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PHENOLOGICAL NOTES ON LATIN AMERICAN
PINUS AND ABIES

WILLIAM B. CRITCHFIELD

VERY LITTLE INFORMATION has been reported on the time of pollen shedding of the many pines and firs native to Mexico and northern Central America. This kind of information is necessary for any breeding operation, and is often of considerable taxonomic and evolutionary interest as well. An example is the difference in pollination time of a month to six weeks between *Pinus radiata* D. Don and *P. attenuata* Lemmon, two closely related closed-cone pines native to California. This difference is a reliable means of distinguishing the two species, and is also the principal mechanism that limits natural hybridization between them.

The reproductive phenology of many conifers, especially the pines, is well documented (summarized by Bingham & Squillace 1957), but I have encountered only a few references to the time of pollen shedding and pollination in Latin American pines and firs growing in their native habitats. Shaw (1909) reported that *Pinus pringlei* Shaw flowers in November or early December, before the associated *P. oocarpa* Schiede. Martínez (1948) noted that *P. durangensis* Martínez, native to northwestern Mexico, flowers in April. Little (1962) reported that occasional trees of a few Mexican pines shed pollen in September and October, and noted pollen and receptive female strobili of *P. ayacahuite* Ehrenb. in October. Mirov (1962) observed in mid-February that *P. oocarpa* had recently completed pollination in the mountains of Nicaragua. Meiosis occurs in the pollen cones of *P. pinceana* Gord. in the middle of March in northeastern Mexico, according to Díaz Luna (1962). Since meiosis in pines generally precedes pollen shedding by about 3 weeks, pollination probably takes place in early April in this pinyon pine. The only mention of the time of pollen shedding in the Latin American firs is Martínez' report (1963) that the pollen cones of *Abies religiosa* (H.B.K.) Schlecht. & Cham. mature between March and May in central Mexico (Hidalgo and the Distrito Federal).

The phenological observations summarized in TABLE 1 were made by three people: John W. Andresen, in southern Mexico and Guatemala during December, 1962; Elbert L. Little, Jr., in northern and central Mexico during March, 1963; and the author on an assignment in Honduras with the Food and Agriculture Organization of the United Nations during January, 1965, and in Guatemala and southern Mexico the following month. Many of these observations are the dates on which pollen collections were made. They often pertain to single trees, and are not always representative of the prevalent stage in the surrounding stand.

Because of the dearth of information on the reproductive phenology of these species, I have also included observations of species that either had not yet begun to shed pollen or had completed shedding when they were observed.

The places listed in TABLE 1 are accurately located by latitude and longitude in most instances, but the elevations are much less reliable, especially in Mexico. The elevations of Mexican localities are in most cases either altimeter readings or estimates from the topographic maps published by the Mexican government, at a scale of 1:500,000. Specimens corresponding to most of the tabulated observations are deposited in the conifer herbarium of the Institute of Forest Genetics at Placerville, California. Some of them are duplicated in the U.S. National Herbarium and in the herbaria of Michigan State University and the Instituto Nacional de Investigaciones Forestales in Mexico City.

The pines shed their pollen earlier in the season in Latin America than in the southern and western United States. The earliest of the southern pines, *Pinus clausa* (Chapm.) Vasey, begins shedding pollen in late December (Dorman & Barber 1956). *P. radiata*, the earliest of the western pines, sometimes begins shedding as early as late January (Duffield 1953). *P. caribaea*, probably the earliest of the Central American pines, was shedding pollen in late October and early November, 1964, in eastern Nicaragua, near the southern end of its range.¹ Farther north, in British Honduras, neither *P. caribaea* nor *P. oocarpa* had begun to shed on November 2-7, 1960.² In Honduras *P. caribaea* had completed pollen shedding by late January, 1965, except for a few possibly aberrant trees in one locality (TABLE 1: Agalteca). The condition of the pollen cones in Honduran stands suggested that this species had shed its pollen earlier than the associated *P. oocarpa*. Central American *P. caribaea* is much earlier in time of pollen shedding than the closely related *P. elliottii* Engelm. This pine of the southeastern United States starts shedding at the end of January and continues for about a month (Dorman & Barber, 1956).

Other Latin American pines also begin to shed pollen much earlier than their U. S. relatives. Pollen shedding of *P. lawsonii* Roehl was at its peak on December 13, 1962, near Lake Patzcuaro in Michoacán, Mexico (elev. 2,000 m.).³ E. L. Little, Jr., observed a few trees of *P. oocarpa* shedding pollen on October 17, 1960, in western Chiapas, Mexico (N. lat. 16°45', W. long. 99°30', elev. 1,100 m.).⁴ In Guatemala and Oaxaca, *P. oocarpa* and *P. teocote* Schiede & Deppe had begun to shed in mid-December, 1962, when J. W. Andresen collected their pollen (TABLE 1). In Honduras *P. oocarpa* had completed shedding nearly everywhere that I saw it during the last half of January, 1965 (TABLE 1).

¹ Personal communication from L. C. Saylor.

² Personal communication from E. L. Little, Jr.

³ Personal communication from L. C. Saylor. Branches bearing mature pollen cones and ovulate strobili are illustrated in North Carolina State College 1963 (Fig. 9).

⁴ Personal communication.

Another widespread Honduran pine, *Pinus tenuifolia* Benth. (often identified as the closely related but more northern *P. pseudostrobus* Lindl.), exhibited, in 1965, an unexpected inversion of the usual relationship between greater elevation and later pollen shedding (see Duffield, 1953, for examples). On El Picacho, a peak of about 1,300 meters (4,360 ft.) elevation in the suburbs of Tegucigalpa, the pollen cones of this species had not yet begun to emerge from the bud by February 3, but two days earlier pollen shedding was general in a stand only a few miles distant but 440 meters (1,440 ft.) higher (TABLE 1: Jutiapa). I observed the same unexplainable phenomenon two weeks later in the Sierra Madre del Sur, south of the city of Oaxaca, Mexico. In the foothills south of this range at an elevation of 760 meters, *P. tenuifolia* had not yet begun to shed, but at the crest of the mountains, 1,200 meters (3,900 ft.) or more higher, shedding was nearly complete (TABLE 1: San Gabriel Mixtepec).

Although the date of pollination in conifers is very much affected by the weather, the sequence among associated species is usually undisturbed by seasonal fluctuations — at least in the U. S. The data presented in TABLE 1 suggest that the Latin American conifers may not all exhibit this degree of constancy in relative pollination time. In the following list of pollen-shedding sequences taken from TABLE 1, simultaneous shedding is indicated by = , successive shedding by /.

PLACE	CHRONOLOGICAL ORDER OF POLLEN SHEDDING
Uruapan, Michoacán	<i>P. douglasiana</i> / <i>P. pseudostrobus</i>
" "	<i>P. oocarpa</i> / <i>P. pseudostrobus</i>
Ciudad Hidalgo, Michoacán	<i>P. montezumae</i> = <i>P. teocote</i>
Paso de Cortés, México	<i>A. religiosa</i> / <i>P. montezumae</i> / <i>P. hartwegii</i>
Zacatepec, Puebla	<i>P. pseudostrobus</i> = <i>P. teocote</i>
Perote, Puebla	<i>A. religiosa</i> = <i>P. hartwegii</i>
Ixtlán, Oaxaca	<i>P. lawsonii</i> / <i>P. pseudostrobus</i> var. <i>oaxacana</i> / <i>P. patula</i> var. <i>longipedunculata</i>
San Gabriel Mixtepec, Oaxaca	<i>P. oocarpa</i> / <i>P. tenuifolia</i>
Honduras (general)	" "

One notable inconsistency appears in these sequences. *Abies religiosa* was just beginning to shed pollen in mid-February, 1965, at 3,400 meters (about 11,000 ft.) in the State of México, long before its associate, *Pinus hartwegii* Lindl. I estimated that this pine would not begin to flower for another month or six weeks. E. L. Little, Jr., collected pollen of the same species in this vicinity near the end of March, 1963 (TABLE 1: Paso de Cortés). But pollen of *A. religiosa* and *P. hartwegii* was collected on the same date near Perote, Puebla, in 1963 (TABLE 1: Cofre de Perote).

Two of the observations listed in TABLE 1 do not agree with earlier reports. I collected pollen of *Abies religiosa* in the State of México (TABLE 1: Paso de Cortés) a month and a half before the April-May date reported

TABLE 1. — Observations on the time of pollen shedding in Latin American pines and firs

SPECIES	DATE	STATE AND/OR COUNTRY	NEARBY PLACE NAME	N. LAT. ° ,	W. LONG. ° ,	ELEVA- TION METERS	POLLEN STAGE ¹
ABIES							
<i>religiosa</i> (H.B.K.)	March 24, 1963	México, Mex.	Bosencheve	19 26	100 11	2950	[Sh]
Schlecht. & Cham.							
"	March 28, 1963	Puebla, Mex.	Cofre de Perote	19 30	97 11	3250	[Sh]
"	Feb. 16, 1965	México, Mex.	Paso de Cortés	19 06	98 41	3400	St
<i>vejari</i> Martínez	March 30, 1963	Nuevo León, Mex.	Cerro Potosí	24 51	100 13	2950	Sh
PINUS							
<i>caribaea</i> Morelet	Jan. 20, 1965	Honduras	Agalteca	14 28	87 12	770	MS
"	Jan. 25, 1965	"	San Esteban	15 10	85 55	800	SO
"	Jan. 27, 1965	"	Miravalles	14 40	87 14	750	SO
<i>montezumae</i> Lamb.	March 25, 1963	Michoacán, Mex.	Ciudad Hidalgo	19 41	100 40	2700	[Sh]
"	"	México, Mex.	Bosencheve	19 24	100 04	3150	[Sh]
"	March 26, 1963	"	Mexico City	19 19	98 50	3100	[Sh]
"	March 29, 1963	Hidalgo, Mex.	Jacala	20 51	99 14	2250	[Sh]
"	March 5, 1965	Guatemala	Chimaltenango	14 38	90 54	2100	NS ²
"	Feb. 16, 1965	México, Mex.	Paso de Cortés	19 06	98 41	3400	NS ²
<i>hartwegii</i> Lindl.	March 26, 1963	"	"	19 05	98 39	3250	[Sh]
"	March 28, 1963	Puebla, Mex.	Cofre de Perote	19 30	97 11	3250	[Sh]
"	Feb. 16, 1965	México, Mex.	Paso de Cortés	19 06	98 41	3400	NS ²
<i>michoacana</i>							
Martínez	Feb. 11, 1965	Oaxaca, Mex.	Sola de Vega	16 31	96 58	1400	NS ²
<i>pseudostrobus</i> Lindl.	March 24, 1963	Michoacán, Mex.	Mil Cumbres	19 39	100 46	2400	MS
"	March 25, 1963	"	Zitácuaro	19 27	100 19	2650	[Sh]
"	March 28, 1963	Puebla, Mex.	Zacatepec	19 19	97 33	2650	[Sh]
"	March 29, 1963	Hidalgo, Mex.	Jacala	20 48	99 16	1860	[Sh]
"	March 30, 1963	Nuevo León, Mex.	Iturbide	24 45	99 57	1600	MS
"	Feb. 5, 1965	Guatemala	Solalá	14 49	91 12	2300	Sh
"	Feb. 18, 1965	Michoacán, Mex.	Uruapan	19 26	102 04	1700	NS ²

by Martínez (1963) in the nearby Distrito Federal. And pollen shedding was general in a stand of *Pinus pringlei* in the Sierra Madre del Sur (TABLE 1: Sola de Vega) in mid-February, two to three months after the flowering time reported by Shaw (1909) for this species. These discrepancies and some of the other observations reported here suggest that conifer pollen shedding may be under less rigid environmental control in Mexico and Central America than in more northern regions.

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PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U. S. D. A.
BERKELEY, CALIFORNIA 94701