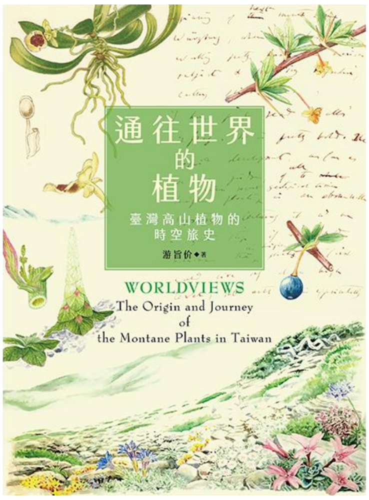
THE ODYSSEY OF TAIWAN'S MONTANE PLANTS

通往世界的植物：臺灣高山植物的時空旅史



Taiwan's mountains – with their subtropical foothills and alpine peaks – have been a haven for rare plants throughout the island's history. But how did they get there? Scientist Yu Chih Chieh leads us through millennia of natural history in one of Asia's great floral ecosystems.

Taiwan's mountains, with their subtropical foothills and alpine peaks, have been a haven for rare plants throughout the island's history. But how did they get there? Plant scientist Yu Chih Chieh takes us all the way back before the days of human migration in this beautifully detailed and copiously illustrated history of Taiwanese mountain flora.

Though perhaps best known for its tropical scenes, Taiwan boasts a central mountain range with over two hundred peaks reaching higher than three thousand meters (for comparison: there are three hundred such peaks in the entire United States), which provide innumerable unique microclimates for all sorts of plant species, many of which live nowhere else in the world. Yu leads us to many of these exquisite habitats using pictures, maps, and stories from his mountaineering youthhood.

Did you know that Taiwan is part of a small region that was spared the geological ravages of the Ice Age? In Yu's words, it is part of a "Noah's Ark" of ancient plants, a refuge that bore them safely through that period and that still protects them today. As Yu says in the introduction, "Each high mountain herb or tree in this book is a crystallization of global biogeography…. The hero in a multi-generational epic, an odyssey that begins in a distant land and ends at high altitude in Taiwan."

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Yu Chih Chieh 游旨价

Naturalist and plant biologist Yu Chih Chieh spent his early youth enjoying the wildernesses of Taiwan, and has dedicated his professional life to educate the world on global biogeography. His PhD dissertation won multiple awards; *The Odyssey of Taiwan's Montane Plants* is his first trade publication.

THE ODYSSEY OF TAIWAN'S MONTANE PLANTS

By Yu Chih Chieh
Translated by Darryl Sterk

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Introduction: Mountains Without Borders

The East Asian Tributary of the River of Life

To a biologist, East Asia is a natural history museum with an extensive collection of ancient relict species, species that once had a wide range but have now gone extinct except in a circumscribed area. Yet with its convoluted topographies and relatively mild climates, it is also a cradle of life, in which sundry endemic species have evolved.

Today, East Asia is home to over 1.6 billion people, but long before humans proliferated here, it was already the most vital place on earth. From space, the lush forests of East Asia resemble green rivers that appear to flow into the Pacific. Everywhere these forests grow, from the tropical rainforests in the south to the boreal forests of the north, and even in the tundra beyond, there are diverse habitats, homes for countless species. Above sea level since the late Cretaceous (145–66 mya), East Asia contains a mighty tributary of the river of botanical life that has not run dry in tens of millions of years. This tributary rounds the tallest mountains in the world, majestic peaks studded with numerous niches, places for new species to evolve. Compared with the Mongolian steppes, barren since the last Ice Age, and the Tibetan Plateau, which weathers the cold Siberian wind year round, warm and humid East Asia is like a land of Canaan. Undisturbed since the early Neogene (23.03–2.58 mya), this land has provided a refuge for "relict" plants and animals, species whose ranges have been curtailed by drastic prehistoric climate change events.

The distinctive natural history of East Asia has made it a phytogeographic region in its own right. It is in fact the phytogeographic region with the greatest plant diversity in the Northern Hemisphere. Many scientists believe that the reason for this diversity is that East Asia was largely spared the ravages of the last Ice Age. It has been a green world there for tens of thousands of years. Approximately 26,000 years ago, around the time of the Last Glacial Maximum, devastating continental glaciers developed in the high latitudes and moved southward through North America and Europe, wiping out any plants that were unable to adapt or migrate fast enough. A continental glacier also developed in the Far East, but it was much more restrained. Outside the glacier cover, on the high-latitude plains, grew a taiga composed of forests of hardy tamarack, in particular the Gmelin larch (*Larix gmelinii*), inlaid with vast meadows of drought-tolerant grass, a pattern that held all the way to the foothills of coastal ranges to the north of Vladivostok. There were monsoon deserts at warmer latitudes to the south, but many areas were nevertheless covered in large evergreen broadleaf forests. In areas with consistently higher humidity, such as mountains or coastal areas, other types of temperate forest flourished. At higher and lower latitudes, temperate forests fashioned a Noah's Ark that vouchsafed the survival of the ancestors of many living East Asian plants.

Today, this Ark remains home to more than 50,000 species of plant, including almost twenty endemic families. Twenty is impressive compared to most of the world's floristic regions, which rarely have more than five. Among the 50,000 species are the living fossils ginkgo (*Ginkgo biloba*, in the endemic family Ginkgoaceae) and the Cathay silver fir (*Cathaya argyrophylla*, in the endemic genus *Cathaya*), both witnesses to the extinctions of the Ice Age. There are also tree species of sassafras (*Sassafras*) and tulip tree (*Liriodendron*) in disjunct distribution with distant North American relatives; and there are species of poppy (in *Meconopsis*) and thistle (in the *Eriocoryne* subgenus *Saussurea*) whose cyan hues are striking against a background of whites and blues on the world's tallest mountains. Over 400 species of primrose (*Primula*) and 600 species of lousewort (*Pedicularis*) turn 3,000-meter high mountains into palettes of color in spring and summer. On misty rainforest floors, four species of corpseflower (*Sapria*) open their bloody mouths and silently hiss, while species of keruing (*Dipterocarpus*) tower high above, whirling their winged fruits into the air at harvest time.

East Asia's rich floral diversity is not just a botanical feast for the eyes, it is also food for thought. Where did it come from? How has it been maintained? We can answer these two questions in terms of the spread of species from place to place or the exchange of species between places. The plants that took refuge in East Asia during the Ice Age did not rest on their laurels, so to speak. Spreading their seeds in all directions, they set off on multigenerational journeys, leaving traces of their passage behind, clues that we can investigate in order to model the formation of the plant world we see today. The most arduous journeys were undertaken by alpine plants, the ones that live above the tree line. In addition to relict plants, East Asian flora has always been known for its alpine plant diversity. Orogeny since the Neogene has gradually raised East Asian horizons, and lofty peaks from the Himalayas in the west to the Hengduan Mountains in the east not only drastically altered the East Asian landscape but also turned it into a seedbed for plants that could tolerate higher altitudes. During the Ice Age, these plants spread along temperature and humidity gradients in all directions. Particularly heroic travelers made it as far south as Sundaland, a Neocene landmass consisting of mainland Southeast Asia, Sumatra, Java, Bali, Borneo, and Mindanao. Other travelers ventured eastward to climb the peaks of Formosa on the edge of the Asian continental shelf. Their odysseys are the epics of the plant world.

Having outrun a continental glacier 26,000 years ago, the Ark of East Asian plant diversity is now leaking and listing. Refugees of the Anthropocene – victims of the human impact on global climate patterns and local ecosystems since the late 18th century – the two groups that make East Asian flora so distinctive are now threatened with extinction: relict plants are being deterritorialized by 1.6 billion people, while alpine plants are slowly getting cooked to death by anthropogenic global warming. The loss of plant diversity is not just a matter of the extinction of individual species, one by one. Because all species are linked in the web of life, the loss of one can have knock-on effects, twisting the web out of shape and causing strands to break. These effects are risks that we are unable to assess with current technology, let alone mitigate. That is why, if most of East Asia's relict and alpine plants do disappear, it might well be an ecological calamity. But it would also be a tragedy that only the perpetrators would be around to mourn, of the erasure not only of plants from the face of the earth but also of the ancestral memory, the annals of vegetal history, that each plant carries in its cytoplasm, the tiniest tributary of the river of life.

Taiwan: the “Pearl of the Orient”

“Formosa is indeed the ‘Pearl of the Orient’ and her crowning glory are the magnificent forests of ever-green Lauraceae and Fagaceae, the gigantic Chamaecyparis *and the lofty Taiwanias which clothe her steep and rugged mountains.”*

Ernest Henry “Chinese” Wilson

Known for centuries as Ilha Formosa, “beautiful island”, Taiwan is also the most beautiful green pearl of the “Oriental” botanical world according to Ernest Henry “Chinese” Wilson, a plant collector who is remembered for his travels in China in the 1910s. Home to both temperate relict and alpine plant species, Taiwan contains a microcosm of East Asian flora. Thanks to its geographical location, insular humidity, and subtropical climate, Taiwan has become one of the most important Ice Age plant refuges. Taiwan has a land area of only 36,000 square kilometers, but many East Asian relicts cluster here. It has a geographical history of no more than six million years, but the natural history of the island’s native plants can be traced back tens of millions of years to the eras in which East Asian endemics evolved.

Taiwan is also distinctive as an *alpine* island. To many botanists, mountainous terrain is probably the most precious and unique natural asset that the earth has given to Taiwan. The complex topographies and microclimates of the island’s mountains, over two hundred of which rise to over three thousand meters above sea level, are the drivers of plant diversity, providing more-than-ample three-dimensional space for the evolution of more than a thousand species of endemic plant. These endemics are particularly numerous in the alpine zone, which lies *above* the tree line. More than half of Taiwan’s alpine plants are endemics, making the flora they compose one of the island’s most unique.

More so than other islands in East Asia’s island arcs – the Japanese archipelago and the Ryukyus – Taiwan is like a plant exchange station, due to its serendipitous location, at the eastern edge of the range of Himalayan plants and at the southern extreme of the range of temperate plants. Taiwan also happens to be a rest stop for plant travelers from the Southern Hemisphere. No wonder the first naturalists who visited Taiwan marveled at the plants they encountered in the mountains. Having landed on what they expected to be just another island, they discovered the distillation of the flora of the Northern Hemisphere, with some Antipodean plants thrown in for good measure. They have written about their travels and their plant discoveries. One encountered *Chaerophyllum involucratum*, a herb from equatorial mountains that is found nowhere else in East Asia, in a glacial landform on Hsuehshan, the second highest *shan*, mountain, in Taiwan. Another climbed to the summit of Yushan, Taiwan’s highest *shan*, to see a Formosan edelweiss, a blossom of snow that had traveled through time and space, to bloom and grow forever at 3,952 meters above sea level, unafraid of the frost.

Biogeography: A Window on Taiwan's Plant Diversity

Many naturalist visitors to Taiwan over the past two and a half centuries have seen the natural history of the island through the prism of biogeography. Biogeography assumes that evolutionary history is inseparable from geological history; it is the study of patterns in the distribution of organisms on Earth, especially in relation to environmental change. When it first emerged in the early nineteenth century, it overlapped with other branches of the natural sciences, particularly ecology. Although still sometimes regarded as subdiscipline of ecology, biogeography is generally considered a discipline in its own right, with its own purview, history, research aims, methods of data gathering and analysis, theory, and institutions: there are learned societies, journals, and departments of biogeography. No doubt it remains interdisciplinary, in that ecology is one of many ways of approaching properly biogeographic problems.

Biogeographers have always been interested in explaining "species distribution", the spatial distribution of species. When a map is laid out, biogeographers intuitively ask three questions: What organisms are on the map? Where are they? Why are they there? Generally speaking, these questions can be answered in terms of the notion of biological "niche". A niche is the position a species occupies, or the role it plays, in a "habitat". A habitat has been defined as a "multidimensional resource space" that contains resources organisms need to fulfill their needs. Different organisms can survive in the same space by playing different roles, like actors in a theatrical production. Theoretically, the distribution of a species should depend largely on the distribution of its habitat in the natural world. In the real world, however, a suitable habitat often has a niche that is left unfilled or filled by something else. Imagine a dramatic production in which nobody bothers to audition for a certain part; imagine yet another production in which an actor gets passed over for a part he has played many times before. In botany, such cases show that there are other factors at work, which theory has to account for.

Biogeographical studies can be ecological or historical depending on the different spatiotemporal scales of the phenomena under investigation. Ecological studies are small in scale (a forest or a wetland over decades to centuries) while historical studies are large (a mountain range or an island over tens of thousands to tens of millions of years). Ecological and historical biogeographers have different theoretical perspectives on discrepancies in niche occupation. In ecological biogeography, the actual distribution of species in a habitat is understood in terms of modes of interaction between species. When a species interacts with other species, for instance, through competition or predation, the actual size of its niche is smaller than the theoretically available size. Different populations of a species may have different food sources or be subject to different pathogens in different pockets of the same habitat; the distribution of these resources and threats should bear some relationship to the distribution of the species in the habitat.

From a historical perspective, the discrepancies between the theoretically possible and the actual distribution of organisms in a habitat also result from broader geohistorical factors. For instance, although the environmental conditions in the Himalayas and the Andes are similar, their biota are very different. Why should this be the case? Because of differences in their orogenic histories and the origins of their native biota. In other words, the two ranges have different natural histories, which historical biogeographers compare in order to explain the present-day biological distribution.

From both ecological and historical perspectives, biological dispersal (seed dispersal by plants, migration by animals) is the final factor to include in explanations of the actual distributions of organisms. For plants, trends in seed dispersal at a regional scale are associated with short-term climatic fluctuations and the dynamics of fruit-feeding animal populations. From a macro-historical perspective, large geological and climatic events (such as the isolation or confluence of ancient seas or the formation or disruption of monsoon systems) are relevant to the ability of plants to spread between suitable habitats, as are the distances between geographic regions.

Alexander Keith Johnston, a Scottish geographer and cartographer, first published this map of the "geographical distribution of plants according to Humboldt's statistics" in 1848. It is Humboldtian because it presents Alexander von Humboldt's theories that "altitude mimics latitude" and that "everything is uncannily connected". Humboldt, in fact, is known as the father of the biogeography, which at the time included geology, hydrology, meteorology, botany, zoology, and even ethnology: for Humboldt, all scholarly disciplines were connected. If not quite as multidisciplinary as it was in its infancy, biogeography remains interdisciplinary today.

The Past and Present Lives of Taiwan's Montane Plants

"Then, you have a man of broad learning and rhetorical skill trace the origins of mountains and rivers, name all the herbs and trees, categorize things, classify events, put words together, like joined to like."

Mei Sheng, "Seven Discoveries," translation based on D. R. Knechtges and J. Swanson

My folks used to take me up to Hehuanshan, one of the most popular alpine destinations in central Taiwan. In the summer, the high season, the observation deck at the highest point on any highway in Taiwan was always the most lively corner of the mountain. I loved that observation deck, not for the view of Hehuanshan, but because of the little gravel slope on the other side of the railing. On that slope grew a sparse stand of dwarf arrow bamboo (*Fargesia demissa*). In the gaps between the bamboo bloomed beautiful blue wildflowers, a kind of gentian (*G. arisanensis*). To me, they looked spirited and radiant, even magical.

How could there be such a pretty plant near the peak of Hehuanshan? I wondered. Might gentians that looked otherwise identical bloom in different colors, perhaps somewhere nearby? Would they bloom only in Taiwan, or around the world?

I imagine a lot of people who visit Hehuanshan have seen *Gentian arisanensis*. Some of them might have asked similar questions to mine. But how many of them keep exploring when they go home? And how many armchair explorers know that if you go in search of answers, you will, like the naturalists who entered what was apparently a fantasy world on the peaks of Taiwan's tallest mountains in the early 20th century, have to reckon with the island's natural history? At the time, it was largely "untranslated", but today geologists have reconstructed the history of the mountains and biogeographers the past and present lives of the plants that live on those mountains. Biogeographers have shown that *Gentian arisanensis* is an endemic species, one that is found only in Taiwan, not just on Hehuanshan but also on Alishan, hence the species epithet. They have also shown that it is closely related to other endemic species of yellow or white gentians that bloom on other Taiwanese peaks and more distantly related to congeners – species in the same genus – in the Hengduan Mountains, where its ancestors may have originated over twenty million years ago and two thousand kilometers away.

The gentian I saw on Hehuanshan, whose ancestors set out across Mainland China and the Taiwan Strait, is not the only plant species in the Central Mountain Range that has undertaken such an incredible multigenerational odyssey. Wherever they came from, and wherever they went, how did they make the trip? Unable to get up and walk, most plants spend their lives rooted in a certain patch of soil, but they have outstanding mechanisms of seed dispersal. Seeds can float on the wind or the ocean waves. They can hitch a ride on the coats or in the guts of animals. Given time, they can chance to cross various geographical barriers, including some that not even animals are up to because they can live at altitudes and in conditions that animals cannot tolerate. Taiwan's alpine plants have relied on their own power of propagation to come to the island and climb its peaks via different routes and through different contingencies. They have adapted to changing circumstances, some evolving into new species, some going extinct. In the end each of them has become an ecological detail, a pixel in the biological panorama of forest and meadow we see today.

In "Seven Discoveries", a piece of "rhymeprose" composed by a man named Mei Sheng over two millennia ago, a learned man was sent out to explore the "mountains and rivers", which we would call the "environment". He was to evaluate the names of the "herbs and trees", which we would call "plants". Then he was to indulge the pleasures of literary creation upon natural themes. In the past two hundred years, many learned men and women, both residents of and visitors to Taiwan, have tried to record the island from various perspectives, exploring aspects of its significance. A famous aerial videographer, Chi Po-Lin, shot Taiwan from above for the award-winning documentary *Beyond Beauty*. Generations of writers have told stories about the relationship between human beings and the land. Every year, hikers go around or across the island, step by step. By now you can guess how biogeographers would understand Taiwan, by reading evolutionary histories from the species that compose its insular biota.

In our imaginations, we biogeographers transcend the limitations of space and time to trace the invisible river of life that flows deep in every species. We take in all the things we see along the way, each divergence (representing the evolution of distinct species) and every convergence (the formation of larger populations through exchange). We'll keep tracing the river until we reach the source at the summit of life, where the view is more sublime than any a climber might see from the top of Yushan.

About the Title

Although the terms used in this book are defined in appendix 1, there are two that deserve special mention here. One is in the subtitle, *The Odyssey of Taiwan's Montane Plants*. In this book, the term "montane plant" refers to temperate plants that live in Taiwan's mountains, mostly high-altitude peaks – which top out at 3,000 to 4,000 meters above sea level – but including some lower altitude prominences.[1] "Montane" may sound rather technical, and I want to explain why I have chosen it over the more familiar term "alpine". It has to do with the definition in ecology of alpine in relation to the "tree line".

The loose definition of "tree line" or "timber line" is the line above which plants with an arboreal habit – i.e., trees – are unable to grow to their normal heights, whether because of low temperature, high wind, or poor soil.[2] Despite the name, you seldom see a line of trees in the mountains in nature. You see instead a belt of rapid ecological transition called an "ecotone." There are trees in this belt, but they have been forced into a "crawling" posture, the habit of a shrub. Each edge of the belt is blurry: trees at the lower edge are only slightly stunted, while at the higher edge they are twisted and gnarled. Above the higher edge, no trees can grow at all. In ecology, mountain tops from the tree "line" up are termed alpine environments. That is why I haven't used the term "alpine plants" in the subtitle, because I am discussing temperate plants, which in Taiwan grow above, in, and even below the tree line. "Montane" includes all of these temperate plants in the Taiwan context.

Montane is obviously cognate with mountain, but there is actually no precise definition of the term "mountain" in geography. Generally, a mountain is steeper than a hill, with a prominence of three hundred to five hundred meters or more. However, in subtropical Taiwan, temperate plants are distributed at a certain altitude, usually at or above fifteen hundred meters above sea level. Obviously, in a book about temperate plants, I will not be discussing plants growing on prominences which may fit the above definition of mountain but which mostly fall below this altitude. Instead, I will discuss plants growing on prominences tall enough for tree lines to form, which happens to be the ecological definition of mountain. Many of the mountains in Taiwan's Central Range do in fact have tree lines. These mountains are local hotspots for the distribution of temperate plants.

I began with a view of a small corner of the world, a view of the beautiful blue bloom that I saw as a boy and that got me curious about issues in biogeography, particularly insular endemism, the evolution of new species in islands, whether physical islands like Taiwan or evolutionary islands like mountains. In chapters 1 and 2, I explore the origins of two endemic

[1] Translator's note: The word 山 *shān* in Mandarin can refer to both mountains and hills, however distinguished. It can be combined with modifiers to produce portmanteaux like 小山 *xiǎoshān*, little *shān*, "hill," and 高山 *gāoshān*, meaning "mountain."

[2] *Stricto sensu*, a tree line is typically understood as forming under the constraint of temperature upon plant growth.

alpine plants, the red cypress (*Chamaecyparis formosensis*) and the mountain lavender (*Oreomyrrhis involucrate*) to lead you beyond a superficial appreciation to a biogeographical understanding of their natural histories. To explore endemism further, I discuss the rapid speciation of barberry (*Berberis sp.*) in chapter 3. In chapters 4 and 5, I contrast the emergence of "new" endemism in two local genera, one acanthus and one orchid, to the persistence of "old" endemism in Taiwan's conifers. In chapters 6, 7, and 8, I focus on three groups of endemic montane plants: temperate plants of Japanese ancestry, limestone-tolerant plants like edelweiss, and alpine plants, the ones that only live *above* the treeline. The afterword, "The Blue Poppy of the Himalaya," speaks to how this book came to be, and where my research has taken me, to the Xishuangbanna Biosphere Reserve in southwestern China, in the basin of the rivers that flow down from the Hengduan Mountains.

I hope it is clear by now that the book you hold in your hands is not just a natural history of Taiwan's montane plants. Each high mountain herb or tree discussed herein is a crystallization of global biogeography. Each is also the hero in a multi-generational epic, an odyssey that begins in a distant land and that ends at high altitude in Taiwan. Let me be your Homer (in R. A. Lattimore's translation of *The Odyssey*), and I will tell you of herbs of many ways, which were driven far journeys, after quitting secret homelands for distant islands. Most of all, let me be your William Blake (in "Auguries of Innocence"):

> To see a World in a Wild Flower,
> or a tree, in the fullness of time;
> shrink a millennium into an hour,
> and a geologic epoch into a climb.

Chapter 1: *Chamaecyparis*'s Disjunct Distribution in East Asia and North America

Beyond the construction camp of Niman-daira (二萬平, a railway station), where we again met the railway track at its terminus, we found ourselves on a steepish northern slope covered with the most wonderful forest it has ever been my luck to see. The Benihi trees were here almost a pure stand and grew to their maximum size and age. Few people would believe that such trees exist. The average tree showed a girth of 30 ft. and height of 150 ft., but of the height only some 50 ft. was trunk; where the trunk ended, suddenly as if it had been lopped off at some time by some giant hand, three or more erect arms continued upwards to terminate in a brush-like manner in somewhat scanty branches and foliage.… The great trunks were reddish in color and fluted with soft bark reminding one of Redwood.… Instinctively one thought of the "big trees" of California, surely the Benihi's only rivals.

William R. Price, Plant Collecting in Formosa*, 1982, pp. 22–23.*[3]

[3] William R. Price (1886-1975) was a field collector at Kew. As he relates in the introduction to *Plant Collecting*

Imagine Price's Surprise

You may have heard of the grove of coniferous giants Price saw, but you couldn't have seen it for yourself.

The *benihi*[4] trees in the grove were harvested for military materiel and building material by the Japanese until the end of the Second World War, and by the Chinese nationalists after, until they were all cut down. Price's exclamation of amazement seems in retrospect like an elegy for the majestic *Chamaecyparis* cypresses of Alishan.

> *A "continental island" like Formosa, which in its small area ranged to altitudes of 13,000 feet, and lying on the Tropic of Cancer, it was obvious even to me then, was something of an exciting hunting ground for an energetic collector.*
>
> *Price, ibid., p. 1.*

Still in his mid-twenties, Price was sent by the Royal Botanical Gardens at Kew to assist Henry John Elwes, a renowned British botanist and lepidopterist, on a collecting trip to Taiwan. In February 1912, he and Elwes arrived by steamer in Tamsui Harbor. After a stay of a few days in Taipei, they embarked south on an expedition to Alishan in the company of a Japanese colleague named Kanehira Ryozo. Why Alishan? Not just because of the trees. The Japanese were still "pacifying" the indigenous peoples in the alpine areas to the north. Moreover, Alishan was more accessible, as construction of the Alishan Forest Railway was in full swing. Price was lucky enough to encounter the mountain's native forest right before the sawing started. Among the many species on Alishan, the *benihi* or red cypress particularly impressed him. It reminded him of the giant sequoia (*Sequoiadendron giganteum*), a California conifer that was once considered the largest organism in the world.

Upon its discovery by Western science in 1853, the giant sequoia unended ideas about the potential size of plants. Forty-nine years later, Japanese botanists were shocked anew to discover the Taiwan red cypress, which belied their assumptions about the size of species in the genus *Chamaecyparis*. The *benihi* was quite a bit bigger than the *hinoki* (*Chamaecyparis obtusa*) they had known in Japan. It was nearly as large as the giant sequoia. They immediately introduced it to the international botanical community as the "mammoth tree of East Asia". Probably due to the language barrier and the lack of photographic evidence, the announcement did not make much of

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in Formosa, he kept a collection diary during his trip to Taiwan, but only edited it five decades later. The edited diary was published posthumously as a book by the Chinese Forestry Society of Taiwan in 1982. The book is part travelogue and part botanical list.

[4] Translator's note: *benihi* (紅火) is *beni hi*, red fire. The red is the color of a dye extracted from the *beni*, the safflower, and then abstracted into a color. The tree has been described in Mandarin as *huǒzhīmù* 火之木, tree (or wood) of flame.

an impression. Only when Elwes and Price saw it in person at Alishan were they convinced of a Taiwanese rival to the giant sequoia.

The *benihi* from the east and the giant sequoia from the west are among the most famous trees in the Northern Hemisphere by virtue of their immense size. Yet although both have evolved similarly large bodies and belong to the cypress[5] family, they are very distantly related. Taxonomically, the giant sequoia is the only living member of the *Sequoiadendron*[6] genus in the Sequoioideae subfamily, while the *benihi* belongs to the *Chamaecyparis*[7] genus in the Cupressoideae subfamily. Their most recent common ancestor lived about a hundred and eighty million years ago. Ecologically, they are also a study in contrasts: the giant sequoia likes fire and the red cypress water. Fire figures in a giant sequoia's life history and survival strategy. Thick bark allows it to survive fires that destroy competitors, clearing the ground for seedlings. Cones that open in response to roasting spread the seeds that therefore have a better chance of receiving the abundant sunlight they need to grow. Today, giant sequoias are found in a few pure stands in valleys in the Sierra Nevada of eastern California. The *benihi*, by contrast, lives on slopes in the cool, humid, green central mountains of Taiwan, which is why it is sometimes referred to as the cloud forest giant. Apart from these basic biological and ecological differences, however, the biggest difference between the giant sequoia and the red cypress may be found in their respective fates at the hands of humans.

In the mid-nineteenth century, a pioneer on a hunting expedition happened upon the biggest tree he had ever seen; but instead of feeling overwhelmed in the presence of the majesty of nature, the men who came to see it when word of its existence spread were inspired to conquer it. On June 27, 1853, after nearly three weeks of sawing, the first giant sequoia was felled by gold prospectors. It was front page news, and tabloid fodder. People kept cutting the trees down for the next forty years. They cut mature trees, even though the wood is too soft and brittle to build with, and younger trees, whose wood had some economic value. It was not until the turn of the century that the plight of the giant sequoia entered the public eye, by which time a third of the groves of giant sequoias had disappeared. With advocacy, particularly by John Muir, the "big tree" became "Nature's forest masterpiece", a priceless work of art in need of conservation. The giant

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[5] Growing in the northern and southern hemispheres in diverse habitats, from humid temperate rainforests to deserts, the cypress family is the most widely distributed group of gymnosperms. It is also the most diverse, with 22 genera, two of which contain the tallest and largest trees in the world: *Sequoia* and *Chamaecyparis*.

[6] Translator's note: The giant sequoia, *Sequoiadendron gigantum*, is also known as the giant redwood, in contrast to the redwood, *Sequoia sempervirens*. *Sequoiadendron* means "Sequoia's tree," in honor of the inventor of the Cherokee syllabary.

[7] Widespread in the Northern Hemisphere during the Paleocene (65-55 mya), when the Earth was significantly warmer than it is today, *Chamaecyparis* is a relatively ancient group of gymnosperms. Only six species survive, with a substantially limited distribution, on warm, humid coasts or mountains on either side of the North Pacific. Two of them are endemic to Taiwan, the Taiwan red cypress (*C. formosensis*) and the Taiwan cypress (*C. taiwanensis*), two to Japan, and two to North America. Although none of the species is a dwarf, the Latin genus name is derived from the Greek *chamai* and *kuparissos*, meaning dwarf cypress. A distinguishing character of the genus is exceptionally small female cones.

sequoia is a star in the story of the development of the American National Park System at about the same time as the discordant dirge of the red cypress was about to sound. The red cypress was branded a natural resource by the Japanese colonial authorities, which built infrastructure to exploit it. The fate of the red cypress was placed in the hands of "logger" barons.

Explanatory Box: The Secrets of the God Tree's Longevity

The growth of woody plant stems can be analyzed into primary growth that makes them longer or taller and secondary growth that makes them wider or thicker. Once they reach a certain age, woody plants with an arboreal habit – i.e., trees – stop growing taller, but they keep getting thicker: the "vascular cambium" can form a new layer of phloem and xylem each year for as long as the tree lives. With centuries or even a millennium of growth, a tree with the right ancestry can attain the girth of a "God Tree".[8] How can trees live that long? The mechanism of tree longevity has always been a mystery, but according to the limited research that has been done on the topic, long-lived species have special physiological and genetic features. *Chamaecyparis* wood contains secondary metabolites that prevent fungal infection and termite infestation, and most species in the genus grow for about fifty years before flowering and fruiting. The vascular cambium of gingko God Trees remains productive throughout the tree's lifespan, nor does the function of immune-related disease resistance genes decline with age, allowing the trees to achieve a nearly ageless state.

Whether *Chamaecyparis* or ginkgo, God Trees only grow so long and large in the right climactic and geological conditions. There are too many pests and diseases, and too much competition for resources, in tropical climates for God Trees to grow. Nor can they grow in areas that see a lot of regional plate tectonic activity.

[8] Translator's note: The term *ShénMù* (神木), "God Tree," came to Taiwan from the Japanese *shinboku*. It generally refers to a gigantic, ancient tree. According to Taiwan's government, however, a *shénmù* is over 1,000 years old. Trees over 2,000 years old are super *ShénMù*. On this definition, age, not size, is what matters to a tree's deification.