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Vegetation recovery after the 1976 páramo fire in Chirripó National Park, Costa Rica

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Abstract: In 1976 a major fire swept through the bamboo -and shrub- dominated páramo of Chirripó National Park, Costa Rica. Dire predictions of irreversible damage made at the time of the fire seem not to have been realized. A survey in 1985 revealed that the vegetation is recovering, although at a slow pace. Differing responses to fire among the major woody perennials have led to shifts in species composition, most notably an increase in the importance of the bamboo *Swallenochloa subtessellata* and the shrub *Vaccinium consanguineum* at the expense of the shrub *Hypericum irazuense*. *Swallenochloa subtessellata* had approximately regained its average prefire adult stature of 1 m after nine years of regeneration, but there were still large patches of uncolonized ground within the study site. Historical and fossil evidence reveals that the 1976 fire was part of a long series of fires on the Chirripó massif.

Key words: fire effects, vegetation recovery, páramo.

In March of 1976 a hiker in Costa Rica's remote Chirripó National Park (Fig. 1) ignited a fire that eventually burned over 5000 hectares of páramo vegetation and a large area of surrounding oak forest (Chaverri, Vaughan & Poveda 1976; *La Nación*, 6 April 1976:10). The fire generated front page headlines in Costa Rican newspapers, where it was decried as an unprecedented national disaster that had threatened a rare and fragile ecosystem. Scientists and journalists alike expressed fears that the páramo vegetation might never completely recover from the disturbance caused by the fire (*La Nación*, 30 March 1976: 1A, 8A, 26A; *Enfoque [La Nación]*, 1 April 1976: 1, 4, 5; *La Nación*, 23 May 1976: 2A; *La República*, 16 May 1976:2).

Research conducted since the 1976 fire has shown that these early perceptions and predictions were largely unfounded. The páramo vegetation of Chirripó National Park is recovering, although at a slow pace (Vaughan, Chaverri & Poveda 1976, Chaverri, Vaughan & Poveda 1977, Weston 1981a, Valerio 1983, Horn 1986a). As of 1981, only one species known to have occurred in the area prior to the fire had not been reported subsequently, and it appeared that even this plant, a species of *Xyris*, might be found if more thorough searches were conducted (Weston 1981a). Far from being a new threat, fire apparently has a long history in the Chirripó páramo (Horn 1989 a), and the vegetation as a whole seems reasonably well-suited to withstand periodic burning. Still, the 1976 fire has left its mark. While the páramo *flora* has not changed appreciatively since the fire, there have been notable shifts in *species composition* in certain areas (Weston 1981a, Horn 1989b).

This paper describes patterns of postfire regeneration at a site within the Valle de los Conejos (Fig. 1b). Trends evident at the site appear representative of recovery patterns throughout much of the páramo. However, variations no doubt exist due to differences in prefire vegetation composition, fire intensity,

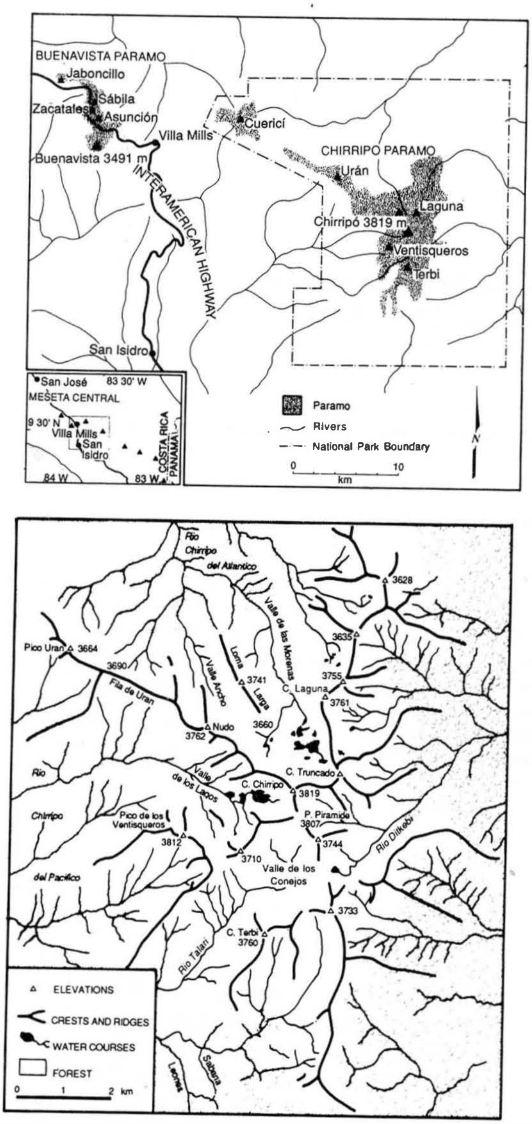

Fig. 1a. Location of the Chirripó and Buenavista páramos within the Cordillera de Talamanca, Costa Rica, and the boundary of Chirripó National Park. The solid line in the inset map represents the crest of the Cordillera de Talamanca; triangles are major peaks. Based on Boza et al. (1987) and the 1:50,000 topographic maps published by the Instituto Geográfico Nacional. Fig. 1b. Sketch map of the Chirripó páramo. Redrawn from Weber (1959).

and other environmental factors. Documentation of regeneration patterns at other sites within the 1976 burn area awaits the publication of the long-term study carried out by Chaverri and associates, who established a series of permanent quadrats immediately following the fire (Chaverri, Vaughan & Poveda 1976).

Before describing the regeneration survey, I present a synopsis of the recent fire history of the park and describe evidence for more ancient fires. By doing so, I hope both to place the 1976 fire in historical perspective and to encourage and facilitate further research on postfire vegetation dynamics within páramo burn sites of different ages.

ENVIRONMENTAL SETTING

Chirripó National Park straddles the rugged crest of the Cordillera de Talamanca and includes the highest peak in Costa Rica, Cerro Chirripó (3819 m) (Fig.1). Protected within the park are about 8000 hectares of treeless neotropical páramo vegetation and over 40,000 hectares of montane forest. Weber (1959) described the Chirripó vegetation based on an expedition to the highland in 1957; more detailed botanical studies have been carried out by Weston (1981a, b) Cleef and Chaverri (in prep.), and Kappelle (in prep.). The higher slopes within the park are dominated by the dwarf bamboo *Swallenochloa subtessellata* (Hitchc.) McClure. Several small-leaved, evergreen shrubs grow intermixed with the bamboo, among which members of the Hypericaceae, Ericaceae, and Compositae are prominent. Grasses, sedges, herbaceous dicots, club mosses, and true mosses occur in the shrub understory and in more open sites.

The evergreen oak *Quercus costaricensis* Liebm. dominates the montane forests that replace the páramo at lower elevations. The upper limit of oak forest ranges in elevation from about 3200 to 3400 m. In most areas a transitional association of small trees and large shrubs separates the bamboo-dominated páramo from the oak forest; this association is often termed madroño, after the common name of the dominant species, *Arctostaphylos arbutoides* (Lindl.) Hemsl. (Weston 1981b).

The climate of the Chirripó massif is characterized by low annual temperatures and seasonal drought. No site-specific meteorological data are available, but data from the Cerro Páramo station (3475 m) near Cerro Buenavista (Fig. 1a) are broadly representative. During 1971-1984 this station showed a mean annual temperature of 7.6º C and an annual rainfall total of about 2500 mm (Instituto Costarricense de Electricidad, unpub. data). Nearly 90% of the total precipitation fell during the May to November wet season. Clouds usually shroud the Talamancan highlands, moderating the seasonal drought. But for weeks or months during the dry season the condensation belt may lie below timberline, leading to clear, dry weather on the Chirripó peaks. Many herbaceous plants die back at this time, and ground litter dries out, providing the fuel for fires. Fuel buildup is favored by the continuously cool temperatures, which retard decomposition (Janzen 1973).

Frost are frequent, but there are no reliable reports of snowfall in the Chirripó massif (Coen 1983). However, glaciers occupied the upper valleys during the Pleistocene, leaving behind a scenic ice-carved landscape and about thirty moraine-dammed lakes. Morainal deposits mantle the granodioritic bedrock in many areas of the park (Weyl 1957, Hastenrath 1973). Soils are generally well-drained and rich in organic matter.

FIRE HISTORY

Recent Fires

Written accounts and photographs document the occurrence of numerous fires in the Chirripó highlands since the mid-century. All have been attributed to human activity, but lightning deserves attention as a possible additional ignition source (Horn 1989a).

The earliest recorded fire began by accident in the Sabana de los Leones (Fig. 1b) and from there spread upslope to the páramo, where it burned for some fifteen days. Photographs and descriptions in Weber (1959) and Weyl (1955a, 1955b, 1956) suggest that the fire burned a minimum of several hundred hectares of páramo and madroño in the Valle de los Conejos and adjacent areas (Horn 1986b). In 1961 the Valle de los Conejos again burned. According to Weston (quoted in Kohkemper, 1968, and *La Nación*, 30 March 1976: 8A), this fire burned the páramo in the middle and upper sections of the valley and also a large area of madroño and oak forest in the lower part of the valley along the trail leading into the park. Park guard Arcelio Fonseca Vargas (pers. comm. 1985) recalled that the 1961 fire also burned the Valle de los Lagos and the Valle de las Morrenas (Fig. 1b) at the base of Cerro Chirripó.

During the dry season of 1963-64, a fire swept across the Cuericí massif on the extreme western edge of current park boundaries (Fig. 1a; Weston 1981a), possibly burning up to 1 km^2 of páramo vegetation. A much smaller fire occurred in January, 1970, when a plane crashed on the Fila Norte about 4 km north of Cerro Chirripó (Kohkemper 1971). Four years later the Sabana de los Leones burned, but the fire did not spread into the páramo (Arcelio Fonseca Vargas, pers. comm. 1985; Weston, quoted in *La Nación*, 30 March 1976: 8A).

The 1976 fire, with its estimated extent of over 5000 hectares, constitutes the largest fire to affect the Chirripó páramo since the mid-century. Ignited on March 22, the fire burned an estimated 90% of the páramo vegetation before it was extinguished by rains in early April (Chaverri, Vaughan & Poveda 1976). In many areas the more moist soil and vegetation below timberline served as a natural firebreak, but in the lower Valle de los Conejos the fire penetrated into the oak forest that had burned in 1961, and from there spread almost a kilometer into the previously unburned oak forest below the 1961 fire line (Weston, quoted in *La Nación*, 30 March 1976: 8A; Chaverri, Vaughan & Poveda 1976).

In April 1977 another large fire affected the Chirripó massif, this one the result of an agricultural fire that had spread upslope out of control. The fire burned an estimated 5000 hectareas of oak forest on slopes to the south of the Sabana de los Leones (*La Nación*, 27 April 1977: 4a), but was extinguished by rain or lack of fuel before it reached the páramo. In early 1982, a helicopter crash near Cerro Ventisqueros set off a fire that covered 15 hectares before it was contained by fire breaks (Arcelio Fonseca Vargas, pers. comm. 1985).

In February and March of 1985, an immense forest fire swept up the south slope of the Chirripó massif, in or near the same area of forest that had burned in 1977. This fire was also the result of agricultural fires that had escaped control. By late March the fire had reached 3300 m, and had jumped fire breaks established near the Sabana de los Leones (McPhaul 1985a,b). Had heavy rains in early April not extinguished the blaze (McPhaul 1985, Mora 1985), it likely would have burned a large portion of the páramo, which after nine years of regeneration since the 1976 fire contained sufficient fuel to support another large fire.

Fire and Drought

The post-1950 fire record in the Chirripó massif suggests that recent fires, although human-set, have been affected by climatic variability, which makes widespread burning more likely in some years than in others. Fig. 2a. shows total precipitation during the driest month and the two consecutive driest months during the period 1952-1985 for the Cerro Páramo (after 1971) and Villa Mills (3000 m; data before 1971) meteorological stations in the Buenavista highlands. I assume that these data reflect trends that would have been evident in the nearby Chirripó highlands. The triangles denote known fire years, with the size of the triangles representing the total area above 3000 m elevation known or suspected to have burned in that year. The 3000 m contour was arbitrarily selected; the area circumscribed includes all of the páramo within Chirripó National Park and some stands of oak forest and madroño. The question mark in 1977 reflects uncertainty as to whether the forest fire that affected the Chirripó massif that year extended above 3000 m. As shown by the figure, the distribution of the larger páramo fires appears related to drought intensity, at least as measured by the simple index of monthly precipitation. The large fires of 1961, 1976, and 1985 all occurred during years in which the driest month recorded less than .5 mm and the two driest months together recorded less than 15 mm rainfall.

Earlier Fires

Documentary evidence of fires during the early historic and prehistoric periods is slim. Aboriginal groups never occupied the uppermost slopes of the Cordillera de Talamanca, but important population centers existed on both sides of the range, and several trails crossed the rugged crest (Kohkemper 1968, Stone 1977). Stories told by the Talamancan Indians to William Gabb in the late 1800s (Gabb 1884) include what seem to be the earliest observations of páramo fires. Several informants related that at various times in the past they had seen smoke and fire on some of the high peaks. Gabb attributed this to either volcanism or the accidental ignition of the dry summit vegetation. Since Gabb's time we have established that there are no active volcanoes along the Talamancan crest; the plumes of smoke observed on the high peaks must have been due to páramo fires.

Analysis of charred plant fragments (charcoal) in a short (110 cm) sediment core recovered in 1985 from the Laguna Grande de Chirripó, a glacial lake located just below and to the west of the summit of Cerro Chirripó, provides fossil evidence of early fires in the Chirripó highlands (Horn 1989a). The core, collected about 20 m off the northwestern shore of the lake at a water depth of 6 m, has

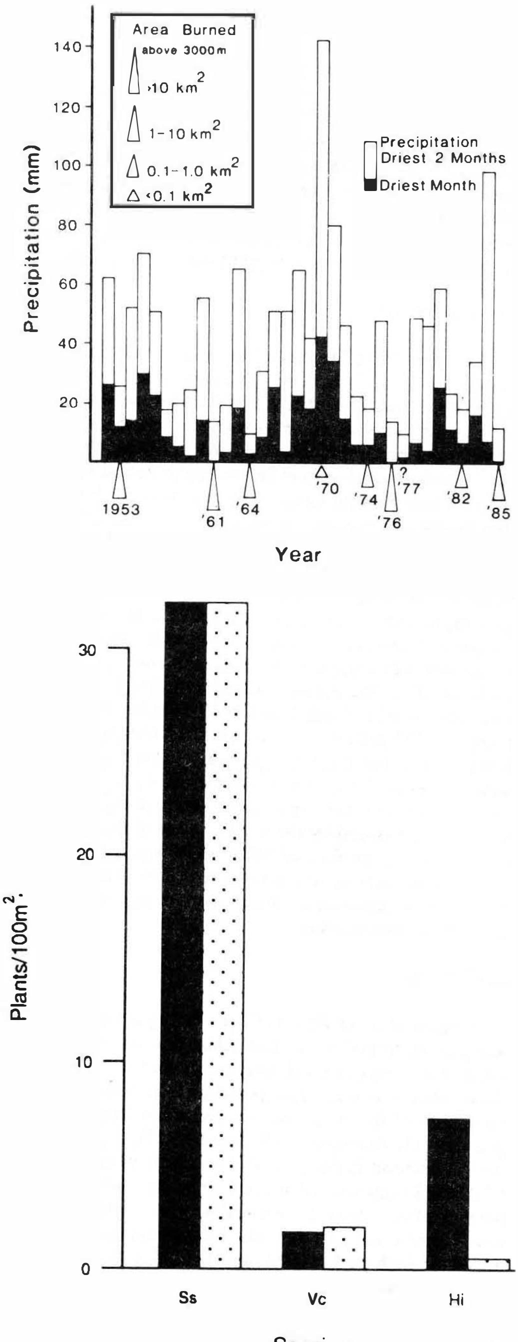

Fig. 2a. Dry season precipitation in the Talamancan highlands and the distribution of recent fires in Chirripó National Park. See text for explanation. Fig. 2b. Prefire (first bar, shaded black) and postfire (second bar, stippled) density of *Swallenochloa subtessellata* (Ss), *Vaccinium consanguineum* (Vc), and *Hypericum irazuense* (Hi) at the Conejos burn site.

a basal radiocarbon date of 4110 ± 90 years B.P. Microscopic and macroscopic charcoal fragments are abundant throughout the length of the core, attesting to a long history of fire in the surrounding watershed and adjacent areas of what is now Chirripó National Park. Fire is clearly not a disturbance factor introduced by modem human society; fires due to human activity or lightning have occurred for at least four thousand years.

STUDY SITE AND METHODS

Postfire vegetation regeneration was surveyed in February 1985, in a one hectare plot located within the broad glacial basin at the head of the Valle de los Conejos (Figs. 3,4,5). The site lies on a south-facing slope between roughly 3480 and 3500 m elevation, and last bumed during the 1976 fire. Ring counts on dead stems of *Vaccinium consanguineum* Klotzsch showed a maximum of 15 rings, suggesting that the site also bumed in the 1961 fire (Hom 1986b).

Cover data for the herb and shrub layers were collected separately using the line intercept method (Bauer 1943). Cover for bamboo and larger shrubs was measured along six randomly located, 100 m transects parallel to the fall of the slope. The cover of herbs and prostrate shrubs was measured along 20 m transects randomly located within five of the longer shrub transects.

Data on postfire shrub and bamboo recovery was collected in six belt transects 100 m long and 2 m wide, centered on the cover transects. Following methods adapted from Williamson *et al.* (1986), I classified all living and dead shrubs and bamboo > 40 cm high into one of three fire response categories: 1) "dead", for plants that had been killed by the fire; 2) "resprouter", for plants that had suffered crown loss but had subsequently resprouted from the base; and 3) "postfire colonist", for plants that showed no evidence of having bumed in the fire and that presumably had become established after the fire occurred. Dead plants were identified to species based on branching pattems and the color and texture of their bark and wood.

Each well-defined cluster of shrub stems was assumed to be a separate individual, except in cases where root connections were clearly evident.. Distinct clumps of bamboo were counted as single plants if they were separated by at least 75 cm of ground devoid of dead or live culms. These criteria may have overestimated the number of separate plants, since underground stems and roots can extend for several meters (Vaughan & Chaverri 1978). However, no other practical means existed to decide what constituted an individual.

The postfire height (highest leaf) of all resprouters and postfire colonists was measured to the nearest cm, and the prefire height of all resprouters and dead plants was estimated by measuring the highest dead stem. Cases in which the highest dead stems were obviously broken were recorded separately. For each shrub I recorded the number of living and/or dead stems present, and the diameter of the largest of each type. Live bamboo clumps were measured and classed by abundance (< 50, 50-100, >). Shrubs were measured in all six transects, but bamboo clumps were only measured in the first three.

Associations between plant species and fire response were tested using Chi-square contingency analysis (Noether 1976), and associations between prefire plant

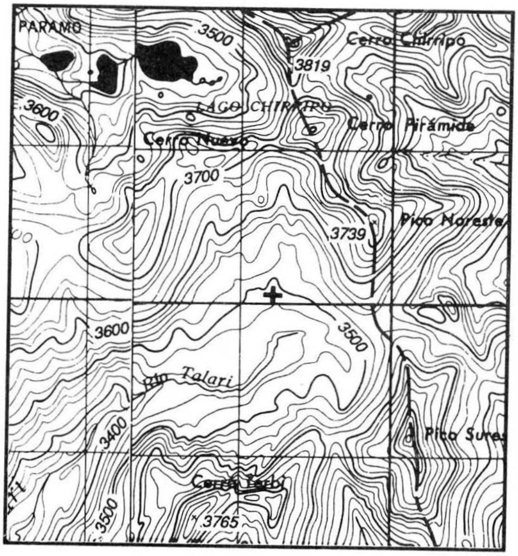

Fig. 3. Topographic map of the upper part of the Valle de los Conejos, with location of study site. Contour elevations in meters. From the 1:50,000 series topographic maps published by the Instituto Geográfico Nacional.

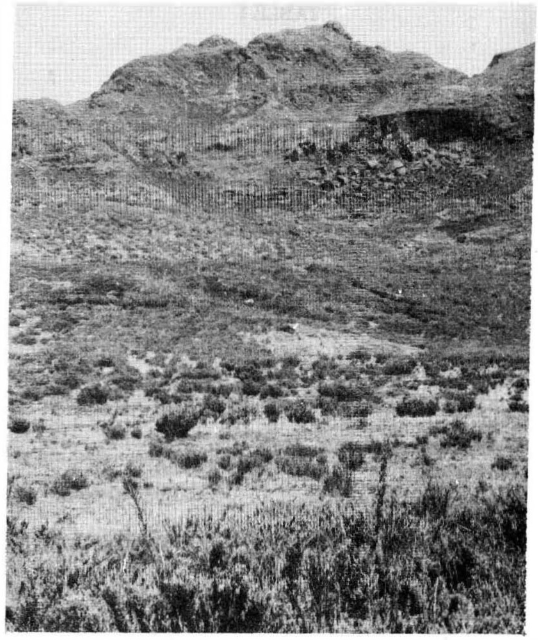

Fig. 4. General view of the Valle de los Conejos. The Conejos study site is visible in the background on the left side of the photograph. Above and to the right of the site is the peak of Cerro Pirámide (3807 m). The photograph was taken in February, 1985.

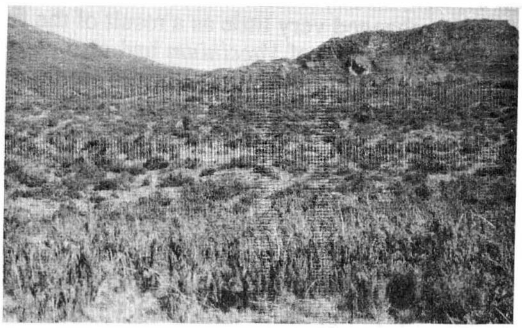

Fig. 5. The Conejos study site in February, 1985. The dominant woody species within the study site, as throughout the Valle de los Conejos, is the bamboo *Swallenochloa subtessellata*. The photograph was taken in February, 1985.

stature and fire response were tested using a median test (Sachs 1984). Voucher specimens were deposited at the herbaria of the Museo Nacional de Costa Rica, the University of California at Berkeley, the University of Wisconsin at Madison, and the Iowa State University (grasses only).

RESULTS

At the time of the vegetation survey, the Conejos site supported a discontinuous shrub canopy (total cover 34%) dominated almost entirely by the bamboo *Swallenochloa subtessellata* (Table 1). The ericaceous shrubs *Vaccinium consanguineum* Klotzsch and *Pernettia coriacea* Klotzsch each covered about 1% of the study area. Rarer shrub species, each accounting for less than 1% of the total cover, included *Garrya laurifolia* Hartweg ex Benth., *Hesperomeles heterophylla* (R. & P.) Hook., *Hypericum irazuense* Kuntze, *Hypericum strictum* HBK, and *Mahonia volcania* Standl. & Steyerm.

The herbaceous cover at the site was dominated by grasses and sedges (Table 1). Sprawling clumps of the grass *Muhlenbergia flabellata* Mez. accounted for more than half of the total herbaceous cover of 59%. Also important were an unidentified species of *Carex* (possibly *Carex donnell-smithii* Bailey), the delicate tuft-forming grasses *Agrostis bacillata* Hack. and *A. tolucensis* HBK, and the large tussock grasses *Cortaderia haplotricha* (Pilger) Conert and *Calamagrostis pittieri* Hack. Dominant among herbaceous and low dicots at the site were the herbs *Valeriana prionophylla* Standl. and *Eryngium scaposum* Turcz., and the

TABLE 1

Cover Data for the Conejos site
Shrub Layer

Species	% Cover
Swallenochloa subtessellata	31.8
Vaccinium consanguineum	1.0
Pernettia coriacea	1.0
Other taxa (each < 1% cover)	1.0
Total cover, shrub layer (%) (overlap excluded)	33.8

Herb Layer

Species	% Cover
Muhlenbergia flabellata	32.5
Agrostis spp.	3.2
Carex sp.	13.1
Pernettia prostrata	4.5
Valeriana prionophylla	2.1
Eryngium scaposum	1.1
Other taxa (each < 1% cover)	2.7
Total cover, herb layer (%) (overlap excluded)	59.0

TABLE 2

Fire response by species, Conejos site
Only species with sample sizes > 20 are listed

	Dead	Resprouter	Postfire Colonist
Swallenochloa subtessellata	5	386	4
Vaccinium consanguineum	2	19	5
Hypericum irazuense	80	5	1

prostrate shrub, *Pernettia prostrata* (Cav.) Sleumer. Less common herbaceous and low plants included *Gnaphalium rhodarum* Blake; unidentified species of *Alchemilla, Sisyrinchium, Westoniella,* and grasses; the fern *Botrychium schaffneri;* and *Chorisodontium* and other mosses.

A total of 525 woody plants were surveyed in the six belt transects. Only 3% had become established since the 1976 fire. All plants that had been present at the time of the fire had suffered complete crown loss. Eighty-three percent had subsequently resprouted from the base, and 17% had died.

Woody species showed significant heterogeneity in fire response (Table 2; $x^2 = 463$, DF=4, p<.001). The frequency of basal resprouting was 99% for *Swallenochloa subtessellata* and 90% for *Vaccinium consanguineum,* but only 6% for *Hypericum irazuense.* Median tests revealed no significant associations between fire response and prefire stature.

The differing response to fire of the major woody species resulted in an increase in the relative importance of *Swallenochloa subtessellata* and *Vaccinium consanguineum* at the expense of *Hypericum irazuense* following the fire. The density of *Hypericum,* which had been the most common woody dicot prior to the fire, declined by 93% (Figure 2b). Very few *Hypericum* plants had colonized the site since the 1976 fire; only one postfire recruit over 40 cm tall was present in the transects, and smaller plants were rarely observed. Four of the 405 bamboo clumps tallied had become established since the fire, most likely via sprouting from preexisting rhizome systems. These postfire colonists about balanced the loss of plants in the fire, such that the absolute density of the bamboo changed very little as a result of the fire. Several shrubs of *Vaccinium* had also colonized the site after the burn, either as seedlings or as new sprouts from surviving rootstocks. These plants more than compensated for the loss of shrubs killed by the fire, resulting in a postfire increase in the density of *Vaccinium* at the site.

Before the fire, *Swallenochloa subtessellata* and *Hypericum irazuense* both averaged about one meter in height, and *Vaccinium consanguineum* averaged about 75 cm in height (Tables 3,4). In nine years of regeneration, *Swallenochloa* had regained 98% of its prefire height. Regenerating *Vaccinium* shrubs had regained 71% of their prefire height, and the rare shrubs of *Hypericum* that had resprouted had recovered 64% of their prefire height.

The highest postfire growth rates measured at the site were for two rare shrub species, *Garrya laurifolia* and *Mahonia volcania.* These shrubs had regenerated to mean heights of 169.5 cm (Median 160.5, sd=57.3, N=4) and 130.0 cm (Median 133, sd= 10.8 N=3) respectively, in nine years. These values represented a 120% recovery of prefire height for both species.

TABLE 3

Prefire and postfire heights and stem diameters of resprouting shrubs and bamboo, Conejos Site
Values listed are mean, (median), standard deviation, and sample size. Sample sizes for prefire heights are smaller than those for postfire heights because of the exclusion of broken dead stems from the calculations

	Height (cm)				Diameter of largest stem (cm)			
Species	Prefire		Postfire		Prefire		Postfire	
Swallenochloa subtessellata	104.6 39.3 N = 107	(100)	102.8 45.8 N = 187	(91)	no data		0.73 0.24 N = 186	(0.70)
Vaccinium consanguineum	107.1 51.9 N = 17	(102)	75.6 25.4 N = 18	(70.5)	3.01 1.33 N = 18	(2.9)	1.98 0.66 N = 18	(2.18)
Hypericum irazuense	143.0 43.8 N = 4	(136.5)	91.0 44.9 N = 4	(90)	2.06 0.96 N = 4	(2.03)	1.19 0.71 N = 4	(1.38)

TABLE 4

Stature of dead shrubs and bamboo and postfire colonists, Conejos Site.
Values listed are mean, (median), standard deviation, and sample size. Sample sizes for prefire heights are smaller than those for prefire diameters because of the exclusion of broken dead stems from the calculations

	Dead plants				Postfire colonists			
Species	Prefire height	(cm)	Prefire diam.	(cm)	Postfire height	(cm)	Postfire diam.	(cm)
Swallenochloa subtessellata	118.0 73.5 N = 2	(118)	no data		50 14.1 N = 2	(50)	0.45 0.07 N = 2	(0.45)
Vaccinium consanguineum	69.0 4.2 N = 2	(69)	2.13 0.04 N = 2	(2.13)	48.2 10.3 N = 5	(42)	0.92 0.41 N = 5	(0.7)
Hypericum irazuense	114.6 33.5 N = 73	(118)	1.58 0.63 N = 77	(1.4)	59 - N = 1		.65 - N = 1	

DISCUSSION

The results of the field survey confirm the slow rates of biomass recovery and litter breakdown documented by Janzen (1973), Williamson *et al.* (1986) and Horn (1989b) following recent fires in the Buenavista páramo of Costa Rica. Nine years after the 1976 fire, the study site and many other areas within the Chirripó páramo gave the appearance of having burned only a few years earlier. Fresh-looking charcoal fragments were abundant on the soil surface, and woody stems killed in the last fire were intact and often still standing.

Patterns of postfire regeneration were similar to those documented at burn sites in the Buenavista highlands. The vigorous resprouting of the bamboo *Swallenochloa subtessellata* and the ericaceous shrub *Vaccinium consanguineum* is in keeping with the results of Janzen (1973) and Horn (1989b). Postfire growth rates at the Conejos site confirm

Janzen's (1983) observations that the bamboo shows one of the fastest rates of regrowth in the páramo vegetation and that height recovery of burned plants requires about 8-10 years.

The high fire-induced mortality of *Hypericum irazuense* at the Conejos site and in many other areas of the Chirripó páramo stands in marked contrast to the situation at Cerro Asunción in the Buenavista highlands, where Janzen (1973) noted abundant suckering by *Hypericum irazuense* three years after burning. However, studies by Williamson *et al.* (1986) and Horn (1989b) at other sites in the Buenavista páramo have revealed low (4-14%) rates of basal resprouting by this species. Whether the higher resprout success of *Hypericum irazuense* at the Asunción site as compared to that at other sites in the Chirripó and Buenavista páramos was related to burn conditions (fire intensity, depth of penetration, soil moisture levels during and after the fire), or to variations in fire hardiness among different *Hypericum* populations is unknown.

At the Conejos site little *Hypericum* recruitment was apparent during the 1985 survey, or in January of 1989 when I revisited the site. This finding conflicts with the results of regeneration surveys in the Buenavista páramo, where burn sites nine or more years old support high densities of *Hypericum irazuense* seedlings (Williamson *et al.* 1986, Horn 1989b). I suspect that the absence of appreciable *Hypericum* recruitment at the Conejos site reflects low seed influx arising from the very large size of the 1976 Chirripó fire and the shortage of flowering plants to reseed the burn area. Inhospitable conditions for seedling establishment, or high rates of seed or seedling mortality, may also contribute.

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RESUMEN

En Marzo de 1976, un incendio de grandes proporciones quemó el páramo dominado por bambú y arbustos del Parque Nacional Chirripó. Las prediciones de daños irreversibles que se hicieron cuando el fuego tuvo lugar no parecen haberse cumplido. Un estudio realizado en 1985 reveló que la vegetación se recupera, aunque muy lentamente. La composición del páramo ha cambiado, porque las diferentes especies leñosas respondieron diferentemente al fuego. Es notable un aumento en la importancia relativa del bambú *Swallenochloa subtessellata* y el arbusto *Vaccinium consanguineum* a costa del arbusto *Hypericum irazuense*. Después de nueve años de regeneración, *Swallenochloa subtessellata* había recuperado su estatura original promedio, pero todavía se observaron areas sin cubierta de vegetación en el sitio de estudio. Evidencias históricas y fósiles revelan que el incendio de 1976 fue sólo uno más en una larga serie de este tipo de eventos en el macizo de Chirripó.

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