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BRIEF ARTICLE

The northern limit of *Alnus* (Fagales) in Costa Rica: modern pollen evidence of a possible range extension

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The genus *Alnus* is represented in Costa Rica by one species, *Alnus acuminata* H.B.K., a 5-20 m tall tree characteristic of montane forest formations (Furlow 1977). Burger (in Janzen 1983) stated that in Costa Rica *A. acuminata* is not known to occur north of Volcán Barva in the Cordillera Central, even though the species ranges northward to Mexico. However, Hartshorn and Poveda (in Janzen 1983) and Haber (1990) report *A. acuminata* to be present within the Monteverde reserve in the Cordillera de Tilarán (one range northwest of the Cordillera Central). According to Haber (1990), the species occurs as low as 900 m on the Atlantic slope, in the Río Peñas Blancas valley (approximate coordinates 10°22'N, 84°38'W).

Recent checks of the herbaria of the Museo Nacional de Costa Rica (February 1994) and the Missouri Botanical Garden (May 1995, by M. Grayum) confirmed the Monteverde reserve as the northernmost limit of plant collections for *Alnus* in Costa Rica. However, we have found evidence that suggests that the northern limit of the plant lies further to the north. Our evidence derives from pollen grains in modern lake sediments, which we have studied across a range of vegetation types in Costa Rica to improve our ability to reconstruct past vegetation from pollen assemblages in lake sediment cores (Rodgers & Horn, 1996). Pollen grains in ancient lake and marine sediments provide key evidence for documenting past distributions of tropical plant taxa (*e.g.* Graham 1992, and references therein), but have been overlooked as sources of information on modern plant distributions. We believe that pollen grains from modern plants, blown or washed into lakes and ponds and preserved in surface sediments, can supplement herbarium records in tropical areas that have been inadequately collected. Our pollen evidence of a possible range extension for *Alnus* in Costa Rica illustrates this potential.

In the course of our study of modern pollen assemblages in Costa Rica we have examined surface sediments from two small lakes on the northern slope of Volcán Arenal, an active volcano located north and east of the Cordillera de Tilarán, on the southernmost end of the Cordillera de Guanacaste (Horn & Haberyan 1993). Our sample from Laguna Cedeño (6 ha, 610 m elevation) contains a diverse pollen assemblage (Table 1) that includes 4.5% *Alnus* pollen. We infer from the importance of *Alnus* pollen in the Cedeño sediments the presence of an unre-

TABLE 1

Modern pollen assemblage from Laguna Cedeño

Taxa	Percentage
Myrica	12.2
Weinmannia	11.6
Melastomataceae/ Combretaceae	11.1
Urticales-Diporate	6.8
Urticales-Triporate	6.8
Cecropia	6.5
Alnus	4.5
Palmae	4.3
Compositae	3.7
Gunnera	3.4
Hedyosmum	3.1
Rubiaceae	2.8
Mortoniodendron	2.8
Crotonoideae	2.3
Gramineae	2.3
Myrsine	2.0
Quercus	2.0
Piper	1.7
Unknown Pollen	1.7
Urticales-Polyporate	1.1
Acalypha	1.1

Table shows the percentages for pollen types exceeding 1% of a total count of 383 pollen grains exclusive of indeterminate pollen and fern spores.

ported population of *Alnus* on Volcán Arenal. *Alnus* is wind-pollinated, and the possibility does exist that the *Alnus* pollen in the Cedeño sediments was derived from populations growing in the Cordillera de Tilarán, or further to the south in the Cordillera Central. However, pollen transport in either case would be against prevailing northeasterly winds (Coen, in Janzen1983). Moreover, both the concentration of *Alnus* pollen in the Cedeño sediments (5.4 x 10^3 pollen grains per dry gram), and its percentage importance, are higher than we would expect were it derived from long distance wind transport from mountains to the south. In our analysis of pollen in surface sediments and soils from 28 other sites ranging from sea level to 3520 m in Costa Rica (Rodgers & Horn, 1996), *Alnus* exceeded 1% of the total pollen only at sites in the Cordillera Central and Cordillera de Talamanca that are within or upwind from known populations (Table 2).

Laguna Cedeño presently lacks a surface inlet, but a lahar or mudflow reached the lake during the 1968 eruption of Arenal (Zapata 1990). Our surface sample was collected with a dredge from the uppermost 5-10 cm of lake sediment and likely includes pollen transported fluvially in the wake of the 1968 eruption, in addition to pollen transported by local downslope winds. We found no pollen of *Alnus* at nearby Laguna La Palma (6 ha, 570 m elevation), which was apparently not in the path of mudflows following the 1968 eruption (Zapata 1990). The absence of *Alnus* pollen in the surface sediments of this lake, located less than 1 km from Cedeño, may provide support for the idea that some of the *Alnus* pollen in Cedeño was fluvially deposited. It may also signal that the population of *Alnus* on Arenal is small and of restricted distribution.

A. acuminata is cultivated for timber and firewood in the highlands of the Cordillera Central, usually on land also used for pasture (Anonymous1980, Burger, in Janzen 1983). However, we are not aware of plantings within pastures near Laguna Cedeño. The uppermost pastures on Arenal are at 550-650 m elevation, which is ≥250 m below the lower elevational limit of forest populations of *Alnus* at Monteverde, and ≥1000 m below the typical elevation of pastures planted with *Alnus* in the Cordillera Central. We believe that the *Alnus* pollen in the Cedeño sediments derives from trees growing within mature or successional forests on Arenal, rather than pastures, but field observations are necessary to confirm this.

Pollen grains of the genus *Alnus* typically have four to six pores, with 3- and 7-pore grains found rarely (Kapp 1969). It may be significant that all grains of *Alnus* pollen in the Cedeño sediments have four pores, rather than five as is most common in modern and Holocene sediments elsewhere in Costa Rica. We request that field collectors who encounter *Alnus* on Arenal (or on other peaks of the Cordillera de Guanacaste, where it might also occur), send us pollen samples for examination and comparison with the Cedeño *Alnus* grains.

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TABLE 2

Percentage of Alnus *pollen in modern pollen assemblages from surface sediments from selected lake and bog sites in Costa Rica*

Site	Location	Elevation (m)	Latitude (°N)	Longitude (°W)	*Alnus* (%)
Laguna Cedeño	Cordillera de Guancaste (North slope of Arenal)	610 m	10.29.11	84.42.19	4.5%
Laguna Botos	Cordillera Central (Volcán Poás)	2600	10.11.18	84.13.44	2.9%
Laguna Barva	Cordillera Central (Volcán Barva)	2840	10.08.55	84.06.25	3.1%
Quebrador Pond	Cordillera de Talamanca	3040	9.36.09	83.47.25	7.4%
Bog 68	Cordillera de Talamanca	2670	9.39.49	83.50.59	7.4%
Bog 70	Cordillera de Talamanca	2670	9.38.51	83.50.47	8.3%
Tres de Junio Pond	Cordillera de Talamanca	2670	9.39.57	83.51.02	9.7%
Asunción Pond[1]	Cordillera de Talamanca	3340	9.39.57	83.45.26	4.8%
Lago Morrenas[1]	Cordillera de Talamanca	3480	9.29.40	83.29.12	15.1%
Lago Chirripó[1]	Cordillera de Talamanca	3520	9.29.05	83.29.52	8.0%

[1] These sites within the páramos surrounding Cerro Buenavista and Cerro Chirripó are upslope and upwind from extensive populations of *A. acuminata*, which reaches its upper elevational limit at approximately 3100 m in the Cordillera de Talamanca (Furlow 1977).

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