

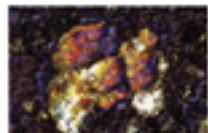
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### Antiquity of Coca-Leaf Chewing in the South Central Andes: A 3,000 Year Archaeological Record of Coca-Leaf Chewing from Northern Chile

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# Short Communication

## ANTIQUITY OF COCA-LEAF CHEWING IN THE SOUTH CENTRAL ANDES: A 3,000 YEAR ARCHAEOLOGICAL RECORD OF COCA-LEAF CHEWING FROM NORTHERN CHILE†

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**Abstract**—Carbon-14 (14C) dating from mummies of the Alto Ramirez culture confirms that coca leaf chewing was an incipient practice among members of a population that peopled the valleys and coastal areas of Northern Chile by 3,000 years before the present (yr.B.P.). Out of eleven bodies from the burial site of Pisagua-7 (PSG-7, S 19° 35', W 70° 13') that were analyzed, two samples tested positive. Mummy 725-A C2 (dated 3,090 to 2,850 two sigma calibrated 14C years before the present) was shown to have a cocaine value of 13.3 nanograms/10 milligrams of sample (ng/10mg), and mummy 741 (2,890 to 2,760 two sigma cal yr B.P.), a 5.6 ng/10mg value.

**Keywords**—benzoylecgonine, cocaine, mummy, Pisagua, radioimmunoassay

Leaves of the coca plant (*Erythroxylum coca* var. *coca* and *Erythroxylum novogranatense* var. *truxillense*) were a part of the daily life of many prehistoric Andean populations, and remain important even today among some groups. Sixteenth century conquistadors found that the Incas employed these leaves for ritual, social and physiological

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purposes. Ritual use included coca leaves put as offerings in formal public sacrifice ceremonies or in personal rites of passage such as placement of a coca-leaf quid within the cheek of a corpse at burial. Coca leaf chewing is an ancient practice highly valued as a way to acknowledge and maintain social bonding even among modern Andean highland populations (Allen 1988). The leaves' cocaine content was exploited as a stimulant, a local anesthetic, an agent to suppress appetite, fatigue, and altitude effects and was imbibed in the form of tea to combat many illnesses. Thus the origin and dissemination of these practices involving a plant of such central importance to the Inca people have become of major interest to students of pre-Inca populations.

The coca shrub belongs to the genus *Erythroxylum*. It consists of about 200 species found mostly in the American tropics; it is also present in Africa, India, tropical Asia, and Oceania (Plowman 1984: 130). However, only two species are the sources of all cultivated South American coca, each having two varieties: *E. coca* var. *coca*, *E. coca* var. *ipadú*, *E. novogranatense* var. *truxillense*, and *E. novogranatense* var. *novogranatense*. *Truxillense*, the variety utilized in the northern Peruvian coast, provides the most ancient evidence for coca use. Plowman's (1984: 135) re-examination of extant archaeological coca leaves from coastal Peru determined that most samples represented Trujillo coca. However, leaves from an Inca mummy bundle found at Arica, Chile, were identified as *E. coca* var. *coca* (Plowman 1984: 135; Mortimer 1901). Bolivian or Huánuco coca (*E. coca* var. *coca*) grows in the montane tropical forest areas of the eastern slopes of the Andes, between 500-1500 meters in elevation. Its range extends from Ecuador to southern Bolivia and extreme northwest Argentina (Plowman 1984: 133). The habitat of the drought-resistant Trujillo variety reaches from the north coast of Peru up to the arid thorn and scrub area of the upper Marañon River and its tributaries, where it interacts with *E. coca* var. *coca*. Plowman (1984: 144) suggests that both varieties were probably traded to the adjacent highland areas including Chavín de Huántar in Peru. It can be proposed that *E. coca* var. *coca* and *E. novogranatense* var. *truxillense* were both

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**FIGURE 1**  
**Mummy 723 from Pisagua 7 Site, Northern Chile\***



\*It was <sup>14</sup>C dated at 2,962 to 2,714, two sigma cal yr B.P. Although not containing evidence of cocaine the body was associated with those with cocaine evidence.

available to the Alto Ramirez people. The habitat of *E. coca* var. *ipadú* is located in the Amazon Basin, and that of *E. novogranatense* var. *novogranatense* in present-day Colombia, making these varieties unlikely to have been used in the Central Andes during the Formative Period. Rostworowski (1973) identified Tacna, Arica and the Azapa Valley as coca cultivation areas during late Inca times.

Coca leaf representations are infrequent in Precolumbian art, although the act of chewing is variously represented throughout the Andes. Small ceramic figurines with prominent cheek bulge were frequent in coastal Ecuador during late Valdivia period (c. 1600-1500 BC; Jones 1974: 12). Elaborate coca chewing scenes are painted on Phase IV (c. 500-650 A.D.) Moche ceramic vessels (Donnan & McClelland 1999: 124, figs. 419, 490). Individuals with a prominent cheek bulge are depicted on lithic sculpture from the Tiwanaku Period (Berenguer 2000: 49). Further to the south, in San Pedro de Atacama, archaeological coca leaves have not been properly identified. However, leather pouches and snail shells containing calcium carbonate are frequently found in burials, suggesting the use of coca leaves c. 400-800 A.D.

The earliest evidence is from the site of Culebras (c. 2000 B.C.), Ancash Dept., Peru where leaves were found in association with gourds containing powdered lime (Engel 1957: 67-68). At the site of Asia, on the central Peruvian coast, Engel (1963: 77) found coca leaves and large deposits of burned lime dating to c. 1800 B.C. Coca has also been reported from Ancón in contexts dated c. 1800-1400 B.C. (Plowman 1984: 140). It should be noted that none of

these have been identified botanically. Furthermore, archaeological evidence cannot predict whether the presence of coca leaves in a tomb reflects its employment as a ritual offering, or whether those leaves indicate that they were chewed or used to prepare a tea beverage.

Radioimmunoassay (RIA) and gas chromatography/mass spectrometry (GC/MS) can detect the very small amount of cocaine (and its metabolite benzoylecgonine) that is absorbed, circulates in blood, enters hair follicle cells and becomes incorporated into the hair shaft. A similar mechanism results in its accumulation in fingernails and toenails. Application of these methods to hair and nail samples of ancient north Chilean coastal mummies revealed the presence of cocaine and its metabolite in many of the mummies' body tissues, indicating coca leaves had been chewed or imbibed as a beverage. In other tombs, however, the persons burying the body had placed coca leaf-filled bags into the tombs or inserted coca leaf quids into the corpse's oral cavity. In many of these cases chemical analyses of the mummies' hair or nail samples revealed no evidence of cocaine or its metabolite, implying that the presence of coca leaves in those samples represented a ritual offering (Aufderheide et al. 1994; Caratmell et al. 1991).

Thus, only demonstration of the chemical presence of cocaine and its metabolite in the body tissues of ancient human remains can establish that the deceased had chewed coca leaves or imbibed their cocaine content as tea. Hence, the evidence from the Pisagua site presented below establishes the earliest date for documented human consumption of cocaine from coca leaves.

**TABLE 1**  
**Radiocarbon Dating and Cocaine Tests from the Pisagua-7 Site**

| Mummy Number | Age(Yr) | Sex* | Cocaine Test |            |             | 14C Lab No.           | Radiocarbon Dates   |                                 |
|--------------|---------|------|--------------|------------|-------------|-----------------------|---|---------------------------------|
|              |         |      | Matrix**     | ng/10mg*** | Pos/Neg**** |                       | 13C-corrected Conventional Radiocarbon Age (+/- 1 sigma B.P.) | Calibrated Date*****<br>2 sigma |
| 726-A        | 5-7     | I    | H            | 0.3        | Neg         | GX16097<br>(Muscle)   | 2955<br>+/- 115   | 1443-858<br>I = 1154<br>BC(RAD) |
| 723          | 25-30   | M    | H            | 0.7        | Neg         | GX16098<br>(Skin)     | 2695<br>+/- 85  | 1012-764<br>I = 833<br>BC(RAD)  |
| 725-A, C2    | 40-45   | F    | H            | 13.3       | Pos         | Beta 169826<br>(Hair) | 2850<br>+/- 50  | 1140-900<br>I = 1000<br>BC(AMS) |
| 741          | 3-4     | F    | N            | 5.6        | Pos         | Beta 170070<br>(Hair) | 2730<br>+/- 40  | 940-810<br>I = 850<br>BC(AMS)   |

\*Sex: I = Indeterminate, M = male, F = female.

\*\*Matrix: H = hair, N = nail.

\*\*\*ng/10mg = nanograms/10 milligrams of sample. Values of 3.0 or greater = positive.

\*\*\*\*Neg = negative, pos = positive.

\*\*\*\*\*I = value at line of intercept. (RAD) = radiometric method; (AMS) = accelerator mass spectrometry method. GX = Geochron Laboratories, Cambridge, Massachusetts. Beta = Beta Analytic Laboratory, Miami, Florida.

The Pisagua-7 site (S 19° 35' 57"; W 70° 13' 15") is a coastal location of the Atacama Desert in northern Chile. The environment of this hyperarid region, free of rainfall, groundwater or vegetation, enhances preservation of organic material and the development of spontaneous (natural) mummification of buried human remains (Figure 1).

Of 18 such mummies excavated from this site by a team led by Mario Rivera, five female and six male bodies had grave artifacts characteristic of the Alto Ramirez culture (Aufderheide et al. 1994), a group dated to about 3,000 to 1,450 years before the present (yr B.P.) (Rivera 2002). The RIA and GC/MS procedural details have been published previously (Cartmell et al. 1991; Springfield et al. 1993). Hair or nails from two of the eleven bodies sampled and analyzed showed the presence of cocaine and benzoylecgonine (Table 1).

The corpses that were dated and yielded positive results correspond to mummy 726-A, a five- to seven-year old child of indeterminate sex who was found clothed in a wool poncho, wearing a head deformer and seed necklaces, and wrapped in a totora reed mat. The hips and knees were semi-flexed, and arms were extended. Death was due to acute, lobar pneumonia in the left upper lobe. Mummy 723 (Fig.2), is a 25 to 35-year old male, lying on his right side with hips and knees flexed, elbows semi-flexed and body covered with wool blanket. Dissection revealed no soft

tissue pathology. Mummy 725-A, C-2 corresponds to one of three isolated skulls adjacent to the headless body of an adult. This head is that of a 40 to 45-year old female, covered with scalp hair showing a single braid on each side. Tabular type cranial deformation is present. No soft tissue pathology was identified upon dissection. Finally, mummy 741 is a three to four-year old female whose largely skeletonized, partly disarticulated body was wrapped in a totora reed mat. Cranial deformation is of the tabular type. No gross pathology was present.

Samples of muscle, hair and skin of these four bodies were dated by Carbon-14 analysis (14C; see Table 1). The hair of two of those samples that revealed a positive reaction to cocaine were accelerated mass spectrometry (AMS) dated thus obtaining a direct and definite date of 3,090 to 2,850 two sigma calibrated 14C years before the present (cal yr B.P.); with a cocaine value of 13.3 nanograms/10 milligrams of sample (ng/10mg) for body 725-A, C2. In addition, the 14C date for body 741 was 2,890 to 2,760 (two sigma cal yr B.P.), with a cocaine value of 5.6 ng/10mg. Additionally, two other mummies that tested negative for cocaine were 14C dated at 3,393 to 2,808, two sigma cal yr B.P. (body 726-A), and 2,962 to 2,714, two sigma cal yr B.P. (mummy 723; see Figure 2). The adult (body 725-A C2) probably acquired the cocaine by chewing coca leaves, because of the presence of advanced periodontitis

with antemortem loss of six teeth, features commonly associated with coca leaf-chewing in mummies (Langsjoen 1996: 475) and in living, coca-leaf-chewing Andean highlanders (Indriati 1998). The child (body 741) most likely ingested coca leaf tea administered as a therapeutic agent to combat what proved to be her terminal illness.

The demonstration of cocaine and benzoylecgonine in the soft tissues of two Alto Ramirez mummies from approximately 2,900-2,700 yr B.P. documents the earliest practice of coca leaf chewing and/or ingestion of coca leaf tea in the Andean region.

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