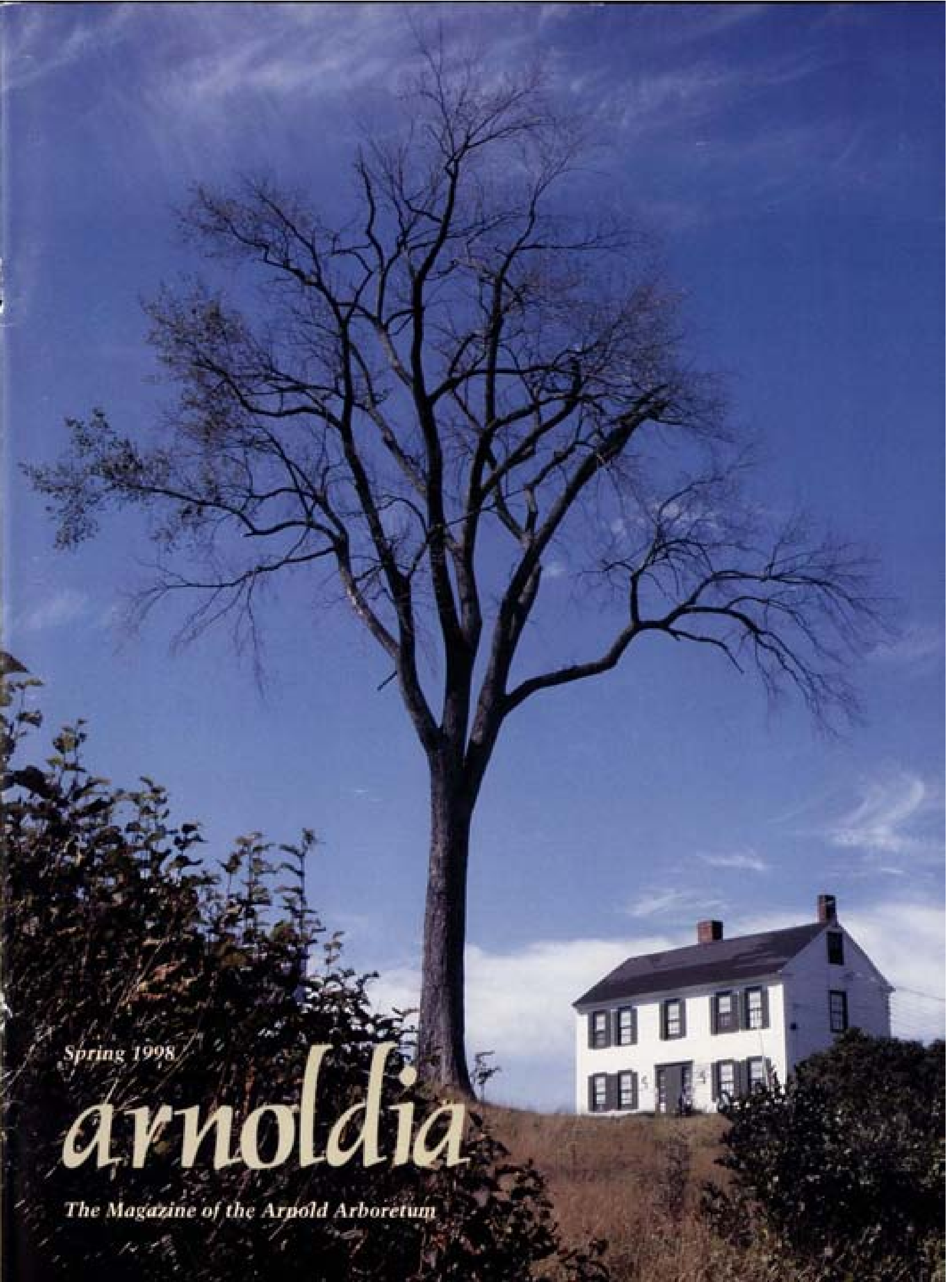
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Karen Madsen, *Editor*
Andy Winther, *Designer*

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Cover: For much of this century, a house and an American elm comprised the basic domestic landscape of eastern North America. Photograph by Peter Del Tredici.

Inside front cover: *Livistonia saribus*, the Livistone palm, named by E. D. Merrill, bears unusual bright-blue fruits Photograph from the Archives of the Fairchild Tropical Garden

Inside back cover: An American elm of classic, vase-shaped form photographed in the Montreal Botanic Garden by Peter Del Tredici.

Back cover: Elmer Drew Merrill, later Director of the Arnold Arboretum, in a detail of a 1902 photograph seen on page 12.

Erratum: In our last issue, Winter 1997-1998, volume 57, number 4, two numbers were inverted in the Arnold Arboretum Weather Station Data—1997. Last spring's last frost was a low of 29° on April 16.

PETER DEL TREDICI

An Evolutionary Perspective on Strengths, Fallacies, and Confusions in the Concept of Native Plants

Stephen Jay Gould

An important, but widely unappreciated, concept in evolutionary biology draws a clear and careful distinction between the historical origin and current utility of organic features. Feathers, for example, could not have originated for flight because five percent of a wing in the early intermediary stages between small running dinosaurs and birds could not have served any aerodynamic function (though feathers, derived from reptilian scales, provide important thermodynamic benefits right away). But feathers were later co-opted to keep birds aloft in a most exemplary fashion. In like manner, our large brains could not have evolved in order to permit modern descendants to read and write, though these much later functions now define an important part of modern utility.

Similarly, the later use of an argument, often in a context foreign or even opposite to the intent of originators, must be separated from the validity and purposes of initial formulations. Thus, for example, Darwin's theory of natural selection is not diminished because later racists and warmongers perverted the concept of a "struggle for existence" into a rationale for genocide. However, we must admit a crucial difference between the two cases: the origin and later use of a biological feature, and the origin and later use of an idea. The first case involves no conscious intent and cannot be submitted to any moral judgment. But ideas are developed by human beings for overt purposes, and we have some ethical responsibility for the consequences of our actions. An inventor may be fully exonerated for true perversions of his intent (Hitler's use of Darwin), but unfair extensions consistent with the logic of original purposes do entail some moral demerit (most academic racists of the nineteenth century did not envision or intend the Holocaust, but some of their ideas did fuel the "final solution").

I want to examine the concept of "native plants" within this framework, for this notion encompasses a remarkable mixture of sound biology, invalid ideas, false extensions, ethical implications, and political usages both intended and unanticipated. Clearly, Nazi ideologues provided the most chilling uses.[1] In advocating native plants along the *Reichsautobahnen*, Nazi architects of the Reich's motor highways explicitly compared their proposed restriction to Aryan purification of the people. By this procedure, Reinhold Tüxen hoped "to cleanse the German landscape of unharmonious foreign substance."[2] In 1942 a team of German botanists made the analogy explicit in calling for the extirpation of *Impatiens*

Grapevines (Vitus *sp.*) *in northeastern Connecticut. This native is a commonplace of second-growth forest where its weight causes serious damage to its host trees.*

parviflora, a supposed interloper: "As with the fight against Bolshevism, our entire Occidental culture is at stake, so with the fight against this Mongolian invader, an essential element of this culture, namely, the beauty of our home forest, is at stake."[3]

At the other extreme of kindly romanticism, gentle arguments for native plants have stressed their natural "rightness" in maximally harmonious integration of organism and environment, a modern invocation of the old doctrine of *genius loci.* Consider a few examples from our generation:

> Man makes mistakes; nature doesn't. Plants growing in their natural habitat look fit and therefore beautiful. In any undeveloped area you can find a miraculously appropriate assortment of plants, each one contributing to the overall appearance of a unified natural landscape. The balance is preserved by the ecological conditions of the place, and the introduction of an alien plant could destroy this balance.[4]

> Evolution has produced a harmony that contrived gardens defy.[5]

Or this from President Clinton himself (though I doubt that he wrote the text personally), in a 1994 memorandum on "environmentally and economically beneficial practices on federal landscaped grounds": "The use of native plants not only protects our natural heritage and provides wildlife habitat, but also can reduce fertilizer, pesticide, and irrigation demands and their associated costs because native plants are suited to the local environment and climate."[6]

This general argument, of course, has a long pedigree, as well illustrated in Jens Jensen's remark in *Our Native Landscape,* published in his 1939 *Siftings:* "It is often remarked, 'native plants are coarse.' How humiliating to hear an American speak so of plants with which the Great Master has decorated his land! To me no plant is more refined than that which belongs. There is no comparison between native plants and those imported from foreign shores which are, and shall always remain so, novelties."[7]

Yet the ease of transition between this benevolent version and dangerous *Volkist* nationalism may be discerned, and quite dramatically, in another statement from the same Jens Jensen, but this time published in a German magazine in 1937:

> The gardens that I created myself shall . . . be in harmony with their landscape environment and the racial characteristics of its inhabitants. They shall express the spirit of America and therefore shall be free of foreign character as far as possible. The Latin and the Oriental crept and creeps more and more over our land, coming from the South, which is settled by Latin people, and also from other centers of mixed masses of immigrants. The Germanic character of our cities and settlements was overgrown. . . . Latin spirit has spoiled a lot and still spoils things every day.[8]

How slippery the slope between *genius loci* (and respect for all the other spirits in their proper places as well) and "my *locus* is best, while others must be uprooted, either as threats or as unredeemable inferiors." How easy the fallacious transition between a biological argument and a political campaign.

When biologically based claims have such a range of political usages (however dubious, and however unfairly drawn some may be), it becomes particularly incumbent upon us to examine the scientific validity of the underlying arguments, if only to acquire weapons to guard against usages that properly inspire our ethical opposition (for if the biological bases are wrong, then we hold a direct weapon; and if they are right, then at least we understand the argument properly, and can accurately drive the wedge that always separates factual claims from ethical beliefs).

Any argument for preferring native plants must rest upon some construction of evolutionary theory—a difficult proposition (as we shall see) because evolution is so widely misconstrued and, when properly understood, so difficult to utilize for the defense of intrinsic native superiority. This difficulty did not exist in pre-Darwinian creationist biology, because the old paradigm of "natural theology" held that God displays both his existence and his attributes of benevolence and omniscience in the optimal design of organic form and the maximal harmony of local ecosystems (see William Paley for the classic statement in one of the most influential books ever written).[9] Native must therefore

Cortaderia jubata *(sawgrass), weedy South American cousin of the garden-variety pampas grass, has invaded the hills of north-coastal California.*

be right and best because God made each creature for its proper place.

But evolutionary theory fractured this equation of existence with optimality by introducing the revolutionary idea that all anatomies and interactions arise as transient products of complex history, not as created optimalities. Evolutionary defenses of native plants rest upon two quite distinct aspects of the revolutionary paradigm that Darwin introduced. (I shall argue that neither provides an unambiguous rationale, and that many defenders of native plants have mixed up these two distinct arguments, therefore rendering their defense incoherent.)

The Functional Argument Based on Adaptation

Popular impression regards Darwin's principle of natural selection as an optimizing force, leading to the same end of local perfection that God had supplied directly in older views of natural theology. If natural selection works for the best forms and most balanced interactions that could possibly exist in any one spot, then native must be best for native has been honed to optimality in the refiner's fire of Darwinian competition. (In critiquing horticulturists for this misuse of natural selection, I am not singling out any group for an unusual or particularly naive misinterpretation. This misreading of natural selection is pervasive in our culture, and also records a primary fallacy of much professional thinking as well.[10])

In *Siftings*, Jens Jensen expressed this common viewpoint with particular force:

> There are trees that belong to low grounds and those that have adapted themselves to highlands. They always thrive best amid the conditions they have chosen for themselves through many years of selection and elimination. They tell us that they love to grow here, and only here will they speak in their fullest measure.[11]
>
> I have often marvelled at the friendliness of certain plants for each other, which, through thousands of years of selection and elimination, have lived in harmonious relation.[12]

The incoherencies of this superficially attractive notion may be noted in the forthcoming admission, in a work of our own generation, that natural does not always mean lovely. Natural selection does not preferentially lead to plants that humans happen to regard as attractive. Nor do natural systems always yield rich associations of numerous, well-balanced species. Plants that we label "weeds" will dominate in many circumstances, however transiently (where "transient" can mean more than a human lifetime on the natural time scales of botanical succession). Such weeds are often no less "native"—in the sense of evolving indigenously—than plants of much more restricted habitat and geography. Moreover, weeds often form virtual monocultures, choking out more diverse assemblages than human intervention could maintain. C. A. Smyser et al. admit all this, but do not seem to grasp the logical threat thus entailed against an equation of "natural" with "right" or "preferable": "You may have heard of homeowners who simply stopped mowing or weeding and now call their landscapes "natural." The truth is that these so-called no-work, natural gardens will be long dominated by exotic weed species, most of which are pests and look downright ugly. Eventually, in 50 to 100 years, native plants will establish themselves and begin to create an attractive environment."[13] But not all "weed" species can be called "exotic" in the sense of being artificially imported from other geographic areas. Weeds can be indigenous too, though their geographic ranges tend to be large, and their means of natural transport well developed.

The evolutionary fallacy in equating native with best adapted may be simply stated by specifying the essence of natural selection as a causal principle. As Darwin recognized so clearly, natural selection produces adaptation to changing local environments—and that is all. The Darwinian mechanism includes no concept of general progress or universal betterment. The "struggle for existence" can only yield local appropriateness. Moreover, and even more important for debates about superiority of native plants, natural selection is only a "better than" principle, not an optimizing device. That is, natural selection can only transcend the local standard and cannot operate toward universal "improvement"—for once a species prevails over others at a location, no pressure of natural selection need arise to promote further adaptation. (Competition within species will continue to eliminate truly defective individuals and may promote some refinement by selection of fortuitous variants with still more advantageous traits, but the great majority of successful species are highly stable in form and behavior over long periods of geological time—not because they are optimal, but because they are locally prevalent.)

For this reason, many native plants, evolved by natural selection as adaptive to their regions, fare poorly against introduced species that never experienced the local habitat. If natural selection produced optimality, this most common situation could never arise, for native forms would be "best" and would prevail in any competition against intruders. But most Australian marsupials succumb to placentals imported from other continents, despite tens of millions of years of isolation, during which the Australian natives should have attained irreplaceable incumbency, if natural selection worked for optimality rather than merely getting by. And *Homo sapiens,* after arising in Africa, seems able to prevail in any exotic bit of real estate, almost anywhere in the world!

Thus the first-order rationale for preferring native plants—that, as locally evolved, they are best adapted—cannot be sustained. I strongly suspect that a large majority of well-adapted natives could be supplanted by some exotic form that has never experienced the immediate habitat. In Darwinian terms, this exotic would be better adapted than the native—though we may well, on defensible aesthetic or even ethical grounds, prefer the natives (for nature's factuality can never enjoin our moral decisions).

We may, I think, grant only one limited point from evolutionary biology on the subject of adaptation in native plants. At least we do know that well-established natives are adequately adapted, and we can observe their empirical balances with other local species. We cannot know what an exotic species will do—and many, and tragic, are the stories of exotics imported for a restricted and benevolent reason that then grew like kudzu to everyone's disgust and detriment. We also know that natives grow appropriately—though not necessarily optimally—in their environment, while exotics may not fit without massive human "reconstruction" of habitat, an intervention that many ecologically minded people deplore. I confess that nothing strikes me as so vulgar or inappropriate as a bright green lawn in front of a mansion in the Arizona desert, sucking up precious water that already must be imported from elsewhere. A preference for natives does foster humility and does counteract human arrogance (always a good thing to do)—for such preference does provide the only sure protection against our profound ignorance of consequences when we import exotics. But the standard argument—that natives should be preferred as best adapted—is simply false within Darwinian theory.

The Geographic Argument Based on Appropriate Place

This argument is harder to formulate, and less clearly linked to a Darwinian postulate, but somehow seems even more deeply embedded (as a fallacy) into the conventional argument for preferring native plants. This argument holds that plants occupy their natural geographic ranges for reasons of maximal appropriateness. Why, after all, would a plant live only in this-or-that region of 500 square kilometers unless this domain acted as its "natural" home—the place where it, uniquely, and no other species, fits best. Smyser et al., for example, write: "In any area there is always a type of vegetation that would exist without being planted or protected. This native vegetation consists of specific groups of plants that adapted to specific environmental conditions."[14] But the deepest principle of evolutionary biology—the construction of all current biological phenomena as outcomes of contingent history, rather than optimally manufactured situations—exposes this belief as nonsense.

Organisms do not necessarily, or even generally, inhabit the geographic area best suited to their attributes. Since organisms (and their areas of habitation) are products of a history laced with chaos, contingency, and genuine randomness, current patterns (although workable, or they would not exist) will rarely express anything close to an optimum, or even a "best possible on this earth now"—whereas the earlier notion of natural theology, with direct creation of best solutions, and no appreciable history thereafter (or ever), could have validated an idea of native as best. Consequently, although native plants must be adequate for their environments, evolutionary theory grants us no license for viewing them as the best-adapted inhabitants conceivable, or even as the best available among all species on the planet.

An enormous literature in evolutionary biology documents the various, and often peculiar, mechanisms whereby organisms achieve fortuitous transport as species spread to regions beyond their initial point of origin. Darwin himself took particular interest in this subject. During the 1850s, in the years just before publication of the *Origin of Species* in 1859, Darwin wrote several papers on the survival of seeds in salt water (how long would they float without sinking? would they still germinate after such a long bath?). He determined that many seeds could survive long enough to reach distant continents by floating across oceans—and that patterns of colonization therefore reflect historical accidents of available pathways, and not a set of optimal environments.

Darwin then studied a large range of "rarely efficient" means of transport beyond simple floating on the waves: for example, natural rafts of intertwined logs (often found floating in the ocean hundreds of miles from river mouths), mud caked on birds' feet, residence in the gut of birds with later passage in feces (Darwin and others studied, and often affirmed, the power of seeds to germinate after passage through an intestinal tract). In his usually thorough and obsessive way, Darwin assiduously collected information and found more than enough means of fortuitous transport. He wrote to a sailor who had been shipwrecked on Kerguelen Island to find out if he remembered any seeds or plants growing from driftwood on the beach. He asked an inhabitant of Hudson Bay if seeds might be carried on ice floes. He studied the contents of ducks' stomachs. He was delighted to receive in the mail a pair of partridges' feet

Eucalyptus globulus *is an important source of fuel and building material in the altiplano of South America, where in some cases it is the sole tree This native of Tasmania and Victoria selfsows and has naturalized throughout the area.*

caked with mud; he rooted through bird droppings. He even followed a suggestion of his eight-year-old son that they float a dead and well-fed bird. Darwin wrote in a letter that "a pigeon has floated for 30 days in salt water with seeds in crop and they have grown splendidly." In the end, Darwin found more than enough mechanisms to move his viable seeds.

"Natives," in short, are the species that happened to find their way (or evolve *in situ*), not the best conceivable for a spot. As with the first argument about adaptation, the proof that current incumbency as "native" does not imply superiority against potential competitors exists in abundance among hundreds of imported interlopers that have displaced natives throughout the world: eucalyptus in California, kudzu in the American southeast, rabbits and other placental mammals in Australia, and humans just about everywhere.

"Natives" are only those organisms that first happened to gain and keep a footing. We rightly decry the elitist and parochial claims of American northeast WASPs to the title of native, but (however "politically incorrect" the point), the fashionable status of "Indians" (so-called by Columbus' error) as "Native Americans" makes just as little sense in biological terms. "Native Americans" arrived in a geological yesterday, some 20,000 years ago (perhaps a bit earlier), on the geographic fortuity of a pathway across the Bering Strait. They were no more intrinsically suited to New World real estate than any other people. They just happened to arrive first.

In this context, the only conceivable rationale for the moral or practical superiority of "natives" (read first-comers) must lie in a romanticized notion that old inhabitants learn to live in ecological harmony with surroundings, while later interlopers tend to be exploiters. But this notion, however popular among "new agers," must be dismissed as romantic drivel. People are people, whatever their technological status; some learn to live harmoniously for their own good, and others do not to their own detriment or destruction. Preindustrial people have been just as rapacious (though not so quickly perhaps, for lack of tools) as the worst modern clear-cutters. The Maori people of New Zealand wiped out a rich fauna of some twenty moa species within a few hundred years. The "native" Polynesians of Easter Island wiped out everything edible or usable (and, in the end, had no logs to build boats or to raise their famous statues), and finally turned to self-destruction.

In summary of my entire argument from evolutionary theory, "native" plants cannot be deemed biologically best in any justifiable way (note that I am emphatically not speaking about ethical or aesthetic preference, for science cannot adjudicate these considerations). "Natives" are only the plants that happened to arrive first and be able to flourish (the evolutionary argument based on geography and history), while their capacity for flourishing only indicates a status as "better than" others available, not as optimal or globally "best suited" (the evolutionary argument based on adaptation and natural selection).

Speaking biologically, the only general defense that I can concoct for natives—and I regard this argument as no mean thing—lies in protection thus afforded against our overweening arrogance. At least we know what natives will do in an unchanged habitat, for they have generally been present for a long time and have therefore stabilized and adapted. We never know for sure what an imported interloper will do, and our consciously planted exotics have "escaped" to disastrous spread and extirpation of natives (the kudzu model) as often as they have supplied the intended horticultural or agricultural benefits.

As a final ethical point (and I raise this issue as a concerned human being, not as a scientist, for my profession can offer no direct moral insight), I do understand the appeal of the ethical argument that we should leave nature alone and preserve as much as we can of what existed and developed before our very recent geological appearance. Like all evolutionary biologists, I treasure nature's bounteous diversity of species (the thought of half a million described species of beetles—and many more yet undescribed—fills me with an awe that can only be called reverent). And I do understand that much of this variety lies in geographic diversity (different organisms evolved in similar habitats in many places on our planet, as a result of limits and accidents of access). I would certainly be horrified to watch the botanical equivalent of McDonalds' uniform architecture and cuisine wiping out every local diner in America. Cherishing native plants does allow us to defend and preserve a maximal amount of local variety.

But we must also acknowledge that strict "nativism" has an ethical downside inherent in the notion that "natural" must be right and best, for such an attitude easily slides to the Philistinism of denying any role to human intelligence and good taste, thence to the foolish romanticism of viewing all that humans might accomplish in nature as "bad" (and how then must we judge Frederick Law Olmsted's Central Park), and even (in an ugly perversion)—but realized in our time by Nazi invocation of nativist doctrine—to the claim that my "native" is best and yours only fit for extirpation.

The defense against all these misuses, from mild to virulent, lies in a profoundly humanistic notion as old as Plato, one that we often advance in sheepish apology but should rather honor and cherish: the idea that "art" must be defined as the caring, tasteful, and intelligent *modification* of nature for respectful human utility. If we can practice this art in partnership with nature, rather than by exploitation (and if we also set aside large areas for rigidly minimal disturbance, so that we never forget, and may continue to enjoy, what nature accomplished during nearly all of her history without us), then we may achieve optimal balance.

People of goodwill may differ on the best botanical way to capture the "spirit of democracy"—from one end of maximal "respect" for nature by using only her unadorned and locally indigenous ("native") products, to the other of maximal use of human intelligence and aesthetic feeling in sensitive and "respectful" mixing of natives and exotics, just as our human populations have so benefited from imported diversity. Jens Jensen extolled the first view: "When we are willing to give each plant a chance fully to develop its beauty, so as to give us all it possesses without any interference, then, and only then, shall we enjoy ideal landscapes made by man. Is not this the true spirit of democracy? Can a democrat cripple and misuse a plant for the sake of show and pretense?"[15]

But is all cultivation—hedgerows? topiary?—crippling and misuse? The loaded nature of ethical language lies exposed herein. Let us consider, in closing, another and opposite definition of democracy that certainly has the sanction of ancient usage. J. Wolschke-Bulmahn and G. Gröning cite a stirring and poignant argument made by Rudolf Borchardt, a Jew who later died trying to escape the Nazis, against the nativist doctrine as perverted by Nazi horticulturists: "If this kind of garden-owning barbarian became the rule, then neither a gillyflower nor a rosemary, neither a peach-tree nor a myrtle sapling nor a tea-rose would ever have crossed the Alps. Gardens connect people, times and latitudes. If these barbarians ruled, the great historic process of acclimatization would never have begun and today we would horticulturally still subsist on acorns. . . . The garden of humanity is a huge democracy."[16]

I cannot state a preference in this wide sweep of opinions, from pure hands-off romanticism to thorough overmanagement (though I trust that most of us would condemn both extremes). Absolute answers to such ethical and aesthetic questions do not exist in any case. But we will not achieve clarity on this issue if we advocate a knee-jerk equation of "native" with morally best, and fail to recognize the ethical power of a contrary view, supporting a sensitive cultivation of all plants, whatever their geographic origin, that can enhance nature and bring both delight and utility to humans. Is it more "democratic" only to respect organisms in their natural places (how, then, could any non-African human respect himself), or shall we persevere in the great experiment of harmonious and mutually reinforcing geographic proximity—as the prophet Isaiah sought in his wondrous vision of a place where the wolf might dwell with the lamb and such non-natives as the calf and the lion might feed together—where "they shall not hurt nor destroy in all my holy mountain."

Endnotes

1 J. Wolschke-Bulmahn and G. Groning, "The Ideology of the Nature Garden. Nationalistic Trends in Garden Design in Germany During the Early Twentieth Century," *Journal of Garden History* (1992) 12(1): 73–80; G. Gröning and J. Wolschke-Bulmahn, "Some Notes on the Mania for Native Plants in Germany," *Landscape Journal* (1992) 11(2): 116–126, J Wolschke-Bulmahn, "Political Landscapes and Technology: Nazi Germany and the Landscape Design of the *Reichsautobahnen* (Reich Motor Highways)," *Selected CELA Annual Conference Papers Nature and Technology*, Iowa State University, 9–12 September 1995, vol. 7.

2 Quoted in Wolschke-Bulmahn, "Political Landscapes," from a 1939 article.

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4 C. A. Smyser et al., *Nature's Design A Practical Guide to Natural Landscaping*, Emmaus, PA., 1982, xi.

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6 President William J. Clinton, *Memorandum for the Heads of Executive Departments and Agencies*, Office of the Press Secretary, 26 April 1994.

7 J. Jensen, *Siftings. The Major Portion of "The Clearing," and Collected Writings*, Chicago, 1956, 45.

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9 W. Paley, *Natural Theology*, London, 1802.

10 See S. J Gould and R. C. Lewontin, "The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme," *Proceedings of the Royal Society of London B* (1979) 205: 581–198; see S. J. Gould, "Exaptation: A Crucial Tool for an Evolutionary Psychology," *Journal of Social Issues* (1991) 47(3): 43–65.

11 Jensen, *Siftings*, 47.

12 Ibid., 59.

13 Smyser et al., *Nature's Design*, vii.

14 Ibid., xi.

15 Jensen, *Siftings*, 46.

16 Wolschke-Bulmahn and Gröning, "The Ideology of the Nature Garden," 80.

Stephen J. Gould is professor of geology at Harvard University, curator of invertebrate paleontology at the Museum of Comparative Zoology, and Alexander Agassiz Professor of Zoology. Among his books and articles on the history of evolution and related topics are *Ever Since Darwin* (1977), *The Panda's Thumb* (1980), *The Flamingo's Smile* (1985), *Wonderful Life* (1989), and *Eight Little Piggies* (1993). This article evolved from a paper presented at the 1994 Studies in Landscape Architecture symposium at Dumbarton Oaks—"Nature and Ideology: Natural Garden Design in the Twentieth Century"—and published in 1997 under the same title, edited by Joachim Wolschke-Bulmahn.

E. D. Merrill, From Maine to Manila

Ida Hay

Twenty-two years of adventure in Southeast Asia preceded E. D. Merrill's career as director of several important botanical institutions, among them the Arnold Arboretum. His knowledge of the flora of Asia and the South Pacific was encyclopedic, and it was said he could name more species at sight than any other American taxonomist.

When twenty-six-year-old Elmer Drew Merrill left New York harbor for Manila on February 22, 1902, he had no idea that he would remain in the Philippines for the next twenty-two years, laying the foundation for a botanical inventory of the archipelago. After accepting a job offer as botanist with the Insular Bureau of Agriculture, he had had less than forty-eight hours to arrange his affairs, pack, and get to the boat. This rough-and-ready approach, spawned of a rigorous childhood in rural Maine, was to characterize Merrill's remarkable life: this would not be the last time he made a major career change at the drop of a hat.

From 1935 to 1946, Merrill was director of the Arnold Arboretum and Administrator of Harvard University's Botanical Collections, which included the Botanic Garden, the Gray Herbarium, the Bussey Institution, the Botanical Museum, the Harvard Forest, the Atkins Institution, and the Farlow Reference Library and Herbarium. When he arrived at Harvard, he had already had sixteen years' experience managing organizations with diverse functions, in addition to an extraordinary record of scholarship and publication in taxonomic botany.

Merrill was born in 1876 in East Auburn, Maine, a village of farmers and shoe factory workers, one of twins. He described his progenitors as simple, hardworking folk who, nevertheless, possessed the "pioneer spirit." His maternal grandfather was a forty-niner who journeyed to California by way of Panama, returning to his wife and children in Maine without having found any gold. Merrill's father had run away to sea at age fourteen and worked as a common sailor until he married; he continued to sign on for extended fishing trips to the Grand Banks during E. D.'s youth. It was the work and the pleasures of rural life that shaped Merrill's character, as he recalled years later:

> Swimming, boating, fishing, hunting, tramping in the woods—many things were more appealing to us than work, but when there was work to be done it always came first."[1]

Yet even at an early age he often found time to collect natural history specimens and to press plants.

Unlike their three older siblings, Elmer and his twin, Dana, continued their education beyond the elementary grades, attending high school in Auburn, three miles distant from their home. In one of his more telling comments on his background, Merrill wrote:

> Many times in winter we walked the entire distance to the city in a howling blizzard only to find "no sessions" because of the inclement weather. We came to have a rather scornful opinion of city people, not blaming the children, but rather the authorities. At times we made the trip on snowshoes. . . . This school experience doubtless had its effect in establishing one quality—that of persistence, a quality to which I believe I owe most of the success as I attained in after life.[2]

After graduating, both young men entered the Maine State College at Orono, which became the University of Maine in 1898, the year they

LIBRARY OF THE ARNOLD ARBORETUM

Merrill, right, and E. B. Copeland, left, with Joseph French and, standing, Henry Osgood, in the bachelor's mess in Manila, ca. 1905. From the time he arrived in the Philippines until he received an appointment as Associate Professor of Botany in the University of the Philippines in 1912, Merrill spent at least half his time working in the field. E. B. Copeland, who joined the botanical staff of the Bureau of Science in 1903, was one of Merrill's traveling companions. In 1909, accompanied by a group of American schoolteachers, the two climbed to the summit of Mount Pulog in northern Luzon, the third known ascent of the mountain by Westerners

received their degrees. Although they enrolled as engineering students, they both transferred to the general science course after a surfeit of math classes during their first year. During his remaining undergraduate years, Elmer took as many biology courses as he could and studied the classification of flowering plants on his own since no formal training was offered. Like most New England botanists of his day, he tramped and botanized on New Hampshire's Mount Washington and likewise explored Mount Katahdin in northern Maine. He later gave his 2,000-specimen herbarium to the New England Botanical Club. He also traded a collection of his pressed plants dating from this period to Nathaniel Lord Britton for a copy of Britton and Brown's *Illustrated Flora of the Northern United States.* Though neither of them could have foreseen it, Merrill would one day succeed Britton as director of the New York Botanical Garden.

The outbreak of the Spanish-American War determined Dana Merrill's career choice. He enlisted in the Maine Volunteer Infantry, received his diploma *in absentia* that spring, and soon headed out to fight in the Philippines. He remained in the Army after the war and advanced through the ranks to brigadier general in 1935.

Elmer remained at Orono for a year after graduation. While he worked as an assistant in the Department of Natural Science, he took additional courses and continued to study systematic botany on his own. (In 1904, the University of Maine awarded him a master's degree for this work.) In 1899 he went to work in Washington at the U.S. Department of Agriculture (USDA) as an assistant agrostologist (a specialist in grasses, a family Merrill termed "particularly difficult"). He found the job rewarding and appreciated the opportunity to become more familiar with the literature of plant taxonomy, but he was still undecided about a career. With time on his hands evenings, he completed a year and a half of medical school. Then the offer of employment in the Philippines turned him permanently in the direction of plant science.

Among the many programs the U.S. government started in the Philippines after taking it over from the Spanish was an Insular Bureau of Agriculture, opened in 1901, the year before Merrill was persuaded by his boss at the USDA to accept the post of botanist there. He had expected to see his brother Dana when he arrived in Manila after the two-month voyage, but in the first of many ironies that would punctuate his life, he found that his twin had sailed for San Francisco two weeks earlier. It would be thirteen years before the two met again.

Merrill quickly applied his energies to the challenges of his new assignment. The previous two and a half years of work on the taxonomy of grasses had expanded his botanical purview from New England to Wyoming, Idaho, and Montana. Compared to that of the Western grasslands and Maine, however, the flora that he now confronted was exuberant and vastly complex. Undaunted, he immediately envisioned a complete survey of the Philippine archipelago, 7,000 tropical islands with extensive, mountainous, old-growth forest ringed by lowlands that had been cultivated for centuries.

Resources for studying this fascinating flora were almost nonexistent in Manila; any botanical specimens and literature that had been assembled during the long years of Spanish rule had either burned in the 1898 war or disappeared during the disruptive period of American takeover. Never one to hesitate, Merrill immediately started collecting weeds behind the vacant house that served as headquarters for the Bureau of Agriculture. And within a month he had left on his first collecting expedition, a six-week trek through the mountains of Luzon to Aparri on the north coast. For the next eleven years he would spend nearly half his time in the field.

Government officials in Manila quickly recognized Merrill's abilities and gave him an additional appointment to the Bureau of Forestry, thereby consolidating botanical research. In 1903 all botanical work was transferred to the Bureau of Government Laboratories, which in 1906 became the Bureau of Science.

LIBRARY OF THE ARNOLD ARBORETUM

Bureau of Science buildings in Manila, 1916. Although Merrill's work in the Philippines commenced in a vacant dwelling rented as headquarters for the Bureau of Agriculture in 1902, within three years a new facility was constructed to house the Bureau of Science. Merrill was director of the Bureau from 1919 to 1923. The destruction of these buildings, along with most of their contents including the herbarium and botany library, during World War II was a tragic episode in Merrill's career, even though he was director of the Arnold Arboretum by that time.

From the outset Merrill spent much time and energy building the reference library that was needed to identify the rich flora he found during his explorations. In 1902 he made a visit to the 85-year-old botanical garden in Buitenzorg, Java (Bogor). He found the library and herbarium there very helpful; in addition to identifying the Philippine plants he had brought along, he was able to familiarize himself with the botanical literature of the Malay Archipelago, the great chain of islands stretching from southern Asia to northern Australia. Undoubtedly this visit inspired his efforts to amass similar resources in Manila: by the time he left the Philippines in 1923, the herbarium had grown from almost nothing to over 250,000 specimens, complemented by a library he characterized as one of the most complete in all of Asia.

Adventures in the Field

Merrill's travels in search of plants took him the length and breadth of the archipelago and included remote areas where few, if any Filipinos, let alone Westerners, had set foot. One of these was the summit of Mount Halcon, which he and a party of forestry and military personnel reached in November 1906 after twenty days of arduous, wet climbing. There existed no report of Westerners having previously attained the summit of this mountain; and apparently local Mangyan tribespeople had never ascended either, for no signs of trails were seen anywhere near the peak and Merrill was sure that no human could get there without cutting a trail, so dense was the mossy forest and so steep the terrain.

Halcon, at 8,500 feet the third highest mountain in the Philippines, is located on northern Mindoro, one of the most humid areas in the entire country. Halcon and its subsidiary ranges capture an enormous amount of precipitation nearly year-round, and the mountain is continually shrouded in fog and clouds. During the ascent Merrill encountered the entire gamut of rainforest vegetation that he later came to know so well. Starting from Calpan to the north, the party soon left behind the coastal lowland with its mangrove swamps, cultivated crops, and abundant tropical weeds. They followed river courses and occasional Mangyan trails through dense vegetation dominated by huge trees with canopies so high and thick that only twilight reached the forest floor. For the most part this was primary forest with a several-storied, species-rich mix of trees that included many Dipterocarpaceae. They also encountered many areas of secondary forest, the abandoned clearings of the Mangyan people who regularly cleared a few acres of the old-growth forest, burned it over, then planted upland rice, corn, and other crops for a year or two before moving on to a new area. Once cultivation stopped, these clearings were rapidly re-vegetated by a mix of indigenous and introduced plants quite different from those of the original rainforest.

Travel was extremely difficult. The rivers the party followed often led them into steep-sided ravines, forcing them to ford the swift water frequently. Then, after finally reaching the ridges at the top of the canyon walls, they had to hack their way slowly through more forest using bolos, the Filipino equivalent of machetes. Sometimes the only way to proceed was to chop their way up 80–degree slopes.

Once they attained 4,000 feet, the vegetation began to change markedly to that known as the mossy forest—a diverse mix of smaller trees including oak, maple, and several Malaysian genera with many-branched, scraggly habits, as well as *Rhododendron, Vaccinium, Rubus,* and other shrubby genera found in more temperate regions. Moisture-loving ferns, mosses, and epiphytes grew even more profusely here at higher elevations than they had in the lower forests:

> Epiphytic ferns and orchids . . . become more plentiful and there is a greater diversity in species; mosses are much thicker and more luxuriant, enwrapping even the branches and branchlets of trees and forming a deep, soft, soil cover, frequently a foot in thickness.[3]

The going was not easier in the mossy forest, even though the woody vegetation became more and more stunted the higher they climbed. Thickets of gnarled trees and branching shrubs, covered with epiphytes and intertwined with vines, allowed no forward progress without first clearing a trail step by step. The temperature had dropped considerably, averaging 60 degrees Fahrenheit in the daytime, and a rainy period that lasted thirteen days set in.

ARCHIVES OF THE FAIRCHILD TROPICAL GARDEN

Veitchia merrillii *(formerly* Adonidia merrillii*) The Christmas palm or Manila palm is admired for its pendulous clusters of crimson fruit, which contrast attractively with its whitish fruit stalks and sheaths. It was known only from cultivation in the vicinity of Manila when named for Merrill by Italian palm specialist Odoardo Beccari (1843–1920). Later the Manila palm's native habitat was determined to be restricted to Palawan and the Calamianes Islands on the basis of specimens collected by Merrill and A. D E. Elmer, one of his colleagues at the Philippine Bureau of Science.*

Surprisingly, when they reached 7,800 feet, the montane brush gave way to vegetation Merrill described as open heath, a collection of tufted grasses broken only occasionally by stunted trees and shrubs. They quickly traversed this area only to find that the final 500 feet of elevation was covered with thickets more dense than any they had previously encountered:

> At times as we came to the crest line, the cold wind would add to our discomfort. . . . Pitcher plants *(Nepenthes)* became very abundant, clambering everywhere in the thickets, so that in cutting our way through the underbrush, at frequent intervals our bolo slashes would upset the equilibrium of from one to a half a dozen pitchers, each holding one-half quart or more of water, which would be precipitated upon us. These irregular douches were far more disagreeable than the constant shower bath from the falling rain.[4]

In storms worse than ever, Merrill and another scientist reached the summit, where clouds obscured the view. They quickly took barometric readings and left a record of their visit sealed in a bottle tied to a tree, since there were no boulders to use for a cairn.

The return trip to the coast took nearly as long as the ascent. They were delayed by more storms, and two members of the party became lost for a while. When the porters were sent back to retrieve supplies left at lower elevations and got cut off by rain-swollen rivers, the party had to forage in the rainforest for a Thanksgiving "dinner" of broiled wood rats and boiled fern tips. Merrill commented that "a man can come nearer to starving to death in a primary tropical forest than in almost any other part of the world," since there is little game, and edible fruit is either too high in the canopy or too widely spaced for efficient harvesting. It was some consolation to Merrill that a new species was later described from the rat skins and skulls left over from the holiday dinner.

Although this was probably the most strenuous of his field trips, Merrill accepted many more challenges in his search for the Philippine flora. On some occasions he walked 36 miles in a single day. There were precarious landings in the surf on remote coasts, and the unnerving experience of collecting plants among the hastily made graves of tribesmen who had resisted American troops. And at times he risked his life by staying overnight in remote villages of the Mountain Province, where headhunters were reputed to live.

In order to determine the relationships between the flora of the Philippines and those of surrounding areas, as well as for help in identifying certain species, Merrill and his associates at the Bureau of Science also made collecting trips to Guam, Borneo, Amboina, Indochina, and China. He acquired additional specimens for the herbarium collection in Manila by exchanging material from the Philippines for Indo-Malaysian, Australian, and Polynesian plants.

Publications

Of course, the fieldwork was only the beginning for Merrill. His observations in the field and subsequent scrutiny of pressed specimens, along with intense study of botanical literature,

LIBRARY OF THE ARNOLD ARBORETUM

Elmer Drew Merrill photographed in Manila, 1914.

ARCHIVES OF THE FAIRCHILD TROPICAL GARDEN

A circle of distinguished friends photographed in the 1940s. Seated from left, Merrill, plant explorer and collector David Fairchild, naturalist and herpetologist Thomas Barbour, and standing, citrus hybridizer Walter T. Swingle and paleontologist Theodore White, in Barbour's Florida garden.

became the material for a prodigious output of publications. He worked assiduously not only on problems of identification and classification but on nomenclature and bibliography as well. In the course of this work, for example, he published several papers updating Manuel Blanco's 1837 *Flora de Filipinas.* His long-term goal was to produce a complete descriptive flora for the Philippines, but first many new species had to be described and published, and their relationships with other plants explained.

"New or Noteworthy Philippine Plants," a series of some seventeen papers, was published intermittently from 1904 to 1922. Merrill also published about twenty revisions of genera or families as they occur in the Philippines. Altogether, between 1904 and 1929, he authored one hundred strictly taxonomic papers on the Philippine flora. Most were published in the Botanical Section of the *Philippine Journal of Science,* which Merrill edited from 1907 to 1918.

The publication in 1912 of the 500-page *A Flora of Manila* was a major step toward his longer-term goal. Since the 1,007 species it covered—a small percentage of the total known for the entire country—were those that inhabited low altitudes and could be found in most towns, this work provided a useful guide for the Philippine people.

But the tasks Merrill assigned himself were not limited to the Philippine flora. In the course of studying the origins of Philippine plants and their relationships to the vegetation of neighboring regions, he wrote exhaustive commentaries on the work of earlier botanists, including the pre-Linnean work of Rumphius on the flora of Amboina in the Moluccas, and the *Flora Cochinchinensis* (1790) of Portuguese missionary Juan Louriero; assembled a great deal of information on the literature of Malaysian botany, and became an expert on the local names for plants of Southeast Asia as well as the biogeography of the region. He also published papers on the plants of Borneo, Guam, Sumatra, Hainan, and Papua, often based on the many specimens that he received from those areas.

Having begun his botanical career at the USDA and gone to the Far East under the auspices of the Department's divisions of agriculture and forestry, Merrill was ever aware of the practical aspects of plant science and of the human influence on the flora. His observations on introduced weeds, cultivated plants, and local plant names initiated a lifelong interest in the origins of agriculture and the migration of plants in pre-Columbian times. "The American Element in the Philippine Flora" (1904), "Medical Survey of the Town of Taytay: The Principal Foods Utilized by the Natives" (1909), and "Notes on the Flora of Manila with Special Reference to the Introduced Element" (1912) are some of his earliest papers in economic botany.

In all his many publications on the flora, Merrill rarely failed to comment on the destruction of forests and other changes in ecosystems caused by human activities:

> The practical extermination of the original vegetation of those regions best adapted to agricultural pursuits is a subject that deserves more consideration than it has received. Unquestionably, many species of plants have been exterminated in various parts of the Malayan region within the past century as the population has increased. The areas being devoted to agriculture are being rapidly enlarged . . . and the consequent destruction of primeval forests over large areas is a strong argument in favor of vigorous and intensive botanical exploration of Malaya.[5]
>
> The enormous trees and shade plants characteristic of the primary forest cannot persist under the conditions demanded by modern agriculture, and they cannot exist in second growth forest, grasslands, and bamboo thickets that rapidly encroach on cleared areas that are abandoned. . . . We are witnessing in our own generation the rapid extermination of some of the noblest types of tropical vegetation . . . [6]

When Merrill wrote these words, the population of the Philippine Islands was less than that of greater London; today the population is ten million greater than that of all the British Isles.

Becoming an Administrator

Merrill would have loved to spend all his time working in systematic botany, but in 1912 a series of additional appointments began to claim much of it. In that year he was appointed Associate Professor of Botany at the University of the Philippines; subsequently, his teaching duties would occupy from 18 to 36 hours per week. Then, in 1919, he was appointed director of the Bureau of Science after a six-month stint as acting director. In this capacity his responsibilities included medicine, public health, chemistry, weights and measures, materials testing, geology, mining, fisheries, zoology, and anthropology, in addition to botany. Although he accepted the position "with diffidence and reluctance," he found in himself a talent for handling problems in fields widely divergent from his own, and his executive ability quickly won him respect. It is perhaps not surprising that the botanist whose identical twin became a brigadier general turned out to have a knack for administration.

But his new role cut even more severely into the time available for preparing the major work he had contemplated:

> My appointment of Director of the Bureau of Science in 1919 clearly indicated to me that I could scarcely hope to consummate my plan of preparing and publishing a general descriptive flora of the Philippines, as I soon realized that most of my botanical work would of necessity have to be done outside of office hours. I accordingly compromised with myself and . . . commenced the actual preparation of my 'Enumeration of Philippine Flowering Plants.'[7]

The four-volume *Enumeration* was issued between 1922 and 1926. In it Merrill attempted to:

> account for all binomials accredited to the Philippine flora, adjust the synonymy, cite all important literature references, illustrative [specimens] when desirable, determine the Philippine and extra-Philippine distribution of each species and record native names.[8]

While it was not the complete, descriptive work that he had hoped to produce, it was a valuable summation of all that he and his colleagues had accomplished. The *Enumeration* allowed Merrill to outline his conclusions on the relationship of the Philippines' climate, geologic history, and plant life to those of adjacent regions. Also included were discussions of the original settlement of the islands; their peoples and languages; and the history of botanical study in the Philippines. Unexpectedly, the

Enumeration served as a kind of closure to Merrill's years in the Philippines, for as it turned out, he left Manila in the fall of 1923 never to return.

The Scientist-Administrator Moves On

Merrill's departure was almost as abrupt as his arrival: he was given only a week to decide whether to accept a position as dean of the College of Agriculture at the University of California. Had there been no family dependent on him, he would undoubtedly have remained in the Philippines. But in 1907 he had married Mary Augusta Sperry of Illinois. After the wedding in Manila, the couple spent a year traveling to China and Japan, followed by a several-month stay in Washington, D.C., and visits to London, Leiden, Berlin, and Florence, where Merrill studied in herbaria. Once settled back in Manila, Mary gave birth to three children over the next seven years. When the third child died in infancy, the Merrills concluded that "Manila was not the proper place in which to bring up a family." In 1915, at the end of another visit to Washington, Mrs. Merrill stayed on with the two children. Elmer returned to Manila and did not see his fourth child, born in 1916, until she was nearly five years old.

> It was not easy to leave the scene of so many years of work, the city in which I made such reputation I bear as a botanist.[9]

As he left Manila in 1923 Merrill took some comfort in the good will of his American and Filipino colleagues in the Bureau of Science and in the resources that he left behind for the ongoing work of inventorying the Philippine flora: a fine library and herbarium, and an exhaustive body of research. Through the field collecting of Merrill and his coworkers, the list of known Philippine species had been extended from 2,500 plants of all types in 1900 to 8,120 species of flowering plants, 1,000 species of ferns, and 3,000 species of cryptogams by 1926, when the final volume of the *Enumeration* was published. Perhaps the greatest of all the ironies in Merrill's life would come during World War II, when the collections of the Bureau of Science were destroyed by Japanese bombs.

By that time Merrill was at the Arnold Arboretum and in a position to help rebuild the collections. As soon as the fighting ended, he rallied curators at Harvard and other major herbaria to send duplicate specimens and library materials to the Philippines. Work on the complete flora of the Islands has been carried forward in recent years by Philippine and American botanists at the Philippine National Herbarium, the Bishop Museum, and the Botanical Research Institute of Texas, using Merrill's meticulous scholarship as a starting point. Tragically, many of the plants to be included may no longer exist by the time the flora is published, since rainforest is being destroyed in the Philippines at a rate second only to Madagascar's. Of the extensive primary forests that once covered the mountainous archipelago, current estimates are that less than three percent remain intact.

Endnotes

[1] E. D. Merrill (hereafter EDM.), "Autobiographical Early years, the Philippines, California," *Asa Gray Bulletin* n.s. (1953) 2(4): 338.

[2] Ibid.

[3] EDM, "The Ascent of Mount Halcon, Mindoro," *Philippine Journal of Science,* section A (1907) 2(3): 200.

[4] Ibid., 195.

[5] EDM, "An interpretation of Rumphius's Herbarium Amboinense," *Bureau of Science Publication,* Manila (1917) 9· 25–26

[6] EDM, "A bibliographic enumeration of Bornean plants," *Journal of the Straits Branch of the Royal Asiatic Society* (1921) Special number. 27–28.

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[8] Ibid.

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Ida Hay, a member of the Arnold Arboretum staff for over twenty years, is the author of *Science in the Pleasure Ground,* a history of the Arnold Arboretum published in 1995 by Northeastern University Press She now lives in Northampton, Massachusetts.

Light in a Bottle: Plant-Collecting in the Philippines

Rob Nicholson

There has been no better time to be a field botanist. It is from the world of plants that cures are again being sought, and compounds isolated from plants are being tested for their anti-viral, anti-cancer, and anti-fungal activity. A small corps of botanists are journeying to the field, gathering samples of bark, leaf, and root, and trundling them back to the biochemistry labs of the world.

The status of botanical compounds has risen in recent years with the success of the taxane group of compounds in fighting cancer. However, funding for research on medicinal plants is notorious for its boom-and-bust cycles, and if the current well-funded efforts bring no major leads, a new downcycle in support may be triggered. At the same time, there is an urgent sense among botanists returning from the field that the work must be done now or never. The relentless spread of human population means that forests continue to be turned into fields and pastures and that individual plant species are harvested into extinction by the multitudes of people who value their timber, flowers, or aphrodisiac bark.

Botanical field collecting for medicinal leads usually proceeds in two phases. Initially a broad assortment of plants is collected from a certain region or from a specified set of plant families. Extracts are made and laboratory-tested for effectiveness against a variety of diseases. If a particular species shows promise—the San Pedro cactus, let us say—the second phase begins with a search for different populations of the same species or for other species within the genus—perhaps the San Roberto cactus—in hopes of achieving a still higher level of effectiveness. Essentially, then, it is find a needle in the haystack, then find a better needle.

Over the last twelve years most efforts have focused on cancer and the HIV virus, and scores of botanical compounds have been tested on cell cultures of these diseases. The work is coordinated by the Developmental Therapeutics Program of the National Cancer Institute (NCI) under the directorship of Dr. Gordon Cragg. Since 1985 over 30,000 plant extracts have been tested for in-vitro effectiveness against sixty types of cancerous tumors, and over 52,000 have been tested against HIV since 1987. Once an effective compound has been isolated and patented, the NCI licenses it to a pharmaceutical firm for further development.

Homolanthus as a Potential Anti-HIV Therapy

Dr. Cragg reported in 1994 that "four novel plant-derived agents with in-vitro anti-HIV activity have been isolated and selected for preclinical development." Among these are extracts from a *Conospermum* species of Australia, *Ancistrocladus korupensis* of Cameroon, and *Calophyllum* of southeast Asia, which was collected and identified by researchers at the Arnold Arboretum and is now in Phase II human clinical trials. A fourth genus of interest to NCI is *Homalanthus*.

There are about 35 species of *Homalanthus*, ranging throughout Indomalaysia and Polynesia. Because none of these is very appealing aesthetically, little had been written about them since 1914, when Elmer Merrill (later director of the Arnold Arboretum) described a number of *Homalanthus* species from the Philippines. Then in the late 1980s, after a decade of work-

MELVIN SHEMLUCK

In lush and humid lowland rainforest, the plant-collecting party stops to catch their breath before a final push up Mt Apo, the highest peak in the Philippines.

MELVIN SHEMLUCK

Amid razor-sharp sawgrass and burnt trunks, expedition members were successful in locating a handful of young Taxus *plants to be tested for anti-cancer activity.*

ing with native healers in Samoa, botanist Paul Cox of Brigham Young University returned to the United States with a number of samples for laboratory analysis, together with documentation of their local medicinal uses. One of Cox's specimens was *Homalanthus nutans.* As members of the euphorbia family, *Homalanthus* are related to such plants as crotons, poinsettia, cassava, and castor beans. Some members of the family contain milky latexes that cause gastrointestinal poisoning, dermititis, or tumors, but a number of them have been used medicinally worldwide to relieve toothaches and oral infections, or as emetics and laxatives.

Plants of the genus *Homalanthus* are small trees, weedy colonizers that thrive along the edges of roads and fields or in newly opened spaces in the forest canopy. Samoans know them as *mamala* and use their bark, leaves, stems, and roots to treat a variety of ailments, one being yellow fever. In Western laboratories a compound extracted from the wood, prostratin, was found to strongly inhibit the killing of human host cells in-vitro by the HIV virus. This first flash of promise set off a cycle of activity. Botanists began collecting and studying the plant, and chemists initiated studies to decipher its mode of activity, thus giving it status as a candidate for clinical trials.

Botanists Take To the Field

At the same time that studies were revealing the medicinal potential of *Homalanthus,* my research partner, Dr. Melvin Shemluck, and I secured a grant from the United States Department of Agriculture to continue our previous research on wild populations of yew, this time collecting live material in the Philippines. *Taxus,* the yew genus, had been the subject of intense research for over a decade thanks to the

MELVIN SHEMLUCK

The cabbage fields of Mt. Pulog represent a classic dilemma of developing countries: increased food production vs biodiversity conservation.

discovery of the compound taxol, an anti-cancer agent found in its needles and bark. We were focusing on disjunct yew populations in order to learn which species or populations produce the most taxol, a crucial piece of information for selecting the best ones for biotechnological applications or plantations. We also hoped to determine the conservation status of wild stands of yews in the Philippines, as well as to procure samples for research groups that are studying the genetic and ecological aspects of yew biology. Since the intriguing results of tests against the HIV virus using prostratin were becoming well known by this time, the USDA extended our mandate to enable us to search for new species or populations of *Homolanthus* while we looked for yew.

Our pretrip research led us to an obscure book on the shelf of the Smith College library, *The Vegetation of the Philippine Mountains,* written in 1919 by William Brown, an associate of Elmer Merrill. His meticulous accounts were rich in all the kinds of data that help in planning a collecting trip, including the timing of monsoons and the altitude of various plant habitats. Brown also described the broad categories of forests found in the Philippines. At the lowest altitudes is the lowland Dipterocarp forest, a tropical rainforest with three stories of trees and a shrub and herb layer at the base. Some of these Dipterocarp trees can reach 130 feet in height and have been the source of Philippine mahogany lumber for hundreds of years. The lower montane, or mid-mountain, forest is found at altitudes of 3,300 to 8,200 feet. Evergreen oaks and laurels are the major component of this two-storied forest, with southern hemisphere conifers such as *Podocarpus* and *Agathis* found in this association. Finally, the lower montane mist forest, or mossy forest, is a high-altitude, single-layer assemblage of low-growing, gnarled, mossy trees bathed by daily mists or rain.

We acquired visual familiarity with *Homalanthus* by studying dried, pressed specimens in herbaria, noting the botanical characteristics of species that would help us distinguish them in the field. Field notes on herbarium labels give invaluable clues to location and often include altitude, associated species, local names of plants, and sometimes, more colorful information, as with the sample of *Homalanthus nutans.* Collected in the Solomon Islands by S. F. Kajewski in 1931, the notes included, "When a man has been infected by an evil spirit the sap of this tree is drunk to get rid of this spirit."

On the Ground in the Philippines

Our first stop in the Philippines was the National Museum in Manila, where we consulted with Philippine flora expert Dr. Domingo Madulid and put together our team. Our next destination was Mt. Pulog; at 9,607 feet it is the highest point on the northern island of Luzon. We drove north from Manila through a snarl of jeepneys, buses, cars, and motorbikes, at one point passing a 40-foot deep lahar flow six miles from its source, Mt. Pinatubo. Our party of four botanists and driver stayed that night in the mountain resort of Baguio, a city much damaged by a recent earthquake. The next day we began our ascent of Mt. Pulog on a road whose quality declined drastically as we hit steeper terrain. As if to further emphasize the power of nature in the Philippines, a front of thunderheads began to drop its moisture on us, making the last twenty miles a battle up the deeply rutted road, its clay soil slippery from the rain. Each time our efforts seemed doomed, we somehow cajoled our vehicle forward.

After reaching the entrance of Mt. Pulog National Park, we moved our gear into the cabin that serves as the park's headquarters and the camp for its solitary caretaker. While the torrent continued into dusk, we dried out under the tin roof, peering out at a *Homalanthus* plant across the stream that had once been a road. The clear light of morning showed the magnitude of settlement on the surrounding slopes: the forests of Benguet pine, *Pinus insularis,* had been intensively cut right up to the park's boundary, and the fields of the local Ifugao tribesmen surrounded our cabin.

Ironically, this degraded forest was ideal habitat for *Homalanthus,* and we had no problem finding several specimens of a large-leaf species, *H. megaphyllus,* a small tree with thick branches, large minaret-shaped buds, and a distinctive, rounded leaf with a red stem. We soon

A robust plant of Homalanthus megaphyllus *found near the headquarters of Mt. Pulog National Park.*

morning produced nothing, and as predicted, the rain began again at noon, reducing visibility to 75 feet. Melvin and I spent the afternoon walking along the edges of cabbage fields and up and down the crude paths that crisscrossed the slopes. It was evident that the forest had been severely depleted since yew was last collected on Mt. Pulog. Each hour of trudging past three-foot-wide pine stumps made us more depressed, and we began to talk of an epitaph for this population of yew.

We returned to the cabin dejected and prepared for defeat, but our gloom changed to joy when our Philippine colleague Ephrain greeted us with a fold of newspaper containing a sprig of yew. Not a thousand yards from the cabin our Ifugao guide had found five adult yew trees (up to 80 feet tall) and a trio of saplings on the edge of a cabbage patch. Once the guide confirmed that this was the plant we sought, he remembered seeing more of them farther north on the other side of the mountain.

We realized, however, that the day of the yew on Mt. Pulog is almost past: because it germinates and grows under a solid canopy, yew is found only in forests of long standing. *Homalanthus*, by contrast, rapidly establishes itself in recently disturbed areas—for instance, in clearcuts or canopy gaps. With farmers clearing the forests higher and higher up the mountains on Luzon, *Homalanthus* is enjoying a newfound prosperity.

To ensure broad genetic diversity, we wanted to collect from widely separated populations. After returning to Manila, we flew to Mindanao, the largest of the Philippines' southern islands, to seek out the yew and *Homalanthus* populations previously documented on Mt. Apo. Mindanao is also home to some rare endemic species of *Homalanthus*, and we hoped to locate some of these.

Mt. Apo is the highest peak in the Philippines; the only access is by foot. Our party of four botanists and three porters began the ascent

had a collection of a half-dozen samples of wood with corresponding cuttings for propagating back at the Smith Botanic Garden.

The cabin was sited at 7,500 feet, the point where the pine forest gave way to the moist, low, and dense mossy forest. Rather than carve out a trail through the heavy undergrowth, we stayed on the path to the summit of Mt. Pulog as we searched for yew trees and other *Homalanthus* species. Some of the species here were recognizable as common farther north in more temperate zones—spicebush *(Clethra luzonica)*, *Berberis barandana*, *Deutzia pulchra*, *Ilex crenata* f. *luzonica*, and dense shrubs of *Rhododendron subsessile*. The most unusual collection of the day was a white-flowered epiphytic rhododendron unique for its thin needle-like leaves.

As we climbed higher the effects of the colder climate became evident in the stunted shrub-like forms of species that grew as trees lower down. At 8,700 feet, the woody flora disappeared altogether, giving way to a tussock grassland interspersed with a dwarf bamboo, *Arundinaria niitakayamensis*. At this point we were still 900 feet from the summit and the temptation to see the ocean from the top of the island beckoned, but our Philippine colleagues counseled that the rains would come again by noon. Since no *Homalanthus* or *Taxus* would be found above treeline, we retreated to search along other paths lower down. The rest of the at the village of Kitapowan and walked upward through lush lowland forest. Towering above us, one spectacular tree, damar, *Agathis dammara,* had an eight-foot-wide trunk oozing a sticky, milky resin, which is the source of a resin used in varnishes.

Clumps of epiphytic orchids, some of them three feet across, cluttered the path, brought down by their own weight from the branches above. Some of the trees were so tall that the first branch was too high to identify, although tentative identification could be made from fragments of floral matter fallen on the path. Other plants, like the bizarrely primitive-looking screwpine *(Pandanus)* or the lush tree ferns, grew in the lower canopy layer and were unmistakable. We found one species of *Homalanthus* on the uphill climb—*H. populneus*—a solitary specimen of 45 feet that had sprouted near a treefall. After a grueling five-hour climb, we set up camp at 7,200 feet on the shores of Lake Venado. Again we found ourselves in a lush, mossy forest belt of southern conifers like *Dacrydium* and *Falcatifolium,* with the vivid scarlet blossoms of epiphytic vireya rhododendrons punctuating the green curtain.

Rain was pouring down again as we rested in camp and botanized around the lakeshore. Here we found trees more closely related to the southern flora: *Tasmannia, Leptospermum,* and *Pittosporum,* but no yew. From our camp we could see the north-facing slope of Mt. Apo. A fire had burned a considerable portion of its forest in 1986, and silvery dead trunks now rose out of a sea of ten-foot sawgrass. The lone path traversing this thicket seemed our only practical route for the next day's climb.

We set off early, aware now that the workday would be cut short by afternoon rains. The only prior collection of *Taxus* on Mt. Apo had been by the botanist Robbins in 1965, at an altitude of 7,500 feet. We moved upward nervously, fearing that Robbins had approached the peak from another direction, or that the fire had eradicated what may have been the only *Taxus* population on Mt. Apo. But at 7,300 feet we spotted a yew seedling, an eight-inch sprig in the moss on the edge of the path, and within the next 400 feet of altitude, we found an additional fifteen seedlings and saplings. These few plants had probably sprouted from seed deposited in the soil prior to the fire, and it seems unlikely that they will survive competition from the sawgrass or withstand the intensity of the full sun should they rise above it.

Although the specimens were too small to yield a sample for laboratory testing, we collected a few cuttings from each to root back at the Smith College greenhouses and to provide material for researchers working on other aspects of the yew. We tried one additional foray off-path in the direction of a promising ravine. But when clouds pumped up and postured threateningly, we turned back. Suddenly the rainy season began in earnest, with a downpour that dwarfed all previous storms. On the way back down the mountain we found one

While curious townspeople looked on, the author and other expedition team members prepared samples for the trip down the mountain more species of *Homolanthus*, *H. rotundifolius*, bringing our total to four.

Conclusion

Upon our return to the U.S. our *Taxus* samples were analysed for relevant medicinal compounds, and data concerning individual tagged trees was sent back to the Philippines. Should plantation culture become an option, these tags can identify elite trees. Cuttings were rooted at Smith College, and from these plants, material was supplied to other researchers working on the yew's taxonomy, biochemistry, and genetics.

Samples from our *Homalanthus* collection were sent to the Natural Products Branch of the National Cancer Institute to begin the long process of analysis and trial. Initial extracts showed significant activity against HIV cell lines, but further development has stalled for a variety of reasons; other plant compounds have shown more promise, as have certain non-plant-derived compounds. Although prostratin, unlike other compounds in its class (phorbol-esters), does not induce tumors, taint by association has dampened interest on the part of pharmaceutical firms. Dr. Paul Cox, the botanist who brought prostratin out of the rainforest, has suggested some plants may produce "gray pharmaceuticals," drugs of proven safety and efficacy that are not marketable in the Western world. Possibly prostratin may fall into this category, a low-cost, plantation-grown treatment option that offers an alternative to high-priced Western drug regimes. The colonizing nature of *Homalanthus* may make it an ideal subject for plantations in forested areas.

In the daily grind of plant-collecting, it is easy to fixate on the immediate goal, the plants themselves, and to forget that each collection, long shot though it is, may be the basis of a cure for thousands or millions of people. The renewed interest in botanical compounds makes collecting far afield possible, yet with each trip comes the realization that we may be chasing and bottling the last rays of light before an eclipse of uncertain dimension and duration.

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Rob Nicholson manages the conservatories of the Smith College Botanic Garden, Northampton, Massachusetts. His article on cutleaf maples appeared in the summer 1997 issue of *Arnoldia*

The Ecology and Economics of Elm Replacement in Harvard Yard

Peter Del Tredici

Two new Dutch elm disease-tolerant American elms have rekindled interest in restoring the species to the landscapes it once dominated.

These new selections of *Ulmus americana*—'New Harmony' and 'Valley Forge', recently introduced by the United States National Arboretum—represent an important horticultural breakthrough,[1] but some basic biological issues should be considered before any new plantings of the American elm are undertaken. The purpose of this article is to articulate these questions in economic as well as ecological terms in order to facilitate the decision-making process that many landscape architects, designers, and town managers now face concerning the use of American elms in historic landscapes.

The American Elm in History

The first question that should be asked is why this tree came to be so widely planted across eastern and central North America in the first place. The explanation can be found in the horticultural literature of the 1800s, particularly in a beautiful book by Lorin Dame and Henry Brooks that was published in 1890, *Typical Elms and Other Trees of Massachusetts*.[2] Profusely illustrated and written long before Dutch elm disease appeared in North America, it serves as a portrait of the American elm at the pinnacle of its landscape dominance. The authors made many important contributions to our knowledge of the American elm, but most significant is their documentation of a key fact: that the huge elms of the past reached their great size by virtue of rapid growth rate, rather than by great age. Other writers who described the American elm in the nineteenth century include F. A. Michaux (1819), A. J. Downing (1841), D. J. Browne (1846), F. J. Scott (1870), G. B. Emerson (1875), and C. S. Sargent (1890).[3] These authors make it clear that the American elm was widely planted for a number of reasons, only one of which was its great size and beauty. Other, more pragmatic reasons gleaned from the literature of the period can be summarized as follows:

- The American elm, a native species, was widely distributed throughout eastern and central North America, typically growing on moist bottomland or along disturbed roadsides.
- It was so easy to transplant that it could literally be ripped out of swamps and planted along roadways.
- It recovered well from the heavy pruning it received following these careless transplanting practices.
- It was highly adaptable, growing equally well on wet or dry sites.
- It grew very rapidly, averaging about a half-inch increase in caliper per year and reaching two to three feet in diameter within seventy years. Shade was in short supply in the nineteenth century, and the American elm provided it more quickly than any other tree.
- It shed its lower branches naturally, making it well suited for locations along heavily trafficked city streets and country roads.

Dutch Elm Disease

The Dutch elm disease fungus, along with its dispersal agent, the European elm-bark beetle, arrived in North America in 1930, hidden under the bark of European elm burl-logs that had

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been shipped into the United States for making veneer.[4] The disease spread so rapidly and killed American elms so quickly that it seemed at first that the species was headed for extinction. Fortunately, this prediction has not come to pass. The species still thrives as a wild tree in wet woods and along streambanks throughout eastern North America.[5] As a landscape plant, however, the American elm is close to extinction. The grand old specimens, four to five feet in diameter, that once graced virtually every town common in New England have been replaced by trees that seldom reach more than eighteen inches across before succumbing to DED or some other disease.

Since the 1960s, there has been considerable publicity about various efforts to "save" or to "bring back" the American elm. Long-term approaches have involved either selecting DED-tolerant American elm cultivars or hybridizing American elm with other elm species that are DED-resistant. In contrast, short-term approaches focus on preserving existing specimens by spraying for the beetle, injecting infected trees with fungicides, and removing diseased limbs as quickly as possible. While these treatments have saved individual trees for up to twenty years, they are at best temporary solutions; the inevitable infirmities of old age are already catching up with older specimens.

Case Study: The Harvard Elms

The American elm has been the mainstay of the Harvard Yard landscape for well over a hundred years. The trees have faced many threats during this time, but none has been as serious as the introduction of Dutch elm disease.[6] In 1979, when Harvard University began to implement an integrated elm protection program, there were 285 elms on campus. Most of them were American elms, but a number of English and European elms of uncertain identity were also mixed in. Most of the trees were about seventy or eighty years old when the protection program began. By 1994, after fifteen years of treatment, there remained only 165 elms, a mortality rate of 42 percent. Detailed figures do not exist, but the average cost of the total protection program

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American elms have long been valued for their exceptional growth rate. This 'Princeton' elm grew more than two meters in a single year Jack Alexander, Arnold Arboretum propagator, points to the start of the current year's growth.

for the Harvard Yard elms over the period is estimated at $25,000 a year, broken down roughly as follows:

- $14,000 for two sprays each year (one dormant oil and one foliage spray)
- $3,000 for fungicide injection each year
- $3,000 for fertilization every third year
- $5,000–$10,000 for pruning and removals

Over the fifteen-year period the total amount spent on the elms was approximately $375,000, or $100 per tree per year, in spite of which, mortality was at 42 percent after fifteen years. By extending these figures out, one can calculate the cost of elm maintenance over twenty years at roughly $500,000, with mortality approach-

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Ulmus americana *'Princeton', a Dutch elm disease-tolerant American elm cultivar, has been growing on the northeast slope of Bussey Hill since 1935* ing 50 percent. By comparison, the annual cost for maintaining non-elm trees in the Yard is approximately $20 a tree.

Replacement Costs

In 1994 an elm replacement program was initiated.[7] The cost of planting 200 new trees in the Yard, most of them four to eight inches in caliper and ten to twenty feet tall, was $470,000, or $2,350 per tree, including a one-year maintenance contract and guarantee.

Essentially, the numbers show that the cost of planting 200 new trees was roughly equal to the cost of maintaining 285 elms for twenty years, of which only half will still be alive and the other half in a state of decline at the end of twenty years. To put it another way, twenty years of maintaining one large elm with only a 50-percent chance of survival costs the same as planting one new four-to-eight-inch caliper tree.

There is no absolute answer to the question of how much one should invest in an elm protection program, and in any case, the question should not be decided purely on an economic basis. Elm protection programs cannot save a tree forever, and in anticipation of the death of the elms, such programs should always be undertaken in conjunction with a program of planting other species of trees. It is clear that the high density of American elms that was seen in many cities and towns during the first third of the twentieth century should not be recreated.[8] Indeed, it was this high density that allowed the elm-bark beetle population to build up rapidly, leading to the epidemic spread of DED. One sees more elms surviving these days than in the past, not because trees are more tolerant of Dutch elm disease than before, but because the reduced elm population has resulted in lower elm-bark beetle populations. This in turn allows more elms to escape detection by their predators. Planting new trees of different species are

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Just months after this photograph was taken, this hundred-year-old American elm, one of the last still standing on Boston's Commonwealth Avenue Mall, succumbed to a heavy wet snow that brought it crashing down onto cars and into townhouse windows.

The remnants of an allée of American elms tower over replacement plantings of Zelkova serrata *on the grounds of Phillips-Exeter Academy in Andover, Massachusetts The zelkova has many merits, but neither in scale nor stature does it resemble the American elm*

an investment in the future that softens the blow when a big elm dies, as it inevitably does.

Achieving Diversity

Unfortunately very few, if any, trees possess the combination of graceful form and great size of the American elm. The honey locust, *Gleditsia triacanthos*, comes about as close as any tree, but it grows much more slowly. *Zelkova serrata* has roughly the same shape but is much smaller. As Koller and Weaver point out, there is no perfect replacement for the American elm.[9] The key to successful substitution is to choose species with the same landscape impact or stature, regardless of whether they possess the American elm's structure.

Within the genus *Ulmus*, there are several potential candidates, but none are without some drawback. The ubiquitous Siberian elm *(U. pumila)*, for example, is highly resistant to DED but is very messy and graceless in form. The lacebark elm *(U. parviflora)* is a handsome tree, but much smaller than its American cousin. Some of the more recent hybrid elms (involving *U. davidiana*, *japonica*, and *wilsoniana*), may eventually prove to be excellent replacements, but they have not yet been thoroughly tested under landscape conditions.[10]

It must also be remembered that DED is only one of several diseases that kill American elms.[11] In particular, phloem necrosis and elm yellows can be lethal to many of the cultivars that have been selected for their tolerance to DED.[12] And the elm-leaf beetle, along with a host of other insects, had been killing elms long before DED arrived on the scene. If the American elm is to make a comeback in the modern American landscape—either as a hybrid or as a disease-tolerant selection—it should be used on an equal footing with other species, never as the predominant species in the landscape.

Another approach to replacing American

elms involves working within a single genus or family, which allows one to approach uniformity and diversity simultaneously. In the Tercentenary Theater part of Harvard Yard, for example, a grouping of legumes including *Cladrastis, Gleditsia, Gymnocladus,* and *Styphnolobium* (formerly *Sophora*), all share a characteristic arching trunk and flat-topped crown, but clearly differ in other aspects of their habit. One can also group different oak species to achieve a measure of uniformity amidst diversity. In the oldest section of the Yard, a grouping of oak species includes *Quercus rubra, palustris, phellos, coccinea, alba, bicolor,* and *acutissima.*

The advantages of increased species diversity can be summarized as follows:

- It offers a measure of protection against an epidemic spread of insects or of fungal and bacterial diseases.
- It allows one to match different microclimates on the site with the most appropriate species.
- It provides greater variation in flower and foliage displays, making a walk across campus a more interesting and potentially a more educational experience.

Conclusion

The desire to restore the American elm to its former status as the primary street tree in the East is very strong. But if "restoring" a given historic landscape means replanting the American elm—or any of its disease-tolerant selections or hybrids—at the density it occupied historically, then it is a mistake. In the popular literature on elms, the unspoken assumption seems to be that if we could only conquer Dutch elm disease, then we could easily recreate the grand, elm-lined streets of the past. This idea is biologically unsound. Because of the dynamic nature of the interaction between host and predator, "disease tolerance" is always a relative phenomenon, not a fixed genetic trait; total immunity is unattainable. Historical accuracy and aesthetic tastes notwithstanding, it is in no one's interest to bring the American elm back to its former position of landscape preeminence.

Endnotes

[1] United States National Arboretum Plant Introduction Announcement, *Ulmus americana* 'Valley Forge' and 'New Harmony' (January, 1997).

[2] An excerpt from *Typical Elms and Other Trees* appeared in *Arnoldia* (1982) 42(2): 49–59.

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[11] Sinclair et al , *Diseases of Trees and Shrubs* (Ithaca, NY· Cornell University Press, 1987).

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Peter Del Tredici is Director of Living Collections at the Arnold Arboretum.

The Arnold Arboretum

SPRING • NEWS • 1998

Katherine H. Putnam Research Fellowships Endowed

George Putnam, chairman, Putnam Funds and the Putnam Investment Company (second from left), and his wife Nancy Putnam, display a photo taken in turn-of-the-century China by E. H. Wilson; it was presented to them by the Arboretum at a reception held in their honor. Standing with the Putnams are James McCarthy (left), director, MCZ, and Robert E. Cook, director, Arboretum.

Fifty friends of George and Nancy Putnam gathered in Cambridge on Friday, May 15, to show their appreciation for two generous endowments established by the Putnams. Two of Harvard's oldest biological institutions, the Arnold Arboretum and the Museum of Comparative Zoology, will benefit from endowments of $1 million each to support research and scholarship

The endowment at the Arnold Arboretum will support the Katharine H. Putnam Research Fellowships, established in memory of Mr. Putnam's mother, an accomplished horticulturist and long-time supporter of the Arboretum. The funds will provide fellowship stipends and related research and project expenses for work in horticulture and botany using the Arboretum's living collections of trees and shrubs.

Putnam Fellowships will fund graduate students, postgraduate scholars, and mid-career professionals who wish to experience the richness of the Arboretum's resources and engage in research work that generates new knowledge and practical applications for horticulture, landscape architecture, and plant conservation. Fellowship awards will be particularly appropriate for young research scientists contemplating a career in public horticulture and education.

"George Putnam has been a friend of the Arboretum for many years," says director Bob Cook. "With the establishment of the Putnam Fellowship endowment, we can continue to offer the most promising scientists an opportunity to work with our collections and to gain the kind of practical experience that is essential for leadership nationally. We deeply appreciate the commitment of George and Nancy Putnam to this critical research and the educational mission of the Arnold Arboretum."

What a Difference a Year Makes

Peter Del Tredici, Director of Living Collections

On Monday, March 31, of last year, I was sitting in Patrick Willoughby's office in the basement of the Hunnewell building as he told me that he had decided to take the job as head of grounds maintenance at Wellesley College, and that his last day as Superintendent would be May 1. As I listened to Patrick talk about his future, I was looking out the window at the occasional snowflakes that had just started to fall. "It won't stick," I said, "none of it has this winter." Within 24 hours I was eating those words. Two feet of sticky wet snow had been dumped on the city of Boston, stopping traffic, downing power lines, and smashing trees. As most people reading this will remember, the Arnold Arboretum was particularly hard hit: over 1,800 trees were damaged, of which 200 have been removed.

But now it is one year later and I am pleased to report that a new superintendent, Julie Coop, is well established in Patrick's old office, and most of the storm damage has been cleaned up. Of particular interest is the fact that the high temperature on the day of the storm was 42 degrees while on the same date one year later, the high was 92! What a difference a year makes.

Spring planting, which was virtually nonexistent last year, has gone very smoothly this year. Over 150 new trees were set out during April alone. Unlike last year, this spring there was no snow to speak of and the weather was moist and cool. This not only allowed the grounds crew to start digging early, but also to dig and plant throughout the entire month.

On behalf of all of us at the Arboretum, I want to take advantage of this dubious anniversary to thank all of our loyal friends and supporters who generously donated labor and money to our storm damage cleanup effort. The donations not only helped with the clean-up, but they also lifted the spirits of the entire Living Collections staff. It's great to know that people care deeply about the future of the Arnold Arboretum. Thank you very much.

CHALLENGE GIFT FOR CHILDREN'S SCIENCE EDUCATION

The Arboretum has received a challenge gift of $100,000 from an anonymous donor. The gift has been directed to Children's Science Education and is intended to encourage others to help endow the Arboretum's Field Studies Experiences (FSE) program.

The FSE program brings children directly from Boston-area classrooms to the Arboretum's landscape. Students work in small groups with a guide while exploring and discussing specific science questions related to one of four different themes: Flowers Change; Plants in Autumn; Native Trees, Native Peoples; and Around the World in Trees. Each year the program serves 3,000 schoolchildren in grades three through five.

The Arboretum's goal in the Harvard University Campaign is to establish an endowment of $2,250,000 that will secure funding for children's science education. Of the total goal, $750,000 will create an endowment for the FSE program. To date, $439,000 has been raised, representing 59% of the goal. "The creation of an endowment for children's science education is critical to our education mission," says director Bob Cook. "It addresses a pressing need for excellence in science education and demonstrates our commitment to children, our most important resource for the future."

If you are interested in making a gift to help the Arboretum qualify for this challenge gift, or would like a copy of our publication "The Arnold Arboretum—An Outdoor Classroom," please contact Lisa M. Hastings, Director of Development, at 617/524-1718 x 145.

Harvard Announces Women's Matching Fund

At a recent forum on women and philanthropy, Harvard announced an initiative aimed at encouraging more women to participate in philanthropy. The Women's Matching Fund will match any gift between $25,000 and $250,000 made by women to any part of the University.

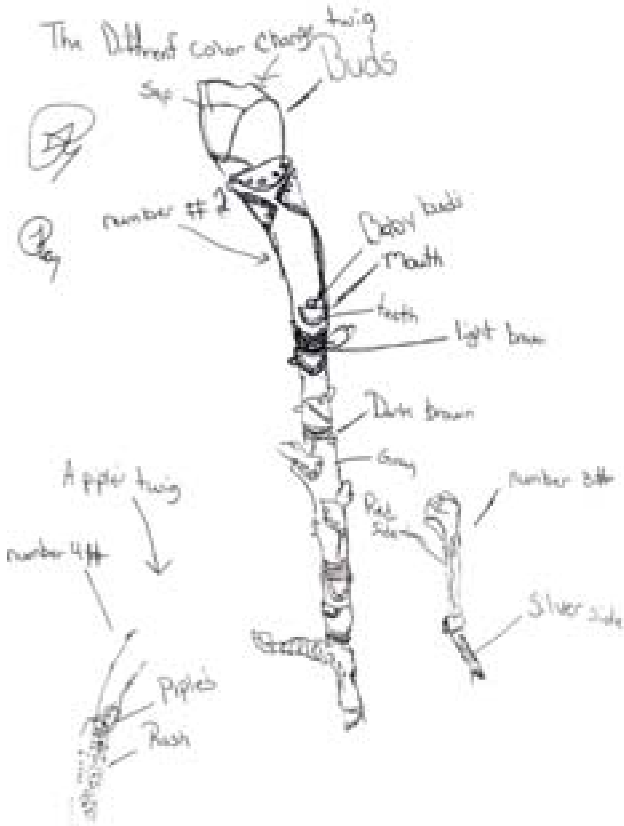
The Women's Matching Fund was created by National Campaign Chair Rita E. Hauser as a way for women to maximize the impact of their gifts to Harvard. Ms. Hauser established the fund with her own gift of $5 million and encouraged other women to bring the fund balance to $15 million. Gifts made by women will be matched on a dollar-for-dollar basis until the fund is depleted.

This new fund offers women who are considering a campaign gift to the Arboretum a unique opportunity to double their gifts. Gifts qualifying for the match can be directed to any of the Arboretum's campaign priorities: Living Collections (including landscape maintenance projects), Children's Science Education, International Biodiversity Conservation, and the new Shrub and Vine Garden.

For more information about the Women's Matching Fund, contact Lisa M. Hastings at 617/514-1718 x 145, or Peg Hedstrom at x 113.

Community Science Connection Goes National

Candace Julyan, Director of Education



In 1995 the Arnold Arboretum received a four-year grant from the National Science Foundation to develop a program to strengthen elementary science teaching and learning and to illustrate ways that science institutions can work throughout the year with local classrooms. The result of this effort is the Community Science Connection (CSC), a seasonal study of trees that spans the entire school year.

Participating teachers begin their study of trees in the spring and summer, learning how to look closely for patterns and changes and to make sense of what they see. In the fall, students begin their work by identifying individual trees and recording the dates when color change begins and ends and when the leaves drop. In the winter, students learn to "read" the information found on a twig and to use that knowledge to determine the best growing year for their schoolyard trees. In the spring, the study question turns to "What comes out of a bud?" While the main focus is on working directly with schoolyard trees, technology provides a connection among the participating classrooms and the Arboretum staff. A project web page enables participants to share data and ideas and provides virtual activities that encourage and support the outdoor investigations.

The goals of CSC are twofold: to work directly with local teachers on meaningful ways to study science through an investigation of trees and to develop a model that can be replicated by other institutions to further their work with local teachers. The first year of the project focused on the first goal. To date we have worked with over fifty teachers in the Boston, Newton, and Brookline schools. In the final year of the project we will continue to work with local teachers and begin work with other science institutions. Descanso Gardens, in collaboration with the science coordinator of the Los Angeles public schools, will replicate our tree investigations with California students. (The director of Descanso, Richard Schulhof, worked on the CSC project during its first year in his former role as the Arboretum's director of public programs.) Los Angeles students and their teachers will be corresponding with Massachusetts colleagues through the website, comparing findings from coast to coast. This work will give us an opportunity to determine the viability of our model for other institutions.

Another interesting development in this project emerged during the past year. The Massachusetts Audubon Society (MAS) was intrigued by our seasonal investigations and used it as a model to create a year-long study of vernal pools During the 1998–1999 school year, groups of teachers from eastern, central, and western Massachusetts will begin a coordinated study of vernal pools that will continue through fall, winter, and spring based on a curriculum outline developed by MAS. These investigations will be supported by the same technology component as the tree studies, with a data exchange, opportunities for conversations, and virtual activities that go along with the actual investigations. All of the technology portion of the MAS project will originate from the Arboretum and the virtual activities will be a joint development venture between staff from MAS and the Arboretum.

While the conversations of the participating classes will remain private, all of the activities for these investigations will be available to interested individuals through the Arboretum's web page (www.arboretum.harvard.edu). We welcome your comments.

On the Grounds

Tom Akin has joined the Arboretum staff as Assistant Superintendent of Grounds. A candidate for the master's degree in plant and soil sciences at the University of Massachusetts, Amherst, he has worked with the University's Extension Service both as a research assistant and extension educator. He comes to us from Weston Nurseries where he was IPM (Integrated Pest Management) Coordinator. Tom's resumé also includes work with the Peace Corps in the Central Africa Republic, first as an English teacher, then as keeper of African killer bees. No doubt he will bring all these experiences to bear at the Arboretum, where his duties will include the coordination of the summer horticultural intern program and its associated training program.

So Long, Fare Well

Jim Gorman, Arboretum tour leader and volunteer coordinator nonpareil, is leaving us for southeastern Pennsylvania and the Longwood Gardens Graduate Program in public horticultural administration. An official staff member at the Arboretum since 1992 and an unofficial staff member even longer, Jim Gorman and the Arnold Arboretum have been synonymous for many in Boston. Wherever his future takes him, we know he will continue to be the best emissary we could hope for. Needless to say, we will miss him, and we wish him all the best.

Annual Fall Plant Sale

Sunday, September 20, 1998
Case Estates, Weston
9:00 am to 1:00 pm

The date has been set for this year's Annual Fall Plant Sale, and we encourage members of the Friends of the Arnold Arboretum and the general public alike to mark their calendars. As usual, the event will feature a wide array of unusual trees, shrubs, herbaceous perennials, and more.

Member benefits at the Plant Sale include "members only" hours from 9:00 to 10:00 am, a free plant of your choice, and a 10% discount on all plant purchases in the Barn. Members at the Sustaining Level ($100) and above gain entrance to the Plant Sale Preview at 8:30 and receive additional free plants. Call the Membership Office at 617/524-1718 x 165 to join or to upgrade your membership and increase your Fall Plant Sale benefits!

Live and Silent Auctions
Straight Sales
Society Row
Education Sessions in the Teaching Garden
Refreshments

Catalogs will be mailed to members in August, and your free plant vouchers will arrive in early September. To volunteer to help out at the Plant Sale, call Kara Stepanian at 617/524-1718 x 129.