MT. PINATUBO: A CASE OF MASS EXTINCTION OF PLANT SPECIES IN THE PHILIPPINES

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ABSTRACT. The eruption of Mt. Pinatubo in Zambales in July 1991 caused serious damage to the vegetation of that mountain and its vicinity. It is feared that several of the more than 60 endemic species recorded in this area have succumbed to the intense heat, ash fall, and lava flow that accompanied the eruption. A detailed floristic inventory of the mountain in the near future will give information on what plants survived and recovered.

INTRODUCTION

Until July 1991, Mt. Pinatubo was a tropical paradise covered with a verdant and luxurious primary forest from the lowland, evergreen rainforest on the lower slopes of the mountain to the montane (mossy) type of forest at elevations above 1,000 m. Not only was the biota teeming with plant species but many of these species were endemic. Elmer (1933) gave a sharp picture of the prevailing vegetation during a botanical survey in 1927:

> "Mt. Pinatubo with the other mountain masses, are (*sic*) awe-inspiring, and challenge (*sic*) any mountaineer. All in all it is (*sic*) a fine alpine spot very similar in places to the country about Baguio. But here there are no pine trees nor Benguet lilies....
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> An easy way for a plant collector is to follow the wooded margins from the meadows or open grasslands. Among this rich marginal vegetation I collected the only "ash" species (*Fraxinus griffithii* Clarke) known from the Philippines, besides a couple of shrubby trees of the "huckle-berry" genus (*Vaccinium benguetense* Vid. and *Vaccinium igorotorum* H.F. Copel.). Several species of wild figs were found, among which one or two were of the strangling kind (*Ficus chrysolepis* Miq. and *Ficus perfulva* Elm.) Along the river which flows by the camping place, half a mile below it, are many interesting plants. Scattered in the shrubby wooded sides were the purplish to pink "mountain-rose" (*Carionia elegans* Naud.), and in the flats, *Saurauia elegans* (Choisy) F. Vill. was very common in the sand gravelly soil, ranging in size from 6 inches to 20 feet high trees (*sic*), all bearing a profusion of flowers; even the small unbranched plants bore flowers. In the elfin woods of the summit region, the pure white panicles of *Ligustrum glabrinerve* Elm. were seen everywhere as plume-like masses. Here also the *Medinilla whitfordii* Merr. was in its floristic splendor. In this chaparral formation, upon exposed ridges, was noticed the small leaved and blood red short tubular flowered *Rhododendron marivelesense* H.F. Copel. Over all the

moss-laden limbs and reclining stems were dense clusters of the golden flowered orchid, *Acoridium curranii* Ames. Another orchid, rare but far more showy and gorgeous in coloration, was *Dendrobium victoriae-reginae* Loher. In its native place, among the somber moss-covered trees and shrubs of wet sheltered ravines, its flowers present a most beautiful and delicate contrast. On the eastern very steep slope below Mt. Pinatubo the whole mountain flank was covered with a pure stand of the large circular-leaved, rank and herbaceous *Halorrhagis micrantha* (Thbg.). Upon raised benches of wide river flats and over which the winds have a free sweep, masses of different kinds of orchids were found, also clumps of sphagnum mosses, and various lot scale-mosses. In the drier stony flats of the river, a brittle ashy lichen densely covered the surface everywhere. *Nepenthes alata* Blco., a pitcher plant, was also growing in this same general region in great masses. In size, this species would vary from a few inches to rambling and finally shrub and tree climbing. The old stems are pliable and about as thick as a man's finger. Only the older plants bear flowers and fruits. The little plants bore thimble-sized pitchers, while those on the mature plants were nearly a foot long. After a rain, these pitchers are full of water, and when collecting in shrubby jungles where they are, the pitchers get tilted and spill their contents upon the collector. No matter how carefully a person tries to walk about in the early mornings among them with dry stockings on one's feet, the younger pitchers lying about on the ground would get turned over and manage here and there to pour their cold water contents upon and over the tops of one's shoes. In the woods of damp fertile soil one walks over *Selaginellas* shoe- or knee-deep. When one penetrates further in, into sheltered ravines and cuts where the sun seldom shines, and that only for a short duration, or in other humid flats, a collector encounters a mass of varied vegetation -- a tree canopy with vines and lianas, high and low shrubs, and different kinds of herbs. In these clammy pockets where one wonders why the ground vegetation never mildews, the observer usually finds plenty of ferns and their allies."

An ethnobotanical study of the Negritoes living on the skirts of Mt. Pinatubo (Fox, 1950) revealed the wealth of plants on this 'holy mountain' and how the indigenous people utilized the plants around them for food, shelter, clothing, medicine, and also social and religious purposes.

As mentioned earlier, in the hinterlands of Mt. Pinatubo may be found several of the most attractive wild orchids in the Philippines. These epiphytic orchids possess large and attractively-colored flowers highly prized in the local and international orchid trade. Merrill (1923-1926) listed 21 species and two varieties of plants endemic to the Zambales mountain range, which includes Mt. Pinatubo. Elmer (1934), on the other hand, described 39 endemic species from Mt. Pinatubo. Using these two sources together, the number of plant species endemic to Mt. Pinatubo or to the Zambales mountain range, including Mt. Pinatubo, totals 61 (Table 1). Indeed, Mt. Pinatubo stands out as one of the centers of endemism for flowering plants in the country. The size and height (1,780 meters above sea level) of the mountain are factors that must have allowed for the development of various types of vegetation from the lowland primary rainforest at the base of the mountain to the montane at the summit. The rugged topography as well as the various soil types and underlying rocks on the mountain slopes also create micro habitats that allow faster

speciation. Table 1 lists the species of plants found on Mt. Pinatubo and adjoining mountains based on Merrill's (1923-1926) and Elmer's (1933, 1943) works. The list is, however, not complete for it is most likely that a number of species still remain undiscovered in the forests.

Prior to its eruption in June 1991, Mt. Pinatubo was one of the richest botanical areas in Luzon, and in the entire country for that matter. Such condition is no longer true. It is feared that the devastation caused by the eruption has caused an irreversible catastrophe to biological diversity of the area. It is very likely that scores of endemic plants and animals inhabiting the mountain were decimated during and after the eruption. This apt to happen since endemic plants are usually delicate organisms that easily succumb even to slight environmental change. It is difficult to imagine how even the most sturdy and resilient plants living on the skirts of the mountain could withstand continuous heavy ash fall, mudflows, and prolonged exposure to extremely hot temperatures. The real damage, however, cannot be ascertained until an intensive botanical survey is made when the volcano has ceased to be active.

The case of Mt. Pinatubo has brought to light the impact of volcanic eruption on the extinction of plant and animal species. It is now clear that onslaught of this natural phenomenon can be as lethal as "kaingin," large-scale illegal logging, and charcoal-making to primary forests in our country. However, unlike illegal logging, "kaingin," and other man-made activities, which could be contained, minimized, or even-stopped through man's will, there is no way that species could be saved from extinction caused by natural phenomenon, here exemplified by the eruption of Mt. Pinatubo.

As a point of comparison, a similar tragedy struck Volcano Island, situated at the center of Taal Lake. In 1911, the volcano violently erupted, completely destroying the vegetation over most part of the island (Brown, Merrill and Yates, 1917; Yates, 1914). But unlike Mt. Pinatubo, where there was still considerable forest cover over most of the mountain, the vegetation of Volcano Island prior to its eruption in 1911 was depauperate and consisted mostly of "a mixture of grass and small trees, which covered all parts of the island except the slopes of the main crater and Mount Tabaro and the dry stream beds" (Brown, Merrill and Yates, 1917).

A study of the revegetation of the island 6 years after its eruption showed that a single species, *Saccharum spontaneum* L., was very prominent in colonizing the barren land. According to Brown, Merrill, and Yates (1917) the revegetation of Volcano Island proceeded very slowly owing, probably, to adverse environmental conditions, the most prominent of which were the presence of excessive amounts of sulphates in the soil, the lack of weathering of the soil particles, the scarcity or ab-

sence of humus, the scarcity of nitrogen, the low water-holding capacity of the soil, and erosion.

About 292 species of plants were found on Volcano Island six years since offer eruption in 1911, and very few of the species, except *Saccharum spontaneum*, had found favorable habitats over any considerable area on the island. The investigators theorized that birds were responsible for bringing various species to Volcano Island," as 54 percent of the total (species) on the island could have been carried to it by this means", (Brown, Merrill, and Yates, 1914). Fifty-six years after the eruption of Taal Volcano, J.V. Pancho (1967) published a floristic account of Volcano Island, showing how diverse the flora on the Volcano Island had become.

From this account of the revegetation of Volcano Island, one could perhaps project these vegetation of Mt. Pinatubo fifty years from now. However, the conditions on Volcano Island are quite different from Mt. Pinatubo: 1) the original vegetation in Volcano Island was a mixture of grass and small trees, while that of Mt. Pinatubo was forest on most of its slopes; 2) apparently there were no endemic species on Volcano Island before its eruption in 1911, while Mt. Pinatubo had many endemic species; 3) Volcano Island is an "isolated land mass," while Mt. Pinatubo has contiguous mountains. Thus, the process of revegetation or the colonizing of pioneer species may be quite different in these two situations.

A detailed ecological and floristic study of Mt. Pinatubo over a given period of time would give important information necessary in understanding the complex processes involved in "bringing back to life" this once tropical paradise.

This tragedy leads us to consider urgent and effective measures to conserve and preserve the remaining diverse species of flora and fauna of our country. The stake in terms of biodiversity is so high that concerted and effective measures must be drawn and immediately implemented to ensure the safety of these endangered biota. There are several options open for consideration. Priority must be focused on highly critical but biologically-rich volcanic mountains such as Mt. Canlaon in Negros, Mt. Irosin in Sorsogon, Mt. Apo in Davao, Mt. Mayon in Albay, Mt. Guiting-guiting on Sibuyan Island, Mt. Kitanglad in Bukidnon, and Mt. Halcon in Mindoro. Some of these mountains, (e.g., Mt. Mayon) have erupted mildly or have shown signs of activity at one time or another; other mountains dormant at present may become active in the future, as these are all of volcanic origin.

As conservation *in-situ*, seems not to be the practical measure here, *ex-situ* conservation through botanic gardens, arboreta, and gene banks should be considered. This is a more practical way of saving endangered plant species found on volcanic mountains since it is difficult to predict when a dormant volcano will sud-

denly become active and bring havoc to human life and to the plants and animals found there. In the case of Mt. Pinatubo a wealth of its rare and endemic plant species may have been saved if these were represented in botanic gardens or arboreta. Unfortunately, many of them must be extinct by now. Who knows if these now-extinct plants may have had the cure for cancer, AIDS, or other deadly diseases, or may have been species that could have been used to improve the quality of food plants and other economic plants. To think too, that these species succumbed so quickly, i.e., in a matter of days or probably weeks, compared to the normal rate of dying out of species, estimated to take thousand of years (Myers, 1983).

Those who cannot fully comprehend the meaning and importance of biodiversity, may not be alarmed at the demise of many rare plant and animal species brought about by Mt. Pinatubo's eruption. This is perhaps the appropriate time to arouse their interest and sentiment The plant species lost on Mt. Pinatubo will not come back to life again. Shall we let other species suffer the same fate?

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Table 1. List of endemic plants in Mt. Pinatubo and nearby mountains in Zambales

Species	Habitat	Source
Family Acanthaceae		
1. ***Hypoestes confertiflora*** Merr.	open places at low altitude	Merrill, 1923-26
Family Anacardiaceae		
2. ***Semecarpus thyrsoidea*** Elm.	wooded depression at 1,219m	Elmer, 1934
Family Annonaceae		
3. ***Artabotrys monogynus*** Merr.	forest at low altitude	Merrill, 1923-26
Family Apocynaceae		
4. ***Parsonsia oblancifolia*** Merr.	thickets and secondary forest at low altitude	Merrill, 1923-26
Family Asclepiadaceae		
5. ***Tylophora hybostemma*** Warb.		
Family Campanulaceae		
6. ***Lobelia nicotianaefolia*** Elm. var. ***mollis*** Elm.	wet ground covered with grasses and low shrubs on thicketed inclines of dense woods at 1,066m altitude	Elmer, 1934
Family Caprifoliaceae		
7. ***Viburnum zambalense*** Elm.	fringe of woods bordering open grasslands at 1,219m elevation	Elmer, 1934
Family Clethraceae		
8. ***Clethra castaneus*** Elm.	in summit shrubberies at nearly 1,828m	Elmer, 1934
Family Commelinaceae		
9. ***Commelina luzonensis*** Elm.	open places in moist ravines of dense wood at 1,066m altitude	Elmer, 1934
Family Elaeocarpaceae		
10. ***Elaeocarpus zambalensis*** Elm.	mixed wood with shrubs in moist depression, 1,219m altitude	Elmer, 1934
Family Euphorbiaceae		
11. ***Gelonium pinatubense*** Elm.	small wooded flat near loghouse 1,219m altitude	Elmer, 1934
12. ***Codiaeum trichocalyx*** Merr.	forest at low altitude	Merrill, 1923-26
13. ***Glochidion longistylum*** C.B. Rob.	forest at low altitude	Merrill, 1923-26
14. ***Phyllanthus cordatulus*** C.B. Rob.	forest at low altitude	Merrill, 1923-26
Family Fagaceae		
15. ***Lithocarpus castellarnauianus*** (Vid.) *A. Camus*= (***Quercus pinatubensis*** Elm.)	heavy or dense woods of moist deep ravine at 1,066m altitude	Elmer, 1934
Family Flacourtiaceae		
16. ***Casearia luteocarpa*** Elm.	humid wooded flats at 1,066m altitude	Elmer, 1934
17. ***Hypericum lackeyi*** Elm.	stony ground of wooded plants near the river or in rock crevices of river beds at 998m above sea level	Elmer, 1934

Table 1. continued

Species	Habitat	Source
Family **Gesneriaceae**		
18. ***Cyrtandra pinatubensis*** Elm.	wet gravelly ground along stream beds of dark, densely wooded gulches at 1,066m altitude	Elmer, 1934
19. ***Cyrtandra quisumbingii*** Elm.	dry humus covered ground of wooded bluffs at 1,219m above sea level	Elmer, 1934
20. ***Cyrtandra quisumbingii*** Elm. var ***minor*** Elm.	narrow ravines or deep cuts of the peak region at 1,828m elevation	Elmer, 1934
Family **Juglandaceae**		
21. ***Engelhardtia permicrophylla*** Elm.	among chaparral formation of the peak region at 1,828m elevation	Elmer, 1934
22. ***Engelhardtia zambalensis*** Elm.	in dense woods mixed with shrubs in dry stony ground of depressions bordering grasslands and along river at 1,219m	Elmer, 1934
Family **Labiatae/Lamiaceae**		
23. ***Pogostemon williamsii*** Elm.	gravelly ground in rock crevices near river at 1,066m elevation	Elmer, 1934
Family **Leguminosae/Fabaceae**		
24. ***Milletia canariifolia*** Merr.	thickets or secondary forest at low altitude	Merrill, 1923-24
25. ***Dalbergia pinatubensis*** Elm.	jungles along dry deep creek cut of open grasslands at 990m	Elmer, 1934
26. ***Derris zambalensis*** Elm.	dense jungles of dry woods or thickets along creek bed at 1,066m elevation	Elmer, 1934
Family **Melastomataceae**		
27. ***Astronia pulchra*** Vid. var. ***obovata*** Merr.	mossy forest on Mt. Tapullo, 1,500m	Merrill, 1923-24
28. ***Astronia zambalensis*** Elm.	densely wooded jungle among grasslands near ridge of the mountain chain 1,219m elevation	Elmer, 1934
29. ***Medinilla negrito*** Elm.	very densely and deeply wooded, wet stony soil along streamlet with series of small waterfalls at 1,219m	Elmer, 1934
30. ***Melastoma pinatubense*** Elm.	scrub thickets near summit of the mountain at 1,752m elevation	Elmer, 1934
Family **Meliaceae**		
31. ***Aphanamixis pinatubensis*** Elm.	damp woods among other shrubs and low trees at 1,219m altitude	Elmer, 1934
Family **Moraceae**		
32. ***Ficus zambalenses*** Elm.	in damp dense woods at 1,143m	Elmer, 1934
Family **Myrsinaceae**		
33. ***Ardisia zambalensis*** Merr.	exposed ridges altitude 1,000-1,400m	Merrill, 1923-24

Table 1. continued

Species	Habitat	Source
Family **Myrtaceae**		
34. ***Syzygium squamiferum*** (C.B. Rob.) Merr.	forest, altitude about 700m	Merrill, 1923-26
35. ***Syzygium subfalcatum*** (C.B. Rob.) Merr.	slopes along streams at low medium altitude	Merrill, 1923-26
Family **Oleaceae**		
36. ***Ligustrum glabrinervae*** Elm.	alpine chaparral formation of the summit region at 1,828m altitude	Elmer, 1934
Family **Orchidaceae**		
37. ***Bulbophyllum zambalense*** Ames	collected at 1,700 m altitude	
38. ***Dendrochilum foxworthyi*** Ames	Mt. Pinatubo, altitude 1,800m	Merrill, 1923-26
39. ***Phaius ramosii*** Ames	exact location in Zambales unknown.	
40. ***Renanthera monachica*** Ames	open grassland at about 100m altitude	
41. ***Tuberalabium sarchochiloides*** (Schltr.) Garay	exact location in Zambales unknown.	
42. ***Vanda boxalii*** Reichb. f.	in Mt. Pinatubo and other parts of Zambales mountain range.	Merrill, 1923-26
Family **Palmae/Arecaceae**		
43. ***Calamus dimorphacanthus*** Becc. var. ***zambalensis*** Becc.	mossy forest on exposed ridge, altitude 2,000m	Merrill, 1923-26
Family **Rosaceae**		
44. ***Rubus zambalensis*** Elm.	mossy forest on Mt. Tapulao, 2,000m	Elmer, 1934
Family **Rubiaceae**		
45. ***Neonauclea monocephala*** Merr.	in forest at low altitude	Merrill, 1923-26
46. ***Lasianthus zambalensis*** Elm.	among scrub vegetation upon a ledge of stream at 1,219m	Elmer, 1934
47. ***Mussaenda pinatubensis*** Elm.	hot and dry river embankments at 1,066m altitude more or less	Elmer, 1934
48. ***Ophiorrhiza bicolor*** Elm.	wet humus covered ground along shaded stream beds	Elmer, 1934
49. ***Ophiorrhiza zambalensis*** Elm.	wet humus covered ground along shaded stream bed at 1,219m above sea level	Elmer, 1934
50. ***Rubia philippinensis*** Elm.	thickets of moist ledges along river at 1,066m elevation	Elmer, 1934
51. ***Williamsia viridescens*** Elm.	in deeply cut densely wooded ravine and upon steep wooded ledges at 1,066m	Elmer, 1934
Family **Rutaceae**		
52. ***Evodia zambalensis*** Elm.	wooded fringes along the meadows at 1,219m elevation	Elmer, 1934

Table 1. continued

Species	Habitat	Source
Family **Staphyleaceae**		
53. ***Turpinia sambucifolia***	in light woods of open grass regions along horse trail at about 914m altitude	Elmer, 1934
Family **Scrophulariaceae**		
54. ***Staurogyne neesii*** (Vid.) C.B. Clarke ex Merr.	along streams at low altitude	Merrill, 1923-26
Family **Symplocaceae**		
55. ***Symplocos purpurascens*** Brand.	ridge forest, altitude about 1,300m	Merrill, 1923-26
Family **Ulmaceae**		
56. ***Trema philippinensis*** Elm.	dry and warm creek banks of open places at 1,219m altitude	Elmer, 1934
Family **Urticaceae**		
57. ***Elatostema brunneolum*** Elm.	wet humus covered stream banks of densely shaded woods at 1143m elevation, more or less	Elmer, 1934
58. ***Pipturus subalpinus*** Elm.	very wet and densely wooded ravines at 1,066m elevations	Elmer, 1934
Family **Verbenaceae**		
59. ***Callicarpa magna*** Elm. var. ***lilacena*** Elm.	in dense very damp wooded flat at about 1,219m elevation	Elmer, 1934
60. ***Clerodendrum philippinense*** Elm.	humid woods at 914m above sea level	Elmer, 1934
Family **Zingiberaceae**		
61. ***Alpinia pinatubensis*** Elm.	locality undetermined	