From Community Based Taxonomy towards Resolving Biodiversity Darkspots

Harald Schneider

Xishuangbanna Tropical Botanical Garden, Chinese Academy of of Sciences

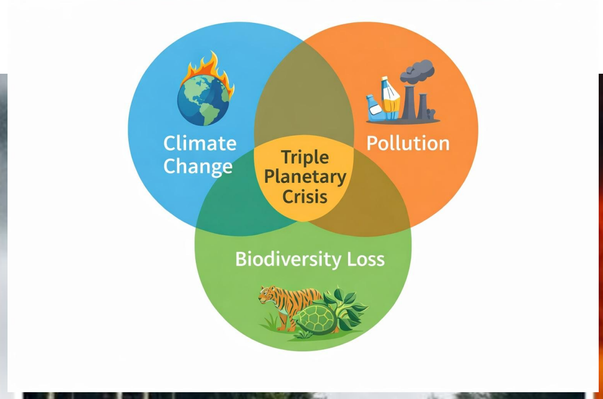
Documenting Biodiversity

The "Taxonomy" Challenge

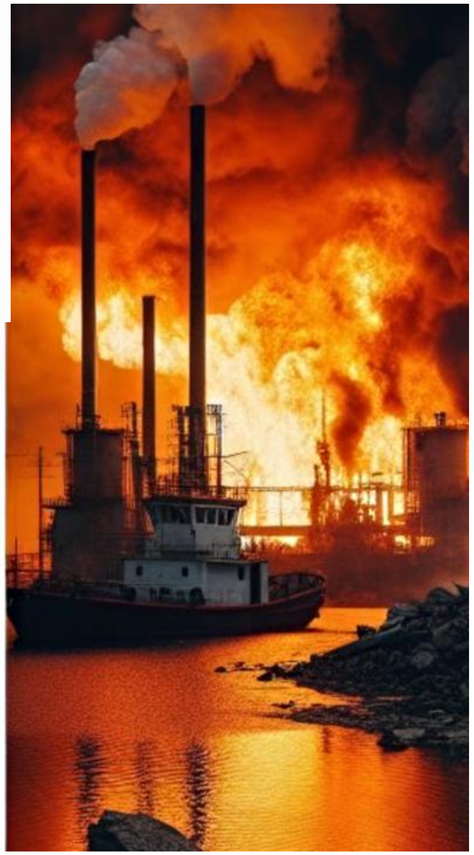


Triple Planetary Crisis — The Key-Challenge to Humanity



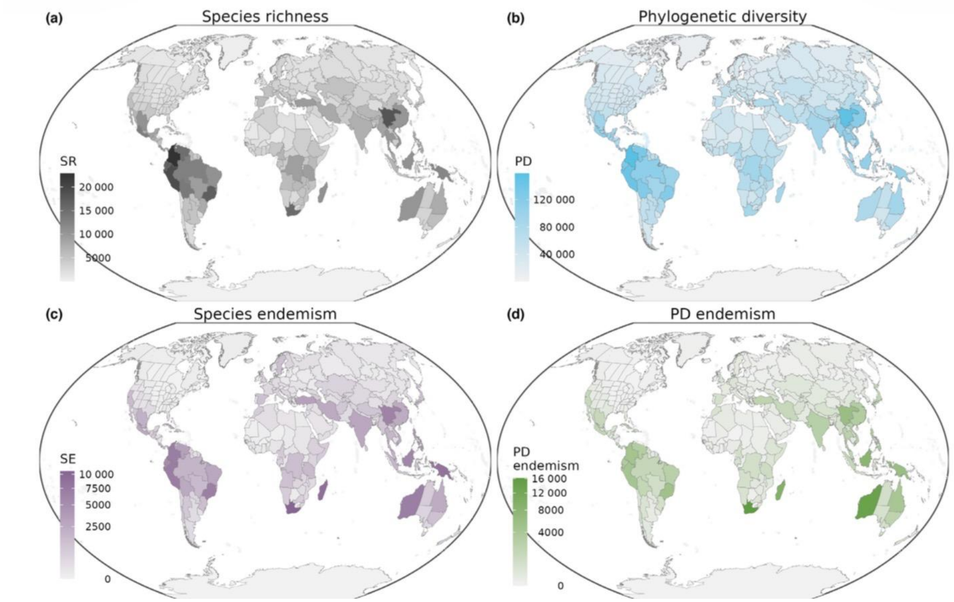






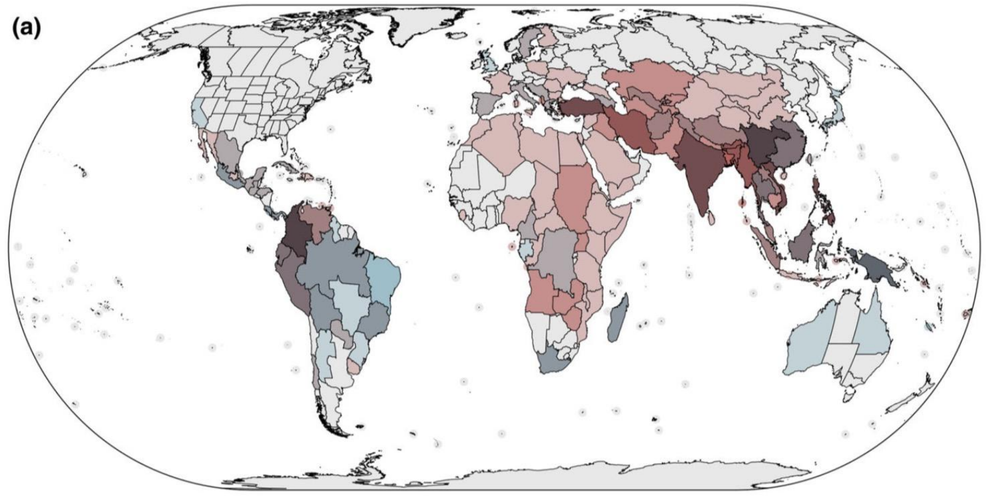
Taxonomy as One of the Key-Sciences

Biodiversity Hotspots - Biodiversity Darkspots



Tietje et al. 2023 New Phytol

Spatial Uneven Distribution of Biodiversity



Ondo et al. 2024 New Phytol

Spatial Uneven Distribution of Biodiversity Knowledge

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Comprehensive Assessment of Biodiversity

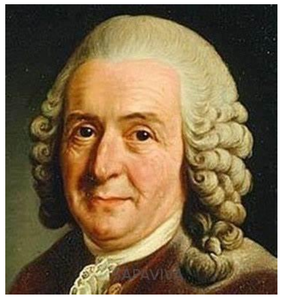


Key Challenge:

Reliable List of “All Species” and “Their Spatial Distribution”

Incomplete Documentation of Biodiversity

Linnean Shortfall

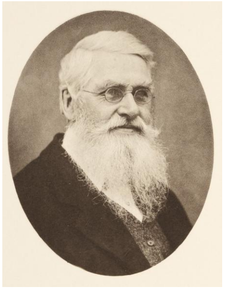


(1) Undiscovered Species

(2) Ambiguity of Status of Described Species



Wallacean Shortfall



(1) Incomplete Recording of Distribution Range

(2) Insufficient Recording of Distribution Range Shifts

Incomplete Documentation of Biodiversity

Foundations: Seven Biodiversity Shortfalls


Seven Shortfalls that Beset Large-Scale Knowledge of Biodiversity

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Keywords

scientific ignorance, biodiversity data, knowledge shortfalls, bias, uncertainty, macroecology, functional ecology

Abstract

Ecologists and evolutionary biologists are increasingly using big-data approaches to tackle questions at large spatial, taxonomic, and temporal scales. However, despite recent efforts to gather two centuries of biodiversity inventories into comprehensive databases, many crucial research questions remain unanswered. Here, we update the concept of knowledge shortfalls and review the tradeoffs between generality and uncertainty. We present seven key shortfalls of current biodiversity data. Four previously proposed shortfalls pinpoint knowledge gaps for species taxonomy (Linnean), distribution (Wallacean), abundance (Prestonian), and evolutionary patterns (Darwinian). We also redefine the Hutchinsonian shortfall to apply to the abiotic tolerances of species and propose new shortfalls relating to limited knowledge of species traits (Raunkiæran) and biotic interactions (Eltonian). We

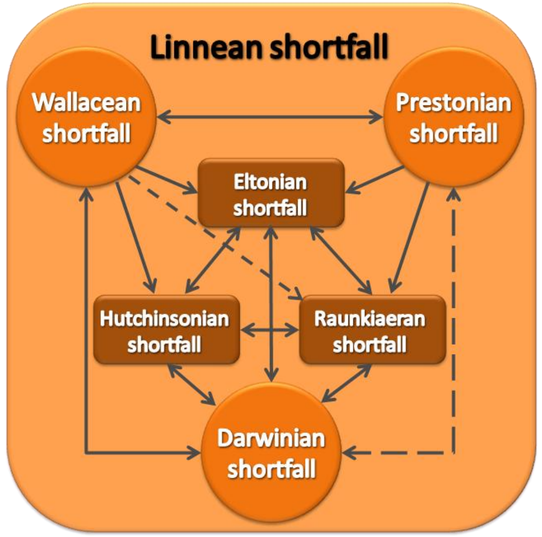

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Table 1 Definitions (and original references) for the seven main shortfalls of biodiversity knowledge

Shortfall	Aspect of biodiversity	Definition
Linnean	Species	Most of the species on Earth have not been described and cataloged (Brown & Lomolino 1998); this concept can be extended to extinct species (discussed in this review)
Wallacean	Geographic distribution	Knowledge about the geographic distribution of most species is incomplete; it is inadequate at all scales most of the time (Lomolino 2004)
Prestonian	Populations	Data on species abundance and population dynamics in space and time are often scarce (Cardoso et al. 2011)
Darwinian	Evolution	Lack of knowledge about the tree of life and the evolution of species and their traits (Diniz-Filho et al. 2013)
Raunkiæran	Functional traits and ecological functions	Lack of knowledge about species' traits and their ecological functions (discussed in this review)
Hutchinsonian	Abiotic tolerances	Lack of knowledge about the responses and tolerances of species to abiotic conditions (i.e., their scenopoetic niche; discussed in this review, redefined from Cardoso et al. 2011)
Eltonian	Ecological interactions	Lack of knowledge on species' interactions and these interactions' effects on individual survival and fitness (discussed in this review)

Various Shortfalls hamper a comprehensive Assessment of Biodiversity

Biodiversity Research — Taking on the Last Frontier

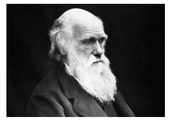
The Multi-Dimensions of Biodiversity

Genetics/ Genomics



Mendelian

Evolution/ Phylogeny



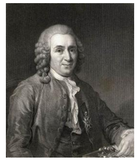
Darwinian

Wallacean



Biogeography

Taxonomy



Linnean

Prestonian

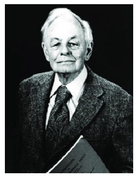


Demography

Hutchinsonian

Raunkiaeran

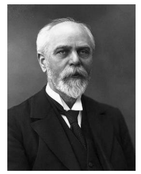
Eltonian



Abiotic Environment

[Grinnellian Niche]





Traits

Biotic Interactions

Comprehensive Assessment of Biodiversity

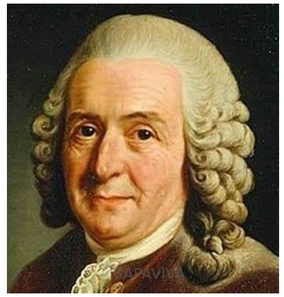
Assembly an “Informed Species List”

Species lists used as the Key-Integrator of Biodiversity Information

Taxonomic Research in the 21st Century

Renaissance of Taxonomic Research

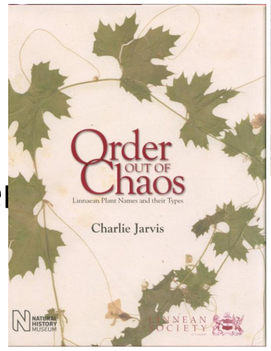
Celebration of the Success in the Past



Carl Linnaeus
(1707—1778)
One of the fathers of Moder
Taxonomy



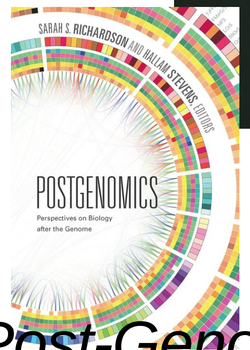




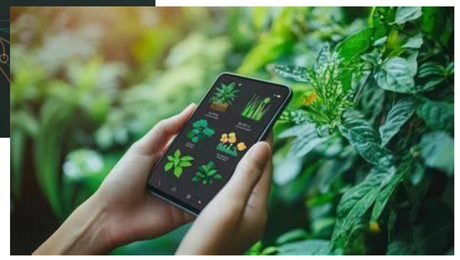
Rebirth embracing the innovations of the Post-Genomic / Post-AI World

Big Data Taxonomy





Post-Genomic Taxonomy



AI & Machine Learning Image Recognition Taxonomy

World Flora — A Reliable List of All Plant Species

Challenge — **Uncertainties** and Conflicting Interpretations

Approach — Expert Consortia

Pteridophyte Phylogeny Group

International Open Consortium of Experts in Ferns and Lycophytes



JSE Journal of Systematics and Evolution

doi: 10.1111/jse.12229

Research Article

A community-derived classification for extant lycophytes and ferns

The Pteridophyte Phylogeny Group

Recommended citation: PPG I (2016). This project was organized by Eric Schuettpelz[1*], Harald Schneider[2*], Alan R. Smith[3], Peter Hovenkamp[4], Jefferson Prado[5], Germinal Rouhan[6], Alexandre Salino[7], Michael Sundue[8], Thaís Elias Almeida[9], Barbara Parris[10], Emily B. Sessa[11], Ashley R. Field[12], André Luís de Gasper[13], Carl J. Rothfels[14], Michael D. Windham[15], Marcus Lehnert[16], Benjamin Dauphin[17], Atsushi Ebihara[18], Samuli Lehtonen[19], Pedro Bond Schwartsburd[20], Jordan Metzgar[21], Li-Bing Zhang[22], Li-Yaung Kuo[23], Patrick J. Brownsey[24], Masahiro Kato[18], and Marcelo Daniel Arana[25]; with additional contributions from (in alphabetical order): Francine C. Assis[7], Michael S. Barker[26], David S. Barrington[8], Ho-Ming Chang[27], Yi-Han Chang[28], Yi-Shan Chao[29], Cheng-Wei Chen[30], De-Kui Chen[31], Wen-Liang Chiou[32], Vinícius Antonio de Oliveira Dittrich[33], Yi-Fan Duan[34], Jean-Yves Dubuisson[35], Donald R. Farrar[36], Susan Fawcett[8], Jose María Gabriel y Galán[37], Luiz Armando de Araújo Góes-Neto[7], Jason R. Grant[17], Amanda L. Grusz[38], Christopher Haufler[39], Warren Hauk[40], Hai He[31], Sabine Hennequin[35], Regina Yoshie Hirai[5], Layne Huiet[15], Michael Kessler[41], Petra Korall[42], Paulo H. Labiak[43], Anders Larsson[44], Blanca León[44], Chun-Xiang Li[45], Fay-Wei Li[15], Melanie Link-Pérez[46], Hong-Mei Liu[47], Ngan Thi Lu[48], Esteban I. Meza-Torres[49], Xin-Yuan Miao[45], Robbin Moran[50], Claudine Massi Mynssen[51], Nathalie Nagalingum[52], Benjamin Øllgaard[53], Alison M. Paul[54], Jovani B. de S. Pereira[55], Leon R. Perrie[14], Mónica Ponce[56], Tom A. Ranker[57], Christian Schulz[58], Wataru Shinohara[59], Alexander Shmakov[59], Erin M. Sigel[1], Filipe Soares de Souza[7], Lana da Silva Sylvestre[60], Weston Testo[8], Luz Amparo Triana-Moreno[61], Chie Tsutsumi[18], Hanna Tuomisto[62], Iván A. Valdespino[62], Alejandra Vasco[63], Raquel Stauffer Viveros[7], Alan Weakley[64], Ran Wei[65], Stina Weststrand[42], Paul G. Wolf[66], George Yatskievych[44], Xiao-Gang Xu[34], Yue-Hong Yan[67], Liang Zhang[68], Xian-Chun Zhang[65], and Xin-Mao Zhou[22].

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*Contributors of **35** Nations*
including various Nations of
the Global South

An update of the Pteridophyte Phylogeny Group classification for extant ferns and lycophytes: PPG II

Running title: PPG II

Recommended citation: PPG II (2026). This project was organized by Joel H. Nitta[1], Michael Hassler[2], Harald Schneider[3], Christopher Hoess[4], Carl Rothfels[5], and Eric Schuettpelz[6]; with additional contributions from (in alphabetical order): Bamigboye Rachael Adebola[7], Gbenga Festus Akomolafe[8], Thaís Elias Almeida[9], Victor B. Amoroso[10], Chinedum Anajemba[11], Maryani A. Mustapeng Andi[11], Marcelo Arana[12], Michael S. Barker[13], David S. Barrington[14], Jeffrey P. Bence[15], Bertrand Black[16], Wang Bo[16], Peter D. Bostock[17], Michel Boudrie[18], Buenaventura Caldera[19], Yi-Han Chang[20], Zhi-Xiang Chang[20], Yi-Shan Chao[21], Cheng-Wei Chen[21], Chi-Chuan Chen[22], Chia-Tung Chen[21], Daniele Ciccozzi[23], João Paulo Condack[24], Fulgent P. Corrinco[25], Fernanda Stefany Nunes Costa[25], Thiago Vieira Costa[26], Glenda G. Cárdenas[27], Benjamin Dauphin[28], Marjorie D. delos Angeles[29], Vinicius Antonio de Oliveira Dittrich[30], Cyprien Dobra[31], Shi-Yong Dong[32], Yi-Fan Duan[33], Jean-Yves Dubuisson[34], Atsushi Ebihara[35], Libor Ekrt[36], Susan Fawcett[37], María Vicent Fernández[37], Rubén Vázquez Ferreira[38], Ashley R. Field[39], Diogo de Freitas[40], Tao Fujiwara[41], André Luís de Gasper[42], Arthur V. Gilman[14], Felipe Gonzatti[43], Jason R. Grant[44], Amanda L. Grusz[45], Christopher Haufler[46], Warren D. Hauk[47], Sabine Hennequin[48], David G. Hill[49], Regina Yoshie Hirai[50], Kiyotaka Hori[51], Layne Huiet[52], Muhammad Irfan[53], Sosuke Ishii[54], Tzu-Tong Kao[55], Mwihaki J. Karichu[56], Venni Koskiniva[57], Michael Kessler[49], Phyo Kay Khine[58], Sylvia P. Kinosian[59], Ralf Knapp[60], Christopher P. Krieg[46], Evelin Krol[46], Li-Yaung Kuo[61], Paulo H. Labiak[62], Marcus Lehnert[63], Samuli Lehtonen[52], Blanca León[64], Chun-Xiang Li[65], Fay-Wei Li[52], Lucas Vieira Lima[66], Stuart Lindsay[67], Melanie A. Link-Pérez[68], Vanessa Lino[62], Hong-Mei Liu[1], Yea-Chen Liu[69], Christian A. López[70], Mario Mairal[58], Gonzalo Javier Marquez[71], Ana Gabriela Martinez-Becerril[9], Olga G. Martínez[72], Fernando B. Matos[73], Klaus Mehltreter[74], Jonas I. Mendez-Reneau[75], Jordan Metzgar[76], Esteban I. Meza-Torres[77], David J. Middleton[62], Sonia Molino[78], Robbin C. Moran[56], Sarah K. Morris[14], Vinciane Mossion[79], Julián Mostacero[80], José Murillo-A.[81], Claudine M. Mynssen[82], Daniel James Ohlsen[83], Barbara Parris[84], Sachin Patil[85], Alison M. Paul[86], Jessie A. Pelosi[13], Jovani B. de S. Pereira[87], Leon R. Perrie[88], Kathryn T. Picard[89], Monica Ponce[90], Jefferson Prado[20], Titien Ngatinem Praptosuwiryo[91], Kathleen M. Pryer[92], Said Pácz[93], Ramil Rajapaksha[94], K. P. Rajesh[95], Tom A. Ranker[84], Ledis Regalado[96], Atiles Reis[97], Radvilė Rimgailė-Voicik[98], Edgar Javier Rincón-Barón[57], Gonzalo Rodriguez Rizk[99], Germinal Rouhan[74], Alexandre Salino[100], Guillermo Santos[58], David Sanin[100], Maria Amalia Scataglini[20], Pedro B. Schwartsburd[101], Emily B. Sessa[56], Hui Shang[102], Wen Shao[102], Wataru Shinohara[103], Alexander Shmakov[104], Erin M. Sigel[105], Sarvesh Kumar Singh[106], Alan R. Smith[13], Filipe Soares de Souza[107], Jacob Suissa[108], Michael Sundue[47], Lana da Silva Sylvestre[20], Carlos Sánchez[109], J. Daniel Tejero-Díez[110], Weston L. Testo[14], Ngan Lu Thi[111], Luz A. Triana-Moreno[112], Carrie M. Tribble[113], Angelo Troia[114], Hanna Tuomisto[57], Aleksey Yuganov[104], Iván A. Valdespino[115], Alejandra Vasco[116], Diego Tavares Vasques[117], Raquel Stauffer Viveros[90], Ting Wang[32], Wita Wardani[90], James E. Watkins Jr.[118], Alan Weakley[119], Keir Wefferling[120], Ran Wei[121], David Wickell[122], Marielle Wilson[123], Michael D Windham[55], Paul G. Wolf[124], Nadia Mariana Wołoszyn[20], Ke-Wang Xu[33], Yue-Hong Yan[102], George Yatskievych[76], Agustina Yañez[58], Jovita Cisliński Yesilyurt[58], Kaimei Zhang[32], Li-Bing Zhang[33], Liang Zhang[125], Xin-Mao Zhou[126], Zheng-Yu Zuo[127]

PPGI 2026

Pteridophyte Phylogeny Group

International Open Consortium of Experts in Ferns and Lycophytes

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Research Article

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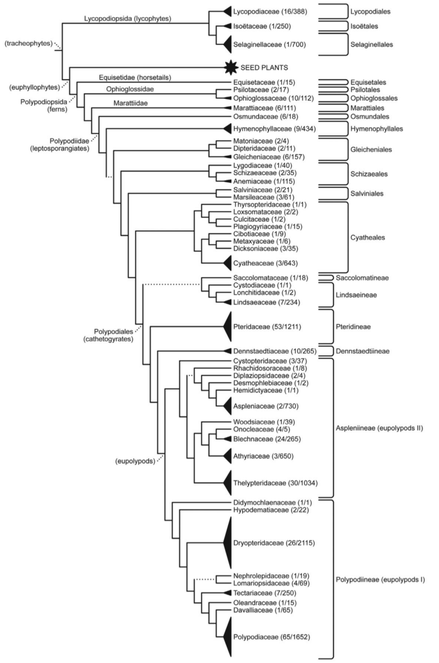


PPGI 2016

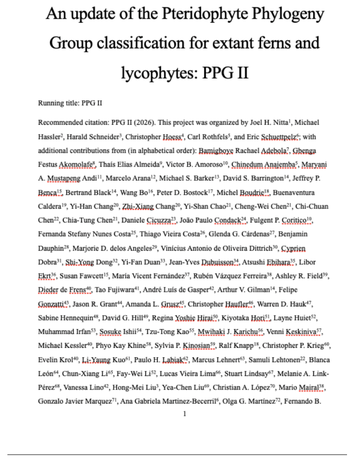
PPGI — Objectives

Provide Consensus Classification of Higher Taxonomic Ranks from Class to Genus

Transition from Pre-Phylogenetic to Post-Phylogenetic Classification of ferns and Lycophytes

Pteridophyte Phylogeny Group

International Open Consortium of Experts in Ferns and Lycophytes



An update of the Pteridophyte Phylogeny Group classification for extant ferns and lycophytes: PPG II

Running title: PPG II

Recommended citation: PPG II (2026). This project was organized by Joel H. Nitta[1], Michael Hassler[2], Harald Schneider[3], Christopher Hoeks[4], Carl Rothfels[5], and Eric Schuettpelz[6]; with additional contributions from (in alphabetical order): Bamigboye Rachael Adebola[7], Gbenga Festus Akomolafe[8], Thaís Elias Almeida[9], Victor B. Amoroso[10], Chinedum Anajemba[7], Maryani A. Mustapeng Andi[11], Marcelo Arana[12], Michael S. Barker[13], David S. Barrington[14], Jeffrey P. Bonca[15], Bertrand Black[14], Wang Bo[16], Peter D. Bostock[17], Michel Boudrie[18], Buenaventura Caldera[19], Yi-Han Chang[20], Zhi-Xiang Chang[20], Yi-Shan Chao[21], Cheng-Wei Chen[21], Chi-Chuan Chen[22], Chia-Tung Chen[21], Daniele Cicuzza[23], João Paulo Condack[24], Fulgent P. Coritico[25], Fernanda Stefany Nunes Costa[23], Thiago Vieira Costa[26], Glenda G. Cárdenas[27], Benjamin Dauphin[28], Marjorie D. delos Angeles[29], Vinicius Antonio de Oliveira Dittrich[30], Cyprien Dobra[31], Shi-Yong Dong[32], Yi-Fan Duan[33], Jean-Yves Dubuisson[34], Atsushi Ebihara[35], Libor Ekrt[36], Susan Fawcett[13], María Vicent Fernández[37], Rubén Vázquez Ferreira[38], Ashley R. Field[39], Dieder de Frens[40], Tao Fujiwara[41], André Luis de Gasper[42], Arthur V. Gilman[14], Felipe Gonzatti[43], Jason R. Grant[44], Amanda L. Grusz[45], Christopher Haufler[46], Warren D. Hauk[47], Sabine Hennequin[48], David G. Hill[49], Regina Youbie Hirai[50], Kiyotaka Hori[51], Layne Huiet[52], Muhammad Irfan[53], Sosuke Ishii[54], Tzu-Tong Kao[55], Mwihaki J. Kariehu[56], Venni Keskiniva[57], Michael Kessler[58], Phyo Kay Khine[59], Sylvia P. Kinosian[60], Ralf Knapp[19], Christopher P. Krieg[46], Evelin Krol[61], Li-Yaung Kuo[62], Paulo H. Labiak[42], Marcus Lehnert[63], Samuli Lehtonen[22], Blanca León[64], Chun-Xiang Li[65], Fay-Wei Li[33], Lucas Vieira Lima[66], Stuart Lindsay[67], Melanie A. Link-Pérez[68], Vanessa Lino[42], Hong-Mei Liu[1], Yea-Chen Liu[69], Christian A. López[70], Mario Mairal[71], Gonzalo Javier Marquez[72], Ana Gabriela Martinez-Becerril[58], Olga G. Martínez[73], Fernando B.

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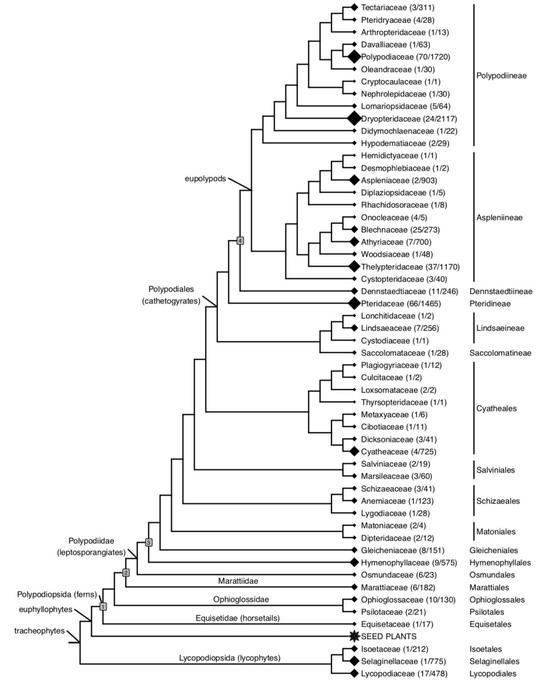
PPGII2026





PPGII — Objectives

(1) Update Classification of Higher Taxonomic Ranks from Class to Genus

(2) Assemble a Expert Curated Species List

Pteridophyte Phylogeny Group

International Open Consortium of Experts in Ferns and Lycophytes



PPG Framework and Principles

Open — Everyone is welcome with Expertise in the Taxonomy of Ferns and Lycophytes

Consensus — Expert Discussions and if necessary Majority Vote

Transparent — Protocols are put in place to provide transparent recording of the decision making process

Integrative — Provide Recommendations

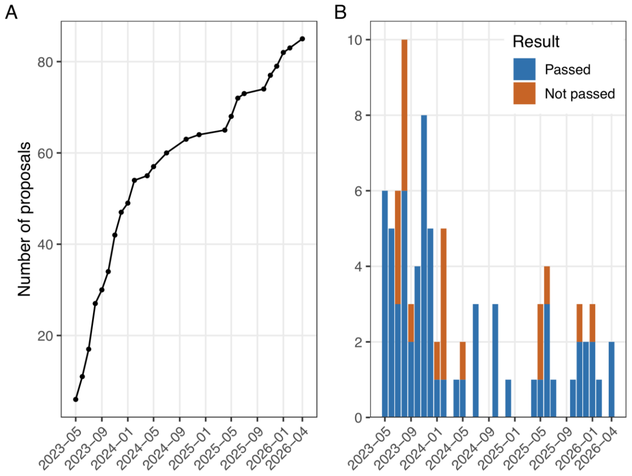
Pteridophyte Phylogeny Group

International Open Consortium of Experts in Ferns and Lycophytes



pteridogroup.github.io
https://pteridogroup.github.io

GitHub Pages - Pteridophyte Phylogeny Group

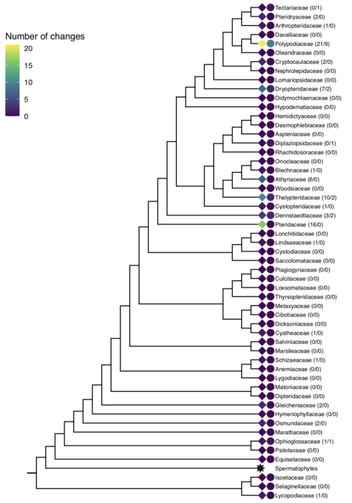


PPG Protocols

(1) Submission of Proposal of Change — Required to be based on Accepted Publications and Conform with the Botanical Code

(2) Open Expert Discussion

(3) Vote (> 50% Role)



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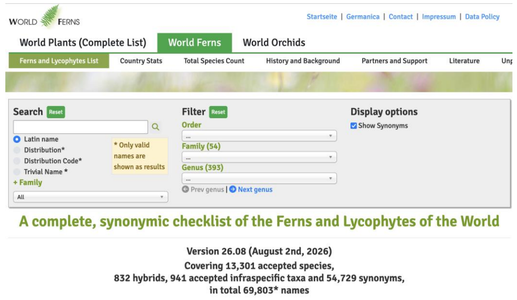
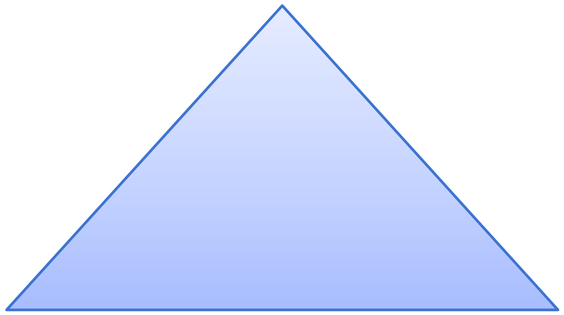
Pathway towards Reliable Species List of all Extant Ferns and Lycophytes

PPG Community

Curation of Species List



Initial List



PPG selected to be the
TEN (Taxonomic Expert Network)
for Ferns and Lycophytes

World Flora Online

Depository Enabling Continuing Updating to stay tuned with the scientific Process

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Why World Flora Online (WFO) ?

- Digital Flora including all Land Plants initiated during the 11th Conference o the Parties to the Convention on Biological Diversity in October 2012 in response to Target 1 of the Global Strategy for Plant Conservation (GSPC) of the U.N. Convention on Biological Diversity

- WFO is a collaborative, International project supports by multiple institutions

- WFO is widely used in other major databases such as Catalog of Life (CoL) and the Global Biodiversity Information Facility (GBIF)

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The Challenge of Curating a Global List of All Species of Ferns and Lycophytes



Resource Limitations

(1) Taxonomic Expertise is a Limited Resource

(2) Regional Expertise need to be integrated



Bottlenecks

(3) Taxonomic Study Depth various across the Tree-of-Life

(4) Taxonomic Study Depth various across the Globe

(5) Taxonomic Study Depth various across Ecosystems

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Need to Expand Network of Experts with Emphasis on Global South (e.g. Africa, Madagascar)

but also Central Asia and South Asia

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Regional Expert Groups



Japan 2017 / 2023

Taiwan Islands 2019

Brunei 2025

Australia 2020

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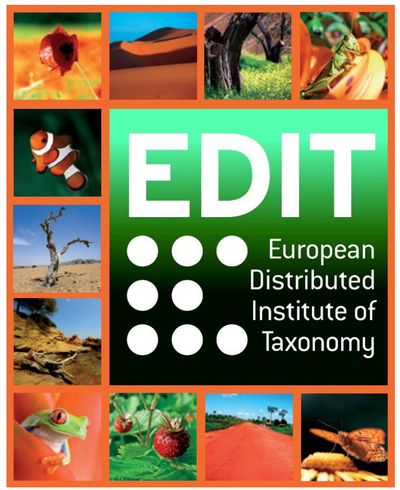
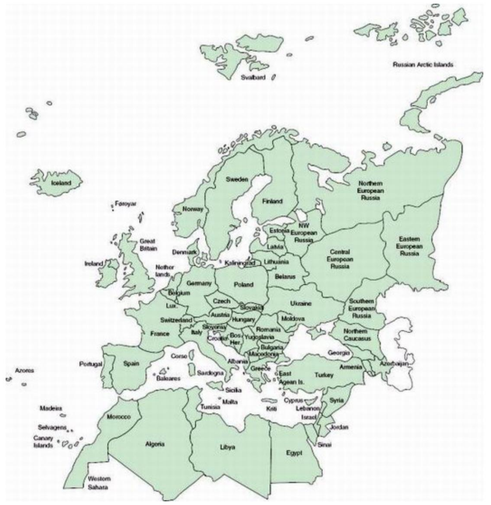
Regional Expert Groups

PPG-EU

Experts in the Fern and Lycophytes occurring in Europe and Adjacent Regions



EURO+MED PlantBase



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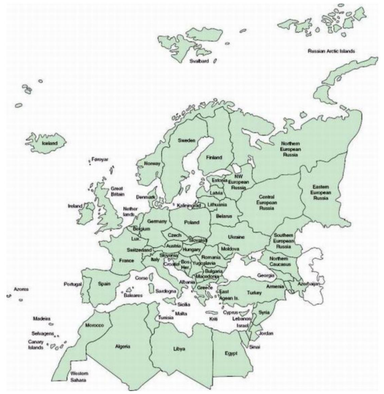
Regional Expert Groups

PPG-EU



Expertise

Tax. Literature

Herbaria

Review and Update

EURO-MED PlantBase

New Checklist

Incorporate into WFO

Revise RedList of European Ferns and Lycophytes

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Regional Expert Groups

PPG-EU

Revision Work Required

(1) Update Classification (Family, Genus, etc.)

(2) Revise Incorrect Species Treatments

(3) Identify Research Targets for Taxonomic Studies and Training Programs

(4) Informed Revision of IUCN RedList of Ferns and Lycophytes in Europe

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PPG-EU

Revise Incorrect Species Treatments

Plant Systematics and Evolution (2018) 304:1009–1022
https://doi.org/10.1007/s00606-018-1529-9

ORIGINAL ARTICLE

Inferring the potential of plastid DNA-based identification of derived ferns: a case study on the *Asplenium trichomanes* aggregate in Europe

Hong-Mei Liu[1] · Stephen R. Russell[2] · Johannes Vogel[3] · Harald Schneider[2,4]

Received: 6 November 2017 / Accepted: 16 June 2018 / Published online: 9 July 2018
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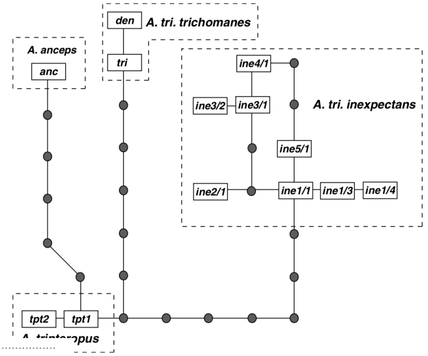
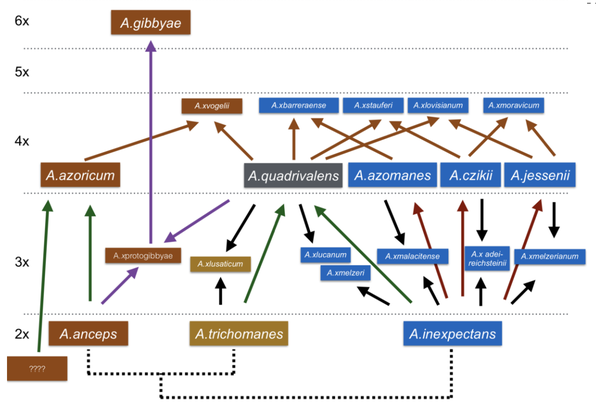
Abstract
The utility of three plastid DNA regions to identify fern species was explored with focus on the European representatives of the *Asplenium trichomanes* aggregate. The sampling included representatives of the three diploid and the four tetraploid taxa recognized in the European flora plus Macaronesia. Besides European samples, the compiled data set comprised specimens of a putative Hawaiian endemic and one species occurring in Southeast Asia. By combining the sequences of three non-coding plastid regions, 13 haplotypes were recovered of which four were found in more than one taxon. Evidences for four distinct diploid lineages were found that correspond to *Asplenium anceps*, *A. inexpectans*, *A. trichomanes* s.s., and *A. tripteropus*. The four tetraploids occurring in Europe shared haplotypes with *A. inexpectans*. Thus, DNA barcoding can successfully identify the diploids, but fail to separate the tetraploids from their diploid ancestors. As a consequence, barcoding analyses of ferns need to take into account the differences of ploidy level measured by evidence independent from the DNA barcode. Evidence for uneven accumulation of intra-species DNA variation was recovered by comparing all species. Furthermore, the study provided evidence that the current taxonomy of these ferns requires to be revised. The two European diploids form well-separated clades and need to be recognized as *A. inexpectans* and *A. trichomanes* s.s. To keep name consistency for all European tetraploids, a new name *Asplenium jessenii* is introduced to replace *A. trichomanes* subsp. *hastatum*.

Keywords Barcoding gap · DNA barcode · Molecular species identification · Polyploidy · Species concepts · Species differentiation







Asplenium jessenii

Add Newly Discovered Species



Polystichum caucasicum

Ekrt et al. 2025
Phytotaxa



Huperzia selago s.l.

Vejovodova et al. 2024
Alpine Botany

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PPG-EU



Checklist in Preparation

Species, Subspecies, Variants, Hybrids

Lycophytes: 59 Taxa

Ferns: 536 Taxa

Identify Hotspot of Taxonomic Shortfalls

Huperzia, Cystopteris, Dryopteris affinis agg., Aspenium ruta-muraria agg., …

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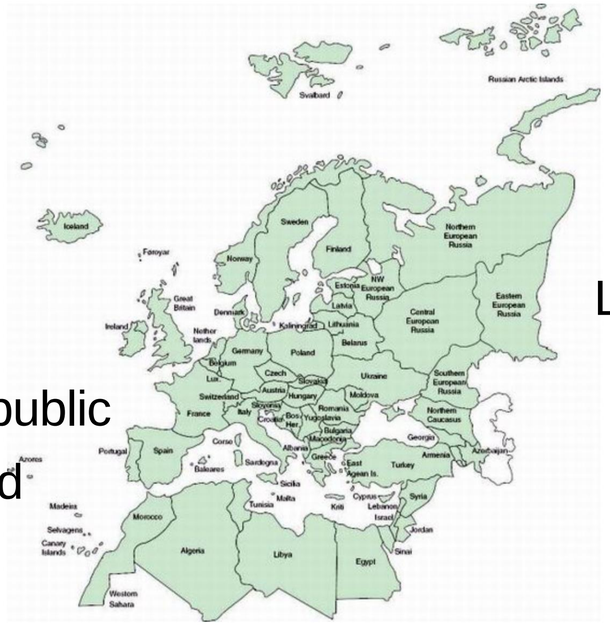
Challenge Uneven Distribution of Expertise

Experts Involved are concentrated in Central/ Western Europe



Germany

UK

Czech Republic

France

Spain

Switzerland

Italy

Finland

Lithuania

Russia

Low Involvement of Experts located in Eastern Europe and Asia Minor

Wallacean Shortfall: Documentation of fern Diversity in Areas with limited Local Expertise (SouthEast Europe, Asia Minor)

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PPG-IndoChina

Yunnan

Chen…. Schneider 2022
Historical Plant Records Enlighten the Conservation Efforts of Ferns and Lycophytes' Diversity in Tropical China. J Nat CON 68

Myanmar

Khine & Schneider 2020
First assessment of pteridophyte composition and conservation status in Myanmar. GECCO 22

Thailand

Lindsay & Middleton
Website of Thailand ferns and lycophytes. RBGE & Various Authors contributing new records



Vietnam

Various Authors contributing new records

Laos

Li et al. 2026 Checklist of Vascular Plants of Laos

Cambodia

Missing

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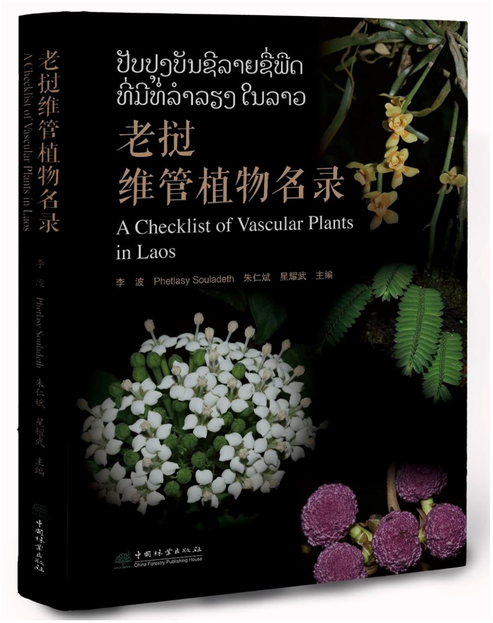

PPG-IndoChina

Link to Flora of Laos Projected launched by XTBG



Bo L, Souladeth P, Zhu RB, Xing YW 2026

A Checklist of Vascular Plants in Laos

7,212 Species versus previous summaries included 5,204 species corresponding to an x-fold increase of 1,16

Sampling Quality varies among Provinces with extremely poor sampling centered in the northern parts of Laos

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PPG-IndoChina

The Region hosts about 1445 fern species and 101 lycophyte Species

South Yunnan

Fern Diversity: 60%

Lycophyte Diversity: 57%

Myanmar

Fern Diversity: 40%

Lycophyte Diversity: 54%

Thailand

Fern Diversity: 43%

Lycophyte Diversity: 53%



Vietnam

Fern Diversity: 53%

Lycophyte Diversity: 77%

Laos

Fern Diversity: 34%

Lycophyte Diversity: 53%

Cambodia

Fern Diversity: 12%

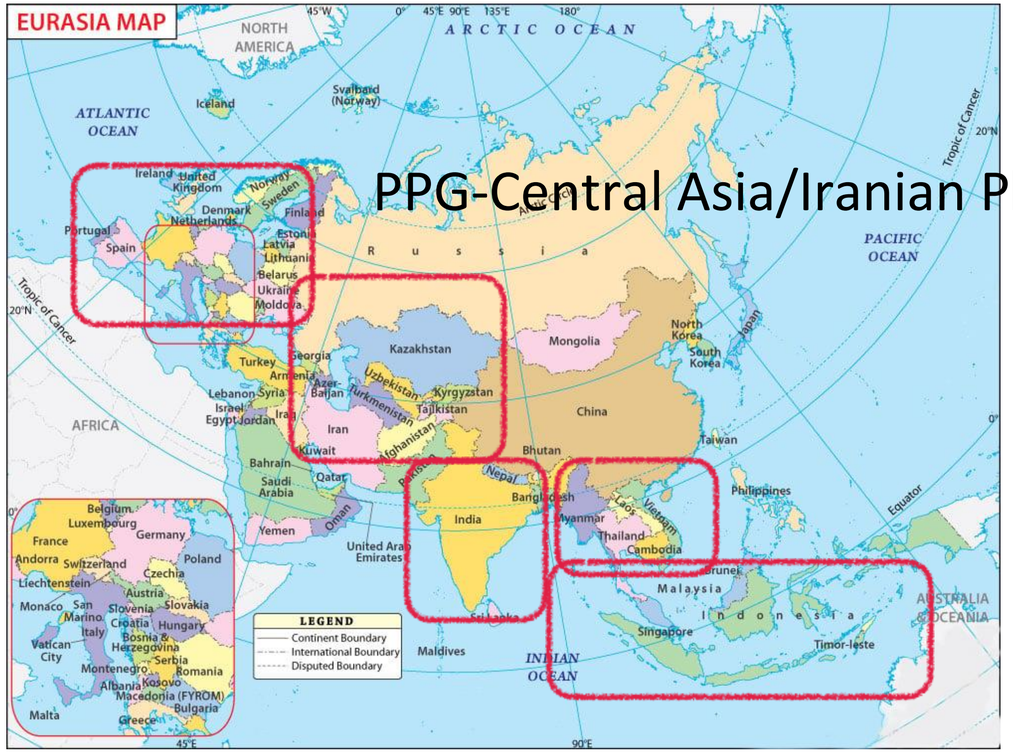
Lycophyte Diversity: 26%

Towards A Complete Species List

Towards A Checklist of All Ferns and Lycophytes in Asia/ Eurasia

PPG-EurMed

PPG-Central Asia/Iranian Plateau



PPG-Indochina

PPG-Malay Archipelago

PPG-Indian Subcontinent

Summary

Take Home Message

Taxonomy in the 21st Century

"Open Expert Communities" are the key towards a reliable Species List of All Plants

Online Tools enable Transparency in International Collaborations among Experts

A global Species List of All Plants integrated via tools such as "World Flora Online" is arguably the key to Achieve the Targets set in International Agreements to Protect Biodiversity (e.g. Kunming-Montreal Global Biodiversity Framework)

Summary

Take Home Message

Taxonomy in the 21st Century

Key Elements in a New Taxonomy Strategy

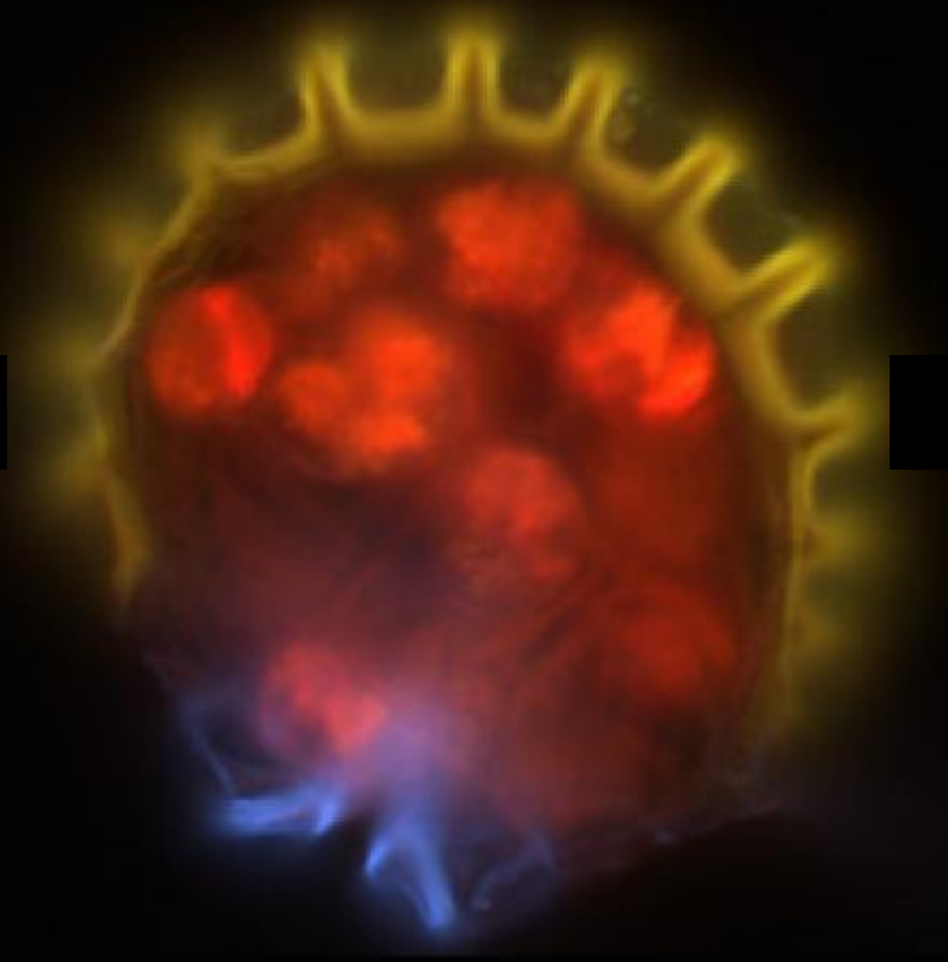
(1) Interplay between Global and Regional Checklist

(2) Integrating Global and Regional Taxonomic Expertise

(3) Expand Human Resources by Training the Next Generation of Taxonomists

(4) Utilize New Technologies to overcome the shortfalls of Outdated approaches

Renaissance of Taxonomy



Post-Genomics

Post-AI

Open International Expert Consortia

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(3) Organizers and Contributors to the Flora of Laos Project in particular Prof. Xing Yaowu

(4) Prof Liu Hongmei

Chinese Academy of Sciences

Yunnan Province Science and Technology

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Thank you for your Attention