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A Reevaluation Of The Function Of Acacia Sp. Pollen For The Inhabitants Of A Classic Mimbres Pueblo Ruin Before The Great Abandonment

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Abstract

The NAN Ranch Ruin (LA 2465) is a Classic Mimbres Pueblo ruin in southern New Mexico. Exodus by inhabitants of the site at about 1130 AD was part of widespread changes of the Ancestral Pueblo, Mogollon, and Mimbres traditions. Several exceptionally scratched Mimbres Black-on-white bowls were recovered in Room 60 of the ruin, one of the last rooms inhabited before abandonment. The wear might have been caused by the halt of bowl production to conserve energy during drought and famine. Pollen grains were extracted from 128 soil samples from 12 rooms. Sample 12 from Room 60 contained an extraordinary percentage of Acacia sp. pollen grains and Tilletia sp. spores. Acacia sp. plants contain alkaloids used in modern herbal supplements to suppress hunger. From ethnographic and clinical observations of the use of hunger suppressants by starving people during a famine, we suggest these pollen remains indicate that the inhabitants of the site were using Acacia sp. to suppress hunger. Sample 12 also contained a disproportionate percentage of Tilletia sp. fungal spores indicating a Tilletia sp. infestation of nearby fields of maize might have decimated the crop and intensified the famine.

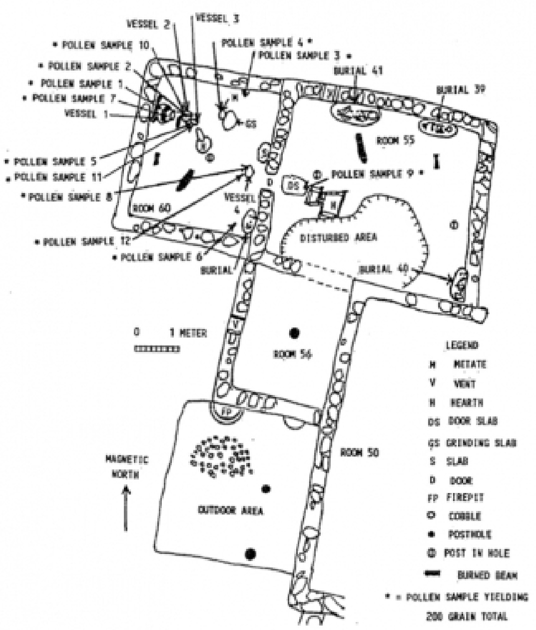
INTRODUCTION

The NAN Ranch Ruin (LA 2465), a Classic Mimbres Pueblo ruin in the Mimbres Valley of southern New Mexico, was occupied from approximately 750 to 1130 A.D. The ruin has at least 100 rooms in three room blocks built over a Mogollon pithouse village. Following early examinations of the ruin by the Cosgroves (Cosgrove and Cosgrove 1932), Shafer and Taylor (1986) and later Shafer and Judkins (1997), the ruin has more recently been investigated to determine adaptive strategies the prehistoric inhabitants in the Mimbres Valley used to survive. The departure of the inhabitants of the site was part of the "Great Abandonment" of people in the American Southwest as the Ancestral Pueblo, Mogollon, and Mimbres cultures collapsed (Monastersky 2015). Shafer (1999) postulated that the major cause of abandonment was famine that resulted from the failure of the crops on the prime agricultural lands near Mimbres settlements. Room 60 (Fig. 1) was one of the last rooms occupied of the NAN Ranch Ruin (Shafer 1982) before abandonment. We present an analysis of pollen samples from NAN Ranch Ruin that suggests that the great percentages of Acacia sp. pollen recovered from Room 60 indicated the plants were used to suppress hunger during famine. A great percentage of Tilletia sp. fungal spores were also recovered from Room 60 indicating that a Tilletia sp. fungus had infested the maize fields surrounding the NAN Ranch site, which may have intensified the famine. Specific details of the procedure used to collect soil for pollen samples during the archeological investigation of the ruin are presented in Shafer (1981) and Shafer and Taylor (1986). The methods used to extract pollen and spores from soil samples from the NAN Ranch Ruin as well as concepts concerning pollen concentration significance are presented in Pendleton (1993) and Pendleton and Pendleton (2007).

Although the data concerning the analysis of these pollen samples from the Nan Ranch Ruin have been published previously, the rationale for this study is to reevaluate the effect of Acacia sp. on the last inhabitants of Room 60. The present publication requires no changes in pollen data or in descriptions of room features or of excavation methods from previous publications. New data is available on the internet concerning the use of Acacia sp. as an additive to herbal medicines for the suppression of hunger to control weight. Previous publications stress the psychotropic effects of Acacia sp. to alter mood during a famine. We present ethnographic and clinical observations of the use of hunger suppressants by starving people during a famine to demonstrate that the desire of starving people for food is secondary to the desire to suppress the feeling of hunger. In the case of manuscripts based on the same database, the International Committee of Medical Journal Editors suggests that "the manuscripts should be considered independently because they may differ in their analytic methods, conclusions, or both (International Committee of Medical Journal Editors 2017)." The International Committee of Medical Journal Editors was an appropriate source for clarification of this point because a clinical trial was the best-documented example by Keys (1950) used to demonstrate that drugs are used to alleviate hunger.

Figure 1

Floor plan of Room 60 at the NAN Ranch Ruin showing significant features from field maps and notes. Location of pollen samples shown at ends of arrows (after Pendleton 1993).



Famine-induced wear on Mimbres Black-on-white bowls at the NAN Ranch Ruin.

Many exceptionally scratched and worn Mimbres Black-on-white vessels were found in Room 60 at the NAN Ranch Ruin. In most Mimbres Pueblo contexts, Bray (1982) observed that use wear was greater on unpainted bowls used for everyday utilitarian purposes. The Mimbres Black-on-white vessels from Room 60 would usually have been kept as valuable heirlooms and not scratched and worn by use as were everyday bowls. Shafer and Taylor (1979) attributed the exceptional vessel wear to unusual activities or to the disruption of pottery production so the prized Mimbres Black-on-white vessels were in constant use. The conclusion is consistent with that observed in two Saladoean Pueblo populations of southeastern Arizona, also suffering from drought and subsequent famine, where production of pottery decreased, less pottery was painted, and other labor-saving activities were initiated (Gerald 1976).

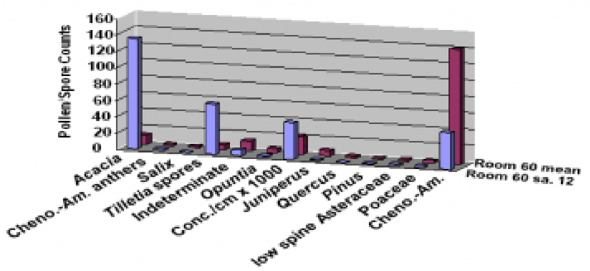
The significance of pollen and spores from Room 60 at the NAN Ranch Ruin.

A large fragment of an unpainted flare-rim bowl was on the floor near the doorway of Room 60 at the NAN Ranch ruin but without any exceptional wear to the bowl surfaces. A pollen soil sample (Sample 12) in association with the flare-rim bowl contained the greatest pollen concentration (21.6 grains/cc of soil) of all the 128 soil samples from all 11 rooms (including 12 surface soil samples along a nearby transect) at the NAN Ranch Ruin (Fig. 2) (Pendleton 1993). A total of 200 pollen grains was counted for most samples for all rooms and for the surface soil samples at the ruin. Sixty-seven percent of the pollen grains in Sample 12 were Acacia sp. Six was the average percentage of Acacia sp. for all 12 samples from Room 60. Except for Sample 12, three other samples (1, 4, and 7) from Room 60 contained only Acacia sp. pollen in trace amounts (less than one percent). Five other rooms (7, 12, 46, 49, and 52) contained only trace amounts of Acacia sp. pollen, and only trace amounts of Acacia sp. pollen were found in surface soil samples from a transect near the NAN Ranch Ruin (Pendleton 1993). Unless a soil sample was in direct contact with many Acacia sp. flowers, only trace amounts of Acacia sp. pollen would be extracted from soil samples because Acacia sp. pollen is not wind pollinated but spread by insects from flower to flower. Unfortunately, the species of Acacia sp. pollen in samples in or near the NAN Ranch Ruin could not be determined. Specific details of the procedure used to collect soil for pollen samples during the archeological investigation of the ruin are presented in Shafer (1981) and Shafer and Taylor (1986). The methods used to extract pollen and spores from soil samples from the ruin as well as concepts concerning the significance of pollen concentration are presented in Pendleton (1993) and Pendleton and Pendleton (2007).

In two earlier publications, Pendleton (1998) and Pendleton et al. (2003), described how Tilletia sp. fungal spores were present in extraordinary concentration (Fig. 2) in Sample 12 from Room 60. Tilletia sp. produce rusts, blasts, and smuts in maize. Of the five strains of bacteriological warfare pathogens identified by the U.S. Chemical Warfare Service, one is Tilletia indica, which causes a great loss to maize seedlings with the right environmental conditions (Barnaby 1999). During the drought postulated to have occurred during the occupation of Room 60 at the NAN Ranch Ruin, the weakened maize plants would have been vulnerable to the spread of fungal pathogens (United States Department of Agriculture 2006) and the release of Tilletia sp. spores over the maize fields surrounding the Nan Ranch Ruin. Tilletia sp. fungal spores might have been deposited onto the surface of Acacia sp. plants before to being carried into Room 60 of the NAN Ranch site resulting in their incorporation (with Acacia sp. pollen) into Pollen Sample 12.

Figure 2

Graph of pollen and spore counts for Room 60 at the NAN Ranch Ruin (after Pendleton and Pendleton 2007). For each sample, a total of 200 pollen grains was counted whenever possible. Tilletia sp. spore counts were recorded but were not included in the total sum of counts of pollen grains for each sample. Because pollen grains of the family Chenopodiaceae and the genera Amaranthus cannot be distinguished using light microscopy, the taxa were combined into the category of Cheno-Am pollen for the graph (Martin 1963).



Psychotropic and medicinal properties of Acacia sp. flowers (Section 3.3)

The prehistoric inhabitants of the NAN Ranch site might have observed the reactions of animals browsing on Acacia sp. plants. Subsequent experimentation by the inhabitants of the NAN Ranch site might have led to the discovery of various medicinal and psychotropic effects of Acacia sp. plants on humans. Modern researchers have noted a sedative effect treating animals with aqueous and ethanol extracts of the leaves, stems and flowers of A. angustissima (Hammer and Cole 1965). A cache of harvested psychoactive Datura sp. (jimsonweed) seeds has been recovered at the Janss site. Like the NAN Ranch site, the Janss site is a Mimbres adobe pueblo (Yarnell 1959) in the Mimbres Valley of New Mexico. Datura contains many bioactive alkaloids (Luanratana 1982). The Datura sp. seed cache demonstrated that psychoactive activity was probably practiced at the Janss site, and knowledge of the activity might have inspired the NAN Ranch inhabitants to use Acacia sp. in a similar way.

Medicinal uses of Acacia sp. plants have been recorded by ethnographers. Historic Indian tribes of the Southwest U.S. used Acacia sp. flowers and leaves brewed as tea to cure nausea, vomiting, and hangovers (Moore 1989). The Mountain Pima used tea made from the bark and flowers of A. farnesiana to reduce fever (Kay 1996). The Warijio Indians (also known as the Guarijio, Warihio, and Varihio) of central Mexico mixed the flowers of A. farnesiana with grease and applied them to bruises to reduce pain (Kay 1996) or applied them directly to the forehead to relieve headache (Altschul 1973). Using boiled flowers and spines of A. cymbispina, a tea was brewed by the Pima Bajo of Sonora, Mexico to cure stomachache (Pennington 1980). Perhaps ingestion of an unusually large amount of Acacia sp. flowers, stems, or leaves containing alkaloids might, during an attempt to achieve a stronger medicinal cure, have produced a psychotropic effect to be repeated if desired later. Furst (1974) noted that many psychoactive plants were smoked, chewed, sucked, or ingested by Mexican Indians for religious and divinatory uses as described by the Spanish colonial clergy of the sixteenth and seventeenth centuries. More than 60 species of the allied genera Mimosa and Acacia in Mexico might have psychoactive principles. Forty-four amines and alkaloids such as mescaline, p-methoxyamphetamine, and amphetamine have been identified in leaves, petioles and attached stems of A. rigidula collected in southwest Texas (Clement et. al 1998). The indole hallucinogen N, N-dimethyltryptamine is naturally present in many North American Acacia species (Richardson III 2007). Pawar et al. (2013) analyzed fresh leaves, twigs, and bark of A. rigidula from Texas using high pressure liquid chromatography and mass spectrometry and determined that the greatest concentrations of amines, chiefly tyramine, were found in the leaf material.

Although psychotropic effects might have been the impetus for use of many Acacia sp. flowers in Room 60 of the NAN Ranch site (Pendleton and Pendleton 2007), it is more probable that another use for these flowers might have been their hunger-suppressing effect during famine. Many amines and alkaloids extracted from A. rigidula are present in many currently popular weight-loss supplements claimed to provide stimulant, appetite suppressant, thermogenic fat-burner, and weight-loss benefits on their labels (Pawar et al. 2013). The labels commonly list amines and alkaloids that originate from leaves of A. rigidula along with material added from other plants such as Ephedra, Hoodia, and ginger root. In April 2004, sale of Ephedra-containing products was prohibited in dietary supplements containing Ephedrine alkaloids (U.S. Food and Drug Administration 2004). Wheat (2006) applied for a patent to use an extract of the leaves, bark, and roots of A. rigidula, A. berlandieri or A. farnesiana with other ingredients to control body weight by promoting fat loss, suppressing appetite, and/or stimulating thermogenesis. Currently, species of Acacia such as A. greggii, A. roemeriana, A. neovernicosa, A. constricta, and A. angustissima are present in New Mexico (Martin and Hutchins 1980). The likely explanation for the use of Acacia sp. plant materials during the abandonment of the NAN Ranch site was probably to suppress feelings of hunger during famine.

Several examples are presented of different cultural groups using chemical substances to curb the desire for food either during famine or to limit food consumption.

Anthropologists observed the behavior of people living on the island of Tikopea at the tip of the Solomon Island archipelago in the South Pacific following hurricanes in 1952-1953. The hurricanes created widespread famine on the island, resulting in the cessation of food offerings to visitors and kinsmen. During the famine, food was not bartered or sold, but tobacco and tobacco seed were overpriced perhaps because of their mood-altering effect (Pendleton et al. 2007).

Tobacco's role in suppressing appetite.

Gerald (1990) postulated that the extraordinary value of tobacco use during a famine was due to its narcotic stimulus. Effects of smoking are usually decreased food intake and a decrease in body weight. The major appetite-suppressing component of tobacco is considered nicotine, which is demonstrated commonly by weight gain associated with cessation of smoking (Jo et al. 2002). Gerald (1976) observed that among the physiological and psychological effects of starvation described in modern clinical studies are increased cravings for tobacco by those familiar with it. Cheskin et al. (2005) determined that food restriction in adult smokers increase cigarette use. Several clinical studies of prisoners of war observed under controlled conditions of incarceration supported both the observations of Gerald (1976) and of Cheskin et al. (2005). G. B. Leyton was a medical officer captured in World War II who observed starvation in German prisoner of war camps in Libya, Italy, and Germany. He noted that for starving prisoners, their desire for tobacco increased greatly following captivity so they would trade even their hoarded food and clothing for a small amount of tobacco (Leyton 1946). Similar behavior was described at an internment camp in German-occupied southern France during World War II. The camp was populated by Spaniards who escaped their country at the end of the Spanish Civil War. In the camp, very sick prisoners trade their bread ration for tobacco (Schwarz 1945). In 1944, 36 male American volunteers began a year-long Minnesota Starvation Experiment at the University of Minnesota to clinically document the psychological and physiological effects of starvation as well as subsequent rehabilitation. The study was done to determine efficient methods of rehabilitation for prisoners of war and other victims of enforced famine in wartime. At frequent intervals, each volunteer was seen briefly by a resident physician to determine his physical condition, and X-rays of their chest were taken approximately once a month. The examination was thorough, and all dimensions and conditions were recorded. A team of three to six examiners determined any physical or psychological fluctuations during rehabilitation phase and at the final phase of the experiment. Interviews of the volunteers by psychologists revealed any changes in personality along with quantitative tests such as the Minnesota Multiphasic Personality Inventory. During the study, several volunteer subjects who were not smokers began to smoke because they claimed it afforded some degree of relief from feelings of hunger (Keys et al. 1950). For the subjects, their desire for tobacco could not be attributed to an addiction to smoking before to the study, but to the desire to suppress feelings of starvation. The suppression of hunger during a period of starvation is primarily due to nicotine, the major pyridine alkaloid of commercial tobacco in cigarettes (Cai et al. 2003).

The use of coca and betel nut as an appetite suppressant.

Many indigenous working people of the Peruvian Andes are habitual users of coca (Erythroxylin coca) because they claim that when the leaves are chewed, coca reduces hunger, enhances the ability to do physical work, and promotes a feeling of warmth in the cold (Mortimer 1901; Little 1970:3236). The effects produced by the use of coca probably are valuable for laborers at high altitude in mountainous terrain. Unlike the other examples of alkaloid use, the indigenous workers of the Peruvian Andes were not suffering from hunger before coca chewing, but perhaps were seeking to avoid hunger to prolong their effective working hours and maximize subsequent payment for physical labor. Much like Acacia sp. leaves, coca leaves contain several alkaloids linked to appetite suppression. Coca leaves are an excellent treatment to relieve distress of altitude sickness and when ingested in leaf form, do not cause dependence or produce toxicity (Weil 1981). Cocaine is the alkaloid in the greatest concentration in coca leaves (Cuiffardi 1949). The long history of chewing coca leaves in Peru is demonstrated by the discovery of several bags of coca leaves with the mummy of a Peruvian king in the Nazca area dated to 500 A.D (Mann 1992).

The nut of the Areca catechu palm, commonly called the betel or aricina nut, is chewed alone or with a pepper leaf (Piper betle) and slaked lime by hundreds of millions of people in Asia. The primary alkaloid arecoline is the neuro-active agent in the nut along with small amounts of the alkaloids arecaidine and guvacine (Mujumdar et al. 1982). Strickland et al. (2003) did two double-blind, randomized, placebo-controlled studies of Indian men selected as volunteers from staff and medical students at Bangalore, India. Study One, eight Indian men received 0, 5, 10, or 20 mg arecoline to the buccal sulcus after an overnight fast. For 6 hours after the fast, hunger was rated every hour. Study Two, 15 Indian men received 0 or 10 mg arecoline after consuming a weight-maintenance meal of 30% fat, 12.5% protein, and 57.5% carbohydrate calculated to ensure a steady state of macronutrient balance. Both studies determined of urine output, percentage of body water, fat-free body mass, basal metabolic rate, energy expenditure, blood biochemistry, hunger assessed in visual analogue scales, subject weight, and other factors. Except for the quantities of arecoline and administration of the meal, the protocol for both studies was identical. The smallest significant hunger ratings were after the 20 mg dose of arecoline and the greatest significant hunger ratings were recorded after the 10 mg dose. These data are consistent with the common belief that specific concentrations of the alkaloids in betel nut suppress hunger for persons in a fasting or non-fasting mode.

Relationship with Tilletia sp. spores in Sample 12 from Room 60 at the NAN Ranch site.

Previous studies (Pendleton 1998, Pendleton et al. 2003) noted that 61 Tilletia sp. spores were recovered at the NAN Ranch Ruin during the counting of the 200 pollen grains in Sample 12 from Room 60. The spores were not included in the total count of pollen for the sample, so as soon as 200 pollen grains were recorded for the sample, counting of the number of Tilletia sp. spores encountered while counting pollen grains ceased. For Sample 12, an exceptional amount of Tilletia sp. fungal spores was recovered (23 percent of the total of both spores and pollen). No spores were found in any other room, so the exceptional amount of spores in Sample 12 is an important indicator that no movement of spores occurred due to wind. If drought was present at the time of occupation in Room 60, stress to the maize plants surrounding the site would (depending on the growth cycle of the fungus when the Acacia sp. plants were gathered) enhance production of spores in the maize fields surrounding the site. If a Tilletia sp. influx into the maize fields was present, the Acacia sp. plants growing near the site would have functioned as collecting surfaces for the vast numbers of spores required to produce the exceptional amount of Tilletia sp. spores found in Room 60, an interior room of the pueblo. Tilletia indica is one of the five most effective anti-crop biological warfare agents as determined by the U.S. Offensive Biological Research Program in 1969. Tilletia indica causes extensive damage to maize while in the seedling stage (Robinson 1981). Although a previous publication by Pendleton (1998) assigned a species designation to the Tilletia sp. spores from Sample 12 in Room 60 at the site, the criteria was based only on teliospore morphology, not molecular data. Similar teliospore morphology, infection regime, and germination were once thought to indicate that Tilletia indica and Tillletia horrida were interrelated, but molecular studies revealed the existence of only a distant developmental association (Carris et al. 2006).

CONCLUSION

The argument presented in this work is that famine provided an impetus for prehistoric starving inhabitants of the NAN Ranch site to gather and ingest (by the methods presented) the leaves and stems of Acacia sp. plants to suppress cravings for food. Other examples of persons desiring to suppress the desire for sustenance by the use of hunger-suppressing substances include modern Tikopeans, prisoners of war, fasting study volunteers, and indigenous inhabitants of the Peruvian Andes. Drought stress on nearby maize during abandonment of the NAN Ranch site was probably intensified by influx of Tilletia sp. demonstrated by the considerable number of fungal spores found almost exclusively in Sample 12 of Room 60, the same sample that contained the substantial number of Acacia sp. pollen grains.

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