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Peyote Alkaloids: Identification in a Prehistoric Specimen of *Lophophora* from Coahuila, Mexico

Abstract. *Mescaline, anhalonine, lophophorine, pellotine, and anhalonidine have been identified in alkaloid extracts of a prehistoric specimen of* Lophophora *from a burial cave in west central Coahuila, Mexico. The specimen is associated with radiocarbon dates of A.D. 810 to 1070 and is one of the oldest materials ever submitted to alkaloid analysis.*

In 1941, Taylor conducted a brief but thorough salvage excavation in a small site, designated as CM-79, in west central Coahuila, Mexico (*1*). The site, a multiple interment burial cave, produced a variety of lithic and perishable artifacts ascribable to the so-called Mayran mortuary complex, which is centered in the Laguna District of southwest Coahuila (*2*). Site CM-79 is essentially a single component locality and is reasonably well dated by a series of three radiocarbon dates of A.D. 810 ± 70, 1020 ± 60, and 1070 ± 75 (*3*). These assays were performed on samples of plaited matting directly associated with the burials at this site.

Among the Mayran mortuary materials recovered from CM-79 were a number of peyote (*Lophophora williamsii*, Cactaceae) buttons strung on a cord and superficially resembling a necklace. One of these buttons was removed from the "necklace" and subjected to alkaloid analysis. The results of that analysis (*4*) follow.

The specimen chosen for the analysis (1.425 g) was ground to a fine powder in a mortar, mixed with ethanol to a slurry, stirred for 48 hours, and filtered. The ethanol extract was evaporated to dryness. The residue was dissolved in water, made alkaline with concentrated ammonia (pH 9), and extracted twice with chloroform and once with a mixture of chloroform and ethanol (3 : 1). The combined chloroform extracts were evaporated to dryness to yield 32 mg (2.25 percent) of alkaloids. These were resolved into phenolic (35 percent) and nonphenolic (65 percent) portions, as previously described (*5*).

Analytical thin-layer chromatography (TLC) was carried out on coated 0.25-mm silica gel F_{254} aluminum sheets in mixtures of chloroform, ethanol, and

Table 1. Mass spectral data for extracted peyote alkaloids and reference compounds.

Compound	*m/e* (relative intensity)				
Nonphenolic alkaloids					
Peak 1	211 (M^+, 13%),	182 (61.5%),	181 (36%),	167 (29.5%),	30 (100%)
Mescaline	211 (M^+, 15%),	182 (61.5%),	181 (31%),	167 (31%),	30 (100%)
Peak 2	235 (M^+, 1.4%),	221 (19%),	220 (100%),	205 (17%)	
Lophophorine	235 (M^+, 1.6%),	221 (15%),	220 (100%),	205 (7%)	
Peak 3	221 (M^+, 4%),	207 (17%),	206 (100%),	191 (17%)	
Anhalonine	221 (M^+, 6%),	207 (15%),	206 (100%),	191 (8%)	
Phenolic alkaloids					
Peak 1	237 (M^+, 1.1%),	223 (20%),	222 (100%),	207 (12%),	161 (44%)
Pellotine	237 (M^+, 0.7%),	223 (20%),	222 (100%),	207 (13%),	161 (40%)
Peak 2	223 (M^+, 2.6%),	209 (18%),	208 (100%),	147 (41%)	
Anhalonidine	223 (M^+, 3%),	209 (16%),	208 (100%),	147 (47%)	

concentrated ammonia (85:15:0.4) and chloroform, ethanol, and diethylamine (85:10:5). The nonphenolic alkaloids showed two components giving R_f values and color reactions (*6*) similar to those of mescaline (3,4,5-trimethoxyphenethylamine) and anhalonine (1-methyl-6-methoxy-7,8-methylenedioxy-1,2,3,4-tetrahydroisoquinoline). In the same way, TLC of the phenolic extract pointed to the presence of anhalonidine (1-methyl-6,7-dimethoxy-8-hydroxy-1,2,3,4-tetrahydroisoquinoline) and pellotine (1,2-dimethyl-6,7-dimethoxy-8-hydroxy-1,2,3,4-tetrahydroisoquinoline)as the major components. Both extracts also exhibited unidentified spots with high R_f values.

Gas chromatography (GC) (*7–9*) was used to further verify the presence of the above-mentioned alkaloids. The nonphenolic alkaloids (Fig. 1) gave several peaks on GC, three of which corresponded in their retention times to mescaline, anhalonine, and lophophorine (1,2-dimethyl-6-methoxy-7,8-methylenedioxy-1,2,3,4-tetrahydroisoquinoline), respectively. The phenolic alkaloids gave two major peaks on GC (Fig. 2) and these had the same retention times as authentic pellotine and anhalonidine.

For the final identification of these five alkaloids, we used gas chromatography–mass spectrometry (GC-MS) (*10*). The appropriate peaks in the two alkaloid extracts gave mass-to-charge (*m/e*) ratios and fragmentations consistent with the TLC and GC findings (Table 1).

All the alkaloids now identified are present in dried tops of *Lophophora williamsii*, "mescal buttons" (*11*). Recently prepared mescal buttons contain about a total of 8 percent alkaloids, 64 percent of which are phenolic (*12*). An 85-year-old sample of "mescal buttons" showed only minor differences in alkaloid composition, but the now-investigated thousand-year-old specimen has a considerably lower alkaloid content (2.25 percent) and only 35 percent are phenolic alkaloids. Some unidentified spots (TLC) and peaks (GC) are probably due to alkaloid degradation products, since they cannot be seen in extracts of new "mescal buttons."

Several studies have indicated the persistence of alkaloids in plant tissues (*13*), but only a few samples have been as old as the one now investigated. *Ilex guayusa* leaves, found in a medicine man's tomb in Bolivia and ^{14}C-dated to A.D. 375, were analyzed for alkaloids and found to still contain caffeine. Traces of nicotine were identified in a tobacco sample from the same tomb (*14*).

The finding of mescaline and related tetrahydroisoquinoline alkaloids in the thousand-year-old drug not only shows the remarkable stability of these compounds in dry, nonpowdered plant tissue but also supports the botanical identification as *Lophophora williamsii*.

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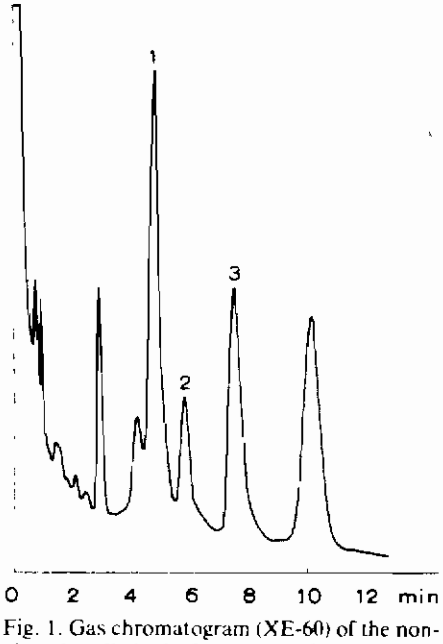

Fig. 1. Gas chromatogram (XE-60) of the nonphenolic alkaloids from a prehistoric specimen of *Lophophora*.

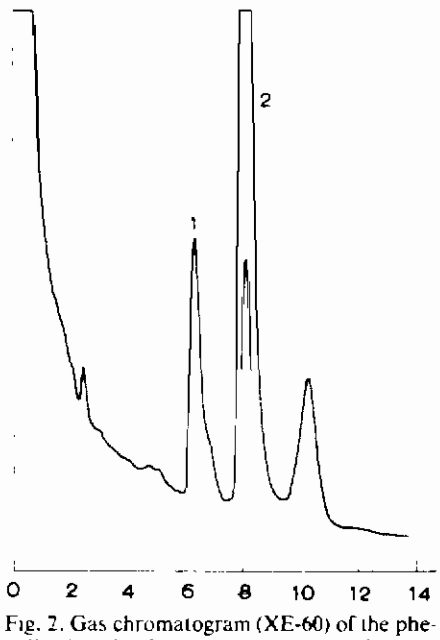

Fig. 2. Gas chromatogram (XE-60) of the phenolic alkaloids from a prehistoric specimen of *Lophophora*.

References and Notes

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