an act of self-determination, and he encourages a “threefold basis for engaging in indigenous tobacco control work: sovereignty, health, and spirituality. Slogans that guide work with American Indians and Alaska Natives include ‘Keep Tobacco Sacred,’ ‘Tobacco: Use It in a Sacred Way,’ ‘Many Voices One Message: Keep Tobacco Sacred.’ The rhetorical strategy implicit in the slogans is to create a distinction between ‘commercial tobacco’ and ‘traditional/ ceremonial tobacco’ and to work against the former. Respect for tribal sovereignty compliments an emphasis on spirituality” (Shorty 2007, p. 130).

A growing number of studies have focused on the development of a culturally specific smoking cessation program for Native Americans (e.g., Choi et al. 2006; Daley et al. 2006; Gohdes et al. 2002; Shorty 2007; Struthers and Hodge 2004; Unger et al. 2008; see also Snyder 2015, this volume). Common themes or priorities include acknowledging the importance of sacred tobacco use (versus recreational use of commercial tobacco), increasing education on the history of tobacco, and defining traditional use. For example, in a study by Choi et al. (2006), American Indian participants “who reported that traditional tobacco use is important were less inclined to use tobacco recreationally.” Yet few programs to date have investigated the roots of traditional tobacco use, which has, in many cases, become obscured by historic events (see Snyder 2015, this volume). As discussed above and below, analysis of ethnographic and archaeological collections is one avenue indigenous communities could use to explore the nature of traditional tobacco practices.

Certainly, commercially grown species of tobacco have replaced traditional tobacco and use of other smoke plants among many Native peoples, a process that began several hundred years ago during earliest days of European colonialism of the Americas. According to Shorty (2007), increased awareness of the history of tobacco and its process of colonialization is critical to future smoking abatement programs as is distinguishing between commercial/manufactured tobacco and traditional/ceremonial tobacco. For example, few realize the extent to which domesticated strains of commercial tobacco have replaced indigenous species of tobacco and other smoke plants. In many cases, “commercial tobacco” has become the tobacco used for ceremonial purposes, “replacing the many *Nicotiana* species or other botanicals originally used by Indians who had a religious smoking tradition” (Shorty 2007, p. 133; see also Winter et al. 2000, p. 359–340). Briece Edwards (personal communication 2014) suggests a reason for this phenomenon: “In our office [Confederated Tribes of Grand Ronde], it may simply be a case of expedited ease. It is easier to buy a pack of cigarettes or even loose leaf at the shop and use it in ceremony than to grow and cultivate the indigenous species today. This is not to say this is true for all tribes and all uses. If anything, it further illustrates the complexity of the subject and the intricacies of use.”

Ever since tobacco began to be grown by Euro-Americans, the commercial tobacco industry has evolved

“...into a colossal, world-wide empire....Today there are thousands of commercial *N. tabacum* varieties. The 1993–1994 U.S. Tobacco Germplasm Collection alone has 2,358 varieties, and very few of them resemble the original Native American strains, which are much shorter and have smaller leaves. Contemporary commercial tobacco is therefore the result of 500 years of controlled selection for larger leaves and standardized levels of nicotine, experimental breeding, recent genetic engineering, and the use of immense quantities of chemical fertilizers, insecticides, and additives. As a consequence, the commercial varieties of *N. tabacum* are very different from the smaller, traditional varieties still grown by Native Americans. The uses to which they are put are also quite different, though many Indians do ingest commercial tobacco for secular purposes and even for ceremonies when they have no other choice” (Winter et al. 2000, p. 358–359).

Future research may shed light on the history of tobacco use and help tribes today establish baseline information critical to the development of culturally specific tobacco cessation programs (Snyder 2015, this volume). More specifically, chemical analysis of archaeological pipes, human hair, or dental calculus may supplement other lines of evidence (ethnographic and archaeological research, oral history documentation, examination of rock art, recovery of leaves in special contexts like dry caves, and flotation analysis to look for seeds) to identify the suite of plants used in traditional smoking in pre- and post-contact era through ethnographic research, oral history documentation, and archaeological analysis.

12.3 Chemical (GC-MS) Residue Studies in Western North America

While there are a wide range of interesting questions that may be addressed through the archaeology of tobacco, resolution of these issues is impeded by the challenges of recognizing tobacco in the archaeological record. The presence of charred tobacco seeds in archaeological sites is currently the main means of determining ancient use. However, this approach is limited due to the exceedingly small size of tobacco seeds, their rarity in the archaeological record due to preservation, taphonomic challenges (combustion of tobacco leaves typically does not include seeds), and the high cost of archaeobotanical analysis.

Residue analysis of archaeological pipes and other materials (e.g., tobacco pestles, human hair) using LC or GC-MS analysis provides an alternative means to trace the origins and spread of tobacco and other smoke plants. In this section, we summarize our recent studies (Eerkens et al. 2012; Tushingham et al. 2013) on the extraction of residues directly from the matrix of stone and clay pipes. As complete pipes and ash content are very rare archaeologically, we sought to develop methods that could be applied to even very small fragments of pipes. Method validation included experimentally smoking tobacco and a suite of other smoke plants used by ethnographic hunter-gatherers in replica clay pipes. We then compared the chemical

signature of residue extracted from these experimental pipes to that of the unsmoked plant material, which allowed us to both identify plant-specific biomarkers and better understand their decomposition following combustion in a pipe.

We developed a chemical and sonication process to directly extract residues from complete and fragmentary pipes. The extracts were then analyzed using GC-MS techniques sensitive enough to identify nicotine and other plant compounds. Three groups of analyzed plants contained detectible biomarkers in both plant tissues and experimental pipes. All of the *Nicotiana* plants contained nicotine, a tropane alkaloid biomarker for tobacco. Nicotine was not detected in non-tobacco plants, but was detected in all modern experimental pipes smoked with tobacco. Together, this suggests that nicotine can be detected in a similar manner in archaeological pipes and that its presence is indicative of ancient tobacco smoking.

Our results suggest that pipes smoked with *N. glauca* or “tree tobacco”, a historically introduced California smoke plant, might be identified via the combined presence of nicotine and anabasine, a pyridine alkaloid, which was found in both the plant and in an experimental pipe smoked with *N. glauca*. Finally, *Arctostaphylos* sp. plants, including *A. uva-ursi* or kinnikinnick, widely smoked in the Northwest Coast, Arctic, Plateau and parts of the Great Basin as a tobacco “substitute” or additive (Moerman 1998, p. 87–88) can be detected via the presence of the ether glycoside arbutin.

12.3.1 Archaeological Applications

Archaeological application of the methods developed above includes the analysis of a suite of pipes from the southern Pacific Northwest Coast and central California (Figs. 12.3 and 12.4).

12.3.1.1 Northwestern California/Southern Pacific Northwest Coast

We tested a total of 16 clay and steatite (soapstone) artifacts (15 fragments and a complete steatite pipe) from the Red Elderberry site (CA-DNO-26) and an adjacent unnamed village (CA-DNO-333), located in Tolowa ancestral territory in the extreme northwestern corner of California (Fig. 12.3) (Tushingam et al. 2013). The Tolowa, along with other groups in northwestern California and southwestern Oregon lived in a coastal rainforest ecozone and shared many cultural traits in common with other Pacific Northwest Coast groups (e.g., permanent plank house dwellings, developed woodworking technology, emphasis on salmon in the diet), but other key cultural elements including the focus on acorns, small size of houses and household units, and extreme autonomy of sociopolitical units made them distinctive among Pacific Northwest Coast groups as well. Recent excavations documented over 9000 years of site use, including the emergence of plank house village life by

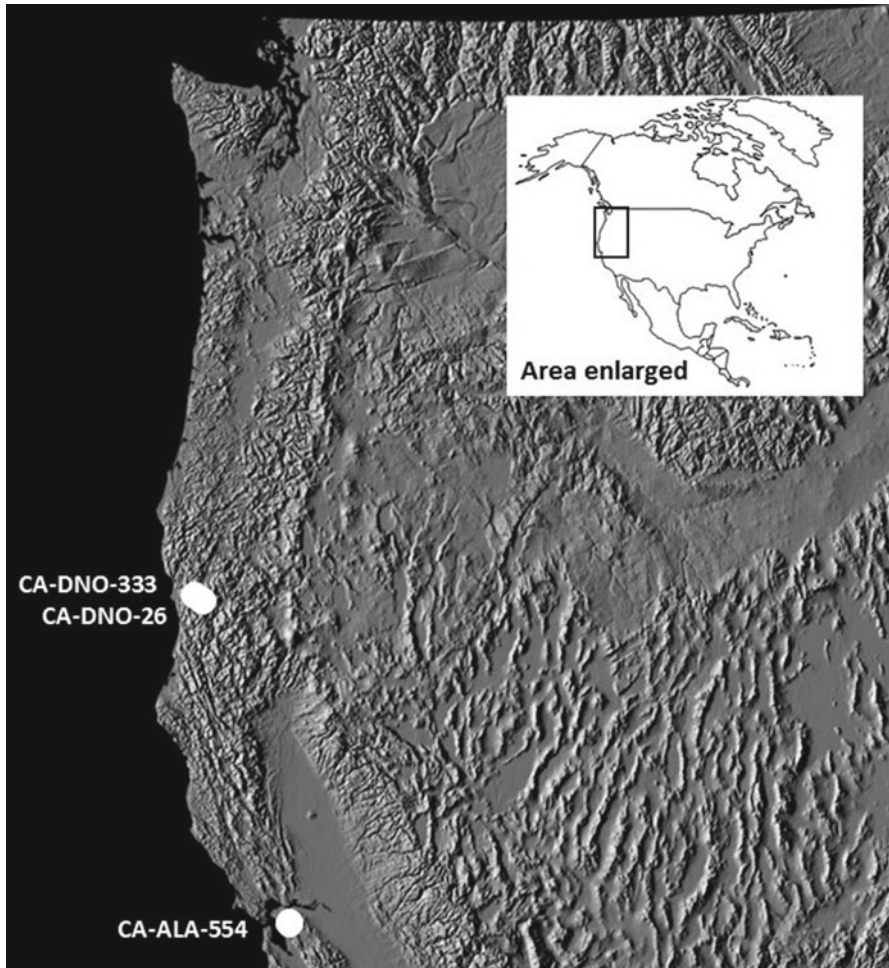


Fig. 12.3 Nicotine-positive artifact site locations

AD 700, a development that seems to be associated with an influx of Athabascan and Algonquian speaking peoples into the region (Tushingham 2009, 2013).

Nicotine was identified in residues extracted from five of the pipe fragments (Fig. 12.4b) and the complete pipe (Fig. 12.4a). Biomarkers for other smoke plants were absent in the ancient pipes. Several pipe fragments were associated with a house dating to AD 1850–1890, confirming historic use of tobacco, confirmed by a number of ethno-historic studies (Balls 1962; Harrington 1932; Kroeber 1941; Winter 2000c; Setchell 1921) and members of the modern Tolowa community. Another fragment was found at site CA-DNO-333 beneath a living surface and slab-lined hearth AMS radiocarbon dated to AD 1230. The oldest nicotine-positive artifact was a complete pipe found in a semi-subterranean plank house radiocarbon dated by AMS to AD 860.



Fig. 12.4 Nicotine-positive artifacts: (a) Complete steatite pipe from site CA-DNO-26 dating to AD 860; (b) clay and steatite pipe fragments from sites CA-DNO-26 and CA-DNO-333 dating to AD 1200 to contact; (c) complete (broken) sandstone pipe from CA-ALA-554 dating to AD 1400-1430; (d) complete steatite pipe from CA-ALA-554 dating to AD 1319–1406. From studies on artifacts from sites CA-DNO-26 and CA-DNO-333 (Tushingham et al. 2013) and site CA-ALA-554 (Eerkens et al. 2012)

The tobacco smoked in these pipes may have been obtained through trade or grown by resident groups. As these sites are located in the coastal rainforest away from the natural habitat of tobacco, it seems likely that, if grown locally, it represents anthropogenic range extension, human management, and/or cultivation of tobacco. In any case, our study shows that tobacco smoking was part of the plank house dwelling cultures in the southern Pacific Northwest Coast very early in time.

12.3.1.2 Central California

We also identified nicotine in a similar study of two complete pipes associated with human interments from CA-ALA-554 (Fig. 12.4c, d), a site located in the city of Pleasanton in central California (Fig. 12.3) (Eerkens et al. 2012). With full support from the descendent community (Ohlone), analysis of these pipes provided important information linking tobacco to these particular items and gave contextual information on the lives of individuals buried with pipes, and perhaps, their role in shamanistic and/or ceremonial rituals. Again, no other alkaloid biomarkers were identified, suggesting tobacco was the main smoke plant associated with these items. Radiocarbon dates on bone collagen from the burials place the presence of tobacco at this site no later than AD 1415, and perhaps as early as AD 1305.

Pipes or pipe fragments are not ubiquitous constituents of prehistoric sites in central California, but they are regularly found in a wide range of environments, especially when funerary contexts are the focus of investigations. For example, three of 185 burials at CA-ALA-554 contain pipes, and one additional pipe was found in a non-burial context (Estes et al. 2012).

While rare, pipes have been found in prehistoric contexts in western North America dating to as old as 2500–4000 BP (e.g., Mack 1994; Touhy 2002), and perhaps even older. Because these chemical analyses of pipes are among the first with confirmed context dates, additional dating of materials associated with other pipes containing nicotine residues will likely push the date of tobacco use back even earlier.

12.4 Summary

Residue analysis has the potential to broaden our understanding of human use of psychoactive plants in ancient societies. Analyses on ancient materials that contain nicotine and other alkaloids will provide insight into the role these substances played in Native American ceremonial and ritual life, and may help us to better understand their historical development into products habitually used by people throughout the world today. Such work will also underscore the importance and evolution of these plants in ritual, economic, and other activities.

We are only beginning to understand the complicated history of the use and spread of tobacco and the many other different smoke plants used by the indigenous peoples of Western North America. Alkaloid-bearing plants were undoubtedly chosen for the psychoactive effects they caused, but tobacco became the most widely used. In our view the wild-domesticated tobacco dichotomy is a false one. Tobacco domestication was likely a continuum and manipulation by Native peoples in the west likely extended the plants' range, and led to genetic and phytochemical changes in these plants. Put another way, plant cultivation, husbanding, and similar processes may have led to genetic selection and perhaps even the creation of new species. Indeed, we have only begun to understand the history of this remarkable plant and its long co-evolution with people.

Our studies in western North America included analyzing modern plants, analyzing samples from experimental pipes, and analyzing archaeological specimens. This sequence allowed us to examine alkaloid biomarkers, including their uptake into artifacts, their breakdown following combustion, and their degradation and preservation over archaeological time. This approach, where residues are extracted directly from the pipe matrix of complete or fragmentary pipes, without any damage to the pipe itself, may expand our future data set of testable artifacts. Evidence of the prehistoric use of tobacco by hunter-gatherers has remained elusive. Our results definitively place *Nicotiana* use at AD 860, continuing into the historic period in the southern Pacific Northwest Coast, and in central California by AD 1305. This was an area where the antiquity of tobacco smoking was, until now, completely unknown.

We are confident that future studies will push the antiquity of tobacco use even earlier, and may help us track the spread of different varieties of tobacco, and the use of other ritual and medicinal smoke plants in the ancient Americas and elsewhere. Tobacco is hypothesized to have been present during the Pleistocene in arid parts of the west (Goodspeed 1954). Thus, it is possible that the first tobacco users in North America were actually hunter-gatherers in western North America. Additional studies will help us better understand the history of human manipulation and cultivation of tobacco, and provide insights into anthropogenic range extension, the origins of addiction and ritual activity, and modern-day issues relating to Native American tobacco use.

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