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BOTANY, ETHNOBOTANY AND CHEMISTRY OF *DATURA LANOSA* (SOLANACEAE) IN MEXICO*

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ABSTRACT

Datura lanosa is native to the western Sierra Madre Occidental and the adjacent coastal plain in northwestern Mexico. It is distinguished from its close relatives, *D. inoxia* and *D. wrightii*, by the lanate pubescence. This medicinal, ceremonial and poisonous perennial herb is well known to the Mexican population and is feared and respected by the indigenous peoples within its range. Preparations from the leaves, roots and seeds are applied topically to alleviate skin ailments and various pains. Ingestion of the plant causes delirium and other toxic reactions. The leaves and stems contain the alkaloids hyoscine (the principal alkaloid), atropine, meteloidine, apohyoscine, apoatropine, tropine, and an unknown alkaloid.

Key words: *Datura lanosa*, flora of Mexico, phytogeography, sympatry, ethnobotany, alkaloids, hyoscine, atropine, meteloidine, apohyoscine, apoatropine, tropine.

RESUMEN

Datura lanosa es nativa del occidente de la Sierra Madre Occidental y de la planicie costera contigua en el noroeste de México. Se distingue de sus especies parientes, *D. inoxia* y *D. wrightii*, por su pubescencia lanosa. Es conocida como planta medicinal, ceremonial y venenosa por la población mexicana. Los grupos étnicos que viven dentro de su área de distribución temen y respetan esta hierba perenne. Las preparaciones a base de las hojas, las raíces y las semillas aplicadas localmente se han utilizado para aliviar los padecimientos de la piel y los dolores del cuerpo. La ingestión de la planta causa delirio y otras reacciones tóxicas. Las hojas y los tallos contienen los siguientes alcaloides: hioscina (el principal), atropina, meteloidina, apohioscina, apoatropina y tropina, además de uno desconocido.

Palabras clave: *Datura lanosa*, flora de México, fitogeografía, simpatría, etnobotánica, alcaloides, hioscina, atropina, meteloidina, apohioscina, apoatropina, tropina.

INTRODUCTION

The lanate perennial jimsonweed of northwestern Mexico (Fig. 1) was recognized as a subspecies of the broadly interpreted *Datura inoxia* Miller by A.S. Barclay in

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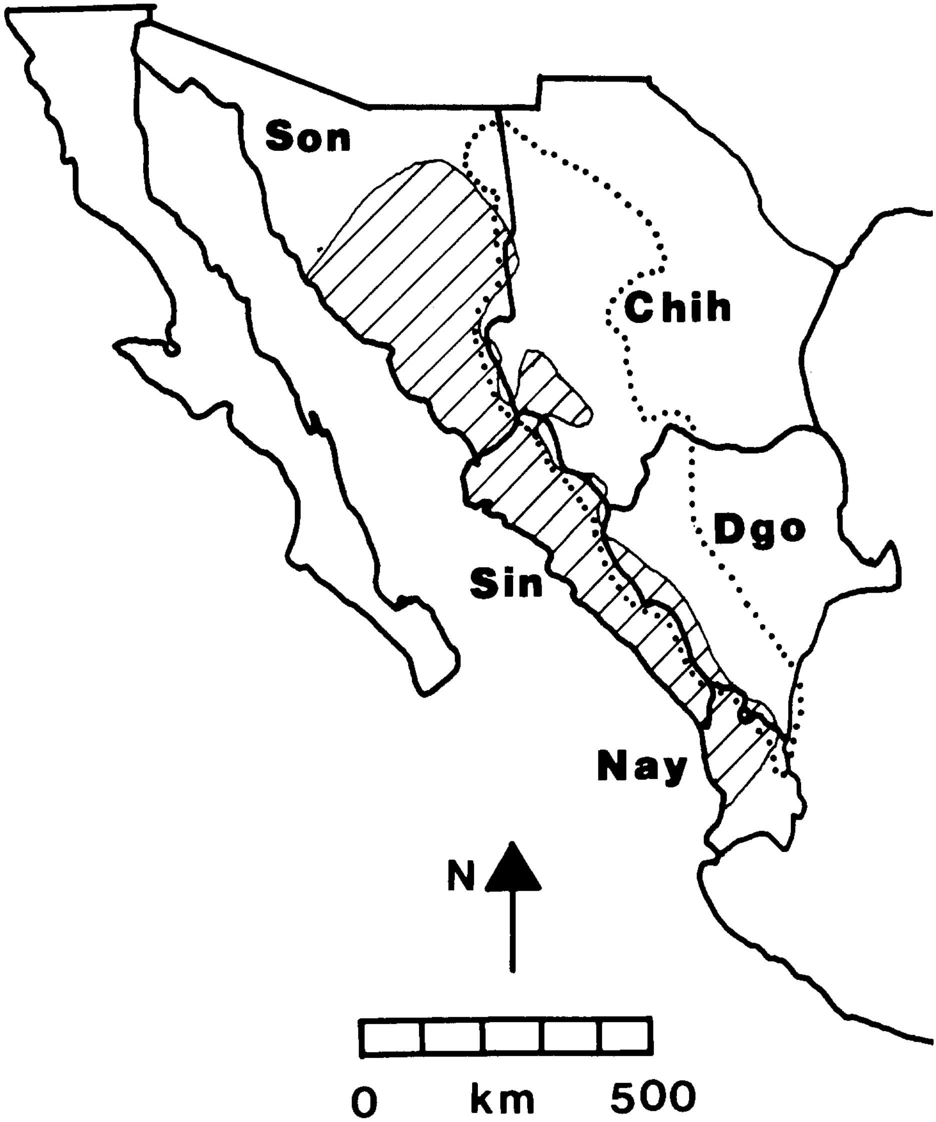


Fig. 1. Study area (zone with diagonal lines) in northwestern Mexico (state abbreviations: Chih = Chihuahua; Dgo = Durango; Nay = Nayarit; Sin = Sinaloa, Son = Sonora). The Sierra Madre Occidental is delineated by the dotted line.

1959. The valid publication of the lanate taxon as a species under a narrower species concept was provided by Bye (1986). In earlier floristic, geographical and anthropological studies, this plant was cited as *D. inoxia, D. metel* L., or *D. meteloides* DC. ex Dunal. The objective of this paper is to summarize bibliographic and herbarium information which deals with *D. lanosa* Barclay ex Bye and to present the first alkaloid chemistry report of this species.

MATERIALS AND METHODS

Taxonomic, ecological and phytogeographic data. Field studies in southwestern Chihuahua by Bye since 1971 indicated the presence of an unusual *Datura* taxon. Study of herbarium specimens from 21 United States of America and Mexican institutions permitted the delineation of this taxon based upon morphological characters, ecological data, and geographic distribution. Subsequent field studies by Bye in southwestern Chihuahua (1977-1988), along the western coast of Mexico from Jalisco to southern Sonora (1984), and in central Sonora (1988) were oriented toward collecting specimens for morphological and chemical analyses, corroborating the existence of populations documented by earlier collections, searching for plants at new geographic localities, and recording the ecological characteristics and associated plants and animals at each site. Sympatry of *D. lanosa* with other species was determined by examination of herbarium specimens of the other *Datura* species from *D. lanosa* localities and by careful exploration of field sites where *Datura* plants were encountered, giving particular attention to the presence of other species and putative hybrid plants. In addition to preparing standard pressed herbarium specimens, massive pressed leaf collections, alcohol-preserved flower and fruit samples, and photographs were made. The Sierra Madre Occidental was delineated from physiographic and topographic maps in García and Falcón (1986). Rivers and their drainage areas were based upon hydrologic catchment basins defined by García and Falcón (1986) and by Dirección General de Geografía del Territorio Nacional (1981).

Ethnobotany. Ethnobotanical, botanical and anthropological literature and documents for northwestern Mexico from the historical period to the present were examined with reference to *Datura*. Information was also gathered from herbarium specimens, a few of which serve as voucher specimens for published reports. Bye conducted open-structured interviews with local inhabitants at the field sites when he collected specimens. Special emphasis was given to nomenclature, utility, management, and special properties of *D. lanosa* and related species. In some cases (especially Indian people), informants were reluctant to talk about or approach the *Datura* plants.

Collection and processing of plant material. Vegetative parts and immature fruits of the ruderal plants were collected between 10 AM and 12 noon on 9 June and 12 September of 1987 from the population at La Bufa, Chihuahua, and were air dried in the shade. Voucher specimens are *Bye et al. 15618, 15619, 15622, 15758.* The plant material was ground using a Wiley mill model 4 with no. 4 screen mesh. The vegetal powder was used to determine the presence of alkaloids in leaves and stems (using 20 g of each part), to isolate and identify the alkaloids (using 3830 g of leaves and stems), and to appraise the total content in leaves, stems, roots and fruits (10 g of each part).

Chromatographic analyses. Thin layer chromatography (TLC) was used in various stages of analysis. Glass plates were coated with silica gel (60 GF254, Merck) or aluminun (basic aluminum D5-F, Fluka) and various solvents and staining agents were employed (Table 1). The developed chromatographs were observed under short and long wave UV light. The initial separation of individual alkaloids employed glass column chromatography (Kieselguhr 40 g; 25 ml phosphate buffer 0.5 N; at pH 8).

Determination of presence of alkaloids. The dried plant material was extracted with methanol. Leaves (20 g) and stems (20 g) were used in each case. The resulting extract was subjeted to an acid-base partitioning sequence to yield the organic phase A. Standard procedures (Harborne, 1984) were followed. Dragendorff, Mayer and silver iodide reagents were used to detect the presence of alkaloids in the organic phase A. Also, a small amount of this phase was dissolved in methanol which was subsequently acidified with HCl 1.0 N; then the reagents were added.

Isolation and identification of alkaloids. Crude alkaloid was obtained from

TABLE 1
SOLVENT SYSTEMS AND STAINING AGENTS USED IN THE THIN LAYER CHROMATOGRAPHIC ANALYSIS OF *DATURA LANOSA*

Solvent system	*Mobile phase*	*Proportion*	*Stationary phase*
I	$CHCl_3$—MeOH	7:3	silica gel
II	$CHCl_3$—MeOH	8:2	silica gel
III	$CHCl_3$—MeOH	9:1	silica gel
IV	$CHCl_3$	1	silica gel
V	$CHCl_3$—$NHEt_2$	9:1	silica gel
VI	$CHCl_3$—MeOH—NH_4OH 25%	85:15:0.7	silica gel
VII	acetone—H_2O—NH_4OH 25%	90:7:3	silica gel
VIII	acetone—NH_4OH 25%	90:3	silica gel
IX	$CHCl_3$—acetone—$NHEt_2$	5:4:1	silica gel
X	acetone—NH_4OH	4:1	silica gel
XI	Et_2O	1	aluminum
XII	Et_2O—EtOH	1:1	aluminum

Reagent	*Composition*	*Reference*
Dragendorff (A)	2.6 g basic bismuth carbonate 7.0 g sodium iodide 25 ml glacial acetic acid 84 ml ethyl acetate 0.5 ml water	Stahl, 1969
Silver iodide (B)	3 ml silver chloride at 10% 97 ml water 10 ml potassium iodide at 6%	Stahl, 1969
I_2	cabinet saturated with I_2	

3.83 kg of vegetative parts using two different methods. The first method consisted of soaking the leaves and stems (1444.9 g) with hexane. The vegetal residue was then extracted with methanol yielding 164.5 g of concentrate. Subsequent acid-base partitioning produced the crude alkaloid. The second method consisted of placing the leaves and stems (2385.1 g) in an alkaline solution ($CHCl_3$:MeOH:NH_4OH; 2:2:1) followed by extraction with chloroform. The chloroformic concentrate (344.5 g) was partitioned using an acid-base sequence and yielded a crude alkaloid. These crude alkaloid extractions were chromatographed (TLC) and both were identical. They were combined for subsequent isolation and identification of individual alkaloids.

The individual alkaloids were separated from 17 g of the crude alkaloid extract using glass column chromatography. A total of 161 fractions of 250 ml each were collected. The following fractions (in parentheses) were eluted from the column with hexane (1-30), hexane-ethyl ether 9:1 (33-94), hexane-ethyl ether 5:5 (90-105), ethyl ether (106-123), chloroform (124-142), saturated chloroform (143-159), and methanol (160-161). Each fraction was analyzed by TLC and the chromatographically similar bands were combined.

In order to isolate and purify each alkaloid, the combined fractions were rechromatographed using a column of basic aluminum (47-125) or silica (126-144), the subsequent new fractions were analyzed by TLC, and the bands were combined based upon similarity. The rechromatographed combined fractions which tested positively for alkaloids were acidified using a saturated solution of picric acid and salts were formed. The fractions and the acidification products are listed in Table 2.

TABLE 2
ORIGINAL ALKALOID-BEARING FRACTIONS ALONG WITH COMBINED RECHROMATOGRAPHED FRACTIONS, SUBSTANCES USED IN ACIDIFICATION OR CRYSTALLIZATION, AND FINAL PRODUCT YIELD WITH ITS CHARACTERISTICS

Fraction	*Yield*	*Rechrom.*	*Acidification or crystallization*	*Final Yield*[1]
47–125	9.3 g	51–95	picric acid	apohyoscine mp = 203–206° C 6.3 mg yellow powder
		212–273	picric acid	hyoscine mp = 184–187° C 430.4 mg
		298–304	picric acid	alkaloid A 75 mg
126–144	5.3 g	64–81	methanol	meteloidine mp = 130–132° C 129.5 mg
145–159	2.0 g		picric acid	atropine mp = 172–175° C

[1] in form of picrate salt

Apoatropine and tropine were detected by co-chromatography with commercially available compounds as standards. The alkaloids in combined fractions 47-125 were rechromatographed. The chromatographic bands of the standards corresponded to the combined fractions 64-107.

The identification of the other purified alkaloids was carried out using infrared spectroscopy, nuclear magnetic resonance and mass spectrometry. The sample data were compared with established information for each alkaloid. Comparative data are available in Pimentel (1989).

Appraisal of alkaloid content. The total alkaloid content for leaves, stems, fruits, and roots was determined following the USP XVIII *Method I for belladonna leaves* (U.S. Pharmacopeia Convention, 1970). For each part of the plant, 10 g were used. Each milliliter of H_2SO_4 (0.02 N) equals 5.787 mg of atropine and 0.06 mg of scopolamine.

RESULTS AND DISCUSSIONS

Taxonomy. Of the three currently recognized sections of *Datura, D. lanosa* (Fig. 2) belongs to the section *Dutra* Bernhardi. It is morphologically and cytogenetically similar to *D. inoxia* of southern United States and the Mexican uplands and *D. wrightii* Hort. ex Regel of southwestern United States and adjacent Mexico. *Datura lanosa* shares with other members of this section the dichotomous branching pattern, swollen perennial roots, ovate leaf blades with acute apex and unequal base, large flowers with funnelform corolla with five corolla teeth (acumen) and five inter-acuminal lobules, and suglobose, spiny capsules with irregular dehiscence. Although the density of the trichomes may vary, the type of pubescence on the lower leaf blade surface, along the veins of the leaves and corollas, on the young stems, and on the fruit pericarp distinguishes this species from its close relatives (Bye, 1986). The pubescence of *D. lanosa* (Figs. 3 and 4) is lanate while that of *D. inoxia* is pilose and that of *D. wrightii* is canescent. Although not always present on all plants, the developing fruit of *D. lanosa* is surrounded by a partially accrescent calyx tube (Figs. 5 and 6) which dries and splits upon maturity (rather than abscising circumscissilely at the calyx base after anthesis). *Datura lanosa* has a diploid chromosome number of $2n=24$ as do other uncultivated species of the genus. All three species *(D. inoxia, D. lanosa,* and *D. wrightii)* have three chromosome pairs with satellites. In contrast to the two closely related species, *D. lanosa* has one chromosome pair with satellites at both ends rather than at only one end (Palomino *et al.*, 1988).

Ecology and phytogeography. As a colonizer of open sites, *D. lanosa* is found in ecologically unstable habitats along rivers and arroyos or in areas perturbed by human activities such as those near roads, trails, construction sites, dwellings, and domestic animal corrals. The populations are usually small (one to 20 plants) and may persist five to ten years before succumbing to competition of subsequent successional seres or to insect predation.

Thorn forest (bosque espinoso) and tropical deciduos forest (bosque tropical caducifolio) are the vegetation types in which this species normally grows. The

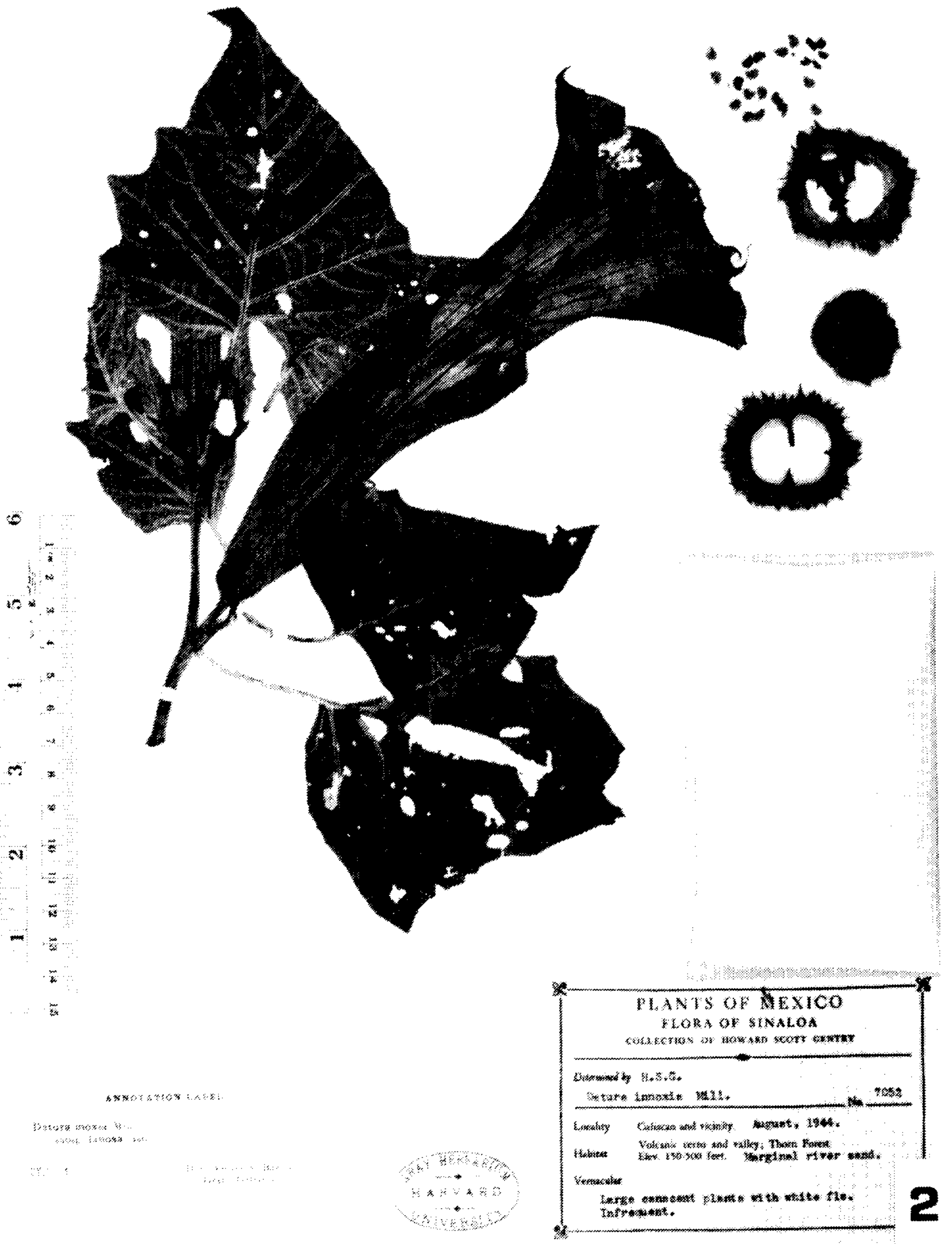
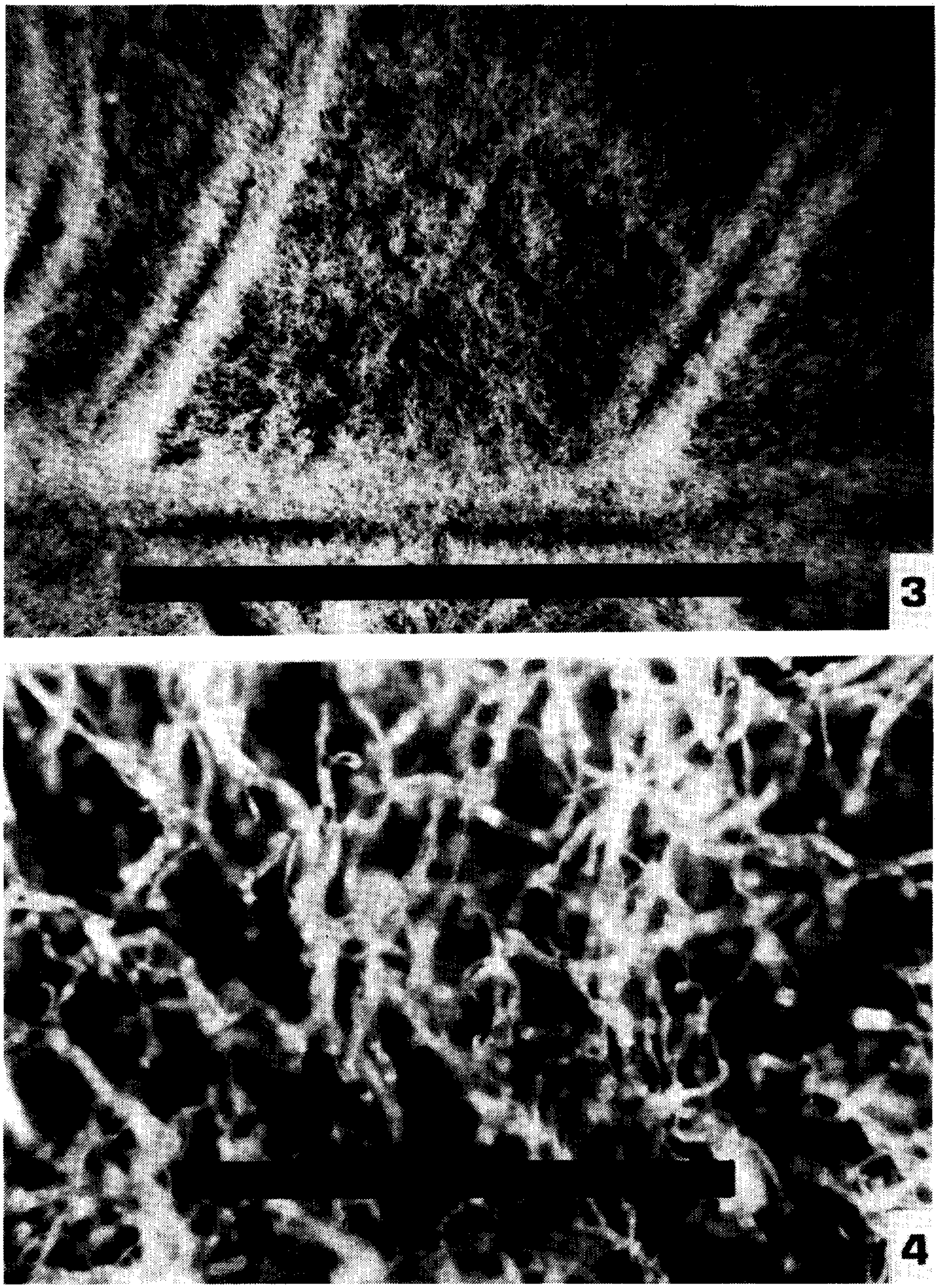
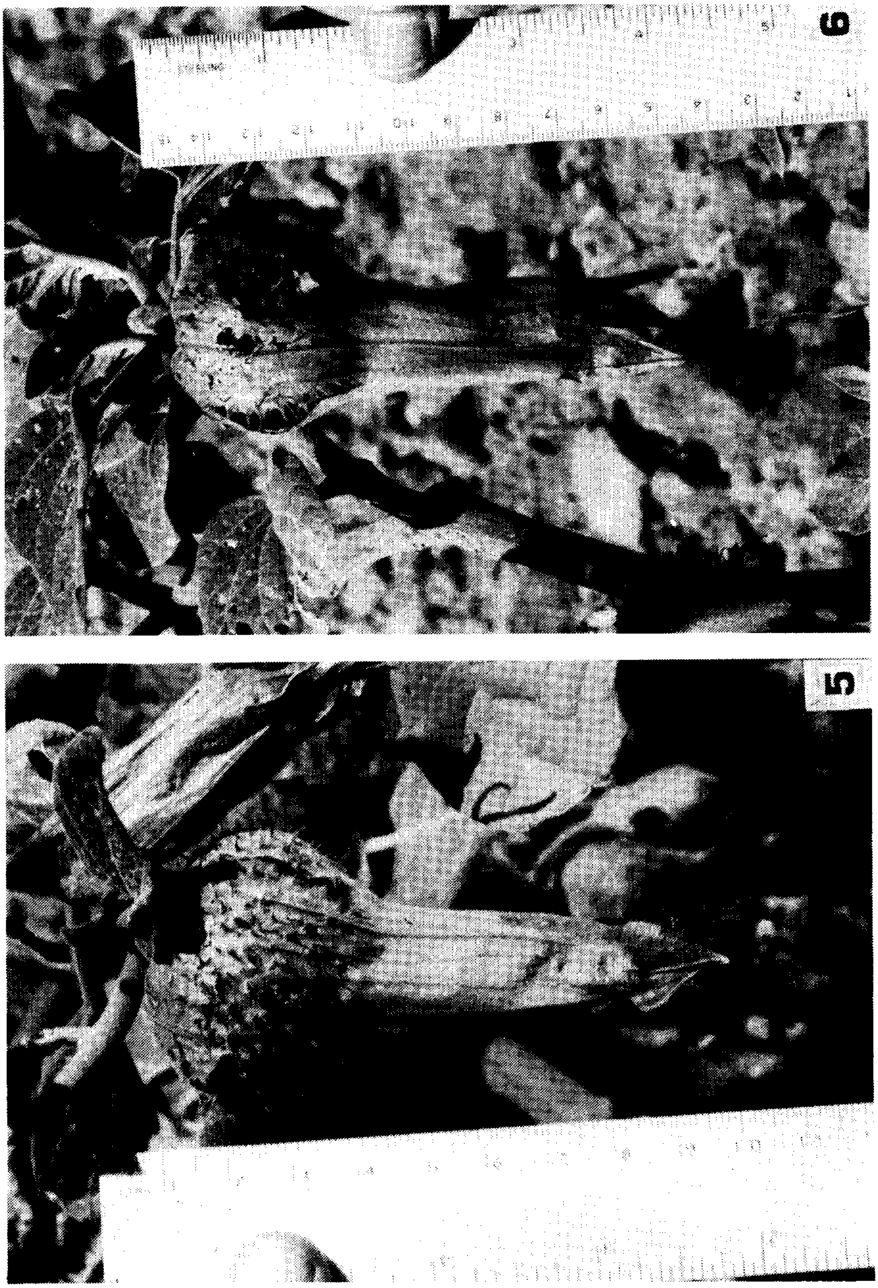


Fig. 2. Holotype of *Datura lanosa (Gentry 7052)* deposited in the Gray Herbarium (GH); scale equals 15 cm.



Figs. 3-4. Pubescence of *Datura lanosa* on underside of leaf blade from holotype *(Gentry 7052)*. 3. Pubescence of lower portion of leaf blade with part of midrib (parallel to scale) and 3 lateral veins; scale equals 10 mm. 4. Pubescence at interface of leaf blade and midrib; scale equals 1 mm.



Figs. 5-6. Developing fruit of *Datura lanosa* surrounded by a partially accrescent calyx tube *(Bye et al. 18009)*. 5. Spines of fruit penetrating green calyx tube; metric scale to left. 6. Green calyx tube split by enlarged fruit; metric scale to right.

natural range of *D. lanosa* includes the eroded western slope and the associated coastal plain of the Sierra Madre Occidental from central Sonora to central Nayarit (Appendix 1). It has been collected in 11 of the 16 major river systems in this region (Table 3, Fig. 7).

TABLE 3
ALTITUDINAL DISTRIBUTION OF *DATURA LANOSA* WITHIN MAJOR RIVER SYSTEMS ARRANGED (NORTH TO SOUTH) FROM CENTRAL SONORA TO NORTHERN NAYARIT. RIVER SYSTEMS THAT HAVE NO HERBARIUM RECORDS OF *D. LANOSA* LACK LOCALITY NAMES.

River system / *Locality*	*Mexican states*[1]	*Elevation (m)*
Sonora	Son	
Hermosillo, Sonora		237
Mátape	Son	
Yaqui	Chih, Son	
Onavas, Sonora		200
Mayo	Chih, Son	
San Bernardo, Sonora		308
Moris, Chihuahua		853
del Fuerte	Dgo, Chih, Son, Sin	
San Blas, Sinaloa		60
El Fuerte, Sinaloa		115
Alamos, Sonora		410
Batopilas, Chihuahua		556
La Bufa, Chihuahua		1100
Huimayvo, Chihuahua		1200
Sinaloa	Chih, Sin	
Guasave, Sinaloa		±20
Bamoa, Sinaloa		42
Mocorita	Sin	
Guamúchil, Sinaloa		45
Culiacán	Dgo, Sin	
Culiacan, Sinaloa		53
near Pericos, 66 km N of Culiacán		300
San Lorenzo	Dgo, Sin	
Elota	Dgo, Sin	
Piaxtla	Dgo, Sin	
Presidio	Dgo, Sin	
Mazatlán, Sinaloa		3
Villa Unión, Sinaloa		±5
Baluarte	Dgo, Sin	
Escuinapa, Sinaloa		14
Acaponeta	Dgo, Nay	
Acaponeta, Nayarit		64
San Pedro Mezquital	Dgo, Nay	
Santiago - Huaynamota	Dgo, Zac, Jal, Nay (Ags, Gto, Mex, Mich)	
Jesús María, Nayarit		600

[1] States through which the tributaries flow are arranged from the headwaters to the mouth. Other tributaries of the Río Santiago flow through the states that are enclosed in parentheses. Ags = Aguascalientes; Chih = Chihuahua; Dgo = Durango; Gto = Guanajuato; Jal = Jalisco; Mex = México; Mich = Michoacán; Nay = Nayarit; Son = Sonora; Sin = Sinaloa; Zac = Zacatecas.

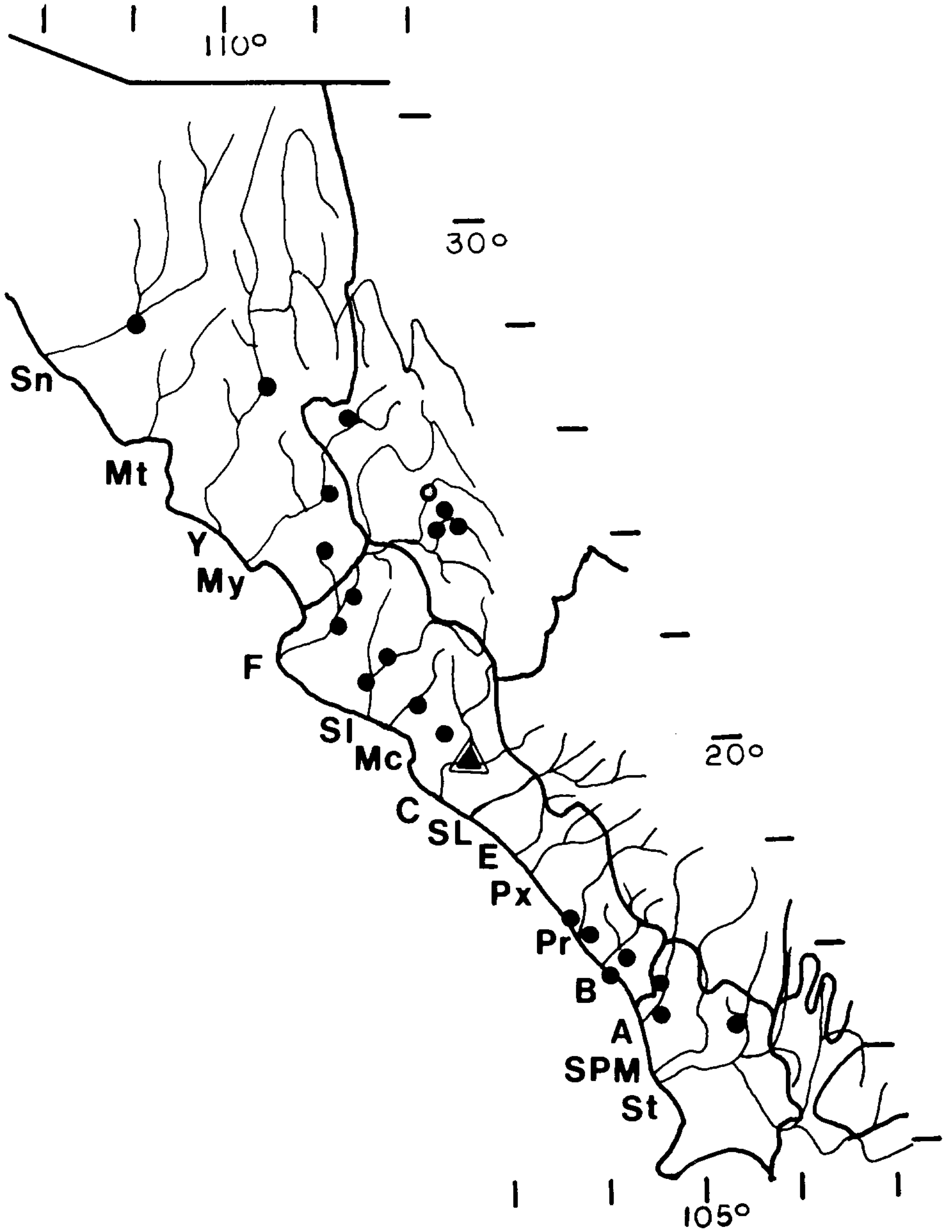


Fig. 7. Documented reports of *Datura lanosa* in relation to major river systems of western Sierra Madre Occidental and associated coastal plain. The river systems from north to south are: Sn = Río Sonora, Mt = Río Mátape, Y = Río Yaqui, My = Río Mayo, F = Río del Fuerte, Sl = Río Sinaloa, Mc = Río Mocorita, C = Río Culiacán, SL = Río San Lorenzo, E = Río Elota, Px = Río Piaxtla, Pr = Río Presidio, B = Río Baluarte, A = Río Acaponeta, SPM = Río San Pedro Mezquital, and St = Río Santiago. Each closed circle marks a general locality with one or more herbarium specimens. The open circle represents the collection of the anthropologist Zingg who worked primarily in the Río Urique drainage. The triangle is the Culiacán region, the type locality.

This species grows in a wide variety of habitats. In the del Fuerte River drainage of Sinaloa and Chihuahua, it occurs from the coastal plain (60 m) up into the deep barrancas (1200 m) along a lateral stream (Arroyo Huimayvo) of the Batopilas River. Near Mazatlán, Villa Unión and Escuinapa, Sinaloa, it grows near sea level. In the upper reaches of the catchment basins, it is found on sandy shelves of the rivers and eroded slopes of volcanic tuff. Although no specimens from the western drainages in Durango have been collected, *D. lansoa* is to be expected below the headwaters of all the rivers from the Culiacán River to the Huaynamota River (the northwestern tributary of the Santiago River). The presence of this species in the upper reaches of the Mayo River and del Fuerte River in Chihuahua and of the Huaynamota River in Nayarit, illustrates the strong association of this species with the upper drainage basin below 1200 m. Based upon the patterns of known ecological distribution (river systems, upper elevational limit, and associated vegetation), the anticipated natural range of *D. lanosa* includes central and southern Sonora, southwestern Chihuahua, Sinaloa, western Durango, and northern and central Nayarit (Fig. 8).

In Sonora (Alamos), Chihuahua (Batopilas), Sinaloa (Bamoa, Culiacán region, Escuinapa region, Guasave, San Blas, Villa Unión), and Nayarit (Acaponeta region) *D. lanosa* grows sympatrically with *D. discolor* Bernh. At La Bufa, Chihuahua, it is found together with *D. quercifolia* H.B.K. Even though different species flower at the same time, no hybrids with intermediate phenotypic characteristics have been observed in these areas of sympatry. Certain taxonomic features that distinguish section *Dutra* from section *Datura* are associated with the presence of strong pre-and/or post-zygotic reproductive barriers. Contrasting morphological characteristics (e.g., long vs. short flowers, long vs. short pollen tubes) are correlated with restricted pollination while different cytogenetic features (e.g., three vs. four chromosome pairs with satellites) would interfere with successful fertilization and seed development. *Datura discolor* is traditionally classified in the same section *Dutra* along with relatives of *D. lanosa* because of the shared feature of a pendulous, spinous fruit. However, it possesses different generative characteristics (e.g., four (rather than three) chromosomes with satellites, shorter flowers with a purple-banded corolla throat, and regularly dehiscing fruits with fewer spines) which may explain its reproductive isolation from sympatric *D. lanosa*. Field observations and experiments with pollinating insects, artificial reciprocal crosses, and meiotic studies are needed to understand this ecological and taxonomic anomaly.

Ethnobotany. "Toloache" (or "toloachi") is the most frequently encountered common name for *D. lanosa*. At Celaya, near Escuinapa, Sinaloa, *D. lanosa* is called "toloache manso" and is segregated from the sympatric "toloache bruta," *D. discolor* (*Bye & Arellano 13361, 13365*, respectively). A similar situation occurs at San Bernardo, Sonora, where *D. lanosa* is called "toloachi grande" (*Gentry 1346*; originally reported as *D. meteloides*, Gentry, 1942) in order to distinguish it from "toloachi" *D. discolor* (*Gentry 1166*; originally reported as *D. inoxia*, Gentry, 1942). "Toloache" is applied generally by Mexican people to all species of *Datura*. "Toloache" is derived from the Nahuatl terms "toloa" and "toloatzin" (derived from 'toloa', 'to incline the head'; Santamaría, 1978). "Belladona" is applied to *D. lanosa* in El Fuerte, Sinaloa *(Gentry 4920)*.

The native names applied by ethnic groups appear to be based upon the

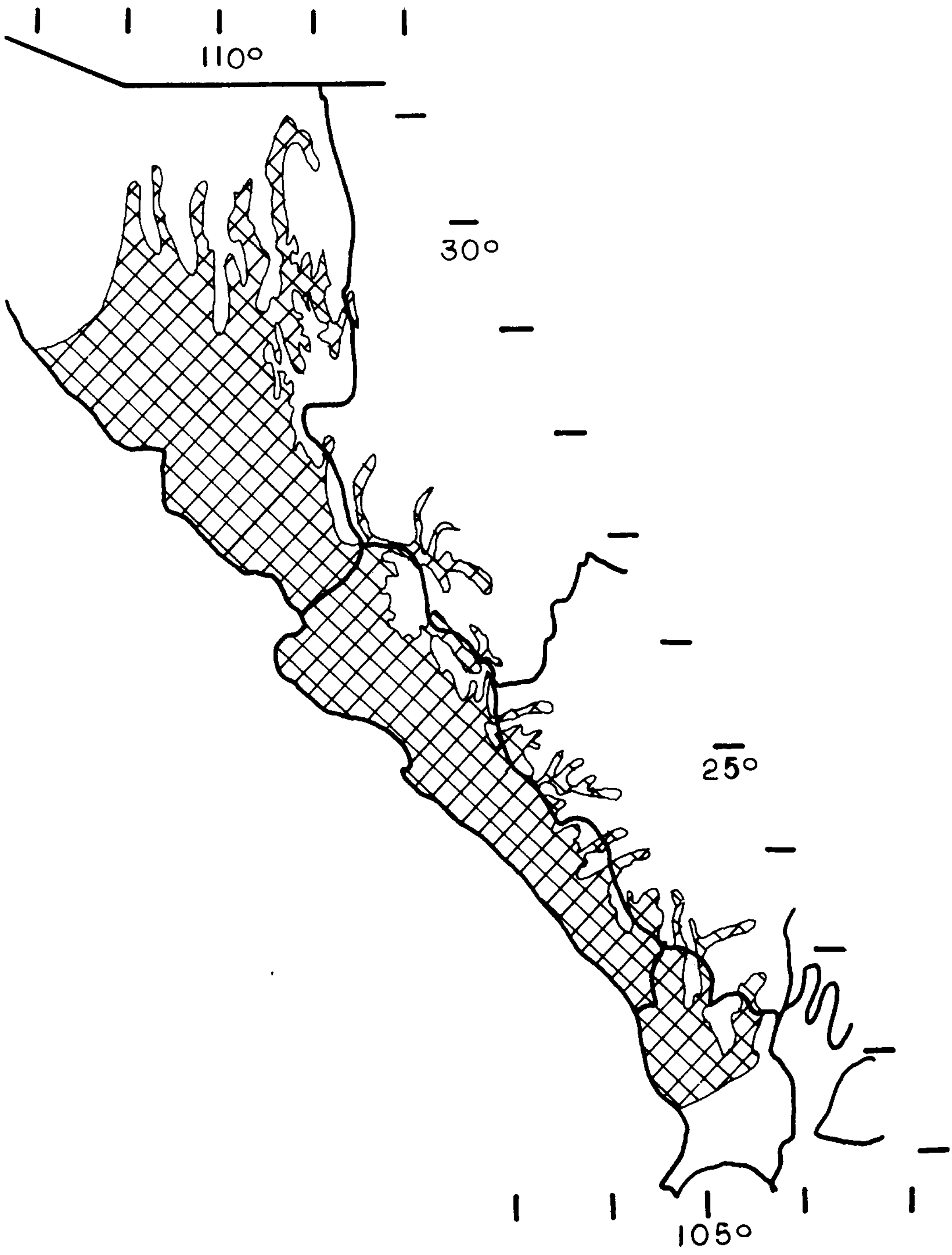


Fig. 8. Probable natural range of *Datura lanosa*.

deliriant effects produced by the plant on the nervous system. Indigenous names of *D. lanosa* recorded for the Tarahumara of western Chihuahua include "ŕikuri," "ŕikúi" (Brambila, 1983), "tikúwari" (Brambila, 1983), and "dekuba" or "rekuba" (Bennett and Zingg, 1935; Thord-Gray, 1955) (derived from 'ŕikú', 'to be drunk'; Brambila, 1976). The Pima Bajo of eastern Sonora call it "hákandam" and state that "it does something to our heads" *(Rea 44).* The Warihio of Sonora and Chihuahua refer to it as "hihyowi" or "tecuyauwi" (Gentry, 1942) (probably based upon 'tekú', 'to be drunk'; Miller, 1978).

Although it is difficult to verify the specific plant identifications in the historiacal documents, some early reports may refer to *D. lanosa,* given the limited number of species in the area, the uniform application of names, and the shared uses. "Toloache" or "toloachi" is recorded from the Guazapares of the del Fuerte River drainage of Chihuahua in 1776 (Fernández, 1950) as well as in Sonora (Esteyneffer, 1978; Nentuig, 1977; Pfefferkorn, 1949) during the 18th century. Nentuig (1977) listed "taguaro" as the Opata name for "toloache" or "estafiate mayor".

According to the Tarahumara, "rikúhuri" is a soul-possessing being that is indifferent to humans unless provoked (Merrill, 1988). It appears as a plant (various species of *Datura*) but its soul looks and acts like a human being. It attacks people who harm it by causing persistent and painful headaches, by guiding sleepy offenders to tops of cliffs from which they fall to their death, or by producing drunkenness after drinking only a little "tesgüino" (fermented maize drink). The plant may cause children to grow up violent and ill-tempered if they mistreat it; hence they are kept away from the plant (Bennett and Zingg, 1935; Thord-Gray, 1955). Because *Datura* is considered such a powerful medicine, only special shamans, using "peyote" (or "jíkuri," various species of Cactaceae; Bye, 1979), can remove the plant from dwellings and relieve the illnesses it causes (Bennett and Zingg, 1935); Thord-Gray, 1955). Most Tarahumara fear and avoid visual and physical contact with the plant for fear of going insane. Some reports indicate the use of the seeds, leaves, and roots in the preparation of "tesgüino" which subsequently induces visions (Bye, 1979).

Even though no ethnobotanical data vouchered by herbarium specimens have been studied from the Huichol area, *D. lanosa* grows in the region (mpio. Nayar, Nayarit). Originally *D. meteloides* (a name generally misapplied to species similar to *D. lanosa*) was reported as "kieri", the dangerous "tree of the wind" (Furst, 1971). "Kieri" is inhabited by evil "kakauyaris" to which offerings and ritual sacrifices are made in a ceremony involving the hunter, his snares, and his rifle as a petitions for authorizing animal hunting (Benítez, 1975). The "kakauyaris" are various supernatural beings who did not survive the creation of the world and were changed into stones or plants. One can be made insane by this plant. "Peyote" (or "híkuri") was given to the Huichol people to protect them from the evil sorcer known as "Kieri Tewíyari" (Furst and Myerhoff, 1966; Myerhoff, 1974). Rather than a species of *Datura* as originally reported, "kieli" is a solanaceous species of *Solandra* which is distinguished from "kiélitsa" or 'bad kieli', the *Datura* (Tim Knab, personal communication; Schultes and Hofmann, 1980). This authentic-false (or good-bad) plant duality composed of taxonomic relatives with similar chemical composition is also found in "híkuri" (*Lophophora williamsii* (Lemaire) Coulter) and "tsuwiri" or "false híkuri" (*Ariocarpus retusus* Scheidweirler) (Furst, 1971).

Reports about the use of *Datura* (known as "toloache" or "hierba del diablo") by the Yaqui Indians of central Sonora require corroboration. Some sources may refer to *D. lanosa.* Martínez (1959, 1969) stated that "toloache" (reported as *D. inoxia* and *D. meteloides*) from Sonora was used by the Yaquis and other northern ethnic groups. The brew of the leaves was employed by women to alleviate birthing pains. In order to treat drunkenness, the Indians drank an infusion of the leaves, smoked the leaves, or chewed the fruit. In order to produce visions, an ointment containing ground seeds and leaves was smeared on the stomach. The most notorious report of *Datura*-induced visions is that of Don Juan, reputed to be a Yaqui, and his apprentice-anthropologist Carlos Castaneda (1969), in which the ritual application and consumption of the plant permit one to 'fly' from place to place like a bird. Should one accept the authenticity of Castaneda's observations (which are questionable; see de Mille, 1990), *D. lanosa* could have been one of the species employed due to its availability in the region (Bye, 1987). Of the 11 Sonoran municipios where Yaqui is the dominant indigenous language (Olivera *et al.,* 1982), 8 are within the range of D. lanosa. If the Yaqui Indians do use and manage *Datura* in Sonora, *D. lanosa* and *D. discolor* are the most likely candidates. Emboden (1979:97) sugggests that "the manipulation by hybridization" of plants by the Yaqui has led to taxonomic confusion of this narcotic plant. Unfortunately he does not discuss the foundation of his assertion which may be nothing more than the misapplication of the *Brugmansia*-model of chemovars (Bristol, 1969) to *Datura.* The extreme antipodal convictions held by native peoples within the area of *D. lanosa* could reflect the existence of selection for and subsequent genetic changes in toloache populations with special biodynamic properties. Two studies suggest that an investigation of the relationship between chemical variation in *Datura* populations and human activities would be useful. Although no chemical documentation for human selection of alkaloid races of *Datura* exist in Mexico, shamans in the Sierra Norte de Puebla of Mexico discern between safe and unsafe *D. stramonium* plants (presumably based upon alkaloid content) (Knab, 1982). Various morphologically-marked chemical forms in *Brugmansia,* once considered a section of *Datura,* have been manipulated by shamans in Sibundoy, Colombia (Bristol, 1969).

Even though recognized and generally avoided (due to its poisonous properties) throughout its range, *D. lanosa* is employed as an herbal remedy, especially for skin ailments. Some Tarahumara Indians claim that it is an effective medicine due to its "very strong spirit" and apply the leaves to the temples and forehead for a short period of time in order to alleviate headaches (Bennett and Zingg, 1935; Thord-Gray, 1955). In the late 19th century, they prepared a lotion from the leaves for cleansing skin ulcers and smoked the dried leaves for asthma *(Palmer 1885-Z).* The people at Moris, Chihuahua, mix the crushed leaves with grease and apply the compound to sores *(Pennington 1968-6 & 1968-7).* The inhabitants of San Bernardo, Sonora, employ a similar preparation in order to relieve aches on the left side of the body *(Gentry 1346).* To cure boils ("granos"), bruises, and swellings, the people at El Recodo, Nayarit, place crushed leaves on the affected part of the body *(Bye & Arellano 13316).* Inhabitants of Alamos, Sonora, use fresh leaves heated with cooking oil for the same purposes *(Bye & Arellano 13346).* The residents of Celaya, Sinaloa, place a cooked leaf on the boil so that it forms a pustule which is subsequently punctured *(Bye & Arellano 13363).*

Similar uses for *Datura* (probably *D. lanosa*) are recorded in the historical documents of 18th Century for northwestern Mexico. In Guazapares, Chihuahua, Fernández (1950) listed "toloache" as an herbal remedy for "flucciones" (abscesses) and "budas" (swellings). The standard medical guide for missionaries, *Florilegio Medicinal* (Esteyneffer, 1978), recommended "tlapa" or "toloache" as a purgative. In Sonora, Pfefferkorn (1949) praised the remedial properties of "toloache" for opening swellings but condemned its use by Indians as a dangerous intoxicant that produced ecstasy, power to cure illness, strength to defeat their enemies, and in some cases, death. Also in Sonora, Nentuig (1977) stated that "toloache" was an excellent remedy for maturing and opening tumors and abscesses, and that the leaves were applied to the painful part of the body before breakfast in order to alleviate spleen ailments.

Alkaloid chemistry and pharmacology. Tropane alkaloids are common in Solanaceae. Evans (1979) reports 31 alkaloids found in *Datura* species. Hyoscine (scopolamine), hyoscyamine, and atropine are the principal constituents in the vegetative parts. These alkaloids and their pharmaceutical derivatives have anticholinergic properties due to competitive antagonism with acetylcholine (a widespread neurotransmitter) at the postganglionic synapse of the parasympathetic nervous system (Innes and Nickerson, 1975; Robinson, 1986; Tyler *et al.,* 1976). Medical applications of these drugs include relief of bowel spasms, reductions of respiratory secretions, alleviation of motion sickness, and antidote in cases of poisoning due to cholinesterase inhibitors (such as those found in organophosphate insecticides). Consumption of *Datura* and overdose of medications containing these alkaloids can cause toxic reactions such as skin rashes and flushings, suppressed salivation or dryness of mouth, vasodilation, hyperpyrexia, exitement, agitation, delirium, difficult urination, eye pain, blurred vision, and sensitivity to light (Tyler *et al.,* 1976; Windholz, 1983).

Thirty different alkaloids were separated from *D. inoxia* using gas chromatography (Witte *et al.,* 1987). The seven alkaloids isolated from *D. lanosa* in this study and those reported for its relatives, *D. inoxia* and *D. meteloides,* are summarized in Table 4.

The organic phase A of the initial methanol extraction of *D. lanosa* tested positive for the presence of alkaloids according to the three reagents used. Using column and thin layer chromatography and various solvent systems, the crude alkaloid extracted from 3.83 kg of dry plant material amounted to 20.0 g (0.52% total alkaloid of dry vegetative parts). However, the relative yield varied according to the extraction process. The methanol extraction with a hexane pretreatment produced more alkaloid (10.0 g of crude alkaloid from 1444.9 g of dry material, or 0.692%) than the alkalinization treatment followed by chloroform extractions (10.0 g of crude alkaloid from 2385.1 g of dry material, or 0.419%).

Because the crude alkaloid extracts were similar, they were combined in order to isolate and purify the individual alkaloids. Two alkaloids were identified by co-chromatography with standards and five others were characterized by infrared spectroscopy, nuclear magnetic resonance, and mass spectrometry. Apoatropine

TABLE 4
ALKALOIDS IN *DATURA LANOSA* AND ITS RELATED SPECIES

Alkaloid	*Part*[1]	*Species*[2]	*References*[3]
apoatropine	+	i	EI, HH
	v	l	P
	+	s	EI, HH
apohyoscine[4]	v	ml	EW2
	v	l	P
atropine	r	ml	EW2
	v	l	P
	+	A	E2
cuscohygrine	+	m	SH
	+	A	E2
datumetine	+	m	S
( )-3α,6β-dihydroxytropane	r	ml	EW2
3,6-ditigloyloxytropan-7β-ol	r	ml	EW2
	+	A	E2
( )-3α,6β-ditigloyloxytropane	+	i	BW EI EWI
	r	ml	BW EW1 EW2 EI
	+	A	E2
hyoscine	r v	ml	EW2
	v	l	P
	+	m	SH
	+	A	E2
hyoscyamine	v	ml	EW2
	+	m	SH
	+	A	E2
meteloidine	r v	ml	EW2
	v	l	P
	+	m	SH
nicotine	+	m	SH
noratropine	+	ml	EL
norhyoscine	r v	ml	EW2
norhyoscyamine	r v	ml	EW2
	+	m	SH
norscopolamine	+	m	SH
6β-propanoyloxy-3α-tigloyloxy —tropane	r	i	BW E2
pseudotropine	r	ml	EW2
tigloidine	+	i	BW EI EWI
	+	m	BW EI EWI
(–)-6β-tigloyloxytropan 3α-ol	+	i	E2
(–)-3α-tigloyloxytropan-6β ol	+	i	E2
tropine	r	i	EW2
	v	l	P
	+	A	E2

[1] v = vegetative part; r = root; + = presence without reference to plant part

[2] i = *D. inoxia;* l = *D. lanosa;* m = *D. metel;* ml = *D. meteloides* which may be *D. inoxia* or *D. wrightii;* A = all species of *Datura*

[3] B&W = Beresford and Woolley, 1974; EI = Evans *et al.*, 1972; E2 = Evans, 1979; EL = Evans and Lampard, 1972; EWI = Evans and Wellendorf, 1959; EW2 = Evans and Woolley, 1965; HH = Hsiao and Ho, 1980; P = Pimentel, 1989; S = Siddiqui *et al.*, 1986; SH = Schultes and Hofmann, 1980

[4] also known as 6, 7β-epoxy-3α-atropoyloxytropane

TABLE 5
DIRECT YIELD OF MAJOR ALKALOIDS FROM LEAVES AND STEMS OF *DATURA LANOSA*

Alkaloid	*Total extract (g)*	*Percentage of isolated alkaloids*	*Percentage of dry biomass*
hyoscine	7.8200	77.02	0.2041
atropine	2.0000	19.69	0.0522
meteloidine	0.1295	1.27	0.0039
apohyoscine	0.1279	1.25	0.0034
alkaloid A	0.0750	0.07	0.0019

TABLE 6
DISTRIBUTION OF ALKALOIDS (EXPRESSED IN TERMS OF ATROPINE AND HYOSCINE EQUIVALENT OF TOTAL ALKALOID FOLLOWING USP METHODOLOGY) IN *DATURA LANOSA*; BASED UPON 10 g EACH OF LEAVES, STEMS, FRUITS, AND ROOTS

Plant part	*Percent of dry biomas*	
	Atropine	*Hyoscine*
Whole leaves	0.3925	0.4115
Stems	0.2519	0.2641
Fruits with immature seeds	0.2226	0.2333
Roots	0.3925	0.4115
Total	1.2595	1.3204

TABLE 7
PERCENTAGE OF ALKALOIDS RELATIVE TO DRY BIOMASS (EXPRESSED IN TERMS OF ATROPINE EQUIVALENT FOLLOWING USP METHODOLOGY) IN DIFFERENT PLANT PARTS OF *DATURA LANOSA* COMPARED TO OTHER MEXICAN HERBACEOUS SPECIES

Species	*Plant parts*						
	Leaves	*Stems*	*Roots*	*Fruits*	*Seeds*	*Corolla*	*Total*
lan	0.3925	0.2519	0.3925	0.2226	——	——	1.2595
dis	0.1064	0.1253	0.0416	——	0.2395	——	0.5128
str	0.0075	0.00216	——	0.00657	0.00570	0.01932	0.0412

lan = *Datura lanosa*; dis = *D. discolor* (Reguero, 1977); str = *D. stramonium* (Galán, 1980) and tropine were detected while hyoscine (scopolamine), atropine, meteloidine, apohyoscine, and an unidentified alkaloid were isolated and characterized. The relative yields of the five major alkaloids are summarized in Tables 2 and 5. Hyoscine is the dominant alkaloid in *D. lanosa* (7.82 g or 77% of isolated alkaloids).

The USP methodolgy for relative quantification of alkaloids indicated that hyoscine is the main alkaloid in the leaves and the roots (0.41% of dry plant weight, in both parts) (Table 6). *Datura lanosa* has a greater alkaloid content than *D. discolor* or *D. stramonium* (Table 7).

CONCLUSIONS

Datura lanosa belongs to section *Dutra* based upon morphological and cytogenetic characteristics similar to those of other species in that section. It is allopatric with respect to certain taxa of this section (e.g., *D. inoxia* and *D. wrightii*). However, *D. lanosa* grows sympatrically with another section member, *D. discolor*, but is reproductively isolated from it. The lanate jimsonweed is distributed along rivers and tributaries of the western escarpment of the Sierra Madre Occidental and the associated floodplains and coastal plain of northwestern Mexico.

The ethnobotanical data indicate that *D. lanosa* possesses various psychoactive and curative properties and is distinguished from other species. Some indigenous names and cultural attributes given by ethnic groups are based upon the delirious effects produced by alkaloids. Its use to alleviate skin ailments and body pains is widespread. Where it grows with other species, *D. lanosa* is segreated nomenclaturally by terms referring to its larger size.

At least seven alkaloids are present in *D. lanosa*. Infrared spectroscopy, nuclear magnetic resonance, and mass spectrometry were used to characterize hyoscine, atropine, meteloidine, apohyoscine, and an unknown alkaloid. Apoatropine and tropine were detected by co-chromatography. Compared to two other herbaceous species *(D. discolor* and *D. stramonium)*, *D. lanosa* has twice the amount of total alkaloids based upon percent of dry biosmass. The principal alkaloid is hyoscine. The methanol extraction using a hexane pretreatment yielded more crude alkaloids per weight of dry plant biomass than the chloroform extraction preceded by alkalinizations.

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APPENDIX 1
HERBARIUM SPECIMENS EXAMINED[1]

MEXICO. CHIHUAHUA: Mpio. Batopilas: Hacienda San Miguel, Batopilas, 1885, *Palmer Z-1* (**F, US**); 1987, *Bye & Meraz 15271;* 1988, *Bye, Ramamoorthy, Castellanos, & Aguilar 16679;* NE of Batopilas, 1982, *Bye & Linares 10418, 10429, 10430;* 1987, *Bye & Meraz 15269, 15275;* 1988, *Bye, Ramamoorthy, Castellanos, & Aguilar 16681;* Guimivo (or Huimayvo), 1987, *Bye & Meraz 15256;* Bacosiachi (or Bacuseachi); 1972, *Bye 2977* (**COLO**); 1987, *Bye, Ramamoorthy, & Meraz 15621;* La Bufa, 1977, *Bye & Weber 8349* (**COLO**); 1979, *Bye 9612* (**COLO**); 1982, *Bye & Linares 10447;* 1984, *Bye, Davis, Randolph, & Gerson 12850* (**COLO**); 1985, *Bye & Linares 14246, 14247, 14248, 14250, 14251, 14252;* 1987, *Bye, Ramamoorthy, Meraz, & Elliott 15618, 15619, 15622;* 1987, *Bye, Ramamoorthy, & Meraz 15758;* 1988, *Bye, Ramamoorthy, Castellanos, & Aguilar 16671.* 1990, *Bye, Basurto, Martinez, Herrera, & Pérez 18009;* Mpio. Moris: Moris, 1968, *Pennington 6* (**TEX**), *Pennington 7* (**TEX**); Mpio. (Urique): (locality unknown) southern Chihuahua, 1931, *Zingg A-73* (**F**); NAYARIT: Mpio. Acaponeta: Acaponeta, 1897, *Rose s.n.* (**US**); El Recodo, 1984, *Bye & Arellano 13316;* Mpio. Nayar: Jesús María, 1977, *Colunga & Zizumbo 13* (**CAS, DES, MEXU, UC**): SINALOA: Mpio. Culiacán: Culiacán, 1910, *Rose, Standley, & Russell 14918* (**NY, US**); 1944, *Gentry 7052* (holotype, **GH**; isotypes, **F, NY, UC, US**); Mpio. El Fuerte: La Constancia, Mochicahui, 1924, *González Ortega 5483* (**MEXU, US**): El Fuerte, 1910, *Rose, Standley, & Russell 13452* (**US**); 1939, *Gentry 4920* (**ARIZ, MO**): San Blas, 1910, *Rose, Standley, & Russell 13355* (**US, NY**): 1927, *Jones 23115 p.p.* (**POM**); Mpio. Escuinapa: Las Cabras, 1984, *Bye & Arellano 13366;* Celaya, 1984, *Bye & Arellano 13363;* Marismas, Escuinapa, s/f, *González Ortega s.n.* (**MEXU**); Mpio. Guasave: Bamoa, 1984, *Bye & Arellano 13355;* Guasave, 1984, *Bye & Arellano 13351;* Mpio. Mazatlán: Bella Vista, Mazatlán, 1924, *González Ortega 6373* (**DS, GH**); Mazatlán, 1925, *González Ortega 5654* (**US**); Villa Unión, 1910, *Rose, Standley, & Russell 13927* (**NY, US**); 1984, *Bye & Arellano 13323, 13324;* Mpio. Salvador Alvarado: Guamúchil, 1973, *B. & J. Hansen & Nee 1400* (**MEXU, US**); Mpios. Salvador Alvarado-Mocoritoz: Pericos, ca. 66 km N of Culiacán, 1984, *Bye & Arellano 13334;* Mpio. unknown: Las Palmas, 1922, *González Ortega 4544* (**US**); SONORA: Mpio. Alamos: Alamos, 1910, *Rose, Standley, & Russell 13010* (**NY, US**); 1968, *Smith CS-4703* (**US**); 1984, *Bye & Arellano 13346;* between Alamos & La Higuera, 1984, *Bye & Arellano 13347;* San Bernardo, 1935, *Gentry 1346* (**ARIZ, F, GH, MEXU, MO, UC, US**); Mpio. Hermosillo: Hermosillo, 1980, *Bettle S-218* (**DES**); s/f, *Quintero H. 039* (**DES**); 1988, *Bye 16163;* Mpio. Onavas: Onavas: 1978, *Rea 44* (**SD**).

[1] Specimens collected by Bye are deposited at **MEXU** and duplicates are to be distributed to other herbaria.