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Postprint: Distribution Characteristics of National Key Protected Wild Plants in Hainan Province and Their Associated Vegetation Types

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Abstract

To reveal the distribution status and habitat characteristics of nationally protected wild plants in Hainan Province, this study, based on the 2021 edition of the "National Key Protected Wild Plants List" and employing methods such as data compilation and field surveys, investigated the distribution patterns and associated vegetation types of nationally protected wild plants in Hainan Province. The results show: (1) A total of 173 species belonging to 83 genera and 53 families of nationally protected wild plants are distributed in Hainan Province, ranking fifth among all provinces in China in terms of species number and first in species density (based on currently published data on nationally protected wild plants). (2) All 19 municipal and county-level administrative regions in Hainan Province have distributions of nationally protected wild plants, with the number of species in central and southern counties being significantly greater than those in northern counties. Among these, Changjiang Li Autonomous County has the highest species richness (75 species), and Lingshui Li Autonomous County has the highest species density (0.6045 ind. · km^2). The species numbers of nationally protected wild plants in Hainan Province are distributed across nine altitude intervals from 0–1867 m (with a gradient value of 200 m), showing a trend of slight decrease, sharp increase, and then gradual decrease with increasing altitude. The altitude intervals with the most species are 800–1000 m and 1000–1200 m, each with 81 species, while the interval with the fewest species is 1600–1867 m, with only 9 species. (3) The habitats of nationally protected wild plants in Hainan Province are complex, depending on 11 vegetation types. Lowland rainforest has the highest species richness (114 species), followed by montane rainforest (105 species), while semi-mangrove has the lowest (1 species). The vegetation type with the greatest degree of disturbance is freshwater wetland grassland, followed by lowland rainforest, and the

least disturbed is montane cloud forest. These research results can provide scientific reference for the conservation and utilization of nationally protected wild plants in Hainan Province.

Full Text

Abstract

To reveal the distribution status and habitat characteristics of nationally key protected wild plants in Hainan Province, this study—based on the 2021 edition of the *List of National Key Protected Wild Plants*—investigated the distribution patterns and underlying vegetation types of these species through data compilation and field surveys. The results show that: (1) Hainan hosts 173 species of nationally key protected wild plants, belonging to 83 genera and 53 families, ranking fifth among all Chinese provinces in species richness and first in species density (based on currently available data). (2) All 19 municipal and county-level administrative regions in Hainan contain nationally key protected wild plants, with species numbers in central and southern counties far exceeding those in the north. Changjiang Li Autonomous County exhibits the highest species richness (75 species), while Lingshui Li Autonomous County shows the highest species density (0.6045 ind. $\cdot$ km^{-2}). These species occur across nine altitudinal zones from 0 to 1,867 m (in 200 m increments), following a pattern of slight initial decline, sharp increase, then gradual decrease. The richest zones are 800 m $\leq$ Alt $<$ 1,000 m and 1,000 m $\leq$ Alt $<$ 1,200 m, each with 81 species, while the poorest zone is 1,600 m $\leq$ Alt $<$ 1,867 m with only 9 species. (3) The habitats are complex, with species relying on 11 vegetation types. Lowland rainforest supports the highest richness (114 species), followed by montane rainforest (105 species), while semi-mangrove supports the fewest (1 species). Freshwater wet grasslands experience the greatest disturbance, followed by lowland rainforest, with montane cloud forests experiencing the least. These findings provide scientific references for the conservation and utilization of nationally key protected wild plants in Hainan.

Keywords: Hainan Province; nationally key protected wild plants; species richness; species density; distribution characteristics; vegetation types

Introduction

Biodiversity is fundamental to maintaining ecological balance and serves as the basis for human survival and development (Eisenhauer & Hines, 2021). Since the Convention on Biological Diversity, biodiversity conservation and sustainable development have gained widespread societal attention (Kelbessa, 2022; Rodriguez-Urrego et al., 2023; Luo et al., 2023; Wang et al., 2023). As one of the world' s most biodiverse countries, China possesses abundant species and numerous endemics, yet faces severe threats from increasing human exploitation (Wei et al., 2021). Plant diversity—a core component of biodiversity—faces particularly serious threats, with accelerating habitat degradation and rapid loss

of genetic resources intensifying species endangerment. Urgent action is needed to protect endangered plant resources, especially wild populations and their habitats.

Following the 2021 release of the new *List of National Key Protected Wild Plants* (hereinafter "the List") by China's National Forestry and Grassland Administration and Ministry of Agriculture and Rural Affairs, scholars have proposed updated conservation recommendations based on the List's changes (Yang et al., 2021; Zhou & Jin, 2021). Subsequently, provincial researchers have reported on adjustments and current distributions in their regions. Some have compared old and new versions of the List, analyzing changes and diversity patterns (Chen et al., 2022a; Chen et al., 2022b; Tong et al., 2022), while others have examined geographical composition and distribution characteristics to reveal floristic features at different scales (Wang et al., 2022; Tian et al., 2023). However, for Hainan—one of China's most species-rich provinces—critical gaps remain: How are nationally key protected wild plants distributed? What are their habitat adaptabilities and conservation statuses? How do their habitats relate to regional vegetation types? These questions remain unanswered.

Located at China's southernmost tip in the northern tropics, Hainan contains extensive tropical rainforests (Yang et al., 2021). The province's tropical monsoon climate fosters exceptionally rich biodiversity, providing critical habitat for many rare and endangered species (Wu et al., 2021). This study analyzes the distribution and underlying vegetation types of nationally key protected wild plants in Hainan based on the List, field surveys, and data collection, aiming to clarify their current status and provide scientific foundations for conservation and utilization.

1. Materials and Methods

1.1 Data Sources

Using the 2021 List as our baseline, we identified 173 nationally key protected wild plant species in Hainan by consulting *Flora Reipublicae Popularis Sinicae* (1959–2004), *List of Species in Hainan* (Yang, 2013), *Illustrated Handbook of Plants in Hainan* (Volumes 1–14) (Yang et al., 2015), *Study on the Illustrations and Distribution Characteristics of Rare and Protected Plants in Hainan* (Yang et al., 2016), and *Vegetation of Hainan* (Volume 1) (Yang et al., 2019). Species distribution data primarily came from field surveys. Data on other provinces' administrative areas and species numbers were obtained from official websites and published literature (Chen et al., 2022a; Chen et al., 2022b; Liu et al., 2022; Tong et al., 2022; Wang et al., 2022; Yang et al., 2022; Fang et al., 2023; Huang et al., 2023; Tian et al., 2023; Yi et al., 2023; Zhang et al., 2023).

1.2 Analysis of Distribution Characteristics and Vegetation Types

We analyzed distribution patterns across two dimensions. For horizontal distribution, we counted species numbers by municipal/county administrative units

and applied species-area relationship theory to eliminate area effects: Ns = cA^z, where Ns is the number of protected species in a county and A is the county area (Xu et al., 2018). For vertical distribution, we used 200 m altitudinal intervals based on each species' elevation range, allowing repeated counting across zones.

Vegetation types were classified using Yang et al.' s (2021) Hainan vegetation system. Hainan' s vegetation comprises natural and artificial types; protected plants occur only in natural vegetation, which includes 14 formation types with 29 subtypes. To accurately reflect habitats, we used subtypes as our statistical unit.

2. Results

2.1 Horizontal Distribution

2.1.1 Provincial-Level Distribution Hainan hosts 173 nationally key protected wild plant species (53 families, 83 genera), including eight first-class species: *Cycas taiwaniana*, *C. rumphii*, *C. shanyagensis*, *Hopea hainanensis*, *Lumnitzera littorea*, *Cymbidium insigne*, *Paphiopedilum appletonianum*, and *P. purpuratum*. The remaining 165 species are second-class, including *Leucobryum juniperoideum*, *Phlegmariurus carinatus*, *Angiopteris hainanensis*, and *Vatica mangachapoi*.

Comparison with other provinces (Table 1) shows Hainan ranks fifth in species richness but first in species density at 0.4920 ind. $\cdot$ km^{-2}.

2.1.2 Municipal and County-Level Distribution All 19 municipal/county administrative regions in Hainan contain nationally key protected wild plants (Figure 1). Excluding Sansha City, species density generally correlates with richness. The central and southeastern regions host the highest diversity, with eight counties exceeding 0.5 ind. $\cdot$ km^{-2}: Changjiang Li Autonomous County (75 species, 0.5842 ind. $\cdot$ km^{-2}), Baisha Li Autonomous County (72 species), Lingshui Li Autonomous County (70 species, 0.6045 ind. $\cdot$ km^{-2}), Qiongzhong Li and Miao Autonomous County (70 species), Ledong Li Autonomous County (62 species), Baoting Li and Miao Autonomous County (56 species), and Sanya City (50 species). The remaining 11 counties show dramatically lower richness (<30 species) and density (maximum 0.4377 ind. $\cdot$ km^{-2}).

Notably, Changjiang has the highest richness (75 species) while Lingshui has the highest density (0.6045 ind. $\cdot$ km^{-2}). Counties with fewest species include Ding' an, Chengmai, Tunchang, Lingao, and Sansha (<10 species). Sansha has only three species (*Suriana maritima*, etc.) due to its coastal location, high soil salinity, and small area (20 km^2), yet its density (0.3677 ind. $\cdot$ km^{-2}) exceeds Wenchang' s (15 species, 0.3468 ind. $\cdot$ km^{-2} across 2,459.98 km^2).

[Figure 1: see original paper]

2.2 Vertical Distribution and Vegetation Types

2.2.1 Altitudinal Distribution Patterns Across Hainan' s elevation range (0–1,867 m), we identified nine 200 m zones. Species richness shows a "slight decline–sharp increase–gradual decline" pattern (Figure 2). Below 200 m, non-zonal vegetation (mangroves, coastal psammophytic jungles/scrub, freshwater wet grasslands) hosts 34 species. From 200–400 m (semi-deciduous monsoon forest to lowland rainforest transition), species numbers are relatively low. The 400–800 m lowland rainforest zone, with some montane rainforest, marks the start of peak richness, which continues through the 800–1,000 m and 1,000–1,200 montane rainforest zones (81 species each). Above 1,200 m, vegetation includes montane rainforest, montane coniferous forest, montane top scrub, and montane cloud forest—while vegetation types diversify, species numbers decline to just nine species at 1,600–1,867 m.

[Figure 2: see original paper]

2.2.2 Vegetation Type Composition Protected plants inhabit 11 vegetation types (Figure 3; Appendix Table 1). As Hainan' s representative vegetation, tropical rainforests along altitudinal gradients provide habitat for most species: lowland rainforest (114 species) with *Vatica mangachapoi*, *Hydnocarpus hainanensis*, and *Amoora tetrapetala*; montane rainforest (105 species) with *Ophioderma pendulum*, *Calocedrus macrolepis*, and *Ormosia xylocarpa*; tropical montane coniferous forest (only *Pinus kwangtungensis* and *P. massoniana* var. *hainanensis*); montane top scrub on karst terrain (*Quercus bawanglingensis*, *Dracaena cambodiana*, *Cycas taiwaniana*); and montane cloud forest (21 species of lycophytes and epiphytic orchids like *Huperzia javanica*, *Cymbidium insigne*, and *Dendrobium nobile*).

Freshwater wet grasslands and semi-deciduous monsoon forests each host eight species, but in different regions: freshwater wet grasslands in northern Hainan (*Ceratopteris thalictroides*, *Ottelia cordata*, *O. alismoides*); semi-deciduous monsoon forests in the drier southwest (*Paranephelium hainanense*, *Hainania trichosperma*). Coastal azonal vegetation provides fragmented habitats: coastal (island) psammophytic jungles (six species: *Vatica mangachapoi*, *Cordia subcordata*); coastal (island) psammophytic scrub (three species: *Pemphis acidula*, *Suriana maritima*, *Glehnia littoralis*); mangroves (four species: *Xylocarpus granatum*, *Nypa fruticans*, *Lumnitzera littorea* in true mangroves; *Hernandia nymphaeifolia* in semi-mangroves).

[Figure 3: see original paper]

2.3 Vegetation Type Characteristics

Hainan' s protected plants rely on 11 vegetation types: six zonal and five azonal. These vegetation types are closely linked to species distributions.

Zonal Vegetation Zonal vegetation forms along altitudinal gradients, comprising montane cloud forest, montane top scrub, tropical montane coniferous forest, montane rainforest, lowland rainforest, and semi-deciduous monsoon forest.

(1) Montane Cloud Forest. Located on high-elevation peaks with persistent fog, strong winds, saturated humidity, and stunted canopies, these forests support humidity-sensitive species, particularly epiphytic orchids. Wang et al. (2022) found orchids dominate epiphytic vascular plants in Hainan' s cloud forests, which also host lycophytes like *Huperzia javanica* and *Phlegmariurus mingcheensis* (Dong et al., 2003; Long, 2011; Wang et al., 2011). Bawangling' s cloud forest is the only known habitat for *H. javanica*. Within Hainan Tropical Rainforest National Park, minimal human activity ensures good protection.

(2) Montane Top Scrub. Restricted to karst terrain with poor, dry soils, abundant light, strong winds, and high rainfall, these scrublands support many dwarf woody and herbaceous endemics like *Cycas taiwaniana*, *Dracaena cambodiana*, and *Quercus bawanglingensis*. The latter occurs only on Eyingling' s summit scrub. Though populations face little human interference, limited expansion on rocky terrain drives endangerment.

(3) Tropical Montane Coniferous Forest. At relatively high elevations, these small, low-diversity stands form through species self-aggregation. Only *Pinus kwangtungensis* and *P. massoniana* var. *hainanensis* occur here—tall trees with wide crowns, high seed production, and strong reproductive capacity that dominate their communities. Both populations within the National Park are well-protected, though *P. massoniana* var. *hainanensis* faces threats from landslides on steep slopes.

(4) Montane Rainforest. Hainan' s most dominant vegetation type occurs on ridges and mid-upper slopes with ample light, low soil moisture, indistinct dominant species, short canopies, and sparse understories. Light human disturbance supports good species condition. It hosts drought-tolerant trees and habitat-specialist herbs as representative or occasional species. Representative species include *Alseodaphne hainanensis*, *Keteleeria hainanensis*, and *Ormosia balansae*—trees with high seed fat content requiring dry conditions to prevent mold (Chen et al., 2011). Occasional species include *Ophioderma pendulum*, *Leucobryum juniperoideum*, and orchids (Feng et al., 2023; Xu et al., 2015). Located in mid-high elevation central mountains with comprehensive protection measures, most endangered plants are well-conserved, though some poorly reproducing species with small populations remain threatened.

(5) Lowland Rainforest. Primarily in valleys and lowlands with abundant water and heat, high plant diversity, complex flora, and distinct strata, these forests suffer severe human disturbance and are mostly recovering, with high shrub density and species diversity. They support shade-loving, moisture-preferring species with high aggregation. Some stands are dominated by protected species: in Diaoluoshan's lowland rainforest, *Vatica mangachapoi* and *Heritiera parvifolia*

form monodominant or mixed stands (Han et al., 2019); in Ganshenling, *Hopea reticulata* dominates (Hu et al., 2017); in Tongguling' s lowland dwarf forest, *Hydnocarpus hainanensis* maintains dominance (Che et al., 2006). Though currently well-protected and recovering, economically valuable species like *Dalbergia odorifera*, *Cibotium barometz*, *Arcangelisia gusanlung*, and *Aquilaria sinensis* face severe human exploitation and small populations.

(6) Semi-Deciduous Monsoon Forest. In southwestern Hainan' s low-elevation, low-rainfall, dry habitats, these mixed deciduous-evergreen forests have lower diversity than rainforests and suffer severe human disturbance. Protected species are mainly drought-tolerant deciduous trees and herbs with some adaptable evergreens. This is the primary habitat for Hainan endemics *Paranephelium hainanense* (rare and scattered in Sanya) and *Hainania trichosperma* (clustered in Ledong). Other species include *Vatica mangachapoi*, *Heritiera parvifolia*, and *Oryza meyeriana* (Huang et al., 2009; Luo et al., 2018; Lü et al., 2021). Unprotected and heavily disturbed, *Paranephelium hainanense* and *Hainania trichosperma* face severe logging pressure.

Azonal Vegetation Azonal vegetation types are heavily degraded, with only five types supporting protected plants: freshwater wet grasslands, coastal psammophytic jungles, coastal psammophytic scrub, semi-mangroves, and true mangroves.

(1) Freshwater Wet Grasslands. Along river and reservoir tributaries in northern Hainan, these herb-dominated, fragmented, and polluted habitats support freshwater-dependent species with strict water quality requirements. They are the sole habitat for aquatic protected plants like *Ceratopteris thalictroides*, *C. shingii*, *Ottelia alismoides*, and *O. cordata*, which typically self-aggregate, though *C. shingii* and *O. cordata* occasionally co-occur. Located near villages with intense human disturbance, these highly sensitive species face extreme threats, particularly *O. cordata*, whose habitat is shrinking (Wu et al., 2023).

(2) Coastal Psammophytic Jungles. Near coastlines with sea wind influence and slightly saline soils, these low-diversity communities support salt-tolerant species. *Cordia subcordata* is the only protected species exclusively found here, while adaptable upland species like *Vatica mangachapoi*, *Renanthera coccinea*, and *Hydnocarpus hainanensis* also occur (Luo et al., 2008; Tao et al., 2014). Under pressure from tourism development, *C. subcordata*' s habitat is shrinking, with extremely few individuals and no protection measures.

(3) Coastal Psammophytic Scrub. On beaches and shores with severe sea winds and occasional seawater inundation, these high-salinity habitats support only a few shrubs and herbs. Protected species include the dwarf shrub *Pemphis acidula*, *Suriana maritima*, and the beach herb *Glehnia littoralis*. Beach development has drastically reduced their habitats, with *S. maritima* now extinct on Hainan Island and only found in Sansha.

(4) Semi-Mangrove. In the transition zone between mangroves and coastal

jungles, these mixed stands of mangrove and evergreen broadleaf species host only *Hernandia nymphaeifolia*. With few individuals and weak reproductive capacity, it now occurs only in Qionghai and Wenchang, though recent conservation measures have been implemented (Yang et al., 2019; Zhang et al., 2023).

(5) True Mangrove. Bordering the sea and perennially inundated with extremely saline soils, these habitats support only mangrove species. Among protected plants, only *Lumnitzera littorea*, *Xylocarpus granatum*, and *Nypa fruticans* occur. *L. littorea* suffers severe reproductive barriers, with only a few individuals remaining in Lingshui and Sanya (Zhang et al., 2018). *X. granatum* is well-protected in Sanya and Lingshui under mangrove conservation measures (Lu et al., 2019). *N. fruticans* occurs in clustered populations in Haikou, Wenchang, Qionghai, and Wanning (Zhang et al., 2023). As characteristic Hainan vegetation, mangroves have established protection measures for key species.

3. Discussion

3.1 High Species Diversity and Concentration in Hainan

Despite being China' s smallest province by land area, Hainan hosts 173 nationally key protected species (16.76% of China' s total) with a species density of 0.4920 ind. $\cdot$ km^{-2}, ranking first among 17 reported provinces. This demonstrates typical high-diversity, high-density characteristics at the provincial level, making Hainan a key region for protected plant diversity—a finding consistent with Yu et al. (2023). This richness stems from Hainan' s tropical monsoon climate with ample light, heat, and moisture, diverse vegetation types, and altitudinal gradients providing varied habitats and growth conditions.

However, uneven vegetation resources and economic development create substantial variation in species richness and density across Hainan' s counties. Central and southern Hainan, home to Hainan Tropical Rainforest National Park and multiple provincial nature reserves across 10 counties (Wuzhishan, Qiongzhong, Baisha, Changjiang, Dongfang, Baoting, Lingshui, Ledong, Wanning, and Sanya), maintains the most intact vegetation with highest diversity, serving as a refuge for many endangered and endemic species (Huang et al., 2023). Northern Hainan, with lower elevation, gentle terrain, and concentrated population, is the primary economic development zone (Zhu, 2012). Intensifying conflicts between development and conservation have fragmented native vegetation, shrinking suitable habitats and reducing protected plant distributions—a pattern consistent with habitat degradation in western Guangxi and southern Guizhou (Liu et al., 2013).

3.2 Relationship Between Distribution and Vegetation Types

Hainan's topography rises from low coastal plains to a central core of Wuzhishan and Yinggeling mountains. Protected plants inhabit 11 vegetation types (six zonal, five azonal) closely associated with altitude, moisture, topography, soil,

and plant composition. Species numbers decrease from central mountains to coastal areas.

Central mountains harbor Hainan' s largest tropical rainforest tracts, with five zonal vegetation types along altitudinal gradients (lowland rainforest → montane rainforest → montane coniferous forest → montane top scrub → montane cloud forest) providing suitable environments for most protected plants. However, distribution is uneven: species numbers decline with elevation, concentrating in lowland and montane rainforests at mid-low elevations. Lowland rainforest, with optimal water-heat conditions, contains the most species but suffers severe human disturbance and high threat levels. Montane rainforest, with lighter disturbance and well-preserved vegetation, is Hainan' s most dominant type and supports the second-highest species numbers.

Coastal lowlands feature azonal vegetation with distinct north-south differences. Northern Hainan only hosts freshwater wet grasslands with species like *Ottelia cordata*, *C. shingii*, and *O. alismoides*, but river pollution from unregulated development is shrinking these habitats, especially for the highly sensitive *O. cordata* (Wu et al., 2023). Southern Hainan also contains semi-deciduous monsoon forest (a second zonal type) in its driest southwestern region, hosting drought-tolerant species like *Paranephelium hainanense*, *Hainania trichosperma*, and *Vatica mangachapoi*.

Coastal azonal vegetation, regulated by salinity, includes coastal psammophytic jungles, scrub, semi-mangroves, and true mangroves. Species distribution correlates inversely with soil salinity: true and semi-mangroves, perennially inundated with extremely saline soils, host only one protected species each, while less saline coastal psammophytic jungles support more adaptable species.

3.3 Conservation Challenges and Recommendations

Hainan's plant diversity conservation relies mainly on in-situ protection through a relatively complete protected area system, including Hainan Tropical Rainforest National Park, national/provincial nature reserves, and forest/wetland parks. However, strengthened protection is needed due to the special habitats of key protected species. Current challenges include:

1. **Narrow habitats** for some species (e.g., *Huperzia javanica* in montane cloud forest, *Quercus bawanglingensis* in montane top scrub, *Hainania trichosperma* in semi-deciduous monsoon forest) limit resource availability, intensify competition, and severely impact survival and reproduction.
2. **Severe human exploitation** of economically valuable species. Wild populations of *Dalbergia odorifera*, *Cibotium barometz*, and *Arcangelisia gusanlung* have been drastically reduced by harvesting, with *D. odorifera* individuals largely eradicated from previously recorded sites.
3. **Severe habitat degradation and fragmentation** threaten extinction for freshwater species like *Ottelia cordata*, *O. alismoides*, and *Ceratopteris*

thalictroides, which are highly sensitive to pollution and habitat loss from urbanization and agricultural chemicals.

4. **Weak reproductive capacity** limits population recovery. *Chunia bucklandioides* has poor seed reproduction, relying mainly on sprouting, while first-class protected *Lumnitzera littorea* suffers severe reproductive barriers with only a few individuals remaining (Zhang et al., 2018).

5. **Inadequate protection outside nature reserves**. Scattered lowland rainforests and strip-distributed semi-deciduous monsoon forests lack protection, with expanding rubber, fruit, and betel nut plantations destroying habitats and populations of species like *Paranephelium hainanense* and *Hainania trichosperma*.

6. **Uncertain status** of some historically recorded species (*Alsophila costularis*, *Cycas rumphii*, *C. shanyagensis*, *Paphiopedilum purpuratum*) not found during surveys.

To address these challenges, we recommend: (1) Continue comprehensive population surveys, especially for species with uncertain distributions, establishing monitoring plots and a Hainan protected plant database to track habitat changes and population dynamics. (2) Implement in-situ protection as primary, ex-situ as supplementary: protect large populations in situ while maintaining habitat stability, and use ex-situ measures for small or narrow-habitat populations for later reintroduction. (3) Expand public education and participation in conservation, promoting lifestyle changes to reduce pollution. (4) Strengthen genetic diversity research for poorly reproducing species like *Chunia bucklandioides* to expand populations. (5) Establish protected micro-reserves and warning signs for unprotected species like *Paranephelium hainanense* and *Hainania trichosperma*. (6) Improve conservation regulations and enforcement. (7) Enhance rural economic development to promote transition from plantation expansion, ensuring sustainable conservation and utilization.

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Appendix Table 1. Vegetation Types Dependent on National Key Protected Wild Plants in Hainan Island

Species Name	Protection Category	Vegetation Type	Population Survival Status
Leucobryum juniperoideum	Category II	Montane rainforest, lowland rainforest, montane cloud forest	General (low populations)
Huperzia javanica (syn. *H. serrata*)	Category II	Montane cloud forest	Poor (fragile habitat, low populations)
Phlegmariurus carinatus	Category II	Montane rainforest, lowland rainforest, montane cloud forest	General (low populations)
P. fordii	Category II	Montane rainforest, lowland rainforest, montane cloud forest	General (low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
P. guangdongensis	Category II	Montane rainforest, lowland rainforest	General (low populations)
P. mingcheensis	Category II	Montane cloud forest	General (low populations)
P. petiolatus	Category II	Lowland rainforest, montane rainforest	General (low populations)
P. phlegmaria	Category II	Montane cloud forest	General (low populations)
P. taiwanensis	Category II	Montane cloud forest	General (low populations)
Helminthostachys zeylanica	Category II	Lowland rainforest	Poor (habitat destruction, low populations)
Ophioderma pendulum	Category II	Lowland rainforest, montane rainforest	Poor (habitat destruction, low populations)
Angiopteris acutidentata	Category II	Lowland rainforest, montane rainforest	General (low populations)
A. caudatiformis	Category II	Lowland rainforest	General (low populations)
A. cochinchinensis	Category II	Lowland rainforest	General (low populations)
A. crassipes	Category II	Lowland rainforest	General (low populations)
A. fokiensis	Category II	Lowland rainforest	General (low populations)
A. hainanensis	Category II	Lowland rainforest	General (low populations)
A. neglecta	Category II	Lowland rainforest	General (low populations)
A. oblanceolata	Category II	Lowland rainforest	General (low populations)
A. caudipinna	Category II	Lowland rainforest	General (low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
A. latipinna	Category II	Montane rainforest	Poor (anthropogenic harvesting, low populations)
A. somae	Category II	Montane rainforest	Doubtful population (historical record, not found)
A. tonkinensis	Category II	Montane rainforest	Doubtful population (historical record, not found)
Cibotium barometz	Category II	Lowland rainforest, montane rainforest	Poor (anthropogenic harvesting, low populations)
Alsophila costularis	Category II	Montane rainforest	General (low populations)
A. latebrosa	Category II	Montane rainforest, lowland rainforest	General (low populations)
A. gigantea	Category II	Montane rainforest, lowland rainforest	General (low populations)
Gymnosphaera podophylla	Category II	Montane rainforest, lowland rainforest	General (low populations)
Sphaeropteris brunoniana	Category II	Montane rainforest, lowland rainforest	General (low populations)
Ceratopteris thalictroides	Category II	Freshwater wet grassland	Poor (severe habitat destruction)
C. shingii	Category II	Freshwater wet grassland	Poor (severe habitat destruction)
Brainea insignis	Category II	Lowland rainforest, montane rainforest	Poor (severe habitat destruction)
Cycas taiwaniana	Category I	Lowland rainforest, montane top scrub	Doubtful population (historical record, not found)

Species Name	Protection Category	Vegetation Type	Population Survival Status
C. rumphii	Category I	Lowland rainforest	Doubtful population (historical record, not found)
C. shanya-gensis	Category I	Lowland rainforest	Doubtful population (historical record, not found)
Keteleeria hainanensis	Category II	Tropical montane coniferous forest	General (habitat damaged by landslides)
Pinus kwangtun-gensis	Category II	Tropical montane coniferous forest	General (low populations)
P. massoniana var. *hainanensis*	Category II	Tropical montane coniferous forest	General (low populations)
Calocedrus macrolepis	Category II	Montane rainforest, lowland rainforest	General (low populations)
Podocarpus annamiensis	Category II	Montane rainforest, lowland rainforest	General (low populations)
P. neriifolius	Category II	Montane rainforest, lowland rainforest	General (low populations)
P. pilgeri	Category II	Montane rainforest	General (low populations)
Cephalotaxus hainanensis	Category II	Montane rainforest	General (low populations)
Michelia gioii	Category II	Lowland rainforest	Poor (very low populations, dioecious)
M. shiluensis	Category II	Lowland rainforest, montane rainforest	Poor (very low populations, dioecious)

Species Name	Protection Category	Vegetation Type	Population Survival Status
Chieniodendron hainanense	Category II	Lowland rainforest, montane rainforest	Poor (anthropogenic harvesting, low populations)
Alseodaphne hainanensis	Category II	Lowland rainforest	General (low populations)
A. rugosa	Category II	Lowland rainforest	General (low populations)
Cinnamomum rigidissimum	Category II	Lowland rainforest, montane rainforest	General (low populations)
Hernandia nymphaeifolia	Category II	Coastal (island) psammophytic jungle, semi-mangrove	General (low populations)
Horsfieldia amygdalina	Category II	Lowland rainforest	Poor (very low populations, dioecious)
H. kingii	Category II	Lowland rainforest, montane rainforest	Poor (very low populations, dioecious)
Arcangelisia gusanlung	Category II	Montane rainforest, lowland rainforest	Poor (anthropogenic harvesting, low populations)
Bretschneidera sinensis	Category II	Montane rainforest	General (low populations)
Cladopus nymanii	Category II	Lowland rainforest	Poor (anthropogenic harvesting, low populations)
C. yinggelingensis	Category II	Lowland rainforest	General (low populations)
Terniopsis daoyinensis	Category II	Lowland rainforest	General (low populations)
Paracladopus chiangmaiensis	Category II	Lowland rainforest	General (low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
Pemphis acidula	Category II	Coastal (island) psammophytic scrub	Poor (very low populations)
Aquilaria sinensis	Category II	Montane rainforest, lowland rainforest	Poor (severe early damage, in recovery)
Hydnocarpus hainanensis	Category II	Lowland rainforest, montane rainforest	Very poor (severe anthropogenic harvesting, extremely low populations)
Begonia hainanensis	Category II	Lowland rainforest	Poor (very low populations)
Camellia sinensis var. *assamica*	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
C. sinensis var. *pubilimba*	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Hopea hainanensis	Category I	Lowland rainforest, semi-deciduous monsoon forest	Poor (very low populations)
H. reticulata	Category II	Lowland rainforest, coastal psammophytic jungle	Poor (very low populations)
Vatica mangachapoi	Category II	Lowland rainforest, montane rainforest	Poor (weak reproduction, low populations)
Lumnitzera littorea	Category I	True mangrove	Very poor (extremely low populations, limited recruitment)
Diplodiscus trichospermus	Category II	Semi-deciduous monsoon forest	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
Firmiana hainanensis	Category II	Lowland rainforest, montane rainforest, semi-deciduous monsoon forest	Poor (very low populations)
F. pulcherrima	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Heritiera parvifolia	Category II	Lowland rainforest, coastal psammophytic jungle	Poor (very low populations)
Sindora glabra	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Dalbergia hainanensis	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
D. odorifera	Category II	Lowland rainforest, montane rainforest	Very poor (severe anthropogenic harvesting, extremely low wild populations)
Euchresta japonica	Category II	Montane rainforest	Poor (very low populations)
Ormosia balansae	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. emarginata	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. fordiana	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
O. glaberrima	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. howii	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. inflata	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. pinnata	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. semicastrata	Category II	Lowland rainforest, montane rainforest, coastal psammophytic jungle	Poor (very low populations)
O. simplicifolia	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. xylocarpa	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Chunia bucklandioides	Category II	Montane rainforest	Poor (weak seed reproduction)
Castanopsis concinna	Category II	Lowland rainforest	Poor (very low populations)
Quercus bawanglingensis	Category II	Montane top scrub	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
Ilex kaushue	Category II	Montane rainforest, semi-deciduous monsoon forest, lowland rainforest	Poor (very low populations)
Citrus japonica	Category II	Coastal psammophytic scrub	Poor (very low populations)
Suriana maritima	Category II	Coastal psammophytic scrub	Poor (very low populations)
Aglaia lawii	Category II	Lowland rainforest	Poor (very low populations)
Paranephelium hainanense	Category II	Semi-deciduous monsoon forest	Poor (very low populations, severe anthropogenic damage)
Glehnia littoralis	Category II	Coastal psammophytic scrub	Poor (very low populations)
Madhuca hainanensis	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Merrillanthus hainanensis	Category II	Lowland rainforest, montane rainforest	General (low populations)
Morinda officinalis	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Cordia subcordata	Category II	Coastal psammophytic jungle	Poor (very low populations)
Gmelina hainanensis	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Wenchengia alternifolia	Category II	Lowland rainforest	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
Ottelia acuminata	Category II	Freshwater wet grassland	Poor (severe habitat destruction)
O. alismoides	Category II	Freshwater wet grassland	Poor (severe habitat destruction)
O. cordata	Category II	Freshwater wet grassland	Poor (severe habitat destruction)
Orchidantha insularis	Category II	Lowland rainforest	Poor (very low populations)
Amomum hainanense	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Etlingera yunnanensis	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
Dracaena cambodiana	Category I	Lowland rainforest, montane rainforest, montane top scrub	Poor (very low populations)
Paris dunniana	Category II	Montane rainforest, montane cloud forest	Poor (very low populations)
P. polyphylla var. *chinensis*	Category II	Montane rainforest, montane cloud forest	Poor (very low populations)
Chuniophoenix hainanensis	Category II	Lowland rainforest	Poor (very low populations)
C. humilis	Category II	Lowland rainforest	Poor (very low populations)
Nypa fruticans	Category II	True mangrove	General (low populations)
Plectocomia microstachys	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
Anoectochilus roxburghii	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
A. baotingensis	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
A. hainanensis	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
Cymbidium aloifolium	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. atropurpureum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. cyperifolium	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. dayanum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. eburneum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. ensifolium	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. floribundum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
C. haematodes	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. hookerianum	Category II	Montane rainforest, montane cloud forest	Poor (very low populations)
C. insigne	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. kanran	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. lii	Category II	Montane rainforest, montane cloud forest	Poor (very low populations)
C. lowianum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. mannii	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. nanulum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
C. paucifolium	Category II	Montane rainforest, montane cloud forest	Poor (very low populations)
C. suavissimum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
C. sinense	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
Dendrobium aduncum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. cariniferum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. chrysanthum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. chryseum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. crystallinum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. denneanum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. densiflorum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. fimbriatum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. hainanense	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
D. hercoglossum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. jenkinsii	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. linawianum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. lindleyi	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. loddigesii	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. nobile	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. salaccense	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. sinense	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. spatella	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
D. strongylanthum	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)

Species Name	Protection Category	Vegetation Type	Population Survival Status
D. williamsonii	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
Ludisia discolor	Category II	Montane rainforest, lowland rainforest	Poor (very low populations)
Paphiopedilum appletoni-anum	Category I	Montane rainforest, lowland rainforest	Poor (very low populations, heavy harvesting)
P. purpuratum	Category I	Montane rainforest, lowland rainforest	Doubtful population (historical record, not found)
Phaius hainanensis	Category II	Montane rainforest	Poor (very low populations)
Renanthera coccinea	Category II	Lowland rainforest, coastal psammophytic jungle, semi-deciduous monsoon forest, lowland rainforest	Poor (very low populations)
Hygroryza aristata	Category II	Freshwater wet grassland	Poor (very low populations)
Oryza meyeriana	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. officinalis	Category II	Lowland rainforest, montane rainforest	Poor (very low populations)
O. rufipogon	Category II	Freshwater wet grassland	Poor (very low populations)
Sorghum propinquum	Category II	Freshwater wet grassland	Poor (very low populations)

Note: Species aliases are given in parentheses.

Note: Figure translations are in progress. See original paper for figures.

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