0083-7792

WEBBIA

June 2022
Vol. 77 - n. 1

Journal of Plant Taxonomy and Geography

FIRENZE UNIVERSITY PRESS

Journal of Plant Taxonomy and Geography (*Webbia*) is a peer-reviewed journal on Plant Taxonomy, Nomenclature, Phylogeny, Phytogeography and Palaeobotany of the Vascular Plants.
The journal aims to allow research in botanical topics such as taxonomy, systematics, nomenclature, molecular phylogeny, conservation, biogeography, and history of botany, and botanical collections.
It was founded in **1905** in Florence by **Ugolino Martelli** (1860-1934), a botanist well known for his studies of and contributions to the systematics of the tropical genus *Pandanus* and on the Flora of Sardinia.
In the 19th century Florence represented one of the most important European centres in Plant Taxonomy and Phytogeography with several notable Italian botanists worth mentioning such as Filippo Parlatore, Teodoro Caruel, Eugenio Baroni, Stefano Sommier, Odoardo Beccari and Ugolino Martelli himself. In 1842 **Filippo Parlatore** (1817-1877) founded in Florence the *Herbarium Centrale Italicum (FI)*, which soon became one of the most important herbaria in the world. Most of the specimens described and/or cited in *Webbia* are still kept in it.
In 1905, and as a consequence of this multitude of activities in Plant Systematics and Phytogeography, Ugolino Martelli established the journal *Webbia-Raccolta di Scritti Botanici*, firstly published annually in a single issue, and later twice a year. Webbia also began to be a place of publication of contributions from Tropical Botany, especially after the Royal Colonial Herbarium founded in 1904 in Rome was moved to Florence in 1914, currently named Tropical Herbarium Study Center (Centro Studi Erbario Tropicale - Herbarium FT) belonging to the Department of Biology of the University of Florence.
Webbia had been created in honor of **Philip Barker Webb** (1793-1845), a close friend of Filippo Parlatore, who before passing away entrusted his personal herbarium and a library rich of old botanical books and publications to the then Botanical Museum in Florence.

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***Webbia.* Journal of Plant Taxonomy and Geography**

Published by
Firenze University Press – University of Florence, Italy
Via Cittadella, 7 - 50144 Florence - Italy
http://www.fupress.com/substantia

Direttore responsabile: **Romeo Perrotta**
Direttore scientifico: **Riccardo Maria Baldini**, University of Florence, Italy

Cover images: Top to bottom, clockwise direction from left corner: Capitula of a plant of *Webbia kraussii* Sch.Bip. (accepted name *Nidorella obscura* (DC.) J.C.Manning & Goldblatt) (Asteraceae, Astereae). Photo credit: Rich Hoyer.- Plant of *Webbia hirsuta* DC. (accepted name *Hilliardiella hirsuta* (DC.) H.Rob.] (Asteraceae, Vernonieae) showing capitula and leaves. Photo credit: John C. Manning.- Plant of *Webbia canariensis* (L.) Webb & Berthel. (accepted name *Hypericum canariense* L.) (Clusiaceae) showing flowers and immature fruits of. Photo credit: Gerardo García Casanova.- Portrait of Philip Barker Webb holding a branch of *Webbia canariensis* (L.) Webb & Berthel. with his left hand. Portrait source: *Histoire Naturelle des Îles Canaries* (Tome 3, Part 2, *Phytographia Canariensis* Section 1: Frontispiece, 1836), courtesy of Carlos Gaviño de Franchy.

WEBBIA Journal of Plant Taxonomy and Geography

Firenze University Press
www.fupress.com/webbia

Cover article

Honoring Philip Barker Webb: the three intriguing stories of *Webbia* as a genus name

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Abstract. The name *Webbia* has been used to describe three different genera: *Webbia* Spach (Clusiaceae), *Webbia* DC., *nom. illeg.* (Asteraceae: Vernonieae), and *Webbia* Sch. Bip., *nom. illeg.* (Asteraceae: Astereae). The title of the botanical journal *Webbia* does not pertain to any of these generic names but is a mere Latinization of the surname Webb, and was created as a patronym that honors the legacy of Philip Barker Webb (1793–1854). The journal is a tribute to Webb's botanical contributions, and his importance in the development of the collections of the *Museo di Storia Naturale di Firenze* in the establishment of the *Herbarium Webbianum*. The journal had an uneasy start, as a book proposal made by the Italian professor (*Università di Pisa*) Ugolino Martelli to the *Società Botanica Italiana* to honor Webb was rejected in 1905. The names *Conyza obscura* DC. and *Erigeron capensis* Houtt. are lectotypified. The nomenclature of *Conyza pinifolia* Lam. is revisited, and it is considered a legitimate name. A specimen housed in G-DC is designated as the neotype of this Lamarckian name.

Keywords: Africa, botanical history, Florence, herbaria, Macaronesia, South Africa, tropical floras.

Citation: Javier Francisco-Ortega, Riccardo M. Baldini, John C. Manning, Kanchi N. Gandhi (2022) Honoring Philip Barker Webb: the three intriguing stories of *Webbia* as a genus name. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 3-21. doi: 10.36253/jopt-12929

Received: February 28, 2022

Accepted: April 4, 2022

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Lia Pignotti

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INTRODUCTION

Founded in 1905 as a book by Italian professor (University of Pisa) Ugolino Martelli[1] (1860–1934, Figure 1A), the journal *Webbia* (Figure 1B)

[1] An extensive biographical account of Martelli was written by Negri (1935).

Figure 1. Images relevant to the early stages of the journal *Webbia*. (A) Ugolino Martelli, founder of the journal [from Negri (1935)]. (B) Cover of the first issue of the journal, then published as a book. Courtesy of *Biblioteca di Scienze – Botanica, Università degli Studi di Firenze*©.

honors Philip Barker Webb (1793–1854, Figure 2A) for his botanical legacy and his contributions in the development of the collections of the *Museo di Storia Naturale di Firenze*. Indeed, Webb's herbarium, documents, library, and house in Paris were bequeathed in his will to the Grand Duke of Tuscany Leopold II of Lorraine (1797–1870). The earnings from the sale of the house created an endowment for the curation of Webb's collections and archives (Parlatore 1856; Stearn 1937).

The plant specimens formed the *Herbarium Webbianum* (Figure 3), which is currently a central part of the FI herbarium of the Botanical section "F. Parlatore" of the Natural History Museum of the University of Florence. Its entire library and archives are kept in the *Biblioteca di Scienze* – Botanical library at University of Florence. Many of Webb's documents are posted online as part of the Humboldt Project (https://www.sba.unifi.it/p1790.html), which was sponsored by the *Max-Planck-Institut für Wissenschaftgeschichte* (Germany) and the *Fundación Canaria Orotava de Historia de la Ciencia* (Tenerife, Canary Islands, Spain). Details concerning the content and scope of Webb's materials held in the *Herbarium Webbianum* were reviewed by Parlatore (1874), Steinberg (1973, 1977), Moggi (1993), and Nepi (2009).

Extensive accounts of Webb's life and achievements were published by many authors, including Hooker (1854), Gay (1856), Parlatore (1856, 1992), Martelli (1904), Chiarugi (1956), and Stearn (1973), and it is

Figure 2. Portraits of relevant botanists involved in the use of the name *Webbia* to describe three different plant genera. (A) Philip Barker Webb holding a branch of *Webbia canariensis* (L.) Webb & Berthel. [accepted name *Hypericum canariense* L.] (Clusiaceae). (B) Édouard Spach. (C) Augustin Pyramus De Candolle. (D) Karl Schultz Bipontinus. Portrait sources: *Histoire Naturelle des Îles Canaries* (Tome 3, Part 2, *Phytographia Canariensis* Section 1: Frontispiece, 1836), courtesy of Carlos Gaviño de Franchy (A); Roberto Miranda, December 2021, portrait based on that published by Wittrock (1905: Tfl. 142) (B); print made by Pierre-Elie Bovet after Amélie Munier-Romilly, ca. 1825, British Library [https://www.britishmuseum.org/collection/object/P_1954-1103-383] (C); and unknown source, courtesy of the Hunt Institute for Botanical Documentation (D).

Figure 3. View of the *Herbarium Webbianum* (FI-Webb). Courtesy of *Sezione Botanica* "F. Parlatore" of the *Museo di Storia Naturale dell'Università degli Studi di Firenze*©.

not the main scope of our contribution to provide a full review of his biography. Nevertheless, because of Webb's connections with Italy, especially with Florence, in the introduction of our paper we provide a historical overview pertinent to Webb's associations with this country, and especially with Tuscany.

Webb's contributions to the Macaronesian island flora are also relevant to our study. A few works, published mostly by Canarian Island scholars, provide details of Webb's significant legacy to Macaronesian botany (Stearn 1937, 1973; García Pérez 1988; Rodríguez Delgado 1998; Relancio and Breen 2006; Suárez Martín 2016, 2018; Rico et al. 2017). Between 1828 and 1830, Webb and the French naturalist Sabin Berthelot (1794–1880) extensively explored this archipelago, visiting all of its islands with the exception of La Gomera and El Hierro. This exploration resulted in the single most important account ever produced on the natural history of the Canaries, the *Histoire Naturelle des Îles Canaries*, a multivolume work, authored mainly by these two naturalists, that was published between 1835 and 1850. Webb's work pertinent to the islands was followed by his seminal publication on the flora of Cabo Verde (Webb 1849). The latter was a floristic treatment for which Webb was invited by the then Kew Garden director Sir William J. Hooker (1785–1865). Interestingly, Webb wrote this treatment without ever visiting Cabo Verde (Rico et al. 2017).

PHILIP BARKER WEBB AND ITALY

At the age of six, Webb, who was born into a wealthy aristocratic family, lost his father, and a large fortune inherited by his mother allowed Webb to receive financial support to travel extensively and to cultivate his passion for classical history, languages, and the natural world. Besides his native tongue English, Webb was fluent in Latin and Greek, as well as in modern Spanish, Italian, and French. Furthermore, he received excellent training in natural history as a student at Christ Church College, Oxford.

In 1815, Webb made his first trip to Italy where he met Alberto Parolini (1788–1867), an Italian humanist and botanist from Bassano del Grappa, Veneto (Figure 4A). This interaction led to a solid friendship that enhanced Webb's fascination for Italy. Subsequently, both undertook an extensive and long joint trip to the Eastern Mediterranean, centered in Greece and Turkey. The voyage started in Naples on 30th April 1819 and finished in the same city on 21st June 1820. The main focus of this journey was to study the natural history of this region and to visit one of the main cradles of the

Figure 4. Images pertinent to Alberto Parolini and Philip B. Webb. (A) Portrait of A. Parolini from Matteo Favaretti collection. (B) Illustration of *Parolinia ornata* Webb (Brassicaceae) as published by Webb (1840: Plate 3), this is the type species of the Canary Island endemic genus *Parolinia* (La Serna Ramos and León Arencibia 1980: 116), dedicated to Parolini by Webb. (C) Image of *P. ornata* in habitat. Photo credit: Gerardo García Casanova (C); courtesy of *Phaidra, Sistema Bibliotecario di Ateneo, Università degli Studi di Padova* (A); and *Biblioteca di Scienze – Botanica*, *Università degli Studi di Firenze*© (B).

Western civilizations. Later, Webb (1840) described the Canarian endemic genus *Parolinia* [seven species and occurring in the islands of La Gomera, Gran Canaria, La Palma, and Tenerife (Santos-Guerra 2021), Figures 4B-C] honoring Parolini's botanical contributions, and recognizing the great friendship that they cultivated ("*Je dédie ce genre singulier à M. Parolini, éleve et compagnon de Brocchi, qui cultive lui-même les sciences naturelles avec succés. Il possède um des jardins de botanique les plus remarquables de l'Italie, et la collection la plus riche des roches de cette péninsule, qu'il livre généreusement aux études des savans étrangers. C'est avec lui que j'ai parcouru l'Italie méridionale, la Grèce, l'Asie-Mineure, et les îles de Malte et de Sicile, et je suis heureux de lui donner ici cette faible marque de ma haute estime et de ma vieille amité*."[2]

Between 1820 and 1821, Webb spent some additional time in Italy visiting the island of Ischia (Naples), Rome, Florence, Milan, and Venice, but his most relevant subsequent expedition was the aforementioned one to the Canary Islands (year 1828–1830). Following his stay in the Canaries, he and Berthelot travelled to France, northern Italy, and Switzerland. After this trip, Webb and Berthelot settled in Paris (between 1833 and 1847), mostly preparing their *Histoire Naturelle des Îles Canaries*. During this period, Webb hardly made any additional voyages outside England and France. It was in 1848 that Webb visited Italy again, and between this year and 1850 he devoted a great deal of his time botanizing in this country.

In Rome, Webb met the aristocrat Contessa Elisabetta Fiorini-Mazzanti (1799–1879) who was an authority on cryptogams. In Florence, Webb was impressed with the botanic garden. Founded in 1545 by the Grand Duke of Tuscany, Cosimo dei Medici (1519–1574), it is one of the oldest botanic institutions of the world. This botanic garden accommodated the *Imperiale e Regio Museo di Fisica e Storia Naturale*, where the *Herbarium Centrale Italicum* (known also as *Erbario Centrale Italiano* and currently as Botanical Section "Filippo Parlatore" of the Natural History Museum of the University of Florence) was located. This herbarium, created by the Grand Duke of Tuscany Leopold II of Lorraine (1797–1870) in 1842, had the Sicilian botanist Filippo Parlatore (1816–1877) as its first director (Figure 5). By then, Parlatore was considered the most talented botanist of the country, and he and Webb developed a great rapport; indeed, Webb's (1854) last publication was prefaced by Parlatore, in which he referred to Webb as "*doctissime amice*" ["most erudite friend"]. Furthermore, Parlatore wrote the treatments of Apiaceae and Poaceae for the *Histoire Naturelle des Îles Canaries* (Parlatore 1842–1843, 1848).

This visit of Webb to Italy took place at the same time that Florence became the main hub for botanical studies of the country. Here, he found in Parlatore a great colleague, and greatly valued the vision of Leopold II as a statesman in supporting botanical endeavors by creating a major herbarium that was part of a natural history museum specifically located in a botanic garden. There is no doubt that the pro-botanical environment that he encountered then in Florence was relevant for Webb to bequeath his documents, collections, library, and Paris house to Leopold II. Webb being a highly cultured person with a well-rounded education and a passion for history, classical cultures, and art also found in Florence a greatly stimulating place. This ancient Italian city provided him with synergistic inspirations from the fields of both humanities and natural history. It is not surprising, therefore, that he elected to leave many of his belongings to the main city of Tuscany.

Webb made his last trip to Italy, including Florence, between late 1852 and July 1853, this happened one year prior to his death in Paris on 31st August 1854. After this journey to Italy, he returned to Paris and only made occasional visits to England (Relancio and Breen 2006: 68).

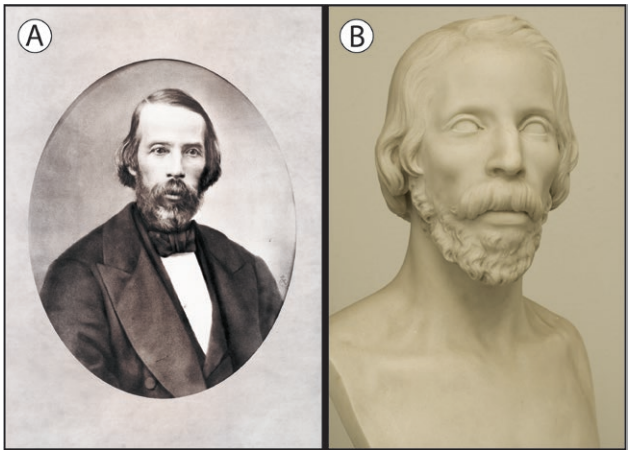

Figure 5. Images pertinent to Filippo Parlatore. (A) Portrait of F. Parlatore. (B) Bust of F Parlatore. Courtesy of *Sezione Botanica* "F. Parlatore" of the *Museo di Storia Naturale dell'Università degli Studi di Firenze*©.

[2] I dedicate this singular genus to M. Parolini, student and mate of Brocchi [it refers to Giovanni Battista Brocchi (1772–1826) who was also born in Bassano del Grappa], who cultivates the natural sciences with success. It has one of the most remarkable botanical gardens in Italy, and the richest collection of rocks from this peninsula, which he generously makes available to the studies of foreign scholars. It was with him that I traveled through southern Italy, Greece, Asia Minor, and the islands of Malta and Sicily, and I am happy to give him here this humble recognition for my high respect and appreciation, and my long-standing friendship.

On 1st December 1855, about a year after the death of Webb, Filippo Parlatore honored the memory of his friend with a lecture delivered at the *Imperiale e Regio Museo di Fisica e Storia Naturale* of Florence in the presence of countless political, diplomatic, cultural and scientific authorities, including a large audience of influential people from Tuscany (Parlatore 1856, 1992 [posthumous]).

Parlatore's lecture, published by him on 24th March 1856, accompanied by Webb's complete bibliography, included a detailed description of Webb's collections and the herbaria represented therein, and also a detailed synopsis of all the botanical collections of the *Herbarium Centrale Italicum*, by then regarded among the top ten most important botanical institutions worldwide (Simpson 2010, Funk 2017, Thiers 2022).

As a testimony of Webb's relationships with important botanists and scientists of the time, Parlatore (1856) also published a selection of correspondence between Webb and natural history scholars such as A. Brogniart, J. Pavón, C. Heineken, A.P. De Candolle, J. D'Urville, M. Lagasca, F.E.L. Fischer, Ch. Guadichaud, F. de Girard, A. de Saint-Hilaire, Ad. de Jussieu, and A. Richard.

WEBBIA: FROM BOOK TO JOURNAL

Prof. Martelli proposed to the *Società Botanica Italiana* to publish a festschrift under the name of *Webbia* to celebrate Webb's 50th memorial anniversary (Martelli 1904, 1905a; Moggi 2006). The original title of the book was a mere commemorative Latin form of the surname Webb to create a patronym (cf., *Arnoldia, Englera, Linnaea, Willdenowia*, etc. as journal names honoring distinguished botanists). Therefore, it is evident that *Webbia*, as a journal title, does not refer to any generic name.

The intention was to title the publication as a tribute to Webb and to enshrine him as a distinguished botanist and as one of the most important foreign contributors who helped to advance botany as a discipline in Italy. It was a recognition of Webb's associations with Italian botanists and to him for bequeathing his collections, library, documents, and house in Paris to the city of Florence.

During that era, it was not an unusual practice to also Latinize names of personalities as patronym to create the titles of new Italian journals (e.g., *Delpinoa* dedicated to Federico Delpino, *Malpighia* as tribute Marcello Malpighi or *Parlatorea* to honor Filippo Parlatore; see list of Italian journal in Lenzi Grillini (1988).

However, the initial efforts for founding *Webbia* met with hurdles. Three major obstacles were encountered by Martelli (1904) when he presented his proposal to the *Società Botanica Italiana*. The first obstacle was by those who felt that such a celebratory initiative should be part of a centennial and not of a fiftieth anniversary event to honor Webb's legacy with the title of a major publication. Stephen Sommier (1848–1922), President of this botanical society at that time, was one of those opponents. Another objection, laid by Pasquale Baccarini (1858–1919), Director of the *Istituto Botanico e dell'Erbario Centrale di Firenze* at that time, was that adequate scientific contributions were not available to justify a publication. The third obstacle was that by then not all of Webb's collections had been transferred from the *Imperiale e Regio Museo di Fisica e Storia Naturale* to the *Istituto Botanico e dell'Erbario Centrale di Firenze*; the latter is at Piazza San Marco, and this is the site at which Webb's collections are currently located. Pasquale Baccarini was also the main proponent of this objection.

Prof. Martelli was obviously frustrated that these objections resulted in the rejection of his proposal, mentioning the same in the foreword to what can be considered as the first issue of *Webbia* (Martelli 1905b): "My proposal to the Italian Botanical Society, based in Florence, was modest and did not want to offend anyone's susceptibility. It was a proposal that a priori I hoped to be accepted with complacency even by those who were hostile to it. It failed, due to the veiled submissiveness of the Presidency of the Botanical Society and the hostility of the Director of the Florentine Botanical Institute, who with smooth words opposed the honors." Undeterred by the lack of support from the *Società Botanica Italiana*, Martelli eventually published this book himself (Lenzi Grillini 1988: 1078–1079). This work as published in 1905 represents the beginning of a long academic journey eventually establishing *Webbia* as a botanical journal (for more details on the first 100 years of the journal, see Moggi 2006). It is beyond any doubt that the founding of the journal *Webbia* was certainly not under quiet and peaceful circumstances, but considering that it is about to reach 120 years of life, it was worth it.

WEBBIA: THE THREE GENERA

The name *Webbia* was used to describe three different genera honoring Webb's legacy. The earliest of these genera belongs to the Guttiferae (or Clusiaceae) and was published in June 1836 by the French botanist Édouard Spach (1801–1879), (Spach 1836a: 408, "*Nous avons dédié ce genre à M. Ph. Barker-Webb, célèbre botaniste anglais, auter (conjointement avec M. Sabin*

Berthelot) un magnifique ouvrage sur l'histoire naturelle des iles Canaries"[3]). As circumscribed by Spach (1836a: 408–410, 1836b: 356) the genus included four Macaronesian endemics (i.e., *W. canariensis* (L.) Webb & Berthel., *W. floribunda* (Aiton) Spach, *W. heterophylla* Spach., and *W. platysepala* Spach) that were previously accommodated in the large and widespread genus *Hypericum* L. Currently, *Webbia* Spach, however, is recognized as *Hypericum* sect. *Webbia* (Spach) R.Keller (Robson 1996), a monospecific taxon that encompasses the Canary Island–Madeiran endemic *H. canariense* L. (Figures 6A and 7). Interestingly, Webb & Berthelot (1836) recognized the genus *Webbia* with three species (*W. floribunda*, *W. canariensis*, and *W. platysepala*). Among the specimens that we examined we found only one that has Webb's handwriting (P05151163, housed in P) that he identified as belonging to *Webbia* (as *W. canariensis*, collected in Aguamansa, Orotava, Tenerife). We also looked for references to *Webbia* in the available correspondence between Webb and Spach. There is a single letter that they exchanged (dated March 29, 1849, document #337.1.1); however, this letter does not contain any mention of this genus.

Perhaps unaware of *Webbia* Spach (June 1836), in October 1836, Augustin Pyramus De Candolle (1778–1841) described *Webbia* DC. (Asteraceae: Vernonieae, "*Dixi in honorem cl. bot. angl. P.B. Webb, Orientis, Africae borealis et insularum Canariensium strenuo observatori*"[4]) to include an assemblage of eight species (De Candolle 1836: 72) mostly confined to South Africa (Figures 6D-F, and 8). Because of the illegitimacy of the name *Webbia* DC. and its taxonomic reassessment, these eight species have been transferred to two different genera. Seven of these species are currently included in the African genus *Hilliardella* H.Rob. (Swelankomo et al. 2016) but the eighth species (*W. serratuloides* DC.) was transferred to the African genus *Polydora* Fenzl ex H.Rob (Robinson 1999: 233), which is now recognized to be illegitimate (IPNI 2022; Manning and Govaerts, in prep.). *Hilliardella* (~10 spp.) is mostly restricted to South Africa (Swelankomo et al. 2016). De Candolle, in a letter sent to Webb (dated April 13, 1833, document #73.9.1–73.9.6), mentioned that he greatly cherished the friendships of Webb and of Sabin Berthelot, and had the intention of honoring them by dedicating a genus from Greece (under the name *Webbia*) to Webb (Figure 9A) and the generic name *Berthelotia* to Berthelot; both generic names were published in 1836 (De Candolle 1836: 72, 375). Curiously, the genus *Webbia* DC. is not from the Mediterranean but from Africa.

Karl Schultz Bipontinus (1805–1867) also described *Webbia* Sch.Bip. (Asteraceae: Astereae, "*Genus dicabi amico clarissimo Philippo Barker Webb*"[5]), as a monotypic genus (*W. kraussii* Sch.Bip.) endemic to South Africa (Walpers 1843: 970, Figures 6B and 10). Unlike the almost coincident date of publications of *Webbia* Spach (Jun 1836) and *Webbia* DC. (Oct 1836), Schultz Bipontinus was aware of *Webbia* DC., which is evident from the following remark (p. 970, footnote): "WEBBIA DC. {DC. Prodr. V. 72. - Endl. Gener. plant. no. 2212. – Wlprs. Repert. bot. syst. II. 541.) a me consideratur ut generis Vernonieae sectio satis naturalis" (sic). Furthermore, Walpers (1842: 386) was aware of *Webbia* Spach and treated it as a synonym of *Hypericum* L.

Currently, *Webbia kraussii* is identified as *Nidorella obscura* (DC.) J.C.Manning & Goldblatt (Manning and Goldblatt 2012: 794). *Nidorella* Cass. (±13 spp.) is a sub-Saharan African genus that has its center of taxonomic diversity in South Africa (Hilliard 1977, Herman et al. 2000). In a letter (Figure 9B) sent to Webb, Schultz Bipontinus also informed Webb about his plans to dedicate to him a new genus from South Africa under the name *Webbia* (letter dated April 17, 1842, document #327.41.1–327.41.1). Schultz Bipontinus (1844–1850) wrote the Asteraceae treatment for *Histoire Naturelle des Îles Canaries*, and further evidence for the friendship that he had with Webb are the 52 letters that they exchanged between 1842 and 1850.

It is worth mentioning that although Webb was aware of the earlier *Webbia* names published in 1836, he probably followed the taxonomy of those two names in Walpers's (1842, 1843) works. Furthermore prior to the publication of the three genera described under *Webbia*, in 1836 and 1843, the Spanish botanist Jose A. Pavón (1754–1840) also had plans to dedicate a genus to him using this name (A. Reyes pers. comm.), as acknowledged by Webb in a letter (Figure 10C) to Pavón (dated September 3 1826, document #272.1.1.0). Pavón did not in the end publish any generic name honoring Webb, but he and Webb remained in contact and part of Pavon's herbarium collections from the Neotropics was eventually added to Webb´s herbarium (Steinberg 1977).

In this article we review the nomenclature and botanical history of taxa that have been assigned to the three different genera that were described using the name of *Webbia*. Previous nomenclature diagnoses for *Webbia* Spach (Robson 1996: 133–135), *Webbia* DC.

[3] We have dedicated this genus to Mr. Ph. Barker-Webb, famous English botanist, author (jointly with Mr. Sabin Berthelot) of a magnificent work on the natural history of the Canary Islands.

[4] Honoring the talented English botanist P.B. Webb tireless explorer of the East, North Africa, and the Canary Islands.

[5] Genus dedicated to my most famous friend Philip Barker Webb.

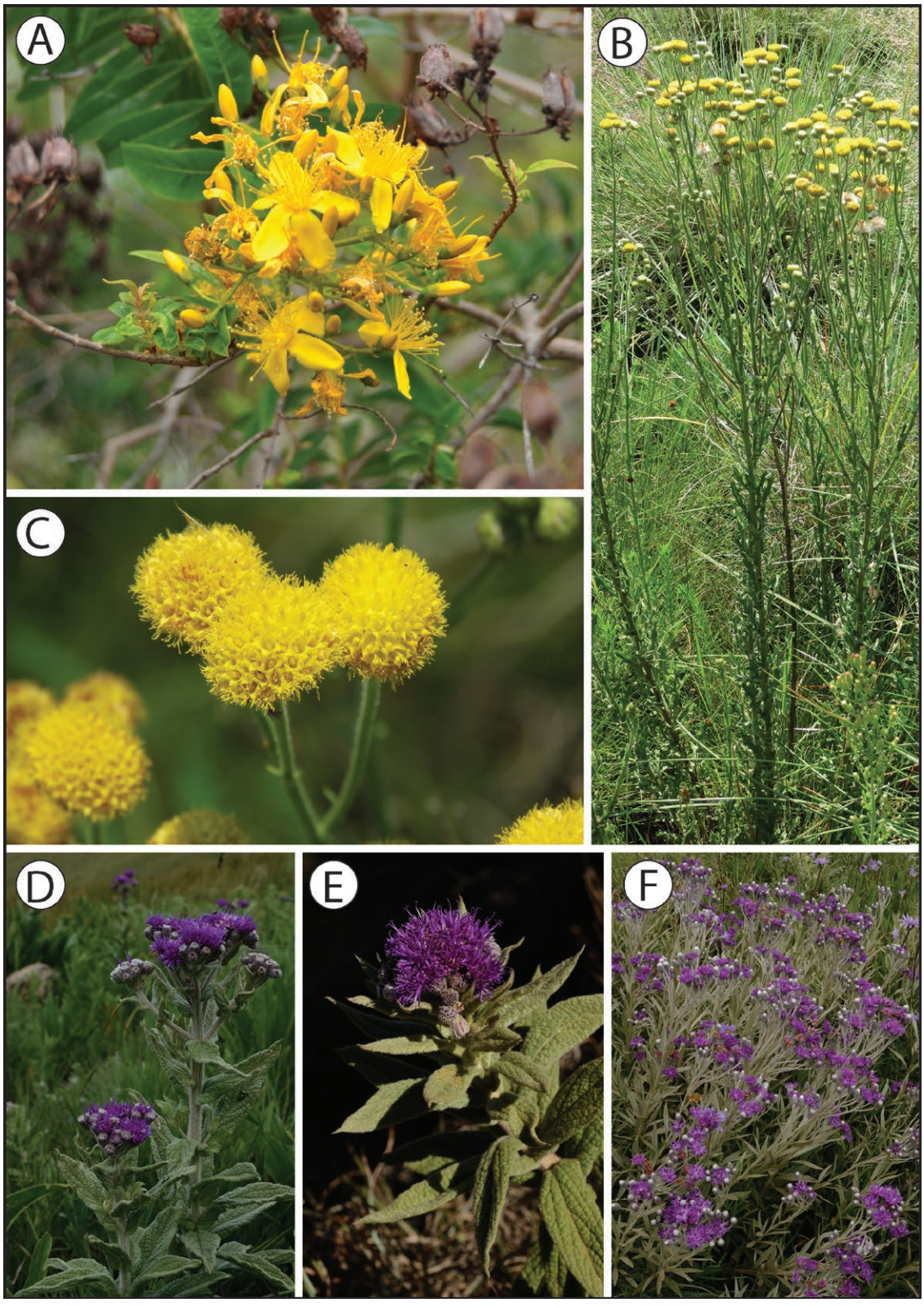

Figure 6. Selection of photos of species that were originally described within *Webbia* Spach, *Webbia*, DC. or *Webbia* Sch.Bip. in habitat. Accepted names are found in nomenclature diagnoses. (A) *Webbia canariensis* (L.) Webb & Berthel. (B) and (C) *Webbia kraussii* Sch.Bip. (D) and (E) *Webbia hirsuta* DC. (F) *Webbia aristata* DC. Photo credits: Arnoldo Santos-Guerra (A); Rich Hoyer (B, C); and John Manning (D–F).

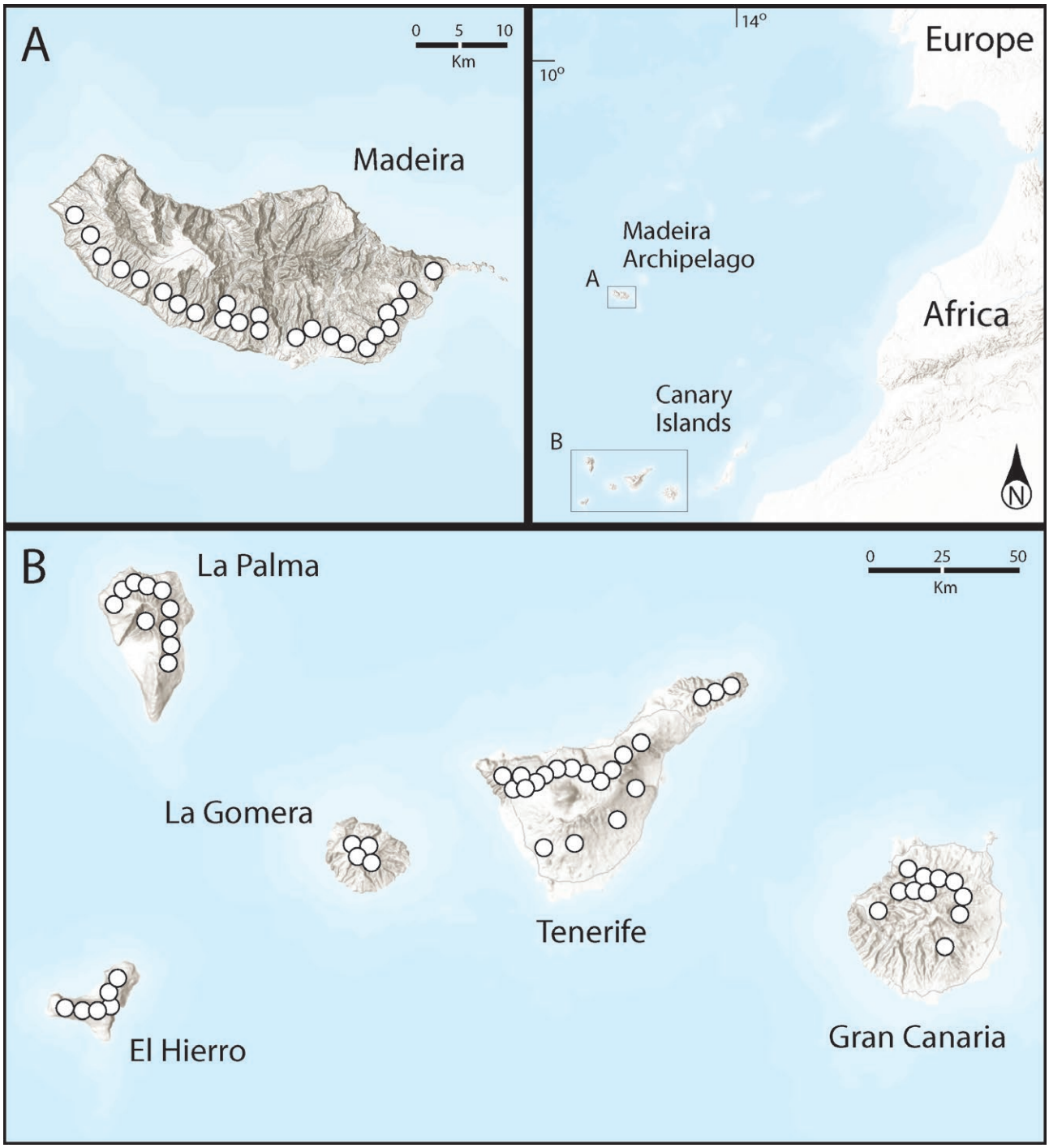

Figure 7. Distribution map of *Webbia* Spach (Guttiferae), accepted name *Hypericum* L. sect. *Webbia* (Spach) R.Keller, monospecific taxon that encompasses *H. canariense* L. Based on Sequeira (pers. comm.) and Gobierno de Canarias (2022).

(Hilliard 1977: 41–43, Jeffrey 1988: 219, 223, 243, Robinson 1999: 233, Swelankomo et al. 2016, Van Wyk and Klopper 2021), and *Webbia* Sch.Bip. (Hilliard 1977: 92) were revisited.

Besides the three *Webbia* generic names, the New Guinea palm genus *Barkerwebbia* Becc. was also dedicated to Webb in the first issue of the journal *Webbia* (Beccari 1905: 281, "*Ho dedicato il nuovo genere Bark-*

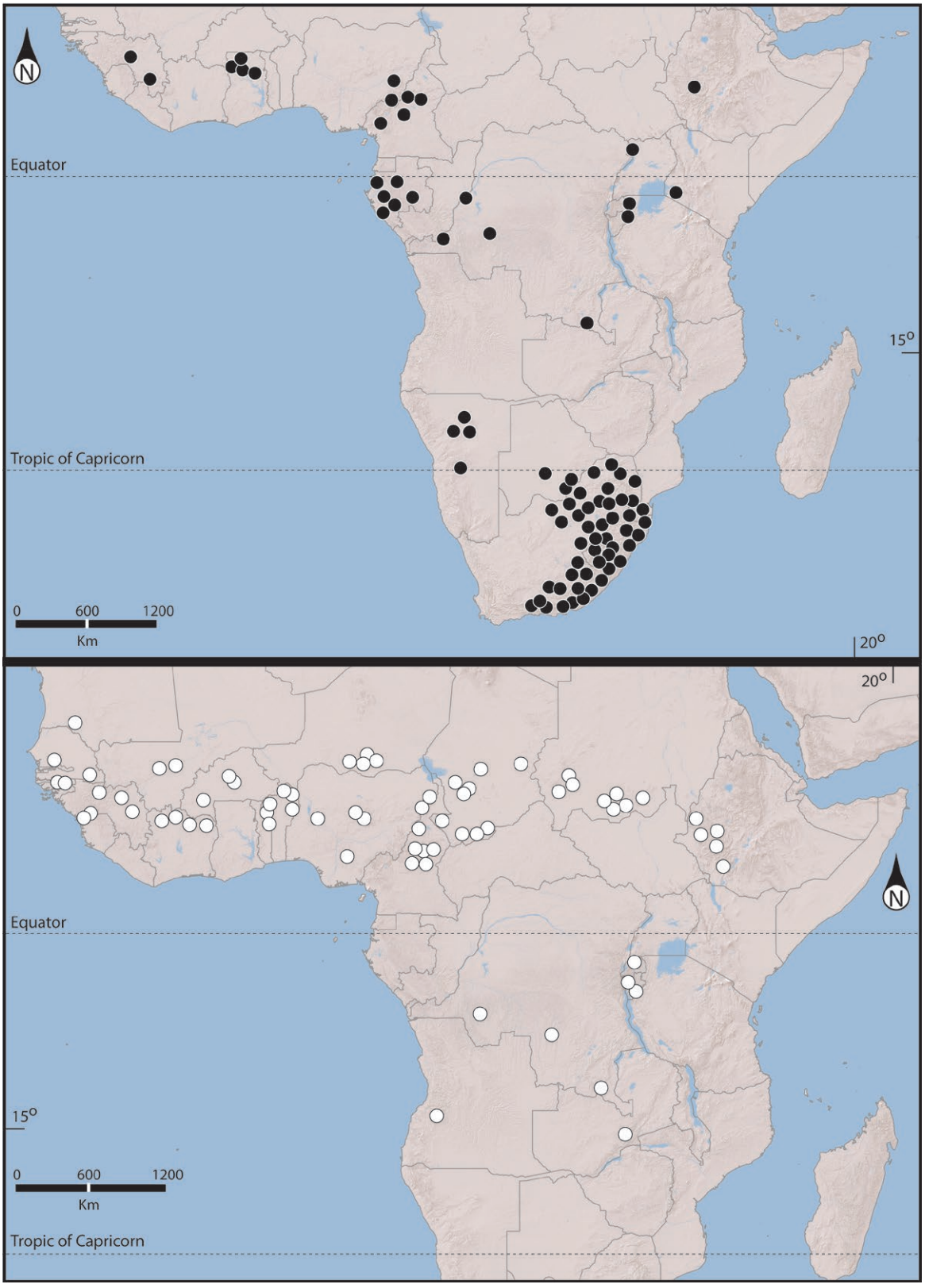

Figure 8. Distribution map of *Webbia* DC. (Asteraceae: Vernonieae). Filled dots: *Webbia serratuloides* DC. Unfilled dots, species of *Webbia* DC. that are currently placed in *Hilliardiella* H.Rob. Based on Swelankomo et al. (2016) and Several Authors (2022).

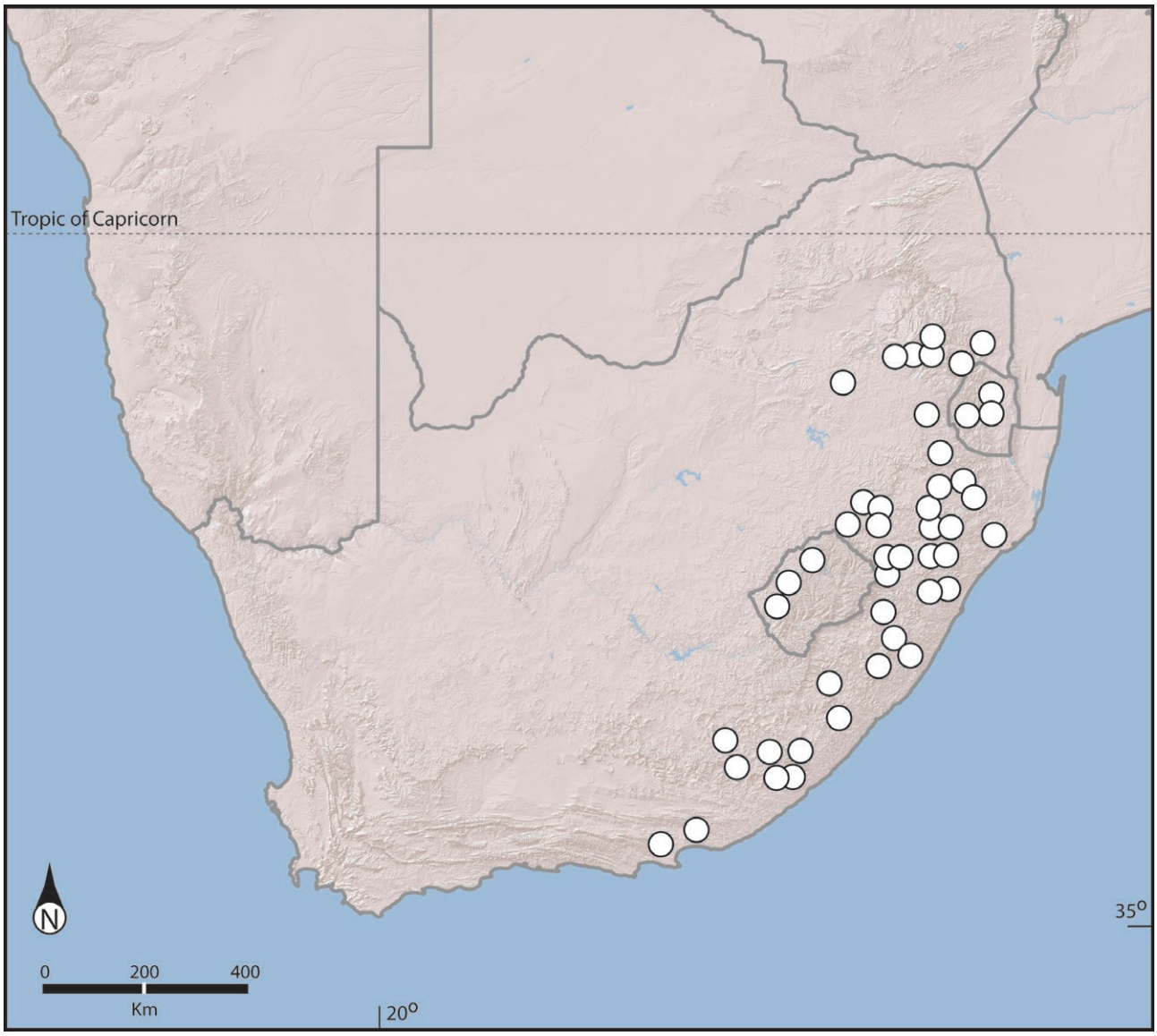

Figure 9. Distribution map of the monotypic genus *Webbia* Sch.Bip. (Asteraceae: Astereae), accepted name *Nidorella obscura* (DC.) J.C.Manning & Goldblatt. Based on Several Authors (2022).

erwebbia a Filippo Barker Webb nella ricorrenza del 50º anniversario della sua morte"[6]). Its nomenclature and systematic placements have been reviewed by Trudgen and Baker (2008) and by Petoe and Barker (2019), and currently *Barkerwebbia* is included within *Heterospathe* Scheff., a genus with a wider distribution from the Philippines to New Guinea, Moluccas, Micronesia, Vanuatu, and Fiji. A revision of the botanical history of *Barkerwebbia*, however, is not the scope of this article.

[6] I have dedicated the new genus Barkerwebbia to Philip Barker Webb in the 50th anniversary of his death.

Webbia Spach[7] (Guttiferae)

Webbia Spach, Hist. Nat. Veg. Phan. 5: 408 (June 1836)

Hypericum sect. **Webbia** (Spach) R.Keller in Engl. & Prantl, Nat. Pflanzefam 3(Abt. 6, Lief. 95): 211. (7 Nov. 1893)

Webbia platysepala Spach, Hist. Nat. Veg. Phan. 5: 410 (June 1836), as '*platypetala*'; Ann. Sci. Nat. Bot., ser. 2. 5:

[7] Accepted names indicated in bold font

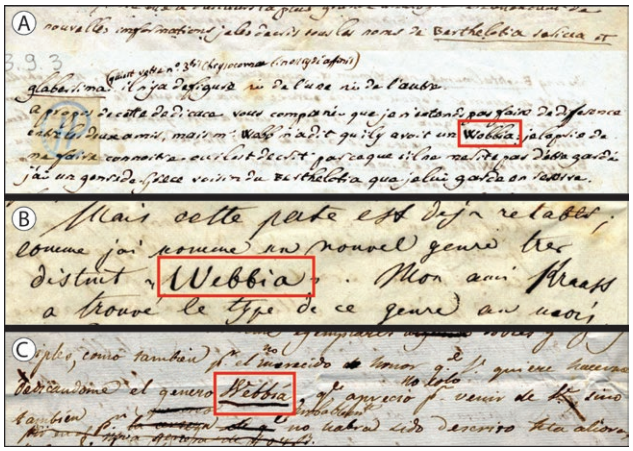

Figure 10. Excerpts from Webb's correspondence that highlight the use of the name *Webbia* as intended to describe genera to honor him. Name *Webbia* is shown inside red squares. (A) Letter from Augustin Pyramus De Candolle, dated April 13, 1833, document #73.9.1–73.9.6. (B) Letter from Karl Schultz Bipontinus, dated April 17, 1842, document #327.41.1–327.41.1. (C) Letter to Jose A. Pavón, dated September 3 1826, document #272.1.1.0. Courtesy of *Biblioteca di Scienze – Botanica, Università degli Studi di Firenze*©. (A) and (B) are posted online as part of the Humboldt Project [https://fundacionorotava.es/humboldt/library/correspondence/; *Max-Planck-Institut für Wissenschafttgeschichte* (Germany) and the *Fundación Canaria Orotava de Historia de la Ciencia* (Tenerife, Canary Islands, Spain)].

356 (June 1836), lectotype designated by Robson (1977: 332).

Hypericum canariense L., Sp. Pl. 2: 784. 1753

Type: *Hypericum frutescens, canariensis, multiflorum canariense* [Hort. Cliff.: 381, no. 9], lectotype designated by Wijnands (1983: 109), BM000646815 (photo!).

(≡) *Webbia canariensis* (L.) Webb & Berthel., Hist. Nat. Îles Canaries (Phytogr.) 1: 48 (Oct. 1836)

(≡) *Hypericum debile* Salisb., Prodr. Stirp. Hort. Chapel Allerton: 369 (Nov. – Dec. 1796), *nom. illeg. superfl.* pro *H. canariense*.

(≡) *Hypericum corymbosum* Moench, Methodus Suppl.: 41 (May 1802), *nom. illeg. superfl.* pro *H. canariense*, non *H. corymbosum* Muhl. ex Willd., Spec. Pl. 3(2): 1457 (Nov. 1802)

(=) *Hypericum floribundum* Aiton, Hort. Kew 3: 104. 1789

Type: Madeira. Fr. Masson (lectotype designated by Robson (1996: 134), BM000617764 (photo!); Madeira, *Masson* (isolectotype BM000617765 (photo!)).

(≡) *Webbia floribunda* (Aiton) Spach, Hist. Nat. Veg. Phan. 5: 410 (June 1836)

(≡) *Hypericum canariense* var. *floribundum* (Aiton) Bornm., Bot. Jahrb. Syst. 33(3): 453 (Dec. 1903)

(≡) *Webbia canariensis* var. *floribunda* (Aiton) Pit. & Proust, Iles Canaries: 134. 1909

(=) *Hypericum canariense* var. *montanum* Buch, Abh. K. Akad. Wiss. Berlin, Phys. Kl. 1816-1817: 382. 1817, *nom. nud.*, as '*montana*'.

(=) *Hypericum canariense* var. *salicifolium* Choisy in DC., Prodr. 1: 544 (Jan. 1824)

Type: Not cited (presumed: in insulis Canariis).

(=) *Hypericum canariense* var. *triphyllum* Choisy in DC., Prodr. 1: 544 (Jan. 1824)

Type: Not cited (presumed: in insulis Canariis).

(=) *Webbia platysepala* Spach, Hist. Nat. Veg. Phan. 5: 410 (June 1836), as '*platypelata*'; Ann. Sci. Nat. Bot., ser. 2. 5: 356 (June 1836).

Type: *Webbia platysepala* Nob. Ténériffe. Webb (holotype P05151177 (photo!).

(≡) *Hypericum platysepalum* (Spach) Steud., Nomencl. Bot. 2nd ed. 1: 789 (Dec. 1840), as '*platypetalum*'.

(≡) *Hypericum platysepalum* (Spach) Walpers Repert. Bot. Syst. 1: 386 (Nov. 1842)

(≡) *Hypericum canariense* var. *platysepalum* (Spach) Bornm., Bot. Jahrb. Syst. 33(3): 453 (Dec. 1903), as '*platysepala*'.

(≡) *Webbia canariense* var. *platysepala* (Spach) Pit. & Proust, Iles Canaries: 134. 1909, as '*platypetala*'.

(=) *Webbia heterophylla* Spach, Hist. Nat. Veg. Phan. 5: 409 (June 1836)

Type: not found.

Typification notes

Spach (1836a, b) published two works that included descriptions for his new genus *Webbia*. The cover of *Historie Naturelle des Végétaux* (Spach 1836a) clearly shows

that it was issued in June 1836. The second work (Spach 1836b), was included in the fifth volume of *Annales des Sciences Naturelles*, and according to Stafleu and Cowan (1985: 768) this was also issued in June 1836. The same publication dates for these two publication create confusion regarding the priority between the two publications. We have chosen the publication by Spach (1836a) as having priority. There are two reasons for our assessment. Firstly, the species name "*Webbia platypetala*" was published in *Historie Naturelle des Végétaux* (Spach 1836a). However, in *Annales des Sciences Naturelles*, the epithet "*platypetala*" was corrected to "*platysepala*" by Spach who remarked as follows: "*platypetala ex errore typographico*" (Spach 1836b). Secondly, Spach (1836b) indicated that *W. heterophylla*, a species that was described by him in the *Historie Naturelle des Végétaux* (Spach 1936a) was included in *W. canariensis*.

Webbia DC.[8] (Asteraceae: Vernonieae)

Webbia DC., Prodr. 5: 72 (Oct. 1836), *nom. illeg.*, non *Webbia* Spach, Hist. Nat. Veg. Phan. 5: 408 (June 1836)

Type: *Webbia pinifolia* (Lam.) DC. (*Conyza pinifolia* Lam., *Vernonia pinifolia* (Lam.) Less.), lectotype designated by Robinson (1999: 229) = *Hilliardiella capensis* (Houtt.) H.Rob. in Robinson et al., PhytoKeys 60: 87 (Feb. 2016)

(≡) ***Hilliardiella*** H.Rob., Proc. Biol. Soc. Washington 112: 229 (Mar. 1999)

Type: *Hilliardella pinifolia* H.Rob., *nom. invalid.* (*Conyza pinifolia* Lam., *Vernonia pinifolia* (Lam.) Less.).

(=) *Vernonia* subsect. Hilliardianae S.B.Jones, Rhodora 83: 66 (Jan. 1981)

Type: *Vernonia oligocephala* (DC.) Sch.Bip. in Walpers (*Webbia oligocephala* DC.).

(=) *Crystallopollen* Steetz in Peters, Reise Mossambique 6 (Bot., 2): 363. 1864. (unplaced accepted genus (J.C. Manning pers. comm.; Manning and Govaerts, in prep.).

Type: *Crystallopollen angustifolium* Steetz. Polydora Fenzl, Flora 27: 312. 1844, *nom. nud.* (lectotype designated by Robinson (1999: 230)).

(=) *Polydora* Fenzl ex H.Rob., Proc. Biol. Soc. Washington 112: 232 (Mar. 1999), *nom. illeg.* and superfl. & illegitimate for *Crystallopollen*.

Type: *P. serratuloides* (DC.) H.Rob. (*Webbia serratuloides* DC., "*Polydora stoechadifolia* Fenzl", *invalid.*).

Vernonia smithiana Less., Linnaea 6: 638. 1831

Type: Democratic Republic of the Congo, Congo – Chrn Smith, C. *Smith s.n.* (holotype BM013860195 (photo!); Fl. Afr. Trop iii: 276 (isotype, K000272867 (photo!).

(≡) *Webbia smithiana* (Less.) DC., Prodr. 5: 72 (Oct. 1836)

(≡) ***Hilliardiella smithiana*** (DC.) H.Rob., Proc. Biol. Soc. Washington 112: 230. (Mar. 1999)

Erigeron capensis (as '*capense*') Houtt., Nat. Hist., Deel [Part] 2, 10: 629 (June 1779)
Type: Illustration in Houtt., Nat. Hist. Deel [Part] 2, 10: t. 69, f. 2 (June 1779), lectotype here designated.

(≡) *Cacalia capensis* (Houtt.) Kuntze, Rev. Gen. 3(2): 138 (Sept. 1898)

(≡) *Vernonia capensis* (Houtt.) Druce, Rep. Bot. Exch. Cl. Brit. Is. 4 (6): 651 (June 1917)

(≡) ***Hilliardiella capensis*** (Houtt.) H.Rob. in Robinson et al., PhytoKeys 60: 87 (Feb. 2016)

(=) *Conyza canescens* L.f., Suppl.: 367 (Oct. 1782)

Type: South Africa, Cape, Thunberg 334 (holotype LINN 993.7 (photo!); possible isotype: UPS-THUNB (19376 — microfiche!).

(=) *Conyza pinifolia* Lam., Encycl. 2: 86 (Oct. 1786)

Type: C B Sp Musée royal (illeg.) Berlin, Krebs 1830, (G-DC, G00464328 (photo!), neotype here designated); isoneotype: P (P022845 (photo!).

(≡) *Vernonia pinifolia* (Lam.) Less., Linnaea 4: 257 (1829), non *V. canescens* Kunth in Humboldt et al., Nov. Gen. Sp. 4 (folio ed.): 27 (Dec. 1818)

(≡) *Webbia pinifolia* (Lam.) DC., Prodr. 5: 72 (Oct. 1836)

(≡) *Hilliardiella pinifolia* H.Rob. [as "(Less.) H.Rob."] in

[8] Accepted names are indicated in bold font

Proc. Biol. Soc. Washington 112: 230 (Mar. 1999), *nom. invalid*.

(=) *Vernonia pinifolia* var. *glabrata* Harv. in Harvey & Sonder, Fl. Cap. 3: 51 (Feb.–June 1865)

Type: South Africa, Eastern Cape, Howieson's Poort, Hutton s.n., holotype (TCD).

Webbia hirsuta DC., Prodr. 5: 73 (Oct. 1836)

Type: "in Africa australi ad Tambukiland et Cafferland (*Eckl.! n. 725 et 1318*), ad Katriviersberg et Port Natal (Dreg.!)"; lectotype designated by Swelankomo et al. (2016): 42. South Africa, KwaZulu-Natal], Port Natal [Durban], R. I 1835 [sic. but evidently March/April 1832 fide Glen & Germishuizen (2010: 155), *Drège 3778*, G-DC-G00464307 (photo!); isolectotype, P021982 (photo!). Other original material: South Africa, KwaZulu-Natal] Katrivierberg, R.V. 1835 [sic. but evidently March/April 1832 fide Glen & Germishuizen (2010: 155)], *Drège 3778* (G-DC-G00464302 (photo!); South Africa, Eastern Cape] Tambukiland, 1834, *Ecklon 725* (G-DC-G00464305 (photo!); Kafferland (Kaffraria) 1835, *Ecklon 1318*, (G-DC-G00464305 (photo!).

(≡) *Vernonia hirsuta* (DC.) Sch.Bip. in Walpers, Repert. Bot. Syst. 2: 947 (Dec. 1843)

(≡) ***Hilliardiella hirsuta*** (DC.) H.Rob., Proc. Biol. Soc. Washington 112: 230 (Mar. 1999)

(=) *Vernonia hirsuta* var. *obtusifolia* Harv. in Harvey & Sonder, Fl. Cap. 3: 51 (Feb.–June 1865)

Type: South Africa, KwaZulu-Natal, Natal, *Williamson s.n.* (TCD); *Gerrard & M'Ken 343* (TCD), syntypes.

Webbia nudicaulis DC., Prodr. 5: 73 (Oct. 1836)

Type: "in Africa australi ad Sz. Key et Basche legit. cl. Drege!" South Africa, Eastern Cape] Zw. Key and Basche (between Kei and Bashee rivers), R. IV, 1835 (sic. but evidently March/April 1832 fide Glen & Germishuizen (2010: 155), *Drège 5072*, (holotype G-DC-G00464303 (photo!).

(≡) *Vernonia dregeana* Sch.Bip. in Walpers, Repert. Bot. Syst. 2: 947 (Dec. 1843), as *nom. nov.*, non *Vernonia nudicaulis* Less., Linnaea 6: 637 (1831).

(≡) *Cacalia nudicaulis* (DC.) Kuntze, Revis. Gen. Pl. 2: 970 (Nov. 1891)

(≡) ***Hilliardiella nudicaulis*** (DC.) H.Rob., Proc. Biol. Soc. Washington 112: 230 (Mar. 1999)

Webbia oligocephala DC., Prodr. 5: 73 (Oct. 1836)

Type: "in Africa australi ad Zw. Omsanculo et Port Natal legit cl. Drege!" South Africa, KwaZulu-Natal] Zw. Omsamculo (and Port Natal [between Umzimkulu and Durban), R.I. 1935 (sic. but evidently March/April 1832 fide Glen & Germishuizen (2010: 155), *Drège 5076* (holotype G-DC, G00464306 (photo!).

(≡) *Vernonia oligocephala* (DC.) Sch.Bip. in Walpers, Repert. Bot. Syst. 2: 947 (Dec. 1843)

(≡) *Vernonia kraussii* var. *oligocephala* (DC.) Harvey in Harvey & Sonder, Fl. Cap. 3: 51 (Feb.–June 1865)

(≡) ***Hilliardiella oligocephala*** (DC.) H.Rob., Proc. Biol. Soc. Washington 112: 230 (Mar. 1999)

(=) *Webbia elaeagnoides* DC., Prodr. 5: 73 (Oct. 1836)

Type: "in Africa australi ad Zw. Omsamwubo et Omsanculo legit cl. *Drège*!". South Africa, KwaZulu-Natal] Zw. Omsamwubo and Omsanculo (between Umzimvubu and Umzimkulu), R.III. 1835 (sic. but evidently March/April 1832 fide Glen & Germishuizen (2010: 155), *Drège* (holotype, G-DC, G00464319 (photo!).

(≡) *Vernonia kraussii* Sch.Bip. in Walpers, Repert. Bot. Syst. 2: 947 (Dec. 1843), as *nom. nov.*, non *Vernonia elaeagnoides* Kunth, in Humboldt et al., Nov. Gen. Sp. ed. Fol. 4: 33 (Apr. 1820).

(≡) *Cacalia elaeagnoides* (DC.) Kuntze, Revis. Gen. Pl. 3: 2: 968 (Dec. 1891), as '*eleagnodes*'.

(≡) *Hilliardiella elaeagnoides* (DC.) N.Swelankomo & J.C.Manning, S. African J. Bot. 106: 50 (Sept. 2016)

Webbia aristata DC., Prodr. 5: 73 (Oct. 1836)

Type: "ad Cap. Bonae Spei ad Katrivier (Dreg. sp. exs.), ad Zw. Key et Basche (Dreg.!), in territorio cesso et Kafferland (Eckl.! et Zeyh.). South Africa, Eastern Cape) Zw. Key and Basche (between Kei and Bashee rivers) R. IV 1835 (sic. but evidently March/April 1832 fide Glen & Germishuizen (2010: 155), *Drège 5074* (lectotype designated by Hilliard (1977: 43): G-DC, G00464322 (photo!)).

(≡) *Vernonia natalensis* Sch. Bip. in Walpers, Repert. Bot. Syst. 2: 947 (Dec. 1843) [as nom. nov., non *Vernonia aristata* Less., Linnaea 4: 313 (1829)

(≡) *Cacalia aristata* (DC.) Kuntze, Rev. Gen.: 138. 1898

(≡) ***Hilliardiella aristata*** (DC.) H.Rob., Proc. Biol. Soc. Washington 112: 230 (Mar. 1999)

Webbia serratuloides DC., Prodr. 5: 73 (Oct. 1836)

Type: "*in Senegambiae locis arenosis ad Albreda secus flumen Gambie Martio sere defloratam legit cl. Perrottet … (v. s. specim. foem. a cl. Perrottet comm.)*". [Gambia] Albreda [illegible] sablonneuse [illegible] Gambia, Mars 1829, *Perrottet s.n.* (holotype, G-DC, G00464329 (photo!).

(≡) *Vernonia perrottetii* Sch.Bip. in Walpers, Repert. Bot. Syst. 2: 947 (Dec. 1843), as *nom. nov.*, non *Vernonia serratuloides* Kunth, in Humboldt et al., Nov. Gen. Sp. 4(ed. Fol.): 26 (Dec. 1818)

(≡) *Polydora serratuloides* (DC.) H.Rob., Proc. Biol. Soc. Washington 112: 233 (Mar. 1999)

Typification notes

The works of Hilliard (1977), Jeffrey (1988), Robinson (1999), Swelankomo and Manning (2016), and Van Wyk and Klopper (2021) provided the basis for our nomenclatural study of names associated with *Webbia* DC. We concur with the conclusions of these studies, but we make a few amendments to their typifications. Firstly, we have assigned bar-code numbers to type specimens identified in these previous works. Furthermore, we have identified the holotype of *Vernonia smithiana* as one of the two isotypes listed by Jeffrey (1988, BM013860195). The original description of this species was based on material collected by the Norwegian botanist Christen Smith (1785–1816) during the ill-fated expedition that he and others undertook to the Congo River region in the summer of 1916 (Lessing 1831: 639). The protologue refers to a specimen that was part of the herbarium of the Danish botanist J.W. Hornemann (1770–1841). Hornemann's herbarium is located in C with additional collections in nine other institutions (Stafleu and Cowan 1979: 333). We could not locate specimens of this species in any of these ten herbaria, and therefore, have accepted BM013860195 as the holotype with an isotype housed in K (K000272867).

The holotype of *Webbia serratuloides* was also located during our study. The identified specimen (G00464329) is housed in De Candolle's herbarium (G-DC) and matches the morphological features and collection provenance indicated in the protologue (De Candolle 1836: 73). The correct nomenclatural placement of this name is part of an ongoing project (John C. Manning pers. comm) and is not included in this contribution.

Furthermore, in our study of *Erigeron capensis*, we designate the illustration included in the species protologue as the lectotype [Houttuyn 1779: 629, plate 69 (Fig. 2)].

We provide a revised interpretation for the name *Webbia pinifolia* (Lam.) DC., as a superfluous but legitimate name for *Erigeron capensis* Houtt. (1783) on the following grounds. In the protologue of his new species *Conyza pinifolia*, Lamarck (1786), at the end of the second paragraph of this species treatment, included the following two synonyms: "*Elichrysum peregrinum angustifolium … calyce spinoso candiodo*. Seb. Mus. I. p. 38. Tab. 23. f. 3. *An Conyza canescens* Lin. f. Suppl. 367 [1782]". Of these, "*Elichrysum peregrinum angustifolium … calyce spinoso candiodo*" is a polynomial and does not affect the status of the name *Conyza pinifolia*. Regarding the citation of "*An Conyza canescens*," it is noted here that in Latin disjunctive clauses, the term 'an' is interpreted as denoting uncertainty by itself, without a verb of doubting, and in disjunctive interrogations, 'an' is read as "not, whether." In other words, the doubtfully cited synonym *C. canescens* does not cause superfluity and illegitimacy to the name *C. pinifolia* Lam., and the Lamarck name is legitimate and can serve as a basionym.

Subsequently, Lessing (1829) published *Vernonia pinifolia* and cited *Conyza pinifolia* as the basionym. Furthermore, in contrast to Lamarck's treatment, Lessing included *C. canescens* as a synonym. It is emphasized here that the new combination *V. pinifolia* was based on the legitimate epithet-bringing synonym *C. pinifolia*. Such new combinations, if they include older legitimate synonyms at the same rank, are nomenclaturally superfluous but not illegitimate (vide Art. 52.4). In this case, because of the existence of *V. canescens* Kunth (1818) for a New World taxon, the name *V. pinifolia* is neither nomenclaturally superfluous not illegitimate.

For his *Webbia pinifolia*, De Candolle cited *Conyza pinifolia* and *Vernonia pinifolia* as synonyms but implicitly excluded *C. canescens*. However, he included *Erigeron capensis* Houtt. as a synonym. Thus, as illustrated by Art. 52, the new combination *W. pinifolia* (Lam.) DC. was nomenclaturally superfluous for *E. capensis*, but not illegitimate when made.

Within his new genus *Hilliardiella*, Robinson (1999: 230) proposed a new combination as "*Hiliardiella pinifolia* (Less.) H. Rob." and cited the basionym as "*Vernonia pinifolia* Less., Linnaea 4:257. 1829." For new combinations made after 1952, direct references to the basionyms are mandatory (vide Art. 41.5). As mentioned above, *Vernonia pinifolia* itself is a new combination with a direct reference to *Conyza pinifolia*, and Robinson erred

in his basionym citation. Since Lessing cited *C. pinifolia* as the basionym and since Robinson (1999: 230) did not refer to the basionym directly, his intended new combination was invalid when made (Art. 41.8(a) and Ex. 25 apply). It is mentioned here that as per Art. 41.8(d), on or after 1 January 1953, citation of an indirect reference to the basionym is treated as a correctable error, not affecting the valid publication of new combination when the resulting new combination would otherwise be the validly published name of a new taxon. In other words, had Robinson (1999: 230) provided or referenced a Latin description and holotype citation, the proposed "*Hiliardiella pinifolia* (Less.) H. Rob." would be corrected to "*Hiliardiella pinifolia* (Lam.) H. Rob." and treated as a valid new combination. In this case, Robinson did directly refer to the Latin description of *Vernonia pinifolia* but did not cite type or holotype. Therefore, Art. 41.8(d) does not apply, and the published new combination "*Hiliardiella pinifolia* (Less.) H. Rob." is invalid.

Regarding the type of the Lamarckian name *Conyza pinifolia*, the protologue states "*Cette plante croît au Cap de Bonne Espérance, & nous a été communicquée par M. Sonnerat*."[9] Pierre Sonnerat (1748–1814) was a French naturalist who travelled and collected both plant and animal specimens primarily in Mauritius but with brief stopovers in Cape Town in South Africa in 1773 and 1782. Sonnerat did not venture much beyond the immediate vicinity of Cape Town, and as the species does not occur there it is unlikely that he himself collected it. His core herbarium is in P with duplicates in C, G, LE, LINN, STB (Stafleu and Cowan 1985: 745). We have not found any material attributable to *Conyza pinifolia* Lam. in the collections of Sonnerat housed in these herbaria. Therefore, we designated a specimen that was collected at the Cape of Good Hope by the German apothecary and naturalist Georg L. E. Krebs (1792–1844) as the neotype. The selected specimen is housed in G-DC (G00464328), it was studied by De Candolle, and it is mentioned in his account for *Webbia pinifolia*, matching the morphological description provided in Lamarck´s (1786) protologue. An isoneotype was found in P (P022845). Krebs died in South Africa and collected in this country over the period 1817–c. 1840.

Webbia Sch.Bip. (Asteraceae: Astereae)

Webbia Sch.Bip., in Walpers, Repert. 2: 970. (Jan. 1843), *nom. illeg.*

Type: Webbia kraussii Sch.Bip. in Walpers, Repert. 2: 971 (Jan. 1843)

Nidorella Cass. in F.Cuvier, Dict. Sci. Natl., ed. 2: 469 (Apr. 1825)

Webbia kraussii Sch.Bip. in Walpers, Repert. 2: 971 (Jan. 1843)

Type: lectotype [inadvertently by Hilliard (1977: 92), ("as holotype")]: *Conyza kraussii* C.H.Schultz est novum genus Karelinae Less. proximum ex recensione seriori autoris, sed, nondum denominatum. N. 602 in collibus prope Knysna River (TUB004915 (photo!); isolectotypes, N. 602 in collibus prope Knysna Gorge, P031296 (photo!); in collibus prope Knysna River, *Dr. Krauss*, (P031297 (photo!); in collibus prope Knysna River, *Krauss*, (W0012365 (photo!).

(=) *Conyza obscura* DC., Prodr. 5: 387 (Oct. 1836)

Type: Omtata and Omsamwubo [between Umtata and Umzimvubu] R.III, Drège 3733 (lectotype here designated, G-DC, G00450339 (photo!)); isolectotypes, Wittebergen [Witteberg], *Drège 3733*, G-DC, G00450317 (photo!); Wittebergen [Witteberg] R. VIII, *Drège 3733*, G-DC, G00450343 (photo!),

(≡) ***Nidorella obscura*** (DC.) J.C.Manning & Goldblatt, Strelitzia 29: 794 (2012)

(=) *Conyza obscura* var. *calvescens* DC., Prodr. 5: 387 (Oct. 1836)

Type: Langkloof, Drège 5717 G-DC (holotype G00450209 (photo!).

Typification notes

Webbia kraussii was known to Harvey (1865: 114) only from the description, and he treated it as a 'doubtful genus–probably a species of *Conyza*'. It was subsequently placed in synonymy under *Conyza obscura* by Hilliard (1977) in her regional monograph of the family for Natal (South Africa). Hilliard's citation of the TUB specimen as the "holotype" of the name can be construed as an act of effective lectotypification as it was inadvertently done in 1977, and at that time, it was not necessary to include a typification statement "here designated" or its equivalent, a phrase required for lecto-, neo-, and epitypifications done on or after 1 January 2001 (Shenzhen Code Art. 7.11; Turland et al. 2018).

Regarding the type of *Conyza obscura*, Hilliard (1977) listed five specimens as 'Types', and thus did not typify

[9] This plant grows in the Cape of Good Hope and it was communicated to us by Mr. Sonnerat.

the name. We found *Drège 3733* at G-DC [G00450339] as the best material agreeing with the description and choose it as the lectotype.

ACKNOWLEDGEMENTS

We dedicate this publication to Dr. Arnoldo Santos Guerra (retired Director of *Unidad de Botánica Aplicada at Jardín de Aclimatación de La Orotava, Instituto Canario de Investigaciones Agrarias*, Canary Islands) in recognition of an influential career in plant ecology, conservation and systematics of the Macaronesian Islands. In the 1980s, when Francisco-Ortega was an undergraduate student, Arnoldo introduced him to the legacy of Webb and other legendary botanists working in Macaronesia (Francisco-Ortega 2013). Andrés Delgado (*Asociación de Amigos del Museo de Naturaleza y Arqueología*, Tenerife, Spain), Daniel Gann (Florida International University [FIU]), and Scott Zona (retired curator of the FIU Wertheim Plant Conservatory) helped with the layout and design of maps or photos. Nancy Janda (Hunt Botanical Institute for Botanical Documentation), Gerardo García Casanova (retired higher education instructor from *Instituto de Educación Superior Zonzamas*, Lanzarote, Canary Islands), Lia Pignotti (FT herbarium), Vasco Bordignon (Bassano del Grappa), Francesca Cagnani and Alessandro Cerretti (*Biblioteca di Scienze – Botanica, Università degli Studi di Firenze*), helped to track down relevant bibliography and portraits. Thanks go to Chiara Nepi, curator of the *Herbarium Webbianum* (FI-Webb), for her kind support and technical assistance. Nancy Korber (retired librarian of Fairchild Tropical Botanic Garden) critically read an early version of the manuscript. Special thanks to Piero Delprete (*Herbier de Guyane*, Cayenne, French Guiana) for the translation from French of the correspondence among P.B. Webb and A.P. De Candolle, and K.S. Bipontinus and to Werner Greuter (B) who interpreted the usage of the Latin term An in association with the name *Conyza pinifolia*.

REFERENCES

Beccari O. 1905. Palme nuove papuane. Webbia. 1: 281–359.

Chiarugi A. 1956. Nel primo centenario della morte di Philip Barker Webb, 1854–1954. Webbia. 11: ix–xviii.

De Candolle AP. 1836. Prodromus Systematis Naturalis Regni Vegetabilis 5. Treuttel et Würtz Paris.

Francisco-Ortega J. 2013. Viera y Clavijo, Arnoldo Santos y los siglos de las luces. Vieraea. 41: 5–20.

Funk V. 2017. North America herbaria and their Tropical plant collections: What exists, what is available, and what the future may bring. In: Friis I, V Baslev (eds.), Tropical Plant Collections: Legacies from the Past? Essential Tools for the future? Royal Academy of Sciences and Letters, Copenhagen. Pp. 73–96.

García Pérez JL. 1988. Viajeros Ingleses en las Islas Canarias durante el Siglo XIX. Servicio de Publicaciones de la Caja General de Ahorros de Canarias, Santa Cruz de Tenerife, Canary Islands, Spain.

Gay MJ. 1856. Notice sur la vie et les travaux de Philippe Barker Webb. Bulletin de la Societé Botanique de France. 3: 37–52.

Glen HF, G Germishuizen. 2010. Botanical exploration of southern Africa. 2nd Ed. Strelitzia. 26: 1–489.

Gobierno de Canarias. 2022. Banco de Datos de Biodiversidad de Canarias. Gobierno de Canarias, Canary Islands, Spain (available online at: https://www.biodiversidadcanarias.es/biota/).

Harvey WN. 1865. Compositae. In: Harvey WH and Sonder OW (eds.), Flora Capensis. Hodges, Smith, and Co, Dublin. Pp. 44–530.

Herman PPJ, E Retief, M Koekomoer, WG Welman. 2000. Asteraceae [Strelitzia 10: 101–170]. In: Leistner OM (ed.), Seed Plants of southern Africa: Families and Genera. Strelitzia. 10: 1–776. National Botanical Institute, Pretoria.

Hilliard OM. 1977. Compositae in Natal. University of Natal Press, Pietermaritzburg, South Africa.

Hooker WJ. 1854. Philip Barker Webb, Esq., of Milford House, Surrey. Hooker's Journal of Botany and Kew Garden Miscellany. 6: 310–315.

Houttuyn M. 1779. Natuurlijke historie 10. Erven van F. Houttuyn, Amsterdam.

IPNI. 2022. International Plant Names Index. The Royal Botanic Gardens, Kew, Harvard University Herbaria & Libraries and Australian National Botanic Gardens (available online at: https://ipni.org/).

Jeffrey C. 1988. The Vernonieae in East Tropical Africa: Notes on Compositae: V. Kew Bulletin. 43: 195–277.

La Serna Ramos I, MC León Arencibia. 1980. Contribución a la tipificación de endemismos canarios descritos por Webb y Berthelot. Vieraea. 10: 109–128.

Lamarck JBAPN. 1786. Encyclopedia métodique. Botanique. Volume 2. Part 2. Chez Panckoucke, Paris.

Lenzi Grillini C. 1988. Cento anni di editoria botanica in Italia. In: Pedrotti F (ed.), 100 anni di ricerche botaniche in Italia (1888–1988). Società Botanica Italiana, Florence. Pp. 1069–1109.

Lessing CF. 1829. De synathereis herbarii regii Berolinensis. Dissertatio prima. Linnaea. 4: 240–288.

Lessing CF. 1831. De Synathereis. Dissertation quarta. Linnaea. 6: 624–721.

Manning J, P Goldblatt. 2012. Plants of the Greater Cape Floristic Region volume 1: The core Cape Flora. Strelitzia. 29: 1–853.

Martelli U. 1904. Per la ricorrenza del cinquantesimo anniversario della morte di Filippo Barker Webb. Bullettino della Società Botanica Italiana. 1904: 231–232.

Martelli U. 1905a. Presentazione di un libro dal titolo Webbia. Bullettino della Società Botanica Italiana. 1904/1905: 165.

Martelli U. 1905b. Prefazione. Webbia. 1: v–xi.

Moggi G. 1993. Botanical collections in Florence from their origin to the present day. Webbia. 48: 35–40.

Moggi G. 2006. Webbia 1905-2005. 100 anni di ricerche tassonomiche e fitogeografiche in Italia / 100 years of taxonomic and phytogeographic research in Italy. Webbia. 61: 193–206.

Negri G. 1935. Ugolino Martelli 1850–1934. Nuovo Giornale Botanico Italiano. 42: 1–16.

Nepi C. 2009. L'Erbario Webb. In: Raffaelli M (ed.), Il Museo di Storia Naturale dell'Università degli Studi di Firenze: Le collezioni botaniche. Università degli Studi di Firenze, Florence. Pp. 103–110.

Parlatore F. 1842–1843. Umbelliferae. In: Webb PB, S Berthelot (eds.), Histoire Naturelle des Îles Canaries. Tome 3. Part 2. Phytographia Canariensis. Section 2. Béthune, Paris. Pp. 147–171.

Parlatore F. 1848. Poaceae. In: Webb PB, S Berthelot (eds.), Histoire Naturelle des Îles Canaries. Tome 3. Part 2. Phytographia Canariensis. Section 3. Béthune, Paris. Pp. 373–428.

Parlatore F. 1856. Elogio di Filippo Barker Webb. Tipografia Le Monnier, Florence.

Parlatore F. 1874. Les Collections Botaniques du Musée Royal de Physique et d'Histoire Naturelle de Florence. Successeurs le Monnier, Florence.

Parlatore F. 1992. Mie memorie [ed. by A. Visconti]. Sellerio Ed., Palermo.

Petoe P, WJ Baker. 2019. A monograph of *Heterospathe* (Areceae, Arecaceae) in New Guinea. Phyototaxa. 413: 071–116.

Relancio M, Y Santos (eds.). 2006. Historia Natural de las Islas Canarias de Philip Barker Webb y Sabino Berthelot: Una introducción. Materiales de la Historia de la Ciencia. 10: 1–212.

Rico L, MC Duarte, MM Romeiras, A Santos-Guerra, C Nepi, J. Francisco-Ortega. 2017. Joseph D. Hooker's 1839 Cabo Verde collections. Curtis's Botanical Magazine. 34: 146–168.

Robson NKB. 1977. Studies in the genus *Hypericum* L. (Guttiferae) 1. Infrageneric classification. Bulletin of the British Museum (Natural History), Botany. 5: 293–355.

Robson NKB. 1996. Studies in the genus *Hypericum* L. (Guttiferae) 6. Sections 20. Myriandra to 28. Elodes. Bulletin of the Natural History Museum. Botany series. London. 26: 75–217.

Robinson H. 1999. Revisions in paleotropical Vernonieae (Asteraceae). Proceedings of the Biological Society of Washington. 112: 220–247.

Rodríguez Delgado O (ed.). 1998. Homenaje a Webb en el II Centenario de su Nacimiento. Instituto de Estudios Canarios & Departamento de Biología Vegetal (Botánica), Universidad de La Laguna, Tenerife, Canary Islands, Spain.

Santos-Guerra A. 2021. Descripción de una nueva especie *Parolinia aridanae* sp. para la flora canaria, endémica de la isla de La Palma. Revista de la Academia Canaria de Ciencias. 33: 123–132.

Several Authors. (2022). African Plant Database (version 3.4.0). Conservatoire et Jardin botaniques de la Ville de Genève, Geneve and South African National Biodiversity Institute, Pretoria (available online at: https://www.ville-ge.ch/musinfo/bd/cjb/africa/index.php?langue=an).

Schultz Bipontinus K. 1844–1850. Compositae. In: Webb PB, S Berthelot (eds.), Histoire Naturelle des Îles Canaries. Tome 3. Part 2. Phytographia Canariensis. Section 2. Béthune, Paris. Pp. 203–473.

Simpson MG. 2010. Plant Systematics. 2nd. Ed. Elsiever, Academic Press. Amsterdam.

Spach E. 1836a. Histoire Naturelle des Végétaux. Phanérogames 5. Librairie encyclopédique de Roret, Paris.

Spach E. 1836b. Conspectus monographiae hypericacearum. Annales des Sciences Naturelles Paris. Séries 2. 5: 349–369.

Stafleu FA, RS Cowan. 1979. Taxonomic literature. Second edition. Volume II: H-Le. Regnum Vegetabile. 98: 1–991.

Stafleu FA, RS Cowan. 1985. Taxonomic literature. Second edition. Volume V: Sal-Ste. Regnum Vegetabile. 112: 1–1066.

Stearn WT. 1937. On the dates of publication of Webb and Berthelot's "Histoire Naturelle des îles Canaries." Journal of the Society for the Bibliography Natural History. 1: 49–63.

Stearn WT. 1973. Philip Barker Webb and Canarian botany. Monographiae Biologicae Canarienses. 4: 15–29.

Steinberg CH. 1973. Macaronesian collections of phanerogams in the Herbarium Universitatis Florentinae. Monographiae Biologicae Canarienses. 4: 30–48.

Steinberg CH. 1977. The collectors and collections in the Herbarium Webb. Webbia. 32: 1–49.

Suárez Martín P. 2016. Cartas Inéditas de S. Berthelot a P.B. Webb. Fundación Canaria Orotava de Historia de la Ciencia, Tenerife, Canary Islands, Spain.

Suárez Martín P. 2018. Cartas Inéditas de A. Moquin-Tandon a P.B. Webb. Fundación Canaria Orotava de Historia de la Ciencia, Tenerife, Canary Islands, Spain.

Swelankomo N, JC Manning, AR Magee. 2016. The genus *Hilliardiella* (Asteraceae: Vernonieae) in southern Africa. South African Journal of Botany. 196: 41–59.

Thiers B 2022 Continuously updated. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium (available online at: http://sweetgum.nybg.org/science/ih/).

Trudgen MS, WJ Baker. 2008. A revision of the *Heterospathe elegans* (Arecaceae) complex in New Guinea. Kew Bulletin. 63: 639–647.

Turland NJ, JH Wiersema, FR Barrie, W Greuter, DL Hawks-Worth, PS Herendeen, S Knapp, W-H Kusber, D-H Li, K Marhold, TW May, J McNeill, AM Monro, J Prado, MJ Price, GF Smith [editors]. 2018. International Code of Nomenclature for algae, fungi and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile. 159: 1–254.

Van Wyk AE, RR Klopper. 2021. *Hilliardiella oligocephala*, the correct name for H. elaeagnoides (Asteraceae: Vernonieae). Phytotaxa: 166–168.

Walpers WG. 1842. Repertorium Botanices Systematicae 1, part 3. Lipsiae.

Walpers WG. 1843. Repertorium Botanices Systematicae 2. Lipsiae.

Webb PB. 1840. Notice sur le Parolinia. Annales des Sciences Naturelles. Seconde Série. 13: 129–139.

Webb PB. 1849. Spicilegia gorgonea. In: Hooker WJ (ed.), Niger Flora; or an Enumeration of the Plants of Western Tropical Africa Collected by the Late Dr. Theodore Vogel. Hippolyte Bailliere, London. Pp. 88–197.

Webb PB. 1854. Fragmenta Florulae Aethiopico-Aegyptiacaei. Victor Masson, Paris.

Webb PB, S Berthelot. 1836. *Webbia* Spach. In: Webb PB, S Berthelot (eds.), Histoire Naturelle des Îles Canaries. Tome 3. Part 2. Phytographia Canariensis. Section 1. Béthune, Paris. Pp. 46–50.

Wittrock VB. 1905. Porträtt af berömda botaniska författare 1:sta hundradet. Icones auctorum botanicorum illustrium. Centuria 1ma. Acta Horti Bergiani. 3(3): Tafl. 1–Tafl. 150.

WEBBIA Journal of Plant Taxonomy and Geography

Firenze University Press
www.fupress.com/webbia

OPEN ACCESS

Citation: Riccardo M. Baldini, Giovanni Cristofolini, Carlos Aedo (2022) The extant herbaria from the Sixteenth Century: a synopsis. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 23-33. doi: 10.36253/jopt-13038

Received: January 30, 2022

Accepted: March 15, 2022

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Charles E. Jarvis

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The extant herbaria from the Sixteenth Century: a synopsis

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Abstract. A synthetic synopsis of the herbaria of the 16th century is provided. The list is in chronological order and resumes the general information on the earliest herbaria from the XVI century facilitating the access by the scientific community to this important source of historical information. Fifteen herbaria are listed, of which the oldest date back to the first half of the 16th century. Nine originated in Italy, three in Switzerland, two in Germany and one in France. For each herbarium, data are provided on chronology, geographical origin, format and extent, current place of conservation, and information on cataloguing and digital accessibility when available.

Keywords: The XVI century, botanical collections, history of botany.

INTRODUCTION

The art of making a herbarium, i.e. preserving pressed dried plants, identified according the best taxonomic knowledge, and assembling them (glued or free) on paper sheets loose or bound in a volume, first arose in Northern Italy in the first half of the Sixteenth Century, having a pioneer in Luca Ghini (Meyer 1857; Camus 1895; De Toni 1907; Chiarugi 1957).

Luca Ghini (1490-1556), native of Croara, a hamlet near Imola in Northern Italy, studied in Bologna, where he probably attended the lectures of Nicolò Leoniceno (1428-1524), a forerunner of modern science who taught in Ferrara for sixty years, and was entrusted with the teaching of medicine at Bologna University for one year, in 1508 (Calvi 1777). Ghini was enrolled in the register of professors of medicine in 1528, and was additionally appointed to the *Lectura simplicium* in 1540 (Bertoloni 1891). His teaching in Bologna lasted until 1544, when he moved to Pisa. During this time Ghini assembled a collection of several hundred specimens, but nothing remains of it, mainly because he used to give his specimens to pupils and colleagues (De Toni 1905; Cristofolini 1992).

Many of the early herbaria underwent the same fate of being lost or dispersed through time: this is the case with the herbarium of the English mer-

chant and botanist John Falconer (d. 1560), as well as of a large part of the collections made by the Swiss physician Felix Platter (1536-1614) and by the Neapolitan botanist Ferrante Imperato (c. 1525-1621). Nevertheless, a conspicuous patrimony has been preserved until the present time.

Although a number of papers have been published about the ancient herbaria unfortunately many of them appeared in comparatively scarce or obscure books or journals, while the few comprehensive studies on this topic (e.g. Saint-Lager 1885; Camus 1895) are obsolete.

The present contribution is intended to bridge this gap, by providing a synthesis of the essential knowledge presently available about the extant herbaria of the Sixteenth Century. The purpose is to facilitate access by the scientific community to this important source of historical information.

In the following synopsis each herbarium has been named either with its traditional denomination, or with a new name congruent with its ascertained or supposed authorship. The herbaria have been ordered chronologically; as several of them (especially the major ones) were assembled over many years, the sequence was based on the *terminus post quem* of the beginning of the composition. Considering that some herbaria have been the subject of a very extensive literature, only the main references have been cited.

SYNOPSIS[1]

"**Anonimo Toscano**" (formerly known as "Herbarium Merini"). (Figure 1)
Dating: 1544 - c. 1545
Author: the former attribution to Michele Merini (Chiovenda 1928) has been recently refuted (Cristofolini and Nepi, 2021); the herbarium is now attributed to an anonymous botanist active in Pisa and/or Lucca (Tuscany, Italy).
Format and extent: one unbound volume, with 201 specimens.
Origin of the collection: plants collected around Pisa and from Pisa Botanical Garden.
Stored in the Botanical Section "Filippo Parlatore", The Natural History Museum, University of Florence, Italy (Herbarium FI).
Catalogue: published in Chiovenda (1927).
Digital images: completely digitalized; images available on request through Botanical Section "Filippo Parlatore", The Natural History Museum, University of Florence, Italy (FI).
Relevant references: Chiovenda (1927, 1928), Cristofolini and Nepi (2021).

"**Petrollini**" (formerly known as "Cibo", also called "Rome herbarium") (Figure 2)
Dating: c. 1550 - 1553
Author: Francesco Petrollini (fl. 1550).
Format and extent: one bound volume (herbarium A), with 516 specimens, and four bound volumes (herbarium B), with 1347 specimens.
Origin of the collection: plants mainly from Italy.
Stored in the Biblioteca Angelica, Rome, Italy.
Catalogue: published in Chiovenda (1909).
Digital images: not available.
Relevant references: Celani (1902); Celani and Penzig (1907); Chiovenda (1908a, b; 1909); Soldano (2002), Stefanaki et al. (2019).

"**Imperato**"
Dating: c. 1550
Author: Ferrante Imperato (Naples c. 1525 - 1621?).
Format and extent: one bound volume (the only one extant from a set of 80 volumes), with 442 specimens. 170 additional specimens stored in the Cirillo herbarium (Istituto Botanico della Regia Scuola Superiore di Agricoltura di Portici, Napoli), and probably came from the lost volumes of the Ferrante herbarium.
Origin of the collection: plants mainly from Italy.
Stored in the Biblioteca Nazionale, Napoli, Italy.
Catalogue: a species list in Ciarallo (1986).
Digital images: not available.
Relevant references: Minieri Riccio (1863), Giglioli (1903), Ciarallo (1986, 1993), De Natale and Cellinese (2009).

"**Aldrovandi**" (Figure 3)
Dating: c. 1551 (beginning of the first volume) - 1586 (end of the XV volume).
Author: Ulisse Aldrovandi (Bologna 1522 - ibidem 1605).
Format and extent: 15 bound volumes, 4800 specimens. It includes some plants sent by his teacher Luca Ghini.
Origin of the collection: mainly Italy.
Stored in the Herbarium of the University of Bologna (BOLO).
Catalogue: Soldano (2000, 2001, 2002, 2003, 2004, 2005).
Digital images: Completely digitalized; images available through http://137.204.21.141/aldrovandi/Explore

[1] The present survey does not include neither the herbaria viva nor the herbarium H.S.251, the oldest of the Sloane Herbarium (BM), which dates "not later than the early decades of the seventeenth century" (Dandy 1958: 62; 131-132), since there is no factual foundation for dating it back to the late sixteenth century, as suggested by Savage (1958: 13).

Figure 1. Herbarium "Anonimo Toscano" **(A)** The anonymous author appears to be very keen to use the space on each page efficiently. Many samples consist of a single leaf, occasionally misidentified, as in the case of the leaf of *Acer opalus* subsp. *obtusatum* (Waldst. & Kit.) Gams, named here "*Folium Anemones candidae Diosch.*"; **(B)** The collection includes relatively uncommon species, like *Notholaena marantae* (L.) Desv. (here named "*Lonchitis aspera similis Cetrach*"), or rare, like *Hottonia palustris* L. ("*Millefolium Diosc. in aquis nascens*"). © Botanical Section "Filippo Parlatore", Natural History Museum of the University of Florence (FI).

Relevant references: Saint-Lager (1885); Soldano (2000, 2001, 2002, 2003, 2004, 2005).

"**Platter**"
Dating: 1552 - ?
Author: Felix Platter (Basel 1536 - ibidem 1614).
Format and extent: eight bound volumes (a further ten are known to be missing), with c. 1800 specimens. The specimens were probably were ordered at the end of the 16th century according to the system of Caspar Bauhin, then yet to be published, and assembled in the extant binding.
Origin of the collection: the provenance of the plants is not known.
Stored in the Burgerbibliothek of Bern, Switzerland.
Catalogue: available through https://www.burgerbib.ch/de/bestaende/privatarchive/einzelstuecke/platter-herbarium
Digital images: available as above
Relevant references: Rytz (1933), Dauwalder (2013).

"**Mendoza**" (Figure 4)
Dating: 1539 - 1554
Author: Unknown.
Format and extent: Four bound volumes, with about 950 specimens.
Origin of the collection: Plants from Italy.
Stored in the Real Biblioteca del Monasterio de San Lorenzo de El Escorial, Spain.
Catalogue: not yet available (a compilation of a list of species is in progress).

Figure 2. (A) View of the Biblioteca Angelica, Rome; **(B)** Herbarium Petrollini, book A; **(C)** Book "B", N. 498: *Geranium nodosum* L. © Biblioteca Angelica, Rome.

Digital images: not available.
Notes: The herbarium was bought by Diego Hurtado de Mendoza (1504-1575) during his stay in Italy (1539-1554) as ambassador of Carlos V in Venice and later in Rome, and was incorporated in the El Escorial library in June 1576.
Relevant references: Colmeiro (1858: 154); Andretta and Pardo-Tomás (2019).

"**Ratzenberger**"
Dating: 1555 - 1592
Author: Caspar Ratzenberger (Saalfeld 1533 - Ortrand 1603).
Format and extent: Three bound volumes, with 746 specimens.
Origin of the collection: plants collected during Ratzenberger's travels, mainly from France and Italy.
Stored in the Ottoneum Museum, Kassel, Germany (Herbarium KASSEL).
Catalogue: a list of identified specimens (without images) available through https://naturkundemuseum.kassel.de/wissenschaft/sammlungen/gefaesspflanzen/ratzenberger/index.htm; a catalogue also in Kessler (1870).
Digital images: not available.
Relevant references: Kessler (1870).

"**En Tibi**"
Dating: c. 1558
Author: Francesco Petrollini (fl. 1550).
Format and extent: one bound volume, with 473 specimens (39 further specimens are missing).
Origin of the collection: plants from northern Italy.
Stored: Naturalis Biodiversity Center, Leiden, The Netherlands (Herbarium L).
Catalogue: not published.
Digital images: available through: https://bioportal.naturalis.nl/result?theme=en_tibi
Notes: the herbarium was probably made in Bologna. It was intended to be a gift to a yet unknown person, possibly the Emperor Ferdinan I. It was purchased by Leiden University around 1690. The name of this herbarium was derived from the cover inscription: "*En tibi perpetuis ridentem floribus hortum*" ["here is for you a smiling garden of everlasting flowers"].
Relevant references: Stefanaki et al. (2018, 2019).

"**Girault**"
Dating: 1558
Author: Jehan Girault (Lyon 1538? - 1608).
Format and extent: one bound volume of 81 pages, with 310 specimens.
Origin of the collection: plants mainly from the region around Lyon.

Figure 3. Herbarium Aldrovandi (**A)** A perfectly preserved specimen of *Orchis simia* Lam. (Vol. 4, fol. 105), collected around Bologna, probably in 1552 (Soldano 2001); (**B)** *Nicotiana tabacum* L. (Vol. 14, fol. 13), one of the oldest extant specimens of this species. The plant (or, possibly, the seed from which it was grown) was delivered to Aldrovandi by a correspondent from Rome in 1567 (see Soldano 2004). © Herbarium BOLO (SMA, Alma Mater Studiorum - University of Bologna).

Stored at the Muséum National d'Histoire Naturelle, Paris, France (Herbarium P).
Catalogue: not published.
Digital images: completely digitalized; images available through https://www.mnhn.fr/fr/herbier-jehan-girault
Relevant references: Saint-Lager (1885).

"**Rauwolf**"
Dating: 1560 - 1575
Author: Leonhard Rauwolf (Augsburg 1535? - Waitzen 1596).
Format and extent: four bound volumes, with some 832 specimens.
Origin of the collection: The first two volumes contain 441 specimens (plus two missing) collected in southern France between 1560 and 1563. The third contains some 200 specimens collected in the Alps and northern Italy in 1563. The fourth contains 191 specimens (plus nine missing) collected in southern France, Lebanon, Syria and Iraq from 1573 to 1575.
Stored at Naturalis Biodiversity Center, Leiden, The Netherlands (Herbarium L).
Catalogue: not available.
Digital images of the fourth volume only are available through http://bioportal.naturalis.nl
Notes: the herbarium was purchased by Leiden University around 1690. Linnaeus did not have access to Rauwolf's herbarium, but he did use a few of the published drawings (Rauwolf 1583) to describe five species.
Relevant references: Rauwolf (1583), Legré (1900), Ghorbani et al. (2018), Stefanaki (2021).

"**Cesalpino**" (Figure 5)
Dating: 1563
Author: Andrea Cesalpino (Arezzo 1524 or 1525 - Roma 1603).

Figure 4. (A) Herbarium Mendoza: list of plant names signed below by Diego Hurtado De Mendoza; **(B)** two sheets: *Lupinus* sp. (left), *Bellis* sp. (right). © Patrimonio Nacional. Real Biblioteca del Monasterio del Escorial. Mesa 25-I-11.

Figure 5. Herbarium Cesalpino (A) Sheet n. 35. N. 90: *Seseli* (Apiaceae), except the left leaf above; (B) Sheet n. 50. N. 119: *Heliotropium europaeum*, N. 120: *Myosotis scorpioides*, N: 121: *Cynoglossum creticum* (Boraginaceae). © Botanical Section "Filippo Parlatore", Natural History Museum of the University of Florence (FI).

Figure 6. Herbarium "Aldrovandi's School" (**A)** *Agrimonia eupatoria* L. The handwritten reference is: "Matthioli 1068", the page number corresponding to the species description in the 1568 edition of Mattioli's Dioscorides. **(B)** *Aquilegia* cf. *atrata* Koch. This species, named here "*Aquilea Matth f. 665*", is depicted in a full-page table in Mattioli (1568: 665). © Herbarium, BOLO (SMA, Alma Mater Studiorum - University of Bologna).

Format and extent: originally in one bound volume of 266 pages (disbound in 2007), with 768 specimens. The specimens are ordered following the system later published by the author himself (Cesalpino 1583).
Origin of the collection: plants collected mainly in central and northern Italy.
Stored in the Botanical Section "Filippo Parlatore", The Natural History Museum, University of Florence, Italy (Herbarium FI).
Catalogue: published in Caruel (1858).
Digital images: not available.
Relevant references: Caruel (1858); Saint-Lager (1885); Nepi (2007), Moggi (2009).

"**Aldrovandi's school**" (Figure 6)
Dating: 1568 - ?
Author: an anonymous pupil of Ulisse Aldrovandi.
Format and extent: one bound volume, with 214 specimens.
Origin of the collection: no indication. Presumably Northern Italy.
Stored in the Herbarium of the University of Bologna (BOLO).
Catalogue: not available.
Digital images: not available.
Notes: all plant names are written in Italian; the only authority cited beside the plant names is Mattioli, with the page numbers corresponding to the 1568 edition of the "Discorsi".
Relevant references: Cristofolini et al. (1993)

"**Ducale Estense**"
Dating: 1570 - 1598
Author: unknown.

Figure 7. Herbarium "Bauhin at Bologna" (**A)** *Capsella bursa-pastoris* L. The concise discussion about the species variability ends with the words "*… ut in Phytopinace monuimus*", that indicate Caspar Bauhin as the author. **(B)** *Gossypium herbaceum* L. The handwritten comment includes the words: "*…quod in horto doctoris Zwinger vidimus - cuius iconem Historia nostra exhibebit*". In fact, in the first volume of J. Bauhin's posthumous *Historia plantarum* (Bauhin and Cherler 1650) we find a description of this species, with reference to the garden of Doctor Zwinger in Basel. © Herbarium BOLO (SMA, Alma Mater Studiorum - University of Bologna).

Format and extent: One volume of 149 pages, containing 181 specimens.
Origin of the collection: Probably around Ferrara (Italy), both from the wild and in gardens.
Stored in Biblioteca Estense, Modena, Italy.
Catalogue: Camus and Penzig (1885).
Digital images available at https://www.asmo.beniculturali.it/progetti/carte-verdi-nellarchivio-di-stato-di-modena/erbario-estense
Relevant references: Saint-Lager (1885), Camus and Penzig (1885), Cremonini (2016, 2021+).

"**Bauhin**"
Dating: c. 1577
Author: Caspar Bauhin (Basel 1560 - ibidem 1624).
Format and extent: 20 boxes with 3352 specimens, free on the sheets (unmounted), collected by Bauhin or sent by his correspondents. The original order is unknow.
Origin of the collection: Plants from many parts of Europe.
Stored in University of Basel, Switzerland (BAS).
Catalogue: not published.
Digital images: Digital images are available through https://herbarium.unibas.ch/index.php/en/herbaria
Notes: this herbarium is the basis of the outstanding Pinax by Caspar Bauhin (1623) and the other publications of this author.
Relevant references: Saint-Lager (1885); Stech et al. (2018).

"**Bauhin at Bologna**" (Figure 7)
Dating: 1596 - 1597
Authors: Caspar Bauhin (1560 - 1624), presumably Jean Bauhin (1541 - 1613), and possibly other coworkers.
Format and extent: one bound volume, with 273 specimens.

Origin of the collection: plants from Northern Italy and the Alps.
Stored in the Herbarium of the University of Bologna (BOLO).
Catalogue: Baldacci (1907).
Digital images: not available.
Notes: the volume seems to have been sent by one or other of the Bauhin brothers as a present to Ulisse Aldrovandi. A research about origin and history of this herbarium is in progress.
Relevant references: Baldacci (1907); Cristofolini et al. (1993); Mossetti et al. (1993).

DISCUSSION

Fifteen herbaria of the XVI Century are presently known, which include some 16,000 exsiccata. Making accessible all of this precious patrimony would represent an unrivalled source of historical and scientific information.

The size of these collections ranges from very comprehensive herbaria (Aldrovandi, with 4800 specimens, Bauhin with 3352) to others that are quite small ("Ducale Estense", with 181 specimens, "Anonimo Toscano" with 201). The authors of ten of the collections are either known (or at least confidently presumed) while those of five herbaria remain unknown.

The geographic distribution of the herbaria is as follows:

- nine herbaria were assembled in Italy by Italian botanists: seven of them are still preserved in Italy ("Anonimo Toscano", Petrollini, Imperato, Aldrovandi, Cesalpino, "Ducale Estense", "Aldrovandi's School"), while the remaining two have been later transferred abroad ("En Tibi", now stored in Leiden, the Netherlands, and "Mendoza" at the Escurial, Spain);
- two herbaria were made by Swiss botanists, with plants collected in different parts of Europe (Platter and Bauhin, both from Basel); a third ("Bauhin at Bologna") originated in Switzerland to be delivered to Aldrovandi in Bologna;
- two herbaria were authored by German botanists (Rauwolf and Ratzenberger), with plants collected in France and Italy;
- one was made by a French botanist (Girault) with plants collected in Southern France.

The geographical distribution of the collections and the biography of their authors reflects the importance of the teaching of Luca Ghini, and the centrality of the Ferrara school.

Indeed the unknown author of "Anonimo Toscano", Aldrovandi, and Cesalpino were all pupils of Luca Ghini, and the collections by Petrollini ("Petrollini" and "En Tibi") as well as the "Ducale Estense" originated in the area between Bologna and Ferrara (Stefanaki et al. 2018, 2019).

The English botanist John Falconer also lived in Ferrara from 1540 to 1547 (Jackson 1885) when he assembled the first English herbarium of which are aware (Amatus Lusitanus 1558), a collection that was mentioned by William Turner (1551) but is today lost.

A further centre of diffusion of herbaria was in Montpellier: this centre is obviously connected to the Bologna-Ferrara core: indeed Guillaume Rondelet (1507 - 1566), the founder of the Montpellier botanical school, had been a pupil of Luca Ghini, as were his disciples Leonard Rauwolf, Felix Platter and Johan Bauhin (Stefanaki et al. 2021). All of them, as well as Caspar Bauhin, were familiar with Ulisse Aldrovandi and the school in Bologna. To the Montpellier school belonged also Jehan Girault, a disciple of Jacques Daléchamps (1513–1588), who was in his turn a pupil of Rondelet. Camus (1895) maintained that J. Falconer was the first botanist to compose a herbarium, during his stay at Ferrara. As a matter of fact, Falconer's stay at Ferrara lasted from 1540 or 1541 to 1547, and Amatus Lusitanus, the earliest witness of his herbarium, lived in Ferrara in the same years; however, the "Anonimo Toscano" was composed between 1544 and c. 1545, and the lost herbarium by Luca Ghini also dates back to the same span of time. Hence, the claim by Camus is possible but unproved.

In conclusion, it seems impossible, and indeed immaterial, to ascertain who was the individual botanist who first composed a herbarium. Nevertheless, one can state with some confidence that this innovation, that was destined to imprint plant science during the following centuries, had its inception in the early forties of the sixteenth century, and had its cradle in the school of Luca Ghini and in the cultural milieu of Ferrara and Bologna, from where it spread in just a few decades through all Europe.

ACKNOWLEDGMENTS

We thank J.L. del Valle Merino of the Real Biblioteca del Monasterio del Escorial and to Anna Letizia Di Carlo and the staff of the Biblioteca Angelica in Rome who opened the doors of their libraries and facilitated the consultation of the herbaria conserved in their institutions. Our appreciation goes also to Chiara Nepi, curator at FI herbarium for her invaluable help and support

for providing the images of the Cesalpino and Anonimo Toscano herbaria, and Lia Pignotti (FT) for her technical support. Thanks also to the Sistema Museale di Ateneo of the University of Bologna for the accession of the Aldovrandi and Bauhin herbaria.

REFERENCES

Amatus Lusitanus. 1558. In Dioscoridis Anazarbei de medica materia libros quinque … enarrationes eruditissimae. Lugduni apud Guilielmum Rouillium.

Andretta E, Pardo-Tomás J. 2019. Books, plants, herbaria: Diego Hurtado de Mendoza and his circle in Italy (1539-1554). History of Science. 2019: 1-25. DOI: 10.1177/0073275319838891

Baldacci A. 1907. Un erbario bolognese del secolo XVII. Memorie della Reale Accademia delle Scienze del'Istituto di Bologna, Classe di Scienze Fisiche, serie 6. 4: 147-159.

Bauhin C. 1623. Pinax theatri botanici. Basileae, Ludovici Regis.

Bauhin J., Cherler JH. 1650.- Historia plantarum universalis. Ebroduni.

Bertoloni A jr. 1891. Ulteriori notizie storiche sull'origine della lettura dei semplici in Italia. Bullettino Società Botanica Italiana. Anno 1891: 215-221.

Calvi G. 1777. Commentarium inserviturum Historiae Pisani Vireti Botanici Academici. Pisis, ex Typographia Fratrum De Pizzornis.

Camus J. 1895. Historique des premiers herbiers. Malpighia. 9 : 283-314 .

Camus J, Penzig O. 1885 Illustrazione dell'Erbario Estense. Atti della Società dei Naturalisti di Modena. Memorie, s. III, v. IV, a. XIX: 18, 27-32.

Caruel T. 1858. Illustratio in hortum siccum Andreae Caesalpini. Florentiae, Le Monnier.

Celani E. 1902. Sopra un erbario di Gherardo Cibo conservato nella R. Biblioteca Angelica di Roma. Malpighia. 16: 1-46.

Celani E, Penzig O. 1907. Ancora sugli erbari conservati nella Biblioteca Angelica. Risposta al dott. E. Chiovenda. Malpighia. 21: 153-174.

Cesalpino A. 1583. De Plantis Libri XVI.

Chiarugi A. 1957. Nel quarto centenario della morte di Luca Ghini. Webbia. 13: 1-14.

Chiovenda E. 1908a. Intorno all'autore dei due erbarii antichissimi che si conservano nella Biblioteca Angelica di Roma. Rendiconti della Regia Accademia dei Lincei. 17: 703-707.

Chiovenda E. 1908b. Sugli erbarii della Biblioteca Angelica di Roma. Replica. Annali di Botanica (Roma). 6: 427-448.

Chiovenda E. 1909. Francesco Petrollini, botanico del secolo XVI. Annali di Botanica (Roma). 7: 339-447.

Chiovenda E. 1927. Un antichissimo Erbario anonimo del Museo Botanico di Firenze. Annali di Botanica (Roma). 17(4): 119-139.

Chiovenda E. 1928. Un antichissimo Erbario anonimo del Museo Botanico di Firenze. Annali di Botanica (Roma). 19(1): 122-144.

Ciarallo A. 1986 L'erbario di Ferrante Imperato. Museologia Scientifica. 3(3-4): 187-204

Ciarallo A. 1993. Gli erbari storici della Biblioteca Nazionale di Napoli. Webbia. 48: 549-554.

Colmeiro M. 1858. La Botánica y los botánicos de la Península Hispano-Lusitana. M. Rivadeneyra, Madrid.

Cremonini P. 2016. Carte verdi nell'Archivio di Stato di Modena: l'Erbario Estense, foglie tra i fogli, un rebus, un progetto. Atti e Memorie. Rivista di Storia della Farmacia. 33(2): 105-115.

Cremonini P. 2021+. Carte verdi nell'Archivio di Stato di Modena: l'Erbario Estense, foglie tra i fogli, un rebus, un progetto. https://www.asmo.beniculturali.it/progetti/carte-verdi-nellarchivio-di-stato-di-modena [last accessed 20.12.2021].

Cristofolini G. 1992. Luca Ghini a Bologna: la nascita della scienza moderna. Museologia Scientifica. 8: 207-221 (1991).

Cristofolini G, Mossetti U, Bonfiglioli C. 1993. Pre-linnean herbaria in Bologna: some newly discovered collections from the time of Ulisse Aldrovandi. Webbia. 48: 555-565.

Cristofolini G, Nepi C. 2021. La paternità del cosiddetto "Erbario Merini" conservato presso il Museo di Storia Naturale dell'Università di Firenze: una questione aperta. Notiziario della Società Botanica Italiana. 5: 1-4.

Dandy J. E. (ed.) 1958. The Sloane Herbarium - An Annotated List of the Horti Sicci Composing it. London, The Trustees of the British Museum.

Dauwalder L. 2013. Felix Platter's Herbarium. Journal of Paper Conservation. 14: 26-32.

De Natale A, Cellinese N. 2009. Imperato, Cirillo, and a series of unfortunate events: a novel approach to assess the unknown provenance of historical herbarium specimens. Taxon. 58: 963-970.

De Toni GB. 1905 Cinque lettere di Luca Ghini a Ulisse Aldrovandi. Padova, Tipografia del Seminario.

De Toni GB. 1907 Sull'origine degli erbari. Atti Società dei Naturalisti e Matematici di Modena, Ser. IV. 8: 18-22.

Ghorbani A, Wieringa JJ, de Boer HJ, Porck H, Kardinaal A, van Andel T. 2018. Botanical and floristic composition of the Historical Herbarium of Leonhard Rau-

wolf collected in the Near East (1573–1575). Taxon. 67(3): 565-580.

Giglioli I. 1903. The Herbarium of Ferrante Imperato at Naples. Nature. 67(1735) : 296-297.

Jackson BD. 1885. Falconer, John (fl.1547). Dictionary of National Biography. London: Smith, Elder & Co. 1885-1900.

Kessler HF. 1870. Das älteste und erste Herbarium Deutschland, im Jahre 1592 von Dr. Caspar Ratzenberger angelegt… Kassel, A. Freyachmidt.

Legré L. 1900. La botanique en Provence au XVIe siècle: Léonard Rauwolff; Jacques Raynaudet. Marseille: H. Aubertin & G. Rolle.

Mattioli PA. 1568. I Discorsi di M. Pietro Andrea Matthioli nelli sei libri di Pedacio Dioscoride Anazarbeo della materia Medicinale. Venetia: Appresso Vincenzo Valgrisi.

Meyer E. 1857. Geschichte der Botanik. Bornträger Verlag, Koenigsberg.

Minieri Riccio C. 1863. Breve Notizia dell'erbario di Ferrante Imperato. Rendiconto della Accademia Pontaniana. 11: 72-79.

Moggi G. 2009. L'Erbario di Andrea Cesalpino. In: Raffaelli M. (ed.), Museo di storia naturale dell'Università degli studi di Firenze (Cataloghi e collezioni). Pp. 1-20. Firenze University Press.

Mossetti U, Bonfiglioli C, Cristofolini G. 1993. Un erbario pre-linneano rinvenuto a Bologna. Museologia Scientifica. 10(3-4): 247-267.

Nepi C. 2007. La 'slegatura' dell'erbario di Andrea Cesalpino (1525-1603). Museologia scientifica. 1: 50-54.

Rauwolf L. 1583. [Aigentliche Beschreibung der Raiß … inn die Morgenländer …]: Der Vierte Thail … Getruckt zu Laugingen, durch Leonhart Reinmichel, in Verlegung Georgen Willers.

Rytz W. 1933. Das Herbarium Felix Platters – ein Beitrag zur Geschichte der Botanik des XVI. Jahrhunderts. Verhandlungen der Naturforschenden Gesellschaft in Basel 44, 1.

Saint-Lager JB. 1885. Histoire des herbiers. Paris, J.B. Baillière.

Savage S. (1958) Introduction. In: Dandy JE. (ed.), The Sloane Herbarium - An Annotated List of the Horti Sicci Composing it. London, The Trustees of the British Museum.

Soldano A. 2000. La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi, Volumi I e II. Atti dell' Istituto Veneto di Scienze, Lettere ed Arti, Classe de Scienze fisiche, Matematiche e Naturali. 158: 1-246.

Soldano A. 2001. La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi, Volumi III e IV, Atti dell' Istituto Veneto di Scienze, Lettere ed Arti, Classe de Scienze fisiche, Matematiche e Naturali. 159: 1-215.

Soldano A. 2002. La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi, Volumi V-VI-VII. Atti dell' Istituto Veneto di Scienze, Lettere ed Arti, Classe de Scienze fisiche, Matematiche e Naturali. 160: 1-248.

Soldano A. 2003. La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi, Volumi VIII-IX-X-XI, Volumi XII-XIII-XIV, Volume XV e considerazioni sull' intera collezione. Atti dell' Istituto Veneto di Scienze, Lettere ed Arti, Classe de Scienze fisiche, Matematiche e Naturali. 161: 1-241.

Soldano A. 2004. La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi, Volumi VIII-IX-X-XI, Volumi XII-XIII-XIV, Volume XV e considerazioni sull'intera collezione. Atti dell' Istituto Veneto di Scienze, Lettere ed Arti, Classe de Scienze fisiche, Matematiche e Naturali. 162: 1-248.

Soldano A. 2005. La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi, Volumi VIII-IX-X-XI, Volumi XII-XIII-XIV, Volume XV e considerazioni sull' intera collezione. Atti dell' Istituto Veneto di Scienze, Lettere ed Arti, Classe de Scienze fisiche, Matematiche e Naturali. 163: 1-171.

Stech M, van Andel T, Aptroot A, Bertin A, Stefanaki A. 2018. Bryophytes and lichens in 16th-century herbaria. Journal of Bryology. 40: 99-106.

Stefanaki A, Thijsse G, Van Uffelen G, Eurlings MCM, Van Andel T. 2018.The En Tibi herbarium, a 16th century Italian treasure. Botanical Journal of the Linnean Society.187: 397-427.

Stefanaki A, Porck, H, Grimaldi IM, Thurn N, Pugliano V, Kardinaal A, Salemink J, Thijsse G, Chavannes-Mazel C, Kwakkel E, van Ande T. 2019. Breaking the silence of the 500-year-old smiling garden of everlasting flowers: The En Tibi book herbarium. PLoS ONE. 14(6): e0217779. https://doi.org/10.1371/journal.pone.0217779

Stefanaki A, Walter T, Porck H, Bertin A, van Andel T. 2021. The early book herbaria of Leonhard Rauwolf (S. France and N. Italy, 1560–1563): new light on a plant collection from the 'golden age of botany'. Rendiconti Lincei. Scienze Fisiche e Naturali. 32: 449-461 https://doi.org/10.1007/s12210-021-01012-1

Turner W. 1551. A new Herball. Steven Mierdman, London.

WEBBIA Journal of Plant Taxonomy and Geography

Firenze University Press
www.fupress.com/webbia

OPEN ACCESS

Citation: Franco Pupulin, Isler F. Chinchilla, Gustavo Rojas-Alvarado, Melania Fernández, Carlos Ossenbach, Diego Bogarín (2022) Typification of Costa Rican Orchidaceae described by Rudolf Schlechter. *Species variorum collectorum*. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 35-126. doi: 10.36253/jopt-12092

Received: September 14, 2021

Accepted: November 11, 2021

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Riccardo M. Baldini

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Typification of Costa Rican Orchidaceae described by Rudolf Schlechter. *Species variorum collectorum*

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Abstract. The typification of 53 orchid species described by Rudolf Schlechter based on specimens gathered in Costa Rica by Paul (Pablo) Biolley, Juan José Cooper Sandoval, Auguste R. Endrés, Carl Hoffmann, Emel Jiménez Segura, Otón Jiménez, Friedrich Carl Lehmann, Ferdinand Nevermann, Richard Pfau, and Henry Pittier in the late 19th and early 20th centuries is discussed, and lectotypes are designated when necessary. Short biographical notes are provided for the main collectors whose Costa Rican orchid gatherings are presented here. Taxonomical and historical backgrounds are presented for the concerned taxa, and the rationale for their typifications is discussed. Lectotypes are proposed for *Epidendrum dolichostachyum*, *E. selaginella, Habenaria jimenezii*, *Hexadesmia jimenezii*, *Masdevallia reflexa*, *Microstylis carpinterae*, *Notylia pittieri*, *Oncidium cabagrae*, *O. costaricense*, *Ornithidium biolleyi*, *Ornithocephalus xiphochilus*, *Physurus lehmannii*, *Platystele bulbinella*, *Pleurothallis pittieri*, *P. sororia*, *Sauroglossum nigricans*, *Scaphyglottis pauciflora*, *S. subulata, Sobralia pfavii*, *Solenocentrum costaricense*, *Stelis coiloglossa*, *S. cooperi, S. cyclopetala*, *S. despectans,* and *S. tonduziana*. An epitype is designated for *Gongora unicolor*.

Keywords: epitypification, flora of Costa Rica, history of botany, lectotypification, nomenclature, Orchidaceae.

INTRODUCTION

Rudolf Schlechter (1872–1925) (Figure 1) was arguably the most proficient orchid taxonomist of the 20th century. With over 5,000 orchid taxa

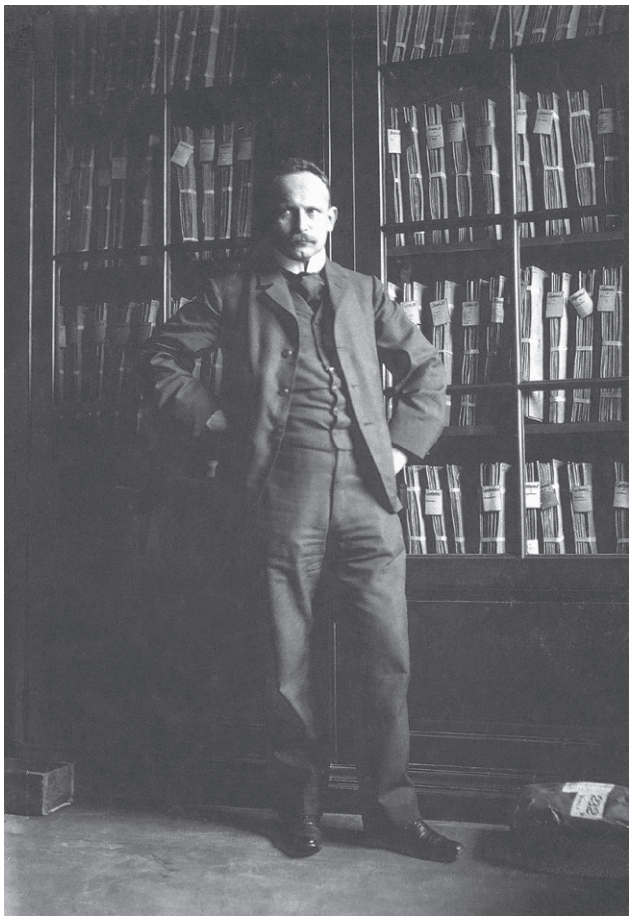

Figure 1. Friedrich Wilhelm Rudolf Schlechter (1872–1925) in the Herbarium of the Botanical Museum in Berlin, 1909. Archives of Rudolf Jenny and courtesy of Dr. N. Kilian, Archives BGBM Berlin-Dahlem.

described before his premature death, he proposed the largest number of new orchid genera and species among his contemporaries and gave birth to monographic revisions of genera and subtribes, as well as national and regional orchid floras. His interest in giving shape to orchid diversity spanned the entire world's tropical floras, from Africa to New Guinea, from Indonesia to South America, from Madagascar to China, from Central America to Japan, from the West Indies to Australia. In 1914 at the age of 42, and many years before ending his botanical activity, he produced an "encyclopedia" of the Orchidaceae, with notes on taxonomy and culture, under the title *Orchideen, ihre Beschreibung, Kultur und Züchtung; Handbuch für Orchideenliebhaber, Züchter und Botaniker* ("Orchids, their description, culture and breeding; manual for orchid lovers, breeders and botanists", Schlechter 1914), a work that Senghas (2002) considered the crowning moment of his career.

From 1899, when he published his first orchid species from Guatemala and Mexico, based on plants collected by Georg Eduard Seler (1849–1922) and his wife Caecilie Seler-Sachs (1855–1933) and received for identification at the Botanical Museum of Berlin-Dahlem (Schlechter 1899), he devoted a considerable part of his work to the study of the Orchidaceae from the American isthmus (for a geographic definition of the region, see discussion in Ossenbach et al. 2007). In the next 25 years, he proposed new genera and species of orchids from Guatemala (Schlechter 1906a, 1906c, 1916, 1918a, 1920, 1921b, 1925), Mexico (Schlechter 1906c, 1914, 1915, 1916, 1918b, 1918c, 1925), Costa Rica (1906a, 1907a, 1907b, 1913a, 1920, 1921a, 1921b, 1923a, 1923b, 1923c, 1923d), Panama (Schlechter 1913a, 1921b, 1922), El Salvador (1913b), and Honduras (Schlechter 1918a). During the 1910's and 1920's, Schlechter was particularly fond of the orchid flora from Mesoamerica, a subject on which he maintained for a long time a fair academic competition with his North American colleague, Prof. Oakes Ames (1874–1950) of Harvard University, who in that same period also devoted himself to a fervent study of the orchid flora of the American isthmus.

It was Costa Rica, however, that truly represented that orchid "El Dorado" (Schlechter 1923c) that he needed to complete his ambitious project of describing a new species of orchid every day of his life (Reinikka 1995). Eventually, he came to describe from the small Central American republic almost four hundred taxa new to science, including 23 new genera, 382 new species, and five subspecific taxa.

Without doubt, a combination of various factors contributed to this prodigious result. The position of Costa Rica in the central portion of the isthmus between two continents, in an area small enough to be affected by the climatic effects of both oceans, but large enough to host a complex system of mountain ranges of different origins that form a defined continental spine, is reflected in a particular number of different life zones and favors the maintenance of an extraordinarily diverse flora. In terms of orchid diversity, Costa Rica has the highest index in the American continent and possibly the highest globally (Karremans and Bogarín 2013), and the recent biogeographical assessment by Crain and Fernández (2020) indicated the unique attributes underpinning diversity patterns and the occurrence of orchid hotspots.

Furthermore, during the last decade of 19th century, Costa Rica saw the birth of a national science as the direct result of the educational reform inaugurated by President Bernardo Soto (1885–1889), who hired a group of European academics to staff the two new public high schools in the capital (Ossenbach 2009) (Figure 2). The

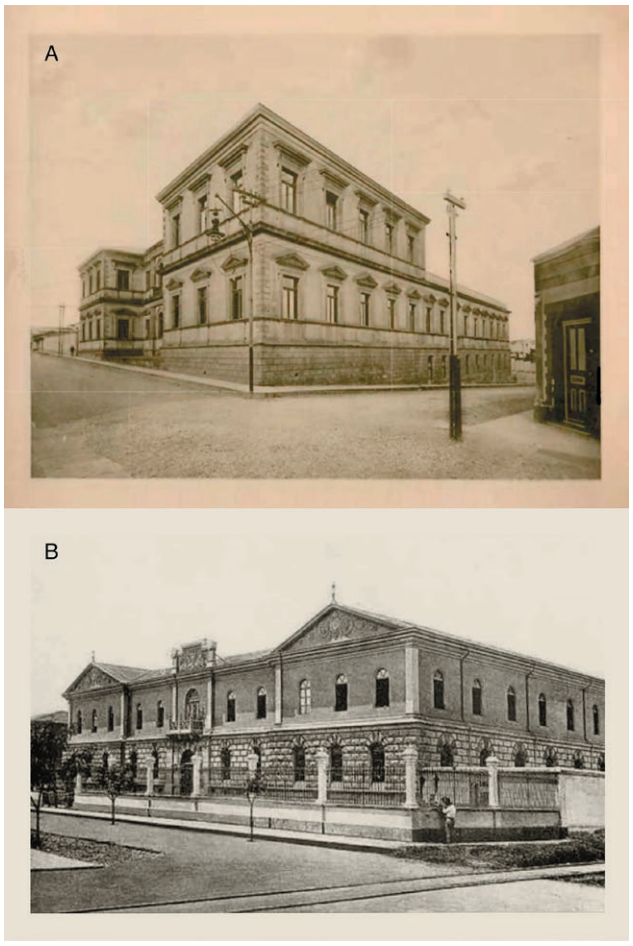

Figure 2. A, Building of the Colegio Superior de Señoritas for girls in 1909. By Vistas de Costa Rica. B, Building of the Liceo de Costa Rica for boys in 1922. By Manuel Gómez Miralles, Documental Patrimonio Arquitectónico.

foundation of the National Museum in 1887 and the Instituto Físico-Geográfico in 1889 symbolized this scientific renaissance. With active botanical institutions and enthusiastic young botanists, early 20th century Costa Rica was in the perfect situation to begin the systematic exploration of its natural resources, and orchids were no exception. The work carried out by the staff of the Museo Nacional, with figures such as the Swiss Henri Francois Pittier (1857-1950), Paul Biolley (1861-1908), and Adolphe Tonduz (1862–1921), the Alsatian Karl Wercklé (1860–1924) and the German brothers Alfred Brade (1867–1955) and Alexander Curt Brade (1881–1971), as well as those of national scholars such as Alberto M. Brenes (1870–1948) and Otón Jiménez Luthmer (1895–1988) among others, had no equal in other Central American countries (Standley 1937; Barringer 1986; Pupulin 2010a; Pupulin et al. 2016; Bogarín et al. in prep).

Finally, it is worth mentioning the personal interest shown by the Cuban Amparo López-Calleja (1870-1951), wife of the notable Costa Rican ornithologist José Cástulo Zeledón (1846–1923), for the flora of her adoptive country, and in particular for orchids, which she cultivated in her large garden in San José. Doña Amparo de Zeledón, as she was respectfully called, supported with her funds many of the field activities carried out by Tonduz and Wercklé (who together collected almost 15,000 specimens of plants for the National Museum) (Ossenbach 2009). Schlechter requested that she expressly arrange for Tonduz to press plants from her orchid garden and send out Wercklé on new collecting excursions, resulting in three shipments of orchid *exsiccata* sent to Schlechter between 1921 and 1923. Schlechter opportunely acknowledged her commitment to creating in her honor the genus *Amparoa* Schltr. (= *Rhynchostele* Rchb.f.), baptizing several orchid species for her name, and dedicating to Doña Amparo a large chapter of his *Beiträge zur Orchideenkunde von Zentralamerika, II. Additamenta ad Orchideologiam Costaricensem*, under the title *Orchidaceae Amparoanae* (Schlechter 1923a).

However, Schlechter's love affair with the orchids of Costa Rica did not depend exclusively on the plants he received for identification from the National Museum, those provided through the interest of Doña Amparo, or the two later mailings by Guillermo Acosta (Schlechter 1923d). He maintained an active collaboration with the Boissier Herbarium, where the orchids that Adolphe Tonduz sent, alive from Costa Rica and subsequently cultivated in the Barbey-Boissier greenhouse Rivage (on the shores of Lake Geneva), were pressed (Pupulin et al. 2016). Furthermore, he visited the famous herbarium of Heinrich Gustav Reichenbach (1823–1889) in Vienna shortly after it was made available again for study, where he studied the early Costa Rican collections by Karl Hoffmann Brehmer (1823–1859), August R. Endrés (1838–1874) Richard Pfau (1856–1897), and Friedrich G. Lehmann (1850–1903), among others, from which he eventually described several new orchid species.

The interpretation of the outstanding work carried out by Schlechter on the orchid flora of Costa Rica has been greatly hampered by the fire of the herbarium at the Botanical Museum of Berlin during an Allied bombing raid in 1943 (Ames 1944, Hiepko 1987) because most of the orchid types, together with Schlechter's analytical sketches, were destroyed (Figure 3). Only those specimens that were moved to the Museum's basements or were on loan to other institutions escaped the fire. Even though some of the orchid types from other regions of the world survived (Butzin 1978), all the type specimens of Orchidaceae from the Neotropics, including the spe-

Figure 3. Part of the Berlin Herbarium destroyed during WWII, March 1943. Archives of Rudolf Jenny and courtesy of Dr. N. Kilian, Archives BGBM Berlin-Dahlem.

cies described by Schlechter, Fritz Kränzlin (1847–1934), and Rudolf Mansfeld (1901–1960) were lost (Butzin 1980). The only known exceptions are a syntype of *Spiranthes goodyeroides* Schltr. from Bolivia (Butzin 1978) and an isotype of *Quekettia australis* Kraenzl., collected in Brazil (Butzin 1980).

It was undoubtedly a fortunate circumstance that the National Museum of Costa Rica kept duplicates of many of the collections made by its scientific staff, which were sent to Schlechter for determination. The German botanist used them as a basis for his descriptions of new Costa Rican orchid species. Many of these isotypes have served to typify the names of Schlechter's orchids, whose original types have been lost (Barringer 1986; Lobo 2004; Pupulin 2010; Pupulin et al. 2016). But even more providential was the fact that during the two decades during which Schlechter devoted himself to describing the orchids that came to him from his correspondents in Costa Rica, his colleague Oakes Ames (Figure 4), who had already developed a reputation of his own in orchidology working on the floras of Malaysia, Indonesia, and the Philippine, directed his attention, with particular emphasis, to the orchids of Mesoamerica. Ames (1908a) described his first orchids of the Central American isthmus only two years after Schlechter, with his second *Decas* of new and critical orchids from Guatemala (Schlechter 1906c), had begun his prolific series of scientific works on the Mesoamerican orchidaceous flora, which would have ended only at his death in 1925. Ames survived Schlechter and continued his work of elucidating Central American orchid flora, albeit with less emphasis, until the mid-1930s. The intense relationship between the two taxonomists was explored by Ossenbach (2009), who highlighted their scientific rivalries and the deeply human aspects of solidarity and friendship that bound them. Not only did Ames contribute financially to the publication of part of Schlechter's work on the orchid flora of the Andean countries after the German botanist had run out of funds for the remaining volumes, but he also supported Schlechter's wife in paying the hospital bills during her husband's illness (Ossenbach 2009). The amount of first-hand information that Schlechter had accumulated in his herbarium during the years of his relationships with the botanists of the Museo Nacional and the group sponsored by Doña Amparo de Zeledón was so fundamental to the understanding of the rich flora of Costa Rica that Ames had several artists at once employed in Berlin to copy (under Schlechter's supervision) the analytical sketches of new species made by the German taxonomist. In a few cases, the tracing was complemented with fragments of the holotype that Schlechter, and later his wife, made available to Ames for the Herbarium of the Botanical Museum at Harvard. After the loss of Schlechter's types in the fire

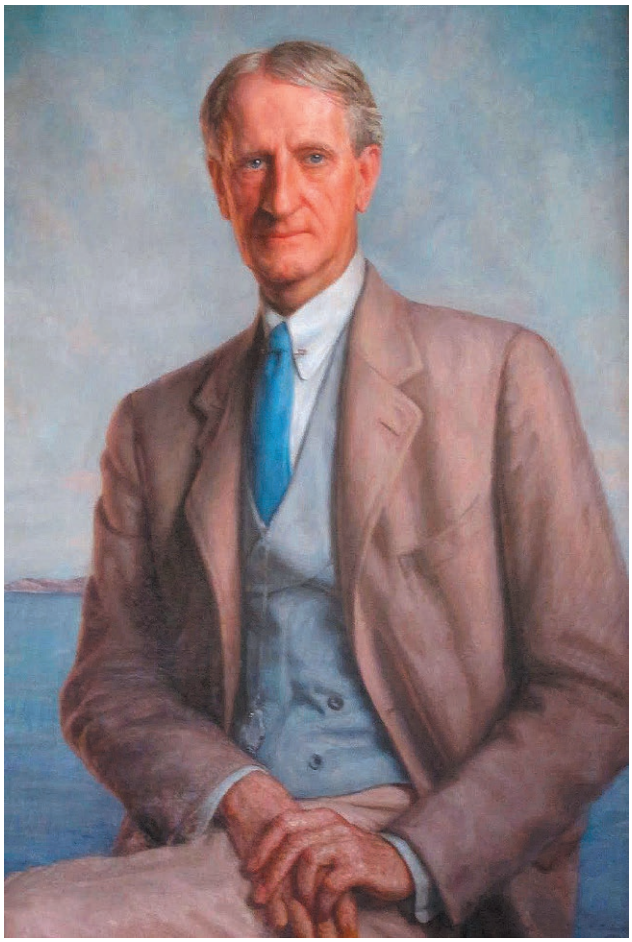

Figure 4. Oakes Ames (1874–1950). Portrait by his wife, Blanche Ames.

of the Berlin Botanical Museum, these materials represent the most precious source available today for scholars to give a face to the descriptions of the new orchid species published by Schlechter in over twenty years of activity, as they make up the only extant evidence of the original materials.

The need for a solid framework that allows a consistent application of species' names relative to the orchid flora of Costa Rica, as well as a critical examination of the taxonomic status of previously synonymized names, has become more and more compelling as the works devoted to the treatment of Orchidaceae for *Flora Costaricensis* are nearing completion. Cataloguing the information on type designations for Costa Rican orchid names and designating new types when appropriate has been particularly important and critical in the orchid species originally described by Schlechter due to the destruction of the main set of type specimens and the associated analytical drawings and notes.

This patient work was inaugurated by Barringer, who in 1986 published a comprehensive paper on the typification of the Costa Rican orchids species described by Schlechter based on the extensive collections by Alberto M. Brenes (Barringer 1986). Pupulin (2010a) faced another large group of orchids described by R. Schlechter from plants collected in Costa Rica by Karl Wercklé, presenting a catalogue of 84 species and providing lectotypification for 60 of them. Another important step was made in 2016, when Pupulin and collaborators typified the over 60 orchid names based on collections carried out by Adolphe Tonduz, proposing 36 lectotypes and two neotypes (Pupulin et al. 2016). Bogarín et al. (in prep) devoted their attention to the orchids sent to Schlechter in 1921 by G. Acosta, upon which the taxonomist described 22 new species in 1923; they designated 13 lectotypes and three neotypes.

The present paper follows previous contributions of this nature. It is dedicated to the typification of orchid species based on Costa Rican material originally gathered by several different collectors and described by Schlechter between 1907 and 1923.

The selection of the floral analyses made by Schlechter for lectotypification purposes, which has been adopted in previous papers (Barringer 1986; Mora and Atwood 1992, 1993; Atwood 1999; Pupulin 2010a; Pupulin et al. 2016), has been questioned by some authors, reviewers or online databases (i.e. Tropicos 2021) based on a supposed "posteriority" of the illustrations compared to the time in which the original materials were prepared (Hermans et al. 2020) or because these drawings are not considered original material and therefore it is an error to be corrected to neotype, Article 9.10 the Shenzhen code (Turland et al. 2018). This is a very strict interpretation of the Article 9.4 that defines original material as the material that "comprises the following elements: (a) those specimens and illustrations (both unpublished and published before the publication of the protologue) that the author associated with the taxon, and that were available to the author prior to, or at the time of, preparation of the description, diagnosis, or illustration with analysis (Articles 38.7 and 38.8) validating the name. However, Article 9.4 *per se* does not delegitimize the reproductions of original material since they are copies of the type material, and therefore, they are unequivocally original material.

Indeed, the fact that Mansfeld published Schlechter's drawings in 1931, five years after the death of the German taxonomist, is certainly undeniable. Likewise, it is unquestionable that the drawings traced by the artists hired by Prof. Ames, and made under the direct supervision of Schlechter, were executed several years after Schlechter had prepared the original materials for the descriptions of his new species. Even more certain is that the negatives exposed in 1929 by J. Francis Macbride in the herbarium of the Berlin Botanical Museum and the pictures taken by Ames were actually printed on photographic paper only years later and that Schlechter never even saw these "photographs". However, no one should doubt that these materials are reproductions of the original material that Schlechter kept in his herbarium and subsequently deposited in the Berlin herbarium. The original drawings affixed to Schlechter's herbarium sheets, immortalized by the negatives of Macbride and Ames, are indistinguishable from those published by Mansfeld (1931) and from the drawings traced for the herbarium of the Botanical Museum of Harvard University (Figure 5). Questioning the conformity of these reproductions to the original materials, that is, questioning their "veracity", simply raises a long-standing and complex problem relating to the technical reproducibility of illustrations, a technological and engineering issue that has continuously evolved and changed over time, to bring today to the apotheosis of electronic image and absolute reproducibility. We believe that no one would question the conformity to the "original" of an image taken today with a mobile phone camera, and the possibility of using it in a publication indicating it as a "lectotype", even if an expert photographer would not miss the possible inconsistencies in the geometry and colors introduced into the image by the perspective, as well as the type of lens, sensor, and software used. The floral analyses published by Mansfeld are in no way "similar" or "inspired" to Schlechter's originals, but their faithful reproduction according to the technical possibilities

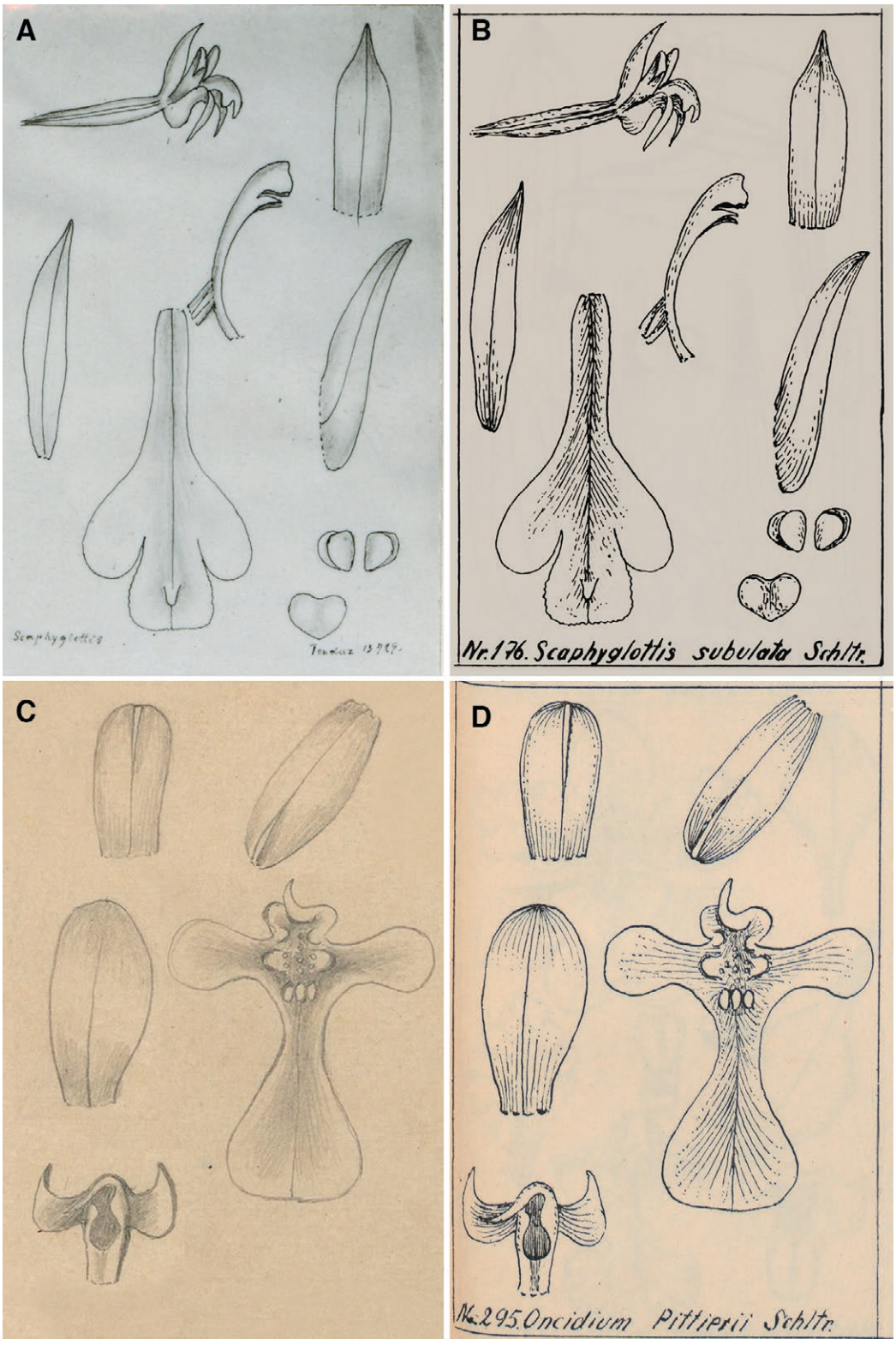

Figure 5. A, Drawing of *Scaphyglottis subulata* from the photo of the holotype taken in the Berlin Botanical Museum and printed in photographic paper kept at AMES 39613. **B**, Drawings based on the type of *S. subulata* published by Mansfeld, 1931: Pl. 44, No. 176. **C**, drawings traced by the artists hired by Prof. Ames, and made under the direct supervision of Schlechter of *Oncidium pittieri* kept at AMES 24264. **D**, Drawings of the type of *Oncidium pittieri* published by Mansfeld, 1931: Pl. 74, No. 295.

allowed by the printing advances of those times (Figure 5B). The artists employed by Ames to work in Schlechter's herbarium did not "imitate" his floral analyses but traced them under the watchful eye of the German botanist. These reproductions were indeed technically closer to the originals than were the engravings made for de Sancha's press concerning the paintings originally made in Peru by the draughtsman of the botanical expedition of Ruiz and Pavón (1794, 1798), or the illustrations of Plumier's Antillean collections published by Burman (in Plumier and Burman 1755), which were themselves copied from what was already a hand-made copy (the *Codex Boerhaavianus*) of Plumier's original drawings (Goethart 1910; Ossenbach 2016), and were used nonetheless to lectotypify Linnaeus's (1759) orchid species (e.g. McLeish et al. 1995). Plumier himself never saw the materials with which the species were lectotypified, for the simple reason that when Burman's work was published in Amsterdam, he had been dead for nearly fifty years. And as for the quality of Burman's copies compared to the original drawings made by Plumier, it might be useful to quote the opinion of John Lindley, who, in addition to being one of the greatest orchidologists of all time, was also an excellent illustrator: "Plumier's Mss. appear, from the copy in Mr. Lambert's Herbarium, to give a very clear account of this beautiful species [*Epidendrum atropurpureum*]; yet Burman, with his usual skill, converted the figure into a caricature […]" (Lindley 1830–1840, p. 100).

Some authors seem to favor using these same materials – which are nothing but reproductions of the original analyses made by Schlechter – under a different type category, selecting them as neotypes rather than lectotypes or just using them as a reference for selecting a neotype (Hermans et al. 2020). However subtle, the difference is certainly more than semantic. As it must be done among the materials that the original author knew and referred to in the description of a new taxon, the designation of a lectotype does not introduce any element of subjective judgment by subsequent authors on the identity of the taxon, except for the verification that the elements chosen for that purpose are in agreement with the protologue (because even the original authors may have made mistakes). On the contrary, the designation of a neotype virtually represents an entirely subjective interpretation of the original authors' ideas and concepts because it uses materials that the author has never known or referred to it. There is undoubtedly a gradient of "certainty" in the various type categories that the Code visualizes to give stability to plant names. All the materials that can be selected to lectotypify a name (e.g. isotypes, syntypes, paratypes, original drawings and illustrations of the type, etc.) have in common the fact that the author of the name has identified them, and therefore adhere to "his" concept of species. Neotypifications and epitypifications, on the other hand, must be viewed with greater caution since they make use of materials that were not identified by the original author and which correspond to the concept of the species according to "someone else", however experienced.

Also, the Tropicos database (https://www.tropicos.org) treated the lectotypifications based on the copy of Schlechter's sketch of the holotype in Pupulin (2010a) and Pupulin et al. (2016) as neotypifications, erroneously stating that "corrected here to neotype because a depiction of the specimen is not considered original material" (Tropicos 2021). However, the Article 9.3 of the Shenzhen code (Turland et al. 2018) states that "a lectotype is one specimen or illustration designated from the original material". Also, Art. 9.12 states that "in lectotype designation… if no isotype, syntype or isosyntype is extant… the lectotype must be chosen from among the uncited specimens and cited and uncited illustrations that comprise the remaining original material". Therefore, if an illustration meets the above requirements, it can be considered original material and thus selected as a lectotype.

For this reason, we choose, in the past, to use these reproductions to lectotypify the species described by Schlechter, and for the same reason, we keep this choice here. Also, other authors favored this view and selected the illustrations of the flower analysis made by Schlechter and posthumously published by Mansfeld (1931) as lectotypes (Guimarães et al. 2019). When none of the syntypes or isotypes has been preserved, these materials must, in our opinion, be considered an integral part of the original materials as Schlechter knew them. They are technically reliable reproductions and certainly incomparably closer to his concepts than any "new" material we might select for typification purposes. It may be that a more orthodox application of the provisions of the Code – but also objectively less sensitive to the essential elements of botany – convinces readers that our lectotypifications must be "corrected" to neotypifications. The Shenzhen code (Art. 9.10) (Turland et al. 2018) admits this possibility, recognizing the value of the conceptual discussion concerning typification and considering our proposals as correctable errors without affecting the validity of the relative interpretations and choices. From our point of view, the choice of lectotypification is undoubtedly more consistent with the taxonomic story of the species discussed in this paper and preferable for nomenclatorial stability.

Schlechter organized his *magnum opus* on the flora of Costa Rican orchids in various chapters, dedicated to those botanists, collectors, and patrons who provided the

most significant contributions, in terms of quantity and variety of materials, to his studies. "*Orchidaceae Amparoanae*", "*Orchidaceae Bradeanae Costaricenses*", "*Orchidaceae Brenesianae*" commemorate some of these important figures (Schlechter 1923a, 1923b, 1923c). The names of other important figures of Costa Rican botany at the turn of the century, such as Tonduz and Wercklé, were recognized in the chapter dedicated to the "patroness" of their activities, Doña Amparo (Pupulin 2010a; Pupulin et al. 2016). The case of Guillermo Acosta, author of two important orchid shipments to Berlin in 1921, has been discussed by Bogarín et al. (in prep), highlighting his close and, in part, unrecognized relationship with Tonduz. The contributions of other collectors, smaller in quantity and perhaps less systematic in intentions, although not less botanically important, were gathered by Schlechter in a particular chapter dedicated to "Various collectors" (Schlechter 1923d). This chapter includes, as its main content in numerical terms, the collections that Guillermo Acosta sent to Schlechter in 1921, whose typification was dealt with by Bogarín and colleagues (in press). Alongside the Acosta orchids, however, there are numerous species of other botanists and naturalists active in Costa Rica at the beginning of the 20th century, whose collections reached Schlechter's desk through the shipments to European specialists made by the curators of the Museo Nacional. For the sake of completeness, we have included in this paper of typification of the orchids *collectorum variorum* also those of some species that did not reach Schlechter's hands directly, since they were not collected during the period of his botanical activity, but rather date back to the second half of the nineteenth century. Schlechter had the opportunity to study them in Vienna when the herbarium of Reichenbach was newly made accessible to the public after it had been closed for 25 years by the will of his testament. Between 1907 and 1923, he described a dozen new species based on the collections that these early travelers and explorers made in Costa Rica from 1857 to 1888 (Schlechter 1907a, 1907b, 1918a, 1920, 1921b, 1923d).

But let us now have a closer look at the different figures, in chronological order and importance, who make up the cast of the "various collectors" of Schlechter's Costa Rican orchids.

COLLECTORES VARII ORCHIDACEARUM COSTARICAE AB R. SCHLECHTER DESCRIPTAE

Karl Hoffmann

The Germans Karl Hoffmann (1833–1859) (Figure 6) and Alexander von Frantzius (1821–1877) came to Costa Rica in 1853, bearing letters of recommendation from Nees von Esenbeck, President of the German Academy, and Alexander von Humboldt for President Juan Rafael Mora. They arrived at Greytown (San Juan del Norte) as passengers of the brig *Antoinette*, together with a group of German immigrants, and continued to Costa Rica along the road of Sarapiquí (Hilje 2007). Frantzius was a professor at the Physiological Institute in Breslau, and Hoffmann was well-known for his practical and literary works during the cholera epidemics in Berlin during the years of 1848 and 1849. Soon they began to explore the country and collect specimens, mainly botanical.

Figure 6. Karl Hoffmann (1823–1859). Courtesy of Luko Hilje.

Hoffmann was later a physician in the Costa Rican army during the war against pro-slavery activist W. Walker. At the same time, Frantzius soon became a successful businessman and owner of a pharmacy. Hoffmann and Frantzius spent their leisure time, the first dedicated to collecting plants and studying their natural distribution, the second to similar studies in mammals and birds. Hoffmann climbed two of Costa Rica's most

important volcanoes: on May 5, 1855, Irazú near Cartago, and in August of the same year, Barva in the province of Heredia.

Hoffmann intended to write a book with the title *Flora and Fauna of Costa Rica*, but he had to abort this idea because of the war and his illness. After the war against Walker, Hoffmann retired to Puntarenas, where he died in 1859. His mortal remains were brought to San José in 1929, where they were buried with military honors.

Hoffmann sent his collections to the herbarium of Berlin, to the renowned botanist Johann F. Klotzsch. They were later described by Reichenbach in 1866 in his *Orchideae Hoffmannianae* (Reichenbach 1866). One can find among them the types for three new species: *Pelexia hoffmannii* Rchb.f., *Epidendrum* (= *Prosthechea*) *ionophlebium* Rchb.f. and *Ponera albida* Rchb.f.

Schlechter described an additional new orchid species collected by Hoffmann as *Epidendrum hoffmannii* (= Prosthechea ionophlebia (Rchb.f.) W.E. Higgins) after he was able to visit Reichenbach's herbarium in Vienna after World War I. Hoffmann collected it in the small village of Curridabat, to the east of San José (misspelled by Schlechter as 'Curidabal') (Pupulin and Karremans 2007).

Auguste R. Endrés

Auguste R. Endrés (1838–1875) was perhaps the most proficient and dedicated botanist who ever studied the orchid flora of Costa Rica. His name appeared sporadically in the *Gardener's Chronicle* since 1871, associated with orchid novelties described by Reichenbach in Hamburg. But unfortunately, we have no portrait of Endrés.

He was born in Herbitzheim, a village in the department of Bas-Rhin in Alsace, France, of a German family, and the roots of his culture were German. In 1855, Endrés moved to New York with his grandfather Auguste Reeb, where he was joined by the rest of the family two years later. Here he made the acquaintance of Isaac Buchanan, a well-known horticulturist, who introduced Endrés to several of the most famous names in orchidology of that time, such as William Hooker, George U. Skinner, James Bateman, Hugh Low, John Day, and Capt. John Dow, probably Endrés' best friend during the years of his Costa Rican adventure. Skinner and Bateman decided to employ Endrés to collect orchids in Costa Rica, following a recommendation by Buchanan.

In 1866, with a commission to collect for Bateman and for Professor Reichenbach, Endrés arrived in Greytown, Nicaragua. He traveled along the San Juan River to neighboring Costa Rica by canoe. His first known orchid, *Dichaea trulla*, was collected and illustrated that same year. During the next seven years spent searching for orchids, Endrés explored all corners of Costa Rica known (Ossenbach et al. 2010; Ossenbach 2013; Ossenbach and Pupulin 2013). Economic constraints forced him to collect orchids for horticultural purposes and even work as the superintendent of the construction of a new road, but he never stopped collecting for science. The Pleurothallid orchids were his main scientific interest, particularly the genus *Lepanthes*, of which Endrés discovered, described, and illustrated, over two-thirds of all the species known from Costa Rica.

Endrés traveled to Europe in 1874 to discuss with Reichenbach – with whom he had a contrasting human and scientific relationship – the future of his research and the use of his materials. During their meeting in Hamburg, Endrés made the acquaintance with the great Czech collector Benedikt Roezl. It was likely on his suggestion that he eventually sailed to Colombia, where he fell ill from pleurisy while traveling toward the highlands of the Cordillera de Santa Marta and died in November of 1874.

What remains of his work shows that Endrés was planning a formal treatment of the orchids of Costa Rica, something to resemble a modern orchid flora. To this aim, he committed himself to explore, collect and prepare specimens, write descriptions, and made botanical illustrations of all the orchid species of Costa Rica he could observe (Pupulin 2013). However, with thousands of botanical drawings, accurate descriptions, and references to the collecting localities ready for the press, plus all the relative dried materials at hand, Reichenbach ended up publishing just a few of them, mainly in his own cryptic descriptive style.

After the death of Reichenbach in 1889, his herbarium, including all Endrés' unpublished work, was bequeathed to the Natural History Museum of Vienna. There, it remained closed for study for another 25 years because of the clauses of his will. Finally, however, Schlechter could study the immense labor left behind by Endrés in the recently opened orchid collection at the Hof Imperial Museum in Vienna during his visit around 1915 (Jenny, pers, comm. 2011), a few months before the beginning of the First World War. Here, among the plants collected 40 years before by Endrés, he described three as new to science (Schlechter 1921a). Schlechter named *Chondrorhyncha endresii* in honor of the great explorer and botanist.

Friedrich Carl Lehmann

As a collector for Hugh Low & Co. of London, Friedrich Carl Lehmann (1850–1903) (Figure 7) went to South America in the late 1870s. Around 1878 he settled

Figure 7. Friedrich Carl Lehmann (1850–1903). Unknown artist.

in Popayán, Colombia, where he held the position of the consul of Germany until his death. He made significant discoveries of new Colombian orchids, especially in the genus *Masdevallia*, which was his favorite. In 1883 he was described as "the most important traveler and collector in the United States of Colombia and neighboring territories of our time" (Regel 1883). In 1878, Reichenbach had published his *Orchidaceae F. C. Lehmannianae ecuadorenses,* where he described Lehmann's collections in Ecuador from the year 1876.

At the beginning of the 1880s, Lehmann traveled to Costa Rica, Panama, and Guatemala. Although his journey's exact dates are not known, the first dated collection from our area is the type specimen of *Catasetum blepharochilum* (=*Catasetum maculatum*) (*Lehmann 1061*, Costa Rica), in December 1881. In a short time, he discovered numerous new Central American species, described later by Schlechter and Kränzlin.

An important number of the orchids collected by Lehmann were described by him and F. Kränzlin in 1899 under the latter's *Orchidaceae Lehmannianae in Guatemala, Costarica, Columbia et Ecuador collectae, quas determinavit et descripsit* (Kränzlin 1899).

Lehmann liked to say: "I attribute my good health, and even my life mainly to two things: First, when in danger either from natives or, worse still, from lawless white men, I never produce a revolver or other weapon… Secondly, I never drink water without first boiling it" (Taylor 1974, p. 176). His precautions did not help him. He shared the fate of many other explorers of these regions and died by drowning in 1903 while trying to cross the Timbiquí River to visit a gold mine in which he had interests. His widow sold his herbarium and his drawings to the herbarium at Kew.

Lehmann was also an excellent illustrator. Many of the pencil drawings with which he accompanied his herbarium specimens are preserved at the herbarium at Kew (Cribb 2010). He also wrote the notes for the geographical descriptions in the monograph of *Masdevallia* edited by the Marquis de Lothian and illustrated by Miss Woolward, where his extensive knowledge about the plants in their native habitats can be appreciated. A new genus was dedicated to him by Kränzlin: *Neolehmannia*.

Lehmann was quite generous in distributing his materials to several botanists and institutions, mostly in Europe. Notable among these were H. G. Reichenbach in Hamburg, R. A. Rolfe in Kew, H. N. Ridley at the British Museum, F. Kränzlin in Berlin (who eventually sold his materials to Hamburg) among others. Even though the largest part of Lehmann's personal herbarium, together with his plant illustrations, were acquired by Kew from his widow in 1903 (Cribb 2010) and are now hosted at the Herbarium of the Royal Botanic Gardens, Kew, UK (K), we are aware of Costa Rican orchid specimens collected by Lehmann in several other herbaria, both in Europe and in the United States.

Interestingly, although the types of some orchid species collected by Lehmann and later described by Schlechter were regarded as destroyed in the herbarium fire of the Berlin-Dahlem Botanical Museum (i.e. Garay 1978; Guimarães et al. 2019; Hágsater 2009; Luer 2017, 2018; Ormerod 2002, 2008), the presence of these specimens at B is highly doubtful. Lehmann used to court his contemporary botanists, sending them plants to provide names for his collections. Certainly, he could not have had a relationship with Schlechter, who was a generation younger, and whose interest in American orchids did not begin until the second decade of 1900, when Lehmann had been dead for over ten years. We know that during the last decade of the 19th century, Lehmann sent material to Fritz Kränzlin, then in Berlin, who in 1899 dedicated a long article to him in which he determined the collections received from Lehmann and described 107 new species, most of them under Lehmann's joint

authorship. This material was probably lent by Kränzlin to the Herbarium of the Berlin-Dahlem Botanical Museum. Still, after 1903 it had to be returned to Kew, which had acquired ownership of Lehmann's collections (Cribb 2010). As to the materials of his private herbarium, probably due to Kränzlin's rivalry with Schlechter, these were eventually not bequeathed to the Berlin-Dahlem Museum, as it might have been expected, but were sold instead to the Herbarium Hamburgense, where they are still held today. In any case, since the article that Kränzlin dedicated to Lehmann includes not only the description of the new species, but also the identification of the remaining material received in Berlin, it is important to note that there is no mention of any of the species collected in Costa Rica and later described by Schlechter. For this reason, it seems reasonable to believe that it was not in Berlin where Schlechter studied Lehmann's material but elsewhere.

Although we have tried to answer the question concerning where Schlechter may have studied Lehmann's Costa Rican plants, we have not reached an obvious conclusion. We have been able to observe specimens of the relatively few orchids collected by Lehmann in Costa Rica between 1881 and 1882 in the herbaria of the Natural History Museum in London (BM), Meise Botanic Garden, Belgium (BR), Geneva, Switzerland (G), the Herbarium Hamburgense, Germany (HBG), the United States National Herbarium at the Smithsonian Institution, Washington, U.S.A. (US), and the Natural History Museum in Vienna, Austria (W) (herbaria acronyms according to Index Herbariorum). None of the specimens we studied, however, are annotated and determined in Schlechter's unmistakable handwriting. We know with certainty that he used to annotate the samples that were sent to him for determination because the National Museum of Costa Rica has a rich series of duplicates of collections made by the scientific staff of the Museum, on which Schlechter affixed his own labels before returning the sheets. This leads us to believe that none of the surviving specimens, among those we have been able to trace, represent the holotype used by Schlechter for his descriptions or, even more so, to make his precise drawings of the plants and their floral analyses.

Even though we cannot state this with absolute certainty, the possibility exists that the holotypes of these species described by Schlechter nevertheless exist in some herbarium, public or private, that we have not had the opportunity to examine. For this reason, in the paragraphs dedicated to the few Lehmannian orchids described by Schlechter, we preferred to indicate that the holotype has not been located. Even if, in the absence of specimens that can be unequivocally interpreted as holotypes, we have designated the relative lectotypes for reasons of nomenclatorial stability, we maintain the hope that such specimens may be found in the future making our lectotypifications superfluous.

Richard Pfau

A Swiss, Richard Pfau (1856–1897) founded a nursery in San José, Costa Rica, in the final years of the XIX century, that sold a great variety of ornamental plants. He also collected native plants for export. Through his collections, we know that he was also in Panama and Colombia, and at least one of the new species described from plants sent to Europe by Pfau came from Mexico: *Vanilla pfaviana* Rchb.f.

Pfau wrote the first work published in Costa Rica about the orchids of this country: *New, Rare and Beautiful Orchids of Costa Rica* (ca. 1895), of greater interest for horticulture than for botany. In this work, Pfau advises on how to grow and pack orchids for exportation and included a list of the species he had for sale in his nursery (Figure 8).

But Pfau's voice was also one of the first to address the rising concern about the destruction of our nature when he describes one of our most beautiful orchids: "Cattleya skinneri, some ten years ago, was a common Orchid all over Central America; but in the last few years it has been exported by shiploads; and to-day – at least in Costa Rica – it has almost become rare" (Pfau ca. 1895).

Pfau also wrote several articles about Central America and its orchids, such as "The climate of Central America, Orchid culture" (Pfau 1883), "Notes on the fertilization of Orchids in the Tropics" (Pfau 1894), and "Costa Rica and its Orchids" (Pfau 1896). As did Roezl and Wallis, Pfau sold his plants in Europe through the agency of Eduard Ortgies in Zurich.

Schlechter described several orchids collected by Pfau in Costa Rica, such as *Sobralia pfavii* and *Telipogon pfavii*. Previously, Reichenbach had described other specimens collected by Pfau in Panamá (*Pleurothallis pfavii* and *Trichocentrum pfavii*), and Rolfe described from Costa Rica *Epidendrum pfavii*, of which a colored illustration by Pfau is preserved on the same sheet as the type specimen in Kew (Figure 9).

Juan José Cooper Sandoval

Henry Cooper, a British mining engineer, came to Costa Rica in 1825, under a contract with the government to survey agricultural lands, claimed by the wealthy landowner Victoriano Fernández, in the north-

Figure 8. Cover of Richard Pfau's book on the orchids of Costa Rica. Printed by the author, San José, ca. 1895.

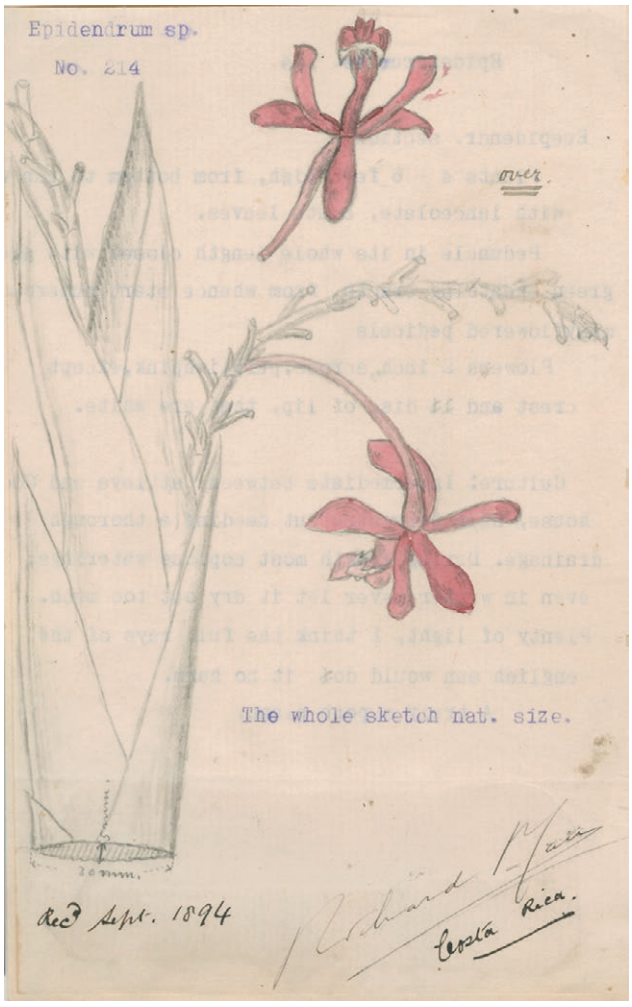

Figure 9. *Epidendrum pfavii*. Coloured illustration by Pfau on the same sheet of type specimen (K000463409).

ern plains of San Carlos bordering a river that has been since then known as Río Cooper. A small hamlet in the same area is also known under the toponym of Cooper. However, it is often misspelled as Kopper, after a German family who settled in the region some thirty years later. Cooper then remained in the country, working in several mines in the hills of Aguacate. He eventually married a Costa Rican girl named Margarita Sandoval, and Juan José Cooper (1843-1911) (Figure 10A), their second son, was born in 1843 (Hilje 2014).

Juan José Cooper was strongly drawn to the natural sciences. Early in his life, he began to work as an assistant to Alexander von Frantzius at his pharmacy in San José. Several young men made their first experiences at von Frantzius' pharmacy, such as Ernesto Rohrmoser, Gerhard Jäger, Manuel Carranza, and Juan José Cooper. They assisted von Frantzius and learned soon to prepare bird skins. Still, their enthusiasm soon diminished, to the point that von Frantzius complained in a letter to Wilhelm Peters, at the Zoology Museum in Berlin: "they behave like small children"! Things changed when young José Cástulo Zeledón (1846–1923) (Figure 10B), rightly called Costa Rica's first naturalist, became his pupil. Through von Frantzius's recommendations, Zeledón was admitted to the Smithsonian Institute in Washington, where he spent several years before returning to Costa Rica as a qualified ornithologist (Hilje 2018).

Zeledón went in 1872 as a zoologist with William Gabb's expedition to Talamanca, and Juan José Cooper went with him as his assistant. They returned to San José with an extensive collection of birds (May 2016). A few years later, when Robert Ridgway described and named the Pacific screech-owl as *Megascops cooperi*, he wrote, "I have named this species at the request of Mr. Zeledón, the collector of the type-specimens, after Mr. Juan Cooper, of Cartago, Costa Rica, a particular friend

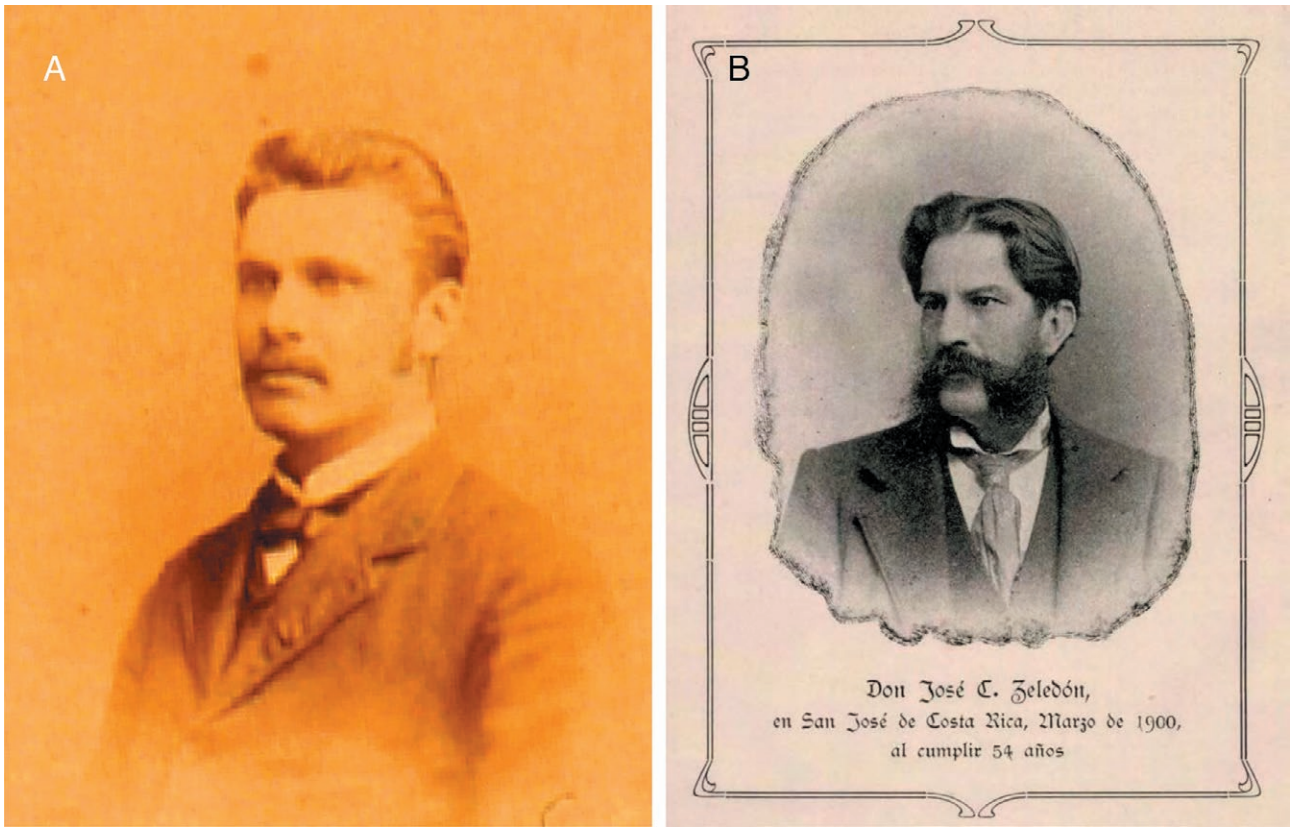

Figure 10. A, Juan José Cooper Sandoval (1843–1811). Courtesy of Luko Hilje. **B**, José Cástulo Zeledón (1846–1923). Unknown photographer.

of his, to whom he is much indebted for many interesting contributions to his collection."

In the early 1890s, Cooper was hired by the recently founded National Museum of Costa Rica as a botanist and taxidermist. Although he collected some 200 species of birds, in his older years, he dedicated himself more to botany, collecting mainly in the vicinity of Cartago, his city of residence. Schlechter named *Stelis cooperi* (collected in 1888) and *Pleurothallis cooperi* (collection date unknown) after him.

Henri Pittier

As part of an educational reform aimed at secularizing public education, the government of President Bernardo Soto (1885–1889) hired a group of European academics to staff the two new public high schools in the capital, San José. The arrival of these academics marks the beginning of a small scientific renaissance in Costa Rica. Two institutions symbolize this renaissance: the National Museum and the Instituto Físico-Geográfico (IFG), founded in 1887 and 1889, respectively.

Among the hired teachers were Pablo Biolley (1861–1908) and Henri Francois Pittier (1857-1950) (Figure 11), who respectively arrived in 1886 and 1887. Pittier lived in Costa Rica until 1905 and, during these years, conducted a systematic exploration of the Costa Rican flora that had no equal in his time in any country of tropical America.

These efforts resulted in the publication of the *Primitiae Florae Costaricensis*, the first flora of Costa Rica, a work that unfortunately was not concluded. It was published in conjunction with a Belgian colleague, Téophile Alexis Durand (1855–1912), and appeared in three volumes and 12 fascicles, published from 1891 to 1905. According to Paul C. Standley (1937: 49), in his introduction to the *Flora of Costa Rica*, "Henri Pittier has undoubtedly gained a more intimate knowledge of the natural history and especially the botany of Central America and northwestern South America than has ever been possessed by any single person."

Although hired to teach at secondary schools, Pittier had more ambitious ideas. After he arrived in Costa Rica, he started to fight to form a meteorological observatory and an institute. The Meteorological Institute was

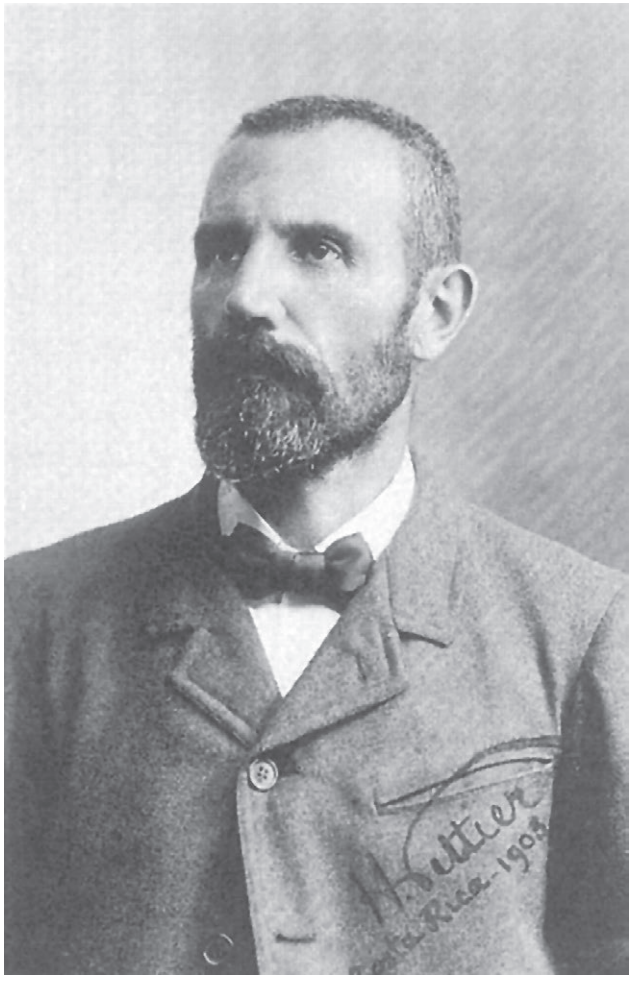

Figure 11. Henri Pittier (1857–1950) in 1903. Unknown photographer.

founded in April 1888 under the direction of Pittier. Pittier's work at the Institute went parallel to the foundation of the National Museum, of which Anastasio Alfaro was named the first director. Pittier, who had been in Costa Rica for only two months, was named on the Board of Directors of the Museum, together with Pablo Biolley and José Cástulo Zeledón. The combined efforts of Pittier, Alfaro, Tonduz, Biolley, Wercklé, Brenes, and the Brade brothers resulted in the formation of the National Herbarium that counted initially with more than 5,000 species and "was unequaled below the Río Grande del Norte" (Standley 1937).

Unfortunately, Alfaro and Pittier, the two prominent scientific entrepreneurs in the small country, never could agree on how to organize their operations. In 1889 the government consolidated the Museum and the Meteorological Institute into one center, the 'Instituto Físico-Geográfico Nacional de Costa Rica'. This was a temporary triumph for Pittier, who was named director. However, integration only lasted a few months, and the Museum was again separated from the rest of the Institute. The inevitable outcome was that constant intrigues and lack of funds led to Pittier's final falling out with the government. In 1905 he left the country to work in the United States and Panama and a long and distinguished career in Venezuela until he died in 1950. The Instituto lost its creator and engine, and Costa Rica a dynamic and prolific scientist with his departure.

Henri Pittier was always interested in orchids. While working on his *Primitiae Flora Costaricensis,* he sent a significant number of specimens to his friend Théophile Durand in Brussels, who passed them on to Schlechter in Berlin for identification. The orchids collected in Panama during his work for the United States government went the same way. After initial differences (Schlechter, for some time refused to return the material sent by Pittier), Pittier worked together with Schlechter until the death of the German scientist in 1925. In 1906, Schlechter dedicated a new genus of orchid to Pittier: *Pittierella* (today a synonym of *Cryptocentrum* or *Maxillaria s.l.*) and several new orchid species, among them *Cranichis pittieri, Epidendrum henrici, Lockhartia pittieri, Notylia pittieri, Oncidium pittieri, Scaphosepalum pittieri*, and *Vanilla pittieri*.

Paul (Pablo) Biolley

Pablo Biolley (1862-1908) (Figure 12) was born in the Swiss town of Neuchâtel in 1862. He obtained his degree in natural sciences there and continued his studies in the Netherlands and Germany. Biolley formed part of the first group of Swiss teachers hired by the government of Bernardo Soto and was appointed as professor of the recently founded 'Liceo de Costa Rica', where he began teaching in 1877. He established himself permanently in Costa Rica, obtaining Costa Rican nationality and marrying a Costa Rican. He died in 1908 at the age of forty-six. His sister Stella arrived in 1889 and was a teacher at the 'Colegio Superior de Señoritas' for many years. In Pablo Biolley's honor, a village and a district in Costa Rica's southern region were named 'Biolley'. Also, an important height in the cordillera of Talamanca carries the name 'Cerro Biolley'.

Immediately after he arrived in Costa Rica, he became one of the scientists who gave generous impulse to the foundation and development of Costa Rica's first scientific institutions and was named naturalist of the National Museum also occupying a chair on the Board of Directors (Díaz and Solano 2009).

Figure 12. Paul Biolley (1862–1908). Unknown photographer.

Biolley accompanied Pittier during many of his explorations, often in the company of Adolphe Tonduz, and was, for a short period (1904) director of the Instituto Físico-Geográfico. He also went on botanical excursions with Charles H. Lankester to the Atlantic region, collecting in Turrialba and Peralta's vicinity.

Although Paul Biolley's primary interest was in entomology, he made important contributions to the knowledge of the Costa Rican flora. To him, we owe, among others, the discovery of the types of *Maxillaria biolleyi* (Schltr.) L.O.Williams) and *Telipogon biolleyi* Schltr. An interesting species of the Costa Rican orchid flora, *Epidendrum insulanum*, was described by Schlechter from a collection by Pittier during an expedition in 1902 with Biolley to Cocos Island.

Emel Jiménez Segura

During the government of President Rafael Yglesias Castro, between 1894 and 1902, several young Costa Rican teachers were sent to complete their education at Santiago de Chile's Pedagogical Institute. Among those who returned to Costa Rica at the turn of the century

Figure 13. Emel Jiménez Segura (1881–ca. 1960) with wife Telma Royo. Courtesy of his grandson Gerardo Mora Jiménez.

were several prominent educators such as José Fidel Tristán, Miguel Obregón Lizano, and Roberto Brenes Mesén. Miguel Obregón was named Consul of Costa Rica in Santiago in 1899, and received the commission of selecting a Chilean professor to take over as director of the Liceo de Costa Rica, founded three years earlier in the aftermath of the educational reform of President Bernardo Soto Alfaro. Doctor Zacarías Salinas was selected and arrived in San José in 1900. He immediately went to work, beginning a profound reform of the school's curricular system.

Salinas hired several of the teachers that had trained in Chile, such as José Fidel Tristán and Roberto Brenes Mesén, and was instrumental in selecting a new group of students that was sent to Santiago in 1901, among them Joaquín García Monge, Alberto Rudín (younger brother of Juan Rudín, brother-in-law of Henri Pittier) and Emel Jiménez Segura (1881–ca. 1960) (Figure 13), who returned from Chile in 1904 and formed part of the new staff of the Liceo. Emel Jiménez was put in charge of the Department of Natural Sciences.

Botanist Otón Jimenéz Luthmer, who studied at the Liceo de Costa Rica and was a pupil of Emel Jiménez, described him as demanding and of strong character but praised his humanity and sense of justice. Jiménez taught his botany classes using live material whenever possible, and for this, he counted on the friendship he had established with Alfredo Brade, a German gardener who had a plant nursery in San José and supplied him with the necessary specimens (Jiménez 1959).

Emel Jiménez continued at the Liceo de Costa Rica until well into the 1940s. In his last active years, between 1938 and 1946, he was joined at the Liceo by another renowned Costa Rican botanist, Rafael Lucas Rodrígues

Figure 14. Wilhelm Heinrich Ferdinand Nevermann (1881–1938). Courtesy of his granddaughter Helga Nevermann.

Caballero. Emel Jiménez and his generation of Costa Rican educators formed in Chile had a strong influence on Costa Rica's educational system in the first half of the XX century.

Schlechter described *Epidendrum urostachyum* from a collection by Emel Jiménez in 1913, in the hills of El Tablazo, to the south of San José.

Ferdinand Nevermann

Wilhelm Heinrich Ferdinand Nevermann (1881–1938) (Figure 14) was born in Hamburg and arrived in October 1909, having graduated with honors as a mechanical engineer a few years earlier. After exploring the whole country and having started a family, in 1918 Nevermann acquired a farm which he called 'Hamburgo', in El Cairo de Siquirres, in the Atlantic region of Costa Rica. While investigating the insects that attacked his banana plantations, Nevermann began an interest that led him to become one of Costa Rica's most important entomologists but a world authority on this subject.

After World War I, the call by the German government to all its citizens living abroad to help refurbish the collections of the German museums that had been destroyed led to Nevermann, sending insect collections to Germany with increasing frequency. In these years, he established close relations with Berlin's Museum and Botanical Garden. Nevermann also sent plants. There is a beautiful white orchid, *Coryanthes nevermannii*, which we owe to him" (Apuntes… 1938: 341). This reference is curious because there is no record of an orchid with the epithet 'nevermannii' in the international registers of botanical nomenclature. The answer to this riddle can be found in a letter by Rudolf Schlechter to Nevermann dated May 8, 1925: "The two orchids which were sent to me interested me vividly. The double inflorescence with the big pendant flowers is a new species of *Coryanthes*, which I will soon describe as *Coryanthes nevermannii* Schltr. It is the first species of *Coryanthes* that until now I have known from Costa Rica. It is for me a special pleasure to dedicate this plant to you. Not smaller interest raised the slender-leaved *Vanilla*. This one also has not yet received a name. It will carry your name as *Vanilla nevermannii* Schltr." (1925 May 8 letter from Schlechter to Nevermann). Schlechter died six months later, in November 1925, and the species dedicated to Nevermann were never published. When in 1943 Schlechter's herbarium was destroyed, all evidence of Nevermann's collections disappeared. Thus, we will never know for sure which species correspond to *Coryanthes nevermannii* and *Vanilla nevermannii*.

In 1936 he took over the Chair of Entomology at the National School of Agriculture, but died shortly afterwards in an unfortunate accident. During the night of June 30, 1938, while studying the nocturnal behavior of a species of ant, he was shot by the son of a neighbor who mistook him for an intruder.

Paul C. Standley visited Nevermann at his farm, where he collected several species of orchids, wrote in his *Flora of Costa Rica*: "To Mr. Ferdinand Nevermann there are special obligations for a most pleasant and profitable visit to his fincas in the lowlands along the Reventazón River. Enviable is the botanist who receives a welcome from so considerate a host, or visits the forest with so competent a guide" (Standley 1937: 59).

Otón Jiménez

Schlechter (1918a, p. 371) wrote: "a young collector stands out lately in Costa Rica, O. Jiménez, who in a short period of activity has already found a series of new species and, through his efforts, promises to enrich significantly our knowledge about the flora of that country, especially of the Orchidaceae." Otón Jiménez (1895–1988) (Figure 15) had the good fortune to study at the Liceo de Costa Rica in its golden age, with teachers like Emel Jiménez, Dr. Michaud, and Paul Biolley. Of a precocious intelligence, he was only 17 years of age when he was appointed as director of the Herbarium of the National Museum, a position he held until 1914. He remembered his first encounter with Charles H. Lankester in 1911: "I still remember his smile while shaking hands with me, observing my youngster-look due to the short trousers, long socks and occasionally a sailor-type blouse, the usual attire of the students of those years […]" (Jiménez, 1967: 248).

Figure 15. Otón Jiménez (1895–1988). Courtesy of Silvia Troyo.

His friendship with Lankester, which lasted throughout their lives, converted him into a lover of orchids, accompanying the great Englishman on many of his collecting trips. Jiménez had the privilege to grow up during a period when the botanical exploration of Costa Rica was in full effervescence. "By 1914, Costa Rica had become the center of scientific research in tropical America" (Evans 1999, p. 20). Jiménez knew the great botanists of his time: Wercklé, Pittier, Tonduz, the Brade brothers, Donnell Smith, Pittier, Britton, Dr. Patiño (Colombia), Wilson Popenoe, Maxon, Standley, Williams, and Allen, and married a daughter of Anastasio Alfaro. Louis O. Williams, who went on a few excursions with Jiménez, described him as "one of the most vivacious and enjoyable gentlemen (and botanists) to be met anywhere" (Williams 1972: 206). In 1915, in a letter to J. Barnhart, Pittier described him as follows: "… a disciple of Tonduz and a pharmacy student, who has already done a large amount of collecting and may yet surpass his master."

Silvia Troyo, a granddaughter of Otón Jiménez, wrote in a personal letter of September 2003: "Because of the ups and downs of the Museum after the departure of Pittier, and because of his studies in Pharmacy, 'Oto' could not continue with the botany, as he wished. However, during the remaining years of his life, he dedicated to botany as much time as he could (which unfortunately was not much). After this period, since the collections at the Museum were not well organized and sometimes were lost, he started to send his collections abroad, I believe for the rest of his lifetime. I know that in the process, many got lost, especially those destined to Europe… his later work, besides collecting and taxonomy, was oriented to the investigation of the nourishing properties of certain plants, or to the study of certain drugs."

Together with Lankester, he had to suffer Oakes Ames' impatience: "When may I expect the specimens that Jimenez has in hand? Now is the time to get this material under the lens." "Otón' has not sent me a scrap. I think it will be wise if you remind him of my needs and accompany him to the post office with the package." (1923 August 24 and December 18 letters from Oakes Ames to Charles H. Lankester). But it was not Ames but Schlechter and several other scientists who really valued Jiménez' work, naming in his honor a series of new species: *Epidendrum jimenezii* Hágsater, *Epilyna jimenezii* Schltr., *Habenaria jimenezii* Schltr., *Lepanthes jimenezii* Schltr., *Pachystele jimenezii* Schltr., *Scaphyglottis jimenezii* Schltr., and *Stelis jimenezii* Schltr.

In addition to being an excellent botanist, Jiménez was a prolific writer, who left interesting articles about

Von Frantzius, Humboldt, Wercklé, Tonduz, Brade, and Lankester; an important bibliographical source for the study of scientific life in Costa Rica during the XIX and the first half of the XX century. "It is much to be regretted that the demands of business affairs have precluded a greater amount of personal fieldwork on the part of one who has such a keen perception of facts and the ability to discover them in strange places." (Standley 1937: 53).

TYPIFICATION OF COSTA RICAN ORCHIDACEAE DESCRIBED BY RUDOLF SCHLECHTER

Species collectoribus variis lectae

1. *Catasetum blepharochilum* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 7: 158. 1920

Type: Cuenca? [(Costa Rica.) "An Rio Toro Amarillo in dichten feuchten Wäldern in der Ebene. Costa Rica. 20 Dezbr. 1881" / "Dans les forets touffues et humides de la plaine sur le Rio Toro Amarillo, 20 Décb. 1881"], *F. C. Lehmann 1061*. Holotype, not found. Isotype, designated as lectotype by Romero and Jenny (1993), G 00168805! (Figure 16). Schlechter's floral analysis published in Mansfeld (1929: Pl. 56, No. 216!). Figure 17.

Catasetum blepharochilum is seldom recorded among the orchids of Costa Rica, even as a synonym of the widespread *C. maculatum*, despite the type specimen having been collected along the Toro Amarillo River on the Caribbean plains east to the Central Volcanic Cordillera in Costa Rica. It was cited neither in Pupulin's catalogue of Costa Rican Orchidaceae (Pupulin 2002) nor in Dressler's treatment of *Catasetum* for the *Manual de plantas de Costa Rica* (Dressler 2003). The reason for this was an error made by Schlechter (1920), who dubiously assigned the type specimen to "Cauca?" (Colombia) and treated the species as an Andean member of the genus. It is regarded as a Colombian conspecific with *C. maculatum* in Ulloa Ulloa et al. (2017), as well as in the major taxonomic databases available on the net [e.g., the Global Biodiversity Information Facility (Döring 2017), Tropicos 2021, WCSP 2021]. The type locality is, however, correctly cited as Costa Rica by IPNI (2020). The isotype at G, that Romero and Jenny (1993) designated as the lectotype, bears two original labels by Lehmann, in German and French, which clearly state that the type specimen was collected in the Caribbean plains of Costa Rica in December 1881, a date that coincides with the visit of Lehmann to the country from December 1881 to May 1882.

The analytical sketch prepared by Schlechter (in Mansfeld 1929) shows the oblong opening (or "mouth") of the deeply saccate, conical lip, provided with delicate hairs along the lateral margins, which is typical of the species and distinguishes it from the similar *C. integerrimum* Hook.

The illustration in Hoehne's (1945, p. 79, No. II) *Flora Brasilica*, which extends the occurrence of *C. blepharochilum* to Brazil, is simply a rearrangement of Schlechter's original sketch posthumously published in the series of his analytical drawings of new orchid species from the Andean countries, edited by Mansfeld in 1929.

2. *Chondrorhyncha endresii* Schltr., Repert. Sp. Nov. Regni Veg. 17: 14. 1921

Type: Costa Rica. "Ohne nähere Standortsangabe", *A. R. Endrés 166*. Holotype, W 0018830!; drawings of the type and descriptions (W 0018831!); drawings of the flower and details (W 0018833!); Endrés' original description of his collection no. 166 (W 0018832!); copy of Schlechter's sketch of the holotype, with a drawing of the plant habit and analysis of the flower (AMES 00106743!) (Figure 18).

This name is a synonym of *Chondrorhyncha bicolor* Rolfe [≡ *Chondroscaphe bicolor* (Rolfe) Dressler] (Pupulin et al. 2009), a concept based on a Costa Rican collection by Richard Pfau (Type: Costa Rica. Without specific locality, *R. Pfau s.n.*, K). For other synonyms of the species see Pupulin (2010b). Dressler (2001, p. 47) considered *C. bicolor* a "lost species," not corresponding to any other Central American species of *Chondroscaphe*, but several of the anomalous features of this species noted in the protologue are attributable to Rolfe's interpretation of the poorly preserved type specimen, which is indistinguishable from Costa Rican populations treated as *C. endresii* (Pupulin 2010b). When Schlechter (1921a) described the forgotten collection kept in Reichenbach's herbarium, together with Endrés' drawings of the plant habit, the flower, and floral details, he did not suspect that it corresponded with the schematic description of *C. bicolor* provided by Rolfe. The shape of the lip, with its oblong, thick, apically bilobed callus, which Schlechter used to characterize *C. endresii*, is nonetheless identical to that of *C. bicolor*, and the drawing of the rostellum of this species, made by Endrés, clearly illustrates the characteristically ligulate, abruptly introrse stigmatic arms that are typical of *C. bicolor* (Pupulin et al. 2009). Among the materials referable to the type at W is a manuscript name by Reichenbach, who intended to publish the species with the name "*Chondrorhyncha umbonata*", and the name "umbonata", in Reichenbach's handwriting, is noted on an envelope mounted on the type sheet (Pupulin et al. 2011, 2013).

Figure 16. Lectotype of *Catasetum blepharochilum* (G 00168805). Reproduced with the kind permission of the Director, Conservatoire et Jardin botaniques de la Ville de Genève.

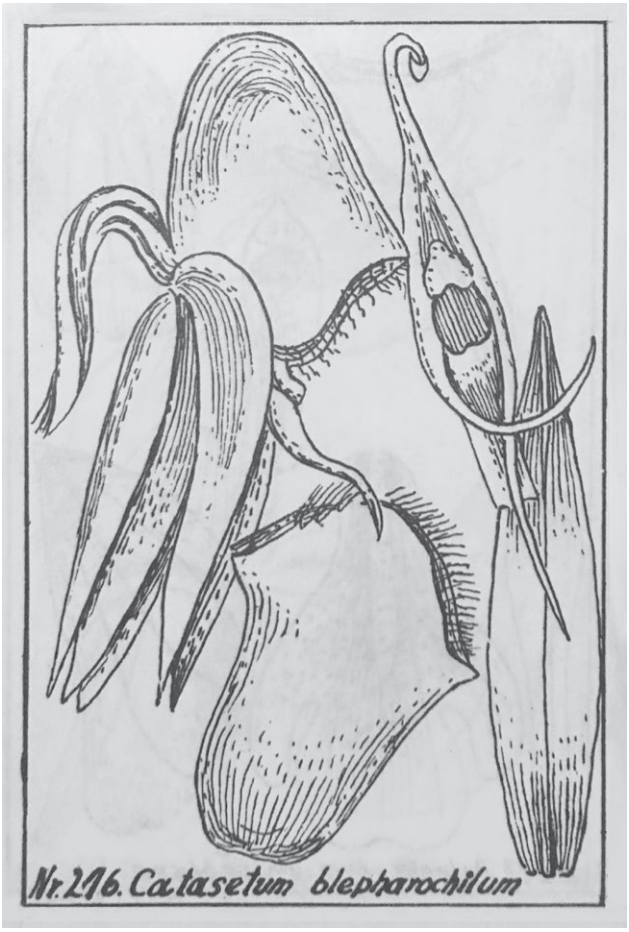

Figure 17. Schlechter's floral analysis of *Catasetum blepharochilum* (in Masfeld 1929: Pl. 56, No. 216).

3. *Chondrorhyncha reichenbachiana* Schltr., Repert. Spec. Nov. Regni Veg. 17: 15. 1921

Type: Costa Rica. "Cataratas, blühend Marz-August", *A.R. Endrés 557*. Holotype, W 0018829 / Rchb.Orch. 49753!; Endrés' drawings of the type and descriptions, W 0018826 / Rchb.Orch. 28550!; floral analysis of the type, originally prepared by Schlechter, published by Mansfeld (1931: Pl. 63, No. 252!); tracing of Schlechter's sketch of the holotype, with drawing of the plant habit and analysis of the flower, AMES 00106751! (Figure 19).

Among the materials that Endrés sent to Reichenbach from Costa Rica was a specimen of an unknown "*Zygopetalum*" with a characteristic dark grey-green foliage and a solitary flower born above the pendent leaves. Reichenbach knew it was a new species, and he annotated the correspondent sheet with the intended name of

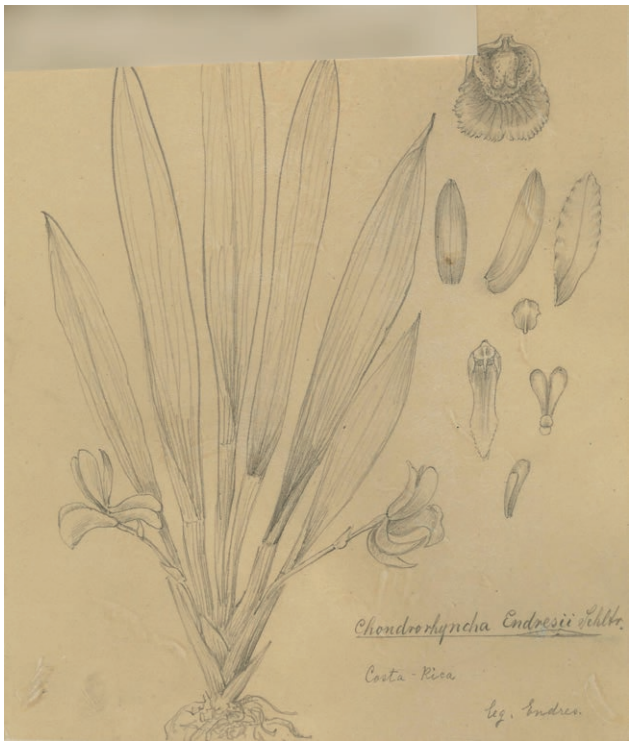

Figure 18. *Chondrorhyncha endresii*, plant habit and analysis of the flower, traced from Schlechter's sketch of the holotype (AMES 00106743). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

"*Chondrorhyncha lamellata*", in allusion to the lamellate callus of the lip. He also used Endrés' accurate sketches to prepare two botanical plates for his *Xenia Orchidacea* (published between 1858 and 1874, and then continued by Fritz Kränzlin until 1900), with the intended names "*Chondrorhyncha lamellata*" and "*Zygopetalum lamellatum*". However, they were never published, and like many other discoveries by Endrés, remained hidden in Reichenbach's herbarium after his death in 1889 (Pupulin 2009). It was only around 1915, just a few months before the beginning of the First World War's hostilities, when Schlechter visited the recently opened orchid collection at the Hof Imperial Museum in Vienna. Here, he found the plant collected 40 years before by Endrés, describing it in 1921 as *Chondrorhyncha reichenbachiana* in honour of his great predecessor.

The large callus that occupies the whole centre of the lip from side to side, noted by Schlechter (1921) in the protologue and his drawing of the type, is diagnostic of the species, which has no close relatives in Central America. The name is the basionym of *Benzingia reichenbachiana* (Schltr.) Dressler.

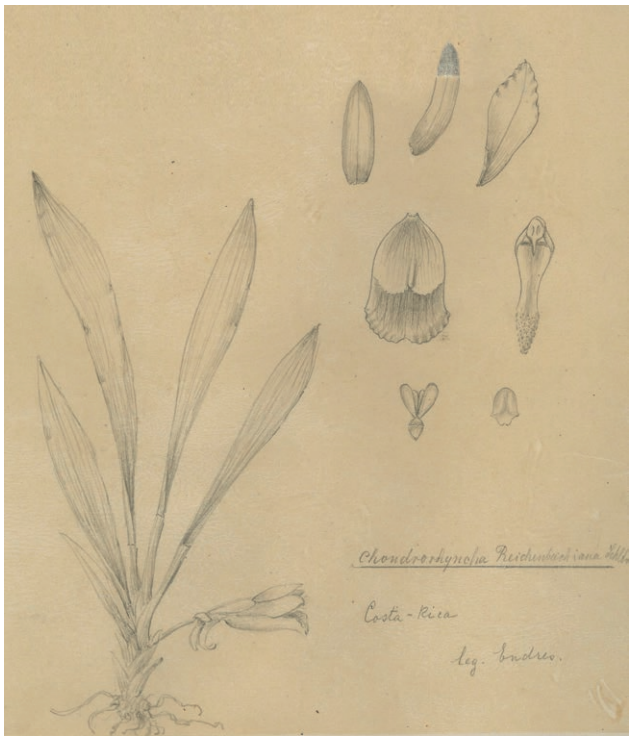

Figure 19. Tracings of Schlechter's original sketch from the holotype of *Chondrorhyncha reichenbachiana* (AMES 00106751). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

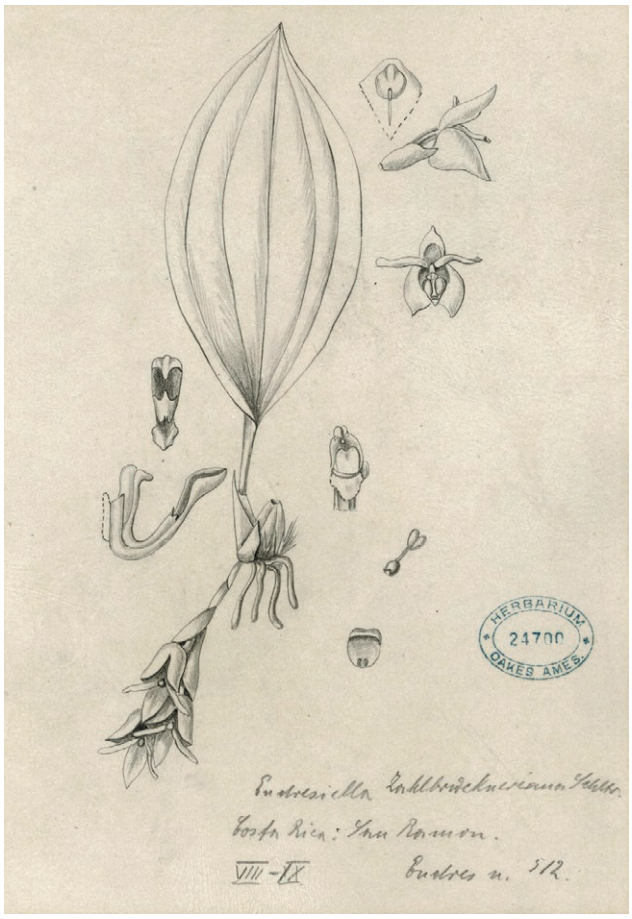

Figure 20. Copy of Schlechter's sketch of *Endresiella zahlbruckneriana* holotype, prepared under his supervision (AMES 99111). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

4. *Endresiella zahlbruckneriana* Schltr., Repert. Spec. Nov. Regni Veg. 17: 14. 1921

Type: "Costa Rica. an der Strasse von San Ramon nach San Carlos, Legua. Blühend im September", *A.R. Endrés 512*. Holotype, W 0019449 / Rchb.f. Orch. 43634!; sketches of the type specimen by Endrés, W 0020711 / Rchb.Orch. 37186!; copy of Schlechter's sketch of the holotype (largely traced on Endrés' drawings), with plant habit and analysis of the flower, prepared under his supervision, AMES 0099111! (Figure 20).

Schlechter created the genus *Endresiella* in 1921 to accommodate a species with the habit similar to a small *Stanhopea* Frost ex Hook., and flowers similar to those of the genus *Schlimmia* Planch. & Linden ex Linden, but smaller. He dedicated the "very excellent new orchid genus to the well-known researcher of the orchid flora of Costa Rica, Endres", noting that his vast collections, together with "marvelously executed drawings", were still largely unpublished in the herbarium of Reichenbach (Schlechter 1921). Schlechter found the imperfect specimen in Reichenbach's Herbarium filed under the genus *Sievekingia* Rchb.f., fortunately, accompanied by excellent and detailed drawings (reproduced in Ossenbach et al. 2013: 316, Figure 316). He dedicated the type species to the Austrian botanist Dr. Alexander Zahlbruckner (1860–1938), curator of the herbarium at the Naturhistorisches Museum in Vienna, then director of the museum's botany department.

The densely packed inflorescence, the white flowers with yellow mesochile and the lateral sepals connate to the middle distinguish the species. This name is the basionym of *Trevoria zahlbruckneriana* (Schltr.) Garay.

5. *Epidendrum cardiophorum* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 9(208–210): 214. 1911.

Type: Costa Rica in dem Wäldern von Tsaki, Talamanca, ca. 200 m, blühend im April 1895, *H. Pittier* [*s.n.*, (*Herb.*

Figure 21. Isolectotype of *Epidendrum cardiophorum* (BR 00000657435). Courtesy of the Meise Botanic Garden Herbarium.

instit. physicgeogr. nat. costaricensis, IFGN)] *9519*. Holotype, B, destroyed; lectotype, designated by Pupulin et al. (2016): CR 9519!; isolectotypes: BR 00000657435! (Figure 21); G 00168668!; US 815035 / 00316361!; copy of Schlechter's drawing of the holotype, made under Schlechter's supervision, AMES (HUH-00070175!).

Pupulin et al. (2016) selected an isotype at CR, which is a complete and fertile specimen in excellent condition, as lectotype (Pupulin et al. 2016 : 289, Figure 17A). As Pupulin et al. (2016) noted, the quote of *Pittier 9519* in the protologue and on the copy of Schlechter's drawing of the type represents a misunderstanding of the numeration system used at the IFGN. The rhizomatous habit with scandent rhizome and stems produced far apart from each other, the ancipitous, short inflorescence, and the small flowers with the part of the perianth less than 1 cm long distinguish this species. *Epidendrum cardiophorum* ranges from Mexico to the northern Andes.

6. *Epidendrum dolichostachyum* Schltr., Repert. Spec. Nov. Regni Veg. 3: 79. 1906

Type: Costa Rica. [San José:] Bei La Palma [1550 m]; blühend im Sep 1896, *H. Pittier* (*10311 Herb. Institut. Costaric.* [Herb. Nac. Costa Rica]). Holotype, B, destroyed [tracing of Schlechter's drawing of the holotype, AMES 00070288! (Figure 22)]. Isotypes: BR 0000006574550!, designated here as the lectotype (Figure 23) (drawing of a flower, AMO, not seen; floral analysis from the type, prepared by Eric Hágsater, CR, two sheets with the same drawings); isolectotype: US, not seen; floral analysis from the holotype, reproduced in Mansfeld (1931: Pl. 49, No. 194!).

Atwood (1989) indicated that the "holotype" of *Epidendrum dolichostachyum* is conserved at CR, but we have not located it. According to Lobo (2003), it was probably never deposited at this herbarium. We found two sheets with copies of a floral analysis of the type of *E. dolichostachyum* prepared by Hágsater; these were probably the materials examined by Atwood (1989).

According to the protologue, *E. dolichostachyum* is morphologically similar to *E. laucheanum* Rolfe, both having narrowly lanceolate, acuminate leaves, a terminal, pendent, many-flowered, racemose inflorescence with ancipitous peduncle, flowers of similar dimensions, with sepals and petals ocher-brown to purplish brown and lime-colored lip, the lip cordate to reniform with incurved sides and recurved at the apex, and the disc with a fleshy costa. Rolfe (1893) described the lip of *E. laucheanum* as having entire margins, while Schlechter (1906b) characterized the lip of *E. dolichostachyum* with subcrenulate margins. However, the flowers on the holotype specimen of *E. laucheanum* (K-000463483) show a lip with minutely erose margins, as previously reported by Santiago and Hágsater (2010). We did not find evidence to separate these taxa, and therefore consider them as conspecific in agreement with Atwood (1989).

Figure 22. *Epidendrum dolichostachyum*, tracing of Schlechter's drawing of the holotype (AMES 70288). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

A specimen collected by A. Tonduz [*10388 Herb. Inst. Fis.-Geogr. Nac.* (BR 0000006573195)] in December 1986, in Alto de Ochomogo (Cartago), Costa Rica, carries an envelope with the annotation: "*H. Pittier 10311* (BR 0000006601348) *Epidendrum dolichostachyum*" (BR-0000006573195), which coincides with the type collection number of *E. dolichostachyum*. Unfortunately, we could not verify that the material contained in this envelope is part of the type of *E. dolichostachyum*.

Figure 23. Lectotype of *Epidendrum dolichostachyum* (BR 0000006574550). Courtesy of the Meise Botanic Garden Herbarium.

7. *Epidendrum hoffmannii* Schltr., Repert. Spec. Nov. Regni Veg. 16: 444. 1920

Type: Costa Rica, [San José:] Curidabal [Curridabat], Mai 1857, *C. Hoffmann 570*. Holotype, W-Rchb.Orch. 51054! (Figure 24); tracing of Schlechter's drawing of the holotype, AMES 70416! (Figure 25).

The comprehensive work by Pupulin and Karremans (2007) revealed a series of details about the history of *E. hoffmannii* that illustrates the taxonomical conundrum in which this species is involved. During his expeditions across Costa Rica, the German physician Karl Hoffmann Brehmer collected two *Epidendrum* plants from the area of "Curidabal" [Curridabat], just a few kilometers outside of the capital city of San José. Deliberately or not, one of the plants was assigned with the collection number *Hoffmann 570*, while the other was left *sine numero*. The plants were sent to Heinrich Gustav Reichenbach, professor of botany and director of the Botanic Gardens at Hamburg University, who probably considered the individuals as belonging to the same species, as he described only one species under the name *Epidendrum ionophlebium*, based on *Hoffmann sine numero* (Reichenbach 1866). The other plant, under field number *Hoffmann 570*, was left to oblivion, until Schlechter had access to the materials sometime around 1915. His eye captured subtle differences between the two individuals and described a new species, *Epidendrum hoffmannii*, based on *Hoffmann 570* (Schlechter 1920). Furthermore, the analysis carried out by Pupulin and Karremans (2007) also revealed that the specimen collected by Hoffmann under his field number 570 and saved at W was mistakenly annotated as *E. ionophlebium*, when it is actually the holotype of *E. hoffmannii*. Apparently, "this specimen is not annotated in Reichenbach's handwriting, and the identification as '*Epidendrum ionophlebium*' was affixed to it when the specimen was mounted in Vienna" (Pupulin and Karremans 2007: 456).

While studying Reichenbach's materials, Schlechter also prepared illustrations of the two *Epidendrum*. Both of these original drawings were destroyed during WWII, but copies prepared under Schlechter's supervision are saved at AMES. This illustration of *E. hoffmannii* distinctly shows a slender plant with ovoid pseudobulbs and narrowly elliptic leaves bearing a short inflorescence with two flowers, characters also seen in the dried specimen. The dissection of the flower displays lanceolate sepals, elliptic petals with acuminate apices, and a lip with a broadly ovate lamina and acuminate apex. These characters, along with the ornate, velvety lip described in the protologue, largely agree with the concept of the widely distributed *Prosthechea chacaoensis* (Rchb.f.) W.E.Higgins and is considered a synonym of the latter.

8. *Epidendrum insulanum* Schltr., Beih. Bot. Centralbl., Abt. 2 36(2): 404. 1918

Type: Costa Rica, [Puntarenas:] Cordon littoral à Wafer Bay, Cocos Island (Pacific Ocean), Jan 1902, *H. Pittier* (*16350 Herb. Nac. Costa Rica*). Holotype, B, destroyed [Schlechter's drawing of the holotype, reproduced in Mansfeld, 1931: Pl. 50, No. 199!; tracing at AMES (HUH 70447!) (Figure 26)]. Isotypes: GR 3580!, selected by Trusty and Blanco (2005) as the lectotype, AMES 73449!; GR 3579! (AMES 73450 / HUH-70446), isolectotype, fruiting (Figure 27); GR 3581! (AMES 73448 / HUH 70445), isolectotype, sterile; CR 16350! (2 sheets), isolectotypes.

Epidendrum insulanum is endemic to Cocos Island, an Oceanic Island situated more than 500 kilometers from the nearest continental point at Cabo Blanco, Península de Nicoya, Costa Rica. On the Island, the species is a common epiphyte in premontane rainforest, where the plants grow on exposed or shady conditions in both shrubs and trees, intermixed with *E. cocoense* (Bogarín et al. 2011). The copy of Schlechter drawing of the holotype well illustrates the single-flowered inflorescences, the erose apex of column lacking the two teeth present in other species of the *Epidendrum ramosum* group, the lateral lobes of the lip that do not cover the apex of column in lateral view, and the triangular callus that runs through the entire lip to form an apical mucro, which are described in the protologue (Schlechter 1918a) and are diagnostic of the species. A modern botanical illustration of *E. insulanum*, based on a living specimen from the island, is provided in Bogarín et al. (2011). Schlechter compared it with *E. repens* Cogn., a species of broad distribution from Mexico to Venezuela and Colombia, and down to Bolivia along the Andes, which also belongs to the *Epidendrum ramosum* group.

9. *Epidendrum paucifolium* Schltr., Repert. Spec. Nov. Regni Veg. 3: 248–249. 1907

Type: Costa Rica. Bei Cuera de Tigre, blühened im Januar 1897, *H. Pittier 10515*. Holotype, B, destroyed. Isotypes: BR 0000006573546!, selected by Santiago and Hágsater (2008) as lectotype (Figure 28); isolectotype: M-0226680!.

Figure 24. Holotype of *Epidendrum hoffmannii* (W-Rchb. Orch. 51054). Courtesy of the Naturhistorisches Museum Wien.

Figure 25. Tracing of Schlechter's drawing from the holotype of *Epidendrum hoffmannii* (AMES 70416). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Figure 26. *Epidendrum insulanum*, tracing of Schlechter's drawing of the holotype at AMES (HUH 70447). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

According to the protologue and type material, *Epidendrum paucifolium* can be distinguished by the combination of non-pseudobulbous stems, 1–2 apical, erect, leaves, oblong to elliptic leaf blades; the apical inflorescence, with ancipitous peduncle, longer than rachis, with 2 tubular, acuminate bracts approximately the same length as the internodes, ancipitous rachis, with concave, lanceolate, perfoliate, acuminate floral bracts, longer than ovary; few-flowered, with 3–4 flowers opened simultaneously, clustered near the inflorescence apex, the slightly extended oblong, acute sepals, recurved margins, obliquely subspatulate, obtuse petals, lip with the ovate, cordate, obtuse, short apiculate, blade; disc with 3 vertical keels extended to near the apex of the lip; the apex of the column with a pair of prominent digitate teeth on the back, and clinandrium with denticulate margins (Schlechter 1907a). It also has fuchsia or magenta flowers with a column basally white (Santiago and Hágsater 2008). *Epidendrum paucifolium* ranges from Costa Rica to the western Panama.

We were unfortunately unable to locate the type locality, "Cuera de Tigre" (or "Cuero de Tigre") on a modern Costa Rican map.

10. *Epidendrum selaginella* Schltr., Repert. Spec. Nov. Regni Veg. 3: 48. 1906

Type: Costa Rica. [San José:] An feuchten Felsen auf dem Recreo, am Wege von Carillo, c. 1200 m, blühend im Juli 1888, *J. Cooper 523*. Holotype, B. destroyed [tracing of Schlechter's drawing of the holotype, AMES 00070862! (Figure 29)]. Isotype: US 579506 / barcode 00093842!, designated here as the lectotype (Figure 30); floral analysis from the holotype reproduced in Mansfeld (1931: Pl. 57, No. 225!).

Epidendrum selaginella belongs to the *Epidanthus* Group characterized by flat leaves, a tiny ligule opposite to the blade, entire lip, and the anther with four poles. The species is distinguished by having thin and apically laterally compressed stems, oblong to ovate, emarginate leaves, flowers congested in the apical third of the inflorescence, papillose ovary, abaxially papillose sepals, and unguiculate lip, with the subdeltate, subcordate and obtuse, blade without a keel. *Epidendrum selaginella* ranges from Costa Rica to central Panama.

Figure 27. Isolectotype of *Epidendrum insulanum* [GR 3581 (AMES 73448)]. Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Figure 28. Lectotype of *Epidendrum paucifolium* (BR 0000006573546). Courtesy of the Meise Botanic Garden Herbarium.

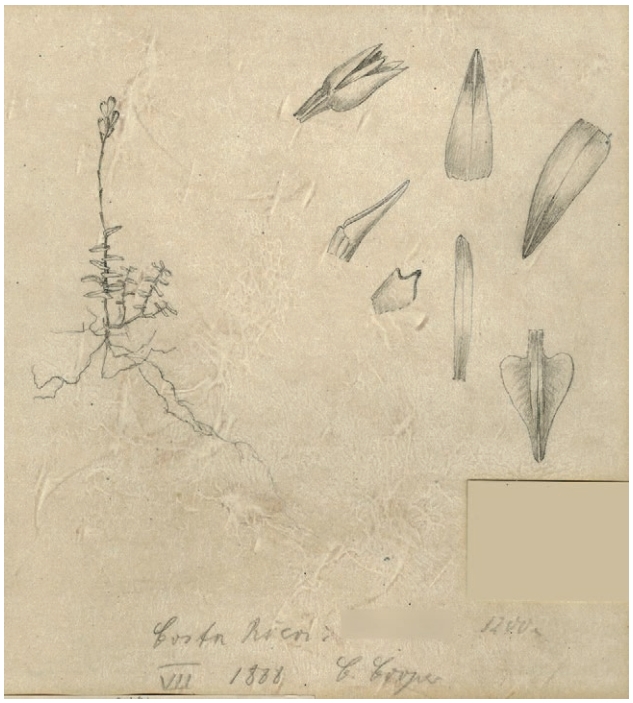

Figure 29. Tracing of Schlechter's drawing from the holotype of *Epidendrum selaginella* (AMES 00070862). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

The sketch of the holotype prepared under Schlechter's supervision includes the plant habit and a floral analysis (Figure 29), the latter reproduced by Mansfeld (1931), clearly showing the diagnostic characters of *E. selaginella*. Three floral drawings that do not belong to the type collection but are instead associated with a collection by Maxon (no. *467*) are placed on the lower-left corner of the sheet of the holotype drawing (AMES 00070862). Schlechter (1906a) stated that the vegetative appearance of this species resembles *Selaginella* P. Beauv., a genus of lithophytic plants, hence its specific epithet.

11. *Epidendrum tenuiflorum* Schltr., Repert. Spec. Nov. Regni Veg. 3: 49. 1906

Type: Costa-Rica. [Cartago:] Bei Aguacaliente, ca. 1300 m; blühend am 2 Jan 1888, *H. Pittier 38*. Holotype, B, destroyed; tracing of Schlechter's drawing of the holotype, AMES 24105 / barcode 00070928!, selected by Mora and Atwood (1992) as lectotype (Figure 31); Schlechter's floral analysis reproduced in Mansfeld (1931: Pl. 58, No. 229!).

Mora and Atwood (1992, t. 1457) designated the tracings of Schlechter's drawing of the holotype (AMES 24105) as the lectotype (cited originally as "type"). This is regarded as a formal lectotypification because the authors indicated by direct citation the term "type" (Art. 7.11) and specified the herbarium where the specimen is kept (Art. 40 note 1). Also, before 1 January 2001, it was not mandatory to include the typification statement phrase "designated here" (*hic designatus)* or an equivalent (Art. 7.11) and "lectotypus", its abbreviation, or its equivalent in a modern language (Art. 9.23) (Turland et al. 2018). Thus, the lectotypification proposed by Santiago and Hágsater (2006) is a superfluous type designation (Art. 10.5). Together with the floral analysis published by Mansfeld (1931), this drawing is the only copy of the original material associated with the protologue of this species. It also includes a sketch of the plant habit that was not included in Mansfeld's compilation. The drawing shows a combination of diagnostic characters consistent with the protologue of *E. tenuiflorum* (Schlechter 1906a), such as the linear leaves and short inflorescence, the trilobed lip provided with short, lanceolate, acute lateral lobes, and a broadly obcuneate, deeply bilobed middle lobe with a tiny apicule, the elongate, shallowly trilobed clinandrium exceeding the column length, with minute lateral lobes and a widely ovate, apiculate middle lobe. It is noteworthy that the lip's lateral lobes were drawn recurved when they are incurved in living flowers, but this is probably because rehydrated material was used to prepare the sketches.

Schlechter (1906a) suggested that *E. tenuiflorum* is morphologically similar to *Epidendrum centropetalum* Rchb.f. (Reichenbach 1852) but differs from the latter by the mostly trilobed clinandrium. However, the two taxa are indistinguishable when comparing the protologues. Therefore, Santiago and Hágsater (2006) consider them conspecific.

12. *Epidendrum urostachyum* Schltr., Beih. Bot. Centralbl., Abt. 2. 36(3): 409-410. 1918

Type: Costa Rica. El Tablazo, près San José, 1900 m, Sept 1913, *E. Jiménez s.n. (n. herb. Nac. Costa Rica 17651)*. Holotype, B, destroyed; traces of the original drawing of the holotype made under Schlechter's supervision, an envelope putatively containing fragments of the holotype, and flowers saved in glycerin, AMES 82254 / barcode 00070965, designated here as the lectotype (Figure 32). Schlechter's drawing of the holotype published in Mansfeld (1931: Pl. 58, No. 231!).

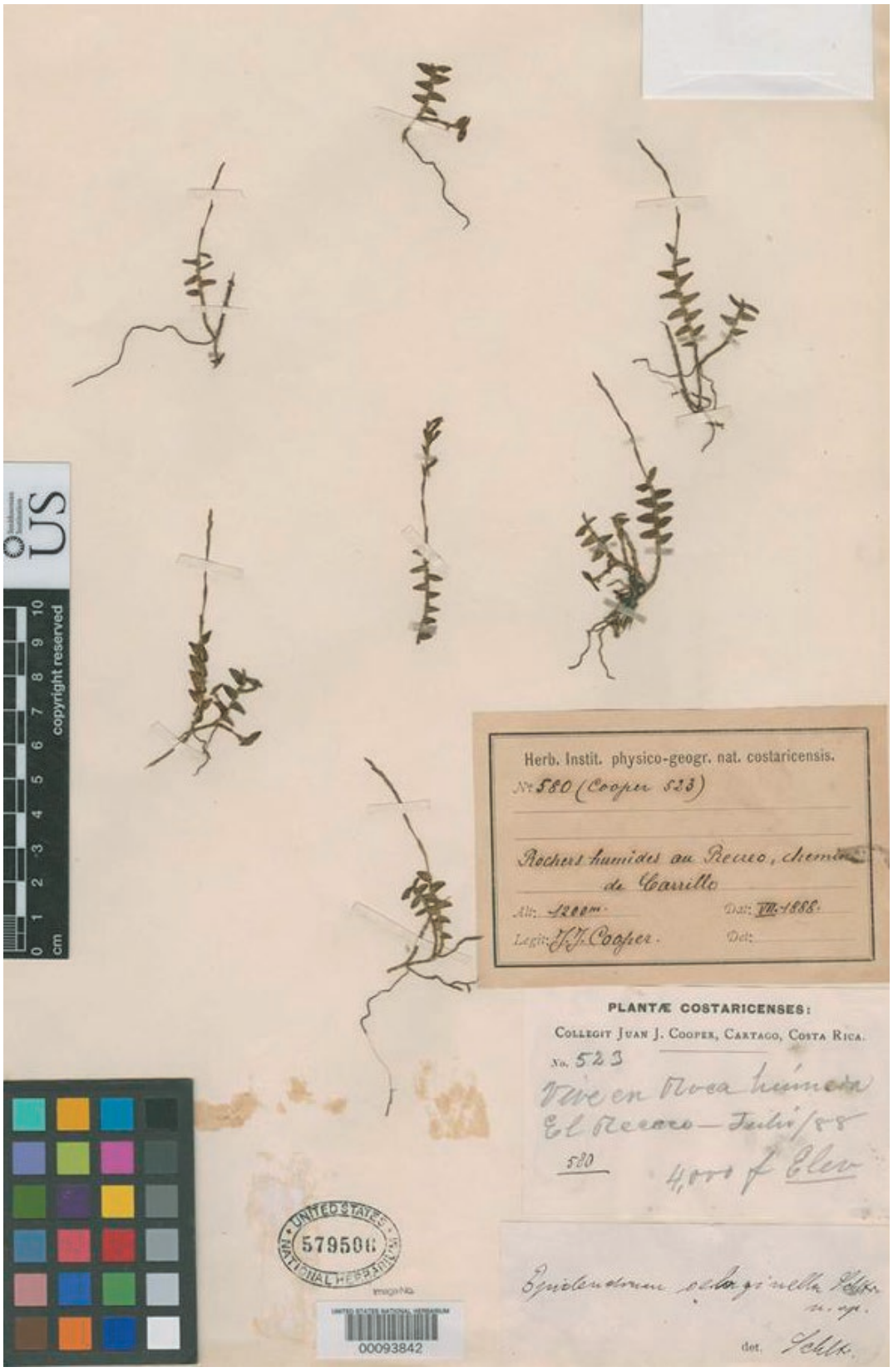

Figure 30. Lectotype of *Epidendrum selaginella* (US 579506). Courtesy of the United States National Herbarium, Smithsonian Institution.

Figure 31. Lectotype of *Epidendrum tenuiflorum* (AMES 24105). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

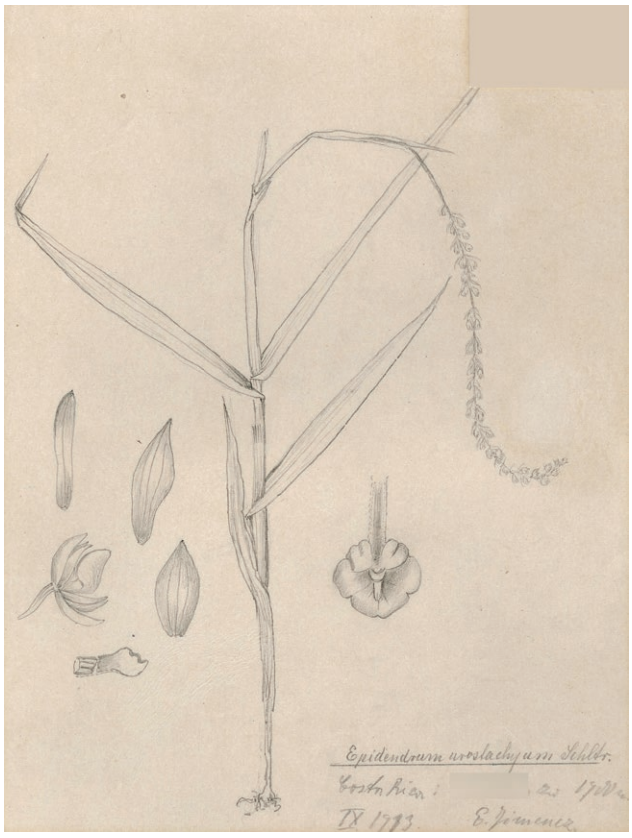

Figure 32. Lectotype of *Epidendrum urostachyum* (AMES 82254). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

The herbarium specimen AMES 82254 is a mixed collection, comprising the tracings of the holotype drawing made under Schlechter's supervision, an envelope supposedly containing "fragments of holotype", and flowers preserved in a separate glycerin collection identified with the same accession number. Since restrictions associated to the COVID-19 pandemic limited our possibilities to confirm and study the contents in the envelope and the glycerin material, we are basing our selection of the lectotype on the tracings of the holotype drawing. The tracings show a slender plant of narrow leaves and hanging inflorescence, which bears flowers with oblong sepals, oblique petals and orbiculate lips. The base of the lip is adnate to the column, while the lamina shows wavy margins and a callus extending to the middle.

Schlechter distinguished *E. urostachyum* from the two morphologically similar species *E. laucheanum* and *E. dolichostachyum* by the smaller flowers and the shape of the lip (Schlechter 1918a). Later, several authors have considered the concept described by Schlechter as *Epidendrum urostachyum* under the synonymy of *Epidendrum laucheanum* (Pupulin 2002, Hágsater 2010, Bogarín et al. 2014), a variable species first found in Popayán, Colombia (Rolfe 1893). *Epidendrum laucheanum* is recognized by a long, hanging inflorescence that arches towards the floor, with ocher-brown flowers and a green to orange or purple lip (Dressler 2003), which largely agrees with the original description and tracings of *E. urostachyum*.

13. *Gongora unicolor* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 19: 299. 1923

Syntypes: Costa Rica. Ohne nähere Standortsangabe (kultiviert im Garten von Mr. C.W. Powell, Panama), *C. H. Lankester s.n.* (B, destroyed). Costa Rica. [Limón:] Las Mercedes, Ebene von Limon, Nov 1921, *F. Nevermann s.n.* (B, destroyed); Schlechter´s floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 62, No. 248!), designated here as lectotype (Figure 33).

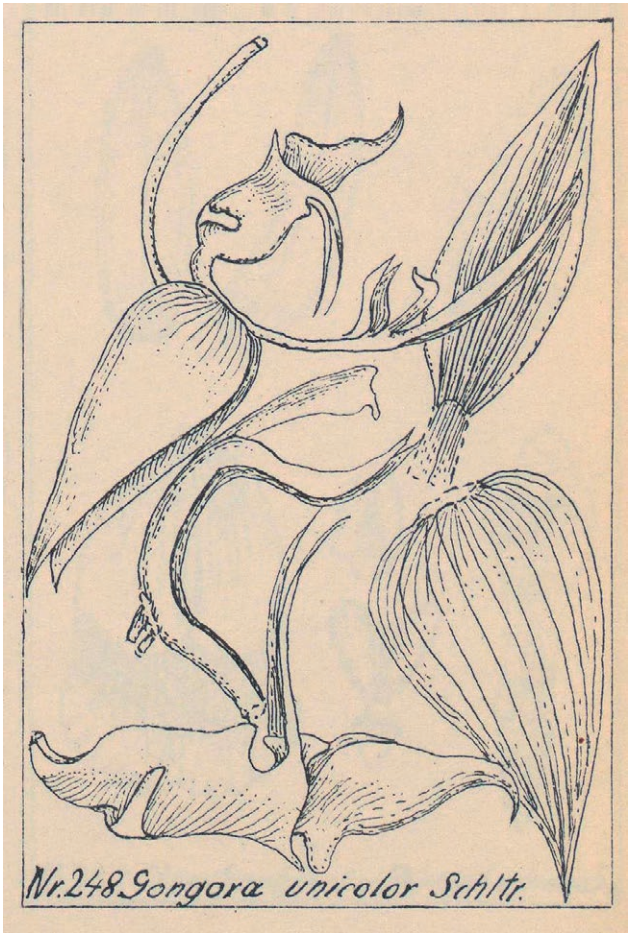

Figure 33. Lectotype of *Gongora unicolor*, in Mansfeld 1931: pl. 62, No. 248.

Epitype, designated here (Figures 34–35): Costa Rica. Heredia: Sarapiquí, Horquetas, road to Rara Avis, deviation point to El Manú, ca. 1 km, 10°19'40" N 83°58'29" W, 120–170 m, tropical rain forest, secondary vegetation and scattered trees along a small river, 27 September 2003. Flowered in cultivation at Lankester Botanical Garden, 16 May 2014, *F. Pupulin, H. León-Páez, C. Ossenbach & B. Arias 4954* (JBL-spirit D0992!); isoepitype: JBL-spirit D0153!.

When publishing *Gongora unicolor*, Schlechter cited two specimens from Costa Rica. One of them was collected by Charles Lankester with no specific locality and cultivated by Powell in Panama. The second one was found by Ferdinand Nevermann, who collected the specimen in the plains of Limón in an area called "Las Mercedes" in the lowlands of the Caribbean watershed. At present, this locality refers to the town of Hamburgo de la Rita, Pococi, Limon, at approximately 50 m in elevation. In the original description, Schlechter failed to declare which of these materials was chosen as the type specimen, and the two specimens must be considered syntypes of *G. unicolor*. Unfortunately, both specimens were lost after the destruction of the Berlin herbarium, and no isosyntypes or other type materials are known. In his "Monograph of the genus *Gongora*", Jenny (1993) cited the drawing reproduced in Mansfeld as an iconotype, but this term is not recognized by the International Code of Nomenclature. In the absence of other materials that can serve for lectotypification, the analytical sketch prepared by Schlechter and reproduced in Mansfeld (1931) is chosen as lectotype. *Gongora unicolor* is a complex species difficult to identify from herbarium materials as the main differences are based on flower color and scent. The immaculate flesh-colored to pale tan flowers with a particular strong scent of either fresh cornmeal (Dressler 1966, 2003) or "unpleasant odour" (Atwood 1987) are the main identifying characteristics of this species. Although not diagnostic, other characters as the distinctively concave base of the lip and the presence of a narrow groove running dorsally from near the base of the lip, are useful to distinguish this species in herbarium material.

The lectotype of *G. unicolor* only shows some floral characters and is taxonomically ambiguous, as it does not allow unequivocal interpretation of the features which are diagnostic of this taxon. Therefore, to favor the interpretation of the lectotype in accordance with Art. 9.9 of the International Code (Turland et al., 2018), we designated as epitype a specimen that was collected in the vicinity of the type locality of *Gongora unicolor*.

14. *Habenaria jimenezii* Schltr., Beih. Bot. Centralbl., Abt. 2. 36(2): 372. 1918

Type: Costa Rica: Río Virilla, Nov. 1912, *O. Jiménez 631*. Holotype: B, destroyed; copy of Schlechter's sketch of the holotype, with a drawing of the plant habit and analysis of the flower, designated here as lectotype, AMES 24314! (Figure 36); Schlechter´s floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 3, No. 10!).

Schlechter´s floral analysis of the holotype reproduced in Mansfeld (1931), and the copy of Schlechter's sketch of the holotype with the drawing of the plant habit at AMES, are the only original material associated with *Habenaria jimenezii*.

According to Pupulin (2002), *H. jimenezii* is a synonym of *Habenaria eustachya* Rchb.f., a species described by Reichenbach in 1885 and distinguished by the oblong

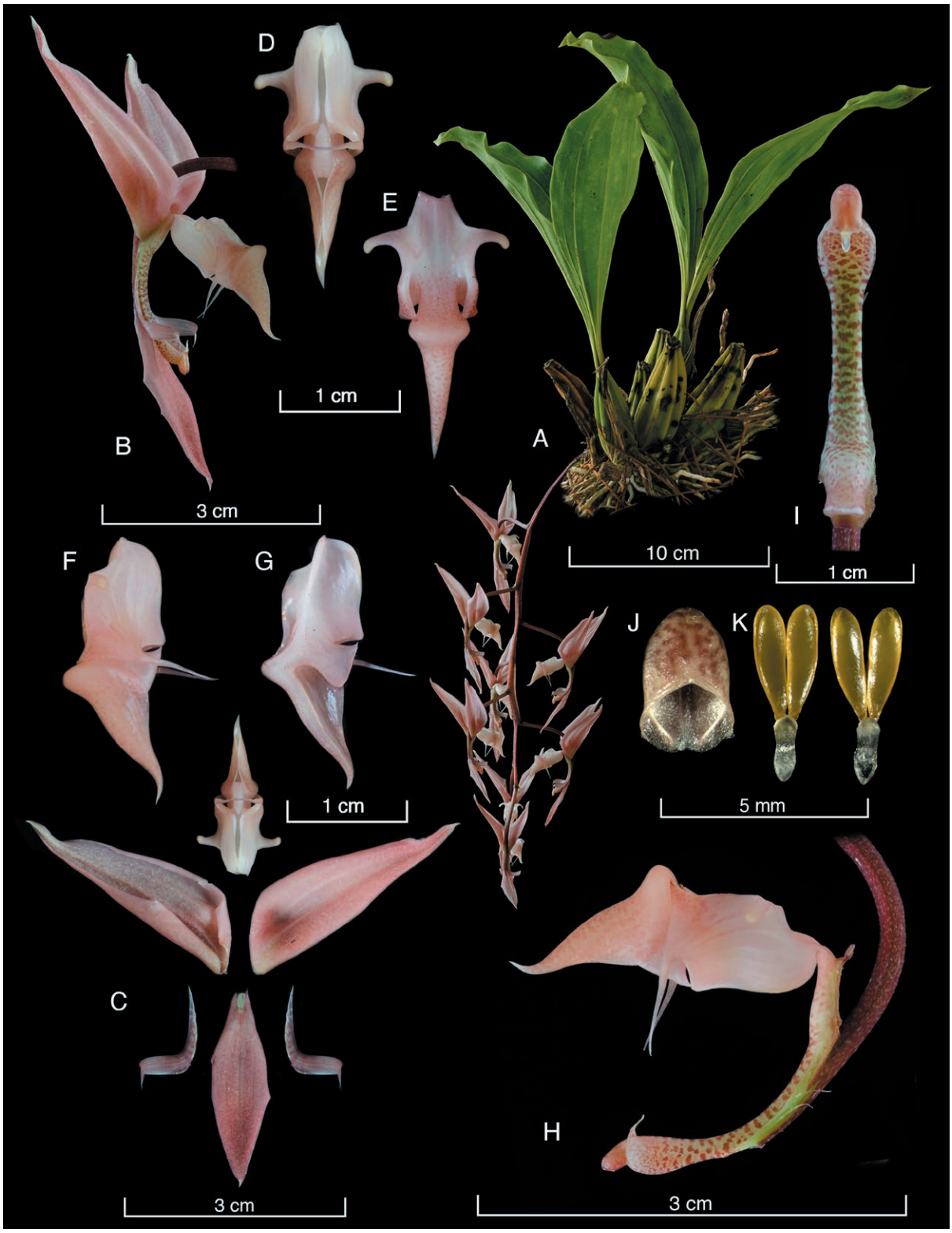

Figure 34. Lankester Composite Dissection Plate of the epitype of *Gongora unicolor* (JBL-spirit D0992). **A**, habit. **B**, flower. **C**, Dissected perianth. **D**, lip, ventral view. **E**, lip, dorsal view. **F**, lip, lateral view. **G**, lip, longitudinal section. **H**, ovary, column and lip, lateral view. **I**, column, ventral view. **J**, anther cap. **K**, pollinarium, ventral and dorsal views. Digital composition by D. Bogarín and F. Pupulin, Lankester Botanical Garden.

Figure 35. *Gongora unicolor*. Photograph of a flower from the epitype (JBL-spirit D0992). Photo by F. Pupulin, Lankester Botanical Garden.

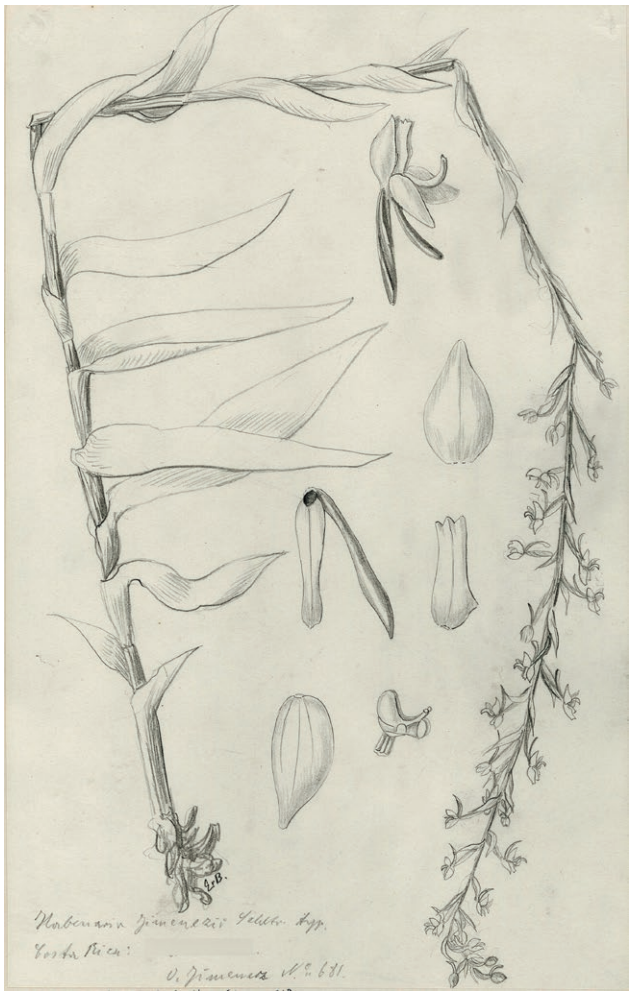

Figure 36. Lectotype of *Habenaria jimenezii* (AMES 24314). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

petals with a bi- or tri-dentate apex and the entire and ligulate lip. *Habenaria jimenezii* was described as similar to *Habenaria odontopetala*, a species with a tri-dentate apex, but according to the author, it differs from the latter by having a vigorous habit, longer flowers, and tridentate petals with an angled margin at the base. The previously mentioned characters of the petals of *H. jimenezii* are well illustrated in the floral analysis of the holotype reproduced in Mansfeld (1931).

15. *Hexadesmia jimenezii* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 19: 293. 1923

Type: Costa Rica. Ohne nähere Standortsangabe, *O. Jiménez s.n. (com. Tonduz)*. Holotype, B, destroyed; photo of the holotype sheet with Schlechter's floral analysis, designated here as lectotype, AMES 00100294! (Figure 37A–B).

(≡) *Scaphyglottis spathulata* C. Schweinf., Bot. Mus. Leafl. 10(2): 28. 1941, *nom. subst., non Scaphyglottis jimenezii* Schltr. 1918.

The photograph of the type sheet that we choose as lectotype specimen did not bear the "Herbarium Berolinensis" stamp. It was taken in Rudolf Schlechter's herbarium before it was deposited at the Botanical Museum of Berlin-Dahlem, where it was eventually destroyed. The type sheet did include four stems, three of which had leaves and one was fertile. It also included the floral analysis made by Schlechter of the flower used for the original description. The plants with a small habit, provided with stipitate pseudobulbs and elliptic-ovate leaves (unique in the species of the genus in Costa Rica) are unmistakable. The drawing made by Schlechter illus-

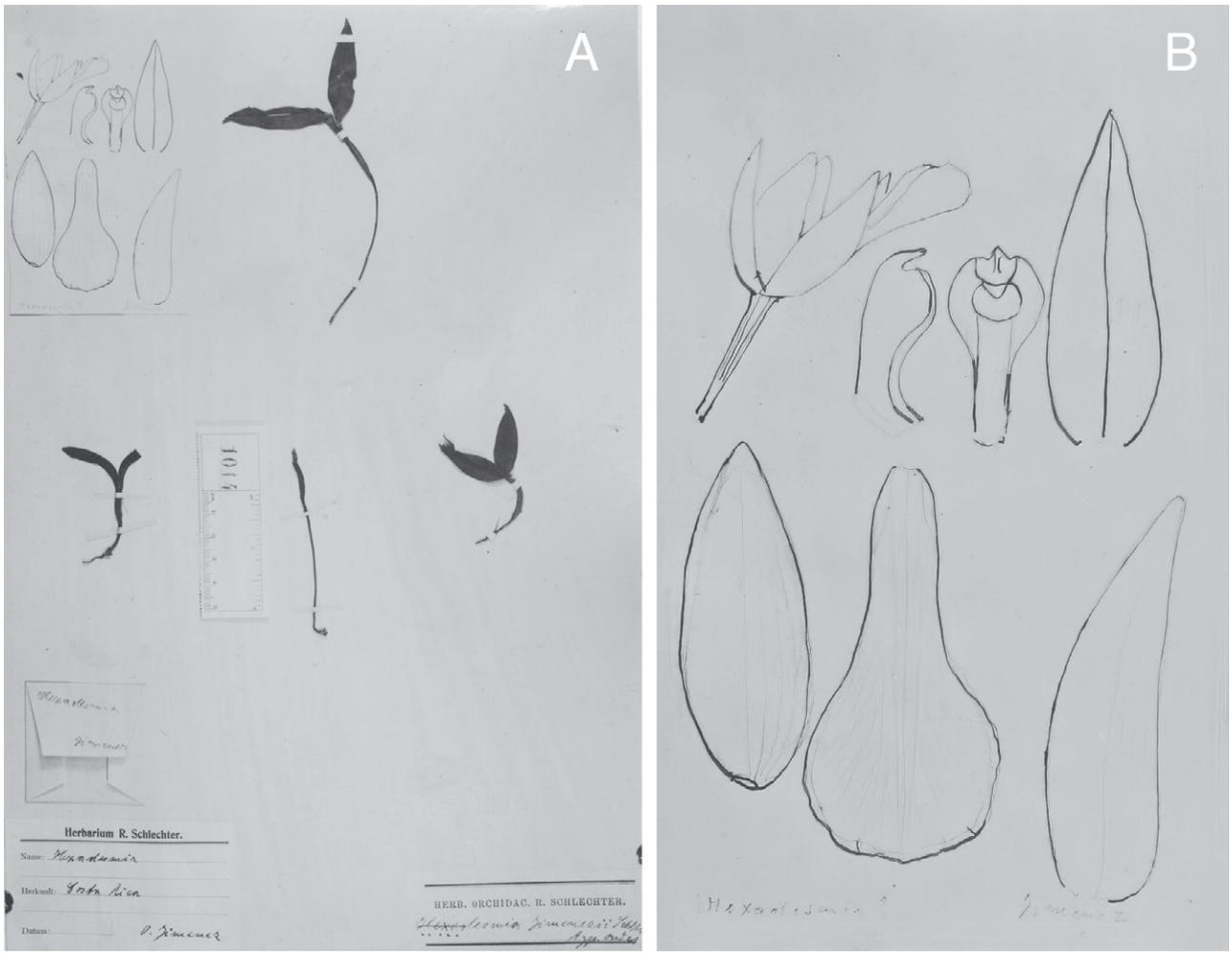

Figure 37. Lectotype of *Hexadesmia jimenezii*. **A**, photograph of the holotype sheet in Schlechter's herbarium, Berlin. **B**, detail of Schlechter's analytical sketch.

trates the cuneate-obovate (spathulate) lip with its long claw and the suborbicular blade, which are described in the protologue (Figure 37B).

Besides the photograph of the type specimen in Schlechter's herbarium, the sheet at AMES also includes a Panamanian collection allegedly from the Panama Canal Zone and flowered in the Botanical Garden of Montreal. It is not part of the type material and is therefore excluded by the lectotype as here selected.

When the species is treated as a member of the genus *Scaphyglottis*, the name is blocked by *Scaphyglottis jimenezii* Schltr. [Beih. Bot. Centralbl., Abt. 2. 36(3): 399. 1918. Type: Costa Rica. La Palma, near San José, 1700 m, Apr 1910, *C. Wercklé 682* (holotype at B, destroyed; lectotype designated by Pupulin 2010a, p. 147)]. For this reason, Schweinfurth (1941) created the new substitute name (*nomen novum*) *Scaphyglottis spathulata*. He compared it with *Scaphyglottis lindeniana* Lindl., doubting that it could even be conspecific (Schweinfurth 1941). The plants of that species are much larger (approx. 10 cm vs. 30 cm), with long pseudobulbs which are distinctly thickened in the terminal third. The inflorescence usually bears several (5–10) flowers at once (vs. 1–3 in *S. spathulata*).

16. *Kefersteinia costaricensis* Schltr., Beih. Bot. Centralbl. 36: 413. 1918

Type: Costa Rica: colline vers le Rio Chirripó, 300 m, Jan. 1900, *H. Pittier 16058* (Holotype, B, destroyed; lectotype, designated by Mora and Atwood (1993), copy of Schlechter's drawing of the holotype at AMES 24761! (HUH 100386) (Figure 38); tracing reproduced in Mansfeld (1931: Pl. 63, No. 250!).

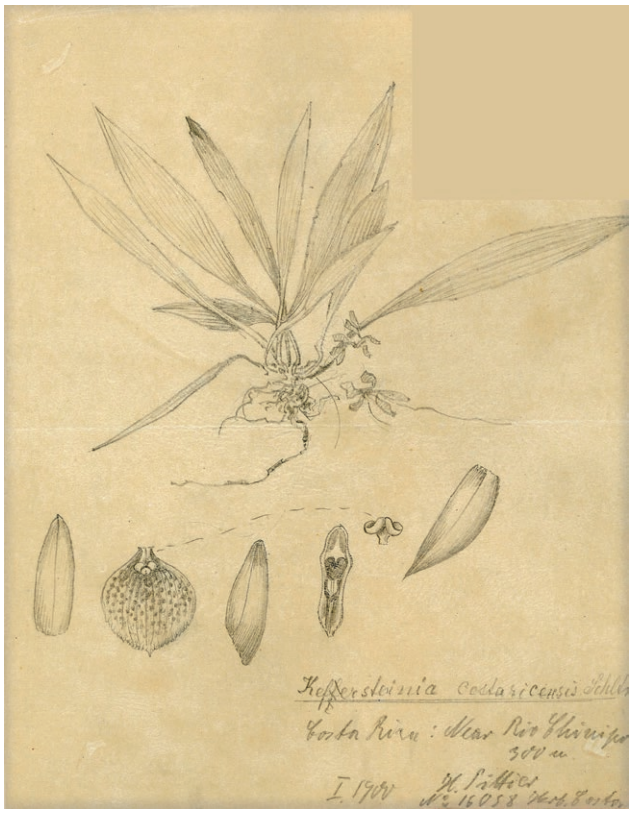

Figure 38. Lectotype of *Kefersteinia costaricensis* (AMES 24761). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

No extant type material of the species is known to exist. Mora and Atwood (1993: 1359) selected the copy of Schlechter's drawing of the holotype at AMES as the lectotype. This designation was achieved before 1 January 2001 (Art. 7.11, of the Shenzhen Code (Turland et al. 2018) in a "non-explicit manner" (Prado et al. 2020; see above the discussion on *Epidendrum tenuiflorum*). The drawing consists of a plant habit, a dissection of the perianth, a detail of the callus, and a front view of the column. In the protologue, Schlechter (1923) described the species with spotted flowers, the stipitate, 3-scutellate callus on the lip, and the column with a high keel, which is consistent with the lectotype. The adaxial view shows a 3-scutellate callus, but the same organ's frontal view agrees with Costa Rican material of this species as discussed by Pupulin (2010b).

Kefersteinia costaricensis differs from other Mesoamerican species by the fleshy, flat, obovate-subquadrate lip with slightly undulate margins and the short tooth well apart from the stigma formed by the keel under the column. The species is restricted to the Caribbean watershed of Nicaragua, Costa Rica, and Panama. It is similar to *Kefersteinia orbicularis* Pupulin, which is limited to the Pacific watershed of Costa Rica, but differs in the orbicular lip, folded down at middle (vs. obovate lip, not folded down at middle in *K. costaricensis*). *Kefersteinia saccata* Pupulin is also similar, but can be distinguished by the saccate lip (vs. flat) (Pupulin 2010b). *Kefersteinia costaricensis* is the basionym of *Chondrorhyncha costaricensis* (Schltr.) Allen.

17. *Lepanthes jimenezii* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 19: 281. 1923

Type: Costa Rica. Ohne nähere Standortsangabe, *O. Jiménez s.n.* Holotype, B, destroyed; tracings of Schlechter's drawing of the holotype, AMES 31565!, based on *O. Jiménez s.n.*, annotated as lectotype by C. Luer on the herbarium sheet and effectively designated by Pupulin and Bogarín 2010 (excluding the specimen *A. Brenes 306* mounted on the same sheet; photo therein). Figure 39.

The drawings designated as lectotype are the only known material referable to this species that can be associated with the protologue after the destruction of Schlechter's material. The flower analysis clearly shows the sepals provided with ciliate margins and short apical tails, the connectives of the lip bearing the blades no higher than the column, and the narrowly oblong upper lobe of the petals, which are typical of the species. Other diagnostic features of *L. jimenezii* are the glabrous inflorescence, the ciliate petals, and the connectives of the lip that embrace the column, hidden by the blades.

Lepanthes jimenezii belongs to a small group of species distinguished by the plants with hispid ramicauls

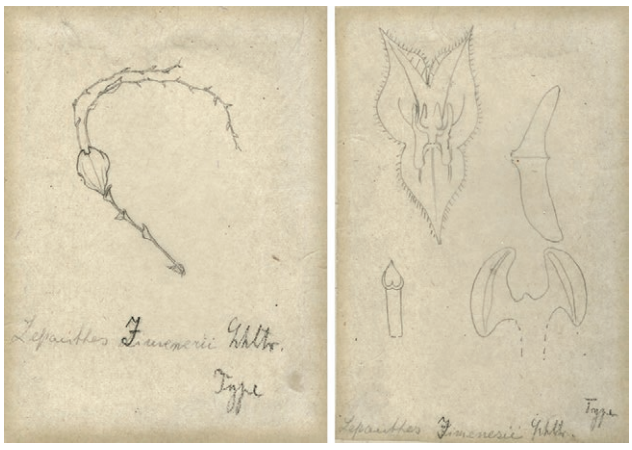

Figure 39. Lectotype of *Lepanthes jimenezii* (AMES 31565). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

and suborbicular leaves, the inflorescences much larger than the leaves and provided with ciliate bracts, the muriculate ovary, the suborbicular to orbicular, ciliate blades of the lip, and the column with distinct apical arms. Species of this group have so far been found only in Costa Rica and Panama. The three species recorded for the flora of Costa Rica have been revised and illustrated by Pupulin and Bogarín (2010).

Due to a mistake in the protologue, *Lepanthes crossota* Luer (1987) is indistinguishable from the copy of Schlechter's drawing of the type of *L. jimenezii*, while the species from Panama that Luer originally intended to describe with the name *L. crossota* (*Luer* 11630, MO!) was eventually described as *Lepanthes caroli-lueri* Bogarín and Pupulin (2010).

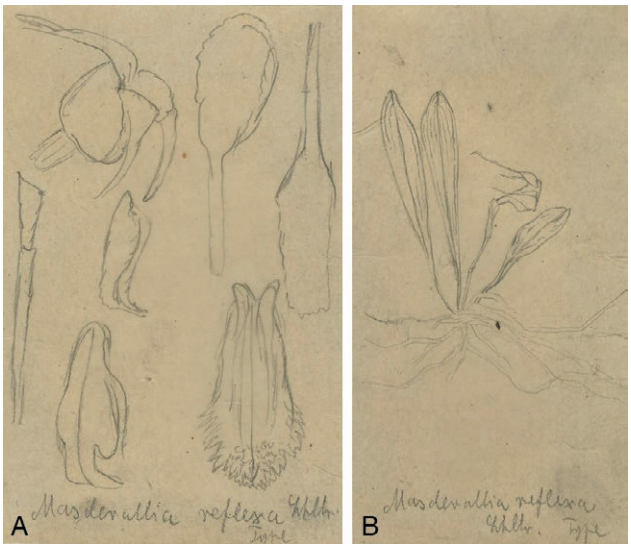

Figure 40. Lectotype of *Masdevallia reflexa* (AMES 31612). **A**, floral analysis. **B**, plant habit. Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

18. *Masdevallia reflexa* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 19: 276. 1923

[non *Masdevallia reflexa* Misas (1977) = *Masdevallia misasii* Braas (1982)].

Type: Costa Rica. [Heredia]: Forêts de Rancho Flores, 2000 m. Février, 1891, *H. Pittier, 2011*. Holotype, B, destroyed; tracing of Schlechter's drawings of the holotype, designated here as lectotype, AMES 31612 / HUH 00101299! (Figure 40A–B).

The drawing based on the holotype, prepared under Schlechter's supervision (Figure 40), shows a combination of diagnostic characters that are consistent with the protologue of *M. reflexa* (Schlechter 1923d), including the narrow, oblanceolate, and obtuse leaves, the narrow petals towards the base and apex, and the oblong outline of the lip, which is gradually wider towards the apex, 2-keeled in the lower half, the margins deeply lacerate to dentate in the apical third, and the apex verrucose.

Schlechter (1923d) suggested that *M. reflexa* is morphologically similar to *M. cupularis* Rchb.f., but *M. reflexa* is distinguished by having narrower and thicker leaves, shorter ramicauls, smaller flowers, apically narrower petals, and the margins of lip deeply lacerate to dentate in the apical third. Nevertheless, Mora and Atwood (1993) and Luer (2000), considered *M. reflexa* conspecific with *M. cupularis*. When comparing the protologues (Schlechter 1923d; Reichenbach 1866), these taxa seem indeed different, as stated by Schlechter (1923d), because in *M. reflexa* the petals are narrow at both ends, acute (vs. obtuse, emarginate at the apex), and the lip is wider apically, with spreading margins, deeply lacerate to dentate in the apical third (vs. narrower, due to the incurved margins, fimbriate in the apical third), and with two basal keels (vs. ecarinate). However, these differences could be an artifact of the dehydrated flower tissue studied by Schlechter when preparing the description and drawing of the type of *M. reflexa*.

According to their protologues, *Masdevallia odontochila* Schltr. (1910c) and *M. reflexa* (Schlechter 1923d) have the same collecting data, both coming from the Rancho Flores Forest (on the southern slope of the Barva Volcano) and attributed to *Pittier 2011*. The references to the two collections differ in the collecting dates and elevations, as the type of *Masdevallia odontochila* was collected in February 1890, at 2043 m elevation, whereas the type of *M. reflexa* was collected in February 1891, at 2000 m elevation (Schlechter 1910c, 1923d). Even though at first glance it seems that *M. reflexa* was described based on the type of *M. odontochila*, the different collecting dates prevent considering the two names homotypic as stated by Mora and Atwood (1993).

The specimen associated with *Pittier 2011* at the National Museum of Costa Rica (CR 2011) is effectively an isotype of *M. odontochila*. The drawings based on the holotypes of *M. odontochila* (AMES 00101287) and *M. reflexa* (AMES 00101299), prepared under Schlechter's supervision, do not have annotations or any reference to vouchers suggesting that they come from the same collection. Undoubtedly, the illustrator that Rudolf Schlechter hired on request by Oakes Ames to trace his type drawings (Ames 1944) had access to the holo-

types of both *M. odontochila* and *M. reflexa*, as he prepared traces of the two specimens. We must not forget that the IFGN used to assign the same number to what they considered specimens belonging to the same taxon and the result of the same collecting "act". The similarity between the two species of *Masdevallia* and the near-identity of the collecting locality, conspired to assign the same *Pittier 2011* number to specimens that in reality belong to two different collections.

19. *Maxillaria stenostele* Schltr., Beih. Bot. Centralbl., Abt. 2, 36(2): 414. 1918

Type: Costa Rica [Heredia]: río Sucio, 300 m, Mar 1882, *F. C. Lehmann 1236*. Holotype, not found; tracing of Schlechter's drawing of the holotype (AMES-24786 / HUH 00101518!), designated here as lectotype (Figure 41); Schlechter's drawing of the holotype, reproduced in Mansfeld (1931: Pl. 65, No. 261!).

Maxillaria stenostele was collected by Lehmann at the beginning of 1882 on the Atlantic lowlands surrounding the Río Sucio, one of Costa Rica's largest rivers. Unfortunately, the holotype of *M. stenostele* was not located in any of the herbaria that may have historically served as the type repository, and no other type materials are known. The copy of the Schlechter's sketch of the holotype preserved at AMES is here chosen as the best reference material to represent the concept of this species. The drawing includes a detailed portrait of the plant's main stem covered with long bracts, as well as a complete dissection of the flower showing the distinctively long column. In fact, *Maxillaria stenostele* was recognized as a new species based on the narrow lip and the slender column. It was later included under the concept of the common and variable *Maxillaria uncata* Lindl. by Atwood and Mora (1999). This is a species recognized by fleshy leaves, whitish to lavender flowers with purple nerve lines and comparatively long column-feet, as well as large pollinaria with long stipes, all characters in accordance with the original description of *M. stenostele*. Szlachetko et al. (2006) proposed the segregation of *Maxillaria* Ruiz & Pavón section *Urceolatae* Christ. into a new generic concept, *Christensonella* Szlach., Mytnik, Górniak & Śmiszek, in which *Maxillaria uncata* was included. The proposal was based on a series of morphological features that include scale-covered, fusiform pseudobulbs, short inflorescences bearing one flower, and a massive, short column-foot (Szlachetko et al. 2006), with which features *M. uncata* agrees.

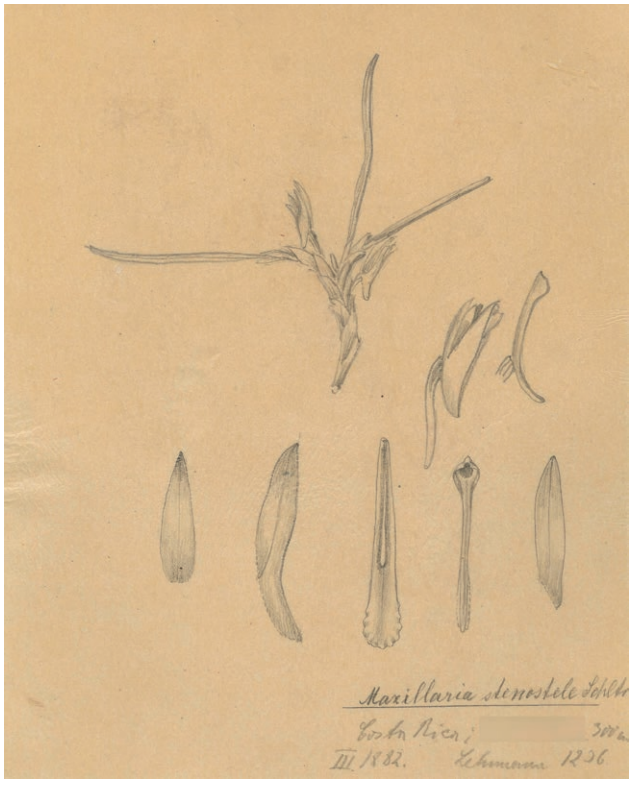

Figure 41. Lectotype of *Maxillaria stenostele* (AMES 24786). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

20. *Maxillaria turialbae* Schltr., Beih. Bot. Centralbl. 36(2): 414–415. 1918

Type: Costa Rica. [Cartago]: Im Turialba-Tal, Jan 1882, *F.C. Lehmann 1098*. Holotype, not found, indicated by Atwood (1989) as destroyed in B; lectotype (first-step), designated by Blanco (2013); lectotype designated here (second-step), G 00414322! (Figure 42); isolectotypes, two without catalogue number, G!; US 00457209!; drawing of the plant habit and floral analysis based on the holotype, AMES 24789!.

When Schlechter described *Maxillaria turialbae* in 1918, he compared it to *Maxillaria aciantha* Rchb.f. However, the first is easily distinguished by the greenish to whitish flowers (*vs.* sepals and petals reddish to orange, and lip dark red). Schlechter (1923d) subsequently realized that *Maxillaria turialbae* is a conspecific with *M. friedrichsthalii* Rchb.f., or *Rhetinantha friedrichsthalii* (Rchb.f.) M.A.Blanco *sensu* Blanco et al. (2007). As is common in *Rhetinantha*, plants of this species have oblong, ridged, bi-, or tri-foliate pseudobulbs separated

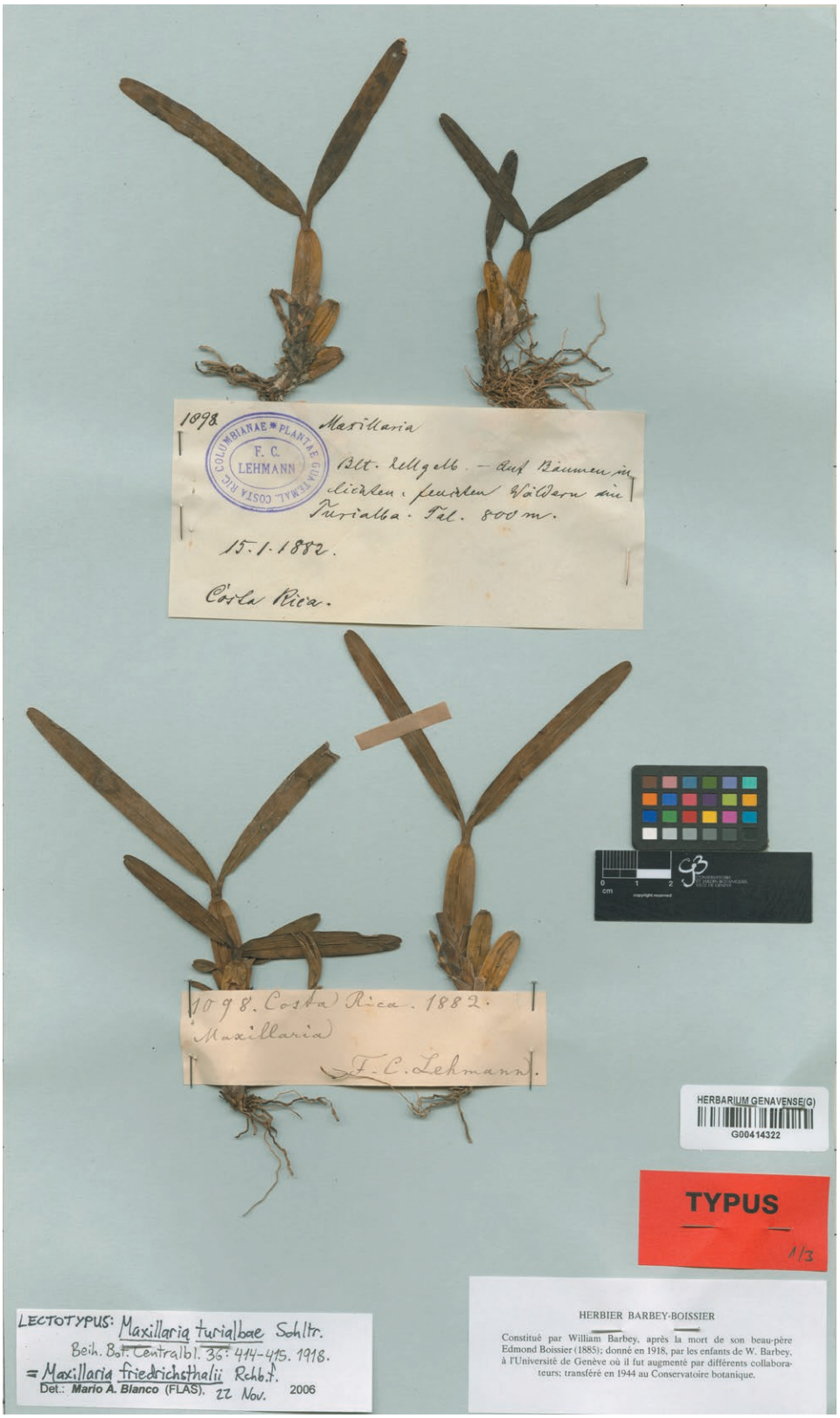

Figure 42. Lectotype of *Maxillaria turialbae* (G 00414322). Reproduced with the kind permission of the Director, Conservatoire et Jardin botaniques de la Ville de Genève.

by an elongated rhizome covered by overlapping scarious bracts. *Maxillaria turialbae* is also similar to *M. scorpioidea* Kraenzl. Both have greenish flowers and often present a lip with maculate margins, but the latter has distinctly larger plants and flowers (Atwood 2003).

In 1989, Atwood cited the holotype of *M. turialbae* as having been destroyed in B and the drawing of the holotype preserved at AMES, which may be considered a "non-explicit designation" of a lectotype. Later, Blanco (2013) found part of the original material of this species at Geneva herbarium and designated a lectotype. Blanco (2013) did not mention any article of the ICN in his discussion of the designation, but probably did it following Art. 9.12 and 9.19 (ICN; Turland et al. 2018). After studying the material at G, three isotypes of F.C. Lehmann 1098 were found, but two of them are currently labeled as "Lectotypus", and only one bears an herbarium code (G00414322, Figure 40). Since the collection of *F.C Lehmann 1098* at G currently corresponds to more than one specimen, besides that two of them are indicated as lectotype, a second-step lectotypification is proposed here to specifically designated one of them as lectotype based on Art. 9.17 (ICN; Turland et al. 2018).

21. *Microstylis carpinterae* Schltr., Beih. Bot. Centralbl., Abt. 2, 36(3): 381. 1918

Type: Costa Rica: Forêts de la Carpintera, Aug. 1891, *H. Pittier & A. Tonduz* (*4394 Herb. Institut. physico-geogr, nat. costaric.* [Herb. Nac. Costa Rica]). Holotype, B, destroyed; isotype, US (814603 / 00093456!), annotated on the sheet by I. F. Chinchilla, 2019, and designated here as lectotype (Figure 43); Schlechter's drawing of the holotype, reproduced in Mansfeld (1931: Pl. 14, No. 55). Figure 44.

The species is distinguished, among other pseudobulbous *Malaxis* with bifoliate pseudobulbs, by the sagittate, apically three-toothed lip with short, triangular, rounded lateral lobes, and the lip cavity with a low, thick keel. The sketch based on the holotype prepared by Schlechter and posthumously published in Mansfeld (1931) clearly illustrates the critical characters of the species (Figure 44). Schlechter (1918a) compared *M. carpinterae* with *M. hastilabia* Rchb.f., but the lip of the latter is hastate, with recurved, uncinate lateral lobes, and a much larger cavity. The name is the basionym of *Malaxis carpinterae* (Schltr.) Ames (Orchidaceae 7: 157. 1922).

22. *Mormodes lobulata* Schltr., Repert. Spec. Nov. Regni Veg. 8: 456. 1910

Type: Costa Rica. Bei Cañas Gordas, blühend im Februar 1897, *H. Pittier 11147* (Holotype, B, destroyed; isotypes, US 577405 / barcode 00036958!; US 815002 / Barcode 00023496, not seen; BR, not seen; CR, barcode CR 11147!; copy of Schlechter's drawing of the holotype at AMES 24414 / HUH 101809!). Figure 45.

We located two possible isotypes of *M. lobulata* in the electronic databases of the US herbarium and one at BR (cited in Tropicos database www.tropicos.com but not in BR database http://www.botanicalcollections.be) which would be good candidates for lectotypification. Another isotype was located at CR and consists of a small pseudobulb without flowers (CR 11147). Therefore, we do not formally designate a lectotype for *M. lobulata* because we have been unable to access three isotypes (BR and US) and the one at CR is sterile. According to the Tropicos database, the name will be lectotypified by Salazar (ined.) in *Flora Mesoamericana* with the specimen at BR.

In addition, a tracing of Schlechter's sketch from the holotype is kept at AMES 24414 / barcode HUH 101809. It shows the dissected perianth, the front view of the column, and the pollinarium and anther cap (Figure 45). Schlechter (1910a) described the species with lanceolate-ligulate, acute, glabrous sepals and petals, the lip as basally unguiculate, widely cuneate-subreniform, truncate with an ovate, shortly acuminate middle lobe, the column with an acuminate clinandrium, and the pollinarium with a wide oblong-subquadrate stipe and cucullate, subcaudate-acuminate anther cap. These features agree with the copy of Schlechter's drawing of the type.

Mormodes lobulata differs from other Central American species of the genus by the glabrous, clearly 3-lobed lip, broad lateral lobes, and a narrower, acute midlobe with an incurved apex. It is restricted to the Pacific watershed of Costa Rica and western Panama (Dressler 2003).

23. *Notylia pittieri* Schltr., Beih. Bot. Centralbl., Abt. 2. 36(3): 418 (1918)

Type: Costa Rica. [Puntarenas:] Sur les *Crescentia* à Boruca, [466 m] III. 1892, *H. Pittier* (*6850* [*Herb. Instit. physico-geogr. nat. costaricensis*; currently Herb. Nac. Costa Rica]). Holotype, B, destroyed [tracing of Schlechter's drawing of the holotype, AMES 24886 / HUH 00101923! (Figure 46)]. Isotypes: AMES 00083037, a flower conserved in glycerine; BR 0000006572525!, designated here as lectotype (Figure 47); Schlechter's draw-

Figure 43. Lectotype of *Microstylis carpinterae* (US 814603). Courtesy of the United States National Herbarium, Smithsonian Institution.

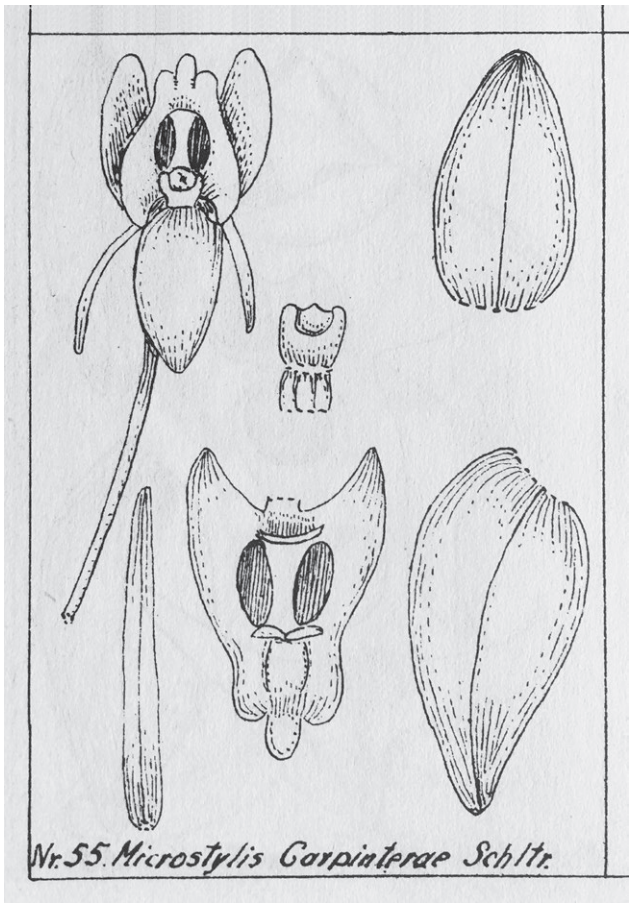

Figure 44. Schlechter's drawing from the holotype of *Microstylis carpinterae*, reproduced in Mansfeld (1931: Pl. 14, No. 55).

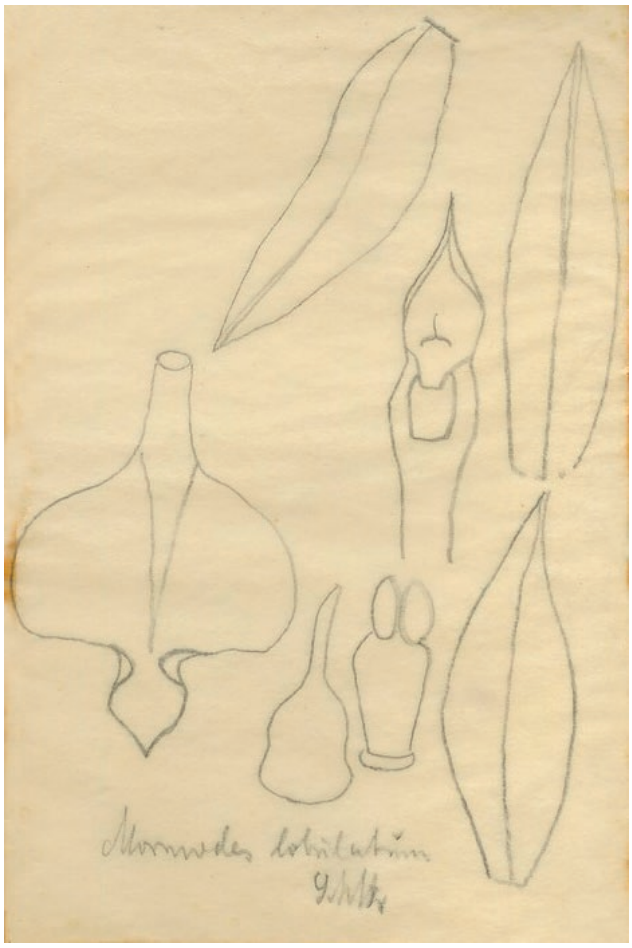

Figure 45. Copy of Schlechter's drawing from the holotype of *Mormodes lobulata* (AMES 24414). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

ing of the holotype, reproduced in Mansfeld (1931: Pl. 81, No. 323).

Notylia pittieri is distinguished by the greenish white lateral sepals, connate above the middle, the white petals, with up to 3 orange blots in the proximal half, and the white and shortly clawed lip, with the blade subdeltate, caudate, acuminate, and a basal thickened keel, extended to near the blade middle. The drawing of the holotype prepared under Schlechter's supervision includes the plant habit and a floral analysis (Figure 46); the latter was reproduced by Mansfeld (1931). These materials consistently represent the diagnostic characters of *N. pittieri*, such as the typical morphology of the lateral sepals and lip.

The isotype (BR 0000006572525), designated here as lectotype, bears the annotation "*Ad. Tonduz 6850*". Thus, despite the locality and collection date being exactly the same of that in the protologue, it gives the impression that Tonduz collected the specimen and that it does not correspond to the type specimen of *N. pittieri*. However, 6850 is the consecutive collection number assigned by the Instituto Físico-Geográfico Nacional Herbarium (IFGN; now the National of Costa Rica Herbarium) to the specimens of the type collection of *N. pittieri*. The IFGN assigned a unique access number to specimens from what was considered a single gathering, whether it was an unicate or consisted of duplicates, and regardless of who collected them (Pupulin et al. 2016, p. 278). Following art. 9.2 (ICN; Turland et al. 2018) it is an error that can be corrected, so the collector's name remains as in the protologue, and the type collection number is attributed to the IFGN.

Schlechter (1918a) compared *N. pittieri* with *N. huegelii* Fenzl, but the latter has fully connate lateral sepals, a shorter and ecarinate lip, and a thicker column. A detailed description of *N. pittieri*, and a modern botanical illustra-

Figure 46. Tracing of Schlechter's drawing from the holotype of *Notylia pittieri* (AMES 24886). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

tion, based on fresh material from a specimen collected in Manuel Antonio National Park, is provided by Pupulin (1998). *Notylia pittieri* ranges from Costa Rica to Panama.

24. *Oncidium cabagrae* Schltr. Repert. Spec. Nov. Regni Veg. 9(214–216): 292. 1911

Type: Costa Rica. In den Wäldern von Cabagra bei Buenos-Aires, ca. 450 m, blühend im März 1892, *H. Pittier 6589*. Holotype, B, destroyed; isotypes, HBG 501825!, selected here as lectotype (Figure 48); AMES 83079, a flower in a microscope slide saved in glycerine, not seen; tracing of Schlechter's drawings of the holotype, HUH 00102386! (Figure 49); Schlechter's floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 72, No. 288).

Henry Pittier collected the type material in Costa Rica in the southern Pacific foothills of the Cordillera de Talamanca in the area of Cabagra, close to Buenos Aires. Given that the holotype specimen was destroyed in the Berlin herbarium fire, Königer and Pongratz (1999) selected a specimen apparently collected by the first author at the *locus typicus* as the lectotype. However, the specimen evidently is not part of the original materials and is therefore not eligible for lectotypification purposes. Königer and Pongratz's designation should rather be interpreted as a neotypification. Furthermore, the mentioned specimen was not located at the Botanische Staatssammlung München by the curators in charge of the collections of that herbarium. However, the selection of a neotype is superfluous, as there are two isotypes of *Pittier 6589* still in existence, one in the University of Hamburg (HBG 501825), and one in the glycerin collection at AMES.

The isotype at Hamburg, originally belonging to Kränzlin private herbarium, is stamped as "Holotypus – fragment", thus implying that it was part of the original specimen studied by Schlechter. It does not bear any annotations in Schlechter's handwriting, but the original label by Kränzlin states that the fragment came directly from the Berlin herbarium, and so it is likely that it was effectively separated from the holotype specimen before its destruction. Notwithstanding its extremely fragmentary conditions, we select it here as lectotype. We refrain from designating an epitype for this taxon because the tracings of Schlechter's analysis at AMES illustrate in sufficient detail the diagnostic features of the species, with its narrow pseudobulbs and basally narrow leaves, the long, multi-flowered inflorescences, the petals distinctly wider than the sepals, the lip with an elliptic callus and rounded apical lobes, and the column with ample wings.

The name *Oncidium cabagrae* is treated by Atwood and Mora (1999), Pupulin (2002), Bogarín et al. (2014), and Kolanowska (2014) as a synonym of *Oncidium dichromaticum* Rchb.f., a species ranging from Costa Rica to Colombia.

25. *Oncidium costaricense* Schltr., Repert. Spec. Nov. Regni Veg. 9(196–198): 30. 1910

Type: Costa-Rica. [Puntarenas]: in den Wäldern von Térraba, ca. 260 m, blühend im März 1891, *H. Pittier 3859*. Holotype, B, destroyed; isotype, designated here as lectotype, US 577125! (Figure 50); isolectotype, US 577126!; tracing of Schlechter's sketch of the holotype, with drawing of the plant habit and analysis of the flower, AMES 24240!; Schlechter's floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 73, No. 289!).

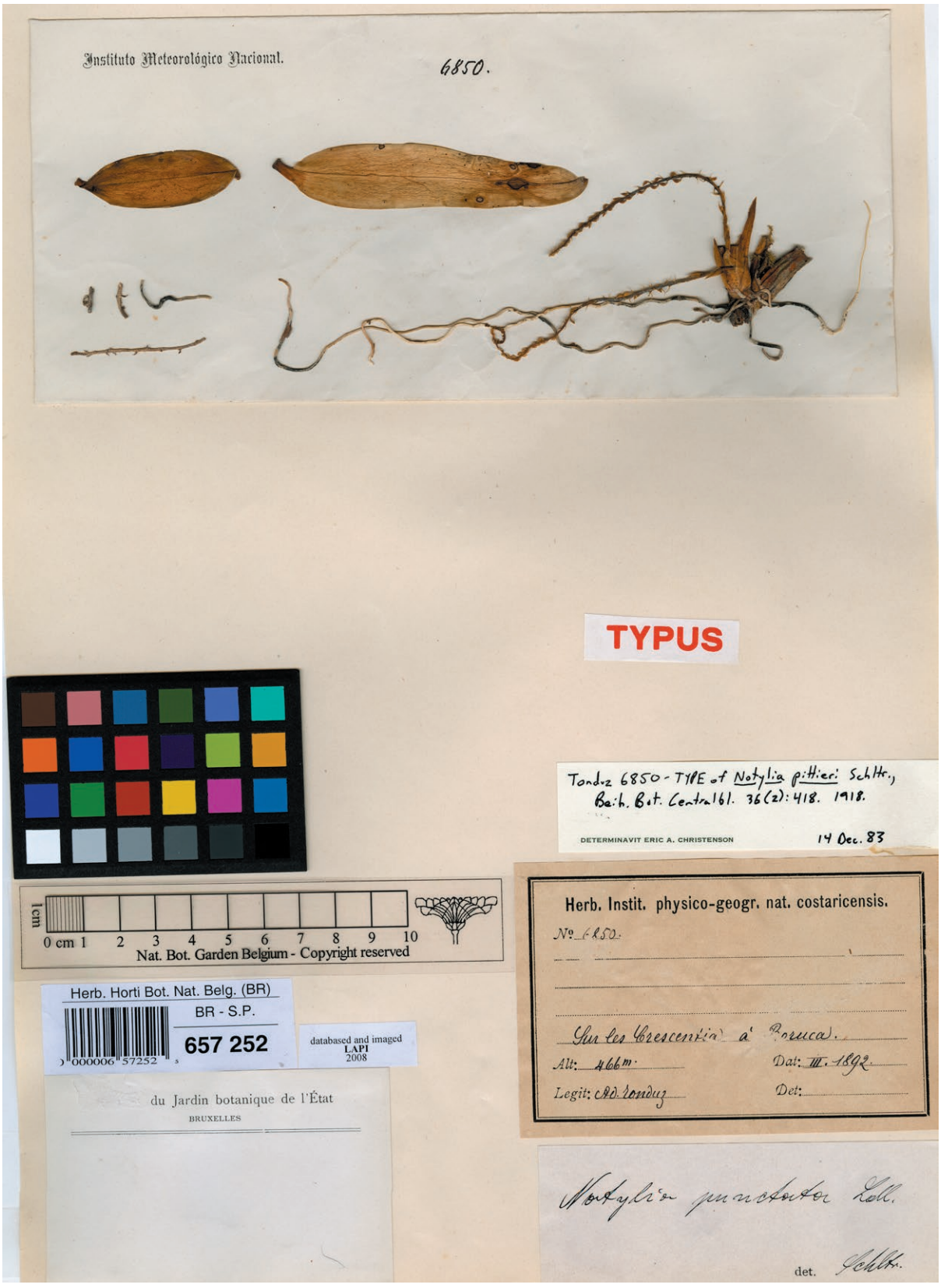

Figure 47. Lectotype of *Notylia pittieri* (BR 0000006572525). Courtesy of the Meise Botanic Garden Herbarium.

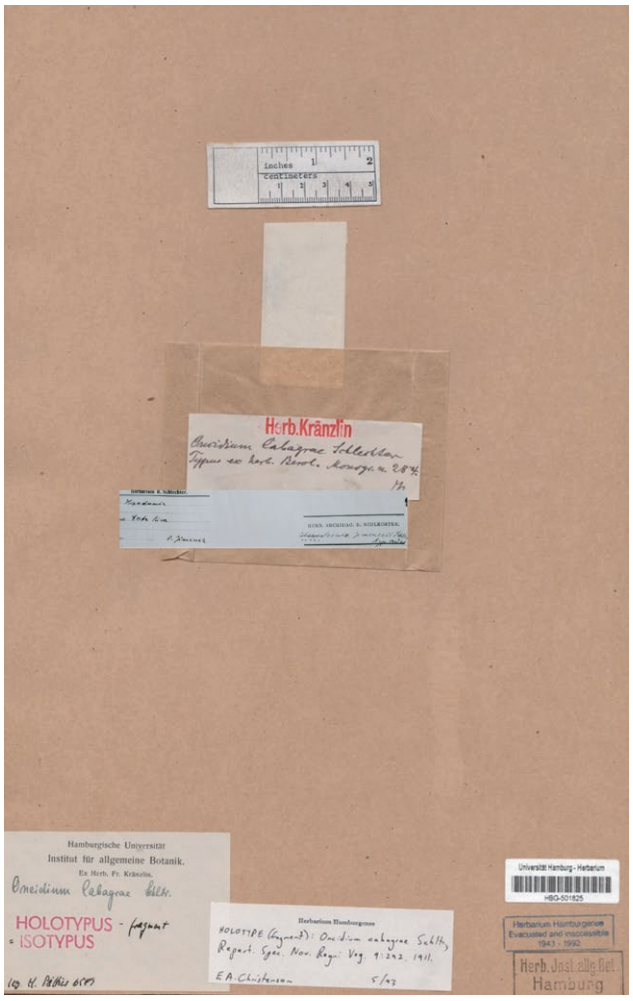

Figure 48. Lectotype of *Oncidium cabagrae* (HBG 501825). Courtesy of the University of Hamburg (HBG).

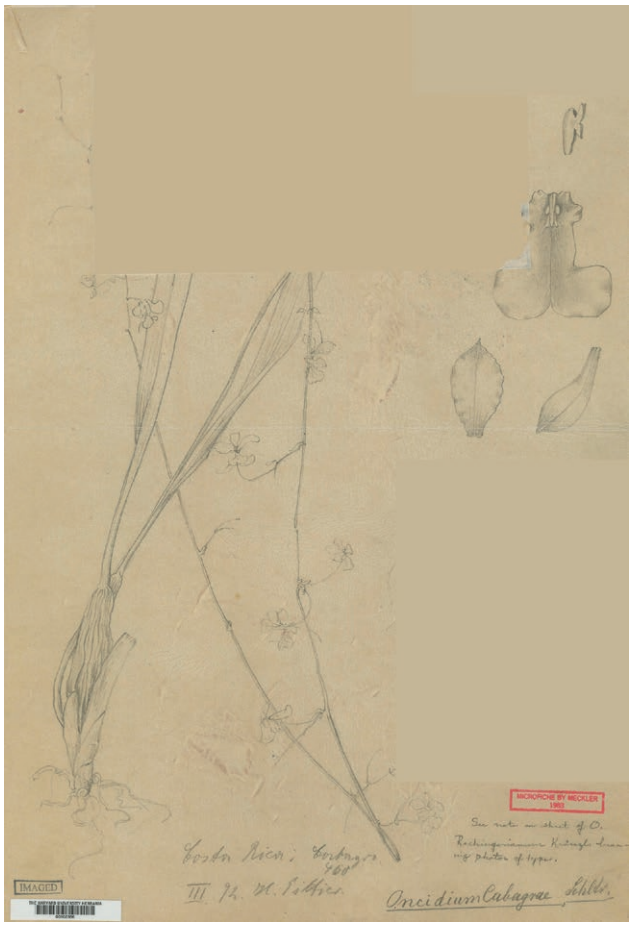

Figure 49. Tracing of Schlechter's drawings from the holotype of *Oncidium cabagrae* (HUH 00102386). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Among his multiple novelties discovered during his time exploring Costa Rica, Pittier collected the type specimen of *Oncidium costaricense* in Térraba, a lowland region in the southern Pacific side of Costa Rica. The holotype of *O. costaricense* was destroyed in Berlin, but two isotypes are preserved at US; one of them is designated here as lectotype.

According to protologue of *O. costaricense* the type was collected in the "*forest of Térraba, c. 2600 m of elevation*" (Schlechter 1910c), and this geographic indication is also annotated on the copy of Schlechter's sketch of the holotype at AMES. However, Schlechter misinterpreted Pittier's writing because the collection data handwritten by Pittier on the isotype specimens at US are spelled as "*dans la forêt a Térraba, 260 m* (in the forest of Térraba, 260 m)".

Oncidium costaricense is considered a synonym of *Oncidium polycladium* Rchb.f. ex Lindl. by Dressler (2003) and Bogarín *et al.* (2014). The shape of the floral parts of the holotype of *O. costaricense* reproduced in Mansfeld (1931) fits those of *O. polycladium* (K 000079559!), which was described in 1855 from a plant collected "*wild in Costa Rica, Veragua, Chiriquí*" (currently Panama). This species is characterized by the large inflorescence (up to 1.5 m long), the wings of the column sub-quadrate, and the midlobe of the lip up to 1 cm wide. *Oncidium costaricense* is also similar to *O. isthmi* Schltr., but the latter has inflorescences with longer primary branches, brighter yellow flowers, and a much wider midlobe of the lip (up to 2 cm) with, consequently, a more conspicuously narrow isthmus. Another very similar species is *O. stenotis* Rchb.f., but the column wings are rudimentary in the latter.

Figure 50. Lectotype of *Oncidium costaricense* (US 577125). Courtesy of the United States National Herbarium (US).

26. *Oncidium megalous* Schltr., Repert. Spec. Nov. Regni Veg. 9: 30–31. 1911

Type: Costa-Rica. In den Wäldern von Esmeralda, Barba-Massif, blühend im Nov 1892, *P. Biolley 7256*. Holotype, B, destroyed; isotype, designated as the lectotype by Christenson (1996: 21, as *O. megalotus*), US (579459 / barcode 00094129!); Schlechter's drawing of the holotype published by Mansfeld (1931: Pl. 74, No. 293!) (Figure 51).

The specimen in the Herbarium at the Smithsonian Institution is the only known isotype. Therefore, Kerry Barringer annotated the sheet proposing this specimen as the lectotype before Christenson (1996) formally published it. The flower analysis drawn by Schlechter (in Mansfeld 1931) clearly illustrates the pandurate-trilobed lip with semi-ovate basal lobes provided with a median, double wart, and a broadly reniform, excise apical lobe, as well as the very large, oblong, entire wings of the column, which distinctly surpasses the androclinium (Figure 51). These features are typical of *O. megalous* and were recorded in the protologue (Schlechter 1911).

According to Atwood and Mora (1999) the name is a synonym of *Oncidium bryolophotum* Rchb.f., also from Costa Rica or Panama. It is a member of the *Oncidium* sect. *Heteranthae* characterized by the paniculate inflorescences of polymorphic flowers, with the branches bearing only a few perfect flowers, the other being reduced to small stars made up of 3–5 greenish needles. Photographs of the species are provided by Pupulin and Dalström (2020: 768–769).

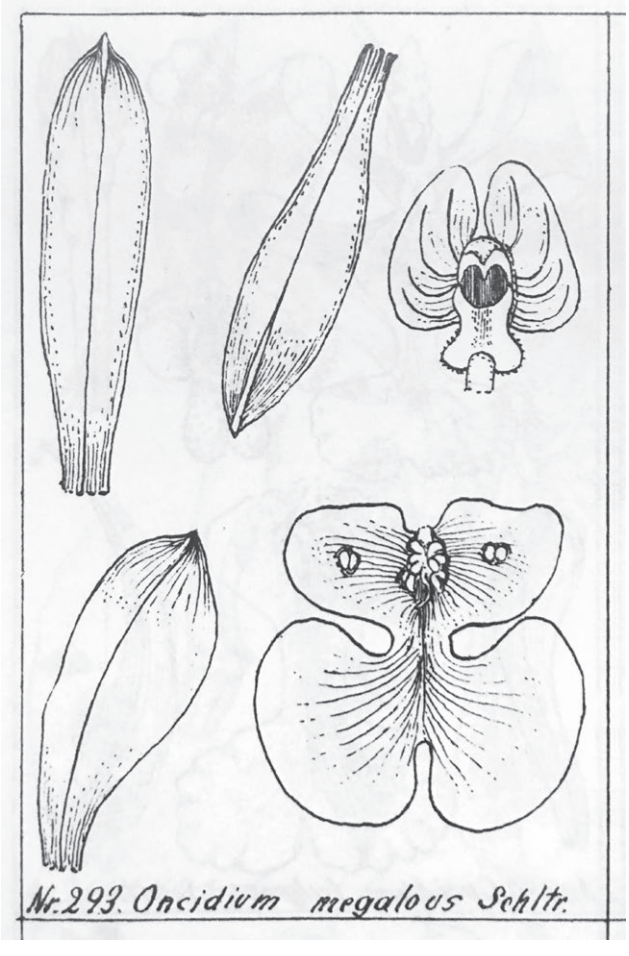

Figure 51. Schlechter's floral analysis from the holotype of *Oncidium megalous*, published by Mansfeld (1931: Pl. 74, No. 293).

27. *Oncidium pittieri* Schltr., Repert. Spec. Nov. Regni Veg. 9(196-198): 31. 1910

Type: Costa Rica. bei La Palma, ca. 1550 m, blühend im September 1896, *H. Pittier 10310*. Holotype, B, destroyed; lectotype designated by Mora and Atwood (1993: 1572), copy of Schlechter's drawing of the holotype at AMES 24264 / HUH 00102528! (Figure 52); reproduced in Mansfeld (1931: Pl. 74, No. 295!).

Figure 52. Lectotype of *Oncidium pittieri* (AMES 24264). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

No extant type material of this species is known to exist. Mora and Atwood (1993: 1572) selected the copy of Schlechter's drawing of the type at AMES as lectotype. The drawing includes the plant habit showing the fan-like arrangement of leaves and floral dissections showing a front view of the sepals, petals, lip, and column. Schlechter (1910c) described the species as having small, compressed, unifoliate pseudobulbs, oblong-ligulate, erect leaves, paniculate inflorescences, yellow flowers with a trilobate lip with divaricate lateral lobes and oblong, subtruncate midlobe, and a column with ample, patent, oblong-falcate wings. These features are shown in the copy of Schlechter's drawing of the type.

Oncidium pittieri is recognized by the wide (up to 8 cm) leaves arranged in a fan and concealing the pseudobulb, the paniculate inflorescence and the yellow, unspotted flowers with subequal lobes of the lip. Atwood and Mora (1999) treated it as an heterotypic synonym of *Oncidium luteum* Rolfe, a species described from a plant without collecting data. The type specimen at K shows a plant with a naked, two-leaved pseudobulb (vs. the characteristic fan of leaves concealing the unifoliate pseudobulb in *O. pittieri*). The species is endemic to Costa Rica and Panama (Atwood and Mora 1999; Dressler 2003).

Figure 53. Lectotype of *Ornithidium biolleyi* (AMES 24137). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

28. *Ornithidium biolleyi* Schltr., Repert. Spec. Nov. Regni Veg. 9: 29–30. 1910

Type: Costa Rica. [San José:] Auf Bergen in der Umgebung von San Jose, *P. Biolley 1052*. Holotype, B, destroyed; tracing of Schlechter's drawing of the holotype, designated here as lectotype, AMES 24137 / HUH 00102669! (Figure 53); Schlechter's floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 58, No. 229).

According to the protologue, *Ornithidium biolleyi* is distinguished among *Ornithidium* species by its long stems, two or more inflorescence per axil, the white flowers, and a column up to 4 mm long, the shortly unguiculate, inconspicuously trilobed lip with an oblong, round midlobe and a reniform callus at the base, and the lateral lobes obtuse, erect, incurved (Schlechter 1910c). The sketch of the holotype prepared under Schlechter's supervision includes the plant habit and a floral analysis (Figure 53), the latter reproduced in Mansfeld (1931), and clearly shows the diagnostic characters described by Schlechter (1910c). The name is considered a synonym of *Camaridium biolleyi* (Schltr.) Schltr. (Bogarín et al. 2014), a species ranging from Costa Rica to Panama.

29. *Ornithidium costaricense* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 8(182/184): 456. 1910

Type: Costa Rica. [Heredia]: In Wäldern bei Rancho-Flores, c. 2040 m, blühend im Feb 1890, *H. Pittier 2177*. Holotype, B, destroyed; lectotype, designated by Atwood and Mora (1999), a copy of Schlechter's sketch of the holotype, AMES-24213! (Figure 54); Schlechter's flower analysis of the holotype, reproduced in Mansfeld (1931: Pl. 70, No. 278) (Figure 55).

Henry Pittier collected the type material in the area of Rancho Flores in the province of Heredia, Costa Rica, but no other original material of the species is known to exist. Atwood and Mora (1999) selected the copy of Schlechter's drawing of the type at AMES-24213 (HUH-102675) as lectotype. The drawing includes a portion of the plant habit depicting the erect stem concealed by multiple leaves, with flowers produced from several leaf axils, and floral dissections showing a front view of the sepals, petals and lip, a side view of the column, and a scheme of the pollinarium. Schlechter (1910a) described

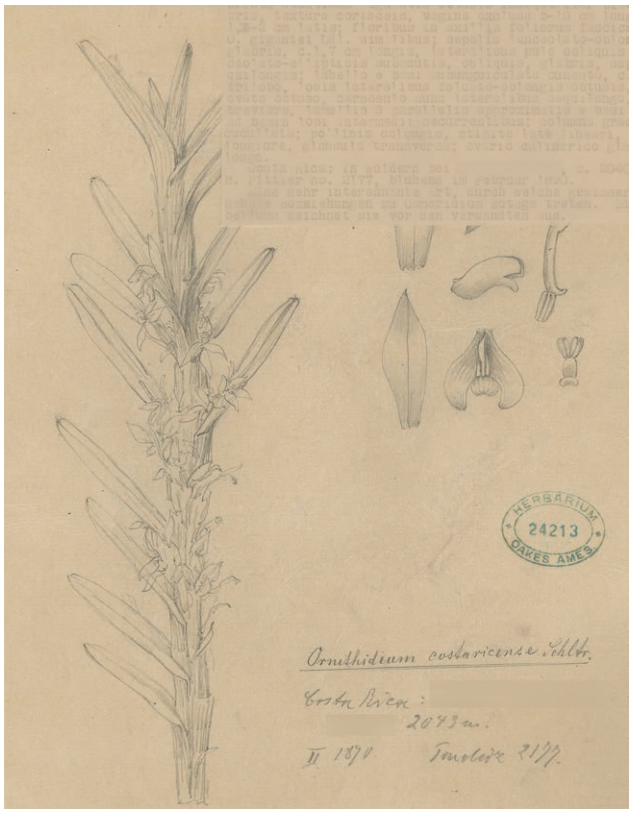

Figure 54. Lectotype of *Ornithidium costaricense* (AMES 24213). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

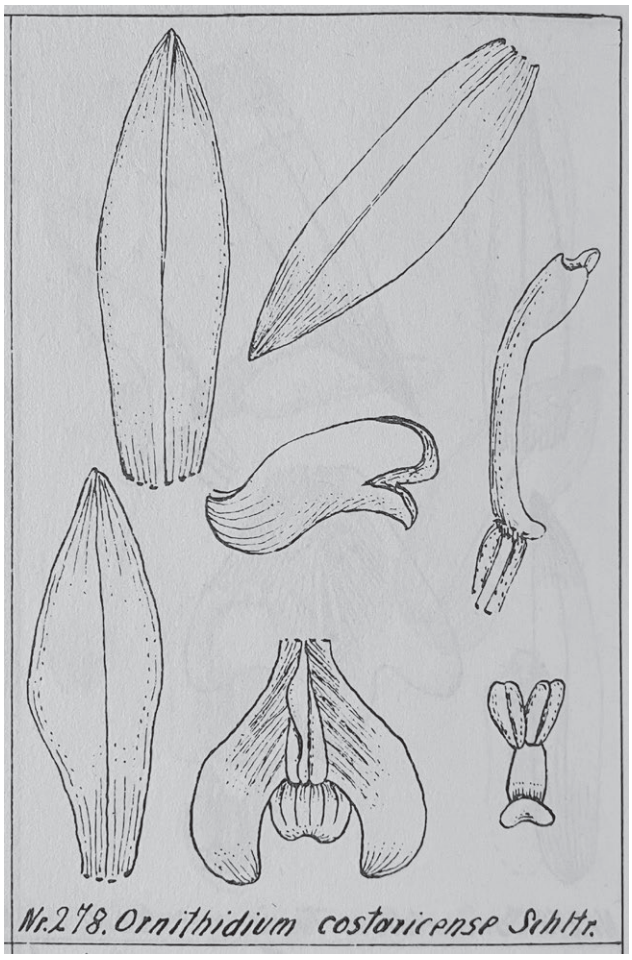

Figure 55. Schlechter's flower analysis from the holotype of *Ornithidium costaricense*, reproduced in Mansfeld (1931: Pl. 70, No. 278). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

the species as having a plant bearing fasciculate inflorescences borne from the leaf axil, lanceolate-oblong, glabrous sepals, lanceolate-elliptic petals, and a three-lobed lip with a cuneate, subunguiculate base. These morphological features are consistent with the copy of Schlechter's drawing of the type that was selected by Atwood and Mora (1999) as lectotype.

Ornithidium costaricense was placed under the synonymy of *Maxillaria falcata* Ames & Correll (Atwood and Mora 1999), a species that was later transferred to *Camaridium* by Blanco et al. (2007). In fact, Schlechter had recognized the resemblance of *O. costaricense* to the *Camaridium* complex in the original description, adducing a difference of this *Ornithidium* from the *Camaridium* group in the shape of the lip.

30. *Ornithocephalus xiphochilus* Schltr., Repert. Spec. Nov. Regni Veg. 3(42–43): 251. 1907

Type: Costa Rica: auf Hügeln in der Nähe des Río Chinipo [Chirripó], ca. 300 m, blühend im 1900, *H. Pittier 16509*. Holotype, B, destroyed; tracing of Schlechter's sketch of the holotype, with drawing of the plant habit and analysis of the flower, designated here as lectotype, AMES 24168! (Figure 56); Schlechter´s floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 77, No. 307!).

The name is considered a synonym of *Ornithocephalus bicornis* Lindl. ex Benth. by Stevens et al. (2001), Pupulin (2002), and Bogarín et al. (2014). Ames also suspected the synonymy, and annotated the herbarium sheet that includes a drawing of the type (AMES 24168) with a label: "*Is this O. bicornis Lindl.?*". The original description and the illustration of the flower of *O. bicornis* preserved at K fits perfectly with *O. xiphochilus*; however, Schlechter compared his species with *O. choroleucus* Rchb.f. The holotype of *O. xiphochilus* was destroyed; therefore, the copy of the floral analysis with

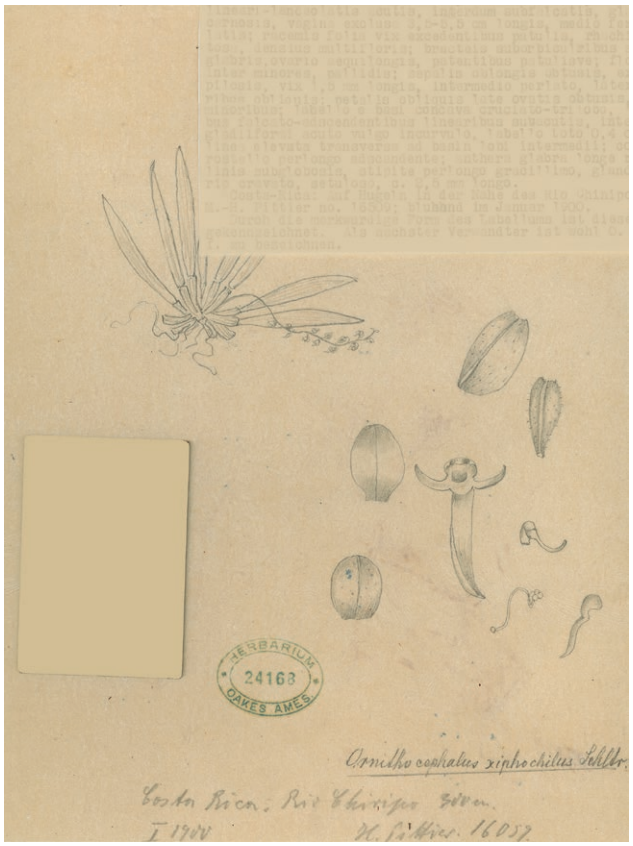

Figure 56. Lectotype of *Ornithocephalus xiphochilus* (AMES 24168). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

the drawing of the habit by Schlechter (AMES 24168), is here designated as lectotype. *Ornithocephalus bicornis* is widely distributed, from Mexico to Peru, Venezuela and French Guyana. Among the species of the genus with hispidulous inflorescences, *O. xiphochilus* is characterized by the greenish-orange sepals with the abaxial surface hispid, and the linear incurved acute lip with a horn-like callus at the base on each side. In Costa Rica, the species is most similar to *O. castelfrancoi* Pupulin, but distinguished by the lip without lateral horn-like calli.

31. *Physurus lehmannii* Schltr., Beih. Bot. Centralbl., Abt. 2, 36(3): 379–380. 1918

Type: Costa Rica. [(San José: Caraigres,) Auf den Tablazo, 9 Feb.] 1882, *F.C. Lehmann 1757*. Holotype, not located. Isotypes: BM 00077967!, two fertile specimens, designated here as lectotype (Figure 57), and US 826005 / barcode 00093390!, two fertile specimens, and photo at AMES 24490 / HUH 00103132!; tracing of Schlechter's drawings of the holotype, AMES 24490 / HUH 00103132! (Figure 58).

Both the isotypes at the herbaria of the British Museum and the Smithsonian Institution are made up of two fertile specimens in perfect condition and represent excellent candidates for lectotypification. The drawing of the type made by Schlechter does not correspond exactly with any of the four extant specimens, although it is very similar to the plant kept on the right of the US sheet. We choose to lectotypify with the sheet at BM as there is a possibility that Schlechter actually saw it during one of his visits to London, whilst this is not possible for the specimen conserved in Washington. The tracings of Schlechter's floral analysis and drawing of the holotype plant at AMES clearly illustrate the habit of the species with slender, relatively short stems and narrow leaf petioles, and the bilobed epichile of the lip transversely oblong and apiculate, which are diagnostic of the species.

As many of the genera in the Goodyerinae closely related to genus *Erythrodes* Blume *s.l.*, *Physurus* Rich. ex Lindl. has a complicated taxonomic history because the characters used to circumscribe the genera in this heterogeneous group of plants are mostly challenging, if not impossible, to observe if not in fresh material. Neotropical *Physurus* species are usually treated under the generic names *Aspidogyne* Garay, *Microchilus* C.Presl, and *Platythelys* Garay.

The name *Physurus lehmannii* is treated by Pupulin (2002), Bogarín et al. (2014), and Kolanowska (2014) as a synonym of the widespread *Physurus vesicifer* Rchb.f. [≡ *Microchilus vesicifer* (Rchb.f.) Ormerod], ranging from Mexico to Panama.

32. *Physurus nigrescens* Schltr., Beih. Bot. Centralbl., Abt. 2 36(2): 380. 1918

Type: Costa Rica. *F. C. Lehmann s.n.* (holotype, not found; lectotype, designated here, copy of Schlechter's drawing of the holotype at AMES 24496 / HUH 103146! (Figure 59), reproduced in Mansfeld (1931: Pl. 13, No. 49!).

Lehmann collected the type material in Costa Rica but without specific locality data, and no extant original material of the species is known to exist. We select the copy of Schlechter's drawing based on the holotype at AMES 24496 (HUH 103146) as lectotype. The drawing includes a portion of the plant habit with five leaves,

Figure 57. Lectotype of *Physurus lehmannii* (BM 00077967). Courtesy of the Natural History Museum (BM).

Figure 58. Tracing of Schlechter's drawings from the holotype of *Physurus lehmannii* (AMES 24490). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

an erect inflorescence, a side view of a flower, and floral dissections showing a front view of the sepals, petals, lip, and column. Schlechter (1918a) described the species as terrestrial with a narrow stem, five leaves, a multiflowered inflorescence, glandulose-pilose outer surface of sepals, and the ligulate petals, the oblong lip with transverse semilunate lobes at the apex, and the glandulose-puberulent, fusiform ovary. These morphological features are consistent with the copy of Schlechter's drawing of the type selected as lectotype.

Physurus nigrescens Schltr. is the basionym of *Erythrodes nigrescens* (Schltr.) Ames and *Microchilus nigrescens* (Schltr.) Ormerod.

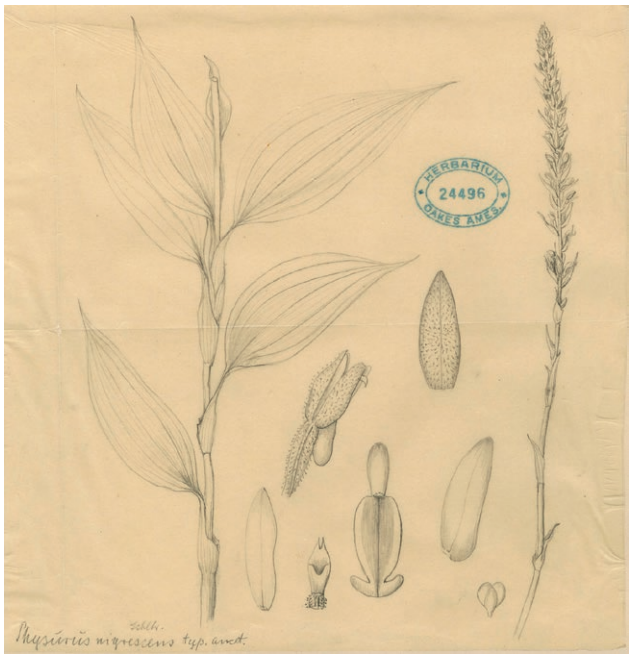

Figure 59. Lectotype of *Physurus nigrescens* (AMES 24496). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

33. *Platystele bulbinella* Schltr., Repert. Spec. Nov. Regni Veg. 8: 565–566. 1910

Type: Costa Rica. [Heredia:] In den Wäldern des Rancho Flores, bei 2043 m, blühend im Februar 1890, *H. Pittier 2013*. Holotype, B, destroyed. Isotypes: US 579445 / barcode 00093718!, designated here as lectotype (Figure 60); AMES 00103247!, sheet with two photographs of the lectotype specimen, and a copy of Schlechter's floral analysis of the holotype; Schlechter's floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 41, No. 164) (Figure 61).

According to the protologue, *Platystele bulbinella* is distinguished among other *Platystele* by the caespitose habit linear to ligulate leaves, the erect, long, densely flowered raceme with 3 or more flowers opened simultaneously, the oblong, obtuse subfalcate lateral sepals and petals, and the subreniform to orbicular and shortly acuminate lip (Schlechter 1910b). The floral analysis based on the holotype of *P. bulbinella* clearly shows these diagnostic floral characters (Figure 60).

Luer (1990) included *P. bulbinella* as a synonym of *Platystele compacta* (Ames) Ames. However, a comparison of the protologues of both taxa reveals that *P. compacta* has oblanceolate leaves (vs. linear to ligulate in *P. bulbinella*), ovate (vs. oblong) and shorter (1 mm long

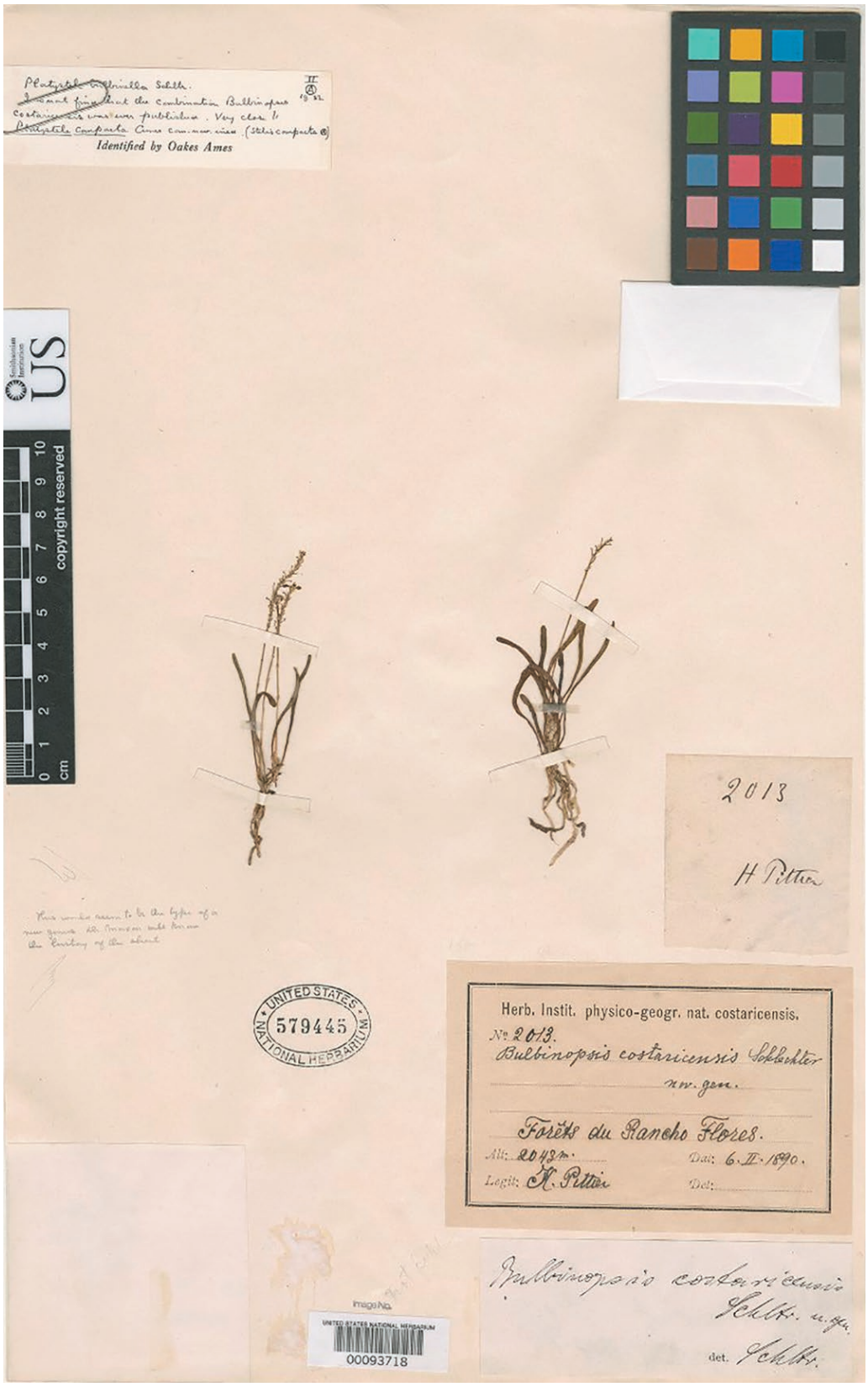

Figure 60. Lectotype of *Platystele bulbinella* (US 579445). Courtesy of the United States National Herbarium, Smithsonian Institution.

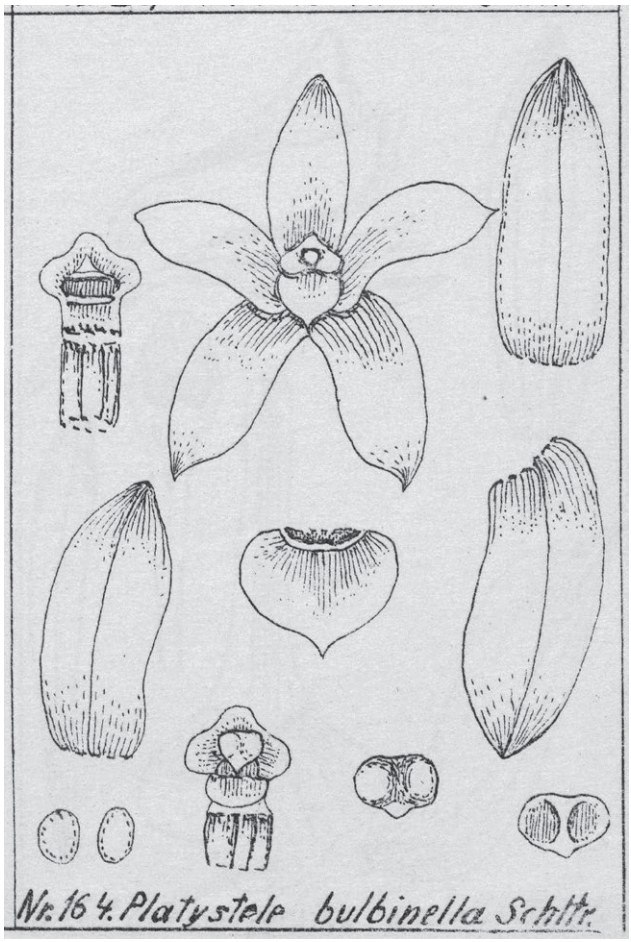

Figure 61. Schlechter's floral analysis from the holotype of *Platystele bulbinella*, reproduced in Mansfeld (1931: t. 41, no. 164).

vs. 2 mm long) sepals, oblanceolate to spathulate petals (vs. oblong, subfalcate), and ovate to lanceolate, apically pointed lip (vs. subreniform to orbicular, shortly acuminate). Also, the types of the two taxa come from ecologically different locations, the type of *P. compacta* having been collected at 350 m altitude in the tropical wet forests of Alta Verapaz, Guatemala, whilst the type of *P. bulbinella* was found in the montane forest of the southern slope of the Barva Volcano, Costa Rica, at over 2000 m in elevation (Ames 1908b; Schlechter 1910b).

At the Harvard University Herbaria, the barcode AMES 00103247 is associated with two sheets. One sheet includes two photographs of the lectotype (US 579445) and a copy of Schlechter's floral analysis of the holotype; plus, two specimens of *Platystele* (*P. C. Standley 38510* and *M. Valerio 78*) collected in Costa Rica, which are not part of the type collection of *P. bulbinella*, and a drawing of a flower that surely illustrates one of the latter specimens. The other sheet contains inflorescence fragments of the two non-type specimens mentioned above.

34. *Pleurothallis cooperi* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 19: 286. 1923.

Type: Costa Rica. Umgebung von Cartago, *J. J. Cooper s.n*. Holotype, B, destroyed. Isotype, selected by C. Luer (1998) as lectotype, AMES 31255 / HUH 00074176!, a fragment of the type specimen (Figure 62); tracings of Schlechter's analytical drawings of the species, same sheet (Figure 63A–B).

Pleurothallis cooperi was collected by Juan José Cooper in the surroundings of Cartago. A fragment of the type specimen was sent to AMES along with a detailed illustration based on the holotype (AMES 31255). Luer (1998) chose the specimen at AMES as lec-

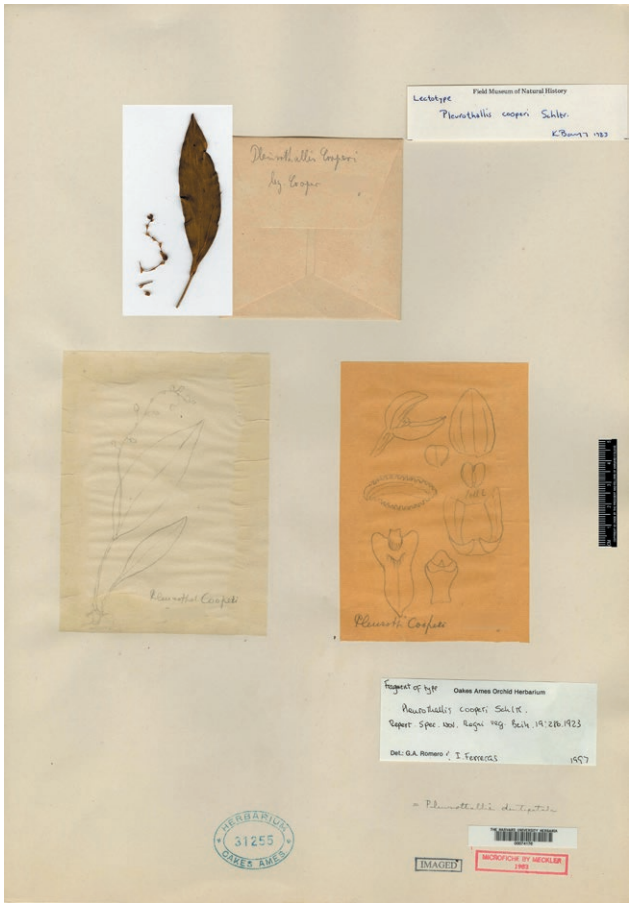

Figure 62. Lectotype of *Pleurothallis cooperi* (AMES 31255). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

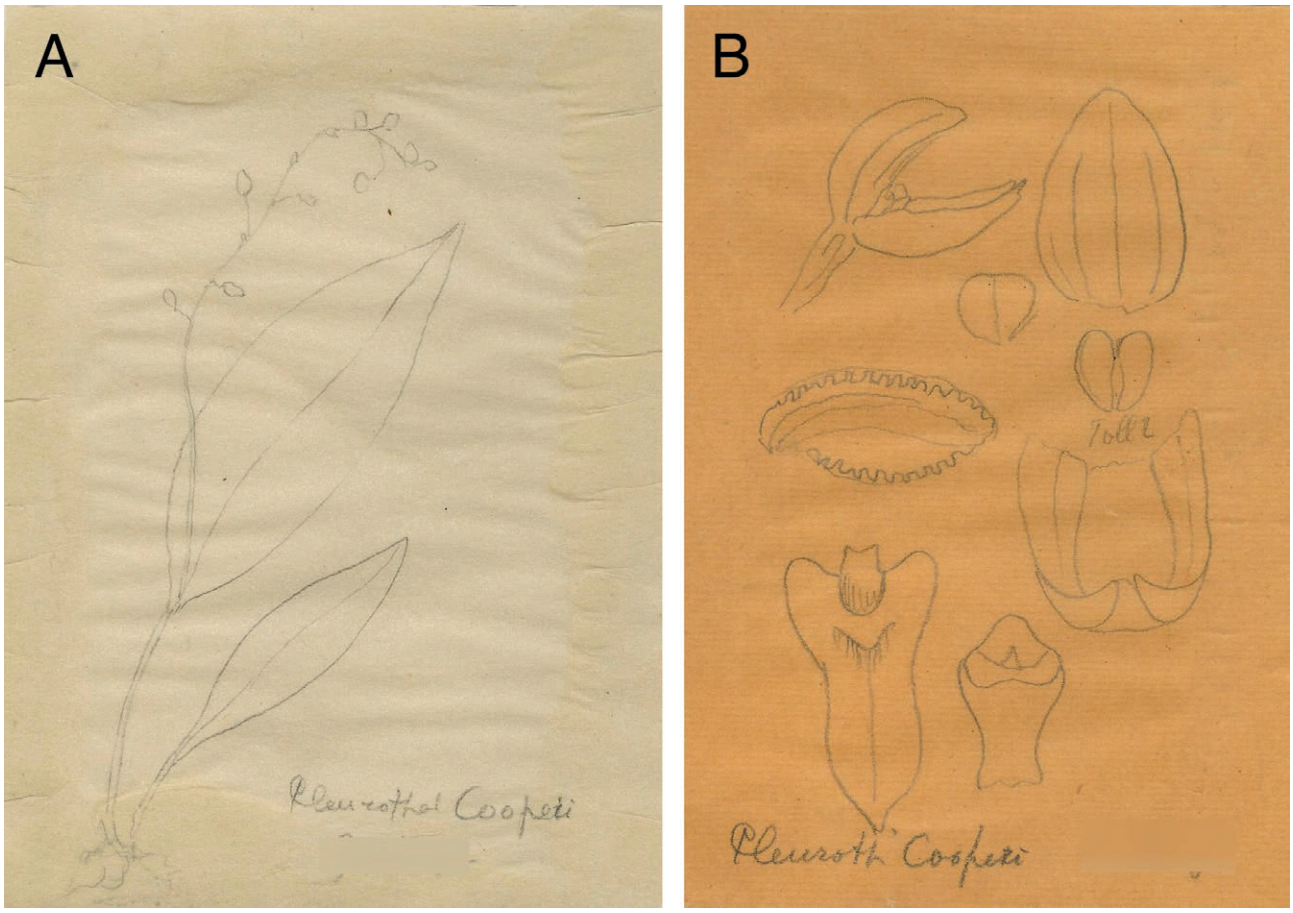

Figure 63. Tracings of Schlechter's analytical drawings from the holotype of *Pleurothallis cooperi* (AMES 31255). **A**, plant habit. **B**, floral analysis. Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

totype and no other type material is known. The fragment includes a leaf and a section of the inflorescence bearing a couple of flowers. Along with this specimen, an illustration depicting the plant habit with two ramicauls with their leaves, and the erect inflorescence borne at the base of the leaf is included, as well as a lateral view of the flower, and a floral dissection showing the ventral view of the synsepal, petals, lip and column. These details are consistent with the description of the protologue.

Pleurothallis cooperi has been included under the concept of *P. dentipetala* Rolfe ex Ames by several authors including Luer (1998), Pupulin (2002) and Bogarín et al. (2014). *Pleurothallis dentipetala* is endemic to the mid-elevation forests of Costa Rica and Panama. The drawing of *P. cooperi*, present on the lectotype, clearly illustrates the erect, cordate leaf, the congested, simultaneously multi-flowered racemes born from behind a spathe, and the flowers with minutely dentate to denticulate (sometimes fimbriate) petal margins and triangular lip with erect basal sides, all features agreeing with the diagnostic characters of *P. dentipetala*.

35. *Pleurothallis listerophora* Schltr., Repert. Spec. Nov. Regni Veg. 3(33–34): 107. 1906

Type: Costa-Rica: bei La Uruca, blühend im Jul 1890, *P. Biolley 2986* [*H. Pittier* 2986]. Holotype, B, destroyed; lectotype, designated by Luer (2000), US 577103! (Figure 64); isolectotype, CR 2986!; tracing of Schlechter's sketch of the holotype, with drawing of the plant habit and analysis of the flower, AMES 00074416!; Schlechter´s floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 32, No. 127!) (Figure 65).

Pleurothallis listerophora, currently only known from Costa Rica and Panama, was described and illustrated by Schlechter as having glabrous sepals (see Mansfeld 1931: pl. 32, No. 127) (Figure 65). However,

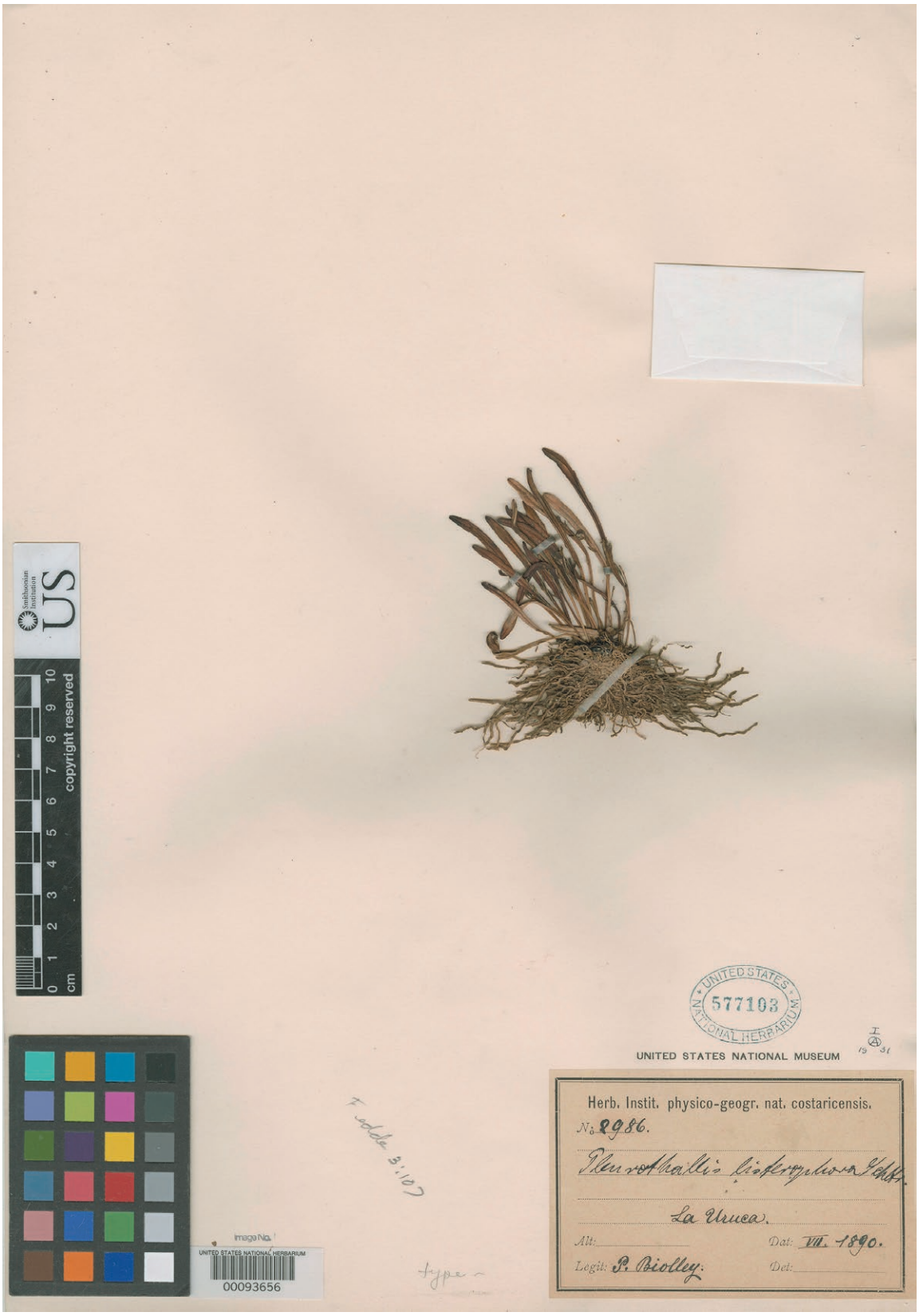

Figure 64. Lectotype of *Pleurothallis listerophora* (US 577103). Courtesy of the United States National Herbarium (US).

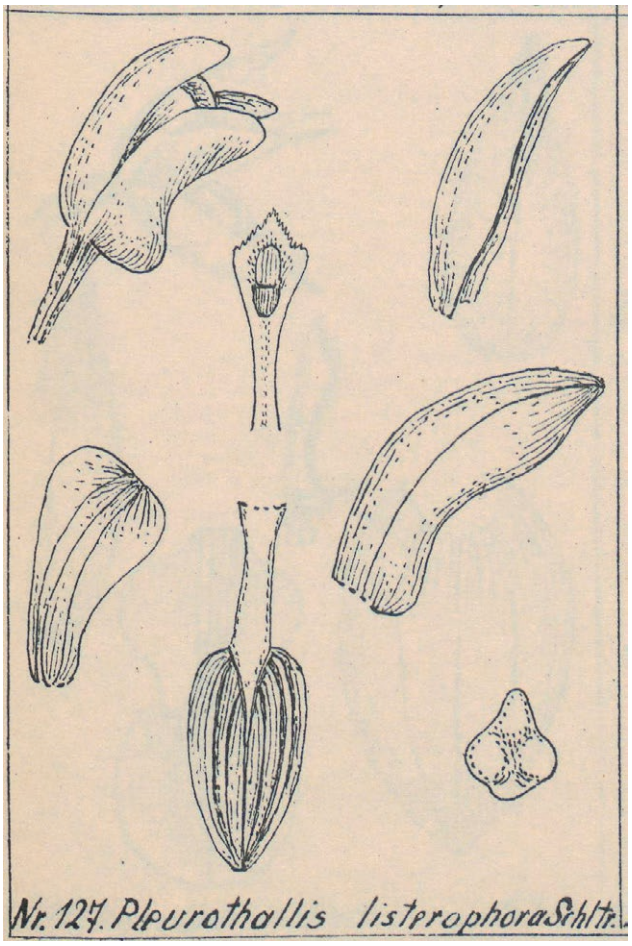

Figure 65. Schlechter´s floral analysis from the holotype of *Pleurothallis listerophora*, reproduced in Mansfeld (1931: pl. 32, No. 127).

Luer (2000) noted that while the morphology of the plant and the shape of the other structures correspond well with the original description, upon rehydrating a flower of the isotype at US (US 577103), the sepals of the flowers are long-pubescent on the adaxial surface (Luer 2000, pl. 24). The protologue of *P. listerophora* cites Pittier as the collector of the type specimen. However, based on the collection data of the label of the lectotype at US and the isolectotype at CR herbaria (not cited by Luer 2000), the main collector Figures as Paul Biolley.

According to the most recent infra-generic classification of *Stelis, P. listerophora* is placed under *Stelis* subgen. *Unciferia* (Luer) Karremans (2019), where it is treated as *S. listerophora* (Schltr.) Pridgeon & M.W.Chase (2001). Among the species of this group, it is recognized by the narrow ovate leaves subequal or shorter than the ramicaul, the inflorescence shorter than the leaves producing one or two flowers simultaneously, the lateral sepals connate to near the apex, and the narrow elliptical lip with a pair of central carinae, marginal angles bellow the middle and unguiculate basally. *Stelis listerophora* is most similar to *Stelis villosa* (Knowles & Westc.) Pridgeon & M.W.Chase, but the latter has inflorescences longer than the leaves, longer pedicels, and the abruptly ungiculate lip oblong above the second third (Luer 2000).

36. *Pleurothallis pittieri* Schltr., Repert. Spec. Nov. Regni Veg. 3(42-43): 247. 1907

Type: Costa Rica [Heredia]: An den Ufern des Río Manewan [Río Macarrón], ca. 2100 m, blühend im 15 Februar 1890, *H. Pittier 2023* (*2067*). Holotype, B, destroyed; lectotype designated here, copy of Schlechter's drawing of the holotype at AMES 23666 / HUH 00074626! (Figure 66), reproduced in Mansfeld (1931: Pl. 34, No. 136!).

The type material was collected by H. Pittier in Costa Rica along the shores of Río Macarrón on the slopes of Barba massif. Schlechter (1907a) cited *Pittier 2067* in the protologue; however, the type illustration bears the number *Pittier 2023*. No extant original material of the species is known to exist. Therefore, we selected the copy of Schlechter's drawing based on the holotype at AMES 23666 as lectotype. The drawing includes the plant habit with three ramicauls bearing several inflorescences, a side view of a flower, and floral dissections showing a frontal view of the spreading sepals and petals, and side view of the lip, front view of the column, pollinarium, and anther cap. Schlechter (1907a) described it as having terete stems with 2–3 amplectent bracts, oblong-elliptic leaves, multiflorous inflorescences developed from a spathe, lanceolate-ligulate sepals, oblique ligulate petals, and a rhomboid, obscurely trilobate lip. These morphological features match the copy of Schlechter's drawing of the type selected as lectotype.

Pleurothallis pittieri Schltr. is considered a synonym of *Crocodeilanthe floribunda* (Poepp. & Endl.) Luer (=*Pleurothallis floribunda* Poepp. & Endl.) and it is the basionym of *Stelis pittieri* (Schltr.) Rojas-Alv. & Karremans when treated in *Stelis* s.l.

37. *Pleurothallis sororia* Schltr., Repert. Spec. Nov. Regni Veg. 10: 294. 1912

[non *Pleurothallis sororia* Schltr. 1920 = *Kraenzlinella erinacea* (Rchb.f.) Solano].

Figure 66. Lectotype of *Pleurothallis pittieri* (AMES 23666). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Figure 67. Tracing of Schlechter's drawing from the holotype of *Pleurothallis sororia* (AMES 00074760). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Type: Costa Rica. [Heredia:] In den Wäldern von Rancho-Flores, ca. 2043 m, blühend im Februar [15] 1890, *H. Pittier 2157*. Holotype, B, destroyed [tracing of Schlechter's drawing of the holotype, AMES 00074760! (Figure 67)]. Isotypes: AMES 00083467, a flower conserved in glycerine; BR 00000065718!, designated here as lectotype (Figure 68); US577084 / barcode 00093697!; Schlechter's floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 36, No. 143!).

According to the protologue, *Pleurothallis sororia* can be distinguished by the combination of terete, thick ramicauls shorter than leaves, covered by a tubular sheath on the lower 3/4; oblong to elliptic, obtuse, thick leaves; long, thick, erect inflorescences with the peduncle covered with 3–4 bracts; ovate, obtuse, compressed, abaxially carinate and apically falcate, incurved floral bracts; muricate ovary; sepals abaxially carinate at the apex; petals bilobed at the base; lip unguiculate and bilobed at the base, with minute, serrulate, incurved lobes and the disc papillose (Schlechter 1912). The above characteristics coincide with the types examined.

Luer (1994) reduced *P. sororia* under the synonymy of *Pleurothallis erinacea* Rchb.f., a species described originally from Ocaña, Colombia (Reichenbach 1885) and recently transferred to *Acianthera* (Doucette et al. 2016). However, Reichenbach (1855, p. 294) characterized the lip blade of *P. erinacea* as serrulate along the margins, whilst in *P. sororia* only the lateral lobes of the lip are serrulate. To assess whether the two names are conspecific, it would be advisable to document variation in

Figure 68. Lectotype of *Pleurothallis sororia* (BR 00000065718). Courtesy of the Meise Botanic Garden Herbarium.

fresh material of specimens from both type localities. Photographs showing morphological and color variations of *P. erinacea* are presented in Karremans and Vieira-Uribe (2020).

38. *Sauroglossum nigricans* Schltr., Beih. Bot. Centralbl. 36(2): 379. 1918

Type: Costa Rica. *H. Pittier s.n.* Holotype, B, destroyed; lectotype designated here, copy of Schlechter's drawing of the holotype at AMES-24450 / HUH-00104123!. Figure 69.

We were unable to locate extant specimens that could be considered original material collected by H. Pittier. Therefore, we select the copy of Schlechter's drawing of the type at AMES as lectotype. The drawing includes a plant habit with fleshy pilose roots, four basal, rosulate, ovate-elliptic leaves, and one erect inflorescence bearing five flowers, a side view of a flower, and a dissection of the perianth, and two views of the column. Schlechter (1918a) described the lip as oblong with basal, hastate angles and a contracted apex and the morphological details illustrated in the lectotype match the protologue.

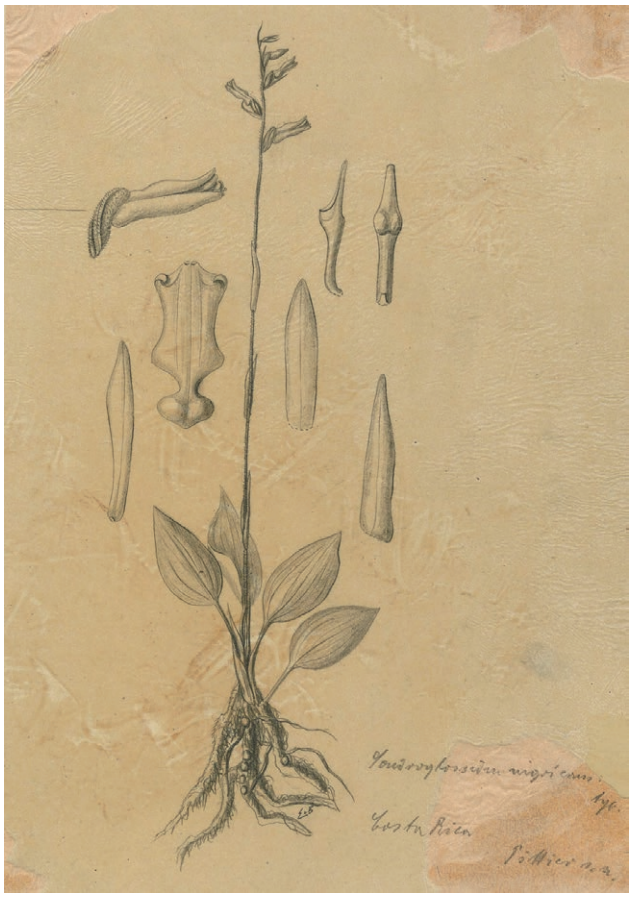

Figure 69. Lectotype of *Sauroglossum nigricans* (AMES-24450). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Sauroglossum nigricans Schltr. is the basionym of *Cyclopogon nigricans* (Schltr.) Schltr. and it is considered an heterotypic synonym of *Cyclopogon cranichoides* (Griseb.) Schltr. This species should be treated as a member of *Cyclopogon* s.l., the most taxonomically challenging genus of the Spiranthinae (Salazar et al. 2018). According to phylogenetic studies by Salazar et al. (2018), *C. cranichoides* is sister to the rest of the species of *Cyclopogon*. In contrast, the genus *Sauroglossum* is polyphyletic as currently defined, with the type species, *Sauroglossum elatum* Lindl., and its close relatives likely being restricted to south-eastern Brazil and Argentina.

39. *Scaphosepalum pittieri* Schltr., Repert. Spec. Nov. Regni Veg. 3: 78. 1906

Type: Costa-Rica [Puntarenas]: im Tale von Agua Buena (Cañas Gordas), ca. 1100 m, blühend im Februar 1897, *H. Pittier* (*11143 Herb. Institut. costaric.* [Herb. Nac. Costa Rica]). Holotype, B, destroyed [drawing by C. Schweinfurth of a flower from the holotype, along with a picture of the isotype saved at US and a copy of the floral analysis from the holotype published in Mansfeld (1931: Pl. 17, No. 67), AMES barcode 00104147! (Figure 70)]. Isotypes: US 815001 / barcode 00447416!, designated here as lectotype (Figure 71); US 577403 / barcode 00093610!

In his monograph of the genus *Scaphosepalum*, Luer (1988) cited the type of *S. pittieri* (*Pittier s.n.*, without further indications) as conserved at the herbarium of the National Museum in Costa Rica. We were unable to retrieve this specimen, and apparently no other specimens of *Scaphosepalum* collected by Pittier are in existence at CR.

Two isotypes of *Scaphosepalum pittieri* are conserved at US. Unlike AMES 577403, the specimen selected here as lectotype includes a fertile plant with remains of the inflorescence, a couple of flowers, and a few fruits. Although the contents of an accompanying envelope are not accessible at the moment due to the restrictions associated with the COVID-19 pandemic, it may contain floral materials useful for further studies. The species was collected from the area of Agua Buena-Cañas Gordas, located in the south Pacific of Costa Rica, close to the border with Panama (Schlechter 1906b).

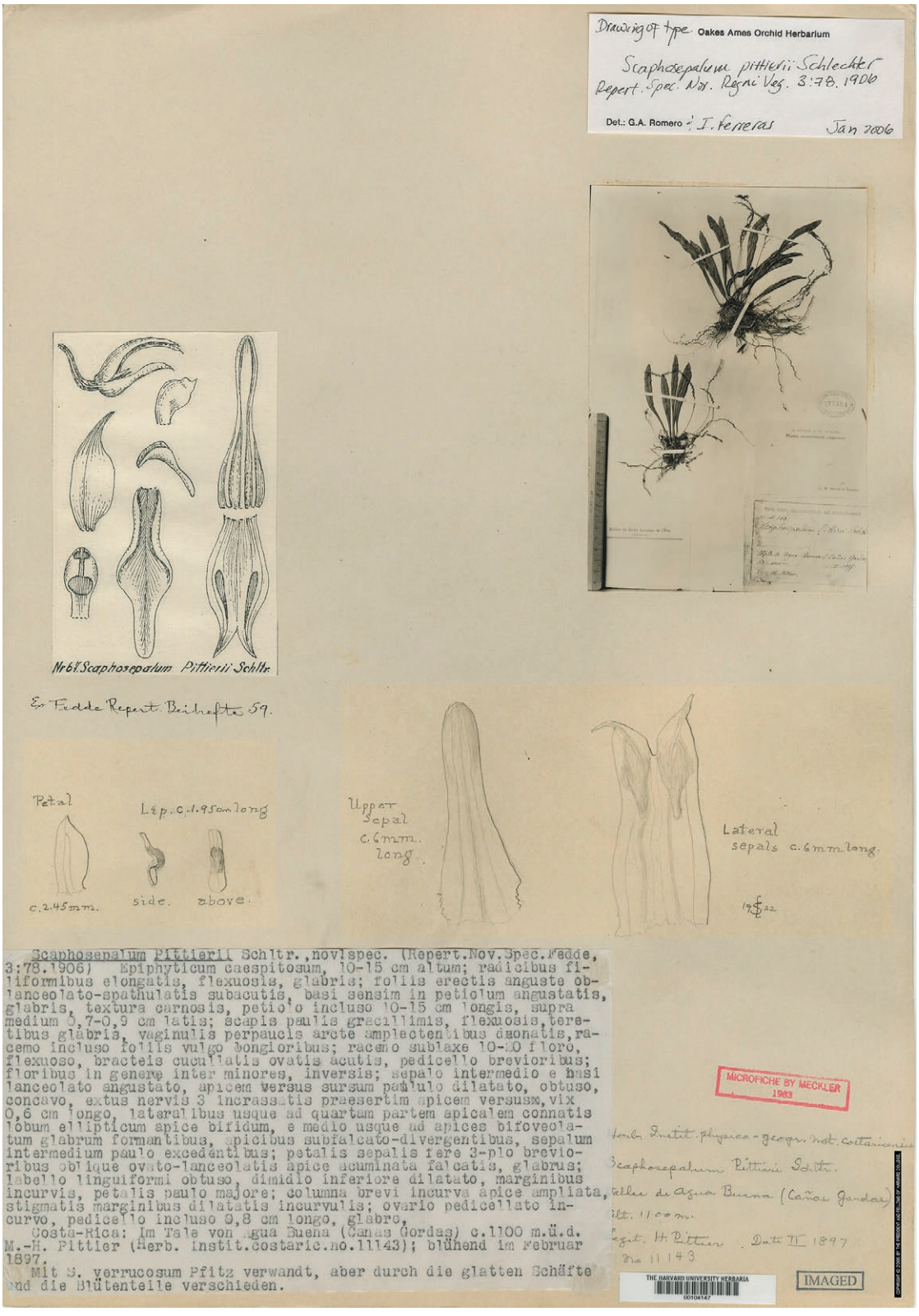

Figure 70. Drawing by C. Schweinfurth of a flower from the holotype of *Scaphosepalum pittieri*, along with a picture of the isotype saved at US and a copy of the floral analysis from the holotype published by Mansfeld (1931: t. 17, no. 67) (AMES barcode 00104147). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Figure 71. Lectotype of *Scaphosepalum pittieri* (US 815001). Courtesy of the United States National Herbarium (US).

Although originally compared to the Colombian *Scaphosepalum verrucosum* (Rchb.f.) Pfitzer, most authors place *S. pittieri* within the highly variable *Scaphosepalum microdactylum* Rolfe concept (i.e., Luer 1988, Mora and Atwood 1993, Pupulin 2002, Dressler 2003). The latter is characterized by the slender and glabrous stems, the long, consecutively multi-flowered racemes, and the flowers with short and wide sepals with morphologically variable apical calli.

40. *Scaphyglottis pauciflora* Schltr., Repert. Spec. Nov. Regni Veg. 3(29–30): 47. 1906

Type: Costa Rica: Ujarrás de Buenos Ayres [Aires], blühend im Februar 1897, *H. Pittier 10627*. Holotype, B, destroyed; isotype, designated here as lectotype, BR 0000006589165! (Figure 72); copy of Schlechter's sketch of the holotype, with drawing of the plant habit and analysis of the flower, AMES 24610!; Schlechter´s floral analysis of the holotype reproduced in Mansfeld (1931: Pl. 43, No. 172!).

Since the holotype of this species was destroyed at B, an isotype found at BR herbarium is designated here as lectotype. This name is considered a synonym of *Scaphyglottis behrii* (Rchb.f.) Benth. & Hook.f. ex Hemls. by Stevens et al. (2001) and Bogarín et al. (2014). Schweinfurth was probably the first to consider these two names conspecific, as he wrote "= *S. behrii* (Rchb.f.) Benth. & Hook.f. ex Hemls" on the herbarium sheet at AMES (24610), which is a copy of Schlechter's sketch of the type.

Scaphyglottis behrii was first described under genus *Ponera* Lindl. in 1855. The original description by Reichenbach is ambiguous, but the shape of the lip as noted in the protologue corresponds well with the tracing of the holotype of *S. pauciflora* by Schlechter, and we agree with Stevens et al. (2001) and Bogarín et al. (2014) in considering the two taxa conspecific.

The species is characterized by the small plants with proliferous fusiform and shortly stipitate pseudobulbs bearing two narrow leaves at the apex and producing an inflorescence with multiple congested white flowers. The sepals and petals are oblong and acute, and the lip is cuneate at the base, with rounded lateral margins above the middle, and the apex sub quadrate and retuse. Small plants with fusiform and narrow herbaceous leaves are also typical of *Scaphyglottis acostae* (Schltr.) C.Schweinf. and *Scaphyglottis crurigera* (Lindl.) Ames & Correll, however, the latter have long-stipitate and not proliferous pseudobulbs.

41. *Scaphyglottis subulata* Schltr., Repert. Spec. Nov. Regni Veg. 8(185/187): 454. 1910

Type: Costa Rica. Bei Carthago [Cartago], blühend im Sept 1889, *A. Biolley 1367*. Holotype, B, destroyed; isotype, BR 0000006590437!, designated here as lectotype (Figure 73); photo of type, AMES 39613 / HUH 00104170! (Figure 74); copy of Schlechter's drawing of the holotype, reproduced in Mansfeld (1931: Pl. 44, No. 176!).

An isotype located at BR-0000006590437, and a photograph of the holotype at AMES 39613, are the only extant specimen from the original material collected by A. Biolley in Cartago, Costa Rica. Therefore, we select the isotype as lectotype. It consists of a plant with three stems, each with one terete leaf. A flower is observed at the apex of the stem placed in the middle. There is also a photograph of the holotype (destroyed at B) kept at AMES 39613 / HUH-00104170 that consists of two stems of a plant with flowers and a sketch showing a side view of a flower, a dissection of the flower, a side view of the column and pollinarium with anther cap. The sketch is placed on the upper right corner of the sheet. Schlechter (1910a) described the plant with cylindric stems, linear-subulate, acute leaves, and flowers developed from the apex of the stem. The sepals are oblong-ligulate, the petals oblique lanceolate-ligulate, acute, and the lip is unguiculate, trilobed with oblong, obtuse lateral lobes and a quadrate, truncate midlobe. These features match the type drawing in the upper-right corner of the photograph of the holotype (AMES 39613).

Scaphyglottis subulata Schltr. is the basionym of *Reichenbachanthus subulatus* (Schltr.) Dressler. The name *Reichenbachanthus lankesteri* (Ames) Mora-Ret. & García-Castro, based on *Hexisea lankesteri* Ames, is a heterotypic synonym of *S. subulata*. *Reichenbachanthus* Barb.Rodr. and *Hexisea* Lindl. are currently treated as synonyms of *Scaphyglottis* Poepp. & Endl.

42. *Sobralia pfavii* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 19: 272–273. 1923

Type: Costa Rica. Ohne nähere Standortsangabe, *Pfau 80*. Holotype, not located [tracing of Schlechter's drawing of the holotype, AMES 31594 / HUH 00104322!]. Isotype: W-Rchb.Orch. 2122!, designated here as lectotype (Figure 75).

The holotype of *Sobralia pfavii* has been traditionally considered as lost in the bombing of the Berlin-

Figure 72. Lectotype of *Scaphyglottis pauciflora* (BR 0000006589165). Courtesy of the Meise Botanic Garden Herbarium.

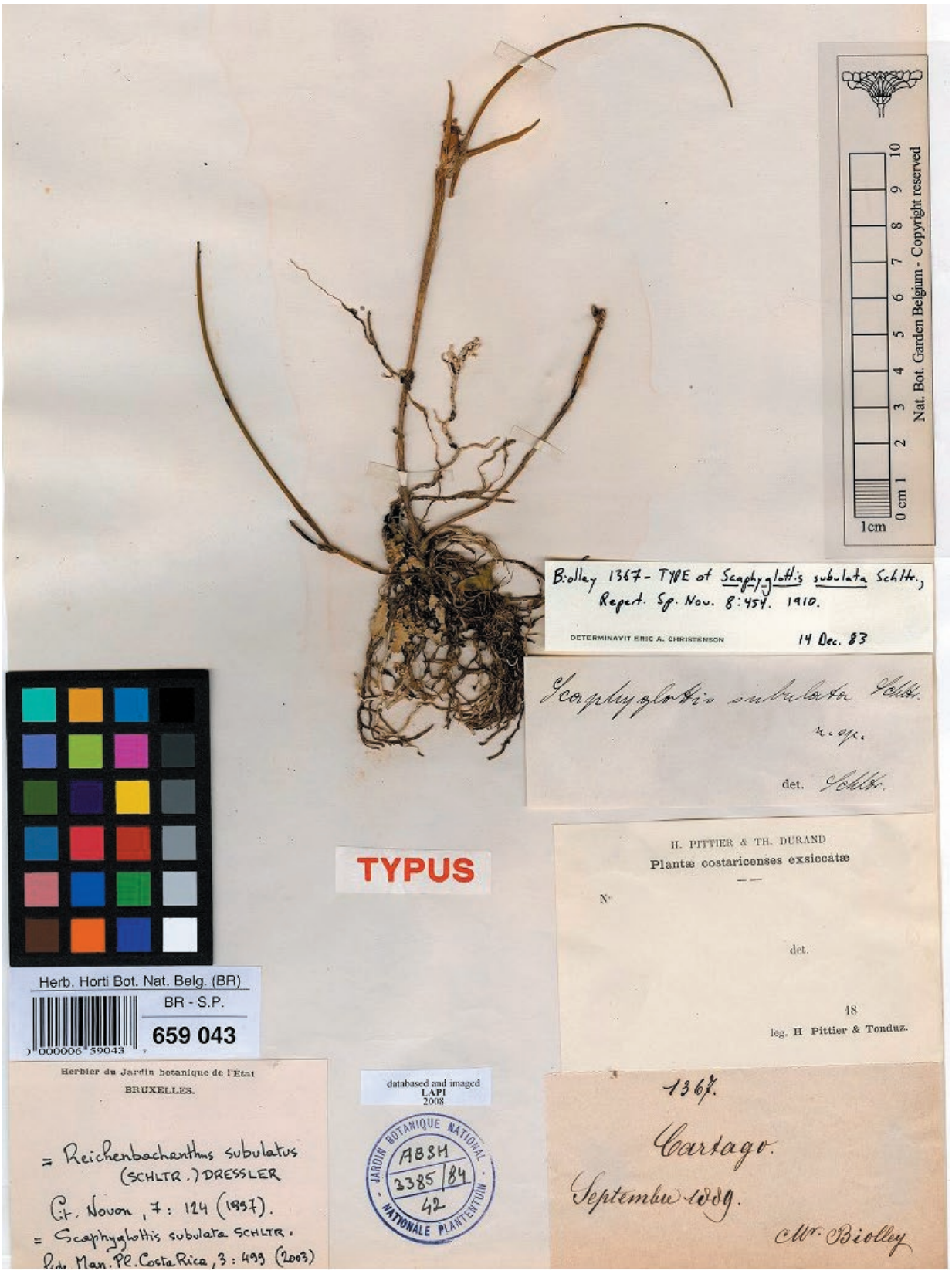

Figure 73. Lectotype of *Scaphyglottis subulata* (BR 0000006590437). Courtesy of the Meise Botanic Garden Herbarium.

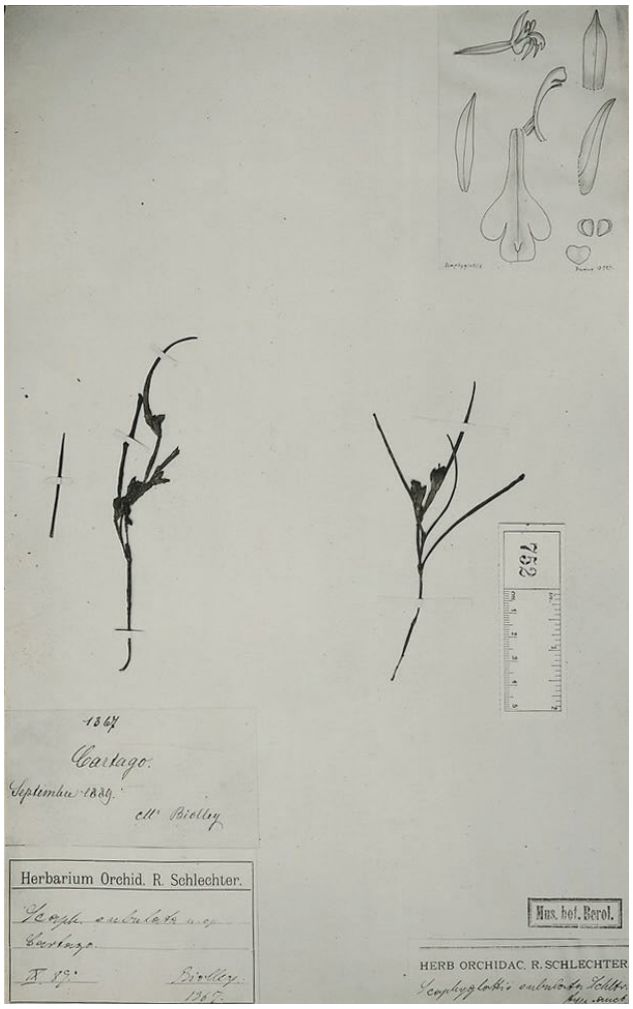

Figure 74. Photo of the holotype of *Scaphyglottis subulata* (AMES barcode 0104170). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Dahlem herbarium in 1943, but this idea is at most a labile hypothesis. The collector of the type specimen, the Swiss Richard Pfau, could not have had any direct contact with Schlechter, as he died in 1897. We know for sure that he sent materials for study (including pressed specimens and quite detailed watercolored drawings) to Reichenbach in Hamburg and to Rolfe at the Royal Botanic Gardens, Kew, but we have no direct evidence of any contact of Pfau with botanists in Berlin.

Reichenbach's herbarium in Vienna kept a sheet of *Sobralia pfavii* sent by Pfau himself, under his field number 80, and Christina M. Smith annotated this specimen as the species holotype. It bears the name, "Sob. Pfavii", in Reichenbach's handwriting, but Reichenbach himself never published the intended name.

The species was effectively described by Schlechter only in 1923, together with another collection of Pfau, *Telipogon pfavii* (Schlechter 1923d), for which a holotype has not been located (see below). This raises the question if Schlechter studied the type material of *Sobralia pfavii* during his visit to the Reichenbach Herbarium. If so, the type sheet at W should be considered as the actual holotype.

The sheets that Schlechter studied in Vienna, and which he selected as types for some of his new species, are usually annotated in his characteristic handwriting, i.e., *Chondrorhyncha endresii* (W-Rchb.Orch. 49751 / W 0018830), *Chondrorhyncha reichenbachiana* (W-Rchb. Orch. 4795 / W 0018829), *Endresiella zahlbruckneriana* (W-Rchb.Orch. 43634 / W 0019449) (Figure 76). In the same way, the drawings that he made of the type specimens of these species – now known through the tracing of his sketches conserved at AMES – were largely copied from the original drawings that Endrés sent to Reichenbach, and which were conserved in his herbarium at the time of Schlechter's visit. Compare, for example, Endrés' illustration of the type specimen of *Endresiella zahlbruckneriana* in Vienna (W-Rchb.Orch. 36018 / W 00209589) with the copy of Schlechter's analysis of the same species at AMES (24700 / HUH 00099111) (Figure 77).

In the case of *Sobralia pfavii*, however, the drawings made by Schlechter of the plant habit and his analysis of the flower (AMES 31594 / HUH 00104322) (Figure 78) only partially corresponded to the specimen conserved in Vienna and annotated as the holotype (Figure 75). There are obvious similarities between the actual specimens kept on the sheet, as well as Pfau's sketch mounted with them, and the sketches made by Schlechter, and it is also noteworthy that Reichenbach annotated the specimen with the intended name of "Sob. Pfavii" – the same eventually adopted by Schlechter – but the sheet at W has no labels with Schlechter's determination and his manuscript indication of "typus". This could suggest that he may have studied another set of the collection made by R. Pfau. For this reason, we prefer, conservatively, to consider that we were unable to locate the holotype of *Sobralia pfavii*, and to treat the specimen at W as an isotype, which we designated here as the species' lectotype.

According to the protologue, *Sobralia pfavii* can be distinguished by the combination of a short, creeping rhizome; stems up to 26 cm tall, with narrow, lingulate, obtuse or bidentate, erect, leaf blades; the sessile, abbreviated inflorescence with floral bracts shorter than the ovary; the sepals, petals and lip yellow, the lip with yellowish-orange throat, the oblong sepals and narrowly oblong, oblique, petals, with wavy margins; and the elliptic lip, apically trilobed, fimbriate to dentate in the distal half, with two ridges extended from the base to

Figure 75. Lectotype of *Sobralia pfavii* (W-2122). Courtesy of the Naturhistorisches Museum Wien.

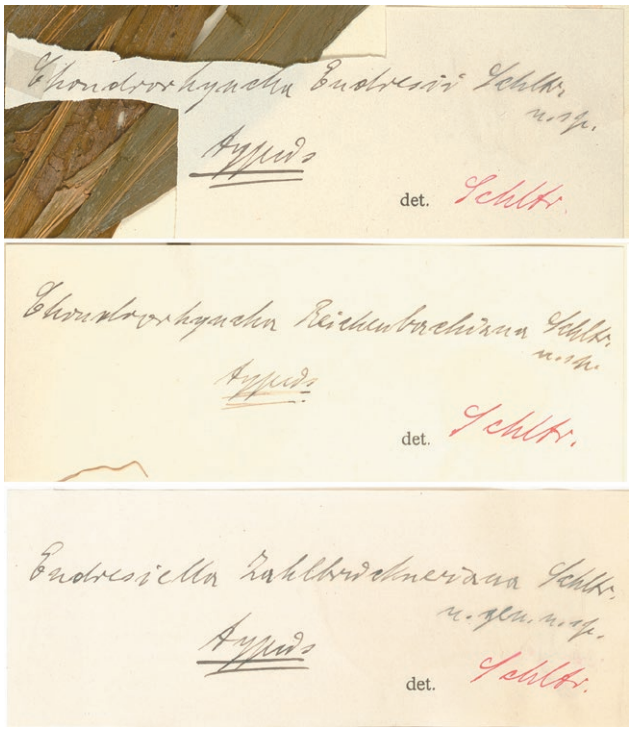

Figure 76. Correction labels by Rudolf Schlechter affixed to the holotypes of *Chondrorhyncha endresii* (W-Rchb.Orch. 49751) (A), *Chondrorhyncha reichenbachiana* (W-Rchb.Orch. 4795) (B), and *Endresiella zahlbruckneriana* (W-Rchb.Orch. 43634) (C). Courtesy of the Naturhistorisches Museum Wien.

the apex, the short, rounded lateral lobes, and the subquadrate, rounded to subtruncate midlobe (Schlechter 1923d). *Sobralia pfavii* is known only from Costa Rica.

43. *Sobralia pleiantha* Schltr., Repert. Sp. Nov. Regni Veg. 3(31-32): 79. 1906

Type: Costa Rica [Puntarenas]: in dem Walde bei Boruca, ca. 450 m, blühend im Feb 1891, *H. Pittier 3855*. Holotype, B, destroyed. Isotypes: BR 0000006589844!, designated here as lectotype (Figure 79); CR 3855!; US-814994 / barcode 00093886!; Z 000068540!. Sheet with two photographs of the isotype saved at US, AMES 24355 / HUH 00104324! (Figure 80A). Tracings of Schlechter's drawing of the holotype, AMES 224354 / HUH 00104323! (Figure 80B). Floral analysis of the holotype, originally prepared by Schlechter and reproduced in Mansfeld (1931: Pl. 4, No. 13!).

Although the holotype specimen of *Sobralia pleiantha* was destroyed, at least three isotypes and two drawings of the holotype are preserved in herbaria across the world. The isotype at CR is sterile and no reproductive organs are preserved in the accompanying envelope, while the isotypes at US and Z show a few flower buds. Therefore, we choose to lectotypify *S. pleiantha* with the type material saved at the herbarium of the Meise Botanic Garden (BR) in Belgium, based on the fertile stem provided with various flowers and flower buds, with an envelope containing more well-conserved dissected flowers. *Sobralia pleiantha* was distinguished as a new species by the multi-flowered, shortened inflorescences, contrasting with the usual single- or few-flowered inflorescences of resembling species of *Sobralia*.

Sobralia pleiantha is considered a synonym of *S. luteola* Rolfe. According to the original description (Rolfe 1898) of *S. luteola*, the plant came from "Tropical America", and flowered in the collection of Pantia [Pandia] Ralli, a well-known businessman and orchid gardener of Greek ascendence. *Sobralia luteola* is only known from Costa Rica and Nicaragua. It is recognized by the pale to creamy yellow flowers with an apically ciliate lip marked with orange along the throat. Individuals often produce more than two flowers simultaneously in a shortened raceme, characteristics that coincide with the original description of *S. pleiantha*.

44. *Solenocentrum costaricense* Schltr., Repert. Spec. Nov. Regni Veg. (205-207): 163. 1911

Type: Costa-Rica: San Isidro de La Arenilla, ca. 1400 m, blühend in August 1903, *H. Pittier 16723*. Holotype, B, destroyed; isotype, CR 16723!, designated here as lectotype (Figure 81); Schlechter's floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 5, No. 20); drawing of Schlechter's sketch of the holotype, with drawing of the plant habit and analysis of the flower, AMES 24437! (Figure 82).

Solenocentrum costaricense Schltr. (1911), the type species of the genus, was described from a plant collected by H. Pittier in central Costa Rica, around San Isidro, Vázquez de Coronado. The holotype of *S. costaricense* was destroyed, but an isotype is preserved at CR, and it is selected here as lectotype. The isotype at CR only holds fragments of the elliptic, long-petiolate leaves; however, the illustrations of the flower based on the holotype at AMES 24437 and reproduced in Mansfeld (1931, pl. 5, No. 20; Figure 77) show the diagnostic characters of the species, including the pilose ovary, the bilobate sepals and petals, and the lunate shape of the lip.

Solenocentrum includes four species distributed from Costa Rica to Bolivia, characterized by its rosette of 3–5

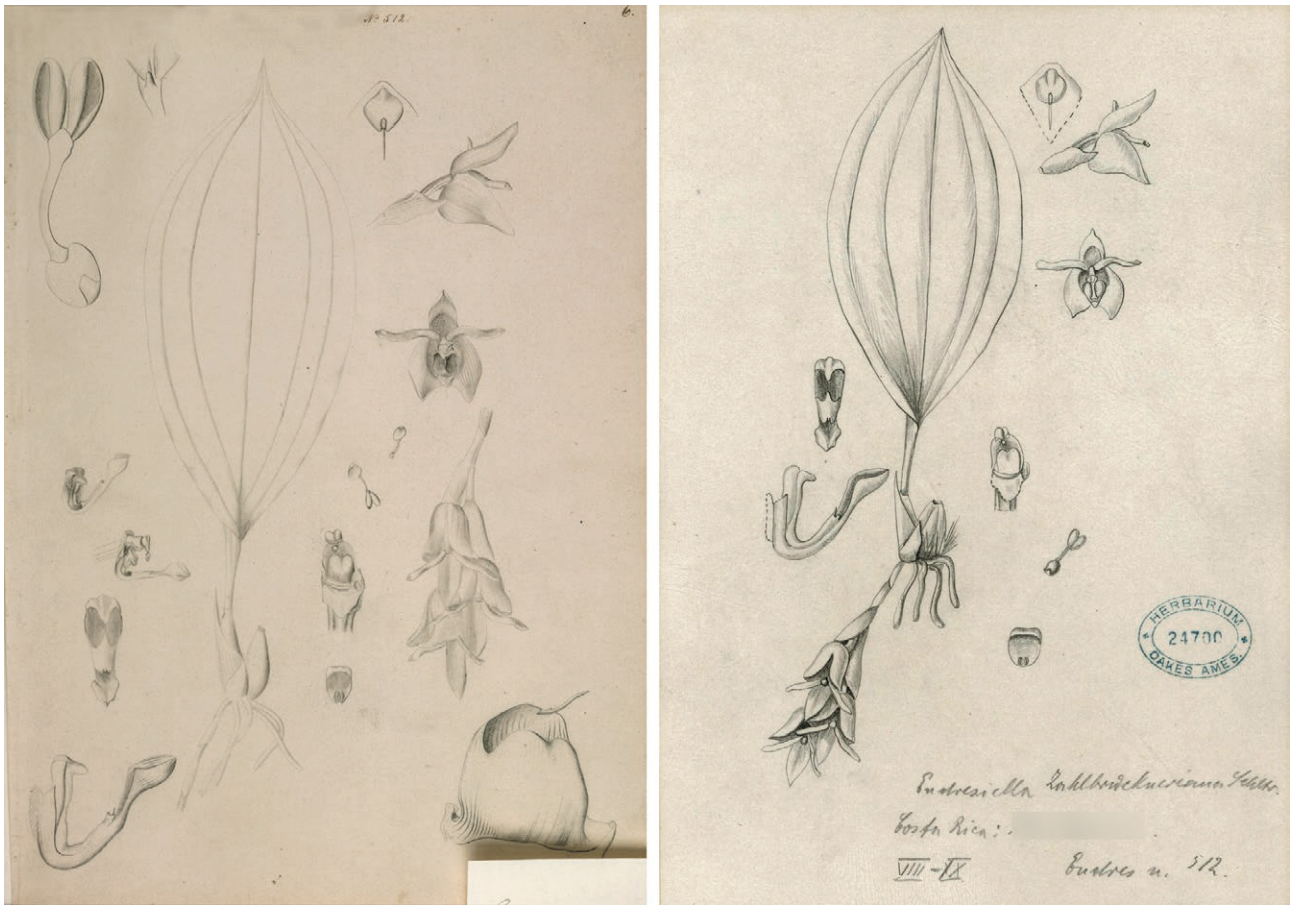

Figure 77. Comparison of the drawings of *Endresiella zahlbruckneriana* made by Endrés (W-Rchb.Orch. 36018) (A) and by Schlechter (AMES) (B). A, courtesy of the Naturhistorisches Museum Wien; B, courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

long-petiolate leaves with elliptic, slightly asymmetrical, acuminate blades; non-resupinate flowers; free sepals; asymmetric, two-lobed petals; and a lip provided with a long, somewhat clavate spur at the base (Dodson 2004, Damián et al. 2020). Among the few species of the genus, *S. costaricense* differs in the bilobate lateral sepals, spur of the lip longer than the column, the lunate lip with a basal lobe at each side, and the glandular-pilose ovary (Dressler 2003, Damián et al. 2020). Its most similar species is *S. maasii* Dressler, but it is easily distinguished from the latter by the glandular-pilose ovary (*vs.* glabrous) and the basal lobes of the lip (*vs.* elobulate).

45. *Stelis coiloglossa* Schltr., Repert. Spec. Nov. Regni Veg. 8(185-187): 453. 1910

Type: Costa Rica. Im Tale des Río Poás, c. 650 m, blühend im April 1890, *H. Pittier 2444*. Holotype, B, destroyed; isotype, US 00093548!, designated here as lectotype (Figure 83); isolectotype, US 000447497!; tracings of the original illustration of the holotype made under Schlechter's supervision at AMES 23704 / HUH 00104682! (Figure 84), reproduced in Mansfeld (1931: Tab. 21, No. 82).

The extant original material collected by H. Pittier along Río Poás, Costa Rica consists of two isotypes at US and the tracings of the original illustration of the holotype made under Schlechter's supervision kept at AMES and published in Mansfeld (1931). One isotype (US 000447497) shows a single stem with an inflorescence, whereas the other isotype (US 00093548) consists of two plants, one with roots and the other with an inflorescence. Therefore, we selected the latter as the lectotype. The tracings of the original illustration of the holotype made under Schlechter's supervision at AMES-23704 show a drawing of a stem with an inflorescence,

Figure 78. Tracings of the drawings of *Sobralia pfavii* made by Schlechter from the plant habit and his analysis of the flower (AMES 31594 / HUH 00104322). Courtesy of the Naturhistorisches Museum Wien; B, courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

a front view of a flower, and a dissection of the flower. Pupulin (2002) considered the species a synonym of *Stelis thecoglossa* Rchb.f.

46. *Stelis cooperi* Schltr., Repert. Spec. Nov. Regni Veg. 3: 276. 1907

Type: Costa Rica. [Cartago:] bei Carthago, ca. 1300 m, blühend im Juli 1888, *Cooper 562*. Holotype, B, destroyed [tracing of Schlechter's drawing of the holotype, AMES 23708 / HUH 00104694! (Figure 85)]. Isotypes: BR 0000006594138!, designated here as lectotype (Figure 86); isolectotypes: AMES 22593 / HUH 00104695!; US 577051 / barcode 00093552!; US 579430 / barcode 00449515!; Schlechter's floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 22, No. 86!).

According to the protologue, *Stelis cooperi* can be distinguished by the combination of erect leaves, short ramicauls, covered by a long, tubular, acute sheath on the lower 3/4; petiolate, elliptical, acute leaves; loosely flowered, unilateral racemes that exceed the length of the leaves, the peduncle with up to three ovate, acuminate bracts, distant from each other; spreading flowers with ovate, obtuse sepals, minute, fleshy, suborbicular and glabrous petals, and a fleshy, glabrous, suborbicular, truncate, emarginate lip, apiculate at the apex (Schlechter 1907b). A sketch based on the holotype made under Schlechter's supervision includes the plant habit and a floral analysis (Figure 85), the latter reproduced in Mansfeld (1931), showing the diagnostic characters described in the protologue. The specimen at AMES (22593 / HUH 00104695) contains a photograph of the isotype that is conserved at US (577051 /

Figure 79. Lectotype of *Sobralia pleiantha* (BR 0000006589844). Courtesy of the Meise Botanic Garden Herbarium.

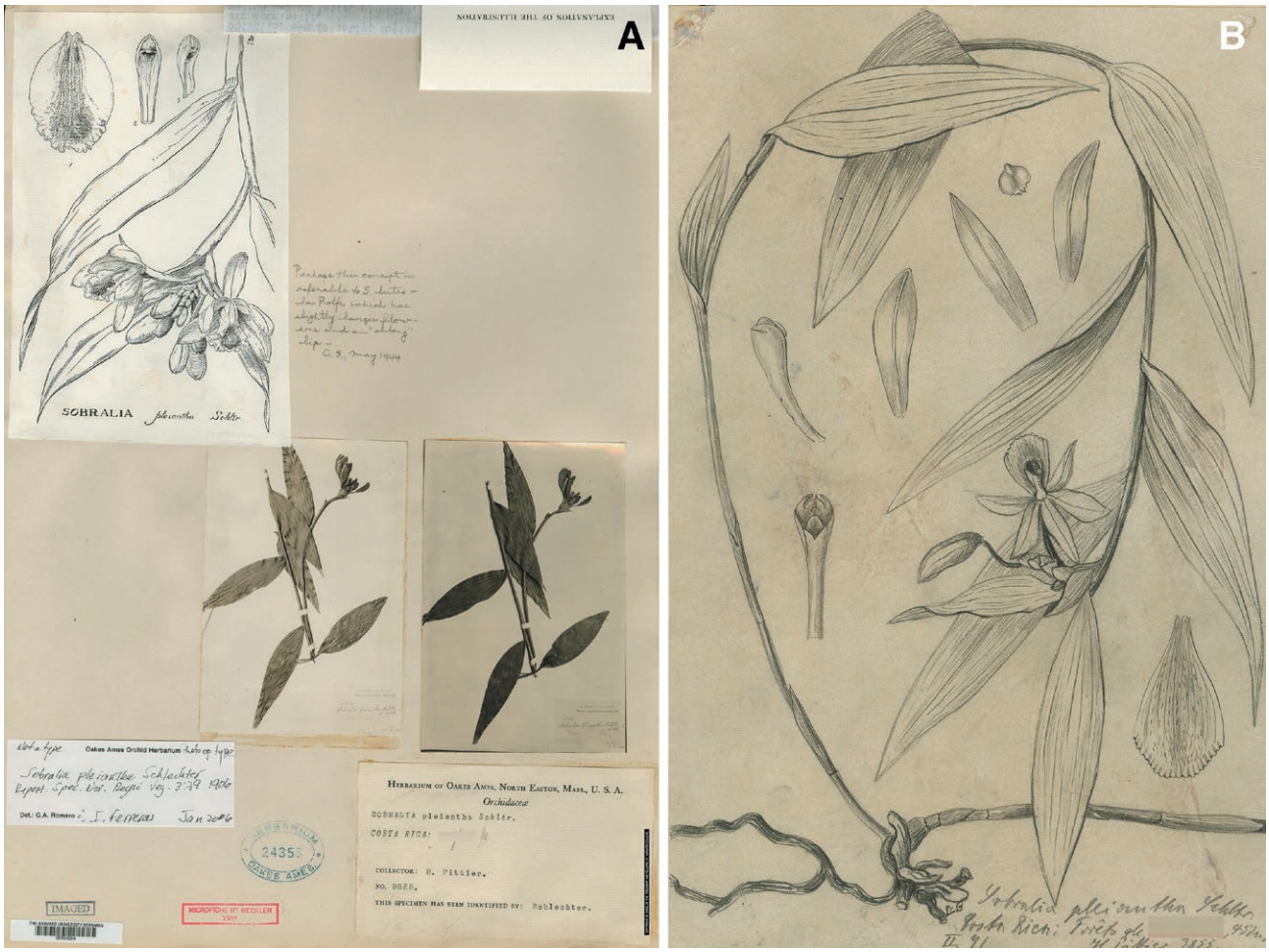

Figure 80. Photographs of the isotypes and tracings of Schlechter's analytical drawings from the holotype of *Sobralia pleiantha*. **A**, sheet with two photographs of the isotype saved at US (AMES 24355). **B**, copy of Schlechter's analyses (AMES 24354). Both courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

barcode 00093552). *Stelis cooperi* is only known from Costa Rica.

47. *Stelis cyclopetala* Schltr., Repert. Spec. Nov. Regni Veg. Beih. 19: 279. 1923

Type: Costa Rica: Ohne nähere Standortsangabe (comm. A. Tonduz), *H. Pittier s.n.* Holotype, B, destroyed; a photo of the holotype, a drawing of a plant, a drawing of a flower, lip and petal, a floral analysis drawn with camera lucida and a description, all based on the holotype, AMES 30423!, designated here as lectotype (Figure 87); photo of the holotype, AMES 33556!.

Schlechter described *Stelis cyclopetala* from a plant collected in Costa Rica (without exact locality), characterized by the length of the column twice longer than the petals. In 1935, Ames included *S. cyclopetala* under the synonymy of *S. ovatilabia* Schltr., a species also described by Schlechter (1918c) from a plant collected in Guatemala. As noted by Ames, Schlechter did not compare his *S. cyclopetala* with *S. ovatilabia*, which also has a column twice as long as the petals, and whose original description fits *S. cyclopetala*. In his discussion of *S. ovatilabia*, Ames argued that the differences, chiefly the more membranous petals in *S. cyclopetala*, are not enough to consider them different species.

The holotype of *S. cyclopetala* at B was destroyed. However, there is material at AMES, including a photo of the holotype (AMES 33556) showing five dried plants and an almost invisible sketch of a flower by Schlechter on the left, just above the label of the "Herbarium R. Schlechter". There is also another sheet (AMES 30423),

Figure 81. Lectotype of *Solenocentrum costaricense* (CR 16723). Courtesy of the Herbario Nacional de Costa Rica.

Figure 82. Copy of Schlechter's sketch from the holotype of *Solenocentrum costaricense* (AMES 24437). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

including the same photo of the holotype of *S. cyclopetala* (top right), next to a copy of Schlechter's sketch of the flower (top center), a drawing of a plant from the holotype (top left), a floral analysis by Blanche Ames, based on a flower from the type (middle right), and a description with an illustration of the flower, lip, and petal, made by Ames from the holotype (center). The photo of the type sheet at AMES does not bear the stamp of the "Herbarium Berolinensis" and was probably taken in the herbarium of Rudolf Schlechter before it was deposited at the Botanical Museum of Berlin-Dahlem. The photo has no authority, but since the sheet of *S. ovatilabia* at AMES 27942 also includes a photo of the holotype taken in Schlechter´s herbarium, with a footnote "photograph of type sheet by AMES", it is probable that also the photo of *S. cyclopetala* was taken by Ames during his visit to Berlin in 1922. The illustrations of *S. cyclopetala* and *S. ovatilabia* made from the types with the aid of camera lucida, were probably prepared by Blanche Ames during her visit to Berlin with Oakes Ames in 1922 (Angell and Romero 2011).

48. *Stelis despectans* Schltr., Repert. Spec. Nov. Regni Veg. 8(185-187): 453-454. 1910

Type: Costa Rica. Bei La Palma, c. 1500 m, Jul 1888, *J.J. Cooper 507*, *IFG-594* (cited in the protologue as *H. Pittier 594*). Holotype, B, destroyed; isotype, US-577054 / barcode 0093557!, designated here as lectotype (Figure 88); isolectotype, AMES 23714! (fragment of a plant in the envelope); copy of Schlechter's drawing of the holotype at AMES 23714 / HUH-00104724! (Figure 89), reproduced in Mansfeld (1931: Pl. 23, No. 89!).

Schlechter (1910a) described the species with terete, unifoliate stems, narrowly oblong-ligulate, coriaceous leaves, lax inflorescences with despectant flowers, oblong-ligulate sepals, connate lateral sepals, obliquely ovate, obtuse petals and the fleshy, ovate, obtuse, obscurely three-lobulate lip. The copy of Schlechter's drawing of the holotype at AMES 23714 shows a plant with four stems and three inflorescences, a front view of a flower, and a floral dissection. Also, the envelope at the upper right corner contains an isotype consisting of a stem without the leaf and two pieces of an inflorescence, and three buds or flowers. In the protologue, Schlechter (1910a) cited *Pittier 594*, but this is a number assigned by the IFG, and the original collection was made by J.J. Cooper under his number *507*. The isotype specimen at US (577054 / barcode 0093557), selected here as the lectotype, shows the number *Cooper 507* right after number *594* on the label of the IFG. The label on the left bottom corner of the sheet at US-577054 shows the original label by J.J. Cooper with the number 507 and the locality "Vive sobre árboles, atmósfera húmeda, La Palma, Julio/88, 6000 f. elevation". This specimen contains three pieces of plants, each with one leaf and inflorescences. This specimen at US 577054 is more complete than that at AMES 23714 and is therefore selected as lectotype.

49. *Stelis jimenezii* Schltr., Beih. Bot. Centralbl., Abt. 2 36(2): 389. 1918.

Type: Costa Rica. [San José]: Ladertena, Hajuelito [La Verbena, Alajuelita, orillas del Río Tiribí], Feb 1912, *O.*

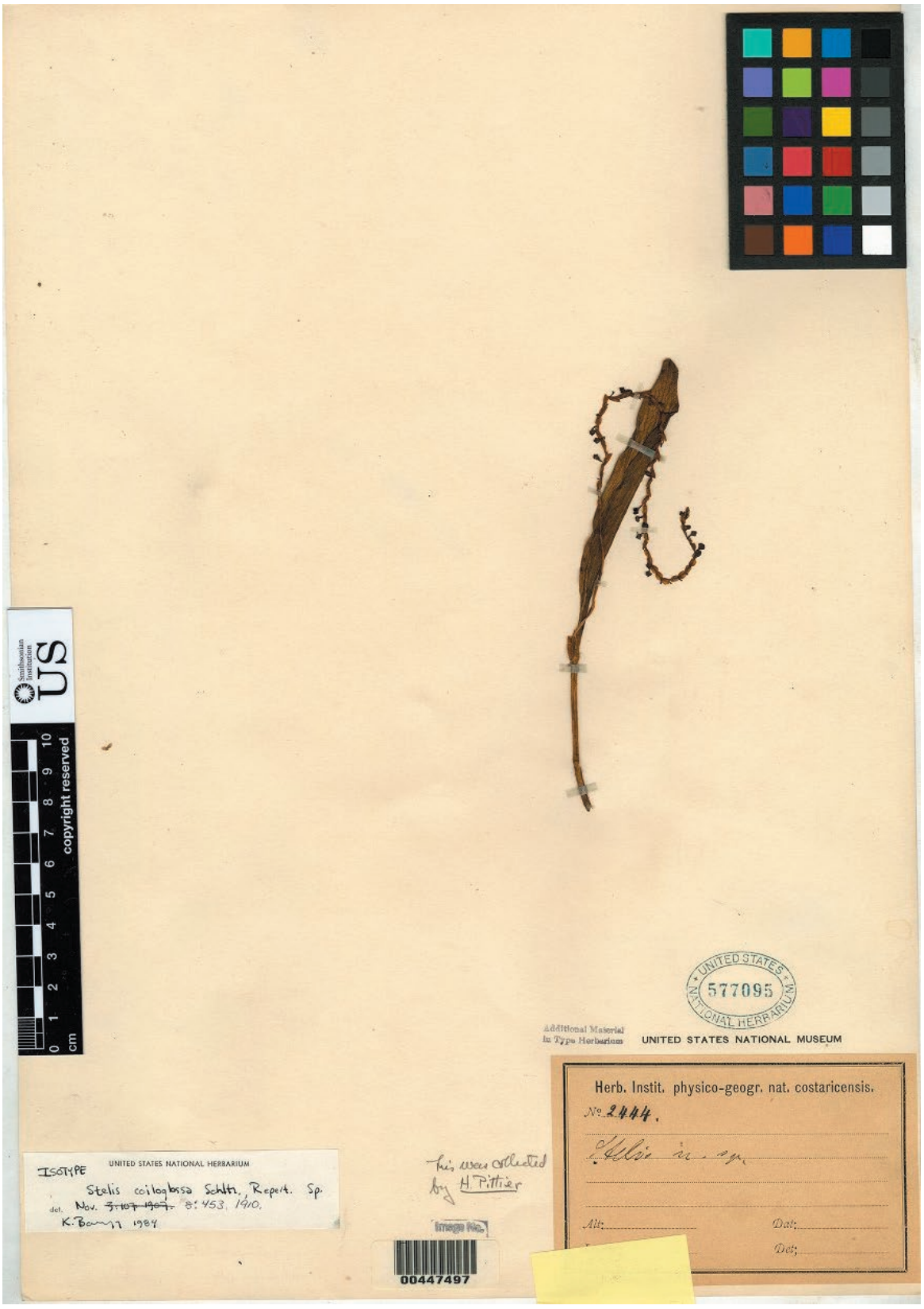

Figure 83. Lectotype of *Stelis coiloglossa* (US 00093548). Courtesy of the United States National Herbarium (US).

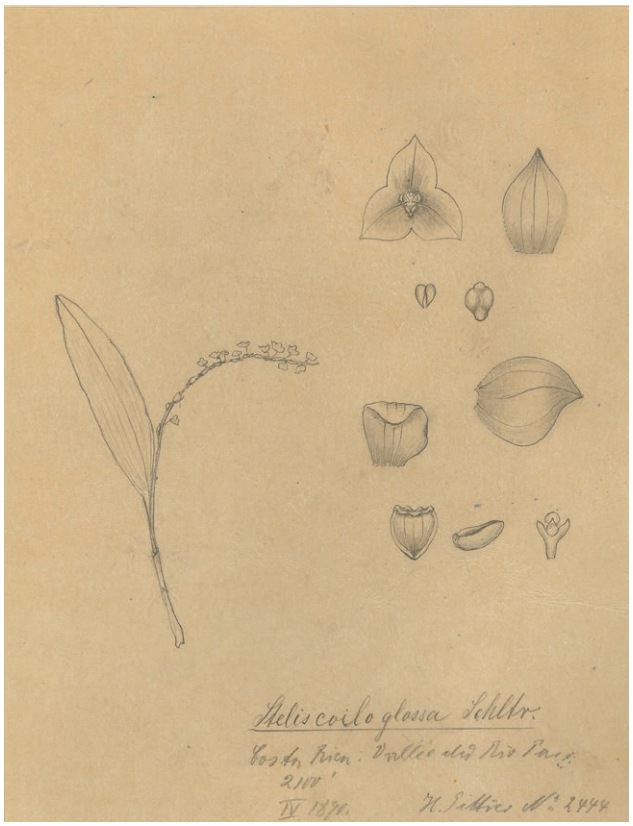

Figure 84. Tracings of Schlechter's original illustration from the holotype of *Stelis coiloglossa*, made under Schlechter's supervision (AMES 23704). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Figure 85. Tracing of Schlechter's drawing from the holotype of *Stelis cooperi* (AMES 23708). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Jiménez 621. Holotype, B, destroyed; lectotype, designated by Luer (2009), CR 34100! (Figure 90); isolectotype, a dried leaf, photo of the holotype, illustration, and flower preserved on glycerin slide, AMES 55235; Schlechter´s floral analysis of the holotype, reproduced in Mansfeld (1931: Pl. 24, No. 94!).

Since the holotype of *S. jimenezii* was destroyed during the bombing of Berlin-Dahlem herbarium, Ignowski et al. (2015) designated an isotype deposited at AMES herbarium as lectotype (AMES 5523). However, the lectotypification was superfluous since a lectotype was already designated by Luer (2009) using an isotype deposited at CR herbarium (Figure 90).

Stelis jimenezii has been considered as synonym of *Stelis ciliaris* Lindl. by Ames (1935), Luer (2009), Bogarín et al. (2014), and Ignowski et al. (2015). When described, no indumentum was mentioned for the perianth of *S. jimenezii*; however, the flowers from the holotype illustrated by Ames (1935) have short and long trichomes on the adaxial surface, with remains of the broken marginal trichomes. This character is diagnostic of *S. ciliaris*, which has sepals with margins ciliate to the apex.

According to Luer (2009), *S. ciliaris* has considerable variation in its wide distribution, with sepals about two millimeters long and broad, but large flowers with sepals up to five millimeters long occur. The sepals long-ciliate up to the apex are also variable, and trichomes are challenging to observe and may get lost on dry specimens. This variation was discussed by Ignowski et al. (2015) for the Brazilian material of *S. ciliaris* together with the variation in the color of sepals: trichomes may be present only on the tip of one of the sepals, completely absent in flowers of some population, or caducous in some individuals, where they fall off with flower aging. The color of the perianth ranges from rose to red-purple, purple-green, green, and greenish-yellow; a variation that led to the description of several taxa now included under the synonymy of *S. ciliaris* (Ignowski et al. 2015).

Figure 86. Lectotype of *Stelis cooperi* (BR 0000006594138). Courtesy of the Meise Botanic Garden Herbarium.

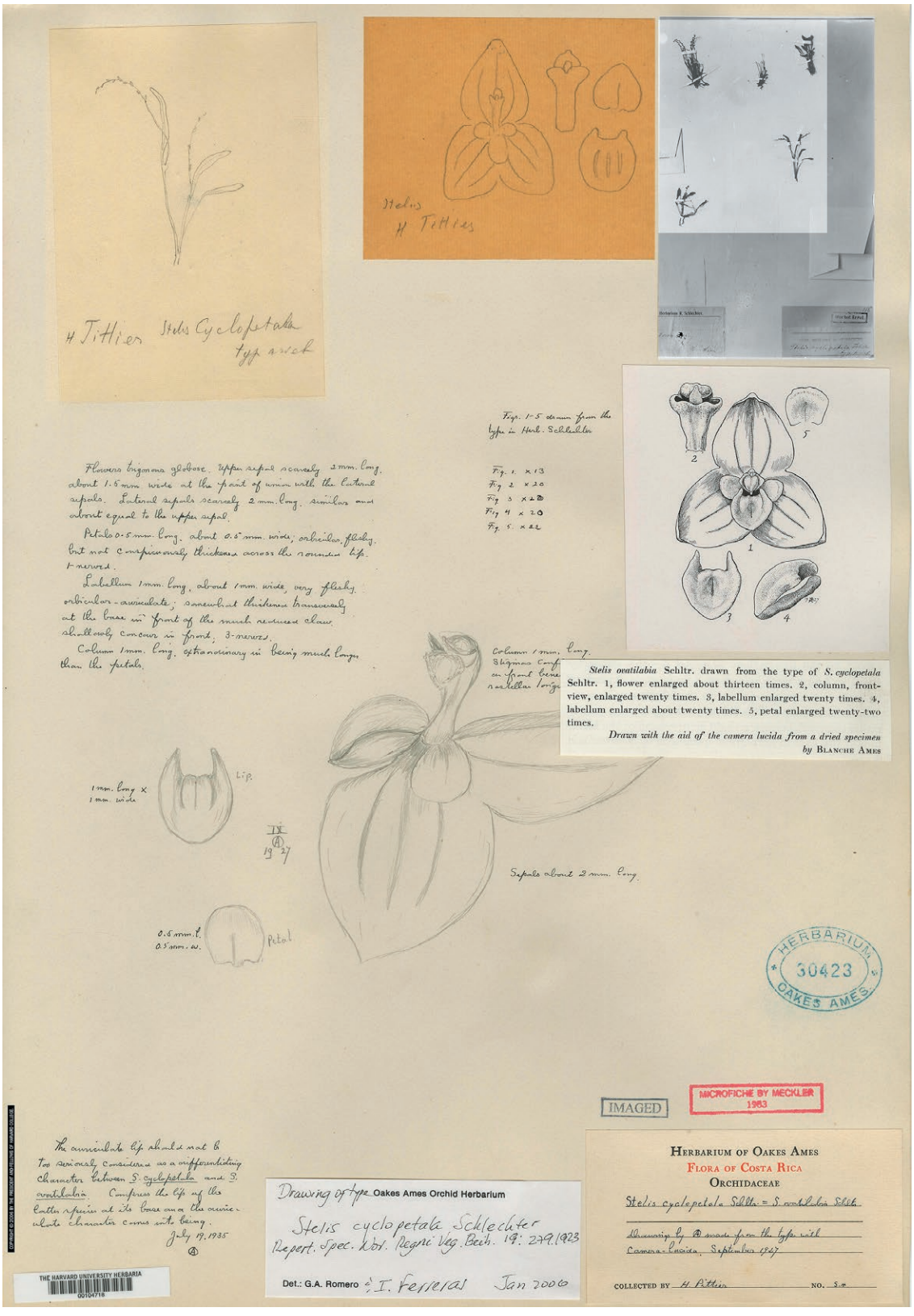

Figure 87. Lectotype of *Stelis cyclopetala* (AMES 30423). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

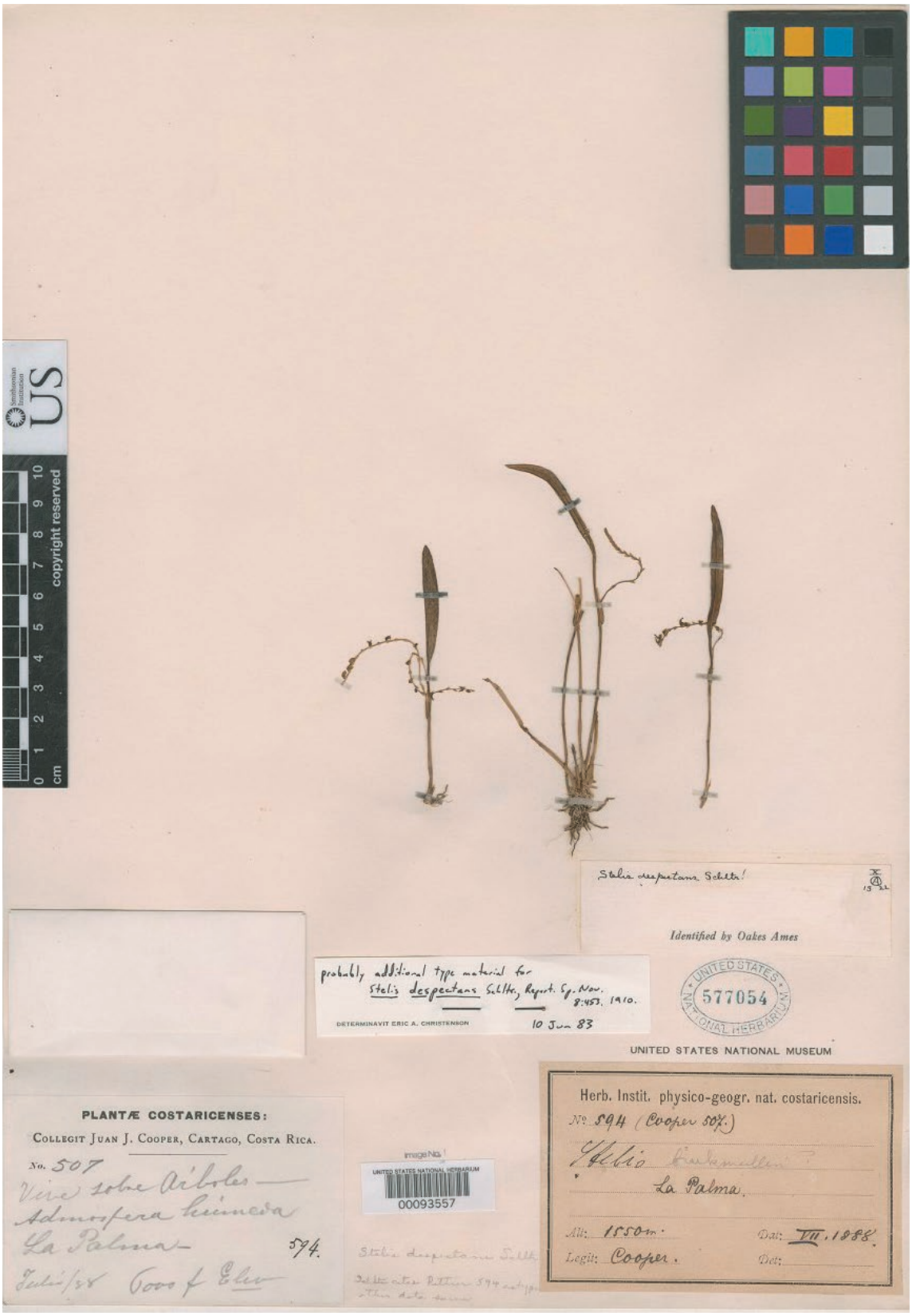

Figure 88. Lectotype of *Stelis despectans* (US 577054). Courtesy of the United States National Herbarium (US).

Figure 89. Copy of Schlechter's drawing from the holotype of *Stelis despectans* (AMES 23714). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

50. *Stelis tonduziana* Schltr., Beih. Bot. Centralbl., Abt. 2 36(2): 393. 1918

Type: [Costa Rica.] La Hondura, La Palma, 2500 m, May 1912, *O. Jiménez 618* (Holotype, B, destroyed; copy of Schlechter's drawing of the holotype, AMES (24938 / HUH-00105009!), designated here as lectotype (Figure 91), reproduced in Mansfeld (1931: Pl. 27, No. 108!).

We were unable to locate extant specimens that could be considered original material collected by O. Jiménez referable to *S. tonduziana*. Therefore, we select the copy of Schlechter's drawing of the holotype at AMES as lectotype. The drawing includes a plant habit with two ramicauls and one inflorescence in each stem, and a front view of a flower with a dissection. Schlechter (1918a) described the species with unifoliate stems, anguste-ligulate, obtuse leaves, racemose inflorescences surpassing the leaves, subnutant flowers with ovate, subacute, 5-nerved sepals, obtrapezoid petals, and a quadrate, fleshy lip. These features match with Schlechter's drawing of the holotype at AMES (24938).

Stelis tonduziana Schltr. is the basionym of *Apatostelis tonduziana* (Schltr.) Garay. The name *Stelis mirabilis* Schltr. has been considered a synonym of *S. tonduziana*.

51. *Telipogon biolleyi* Schltr., Repert. Spec. Nov. Regni Veg. 9(214–216): 293. 1911

Type: Costa Rica: sur un tronc dans les forêts du Barba, 31.VIII.1889 (in den Wäldern des Vulcan Barba, blühend im August 1889), *P. Biolley 1340*. Holotype, B, destroyed; lectotype, designated by Dodson and Escobar (1987), US 577067! (Figure 92); copy of Schlechter's sketch of the holotype, with a drawing of the plant habit and analysis of the flower, AMES 24892! (Figure 93); Schlechter´s floral analysis of the holotype reproduced in Mansfeld (1931: Pl. 78, No. 309!).

Telipogon biolleyi is found in Panama and Costa Rica. In the latter it is found from 1300 to 2000 meters in elevation and is one of the most common and widely distributed species in the genus. The species was named in honor of P. Biolley, who collected the species around the Barba Volcano in Heredia, Costa Rica. Since the holotype of *T. biolleyi* was destroyed at Berlin-Dahlem herbarium, Dodson and Escobar (1987) designated the isotype US 577067, which comprised a dried plant with the inflorescence lacking flowers, as lectotype.

Among the species found in Costa Rica and Panama, *T. biolleyi* is characterized by the small habit, up to 5 cm tall, with the inflorescence longer than the leaves, up to 20 cm long, and flowers yellowish with the base of the petals and lip dark-red to brownish, and a conspicuous, thick, elevated, circular to ovate, hispidulous callus occupying 1/3 of the lip surface at the base. The callus of the lip is well illustrated in the copy of the sketch of the holotype made by Schlechter, reproduced in Mansfeld (1931) and traced for the herbarium of Oakes Ames (Figure 93).

Dodson and Escobar (1987) considered *Telipogon endresianus* Kraenzl. an heterotypic synonym of *T. biolleyi*.

52. *Telipogon pfavii* Schltr., Repert. Spec. Nov. Regni Veg. 17: 143-144. 1921

Type: Costa Rica. Ohne genauere Standortsangabe [without exact location], *R. Pfau 9301*. Holotype, not located; tracings of Schlechter's drawing of the holotype,

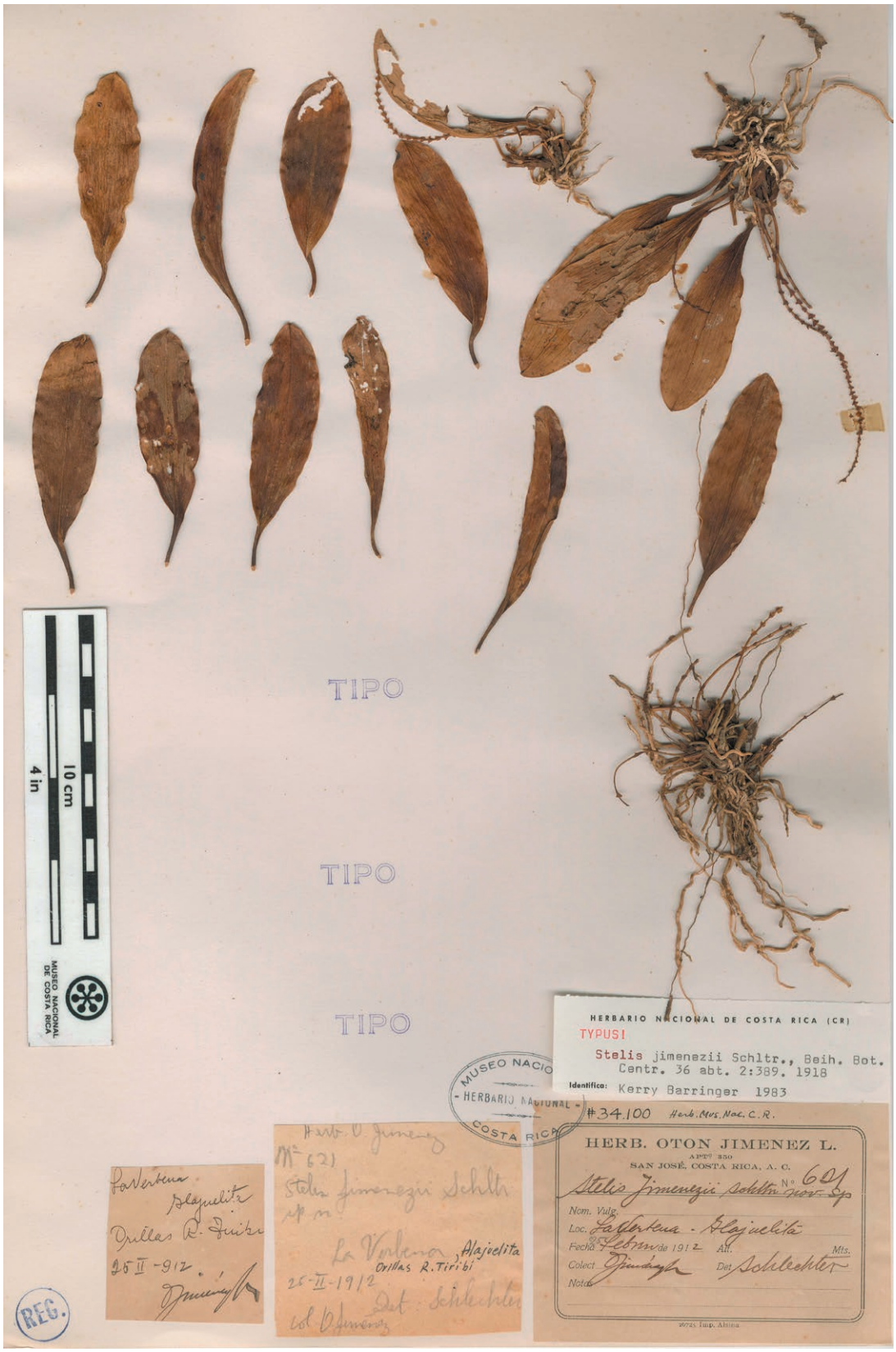

Figure 90. Lectotype of *Stelis jimenezii* (CR 34100). Courtesy of the Herbario Nacional de Costa Rica.

Figure 91. Lectotype of *Stelis tonduziana* (AMES 24938). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

AMES 24894 / HUH 00105221!, designated here as lectotype (Figure 94); floral analysis from the holotype reproduced in Mansfeld (1931: Pl. 78, No. 311!).

The tracings of the type's original illustration, designated here as lectotype, are the only known original material of *Telipogon pfavii*. The flower tracings show the reticulate to nervose flowers with wide petals and the lip with a pink callus that does not surround the column, unlike similar *Telipogon* species like *Telipogon ballesteroi* Dodson & R.Escobar and *Telipogon cascajalensis* Dodson & R.Escobar. In addition, the column shows a short fascicule of spines on each side of the anther, difficult to detect at sight.

In their treatment of the Costa Rican species of *Telipogon*, Dodson and Escobar (1987) included a copy from the tracings of *T. pfavii* saved at AMES (00105221), accompanied by two images of a plant of *T. pfavii* collected by Calaway Dodson and Clarence Horich in Costa Rica in 1962 (*s.n.*, "Costa Rica: El Cedral, Jul-Aug 1962"). The plant, photographed by Leon Glicenstein 15 years later (images saved at JAUM and RPSC), is the only record of *T. pfavii* that we have seen. Unfortunately, no specimens from this collection were prepared at the time.

53. *Vanilla pompona* subsp. *pittieri* (Schltr.) Dressler, Lankesteriana 9: 341. 2010

Type: Costa Rica. [Puntarenas:] In der Wäldern an Ufern des Rio Ceibo bei Buenos Aires, c. 200 m [1892]; blühend im Januar 1890, *H. Pittier 6600* (holotype, B, destroyed; drawing of the holotype, AMES 24329 / HUH 00090744!); lectotype designated by Karremans et al. 2020, BR 642325 / barcode 0000006423254! (Figure 95); isolectotypes, US 579442 / barcode 00319514!; US 814996 / barcode 00093334!

Vanilla pittieri Schltr. in the basionym of *Vanilla pompona* subsp. *pittieri*. Dressler created the latter to categorize a population of *Vanilla pompona* Schiede in the Costa Rican southern Pacific slope, which apparently is distinguished from the typical *V. pompona* by having elliptical (vs. oblong) leaf blades and the simple lip with entire margin (vs. simple, with undulate, apically denticulate to dentate, recurved margin) (Soto Arenas and Dressler 2010).

Schlechter (1906d) described *Vanilla pittieri* with long, voluble, smooth, foliate stems, shortly petiolate, oblong, acuminate, fleshy-textured leaves, axillary inflorescences bearing to 10 flowers, floral bracts shorter than the ovary, lingulate, obtuse, subfalcate, pluri-veined sepals 7.5 mm long, oblique lateral sepals, petals similar to sepals, pluri-veined, with sinuous and parallel veins, lip shorter than sepals, obovate-spatulate, linear-unguiculate, obtuse, pluri-veined, with sinuous and parallel veins, a penicillate callus in the third apical, made up by flabelliform, laciniate, congested, retrorse scales, thin column 5.5 cm long, widening towards the apex, subquadrate, cucullate anther cap, and cylindrical ovary 3 cm long. Schlechter indicated that *V. pittieri* is well distinguished from other species of *Vanilla* by floral morphology, but above all, by the strange veins of the petals and lip, and that it has large flowers, similar to the flowers of *V. pompona*, but he did not discuss how to separate them. The characters mentioned by Schlechter are consistent with the type specimens and the drawing of the holotype at AMES.

Figure 92. Lectotype of *Telipogon biolleyi* (US 577067). Courtesy of the United States National Herbarium (US).

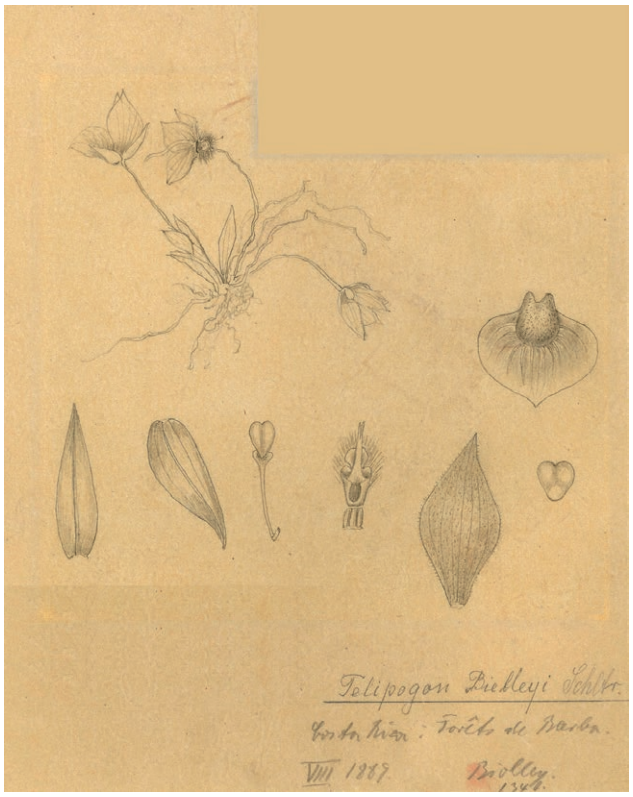

Figure 93. Tracings of Schlechter's sketch of the plant habit and analysis of the flower from the holotype of *Telipogon biolleyi* (AMES 24892). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

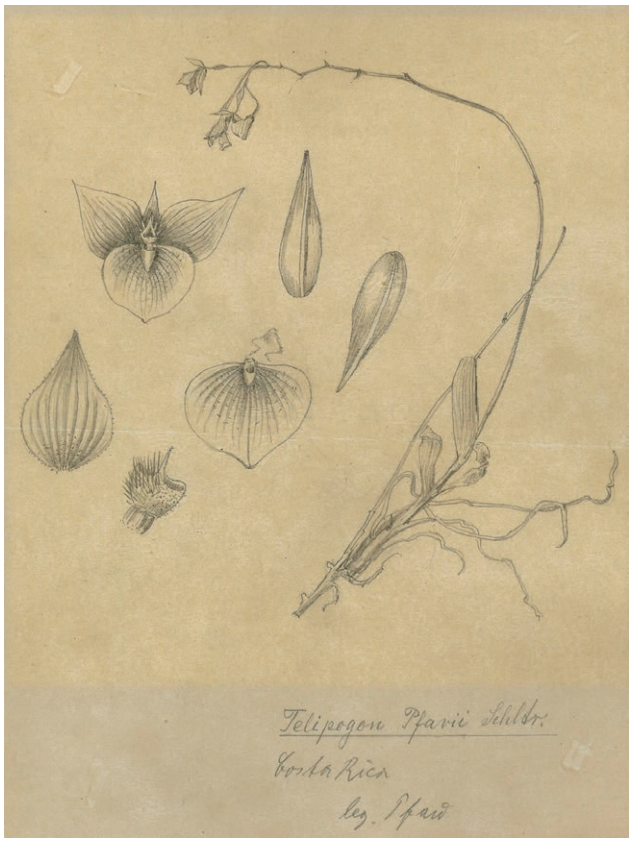

Figure 94. Tracings of Schlechter's drawing from the holotype of *Telipogon pfavii* (AMES 24894). Courtesy of the Harvard University Herbaria, reproduced with permission of the President and Fellows of Harvard College.

Nevertheless, *V. pittieri* or *V. pompona* subsp. *pittieri* cannot be distinguished from the widely distributed *V. pompona*. The distinctive characters that Schlechter diagnosed are due to an artifact of the drying of the type material. Karremans et al. (2020) studied specimens from the type locality of *V. pittieri* and provided a modern illustration of a specimen collected there. They concluded that *V. pittieri* is indistinguishable from *V. pompona*, and therefore conspecific.

ACKNOWLEDGMENTS

We are thankful to the curators and staff of the herbaria to whom we directed our requests of information and who assisted us in retrieving suspected collections by Lehmann stored at their institutions, and in particular to Ann Bogaerts (Plantentuin Meise, Belgium), Christian Bräuchler (Natural History Museum Vienna, Austria), Hans-Joachim Esser (Staatliche Naturwissenschaftliche Sammlungen Bayerns, München, Germany), Norbert Holstein (Natural History Museum, London. U.K.), Vanessa Invernon (Muséum National d'Histoire Naturelle, Paris, France), Ingrid P. Lin and Susan Lutz (National Herbarium, Smithsonian Institution. Washington, U.S.A.), Silvia Lobo, Armando Estrada and Alexander Rodríguez (Museo Nacional de Costa Rica), Alan Paton (Royal Botanic Gardens, Kew, U.K.), Matthias Schultz (Herbarium Hamburgense, University of Hamburg, Germany), and Fred Stauffer (Conservatoire et Jardin botaniques de la Ville de Genève, Switzerland). The precise annotations, corrections and suggestions by Phillip J. Cribb and Adam P. Karremans on the first draft of the manuscript greatly improved the final version presented here to the readers. This study was conducted in partial fulfillment of the Project 814-B2-043, "*Tipificaciones de especies de orquídeas descritas por R. Schlechter en Costa Rica y Panamá*" supported by the Vice-Presidency of Research, University of Costa Rica.

Figure 95. Lectotype of *Vanilla pittieri* (BR 0000006423254). Courtesy of the Meise Botanic Garden Herbarium.

REFERENCES

Ames O. 1923. Letters to Charles H. Lankester, 24 August and 18 December.

Ames O. 1908a. Orchidaceae: Illustrations and studies of the family Orchidaceae. Fascicule II. Boston (MA): Houghton, Mifflin and Company.

Ames O. 1908b. Orchidaceae: Illustrations and studies of the family Orchidaceae. Fascicle III. Boston (MA): Merrymount Press.

Ames O. 1935. Studies in *Stelis*. V. Two rare species from middle America. Bot Mus Leafl. 3(10): 149–176.

Ames O. 1944. Destruction of the Schlechter Herbarium by bombing. Amer Orchid Soc Bull. 13(4): 105–106.

Angell B, Romero R. 2011. Orchid Illustrations at Harvard. The Bot Artist. 17(1): 20–21.

Apuntes para la biografía de Nevermann. 1938. Revista Agric. 10(8): 334–345.

Atwood JT. 1987. The vascular flora of La Selva Biological Station, Costa Rica. Orchidaceae. Selbyana. 10(1): 76–45.

Atwood JT. 1989. Orchids of Costa Rica. Part 1. Icon. Pl. Trop. 14: t. 1301–1400.

Atwood JT. 1999. *Maxillaria* Ruiz & Pavón. In: Atwood JT, Mora-Retana DE. (eds.) Family #39 Orchidaceae: Tribe Maxillarieae: subtribes Maxillariinae and Oncidiinae. Chicago Natural History Museum, Chicago, pp. 32–84.

Atwood JT. 2003. *Maxillaria*. In: Hammel BE, Grayum MH, Herrera C, Zamora N. (eds.). Manual de plantas de Costa Rica. Vol. III. Monocotiledóneas (Orchidaceae-Zingiberaceae). Saint Louis (MO): Missouri Botanical Garden Press, pp. 291–332.

Atwood JT, Mora DE. 1999. Family #39 Orchidaceae: Tribe Maxillarieae: subtribes Maxillariinae and Oncidiinae. In: Burger WC. (ed.). Flora Costaricensis. Fieldiana, Bot., n.s. 40, pp. 1–182.

Barringer K. 1986. Typification of Schlechter´s Costa Rican Orchidaceae I. Types collected by A. Brenes. Fieldiana, Bot., n.s. 17: 1–24.

Blanco MA. 2013. New combinations and synonyms in the Maxillariinae (Orchidaceae). Selbyana. 31(1): 52–59.

Blanco MA, Carnevali G, Whitten WM, Singer RB, Koehler S, Williams NH, Ojeda I, Neubig KM, Endara L. 2007. Generic realignments in Maxillariinae (Orchidaceae). Lankesteriana. 7(3): 515–538.

Bogarín D, Warner J, Powell M, Savolainen V. 2011. The orchid flora of Cocos Island National Park, Puntarenas, Costa Rica. Botanical Journal of Linnean Society. 166(1): 20–39.

Bogarín D, Serracín Hernández Z, Samudio Z, Rincón R, Pupulin F. 2014. An updated checklist of the Orchidaceae of Panama. Lankesteriana. 14(3): 135–364.

Butzin F. 1978. ln Berlin vorhandene Typen von Schlechters Orchideenarten. Willdenowia. 8(2): 401–407.

Butzin F. 1980. Typenstudien im Berliner Orchideen-Herbar: Arten von Kränzlin und Mansfeld. Willdenowia. 10: 147–149.

Christenson EA. 1996. Notes on Neotropical Orchidaceae II. Lindleyana. 11(1): 12–26.

Crain BJ, Fernández M. 2020. Biogeographical analyses to facilitate targeted conservation of orchid hotspots in Costa Rica. Diversity and Distribution. 26: 853– 866.

Cribb P. 2010. The orchid collections and illustrations of Consul Friedrich C. Lehmann. Lankesteriana. 10(2–3): 5–217.

Damián A, Salazar GA, Mitidieri N, Altamirano, S. 2020. A new species and first record of the genus *Solenocentrum* (Orchidaceae: Cranichidinae) from Peru. Lankesteriana. 20(3): 339–344.

Díaz RE, Solano Chaves FJ. 2009. Costa Rica: Desarrollo científico. Una mirada en su historia natural a través de Paul Biolley Matthey (1886–1908). In: Lértora CA (ed.). Geografía e Historia Natural: hacia una historia comparada. Estudio a través de Argentina, México, Costa Rica y Paraguay. Buenos Aires: Ediciones FEPAI; pp. 209-238.

Dodson CH. 2004. Native Ecuadorian Orchids, Vol. V: *Rodriguezia–Zygosepalum*. Sarasota (FL): Dodson Publishing.

Dodson CH, Escobar R. 1987. The Telipogons of Costa Rica (I). Orquideología. 17: 3–69.

Doucette A, Timyan J, Henrys I, Cameron KM. 2016. A tiny new species of *Specklinia* from Haiti's Parc National Naturel Macaya and new combinations in *Acianthera* (Pleurothallidinae, Epidendreae, Epidendroideae, Orchidaceae). Phytotaxa. 275(3): 263–276.

Döring M. 2017. GBIF Type Specimen Names. GBIF Secretariat. Checklist dataset [accessed 2020 Nov 16] https://doi.org/10.15468/sl9pyf

Dressler RL. 1966. Some observations on *Gongora*. Orchid Digest. 30: 220–223.

Dressler RL. 2001. Sobre el género *Chondroscaphe*, con dos especies nuevas de América Central, *Chondroscaphe atrilinguis* y *C. laevis*. Orquideología. 22(1): 12–22.

Dressler RL. 2003. Orchidaceae. In: Hammel BE, Grayum MH, Herrera C, Zamora N. (eds.). Manual de plantas de Costa Rica. Vol. III. Monocotiledóneas (Orchidaceae-Zingiberaceae). Saint Louis (MO): Missouri Botanical Garden Press, pp. 1–595.

Evans S. 1999. The green republic, a conservation history of Costa Rica. Austin (TX): University of Texas Press.

Garay LA. 1978. Flora of Ecuador, 225(1). Orchidaceae: Cypripedioideae, Orchidoideae, Neottioideae. In: Harling G, Sparre B. (eds). Flora of Ecuador 9. University of Goteborg, Stockholm, Sweden, pp. 1–305.

Goethart JWC. 1910. Die Boerhaave'schen Copien der Abbildungen des Botanicon Americanum von Plumier. Meded. Rijks-Herb. 5(1): 75.

Guimarães LRS, Salazar Chávez GA, Barros F. 2019. Lectotypifications and taxonomic notes in the *Stenorrhynchos* clade (Spiranthinae, Orchidaceae). Phytotaxa. 394(1): 111–117.

Hágsater E. 2009. The genus *Epidendrum*. Part 8. "Species new & old in *Epidendrum*". Icon. Orchid. 12: t. 1201–1300.

Hágsater E. 2010. The genus *Epidendrum*. Fascicle 13. Part 9. "Species new & old in *Epidendrum*". Icon. Orchid. 13: t. 1301–1400.

Hermans J, Verlynde S., Rajaovelona L, Cribb, PJ, Hervouet JM. 2020. New species and nomenclatural changes in *Angraecum* (Orchidaceae) from Madagascar. Kew Bulletin. 75(4): 1–20.

Hiepko P. 1987. The collections of the Botanical Museum Berlin-Dahlem (B) and their history. Englera. 7: 219–252.

Hilje L. 2007. *Karl Hoffmann, Cirujano Mayor del Ejército Expedicionario*. Alajuela, Costa Rica: Editorial Colegio Universitario de Alajuela (CUNA).

Hilje L. 2014. Aquella inexplorada region de San Carlos. Herencia. 27(1–2): 77–110.

Hilje L. 2018. José Cástulo Zeledón, primer naturalista costarricense. Ci. Amb. 52(1): 209–220.

Hoehne FC. 1945. Orchidaceae. In: Hoehne FC, editor. Flora Brasilica, vol. 12, part 2. Sao Paulo: Secretaria da Agricultura, Indústria e Comércio de Sao Paulo, pp. 1–389.

Ignowski H, Toscano de Brito A, Bona C, Smidt E. 2015. Nomenclatural notes on *Stelis ciliaris* (Pleurothallidinae, Orchidaceae). Phytotaxa. 218: 30–38.

IPNI: International Plant Names Index. 2020. The Royal Botanic Gardens, Kew, Harvard University Herbaria & Libraries and Australian National Botanic Gardens; [accessed 2020 Nov 16]. http://www.ipni.org.

Jenny R. 1993. Monograph of the genus *Gongora* Ruiz & Pavon. Champaign (IL): Koeltz Scientific Books.

Jiménez O. 1959. Alfredo Brade, naturalista. Brecha. 4(3): 1-3.

Jiménez O. 1967. Charles Herbert Lankester. Revista Agric. 248–264.

Karremans AP. 2019. To be, or not to be an *Stelis*. Lankesteriana. 19(3): 281–343.

Karremans AP, Bogarín D. 2013. Costa Rica, land of endless orchids. Orchids (West Palm Beach). 82(7): 408–411.

Karremans AP, Vieira-Uribe S. (eds.). 2020. *Pleurothallids, Neotropical jewels, volume I*. Quito, Ecuador: Imprenta Mariscal.

Karremans AP, Chinchilla IF, Rojas-Alvarado G, Cedeño-Fonseca M, Damián A, Léotard G. 2020. A reappraisal of Neotropical *Vanilla*. With a note on taxonomic inflation and the importance of alpha taxonomy in biological studies. Lankesteriana. 20(3): 395–497.

Kolanowska M. 2014. Orchids of the Darién Gap. Koenigstein (HE): Koeltz Scientific Books.

Königer W, Pongratz D. 1999. Neue Lectotypen. Arcula. 9: 265.

Kränzlin F. 1899. Orchidaceae Lehmannianae in Guatemala, Costarica, Columbia et Ecuador collectae, quas determinavit et descripsit. Beibl Bot Jahrb Syst. 26(2-3): 437–502.

Lindley J. 1830–1840. The Genera and Species of Orchidaceous Plants. London: J. Ridgways & Sons.

Linnaeus C. 1759. *Systema Naturae per regna tria naturae… Editio decima, reformata* [10th revised edition]. Vol. 2. Holmiae (SK): Impensis Direct. Laurentii Salvii.

Lobo CS. 2003. Colección Tipo del Herbario Nacional de Costa Rica (CR). IV. Revisión y actualización de las monocotiledóneas. Brenesia. 59–60: 21–34.

Lobo CS. 2004. Tipos de Orquidáceas brenesianas, descritas por R. Schlechter, en el herbario nacional de Costa Rica. Lankesteriana. 4(1): 37–45.

Luer CA. 1987. New *Lepanthes* species from Costa Rica and Panama. Lindleyana 2: 185–217.

Luer CA. 1988. Icones Pleurothallidinarum V. Systematics of *Dresslerella* and *Scaphosepalum*. Addenda to *Porroglossum*. Monographs in Systematic Botany from the Missouri Botanical Garden. 26: 21–106.

Luer CA. 1990. Icones Pleurothallidinarum VII. Systematics of *Platystele*. Monographs in Systematic Botany from the Missouri Botanical Garden. 38: 1–135.

Luer CA. 1994. Icones Pleurothallidinarum XI. Systematics of *Lepanthes* subgenus *Brachycladium* and *Pleurothallis* subgenus *Aenigma*, subgenus *Elongatia*, subgenus *Kraenzlinella*. Addenda to *Dracula*, *Lepanthopsis*, *Myoxanthus*, *Platystele*, *Porroglossum* and *Trisetella*. Monographs in Systematic Botany from the Missouri Botanical Garden. 52: 1–137.

Luer CA. 1998. Icones Pleurothallidinarum XVII. Systematics of subgen. *Pleurothallis* sect. *Abortivae* sect. *Truncatae* sect. *Pleurothallis* subsect. Acroniae subsect. *Pleurothallis* subgen. *Dracontia* subgen. *Unciferia*. Addenda to Dracula, *Lepanthes*, *Masdevallia*, *Porroglossum* and *Scaphosepalum*. (Orchidaceae). Monographs in Systematic Botany from the Missouri Botanical Garden. 72: 1–121.

Luer CA. 2000. Icones Pleurothallidinarum XIX: Systematics of *Masdevallia* Part One. *M.* subgenus *Polyantha*, section *Alaticaules*, section *Polyanthae*. Monographs in Systematic Botany from the Missouri Botanical Garden. 77: 1–264.

Luer CA. 2000. Icones Pleurothallidinarum XX. Systematics of *Jostia*, *Andinia*, *Barbosella*, *Barbrodria*, *Pleurothallis* subgen. *Antilla*, subgen. *Effusia*, subgen. *Restrepioidia*. Monographs in Systematic Botany from the Missouri Botanical Garden. 79: 1–74.

Luer CA. 2009. Icones Pleurothallidinarum XXX. *Lepanthes* of Jamaica: Systematics of *Stelis*: *Stelis* of Ecuador. Part 4; Addenda, systematics of *Masdevallia*: new species of *Lepanthes* from Ecuador, and miscellaneous new combinations. Monographs in Systematic Botany from the Missouri Botanical Garden. 115: 1–265.

Luer CA. 2017. Icones Stelidarum (Orchidaceae) Colombiae IV. Harvard Papers in Botany. 22(2): 81–112.

Luer CA. 2018. Icones Stelidarum (Orchidaceae) Colombiae V. Harvard Papers in Botany. 23(1): 19–45.

Mansfeld R. 1929. Figuren-Atlas zu den Orchideenfloren der südamerikanischen Kordillerenstaaten von R. Schlechter. Repert Spec Nov Regni Veg. Beih. 57: t. 1–142.

Mansfeld R. 1931. Blütenanalysen neuer Orchideen von R. Schlechter. II. Mittelamerikanische Orchideen. Repert Spec Nov Regni Veg Beih. 59: t. 1–81.

May RH. 2016. En los pasos de Zeledón. Historia de la ornitología nacional y la Asociación Ornitológica de Costa Rica. San José: Editorial Asociación Ornitológica de Costa Rica.

McLeish I, Pearce NR, Adams BR. 1995. Native Orchids of Belize. Rotterdam (NL): Balkema.

Mora DE, Atwood JT. 1992. Orchids of Costa Rica. Part 2. Icon. Pl. Trop. 15: t. 1401–1500, 1305a, 1344a, 1362a.

Mora DE, Atwood JT. 1993. Orchids of Costa Rica. Part 3. Icon. Pl. Trop. 16: t. 1501–1600, 1454a, 1455a, 1492a, 1539, 1572.

Ormerod P. 2002. Taxonomic changes in Goodyerinae (Orchidaceae: Orchidoideae). Lindleyana. 17: 189–238.

Ormerod P. 2008. Studies of Neotropical Goodyerinae (Orchidaceae) 3. Harvard Papers in Botany. 13(1): 55–87

Ossenbach C. 2009. Orchids and orchidology in Central America. 500 years of history. Lankesteriana. 9(1–2): 1–268.

Ossenbach C. 2013. Auguste R. Endrés (1838–1874) — His life. In: Ossenbach C, Pupulin F, Jenny R. (eds.). Orchids in the Life and Work of Auguste R. Endrés. Vol. 1. The Texts. Naturhistorisches Museum, Vienna, Austria. Pp. 83–111.

Ossenbach C. 2016. Orchids and Orchidology in the Antilles: An Encyclopaedic History. Oberreifenberg (HE): Koeltz Botanical Books.

Ossenbach C, Dressler RL, Pupulin F. 2007. Orchids of the American isthmus: checklist and conservation status. San José (CR): Ed. Orquideario 25 de mayo.

Ossenbach C, Pupulin F. 2013. Orchid Collecting on that Rich Coast. In: Ossenbach C, Pupulin F, Jenny R. (eds.). Orchids in the Life and Work of Auguste R. Endrés. Vol. 1. The Texts. Naturhistorisches Museum, Vienna, Austria. Pp. 83–111.

Ossenbach C, Pupulin F, Jenny R. 2010. Orchid itineraries of Augustus R. Endrés in Central America: a biographic and geographic sketch. Lankesteriana. 10(1):19–47.

Ossenbach C, Pupulin F, Jenny R (eds.) 2013. Orchids in the life and work of Auguste R. Endrés. Vol. 2. The Illustrations and the Catalogue. Wien: Verlag des Naturhist. Mus. Wien.

Pfau R. 1883. The climate of Central America, Orchid culture. Gard. Chron., n.s. 20: 599–600.

Pfau R. 1894. Notes on fertilisation of orchids in the tropics. Orchid Review. 2: 295–296.

Pfau R, ca. 1895. New, rare, and beautiful orchids of Costa Rica. San José (CR): San José.

Pfau. R. 1896. Costa Rica and its orchids. Gard. Chron., 3 s. 19: 548–549.

Plumier C, Burman J. 1755. *Plantarum americanarum fasciculus primus* […]. Amstelaedami (NL): Sumtibus Auctoris.

Prado J, Hirai RY, Moran RC. 2020. (026) Proposal to add a new recommendation after Article 7 and a new entry to the Glossary. Taxon. 69: 1379–1380.

Pridgeon AM, Chase MW. 2001. A phylogenetic reclassification of Pleurothallidinae (Orchidaceae). Lindleyana. 16: 235–271.

Pupulin F. 1998. Orchid florula of Parque Nacional Manuel Antonio, Quepos, Costa Rica. Revista de Biologia Tropical. 46(4): 961–1031.

Pupulin F. 2002. Catálogo revisado y anotado de las Orchidaceae de Costa Rica. Lankesteriana. 4: 1–88.

Pupulin F. 2009. *Benzingia reichenbachiana*. Curtis's Botanical Magazine. 26(3): 237–244, pl. 652.

Pupulin F. 2010a. Orchidaceae werckleanae: typification of Costa Rican orchid species described from collections by K. Wercklé. Botanical Journal of the Linnean Society. 163: 111–154.

Pupulin F. 2010b. Family #39 Orchidaceae: Tribe Cymbidieae: Subtribe Zygopetalinae. In: W. Burger (ed.). Flora Costaricensis. Fieldiana, Bot., n.s. 49: 1–60.

Pupulin, F. 2013. Endrés as an Illustrator. In: Ossenbach C, Pupulin F, Jenny R. (eds.). Orchids in the Life and Work of Auguste R. Endrés. Vol. 1. The Texts. Naturhistorisches Museum, Vienna, Austria. Pp. 182–218.

Pupulin F, Karremans A. 2007. The strange story of Hoffmann's two Epidendrums. Orchids (West Palm Beach). 77(6): 454–457.

Pupulin F, Dressler RL, Medina H. 2009. A revision of the white-flowered species of *Chondroscaphe* (Orchidaceae: Zygopetalinae). Orchid Digest .72(1): 32–51.

Pupulin F, Bogarín D. 2010. Illustrations and studies in Neotropical Orchidaceae — The *Lepanthes jimenezii* group (Pleurothallidinae). Harvard Papers in Botany. 15(1): 111–121.

Pupulin F, Ossenbach C, Jenny R, Vitek, E. 2011. Typi Orchidacearum ab Augusto R. Endresio in Costa Rica lecti. Ann. Naturhist. Mus. Wien, B 112: 265–313.

Pupulin F, Ossenbach C, Jenny R, Vitek E. 2013. Species Endresianae. In: Ossenbach C, Pupulin F, Jenny R. (ed.). Orchids in the life and work of Auguste R. Endrés. Vol. 1. The Texts. Vienna: Verlag des Naturhist. Mus. Wien, pp. 305–343.

Pupulin F, Bogarín D, Fernández M., Díaz-Morales M, Aguilar V J, Ossenbach Sauter, C. 2016. Orchidaceae tonduzianae: typification of Costa Rican Orchidaceae described from collections of Adolphe Tonduz. Harvard Papers in Botany. 21(2): 263–320.

Pupulin F, Dalström S. 2020. *Oncidium* Sw. In: Pupulin F, and collaborators. (ed.). Vanishing Beauty, Native Costa Rican Orchids. Vol. 2: *Lacaena–Pteroglossa*. Oberreifenberg (HE): Koeltz Botanical Books, pp. 748–785.

Regel E. 1883. Herr F.C. Lehmann. Gartenflora 32: 887.

Reichenbach HG. 1852. Neue Orchideen der Expedition des Herrn J. de Warszewicz. Bot. Zeitung (Berlin). 10: 729–735.

Reichenbach HG. 1855. Wagener's Orchideen aus Ocaña. Bonplandia (Hanover). 3(5): 65–73.

Reichenbach HG. 1878. I. Orchidaceae Lehmannianae Ecuadorenses. Otia Bot. Hamburg. 1(8): 3–31.

Reichenbach HG. 1866. III. Orchideae Wendlandianae. Beitr. Orchid.-K. C. Amer. 93: 61–102.

Reinikka M.A. 1995. A history of the orchid. Timber Press, Portland, Oregon.

Rolfe R. 1893. New orchids: Decade 5. Bull Misc Inform Kew. 1893(74/75): 62.

Rolfe R. 1898. New orchids: Decades 21 and 22. Bull Misc Inform Kew. 1898(140): 199.

Romero G, Jenny R. 1993. Contributions toward a monograph of *Catasetum* (Catasetinae, Orchidaceae) I: A checklist of species, varieties, and natural hybrids. Harvard Papers in Botany. 4: 59–84.

Ruiz H, Pavón J. 1798. *Systema vegetabilium Florae Peruvianae et Chilensis, characteres prodromi genericos differentiales, specierum omnium differentias, durationem, loca natalia, tempus florendi, nomina vernacula, vires et usus nonnullis illustrationibus interspersis complectens*. Typis Gabrielis de Sancha. Madrid.

Ruiz H, Pavón J. 1794. *Flora peruvianae et chilensis prodromus*. Typis Gabrielis de Sancha. Madrid.

Salazar GA, Batista JAN, Cabrera LI, van Den Berg C, Whitten WM, Smidt EC, Buzatto CR, Singer RB, Gerlach G, Jiménez-Machorro R, Radins JA, Insaurralde IS, Guimarães LRS, Barros F, Tobar F, Linares JL, Mújica E, Dressler RL, Blanco MA, Hágsater E, Chase MW. 2018. Phylogenetic systematics of subtribe Spiranthinae (Orchidaceae: Orchidoideae: Cranichideae) based on nuclear and plastid DNA sequences of a nearly complete generic sample. Botanical Journal of the Linnean Society. 186(3): 273–303.

Santiago E, Hágsater E. 2006. *Epidendrum centropetalum* Rchb. f. In: Hágsater E, Sánchez Saldaña L. (eds.). The genus *Epidendrum*. Part 5. "Species new & old in *Epidendrum*." Icon. Orchid. 8: t. 801–900; t 817.

Santiago E, Hágsater E. 2008. *Epidendrum paucifolium* Schltr. In: Hágsater E, Sánchez Saldaña L. (eds.). The genus *Epidendrum*. Part 7. "Species new & old in *Epidendrum*." Icon. Orchid. 11: t. 1101–1200; t 1155.

Santiago E, Hágsater E. 2010. *Epidendrum laucheanum* Rolfe ex Bonhof. In: Hágsater E, Sánchez Saldaña L. (eds.). The genus *Epidendrum*. Part 9. "Species new & old in *Epidendrum*." Icon. Orchid. 13: t. 1301–1400; t 1346.

Schlechter R. 1899. Orchidaceae. In: Lösener T. (ed.). Plantae Selerianae, die von Eduard Seler und Frau Caecilie Seler in Mexico und Centralamerika gesammelten Pflanzen (Orchidaceae). Bull Herb Boissier 7: 534–545.

Schlechter R. 1906a. XII. Orchidaceae novae et criticae. Decas V. Repertorium Specierum Novarum Regni Vegetabilis Beih. 3: 45–51.

Schlechter R. 1906b. XXIV. Orchidaceae novae et criticae. Decas IV. Repertorium Specierum Novarum Regni Vegetabilis Beih. 3: 77–82.

Schlechter R. 1906c. Orchidaceae novae et criticae, Decas II. Repertorium Specierum Novarum Regni Vegetabilis Beih. 1–2: 129–134

Schlechter R. 1906d. XXXVI. Orchidaceae novae et criticae. Decas VII. Repertorium Specierum Novarum Regni Vegetabilis Beih. 3: 106–111.

Schlechter R. 1907a. Orchidaceae novae et criticae, Decas

VIII. Repertorium Specierum Novarum Regni Vegetabilis Beih. 3: 246–251.
Schlechter R. 1907b. Orchidaceae novae et criticae, Decas IX. Repertorium Specierum Novarum Regni Vegetabilis Beih. 3: 276–280.
Schlechter R. 1910a. CLII. Orchidaceae novae et criticae. Decas XIV–XV. Repertorium Specierum Novarum Regni Vegetabilis Beih. 8: 561–572.
Schlechter R. 1910b. III. Orchidaceae novae et criticae. Decas XVI–XVII. Repertorium Specierum Novarum Regni Vegetabilis Beih. 9: 21–32.
Schlechter R. 1911. XXXI. Orchidaceae novae et criticae. Decas XVIII. Repertorium Specierum Novarum Regni Vegetabilis Beih. 9: 163–164.
Schlechter R. 1912. L. Orchidaceae novae et criticae. Decas XXVI. Repertorium Specierum Novarum Regni Vegetabilis Beih. 10: 291–298.
Schlechter R. 1913a. Orchidaceae novae et criticae. Decas XXXVIII. Repertorium Specierum Novarum Regni Vegetabilis Beih. 12: 202–206.
Schlechter R. 1913b. Orchidaceae novae et criticae. Decas XXXIX. Repertorium Specierum Novarum Regni Vegetabilis Beih. 12: 212–216.
Schlechter R. 1914. Die Orchideen: ihre Beschreibung, Kultur und Züchtung. Handbuch für Orchideenliebhaber, Züchter und Botaniker. Berlin: P. Parey.
Schlechter R. 1915. Neue und seltene Garten-Orchideen. Orchis. 9: 49–54.
Schlechter R. 1916. Neue und seltene Garten-Orchideen. Orchis. 10: 183–190.
Schlechter R. 1918a. Kritische Aufzaehlung der bisher aus Zentral-Amerika bekanntgewordenen Orchideen; D. Beschreibungen neuer Arten. Beih Bot Centralbl. 36: 371–421.
Schlechter R. 1918b. Orchidaceae novae et criticae. Decas LI–LIII (Additamenta ad Orchideologiam guatemalensem). Repert Spec Nov Regni Veg. Beih. 15: 143–209.
Schlechter R. 1918c. Orchidaceae novae et criticae. Decas LIV. Repertorium Specierum Novarum Regni Vegetabilis Beih. 15: 210–217.
Schlechter R. 1920. Orchidaceae novae et criticae. Decas LXVI–LXVII. Specierum Novarum Regni Vegetabilis Beih. 16: 437–450.
Schlechter R. 1921a. Orchidaceae novae et criticae. Decas LXVIII. Repert Spec Nov Regni Veg. Beih. 17: 12–18,
Schlechter R. 1921b. Orchidaceae novae et criticae. Decas LXIX. Repertorium Specierum Novarum Regni Vegetabilis Beih. 17: 138–144.
Schlechter R. 1922. Beiträge zur Orchideenkunde von Zentralamerika, Orchidaceae Powellianae Panamenses. Repertorium Specierum Novarum Regni Vegetabilis Beih. 17: 3–95.
Schlechter R. 1923a. Beiträge zur Orchideenkunde von Zentralamerika, II. Additamenta ad Orchideologiam Costaricensem, I. Orchidaceae Amparoanae. Repertorium Specierum Novarum Regni Vegetabilis Beih. 19: 3–75.
Schlechter R. 1923b. Beiträge zur Orchideenkunde von Zentralamerika, II. Additamenta ad Orchideologiam Costaricensem, II. Orchidaceae Bradeanae Costaricenses. Repert Spec Nov Regni Veg. Beih. 19: 76–157.
Schlechter R. 1923c. Beiträge zur Orchideenkunde von Zentralamerika, II. Additamenta ad Orchideologiam Costaricensem, III. Orchidaceae Brenesianae. Repertorium Specierum Novarum Regni Vegetabilis Beih. 19: 158–269.
Schlechter R. 1923d. Beiträge zur Orchideenkunde von Zentralamerika, II. Additamenta ad Orchideologiam Costaricensem, IV. Orchidaceae novae et rariores collectorum variorum in Costa Rica collectae. Repertorium Specierum Novarum Regni Vegetabilis Beih. 19: 270–307.
Schlechter R. 1925. Orchidaceae novae et criticae. Decas LXXVIII–LXXIX. VI. Repertorium Specierum Novarum Regni Vegetabilis Beih. 21: 330–343.
Senghas K. 2002. Leben und Wirken von Rudolf Schlechter. In: Brieger G, Maatsch R, Senghas K. (eds.). Die Orchideen. 3. Auflage, Band I. Berlin: P. Buchverlag., pp. 1–6.
Schweinfurth C. 1941. Nomenclatorial changes *Hexadesmia* to *Scaphyglottis*. Bot Mus Leafl. 10: 27–28.
Stevens WD, Ulloa Ulloa C, Pool A, Montiel Jarquín OM. 2001. Flora de Nicaragua. Monographs in Systematic Botany from the Missouri Botanical Garden 85.
Szlachetko, DL, Mytnik-Ejsmont J, Górniak M, Smiszek M. 2006. Genera et species orchidalium. 15. Maxillarieae. Polish Bot. J. 51: 57–59.
Soto Arenas MA, Dressler RL. 2010. A revision of the Mexican and Central American species of *Vanilla* Plumier ex Miller with a characterization of their ITS region of the nuclear ribosomal DNA. Lankesteriana. 9(3): 285–354.
Standley PC. 1937. Flora of Costa Rica. Part. 1. Publ. Field Mus. Nat. Hist., Bot. Ser. 18(1): 1–398.
Stevens WD, Ulloa Ulloa C, Pool A, Montiel Jarquín OM. 2001. Flora de Nicaragua. Monographs in Systematic Botany from the Missouri Botanical Garden 85: 1–2666.
Taylor P. 1974. An account of the life of the celebrated collector F. C. Lehmann. Orchid Digest 38(5): 175–176.
Tropicos. 2021. Saint Louis (MO): Missouri Botanical Garden; [accessed 2021 April 13]. https://tropicos.org

Turland NJ, Wiersema JH, Barrie FR, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Kusber W-H, Li D-Z, Marhold K, May TW, McNeill J, Monro AM, Prado J, Price MJ, Smith GF. (eds.). 2018. International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile. 159. Glashütten (HE): Koeltz Botanical Books.

Trusty JL, Blanco MA. 2005. Las orquídeas de la Isla del Coco. Epidendrum. 27: 12–13.

Ulloa Ulloa C, Acevedo-Rodríguez P, Beck SG, Belgrano MJ, Bernal R, Berry PE, Brako L, Celis M, Davidse G, Gradstein SR, Hokche O, León B, León-Yánez S, Magill RE, Neill DA, Nee MH, Raven PH, Stimmel H, Strong MT, Villaseñor Ríos JL, Zarucchi JL, Zuloaga FO, Jørgensen PM. 2017. An integrated assessment of vascular plants species of the Americas. Science. 358(6370): 1614–1617. Accompanied by: Online Suppl. Materials 1–23 + 1–2497.

WCSP: World Checklist of Selected Plant Families. 2021. Kew (LDN): Roy. Bot. Gard., Kew; [accessed 2021 Apr 13]. http://wcsp.science.kew.org/

Williams LO. 1972. Floristic studies on Central America, past, present and planned. I Congreso Latinoamericano y V Mexicano de Botánica. Memorias de Symposia Sociedad Botanica de Mexico S.C.: 199–213.

WEBBIA Journal of Plant Taxonomy and Geography

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OPEN ACCESS

Citation: Kean Roe F. Mazo, Daniel L. Nickrent, Pieter B. Pelser (2022) *Macrosolen zamboangensis* (Loranthaceae), a new mistletoe species from Zamboanga Peninsula, Philippines. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 127-134. doi: 10.36253/jopt-12339

Received: November 24, 2021

Accepted: January 17, 2022

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Riccardo M. Baldini

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Macrosolen zamboangensis (Loranthaceae), a new mistletoe species from Zamboanga Peninsula, Philippines

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Abstract. *Macrosolen zamboangensis*, a new mistletoe species from the Zamboanga peninsula of the island of Mindanao (Philippines), is described. The new species is a member of the widespread *M. melintangensis* species complex, but differs from the previously described species in this complex in having a conspicuously papillose corolla head. It is also the only species in this complex that displays a combination of papillose pedicels, calycula and fruits, at least 3–4 inflorescence axes grouped at a node, and relatively small flowers that are clustered at the apex of a raceme (a subumbel) instead of being more evenly distributed along the inflorescence axis. The conservation status of this new species is considered Vulnerable (V).

Keywords: hemiparasitic plants, *Macrosolen melintangensis*, mistletoe, species complex, taxonomy, western Mindanao.

INTRODUCTION

Macrosolen (Blume) Rchb. (Loranthaceae; Elytranthinae) is a genus of hemiparasitic epiphytes represented by at least 25 (Vidal-Russell and Nickrent 2008), but perhaps as many as 40 (Tagane et al. 2017) species. It is recognized by having spikes or racemes with decussate pairs of 6-merous flowers that are each subtended by one bract and two bracteoles, petals that are fused to the middle or higher, reflexed corolla lobes, and 4-locular anthers (Barlow 1997, Tagane et al. 2017). *Macrosolen* is distributed in southern Asia and the Malesian region, with a center of diversity in Borneo (Barlow 1997). In the Philippines, there are seven currently recognized *Macrosolen* species, two of which are endemic (Pelser et al. 2011 onwards). The island of Mindanao is a center of diversity for the genus as all seven Philippine species can be found there (Pelser et al. 2011 onwards). During field work in the munici-

pality of Leon B. Postigo, Zamboanga del Norte (Zamboanga Peninsula, Mindanao), an unknown species of *Macrosolen* was documented and collected. Initially, it was identified as *M. melintangensis* (Korth.) Miq. using Barlow's (1997) taxonomic key, but further investigation revealed several morphological differences.

Macrosolen melintangensis is a taxonomically challenging species complex with unclear species boundaries. Vegetatively, it is characterized by having opposite, petiolate, ovate, medium sized, bifacial leaves. It has few-flowered racemes with bracteoles that are nearly free, and slender corollas that are mostly 20–30 mm long and usually have weakly developed wings (Barlow 1995). Most recently Barlow (1995, 1997) used a broad delimitation of *M. melintangensis*, in which he subsumed a large number of species recognized by Danser in his taxonomic treatments of *Macrosolen* (Danser 1931, 1934, 1935, 1941): *M. bellus* Danser, *M. floridus* Danser, *M. javanus* Danser, *M. lowii* (King) Tiegh., *M. sumatranus* Danser, and *M. urceolatus* Danser. Barlow (1995) also provisionally included *M. demesae* (Merr.) Danser and *M. tenuiflorus* Danser as synonyms. As a result, *M. melintangensis* is currently circumscribed as a quite polymorphic species with a large distributional area (Borneo, Cambodia, Java, Malay Peninsula (including Singapore), Philippines, Sumatra and Thailand; Barlow 1995). Barlow interpreted the much narrower species delimitation of this complex by Danser (1931, 1934, 1935, 1941) as a segregation into "local races" (Barlow 1995: 28) and concluded that these do not merit recognition at the species level, because of the absence of "sharp morphological discontinuities" among them. However, Barlow (1995, 1997) did not present data in support or this view, nor provide a more detailed discussion. Further, our current study in search of the identity of the Zamboanga *Macrosolen* plants revealed morphological patterns that suggest that more than one species should be recognized within the *M. melintangensis* complex (see Discussion), although more detailed studies are required to determine their exact number.

In this study, we compare the *Macrosolen* plants from Zamboanga with *M. melintangensis* sensu Barlow (1995, 1997), the putative species that Danser (1931, 1934, 1935, 1941) recognized within this species complex, as well as other species that display morphological similarities. We conclude that the Zamboanga plants are best considered as a new species under the unified species concept (De Queiroz 2007), because they are morphologically different from all members of the *M. melintangensis* species complex.

MATERIALS & METHODS

A specimen of the new species (two duplicates: holotype and isotype) was collected under Wildlife Gratuitous Permit (GP) No. R-IX-03-2021 issued by Department of Environment and Natural Resources (DENR) Region 9. Morphological observations and measurements were made from fresh and dried material and photographic images *in situ* of this specimen. Photos of type and other specimens at B, BM, K, L, P, and protologues of other *Macrosolen* species were also examined. A total of 39 characters were scored (when possible) for 10 members of the *M. melintangensis* complex (including the new species) and three other *Macrosolen* species that resemble the new species in aspects of their morphology. These data are presented in Supplemental file 1. Figure 1 illustrates the terminology used to describe mature flower buds of *Macrosolen*.

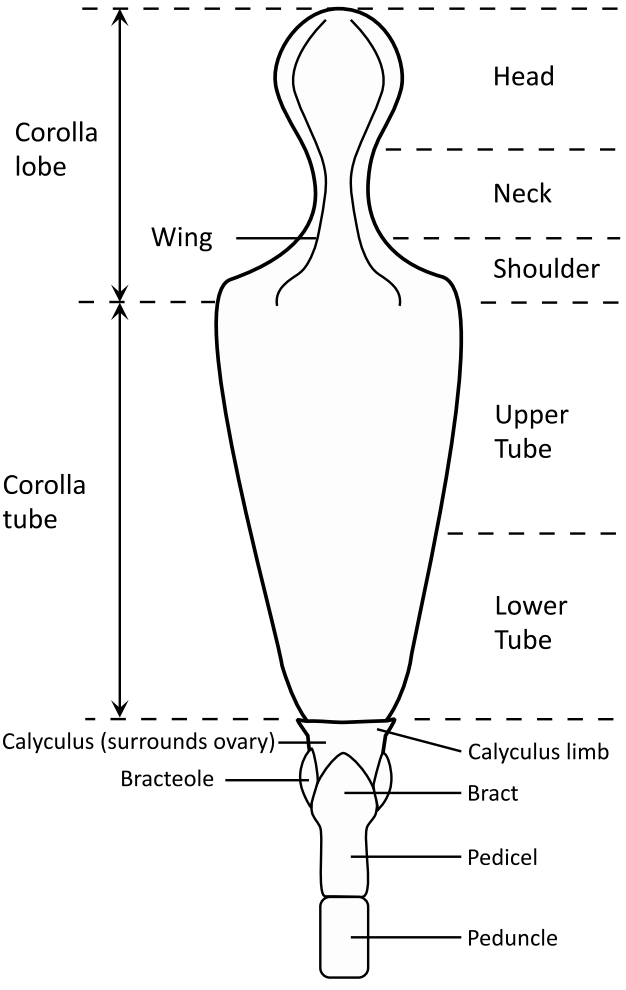

Figure 1. Terminology for describing mature flower buds.

Macrosolen zamboangensis Mazo, Nickrent & Pelser, **sp. nov**. (Figure 2)

Type: Philippines, Mindanao, Zamboanga del Norte Province, municipality of Leon B. Postigo, barangay Tinuyop, Oro River, 8° 3' 33.19" N, 122° 55' 21.81" E, 337 m.a.s.l., 17 Mar. 2021, *K.R.F. Mazo 37* (holotype PNH; isotype CMUH).

Diagnosis

Macrosolen zamboangensis is similar to species of the *M. melintangensis* complex, but unique in having conspicuously papillose flowers and fruits in combination with relatively short corollas (i.e. less than 20 mm in mature flower buds) of flowers that are clustered in subumbels. The inflorescences are generally 3–4 per axil, more numerous than in other members of the complex.

Description

Hemi-parasitic epiphyte with epicortical runners. Internodes terete, slightly flattened in the apical region when young, glabrous, light brown when mature. Nodes thickened. Leaves opposite or subopposite; petiole (7–)8–14 × 2.5–4.0 mm, flat adaxially, rounded abaxially; lamina bifacial, ovate or elliptic, 7.5–14(–15.6) × 3.3–7.7 cm, base rounded or obtuse to broadly cuneate, margin entire, apex acuminate to caudate, coriaceous, glabrous, adaxial surface somewhat shiny, abaxial surface dull, both surfaces light olive green, midrib prominent on both sides, lateral nerves 5–7 pairs, adaxially slightly prominent, abaxially prominent, brochidodromous. Inflorescences (1–)3–4(–5) per leaf axil, at older leafless nodes or on epicortical runners, subumbels (rarely racemes) of (2–)4–6 flowers crowded at the peduncle apex; prophylls caducous, ovate, c. 1 × 1.2 mm, apex mucronate; peduncles 3.2–8.0 × 1.1–1.8 mm, terete, glabrous or slightly papillose, with raised lenticels; pedicels 0.9–2.3 × c. 1 mm, slightly papillose. Central bracts broadly ovate, carinate, c. 1 × 1.2 mm, apex acute and occasionally mucronate, papillose. Bracteoles connate at base, broadly ovate, carinate, c. 1 × 1.2 mm, apex acute, papillose. Calyculus ellipsoid to slightly urceolate, 2.8–3.4 × 2.3–2.6 mm; limb cylindrical, c. 0.4 × 1.4–1.6 mm, margin shallowly crenate; conspicuously papillose, greyish green. Corolla in mature buds lageniform, straight or very slightly curved, slightly flaring from the base above calyculus limb, 15–19.2 mm long, wings prominent and symmetrical; tube 9.4–13.4 mm long, length/width ratio 2.4, tube grading from orange to red from lower to upper portion including shoulder; shoulder 2.3–2.6 mm long, wings prominent, glabrous; neck 0.8–1.3 × 1.8–2.6 mm, wings prominent, glabrous, black; head not distinctly clavate, 4.5–5.7 × 1.8–2.2 mm, wings not prominent, apex acute to obtuse, conspicuously papillose, greyish green; corolla lobes 6, reflexed but not twisting after anthesis, linear, 7.4–9.2 × 0.6–1.0 mm, adaxial surface glabrous. Stamens 6, free part of the filament 2.5–3.6 × 0.46–0.55 mm, green at base grading into yellow-orange at apex or yellow-orange throughout; anthers basifixed, 1.1–1.6 × 0.45–0.55 mm, base and apex obtuse, locules continuous, connective yellow-orange, anther sacs cream. Style 18–22 mm long, articulated above a conical base, distally not thickened, green; stigma ellipsoid to nearly globose, 0.6–0.7 mm wide, red. Fruit globose, c. 7 × 8 mm when mature, papillose but with warts that are less prominent than those on the ovary, brownish-red or purplish; calyculus limb crenate, c-. 0.2 mm long, light green to almost colorless; stylar base forming a short nipple-like beak, 0.2–0.4 mm long, yellow. Seeds 1, ellipsoidal, 5–6 × 4 mm, longitudinally 6-grooved.

Etymology

The specific name refers to the Zamboanga peninsula of the island of Mindanao, Philippines, where this species was discovered.

Phenology

This new species was observed flowering and fruiting between February and June.

Distribution and habitat

Thus far, *M. zamboangensis* is only known from its type locality, which is in a disturbed lowland tropical rain forest and at 320–350 m elevation. *Macrosolen zamboangensis* was observed growing on *Mangifera* sp. (Anacardiaceae), *Palaqium* sp. (Sapotaceae), and species of Sapindaceae.

Conservation status

The number of populations and individuals, and the extend of the distribution of *M. zamboangensis* are still unknown. Nine plants were observed during the fieldwork for this study. The habitat of *M. zamboangensis* is not a protected area and threatened by small-scale mining, forest clearings for charcoal making, and illegal logging. Following the IUCN guidelines, we consider this species vulnerable under criterion VU:D2 (IUCN Standards and Petitions Committee, 2019).

Discussion

The abaxial surfaces of the corolla lobes in the floral head of *Macrosolen zamboangensis* are covered with a greyish-green papillose indumentum. This feature is par-

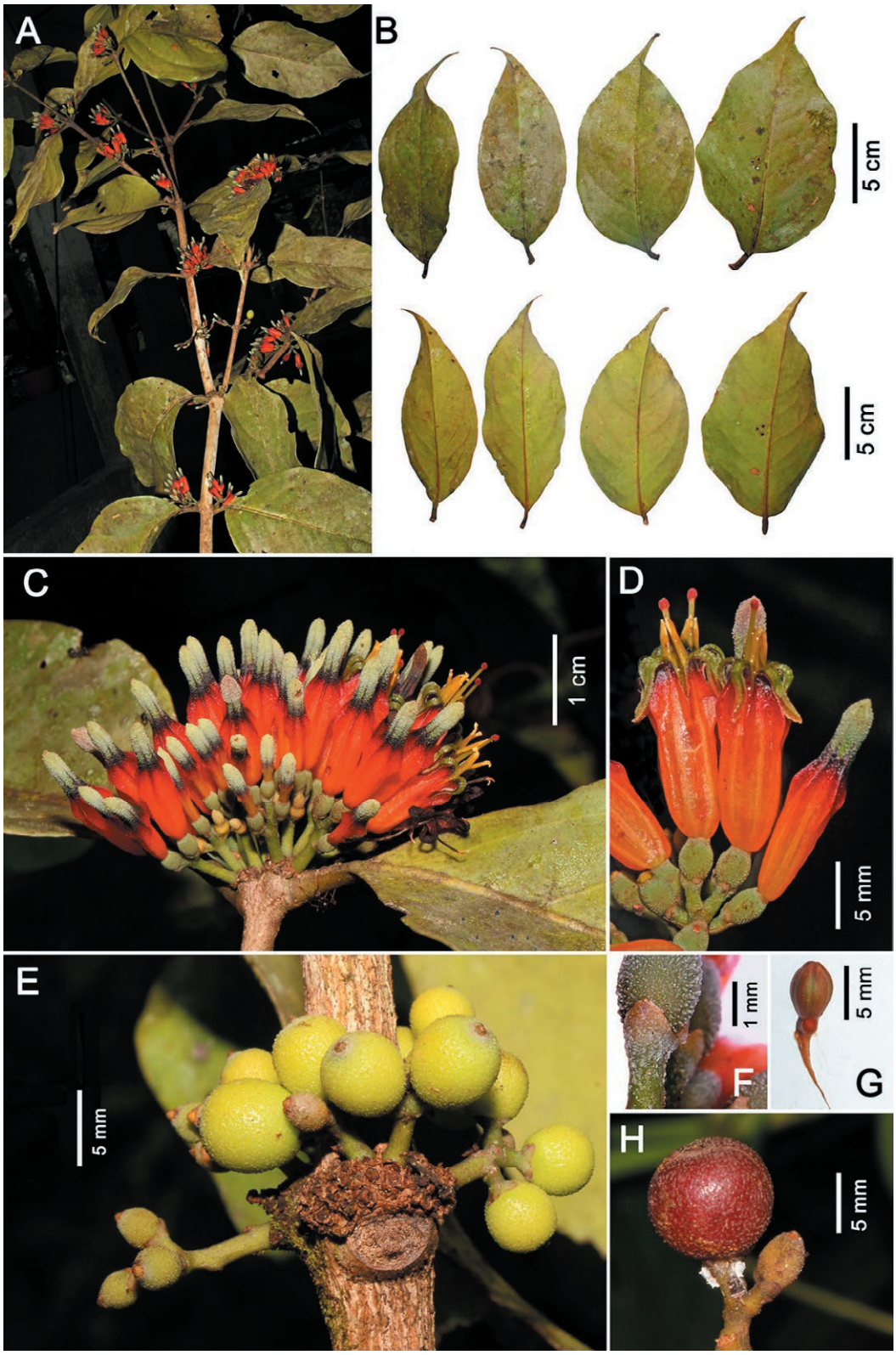

Figure 2. Morphological features of *Macrosolen zamboangensis*. A. Habit of mistletoe. B. Leaf variation, adaxial surfaces above, abaxial surfaces below. C. Inflorescence. D. Closer view of flowers in bud stage and at anthesis. E. Infructescences emerging from swollen node. F. Closer view of calyculus/ovary, subtending bract, and pedicel. G. Seed removed from fruit. H. Mature fruit with scale insects on pedicel.

ticularly conspicuous when the flower buds are mature, but have not yet opened (Fig. 2c, d). It is an important diagnostic character for this species because flowers with a similar indumentum have thus far only been recorded for *M. papillosus* (Gamble) Danser from Borneo, Peninsular Malaysia, and Singapore (Gamble 1914; Barlow 1997). The protologue of *Elytranthe papillosa* Gamble describes the corolla as prominently papillose. Danser (1931) indicates the corolla is "beset with more or less numerous papillae".

We wish to point out that three different terms for these types of excrescences have been used in Loranthaceae: papillate, tuberculate, and verrucate. The latter two are considered synonymous in Stearn (1992) and one recent plant taxonomy text synonymized all three (Simpson 2019). All describe excrescences or warts that are rounded projections, either regular or irregular in shape. Barlow (1997, p. 373) described the calyculus of *M. papillosus* as "shortly tomentose and more or less tuberculate" and later says "verrucose inflorescence parts and papillose fruits." Both *M. papillosus* and *M. zamboangensis* have excrescences on their calycula, flower bud apices, and fruits (Fig. 2e, f, h). Those of *M. papillosus* are generally larger (c. 0.2 mm) and coarser compared with *M. zamboangensis* (0.1 mm).

Macrosolen zamboangensis can further be distinguished from *M. papillosus* by its larger leaf lamina (7.5–15.6 × 3.3–7.7 cm vs. 2.5–4.0 × 0.8–2 cm), different leaf shape (ovate or elliptic vs. obovate to spatulate), longer petioles (7–14 vs. 1–3 mm long), and the shape of its leaf apex (acuminate to caudate vs. rounded or slightly emarginate) (Fig. 2a, b). Further, *M. zamboangensis* usually has a longer mature corolla bud (15–19.2 vs. 10–15 mm; Fig. 2c, d). Finally, *M. papillosus* typically has one pair of flowers on a peduncle that is solitary in the leaf axil, whereas *M. zamboangensis* has a raceme or subumbel of usually 2–3 flower pairs with typically 3–4 peduncles per axil (Fig. 2c).

In his revision of *Macrosolen* for the Malesian region, Barlow (1997) wrote that papillose indumentum is not only found in *M. papillosus*, but that the inflorescences of *M. melintangensis* (sensu Barlow 1995) are also very rarely papillose. This description apparently applies to one component of the complex, *M. lowii*, where Danser (1931) described the inflorescences as "densely papillose hairy. " Although Barlow (2002, p. 694) mentioned that some specimens from Thailand have "tuberculate" fruits, papillose indumentum is, however, not present on the corolla of this species. Despite these differences in indumentum between *M. zamboangensis* and *M. melintangensis*, both species share similarities, particularly in leaf shape and size, length of corolla, and relative length of the corolla tube. In fact, *M. zamboangensis* plants with three pairs of flowers per inflorescence key to *M. melintangensis* in Barlow (1997). A comparison with the descriptions of *M. melintangensis* in Barlow (1995, 1997) suggests, however, that *M. zamboangensis* generally has smaller flowers (corolla in mature flower bud 15–19.2 vs. usually 20–30 mm long) with shorter pedicels (0.9–2.3 vs. mostly 2–4 mm long) and longer calycula (2.8–3.4 vs. 1.8–2.5 mm). Also, *Macrosolen zamboangensis* typically has shorter anthers than what Barlow recorded for *M. melintangensis* (1.1–1.6 vs. 1.5–3 mm long). However, the morphological diversity of *M. melintangensis* sensu Barlow extends beyond the descriptions in his publications (Barlow 1995, 1997) because these only partially capture the morphological diversity of the following species that he included as synonyms: *M. bellus*, *M. demesae*, *M. floridus*, *M. javanus*, *M. lowii*, *M. sumatranus*, *M. tenuiflorus,* and *M. urceolatus*. We therefore also compared *M. zamboangensis* with these species individually. If this narrower delimitation of the *M. melintangensis* complex is used, differences in, amongst others, petiole length, leaf shape, inflorescence type and corolla size and shape can be used in addition to the presence of a papillose corolla to delimit *M. zamboangensis*.

Danser (1935) listed two Philippine members of the *M. melintangensis* complex: *M. bellus* and *M. demesae*. *Macrosolen zamboangensis* can be distinguished from *M. bellus* in leaf morphology. It generally has longer petioles (7–14 vs. 1.8–7.9 mm) and a rounded or obtuse to broadly cuneate instead of a decurrent or attenuate leaf base (Fig. 2b). In addition, the anthers of *M. zamboangensis* are shorter than those of *M. bellus* (1.1–1.6 vs. 2.5 mm; Danser 1935). They are also considerably shorter than the free part of the filament (2.5–3.6 mm), whereas the anthers of *M. bellus* are only slightly shorter than the free part of their filaments (3 mm; Danser 1935).

As far as we are aware, *M. demesae* is only known from descriptions by Merrill (1914) and Danser (1935) of the type material, and neither Barlow or we were able to find any surviving specimens. The holotype reported from PNH is presumed lost. This type material came from Zamboanga, the same part of Mindanao where *M. zamboangensis* grows. *Macrosolen demesae* is different from *M. zamboangensis* in leaf morphology. It has sessile or nearly sessile leaves (petiole 0–1 mm) with 10 lateral nerve pairs, whereas those of *M. zamboangensis* are clearly petiolate and have 5–7 lateral nerve pairs (Fig. 2b). In addition, the inflorescences of *M. demesae* are solitary vs. usually 3–4 per axil. The flowers are uniformly red (vs. orange-red with black neck and greyish green head) and the calyculus/ovary is smaller (2 × 1 mm vs. 2.8–3.4 × 2.3–2.6) (Fig. 2c, d).

Macrosolen lowii from Peninsular Malaysia, Thailand and possibly Cambodia (King 1887; Danser 1938; Barlow 2002) resembles *M. zamboangensis* in having puberulous (King 1887) or papillose (Danser 1931) peduncles, pedicels and bracteoles. However, it has smaller leaves (3.6–6 × 1.2–4 vs. 7.5–15.6 × 3.3–7.7 cm) that are more strongly bifacial and have shorter petioles (2.3–4.4 vs. 7–14 mm). Its flowers are larger than those of *M. zamboangensis* (mature bud corolla 24–34 vs. 15–19.2 mm long) and have a different shape (King 1887, Gamble 1914, Danser 1931). The corolla tube in *M. lowii* is more slender than that of *M. zamboangensis* (length/width ratio 4.2 vs. 2.4) and is pink, pinkish or white (Danser 1931) vs. orange to red (Fig. 2c, d).

Macrosolen javanus represents the *M. melintangensis* complex in Java. It differs from *M. zamboangensis* by its larger flowers (mature bud corolla 25–33 vs. 15–19.2 mm), which are similar in size to those of *M. lowii*. Likewise, its corolla tube is more slender (length/width ratio 5 vs. 2.4).

Danser (1931, 1934, 1941) also recognized three Bornean species and one species from Sumatra in the *M. melintangensis* complex, but expressed some doubts as to whether they are indeed taxonomically distinct from each other: *M. floridus*, *M. sumatranus, M. tenuiflorus*, and *M. urceolatus*. These four species have a distinctly different inflorescence morphology than *M. zamboangensis*. Whereas the flower pairs of *M. zamboangensis* are usually placed in a subumbel, i.e. with flowers crowded at the apex of the peduncle (Fig. 2c, e), those of the three Bornean taxa are in racemes with flowers more evenly distributed along the inflorescence axis (Danser 1931, 1934). Although we were not able to observe mature flowers or buds on the type material of *M. urceolatus*, the morphology of its immature buds suggests that they are more slender than those of *M. zamboangensis* and have a longer neck.

Neither Barlow (1995) or we were able to locate any surviving type material of *M. tenuiflorus* or other specimens collected and identified as this species, but Danser's (1931) illustration of *M. tenuiflorus* shows that it has flowers with dimensions similar to those of *M. zamboangensis*. It differs by its narrower leaves (2.5–4 vs. 3.3–7.7), smaller calyculus/ovary (1.5 × 1 vs. 2.8–3.4 × 2.3–2.6), the presence of an oviformous style base, and uniformly red flowers (Danser 1931). In contrast to *M. tenuiflorus*, type material for both *M. floridus* and *M. sumatranus* is extant, however, these sheets lack mature flower buds for analysis. For this reason we relied mostly upon descriptions. Moreover, *M. floridus* differs by having longer pedicels (i.e. 3–4 vs. 0.9–2.3 mm), a longer neck (c. 3.6 vs. 0.8–1.3 mm) and shorter head (c. 2.3 vs. 4.5–5.7 mm) on the mature flower bud, as well as a pink vs. orange to red corolla tube (Danser 1934). *Macrosolen sumatranus* mostly stands out from the three other species in this racemose group by its yellow corolla tube and red head (Danser 1931).

Macrosolen melintangensis sensu stricto is a very poorly known species described from Sumatra. The protologue (Korthals 1839) is very brief and lacks diagnostic detail, and later authors (Miquel 1856; Danser 1931) were not able to add much more information about the morphology of this species. Walpers (1843) mentions that the corolla is 35 mm long and red, which is considerably longer than the corolla of *M. zamboangensis* (i.e. 15–19.2 mm in mature flower buds; Fig. 2c, d). The type material at L is sparse and the single remaining inflorescence no longer bears flowers (Danser 1931; Barlow 1995), but it is evident that it is a raceme that had evenly distributed flower pairs. *Macrosolen melintangensis* s. str. is therefore also different from *M. zamboangensis* in inflorescence morphology.

In his revision of *Macrosolen* from the Malesian region, Barlow mentioned that *M. melintangensis* sensu Barlow is similar to *M. retusus* (Jack) Miq. from Borneo, Peninsular Malaysia, Singapore, and Sumatra, and to *M. robinsonii* (Gamble) Danser from China, Peninsular Malaysia and Vietnam (Danser 1931, 1938, Barlow 1997). *Macrosolen retusus* is, however, distinctly different from *M. zamboangensis* in its leaf morphology and flower color. The leaves of *M. retusus* are usually obovate and have a rounded or more rarely obtuse apex that can be retuse. In contrast, those of *M. zamboangensis* are typically ovate or elliptic, with an acuminate to caudate apex (Fig. 2b). *Macrosolen retusus* also has shorter petioles (3–5 vs. 7–14 mm long) and has a leaf base that is cuneate (rarely rounded) instead of broadly cuneate, rounded or obtuse. The corolla tube of *M. retusus* is often pink or violet (vs. orange to red) and is generally larger (18–25 vs. 15–19.2 mm long) (Danser 1931, Barlow 1997). *Macrosolen robinsonii* stands out from *M. zamboangensis* and other members of the *M. melintangensis* complex by its subsessile inflorescences (peduncles 0.9–2.5) but information on flower dimensions is confusing. Danser (1931) indicated that the corollas in mature buds were 11–13 mm long but he amended that to 11–15 (Danser 1936) and later (Danser 1938) simply to 12. Barlow (1997) extends the size considerably reporting 15–25(–30) mm long for the corolla length. Because the leaves of *M. robinsonii* are narrower than those of *M. zamboangensis* (0.8–3.5 vs. 3.3–7.7 mm wide), and because it has an involucre (pairs of triangular scales, up to 2 mm long) present at the base of the inflorescence peduncle, these two taxa are distinct.

CONCLUDING REMARKS

Naming a new species in a mistletoe genus such as *Macrosolen* presents a number of challenges. These include the absence of type specimens associated with various names, variations in descriptions of the same taxa by different authors, and weighing the extent of polymorphism present within a taxon prior to considering it a species. Although photographs of herbarium specimens provide invaluable data for this type of work, the quality of specimens varies considerably and crucial details (e.g. of flowers) are not always visible. For the Philippine flora in particular, specimens (including types) were destroyed in WWII and no collections currently held in PNH and various in-country university herbaria are digitized and available for viewing on the internet. To fully explore species boundaries in *Macrosolen*, the morphological character variation should be examined in the context of a molecular phylogeny, but currently no such data exist. As discussed here, the *M. melintangensis* complex may contain as few as four and as many as 13 species. All of these taxa can be characterized, more or less, by unique combinations of characters. For the 39 morphological characters considered here, we propose that *M. zamboangensis* shows sufficient phenotypic differences from other members of the complex to be considered a distinct species.

Additional specimens examined

PHILIPPINES. *Macrosolen bellus* Danser. Catanduanes, *Bur. Sci. 30447 Ramos* (lectotype BM; isolectotype P), 14 Nov. to 11 Dec. 1917 (photos!).

MALAYSIA. *Macrosolen floridus* Danser. Borneo, Sabah, Mt. Kinabalu, *J. & M.S. Clemens 31411* (holotype B; isotypes BM, K, L), Penibukan, Spur S. of Kina Taki river, 7 Feb. 1933 (photos!); *J. & M.S. Clemens 28246* (L), Tenompok, 24 Feb. 1932 (photo!). *Macrosolen lowii* (King) Tiegh. Peninsular Malaysia, *Scortechini 861* (holotype K; isotype L), Perak (photos!). *Macrosolen robinsonii* (Gamble) Danser. Peninsular Malaysia, *Wray & Robinson 5404* (syntypes BM, K), Pahang, Gunong Tahan, 3 June 1905 (photos!).

INDONESIA. *Macrosolen javanus* Danser. Java, *Koorders 26726B* (L), Pangentjongan, 18 Jan. 1897 (photo!); *Koorders 26742B* (L), Pangentjongan, 4 Feb. 1897 (photo!); *Docters van Leeuwen 3024* (isotype L), Pateungteung, 9 Nov. 1918 (photo!). *Macrosolen melintangensis* (Korth.) Miq. Sumatra, *Korthals s.n.* (syntype L, two sheets), G. Malintang (photos!). *Macrosolen sumatranus* Danser. Sumatra, *Bünnemeijer 3335* (holotype L), Agam, Brani, 26 June 1918 (photo!). *Macrosolen urceolatus* Danser. Borneo, *Van Wijk 65a* (isotype L), Kahajan, Bahaoen, 25 Sept. 1938 (photo!).

ACKNOWLEDGEMENTS

The authors would like to thank the Department of Environment and Natural Resources (DENR) Region 9 for the issuance of a gratuitous permit, and the local government and indigenous community of Leon B. Postigo for their support. The first author expresses his gratitude to the Department of Science and Technology-Science Education Institute (DOST-SEI), and the Department of Science and Technology- Science and Technology Regional Alliance of Universities for Inclusive National Development (DOST PROJECT STRAND) for his scholarship grant.

REFERENCES

Barlow BA. 1995. New and noteworthy Malesian species of Loranthaceae. Blumea. 40: 15–31.

Barlow BA. 1997. Loranthaceae. Flora Malesiana Ser. I. 13: 209–442.

Barlow BA. 2002. Loranthaceae. Flora of Thailand 7: 665–706.

Danser BH. 1931. The Loranthaceae of the Netherlands Indies. Bulletin du Jardin Botanique de Buitenzorg, Ser. 3. 11: 233–519.

Danser BH. 1934. Miscellaneous notes on Loranthaceae 1–6. Recueil des Travaux Botaniques Néerlandais. 31: 223–236.

Danser BH. 1935. A revision of the Philippine Loranthaceae. Philippine Journal of Science. 58: 1–110.

Danser, BH. 1936. Miscellaneous notes on Loranthaceae 9–15. Blumea 2: 34–59.

Danser BH. 1938. The Loranthaceae of French Indo-China and Siam. Bulletin du Jardin Botanique de Buitenzorg, Ser. 3. 16: 1–63.

Danser BH. 1941. Miscellaneous notes on Loranthaceae, 25. Blumea 4: 259–260.

De Queiroz K. 2007 Species concepts and species delimitation. Systematic Biology. 56: 879–886.

Gamble JS. 1914. Materials for a Flora of the Malayan Peninsula. No. 24. Journal of the Asiatic Society of Bengal, Natural History. 75: 279–391.

IUCN Standards and Petitions Committee. 2019. Guidelines for Using the IUCN Red List Categories and Criteria: Version 14. http://www.iucnredlist.org/documents/RedListGuidelines.pdf.

King G. 1887. On the species of Loranthus indigenous to

Perak. Journal of the Asiatic Society of Bengal, Natural History. 56: 89–100.
Korthals PW. 1839. Verhandeling over de op Java, Sumatra en Borneo verzamelde Loranthaceae. Verhandelingen van het Bataviaasch Genootschap der Kunsten en Wetenschappen. 17: 199–288.
Merrill ED. 1914. New or noteworthy Philippine plants. Philippine Journal of Science, section C Botany. 9: 261–292.
Miquel FAW. 1856. Flora van Nederlandsch Indië 1 (1). Van der Post, Amsterdam.
Pelser PB, Barcelona JF, Nickrent DL (eds). 2011 onwards. Co's Digital Flora of the Philippines. http://www.philippineplants.org.
Simpson, M. 2019. Plant systematics, 3rd edition. Elsevier, Amsterdam.
Stearn, WT. 1992. Botanical Latin: History, grammar, syntax, terminology and vocabulary, 4th edition. Timber Press, Portland.
Tagane S, Dang VS, Ngoc NV, et al. 2017. *Macrosolen bidoupensis* (Loranthaceae), a new species from Bidoup Nui Ba National Park, southern Vietnam. PhytoKeys. 80: 113–120.
Vidal-Russell R, Nickrent DL. 2008. Evolutionary relationships in the showy mistletoe family (Loranthaceae). American Journal of Botany. 95: 1015–1029.
Walpers WG. 1843. Repertorium botanices systematicae 2. Friderici Hofmeister, Leipzig.

A Supplementary file data is downloadable at: https://oaj.fupress.net/index.php/webbia/article/view/12339/10741

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Citation: Wong Sin Yeng, Peter C. Boyce, Adeline Y.M. Hii (2022) Studies on Schismatoglottideae (Araceae) of Borneo LXVIII: *Bucephalandra adei*, a new species from Kalimantan, Indonesian Borneo. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 135-144. doi: 10.36253/jopt-12167

Received: October 10, 2021

Accepted: November 20, 2021

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Alistair Hay

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Studies on Schismatoglottideae (Araceae) of Borneo LXVIII: *Bucephalandra adei*, a new species from Kalimantan, Indonesian Borneo

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Abstract. *Bucephalandra adei* S.Y.Wong, P.C.Boyce & A.Y.M.Hii, is described as new additional the six already known species in which the spadix appendix exceeds the length of the fertile portion of the spadix. All are endemic to Borneo. An key to identification for the seven species and a distribution map is provided. Recognition of *B. adei* takes *Bucephalandra* to 32 described species.

Keywords: *Bucephalandra*, Kalimantan, Borneo, geology.

INTRODUCTION

Since being monographed by Bogner and Hay (2000) the genus *Bucephalandra* Schott has expanded from two to 31 accepted species. Twenty of these occur exclusively in Kalimantan, while eight are restricted to Sarawak, one occurs in both Sarawak and Brunei, and two are endemic to Sabah (Boyce et al. 1995; Boyce and Wong 2012, 2014; Okada and Mori 2000, Wong and Boyce 2014, 2016; Wong et al. 2018).

Most species of *Bucephalandra* have geographically restricted ranges, occasionally acutely so, and almost all are obligated to a particular geology such that that the actual total of *Bucephalandra* species is very likely significantly more than the current number of described species. We have incomplete sets of data for more than twenty taxa still impossible to place to species from which, as more data becomes available, we are describing novelties (Wong and Boyce 2016; Wong et al. 2018). Here we continue this process with the description of a highly distinctive species from Kalimantan Barat belonging to an un-named informal group of species wherein the spadix appendix is longer than the fertile portion of the spadix. Geology in this paper is specified based on Hutchison (1989, 2005) and Tate (2001).

Bucephalandra adei S.Y.Wong, A.Y.M.Hii & P.C.Boyce, **sp. nov.**

Type: Indonesia, Kalimantan Barat, Ngabang, Landak, Riam Desa Sungai Durian, 0°31'41"N 109°47'39"E, 45 m asl, 27 July 2017, *Ade Agus Setiawan AR-2766* (holotype SAR + spirit; isotype BO + spirit). (Figures 1 and 7A).

Diagnosis

The papillate staminodes of *Bucephalandra adei* distinguish it from all other *Bucephalandra* species in which the length of the spadix appendix exceeds that of fertile portion of the spadix

Description

Small to moderate obligate rheophytic herbs averaging 10 cm tall but ranging from 5 to 15 cm tall. Stem initially sub-erect, later much-elongating and becoming decumbent and rooting from behind active tip, with active portion sub-erect, oldest stems up to 6 cm long × 1 cm in diam., light green. Leaves c. 7 together; petiole 3–6 cm long × c. 1–2 mm in diam., adaxially canaliculate, brownish red, sheathing at leaf base, wings extended into a very narrowly triangular ligular portion to 3-5 cm long; blade elliptic 7–10–(13.5) cm long × 2.2–3.7 cm wide, slightly coriaceous, glossy medium green with major veins darker adaxially, pale and reddish abaxially, base cuneate, apex rounded and apiculate for c. 2–3 mm, margin smooth; midrib abaxially and adaxially prominent, strongly reddish abaxially; primary lateral veins 3–6 on each side, diverging at 20° and running to a marginal vein; interprimary veins finer; secondary venation adaxially ± obscure, abaxially faint; tertiary vein adaxially obscure, forming a faint tessellate reticulum. Bloom solitary; peduncle exceeding petioles, 5.5–8.5 cm long × 1.6–2 cm diam., conspicuously longitudinally ribbed, reddish green. Spathe oblong-ovate, not constricted, 5.5 cm long; lower spathe funnel-form, 0.5 cm tall, lime-green, persistent; limb inflating and gaping distally to form a narrow opening at pistillate anthesis, caducous during staminate anthesis, glistening white tinged with pink, apiculate for c. 3 mm, apiculum green. Spadix 2.3–3 cm long; pistillate zone c. 2.6 –5 mm long × c. 2.6–2.8 mm in diam., with c. 3 or 4 spirals of pistils; pistils polygonal-globose, c. 0.8 mm long × 0.9 mm in diam., lime-green; stigma sessile, umbonate, c. ½ diameter of ovary, impressed with edges of pistil forming a raised rim, papillate and with a conspicuous stigmatic droplet at anthesis; pistillodes very small, in a single incomplete row at base of pistillate zone, 'u'-shaped, in all c. 0.2 mm in diam.; interstice with two rows of scale-like staminodes, these 2.5–3.3 mm long × c. 2 mm wide, staminodes initially erect (pistillate anthesis), later reflexing to seal off persistent lower spathe, green; staminate zone 5–5.2 mm long × 4–4.7 mm in diam., consisting of four or five rows of florets; staminate florets upward-directed during pistillate anthesis, reflexing to almost perpendicular with spadix axis during staminate anthesis, creamy white, rather distant; stamen c. 1–1.5 mm across; filament short, stout; connective arching, strap-like, pink; thecae inserted ventrally on connective, paler cream, ellipsoid, c. 1 mm long × c. 0.4 mm wide, smooth; thecae horns c. $^1/_5$ length of associated theca, pointing horizontally, stiffly setaceous. Appendix blunt cylindrical, 13–18 mm long × 5–6.3 mm in diam., bright yellow; appendix staminodes mostly obpyramidal with the top surfaces papillate, those of basal $^1/_3$ of spadix larger, 2–3 mm in diam., the rest 1–2 mm in diam., densely arranged. Fruiting spathe broadly funnel-form, c. 1 cm in diam., medium green. Fruit and seed not seen.

Eponymy

The species is named for the collector of the type material, Mr Ade Agus Setiawan.

Distribution

Known only from the type locality where it is locally abundant.

Ecology

Riverside Cretaceous hard sandstone rocks and boulders under open perhumid lowland forest between 45 and 90 m asl.

Notes

Six other *Bucephalandra* possess a sterile appendix longer than the fertile portion of the spadix (see key below): *Bucephalandra aurantiitheca* S.Y.Wong & P.C.Boyce (Fig. 7B), *B. chimaera* S.Y.Wong & P.C.Boyce (Fig. 7C), *B. elliptica* (Eng.) S.Y.Wong & P.C.Boyce (7D), *B. minotaur* S.Y.Wong & P.C.Boyce (Fig. 7E), *B. oncophora* S.Y.Wong & P.C.Boyce (Fig. 7F) and *B. vespula* S.Y.Wong & P.C.Boyce (Fig. &G). From all these *B. adei* differs by the papillate, not smooth appendix staminodes. *Bucephalandra adei* and *B. elliptica* occur on sandstone boulders, *B. aurantiitheca*, *B. chimaera*, *B. minotaur* and *B. vespula* on granites, and *B. oncophora* is restricted to nickel-bearing Pentlandite (Map 1).

1. Appendix staminode tops papillate **.... *Bucephalandra adei***

– Appendix staminode tops glabrous..... 2

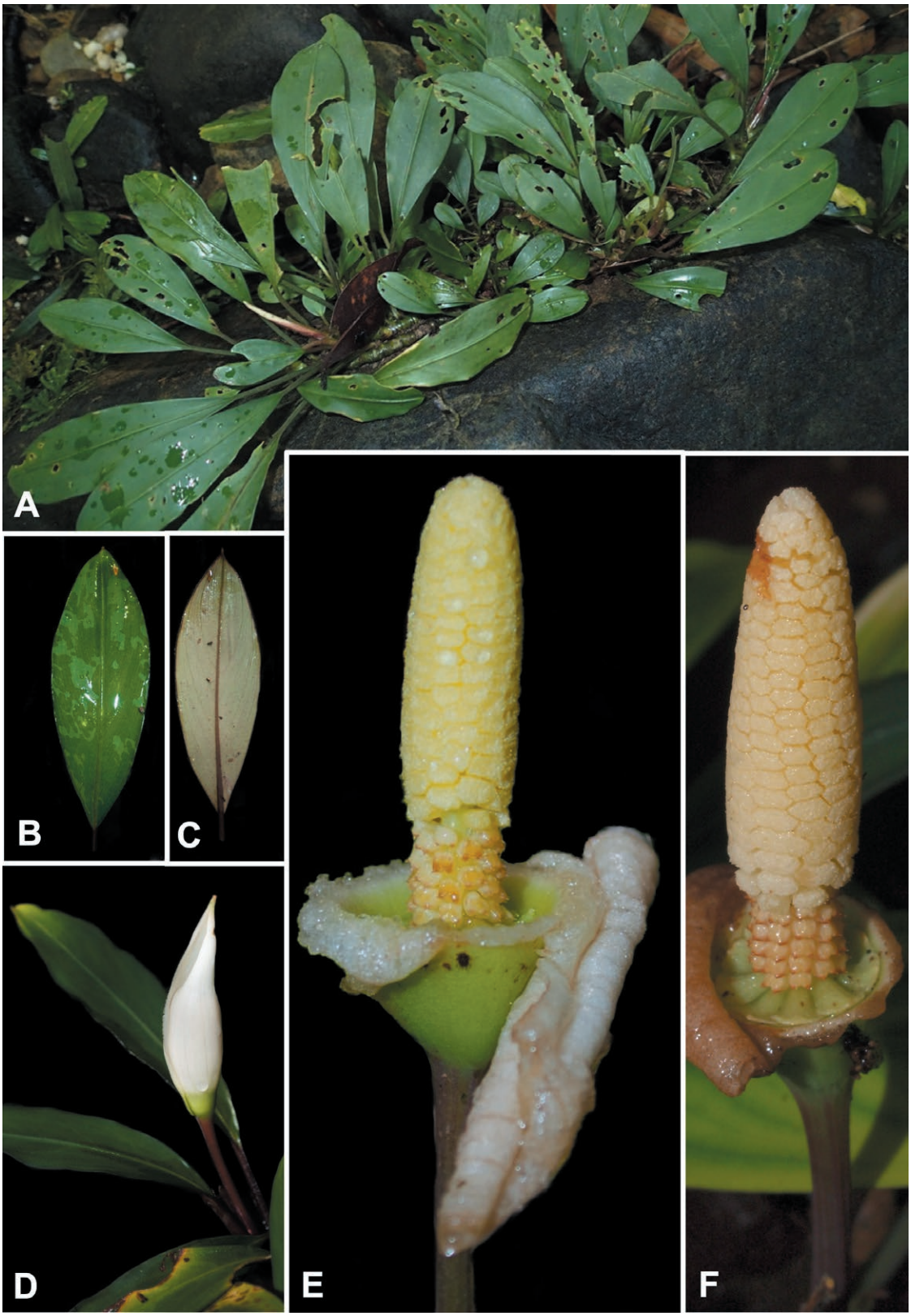


Figure 1. *Bucephalandra adei* (A) Plants in habitat. (B & C) Leaf blade adaxial and abaxial views. (D) Bloom at pistillate anthesis. (F) Bloom post staminate anthesis with spathe limb largely shed and interstice staminodes reflexed to seal off the lower spathe. All from *AR-4782*.

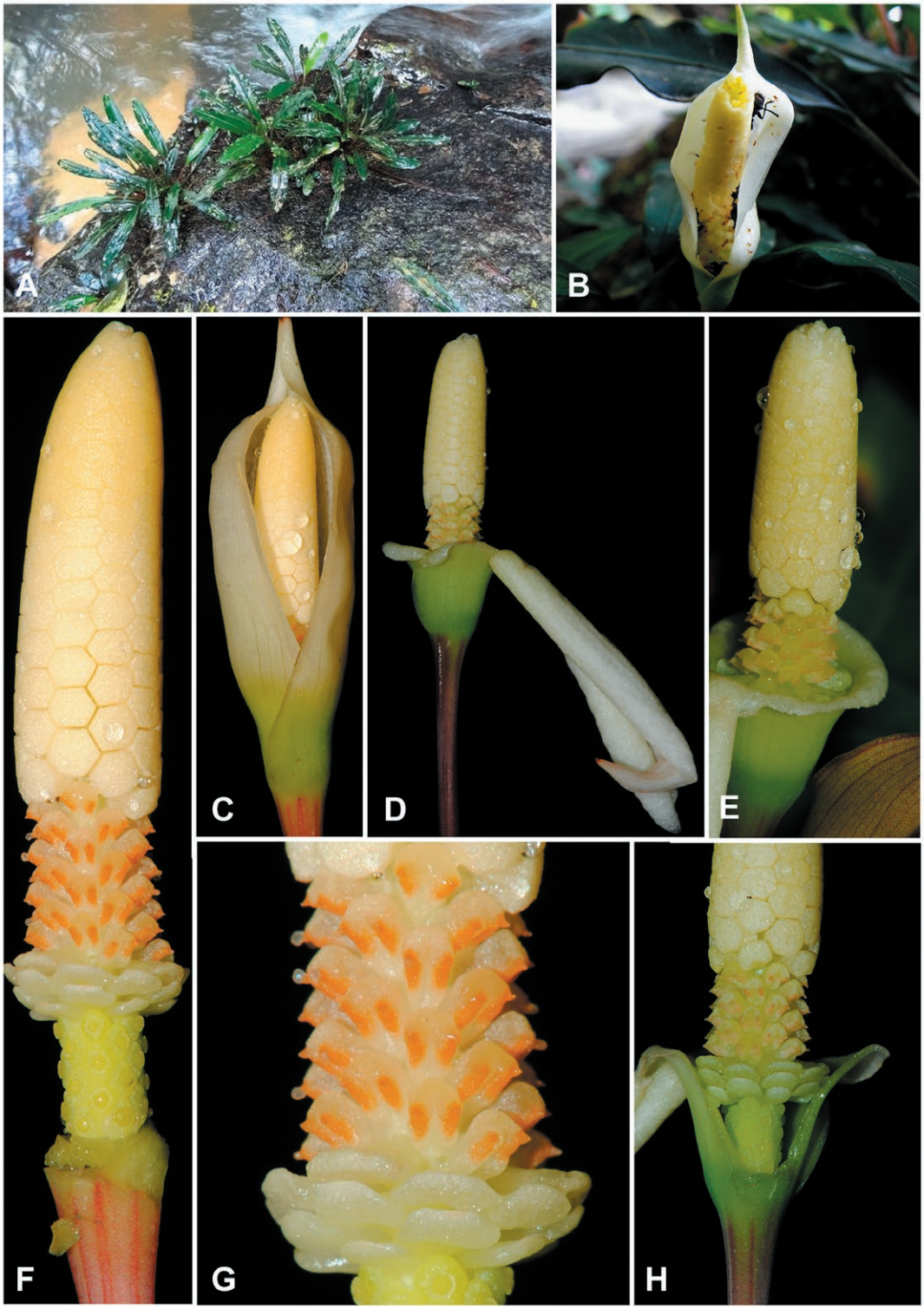


Figure 2. *Bucephalandra aurantiitheca* (A) Plants in habitat. (B) Bloom in habitat; note the presence of several chrysomelid beetles, the suspected pollinator. (C). Bloom at early pistillate anthesis. (D) Bloom at staminate anthesis; the spathe limb is about to fall. (E) Bloom at staminate anthesis, the reflexed interstice staminodes are just visible blocking the entrance of the persistent lower spathe. (F) Bloom at staminate anthesis; spathe artificially removed. (G) Detail of staminate floret zone at staminate anthesis; note the pollen droplet at the tips of the thecae horns. (H). Spadix at staminate anthesis, spathe limb fallen naturally, nearside of lower spathe artificially removed; note that the interstice staminodes have reflexed to seal the lower spathe entrance. All from *AR-3937*; A & B by K. Nakamoto; C–H by P.C. Boyce.

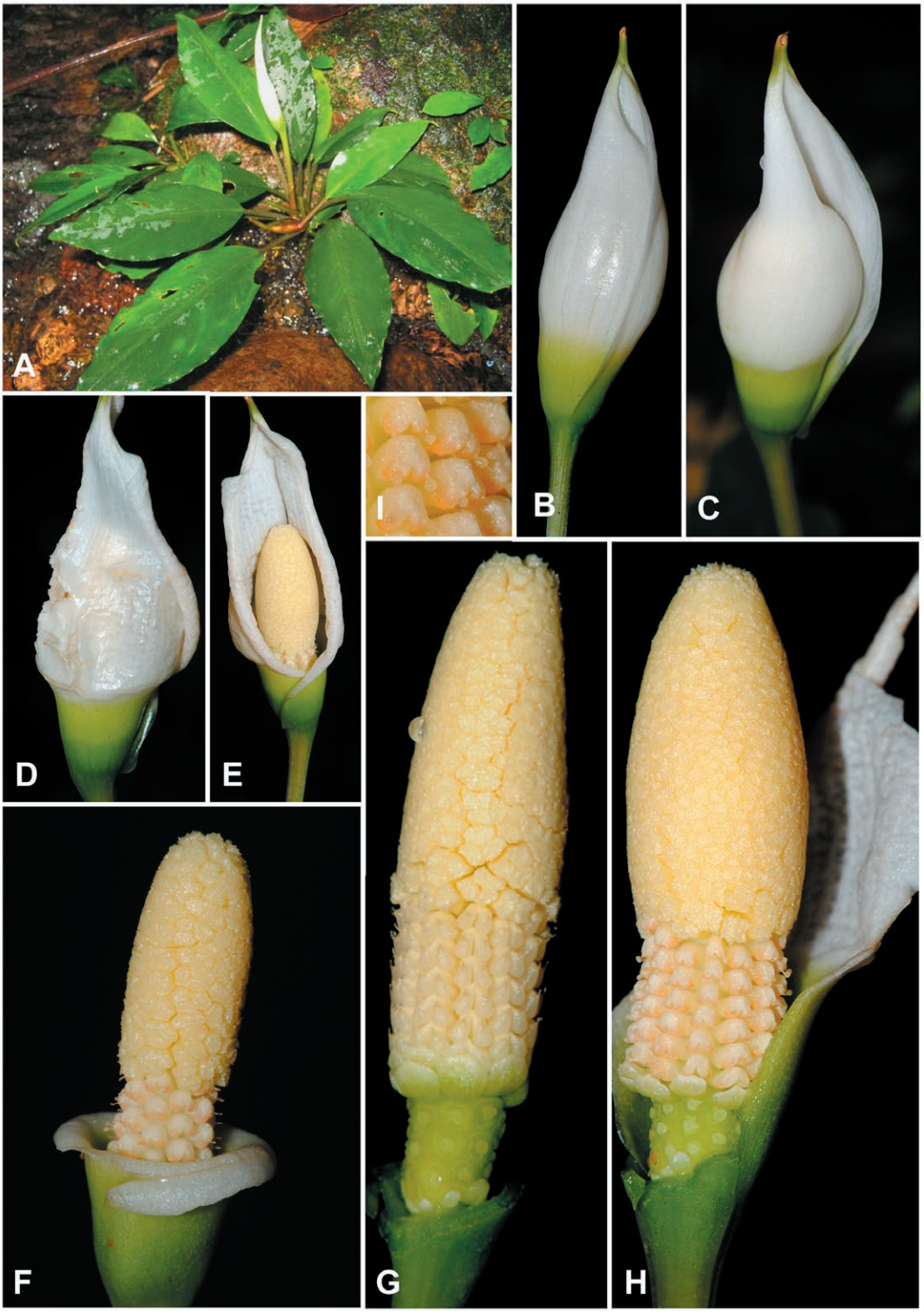


Figure 3. *Bucephalandra elliptica* (A) Plants in habitat. (B & C) Bloom at early (B) and mid (C) pistillate anthesis; note the changes in spathe limb shape; (D & E) Bloom at staminate anthesis, with the spathe limb beginning to deliquesce (F) bloom at peak of staminate anthesis; note that the spathe limb is mostly now separated from the lower, persistent part. (G) Spadix at pistillate anthesis, spathe limb; note that the interstice staminodes are still erect and that the staminate floret thecae have yet to reflex. (H) Spadix at onset of staminate anthesis, spathe partially artificially removed; note that the interstice staminodes have lowered and that the thecae of the staminate flowers have reflexed. All from *AR-3564*.

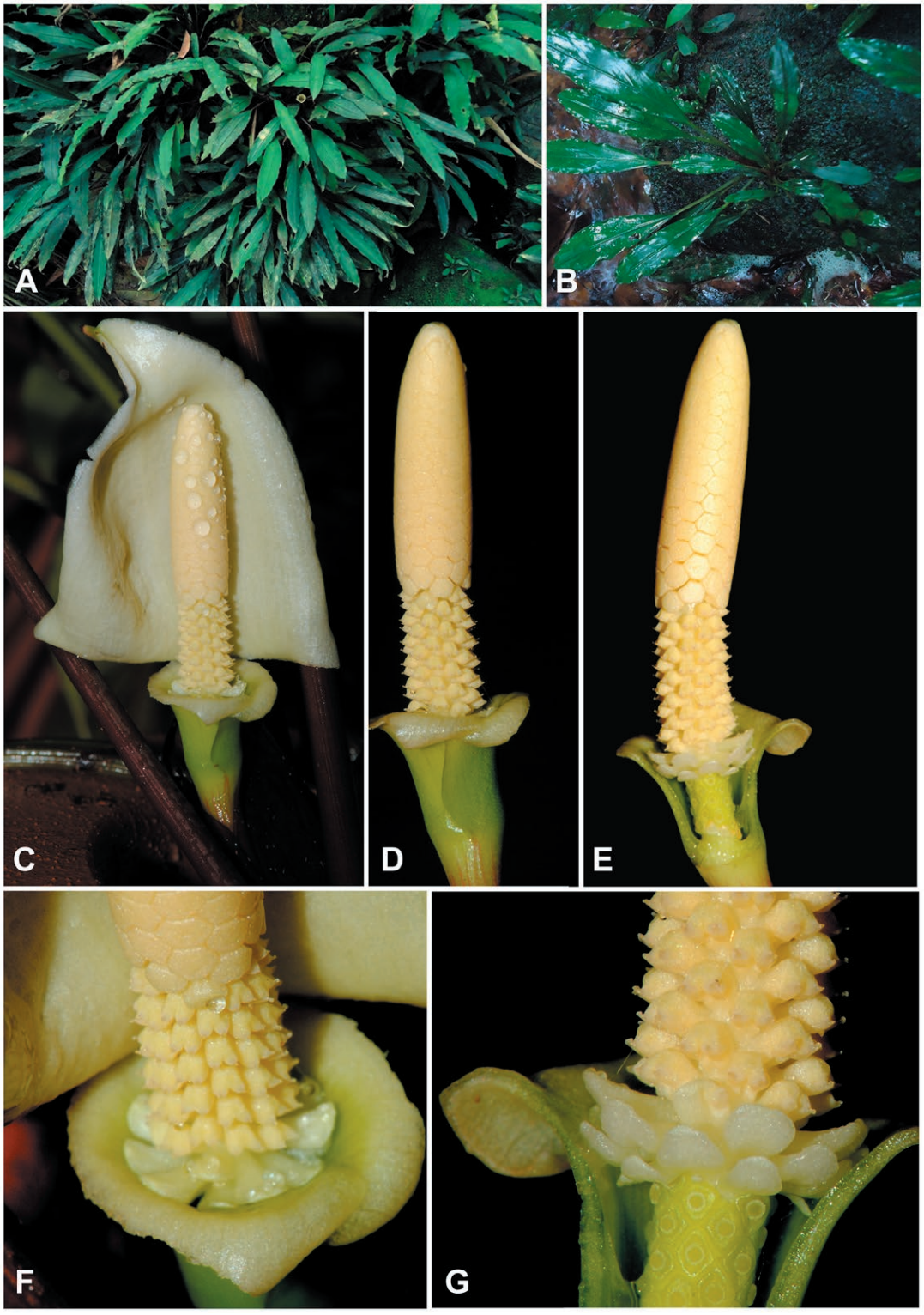


Figure 4. *Bucephalandra minotaur* (A & B) Plants in habitat. (C) Bloom at staminate anthesis, with the spathe limb nearly shed. (D) Bloom at staminate anthesis, spathe limb shed. (E) Bloom at staminate anthesis; spathe limb fallen naturally, nearside part of lower spathe removed artificially; note that the interstice staminodes have reflexed to close the entrance of the lower spathe. (F) Detail of the interstice staminodes sealing the lower spathe. (G) Detail of lower spathe and fertile portions of staminate phase spadix, nearside part of spathe artificially removed. All from *AR-3951*.

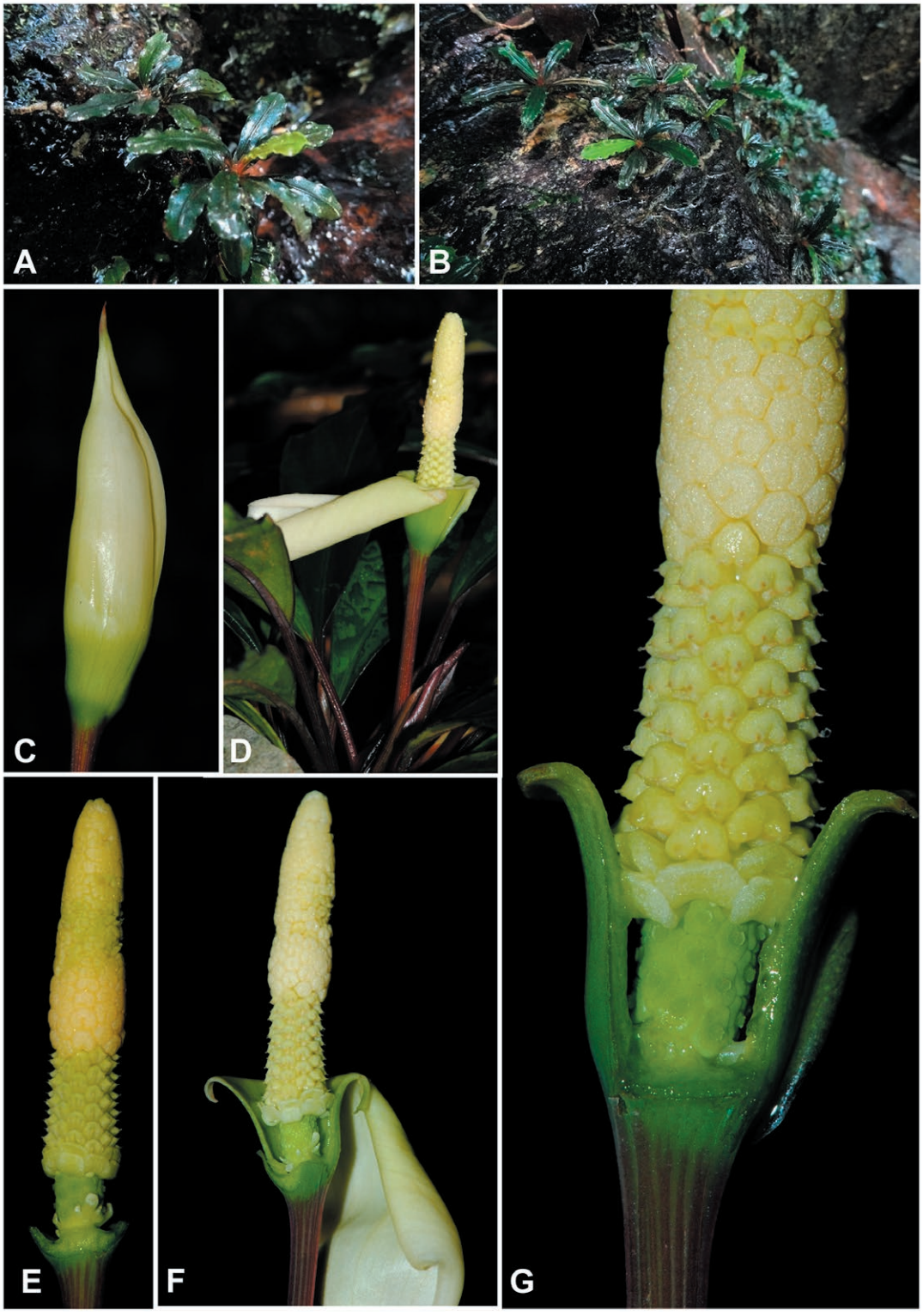


Figure 5. *Bucephalandra oncophora* (A & B) Plants in habitat. (C) Bloom at pistillate anthesis. (D) Bloom at staminate anthesis, spathe limb shedding. (E) Spadix at pistillate anthesis, spathe artificially removed; note different form of the distal and proximal appendix staminodes. (F) Spadix at staminate anthesis, spathe limb fallen naturally, nearside of lower spathe artificially removed; note interstice staminodes are beginning to reflex; compare the posture of the thecae horns with those in E. (G) Detail of staminate flowers and reflexed interstice staminodes, nearside lower spathe artificially removed. All from *AR-3932*.

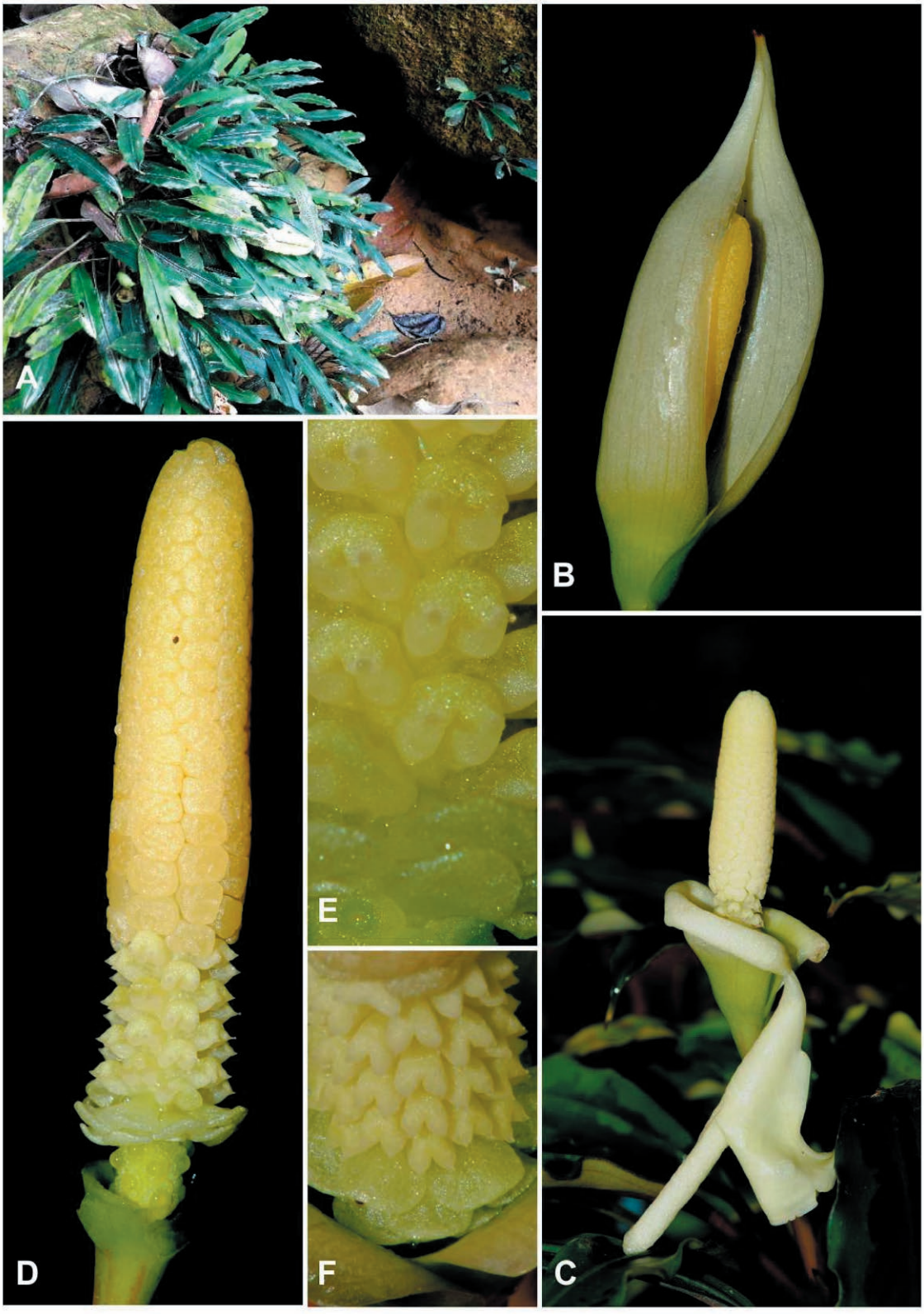


Figure 6. *Bucephalandra vespula* (A) Plants in habitat. (B) Bloom at pistillate anthesis. (C) Bloom at staminate anthesis, the spathe limb beginning to shed. (D) Spadix at staminate anthesis, spathe artificially removed; note the reflexed interstice staminodes and staminate flower thecae. (E & F) Detail of the staminate florets at staminate (E) and pistillate (F) anthesis. All from *AR-3664*.

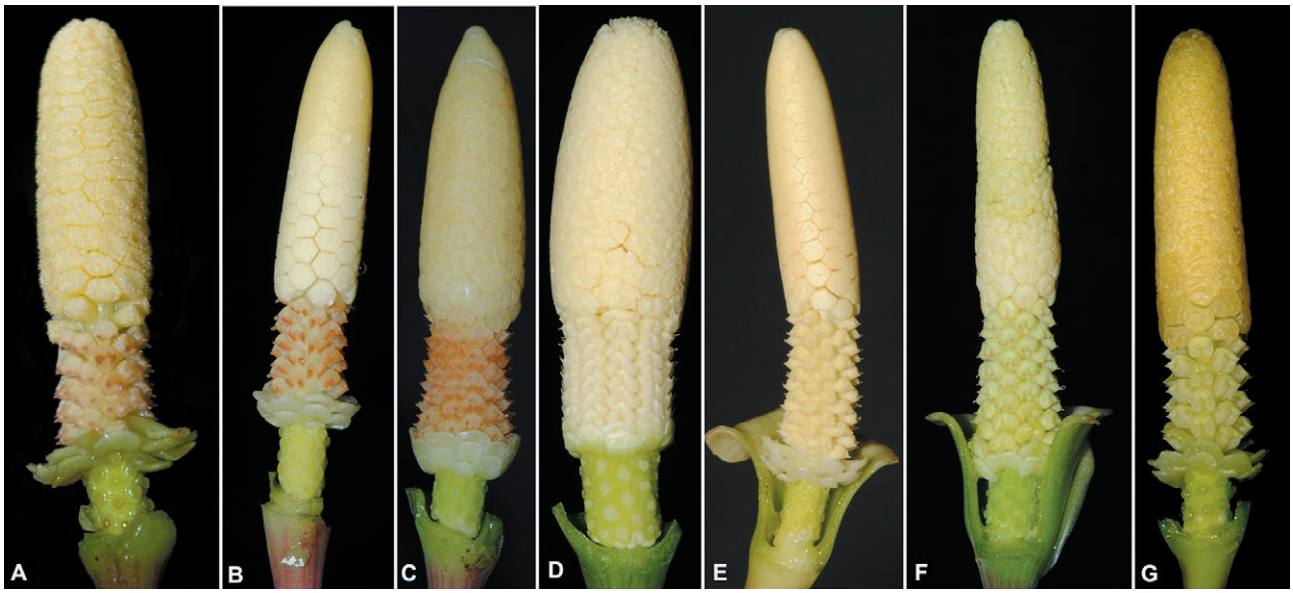


Figure 7. Spadix comparisons (spathe artificially removed). (A) *Bucephalandra adei* [*AR-2766*]. (B) *Bucephalandra aurantiitheca* [*AR-3937*]. (C) *Bucephalandra chimaera* [*AR-3846*]. (D) *Bucephalandra elliptica* [*AR-3564*]. (E) *Bucephalandra minotaur* [*AR-3951*]. (F) *Bucephalandra oncophora* [*AR-3932*]. (G) *Bucephalandra vespula* [*AR-3664*].

2. Appendix staminode tops corrugated**.** Sarawak: Sri Aman, sandstones ..... ***Bucephalandra elliptica***

– Appendix staminode tops smooth 3

3. Staminate florets arching upward from spadix with thecae horns very short and downwards directed; thecae dark orange, embedded in connective and presented on exposed ventral surface of stamen at staminate anthesis. Kalimantan Barat: Sekadau and Nanga Taman, granite..... ..... ***Bucephalandra aurantiitheca***

– Staminate florets with filament and connective perpendicular to spadix with thecae horns upwards directed; thecae not embedded in connective and presented on dorsal surface of stamen at staminate anthesis..... 4

4. Appendix fusiform, base tapering; staminate florets orange. Kalimantan Barat: Nanga Taman, granite ....***Bucephalandra chimaera***

– Appendix cylindrical, base not tapering; staminate florets cream 5

5. Staminodes of lower appendix morphologically identical to those of upper appendix. Kalimantan Barat: Sekadau/Melawi Regencies boundary, granite ... ***Bucephalandra minotaur***

– Staminodes of lower appendix irregularly rounded, markedly larger than upper appendix staminodes..... 6

6. Stigmas sessile; lower appendix staminodes regularly rounded, not conspicuously wider than rest of appendix, each staminode with a conspicuous shallow suture. Kalimantan Barat: Kayu Lapis, sandstone..... ***Bucephalandra vespula***

– Stigmas stipitate; lower appendix staminodes irregularly rounded, conspicuously wider than rest of appendix, each staminode without a suture. Kalimantan Barat: Nanga Taman, Pentlandite ..... ***Bucephalandra oncophora***

Additional specimen examined (paratype)

INDONESIA: Kalimantan Barat, Ngabang, Landak, Riam Desa, Sungai Durian, 0°31'41"N, 109°47'39"E, 45 m elev., 11 June 2014, *Hiroyuki Kishi AR-4782* (SAR).

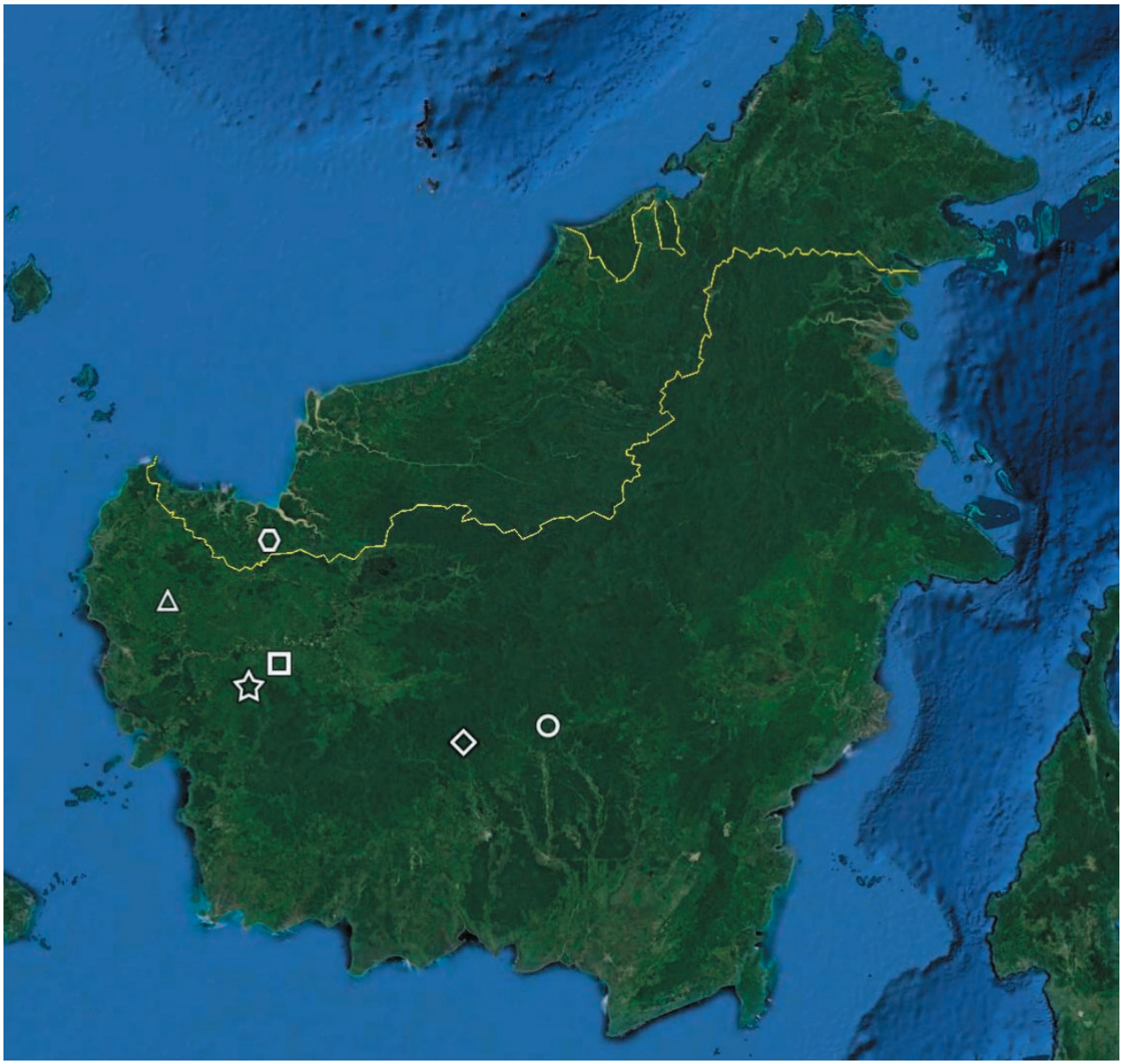
REFERENCES

Bogner J, Hay A. 2000, Schismatoglottideae in Malesia II — *Aridarum*, *Bucephalandra*, *Phymatarum* and *Piptospatha*. Telopea. 9: 183–194.

Boyce PC, Bogner J, Mayo SJ. 1995. *Bucephalandra catherineae*, a new species from Kalimantan. Botanical Magazine. 12(3): 150–153.

Boyce PC, Wong SY. 2012. Studies on Schismatoglottideae (Araceae) of Borneo XX: Beccari's < La Più piccola delle Aracee> (*Microcasia pygmaea*) recollected and transferred to *Bucephalandra* Schott. Webbia. 67(2): 139–146.

Boyce PC, Wong SY. 2014. Studies on Schismatoglottideae (Araceae) of Borneo XXXXI: Additional new species of *Bucephalandra*. Willdenowia. 44: 415–420. DOI: 10.3372/wi.44.44312.



Map 1. △ = *Bucephalandra adei*; ⬡ = *Bucephalandra elliptica*; ☆ = *Bucephalandra oncophora*; □ = *Bucephalandra aurantiitheca* and *B. chimaera*; ◇ = *Bucephalandra minotaur*; ○ = *Bucephalandra vespula*.

Hutchinson, CS. 1989. Geological Evolution of South-East Asia. Malaysia: Oxford University Press.

Hutchinson, CS. 2005. Geology of north-west Borneo: Sarawak, Brunei and Sabah. Elsevier, The Netherlands.

Okada H, Mori Y. 2000. Three new species of Schismatoglottideae, Araceae, from Borneo. Acta Phytotaxonomica et Geobotanica. 51(1): 1–9.

Tate RB. 2001. The geology of Borneo island CDROM. Kuala Lumpur: Persatuan Geologi Malaysia/Geological Society of Malaysia.

Wong SY, Boyce PC. 2014. Studies on Schismatoglottideae (Araceae) of Borneo XXX — New species and combinations for *Bucephalandra* Schott. Willdenowia. 44: 149–199.

Wong SY, Boyce PC. 2016. Studies on Schismatoglottideae (Araceae) of Borneo LVII: *Bucephalandra filiformis* — a new species from Maligan, Sarawak, Malaysian Borneo. Aroideana. 39(2): 56–60.

Wong SY, Boyce PC, Kartini S. 2018. Studies on Schismatoglottideae (Araceae) of Borneo LXVII: *Bucephalandra danumensis*, a new species from Sabah, Malaysian Borneo. Webbia. 73(2): 225–231. DOI: 10.1080/00837792.2018.1522840.

WEBBIA Journal of Plant Taxonomy and Geography

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Citation: Wong Sin Yeng, Peter C. Boyce (2022) Schismatoglottideae of Borneo LXXII – A new species of *Schottarum* (Araceae) from Sarawak, Malaysian Borneo. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 145-152. doi: 10.36253/jopt-12176

Received: October 13, 2021

Accepted: November 11, 2021

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Alistair Hay

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Schismatoglottideae of Borneo LXXII – A new species of *Schottarum* (Araceae) from Sarawak, Malaysian Borneo

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Abstract. *Schottarum inconspicuum* S.Y.Wong & P.C.Boyce, is described as a new species from the easten part of the Rejang Basin, taking the genus to three species. All are illustrated from living plants. A distribution map is provided.

Keywords: *Schottarum*, Rejang Basin, Borneo, shales.

INTRODUCTION

Schottarum P.C.Boyce & S.Y.Wong (Boyce and Wong 2008) is a small genus of Bornean Steenisian rheophytes (Boyce and Wong 2019) allied to *Schismatoglottis* (in which genus both described species have formerly been placed – see Hay in Hay and Yuzammi 2000). It is defined by ovaries with basal placentation, few-seeded fruits with the seeds lacking a micropylar appendage, a spathe limb divided from the narrowly campanuliform persistent lower spathe by a pronounced constriction, with the persistent lower spathe reflexing and opening along the free margins at fruit maturity, and pollen released in dense fine threads (Wong 2013; Low et al 2018). It is distinguished from similar Schismatoglottis (*S. multiflora* Ridl., etc.) by the basal (not parietal) placentation and by the persistent lower spathe not splitting into pieces at fruit maturity. *Schottarum* is also reminiscent of *Bidayuha* S.Y.Wong & P.C.Boyce, the latter differing by seeds with a pronounced micropylar appendage, the persistent lower spathe splitting basipetally at fruit maturity and, uniquely in the tribe, a spathe with a very curious waxy-oily texture.

Schottarum was erected upon *Schottarum sarikeense* (Bogner and M.Hotta) P.C.Boyce & S.Y.Wong (Fig. 1 & 4C) with a second species, *S. josefii* (A.Hay) P.C.Boyce, S.Y.Wong & S.L.Low (Fig. 2 & 4B), recognized in 2013 (Low et al. 2013). Both occur in the western Rejang Basin, to the west

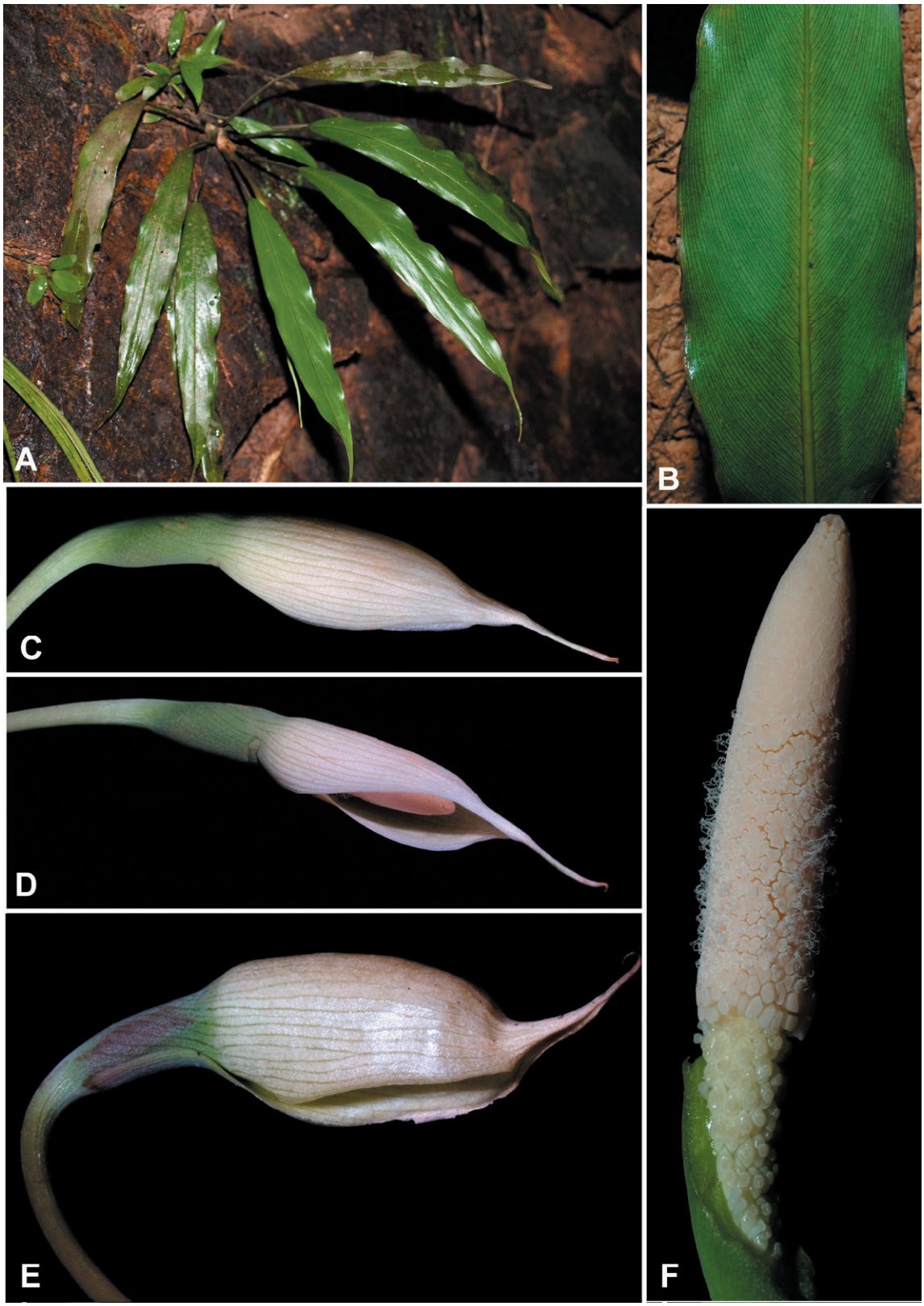

Figure 1. *Schottarum sarikeense* (A) Plant in habitat. (B) Leaf blade abaxial surface showing the fine venation. (C & D) Bloom at pistillate anthesis. (E) Bloom at staminate anthesis. (F) Spadix at staminate anthesis, spathe artificially removed. All from *AR-1605*.

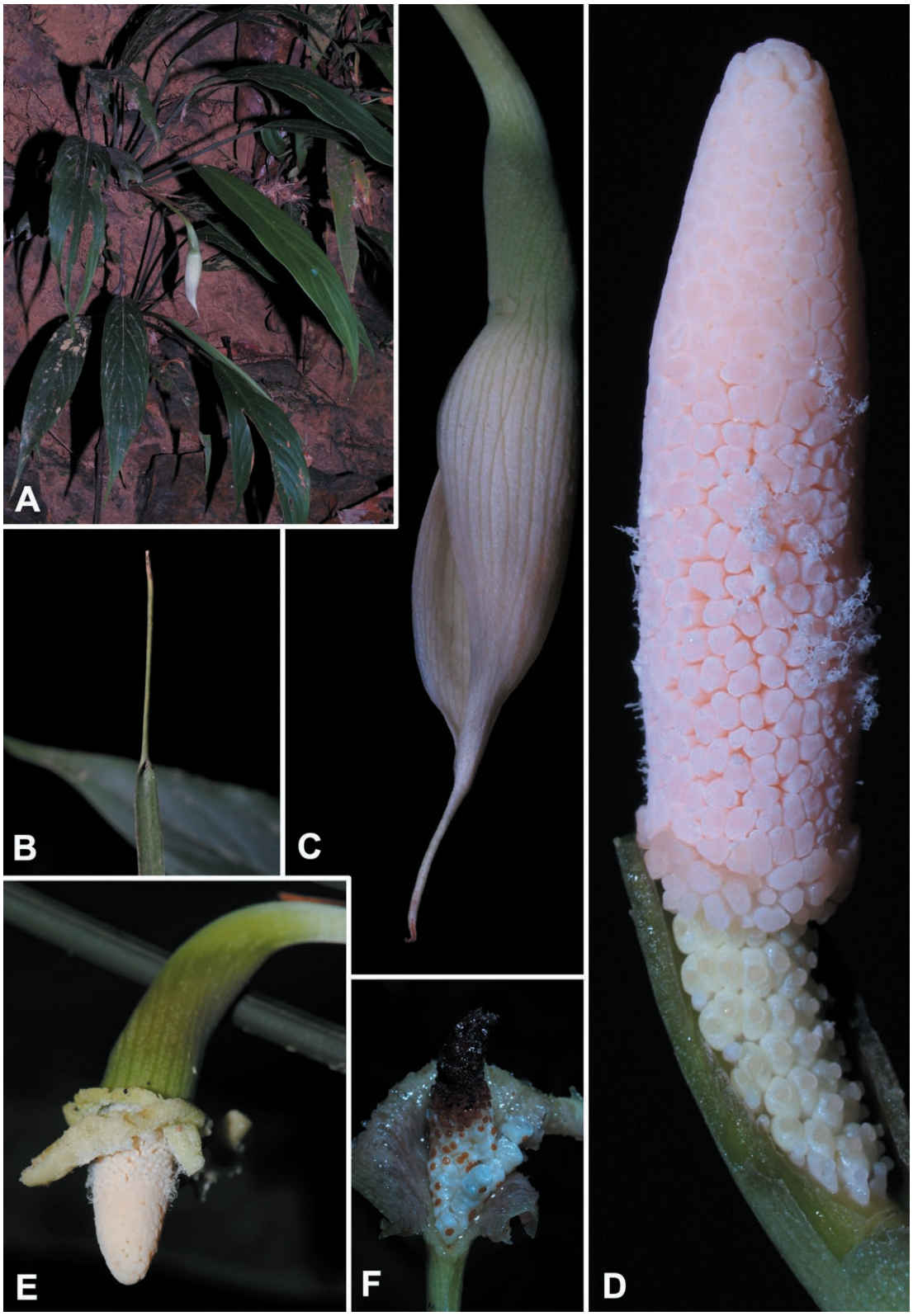

Figure 2. *Schottarum josefii* (A) Flowering plant in habitat. (B) Detail of leaf blade terminal tubular mucro. (C) Bloom at pistillate anthesis. (D) Spadix at staminate anthesis, spathe artificially removed. (E) Bloom at late staminate anthesis with spathe limb partially shed. (F) Ripe infructescence with persistent lower spathe already opened and fruits being shed. All from *AR-2418*.

of the Rejang and Kanowit rivers, with *S. sarikeense* in the north and *S. josefii* in the south (Map 1). Here we describe a third species, from the central east Rejang Basin. All three species are shale obligates. Geology in this paper is specified based on Hutchison (1989, 2005) and Tate (2001).

Schottarum inconspicuum S.Y.Wong, & P.C.Boyce, **sp. nov.**

Type: Malaysia. Sarawak, Kapit, Nanga Gaat, Batang Balleh, Rejang Wood Concession, Sungai Piat, 1°38'9.10"N 113°24'9.90"E, 480 m asl, 14 Oct 2003, *P.C. Boyce & Jeland ak Kisai AR-117* (holotype SAR + spirit). (Figure 3 and 4A).

Diagnosis

Schottarum inconspicuum differs from both *S. josefii* and *S. sarikeense* by the fusiform (vs bluntly conic) spadix appendix equalling (vs about half as long as) the staminate floret zone, by the pistillate floret zone being about one third free (vs fully adnate or at most only slightly free from the spathe), and the much smaller and more densely congested pale green pistillate florets.

Description

Small obligate rheophytes to 15 cm tall. Stem pleionanthic, condensed; roots thin but tough, wide-spreading, adhering strongly to rocks. Cataphylls conspicuous, papery, soon marcescent. Leaves numerous; petiole 5-7 cm long, shorter than blade, slender, almost terete, adaxially very narrowly canaliculate; petiolar sheath sheathing only at extreme base, wings extended into a 3-4 cm long very narrowly triangular ligular marcescent portion; leaf blade thinly leathery, narrowly elliptic, 8-15 cm long, 1.5-3 cm wide, rather pale bright green, somewhat paler beneath, base cuneate, apex acuminate with a conspicuous tubule to 3 mm long; midrib abaxially prominent, adaxially flush with blade to slightly impressed; primary lateral veins fine, 6-7 on each side, prominent adaxially, pellucid; interprimary venation pellucid, fine and dense, barely differentiated from primary venation; secondary and tertiary venation obscure. Bloom solitary, nodding (down-curved in lower part), c. 4 cm long; smelling slightly esteric during anthesis; peduncle shorter than petiole, 4-5 cm long, medium green, terete; lower spathe very narrowly campanulate, 1.5-2 cm long, glaucous pale green, differentiated from limb by a constriction; spathe limb caducous, dull white with slightly darker veins, more-or-less oblong lanceolate, inflating and somewhat cucullate over spadix at anthesis, narrowed into an abrupt beaked tip; spadix subcylindric, c. 3 cm long; pistillate floret zone 2-2.5 cm long, dorsally adnate to spathe for about two thirds its length; pistils subglobose, , c. 0.8 mm diam., pale green; stigma sessile, discoid, about as wide as the ovary, papillate; interpistillar staminodes absent from among the pistils, confined to scattered few along the spathe/spadix adnation, block-like, very slightly exceeding the pistils in height; sterile interstice comprised of a few irregular whorls of sterile stamens at base of staminate floret zone, with some coalesced into larger structures, these expanding laterally during pistillate anthesis; staminate floret zone cylindrical, 1 cm long, faintly wider distally than proximally; staminate florets partially to completely connate into groups of two to three stamens, with a few of these groups congested into random clusters; stamens truncate, flat-topped, c. 0.7 mm across, rather irregular in shape and size, ellipsoid to dumbbell-shaped from above; filament block-like; connective flat; thecae embedded in stamens, opening via a terminal pore; pollen in dense fine strings; appendix fusiform, c. 1.5 cm long, basally slightly wider than the top of staminate floret zone, distally widening and then tapering and finally narrowly obtuse, pale yellow; appendix staminodes columnar, flat-topped, c. 0.5 mm wide. Fruiting peduncle arching, later declinate; fruiting spathe narrowly urceolate, about 1 cm long, reflexing and opening along the free margins (not splitting) at fruit maturity; fruit oblong-globose; seed ellipsoid, c. 0.5 mm long, micropyle blunt; testa longitudinally very finely ridged.

Etymology

From Latin, *inconspicuus* (neuter *inconspicuum*), unremarkable – in allusion to the small and easily overlooked plants.

Distribution

Known only from the area around Nanga Gaat where it is scattered and seldom abundant.

Ecology

Paleogene deepwater shale riverside rocks and boulders under shady perhumid lowland gallery forest between 150 and 480 m asl.

Notes

With their rather featureless leaf blades sterile plants of the three described *Schottarum* species are highly similar in appearance; even when flowering, plants are likely overlooked since the nodding blooms are held beneath the foliage. Much as with outwardly

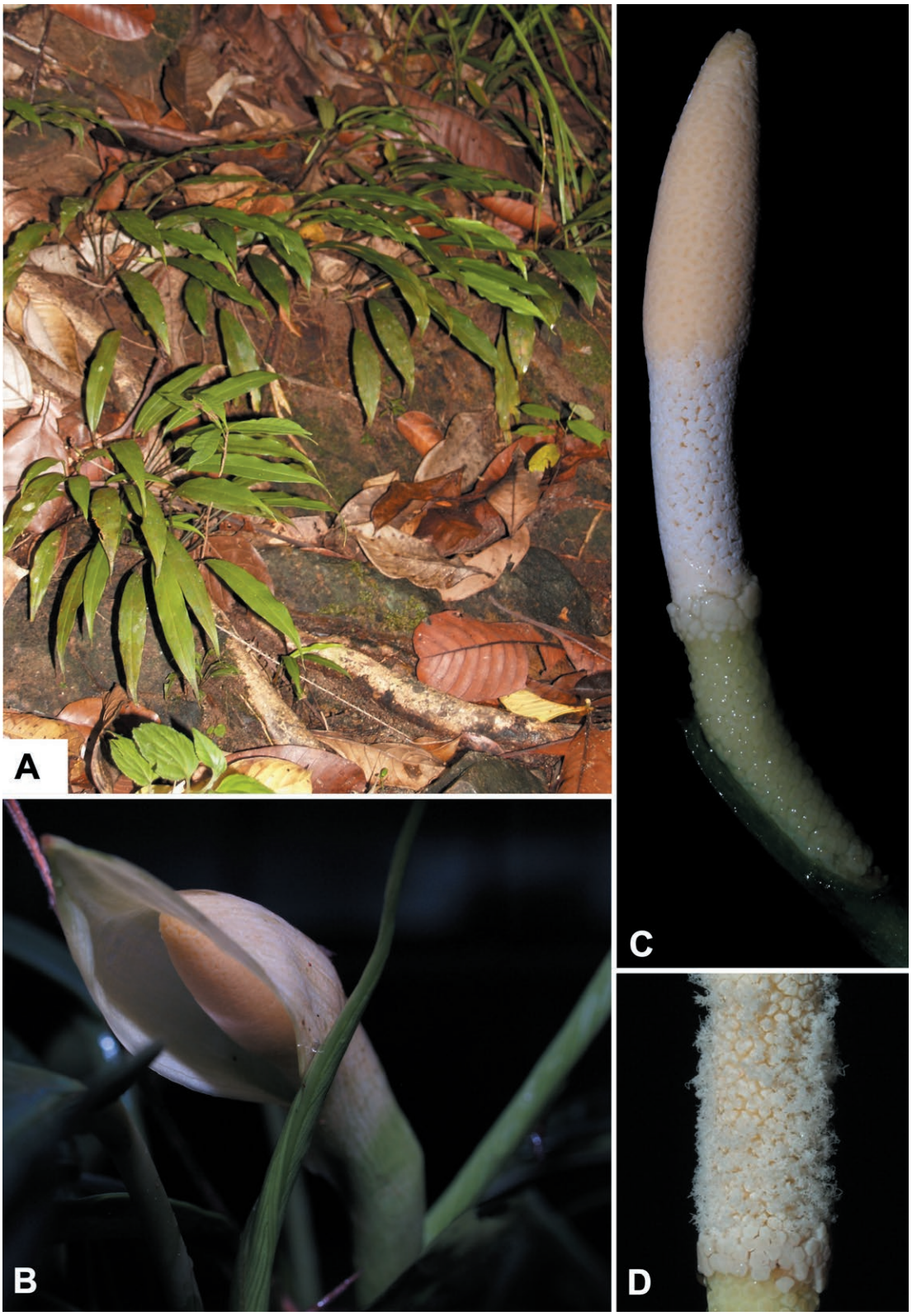

Figure 3. *Schottarum inconspicuum* (A) Plants in habitat. (B) Bloom at staminate anthesis. Leaf blade abaxial surface showing the fine venation. (C) Spadix at staminate anthesis, spathe artificially removed. (D) Detail of staminate zone with pollen shed in fine dense strings. All from *AR-117*.

Figure 4. Spadix comparisons (A) *Schottarum inconspicuum* [*AR-117*]. (B) *Schottarum josefii* [*AR-2418*]. (C) *Schottarum sarikeense* [*AR-1605*].

highly homogenous *Ooia* S.Y.Wong & P.C.Boyce (Wong & Boyce 2016) species, examination of the spadix at the onset of pistillate anthesis is critical for species determination.

Additional specimens examined (paratypes)

MALAYSIA: Sarawak. Kapit. Nanga Gaat, Batang Balleh, Rejang Wood Concession, Sungai Piat,

Map 1. △ = *Schottarum josefii*; ☆ = *Schottarum sarikeense*; ○ = *Schottarum inconspicuum*.

1°38'9.10"N 113°24'9.90"E, 480m asl., 14 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-102* (SAR + spirit). Nanga Gaat, Batang Balleh, Rejang Wood Concession, stream below Camp Gahada, 1°41'49.40"N 113°26'16.30"E, 350m asl., 15 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-135* (SAR + spirit). Nanga Gaat, Batang Balleh, Rejang Wood Concession, km 65 road to Camp Gahada, 1°42'01.1"N 113°31'14.8"E, 190m asl., 12 May 2004, *P.C.Boyce, Jeland ak Kisai & Jepom ak Tisai AR-326* (SAR + spirit). Nanga Gaat, Batang

Balleh, Rejang Wood Concession, km 3.5 after heli-logging camp on road to Camp Gahada, Sungai Bereng, 1°45'36.0"N 113°27'54.7"E, 228m asl., 15 Dec 2004, *P.C.Boyce, Jeland ak Kisai & M.Gibernau AR-890* (SAR + spirit). Nanga Gaat, Batang Balleh, Rejang Wood Concession, km 65 road to Camp Gahada, 01°41'59.7"N 113°31'13.7"E, 182m asl., 16 Dec 2004, *P.C.Boyce, Jeland ak Kisai & M.Gibernau AR-921* (SAR + spirit).

REFERENCES

Boyce PC, Wong SY. 2008. Studies on Schismatoglottideae (Araceae) of Borneo VII: *Schottarum* and *Bakoa,* two new genera from Sarawak, Malaysian Borneo. Botanical Studies (Taipei). 49: 393–404.

Boyce, P.C. & Wong S.Y. 2019. Borneo and its disproportionately large rheophytic aroid flora. Gardens' Bulletin Singapore. 71(Suppl. 2): 497–524.

Hay A, Yuzammi. 2000. Schismatoglottideae (Araceae) in Malesia I — *Schismatoglottis.* Telopea. 9: 1–177.

Hutchinson CS. 1989. Geological Evolution of South-East Asia. Malaysia: Oxford University Press.

Hutchinson CS. 2005. Geology of north-west Borneo: Sarawak, Brunei and Sabah. Elsevier, The Netherlands.

Low SL, Wong SY, Boyce PC. 2013. *Schottarum* (Schismatoglottideae: Araceae) substantiated based on combined nuclear and plastid DNA sequences. Plant Systematics and Evolution. 300(4): 607–617.

Low SL, Wong SY, Boyce PC. 2018. Naming the chaos: generic redelimitation in Schismatoglottideae (Araceae). Webbia. 72(2): 1–100.

Tate RB. 2001. The geology of Borneo island CDROM. Kuala Lumpur: Persatuan Geologi Malaysia/Geological Society of Malaysia.

Wong SY. 2013. Rheophytism in Bornean Schismatoglottideae (Araceae). Systematic Botany. 38(1): 32–45.

Wong SY, Boyce PC. 2016. Studies on Schismatoglottideae (Araceae) of Borneo LI: *Ooia* revised, including a reconsideration of *Ooia grabowskii*. Journal of Japanese Botany 91 (Suppl.): 138–167.

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Citation: Wong Sin Yeng, Peter C. Boyce (2022) Studies on Schismatoglottideae (Araceae) of Borneo LXXIII - *Schismatoglottis auyongii* [Calyptrata Clade], a new species for the Penrissen Range, Sarawak. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 153-157. doi: 10.36253/jopt-12256

Received: November 1, 2021

Accepted: November 10, 2021

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Alistair Hay

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Studies on Schismatoglottideae (Araceae) of Borneo LXXIII - *Schismatoglottis auyongii* [Calyptrata Clade], a new species for the Penrissen Range, Sarawak

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Abstract. *Schismatoglottis auyongii* is described and illustrated as a new clumping species of the *Schismatoglottis* Calyptrata clade from wet slopes in hill forest on the extremely hard Paleogene sandstones of the Penrissen Range, SW Sarawak.

Keywords: Borneo, Malaysia, Penrissen Range, Sarawak, *Schismatoglottis*.

INTRODUCTION

Schismatoglottis Zoll. & Moritzi was last monographed for Borneo by Hay (Hay and Yuzammi 2000), recognizing 62 species, of which 31 were then newly described. Subsequently the total for Borneo has risen to 129 species, of which 84 occur in Sarawak (Wong et al. 2018). These total species counts are assuredly going to rise with the eventual inclusion of currently incomplete material for approximately 40 undescribed species, and on-going fieldwork that continues to reveal plentiful further novelties. Here we describe a new clumping species of the Schismatoglottis Calyptrata clade (sensu Low et al. 2018) from wet slopes in hill forest on the extremely hard Paleogene sandstones of the Penrissen Range, SW Sarawak. Geology in this paper is specified based on Hutchison (1989, 2005) and Tate (2001).

Schismatoglottis auyongii S.Y.Wong & P.C.Boyce, **sp. nov.**

Type: Malaysia. Sarawak, Kuching, Padawan, Puncak Borneo, forested steep gully, 1°07' 41.7"N110°12'59.7"E, 870 m asl. 15 Sep 2014, *Wong Sin Yeng & P.C.*Boyce AR-489 (SAR!, holotype + spirit). (Figures 1 and 2).

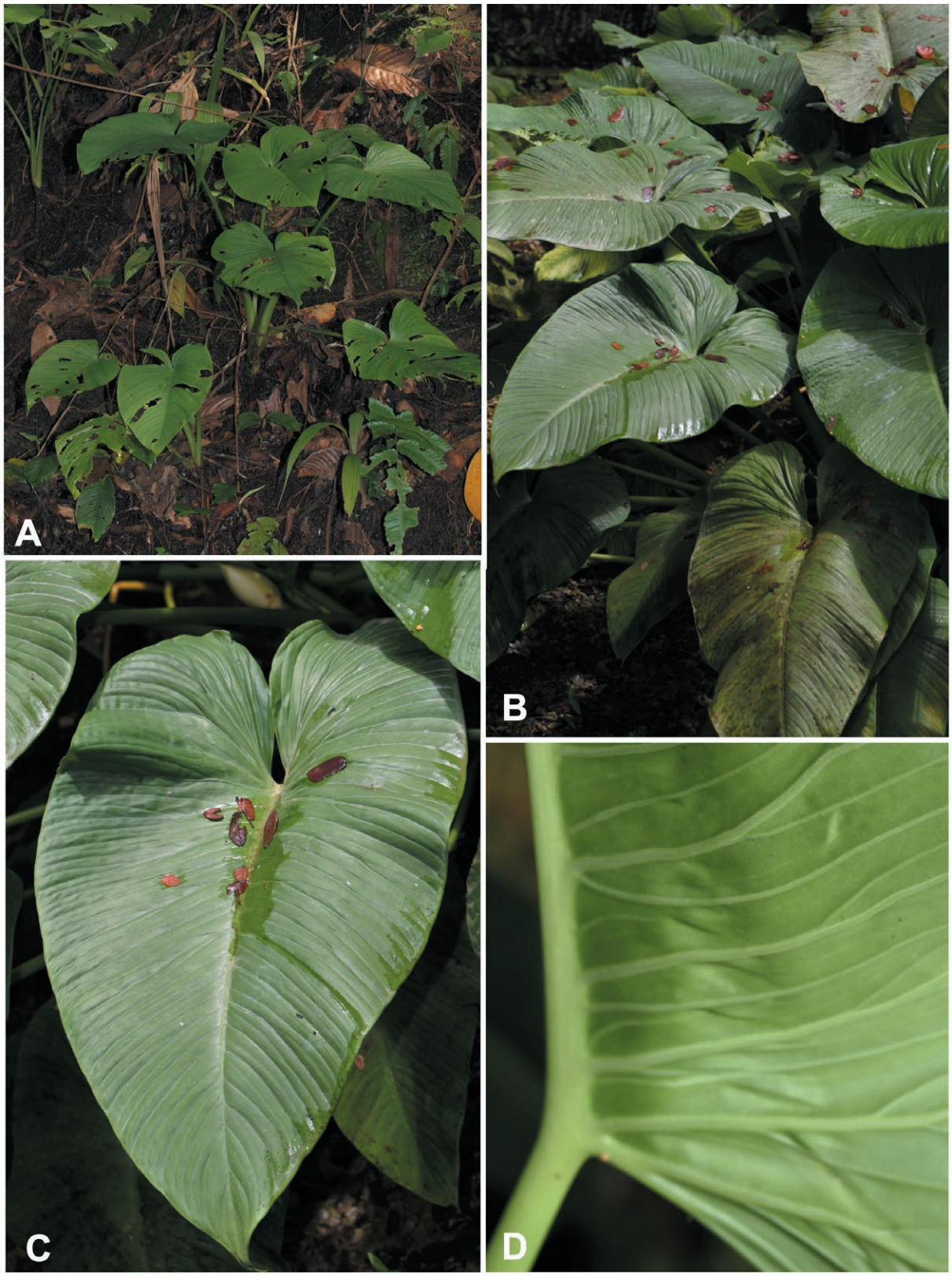

Figure 1. *Schismatoglottis auyongii* (A & B) Plants in habitat. (C) Leaf blade adaxial surface showing the quilted texture. (D) Detail of leaf blade abaxial surface in the region of the posterior lobes. All from *Wong Sin Yeng & P.C.Boyce AR-489*.

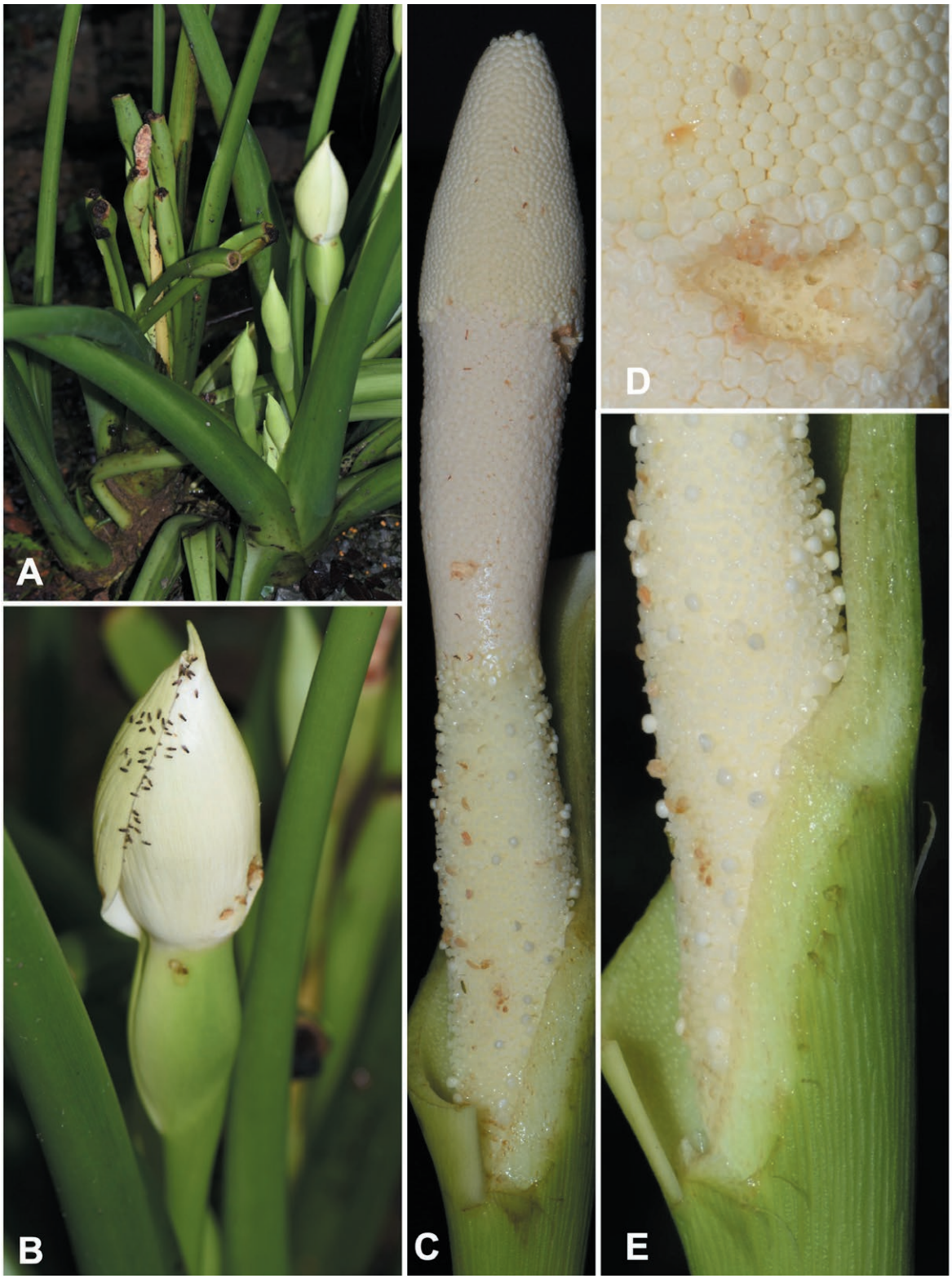

Figure 2. *Schismatoglottis auyongii* (A) Flowering habit; note the succession of developing blooms. (B) Bloom at pistillate anthesis with numerous Colocasiomyia on the spathe limb. (C) Spadix at late pistillate anthesis, spathe artificially removed. (D) Detail of upper part of staminate zone and lower part of appendix; the damage caused by Chrysomelid beetles. Spathe, artificially removed, natural form. (E) Pistillate zone of spadix at pistillate anthesis, spathe artificially removed. All from Wong *Sin Yeng & P.C.Boyce AR-489*.

Diagnosis

Schismatoglottis auyongii is most like *S. trivittata* Hallier f., (N.B., incorrectly attributed to Hallier (senior) in IPNI, POWO and the Kew World Checklist) to which it keys in Hay & Yuzammi (2000), differing by the much larger and more robust habit, leaf blades with the major veins impressed (and larger blades with a quilted appearance), and posterior lobes overlapping across the sinus, the spadix adnate to the spathe for c. ½ its length (vs spadix free), and the much stouter appendix. *Schismatoglottis auyongii* additionally approaches several Bornean species (*S. clarae* A.Hay, *S. moodii* A.Hay, and *S. niahensis* A.Hay) from which it may be differentiated as follows: from S. clarae by the strongly cordate leaf blades (vs leaf blade base acute to rounded and not at all cordate); from *S. moodii* by the posterior lobes overlapping across the sinus (vs posterior lobes out-turned); and from *S. niahensis* by the stems entirely hypogeal (vs stems largely epigeal).

Description

Robust clumping herb up to 150 cm tall although often closer to 100 cm. Stem hypogeal, hapaxanthic, very stout, c. 6 cm diam. in biggest individuals. Leaves to 12 together; petiole to c. 65 cm long, sheathing in the lower 2/5, medium green with rather dense paler short streaks; wings of sheath fully attached, tapering, apically truncate; blade broadly ovato-sagittate, 25–50 cm long × 15–30 cm wide, adaxially semi-glossy bright medium green, slightly paler abaxially, base cordate, posterior lobes to 11 cm long, in all but the smallest leaves the lobes overlapping in the sinus, tip acute and acuminate for 2–4 cm; midrib prominent, with 11–15 primary impressed lateral veins on each side, irregularly alternating with lesser interprimaries and diverging at c. 60°, the lower ones usually branched, giving off 1 or 2 veins similar in size to the interprimaries, and arising at almost 90° to the midrib, leaf blades, especially the biggest ones, with a somewhat quilted appearance; secondary venation arising from the midrib and from along the lower c. ½ of the proximal primary veins; tertiary venation obscure. Blooms up to 12 together, arising and maturing sequentially; peduncle 13–20 cm long. Spathe 12–15 cm long; lower spathe narrowly ovoid, 4–6 cm long, differentiated from the limb by a strong constriction, semi-matte pale green; limb broadly ovate, 8–10 cm long, white, rather thick, inflated over the appendix at anthesis, caducous. Spadix with the pistiilate zone adnate to the spathe for about half its length, 8.5–13 cm long, subcylindric to very faintly hourglass shaped; pistillate zone 4–6 cm long, adnate to the spathe for c. ½ its length, 0.8–1.2 cm wide in the middle, distally slightly conic, c. 4–7 mm diam. at the top; pistils very crowded, bottle-shaped, c. 1 mm diam. very pale yellow; stigma slightly elevated on a short style, button-like, papillate, about as wide as the ovary; interpistillar staminodes scattered among the pistils, stalked, clavate with the head depressed globose, exceeding the pistils, waxy white; sterile interstice ill-defined, the upper part of pistillate zone covered with two incomplete whorls of squashed pistils mixed with a few interpistillar staminodes level with the spathe constriction; staminate zone slightly obconic, 2.4–3.4 cm long, 8–9 mm diam. at top; stamens densely crowded, not obviously arranged in to discrete flowers, truncate, c. 1 mm across, butterfly shaped with the connective narrow, the thecae tops slightly excavated with a wide rim, waxy white; appendix bluntly conoid, 1.7–2.6 cm long, the base slightly wider than top of the staminate zone, 0.9–1.1 cm diam. at base; staminodes of appendix columnar, irregularly polygonal with very rounded angles, rounded-topped, c. 0.5 mm diam., pale cream. Infructescence unknown at maturity, developing infructescences declinate, persistent spathes narrowly fusiform with a conspicuous scar from the fallen spathe limb.

Eponymy

Named for the late Datuk Au Yong Nang Yip (1938 - 2009) who in 1969 founded the Orchidwoods Company, Kuching, Sarawak, and whose name remains one of the most famous associated with the discovery and cultivation of Bornean native orchids, and orchid hybridisation. Orchidwoods are the recipients of countless awards for orchid growing and breeding and have earned the name as Sarawak's most reputable establishment in the industry.

Distribution

Restricted to the Penrissen range in SW Sarawak.

Ecology

Occurring between 480 and 1100 m asl on wet slopes under rather open hill forest over Paleogene sandstones, often gregarious on rocky permanently wet seepages and road cuttings in light shade.

Notes

Much as with the stoloniferous species of the *Schismatoglottis* Calyptrata clade (Wong & Boyce 2021), the taxonomy of the clumping species of the clade remains much understudied, the situation made exasperating by several of the earliest published names, including *S. trivittata*, the species to which *S. auyongii* is

most similar, being based on cultivated plants of imprecise origin and with inadequate nomenclatural types (see Hay in Hay and Yuzammi 2000: 149). We are taking a pragmatic approach and describing as new those entities that are consistently distinct. In habitat blooms are visited by *Colocasiomyia* (Diptera: Drosophilidae), the likely pollinators, and Chrysomelidae beetles, the latter causing extensive damage to the staminate florets and the appendix staminodes (Figure 2, B & D) — see also Chai and Wong (2019) and Hoe et al. (2018).

Additional specimens examined (paratypes)

MALAYSIA: Sarawak. Kuching, Padawan, Puncak Borneo, Air Terjun Semangas, 1°08'26.6"N 110°13'36.1"E, 472 m asl., 16 Sep 2014, Wong Sin Yeng & P.C.Boyce AR-4981 (SAR) & Wong Sin Yeng & P.C.Boyce AR-4982 (SAR).

ACKNOWLEDGEMENTS

We extend our thanks to Au Yong Kien Chung for assisting with the preparation of this paper. Fieldwork was most recently under Sarawak Forestry Department Permission to Conduct Research on Biological Resources – Permit No. (67) JHS/NCCD/600-7/2/107/ Jld.2 and Park Permit No WL33/2019.

REFERENCES

Chai SK, Wong SY. 2019. Five pollination guilds of aroids (Araceae) at Mulu National Park (Sarawak, Malaysian Borneo). Webbia. 74(2): 353–371.

Hay A, Yuzammi. 2000. Schismatoglottideae (Araceae) in Malesia I — *Schismatoglottis*. Telopea. 9: 1–177.

Hoe YC, Gibernau M, Wong SY. 2018. Diversity of pollination ecology in the *Schismatoglottis* Calyptrata Complex Clade (Araceae). Plant Biology. 20(3): 563–578.

Hutchinson,CS. 1989. Geological Evolution of South-East Asia. Malaysia: Oxford University Press.

Hutchinson, C.S. 2005. Geology of north-west Borneo: Sarawak, Brunei and Sabah. Elsevier, The Netherlands.

Low SL, Wong SY, Boyce PC. 2018. Naming the chaos: generic redelimitation in Schismatoglottideae (Araceae). Webbia. 72(2): 1-100.

Tate RB. 2001. The Geology of Borneo Island CD-ROM. Persatuan Geologi Malaysia: Geological Society of Malaysia.

Wong SY, Boyce PC. 2021. Studies on Schismatoglottideae (Araceae) of Borneo LXX — New colonial species for the *Schismatoglottis* [Calyptrata Clade] from Sarawak. Webbia. 76(2): 81–103.

Wong SY, Hay A, Boyce PC. 2018. An annotated checklist for *Schismatoglottis*. Aroideana. 41(2–3): 34–200.

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Citation: Wong Sin Yeng, John-Michiel Koens, Peter C. Boyce (2022) Studies on Schismatoglottideae of Borneo LXXV — Two ornamental new species of *Schismatoglottis* from Borneo. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 159-167. doi: 10.36253/jopt-12810

Received: February 14, 2022

Accepted: February 28, 2022

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Alistair Hay

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Studies on Schismatoglottideae of Borneo LXXV — Two ornamental new species of *Schismatoglottis* from Borneo

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Abstract. Two ornamental new species of *Schismatoglottis* are described and illustrated from Borneo. *Schismatoglottis metallica* from Kalimantan Barat, Indonesian Borneo, assigned to the *Schismatoglottis* Multinerva clade, and *S. reticosa* from the upper Engkari river in SW Sarawak, Malaysian Borneo, provisionally placed in the Petradoxa clade. Recognition of these novelties takes *Schismatoglottis* on Borneo to 132 species, of which 86 have been described since the year 2000.

Keywords: *Schismatoglottis*, Borneo, Kalimantan, Sarawak, Indonesia, Malaysia.

INTRODUCTION

Schismatoglottis Zoll. & Moritzi was monographed for Borneo by Hay (Hay and Yuzammi 2000), recognizing 62 species, of which 31 were then new. Including the two novelties proposed here the total for Borneo now stands at 132 species, of which 86 have been described since the year 2000 (Wong et al. 2018) and with 131 endemic to the island – the sole exception being *Schismatoglottis wallichii* Hook.f., which extends to Borneo from Peninsula Malaysia. Species numbers for Borneo are inevitably set to increase as fieldwork takes in areas hitherto not investigated for Araceae given that most terrestrial aroid species have restricted distributions such that even in quite small areas it is possible to find upwards of a dozen species that occur nowhere else. It is entirely feasible that *Schismatoglottis* on Borneo alone will surpass 250 species.

Clades cited are as per Low at al. (2018). Geology is specified based on Hutchison (1989, 2005) and Tate (2001).

Schismatoglottis metallica S.Y.Wong, Koens & P.C.Boyce, **sp. nov.**

Type: Cultivated by John-Michael Koens, Westbrook, Qld, 26 Nov 2021, sub. *AR-4083* (original collection: Indonesian Borneo, Kalimantan Barat, Sekadau, Nanga Taman, south of Nanga Taman, 14 Dec 2010, *Kazuya Nakamoto s.n.*) (holotype BO! + spirit; isotype SAR! + spirit). (Figures 1, 2 and 3A).

Diagnosis

Schismatoglottis metallica is overall most similar to *S. hayi*, *S. multinervia*, and *S. porpax* by the densely and minutely puberulent petioles. *S. metallica* differs from the first two by its spathe limb scarcely opening or altering in appearance during anthesis (vs spathe limb spreading and reflexing, and at the same time the spathe limb interior darkening and becoming very glossy), and from *S. porpax* by the spadix with a dense zone of staminodes at the top of the pistillate zone and lacking an elongated interstice separating the pistillate and staminate zones. The spadix of *S. metallica* is reminiscent of those of *S. meriraiensis* and *S. puberulipes*, from both of which it is distinct by its spathe limb scarcely opening (vs opening wide), and further from *S. meriraiensis* by its puberulent (vs smooth) petioles, and from *S. puberulipes* by its erect leaves (vs leaves forming a rosette appressed to the ground).

Description

Small herb to ca. 20 cm tall with vegetative tissues faintly aromatic (terpenoids). Stem initially condensed, epigeal, maroon, in older plants stems somewhat elongating, erect-ascending and rooting from the nodes, ca. 10 mm diam., active portions obscured by petiole bases. Leaves up to ca. 20 together forming a compact clump; petiole 5–19 cm long, rather stout, pale to rather deep maroon, densely and minutely puberulent with short straight colourless hairs, longitudinally ridged, the angles narrowly crisped-alate, sheathing in lower 1/3–2/5 (sometimes sheathing for entire length in leaf below a bloom); wings of sheath fully attached, thickly membranous, persistent, spreading, abaxially puberulent, bluntly ligulate; blade oblong-ovate, 8–13 cm long, 4–6.7 cm wide, erect to spreading, glossy metallic dark bronze-maroon adaxially, matte pale maroon abaxially, margins somewhat undulate, base briefly but distinctly cordate with rounded posterior lobes 1–2 cm long, tip acute to obtuse, with a short terminal tubule, attached blades and detached whole or partial blades spontaneously producing adventitious plantlets on the abaxial surfaces along the main veins; midrib abaxially prominent, pubescent as for petiole; primary lateral veins 11–16 on each side of mid-rib, alternating with lesser interprimaries, diverging at the angle of 70°–90°(–100°) then rather sharply acropetally deflected before reaching margin, adaxially somewhat prominent near midrib, abaxially puberulent near midrib, adaxially impressed, especially in the proximal half; secondary venation arising from both midrib and bases of primary veins; tertiary venation abaxially forming a tessellate reticulum, all venation abaxially slightly to notably darker than the surrounding tissue. Blooms 3–5 in sequence, the synflorescence subtended by a cataphyll usually with reduced but well differentiated petiole and blade; peduncle short, largely hidden within leaf bases, bright maroon, puberulent as for petioles. Spathe ca. 4 cm long, exterior semi-glossy; lower spathe ovoid, ca. 1.5 cm long, differentiated from limb by a distinct constriction, intense maroon-green with darker longitudinal striae; spathe limb broadly ovate, tip apiculate, pale pink with branching/broken maroon striations, inflated and opening by the lower half slightly gaping at onset of pistillate anthesis, then splitting slightly above the constriction, with the damaged edges darkening before the limb falls. Spadix ca. 3 cm long, sessile and inserted obliquely onto lower spathe/peduncle, pistillate zone conic, medium green; pistillate florets crowded, sub-globose, ca. 1 mm diam.; stigma button-like, papillate, about half diameter of ovary, darkening at anthesis and producing a droplet; sub-pistillar staminodes confined to a single row around base of pistillate zone, depressed-globose, attached at narrower end, ca. 1 mm wide, waxy dull creamy-while; sterile interstice ca. 5 mm long, slightly thicker than top of pistillate zone and sharply contracting into staminate zone, completely covered with irregularly polygonal staminodes, these ca. 1 mm long, 0.3–1 mm wide at top, waxy white; staminate floret zone obconoid, ca. 1 cm long, basally ca. 2 mm diam., apically ca. 4 mm diam., cream; stamens very crowded, ca. 0.5 mm diam., more or less dumb-bell-shaped, truncate, with at least some stamens with a wide paler connective; appendix rather broadly ellipsoid, ca. 1 cm long, ca. 4 mm wide, composed of irregularly polygonal more or less flat-topped staminodes ca. 0.4 mm diam. Fruiting spathe narrowly urceolate, ca. 1.5 cm diam., medium green. Fruits and seeds not observed.

Etymology

From Latin, *metallicus*, metallic, coined to draw attention to the metallic lustre of the mature foliage.

Distribution

Known with certainty only from the type locality.

Figure 1. *Schismatoglottis metallica* (A) Plants in habitat. (B) Leaf blade, abaxial surface. All from *Kazuya Nakamoto s.n.*

Figure 2. *Schismatoglottis metallica* (A) Flowering habit; note the succession of developing blooms. (B) Bloom at pistillate anthesis. (C) Bloom at pistillate anthesis, nearside spathe artificially removed. (D). Bloom at onset of staminate anthesis, spathe limb beginning to shed. All from *AR-4083*.

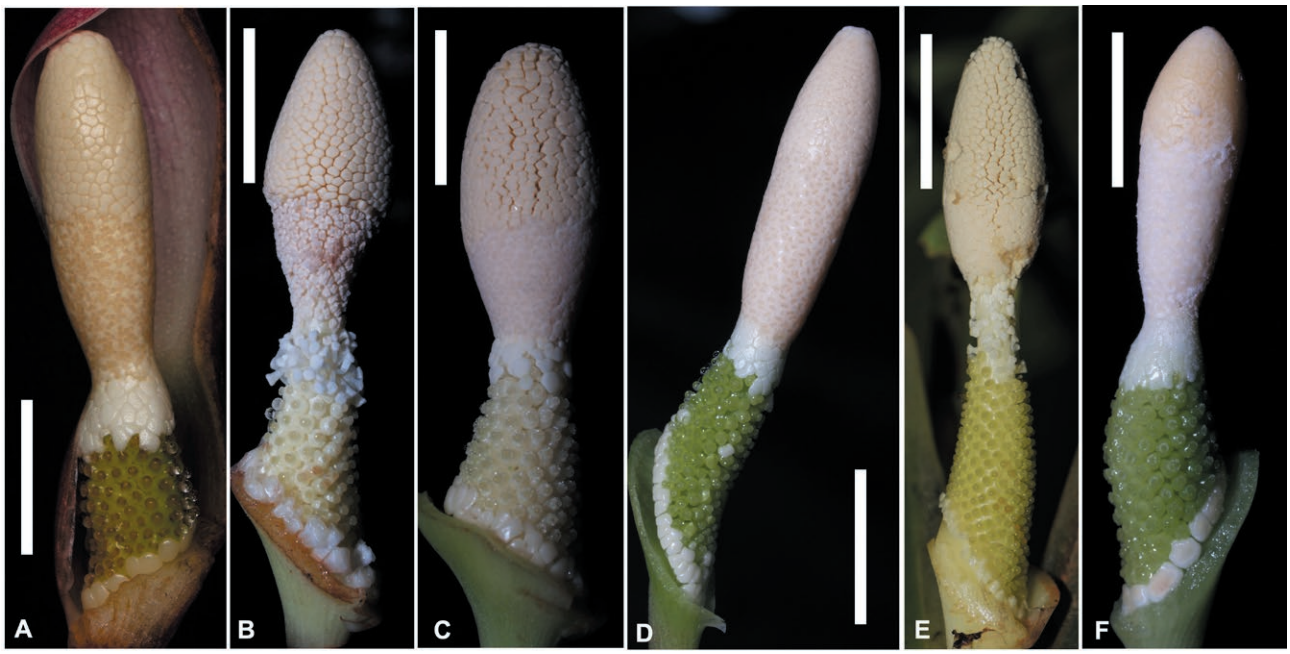

Figure 3. Spadix of species of the *Schismatoglottis* Multinervia Clade compared. (A) *Schismatoglottis metallica* [*AR-4083*]. (B) *Schismatoglottis hayi* [*AR-1879*]. (C) *Schismatoglottis multinervia* [*AR-1932*]. (D) *Schismatoglottis meriraiensis* [*AR-1281*]. (E) *Schismatoglottis porpax* [*AR-4684*]. (F) *Schismatoglottis puberulipes* [*AR-1062*]. Scale bar = 1 cm.

Ecology

Occurring terrestrially at about 400 m asl. in deep leaf litter deposits in damp shady humid lowland forest on lower Cretaceous granites.

Notes

The *Schismatoglottis* Multinervia Clade comprises species with pleionanthic shoots, crushed vegetative tissues smelling of terpenoids, petioles and abaxial major veins often pubescent, leaf blades with scalariform higher order veins, and a largely hourglass-shaped spadix with 1–2 rows of large staminodes in at the junction of the pistillate zone with the spathe. Some species have viviparous leaf blades, producing plantlets from portions of damaged leaves or from the distal-most portion of the mid-rib on the leaf blade undersurface. Recognition of *Schismatoglottis metallica* takes the clade to five described species: *S. hayi* S.Y.Wong & P.C.Boyce (Figure 3B – Wong & Boyce 2011), *S. multivervia* M.Hotta (Figure 3C – Hotta 1966), *S. meriraiensis* P.C.Boyce & S.Y.Wong (Figure 3D – Boyce & Wong 2015), *S. porpax* S.Y.Wong, Kartini & P.C.Boyce (Figure 3E – Wong et al. 2019) and *S. puberulipes* Alderw. (Figure 3F – Alderwerelt 1022).

Schismatoglottis metallica is additionally one of the most attractive non-variegated *Schismatoglottis* species so far discovered, with the contrast between the metallic-lustred bronze upper surface and matte magenta lower surface of the leaf blades particularly striking.

Propagation is readily affected from the adventitious plantlets that spontaneously arise from the major veins on the undersurface of older leaf blades, or even from detached portions of the blade, a trait shared with the related *Schismatoglottis meriraiensis* and *S. puberulipes*.

Schismatoglottis reticosa S.Y.Wong, Koens & P.C.Boyce, **sp. nov.**

Type: Malaysia. Sarawak, Sri Aman, Lubok Antu, Nanga Segerak, Ulu Sungai Engkari, Lanjak Entimau W.S., Sungai Segerak, 1°24'21.9"N 112°00'14.6"E, 400 m asl, 16 Mar 2015**,** *Wong Sin Yeng, P.C.Boyce & Bada ak Chendai AR-5138* (holotype SAR!, + spirit; isotype SAR!, + spirit). (Figures 4 and 5).

Diagnosis

Schismatoglottis reticosa is unique in the genus by the combination (in adult plants) of leaves in distichous fans with leaf blades adaxially with very prominent raised-tessellate venation formed by the parallel primary and interprimary venation and scalariform secondary veins.

Figure 4. *Schismatoglottis reticosa* (A) Plants in habitat. (B) Leaf blade adaxial surface. (C) Leaf blade abaxial surface. All from *AR-5138*.

Figure 5. *Schismatoglottis reticosa* (A) Detail of staminate zone and appendix, staminate anthesis. (B) Bloom at pistillate anthesis. (C) Bloom at staminate anthesis, nearside spathe artificially removed. (D). Fruiting spathe. All from *AR-5138*.

Description

Lithophytic herbs to ca. 20 cm. Stem much-condensed, slightly creeping-erect in older plants, with internodes to 1 cm long, 1 cm diam., densely rooting at the base. Leaves spiro-distichous in juvenile plants, strictly distichous in adult plants with the blades held flat or somewhat pendent, foliage leaves alternating with brittle, soon-marcescent then deliquescent, slender tapering lanceolate weakly scabrid cataphylls each up to 4 cm long; petiole shorter than blade, arching to almost straight, 8–25 cm long, subterete, semi-glossy dark green, minutely scabrid, sheathing only at very base, with the petiolar sheath reduced to an obscure ridge; blade oblong-elliptic, 12–20 cm long × 5–8 cm wide, rather thick and stiffly brittle, adaxially semi-glossy deep green, much paler and matte abaxially, base cuneate to narrowly rounded, apex acuminate and apiculate for ca. 1 cm; midrib adaxially more or less flush with blade and contrasting cream, especially visible on newer leaves, abaxially prominent; primary lateral veins ca. 20 on each side, diverging at 45–60°, conspicuously raised on both surfaces; secondary venation abaxially visible as a semi-translucent tessellate reticulum, abaxially forming a prominent raised reticulum by the scalariform secondaries between the parallel primary and interprimaries; tertiary venation invisible. Bloom nodding to pendulous, solitary, with a slight esteric odour at pistillate anthesis, subtended by brittle lanceolate cataphylls, peduncle cylindric. Spathe with a moderate constriction between the lower part and the limb, 5–6.5 cm long; lower spathe narrowly ovoid and asymmetric, dorsally shallowly flattened-convex corresponding to the adnation of the pistillate floret zone, pale green with very fine paler longitudinal veins, dorsally ca. 1.5 cm long, ventrally ca. 2 cm long, persistent; spathe limb inflating and slightly gaping at pistillate anthesis, opening further at staminate anthesis with the upper half opening at pistillate anthesis, initially via a narrow terminal slit, then wide-gaping (ca. 2 cm wide), and weakly fornicate, with the interior becoming rather slimy, then whole limb degrading-caducous with the rim remaining above the lower spathe insertion reflexing somewhat, exterior yellowish white with very fine darker longitudinal lines, apex somewhat green-tinged, interior dirty whitish green, broadly lanceolate 4.5–5.5 cm long, bluntly rostrate for ca. 3 mm. Spadix 4.5 cm long, elongated conic cylindrical; pistillate zone 1.5 cm (dorsal side) to 2 cm long (ventral side), weakly conic, obliquely inserted, distally ca. 6 mm diam., dull yellow; pistillate florets small, crowded, ca. 1 mm diam., barrel-shaped, dull yellow; stigma sessile, discoid, slightly narrower than top of pistil, ca. 1.5 mm tall × 0.8 mm wide, papillose; infrapistillar pistillodes forming an interrupted row at junction with peduncle, ca. 1.2 mm long, slimmer than pistils, slender-cylindric whitish green; sterile interstice with about 5 spirals of staminodes; interstice staminodes weakly columnar-polygonal ca. 1 mm across, white, initially equalling the height of pistils; staminate zone cylindric, ca. 1.5 cm long × 0.4–0.5 cm diam., cream; stamens irregularly densely crowded and individual florets difficult to distinguish, rectangular dumbbell shaped from above, truncate with thick connective slightly elevated above thecae, thecae opening by a single pore; pollen released in copious fine strings; appendix narrowly fusiform, blunt, proximally slightly wider than top of staminate zone, 1.5–2 cm long, widest part ca. 8 mm diam., distally tapering and narrowly obtuse, white; appendix staminodes irregularly polygonal, ca. 0.5 mm wide. forming sinuous longitudinal groups. Fruiting spathe very narrowly cylindrical-urceolate, pendulous; fruit and seed not observed.

Etymology

From the Latin noun, *rete*, *retis* – a net, reflecting the diagnostic raised venation of the adaxial surface of the leaf blade.

Distribution

So far known only from the upper reaches of the Engkari river where it is uncommon.

Ecology

Occurring between 350 and 400 m asl. under very humid gallery forest on steep shaded slopes of Cretaceous shales above small rivers.

Notes

Although yet to be analysed with molecular data *Schismatoglottis reticosa* most likely belongs in the Petradoxa clade (Wong & Boyce 2014; Low et al. 2018) in which the distichous leaf blade arrangement, tessellate higher-order venation, scabrid petioles with the petiolar sheath reduced to a thickened ridge, marcescent-deliquescent prophylls, nodding blooms, thecae with a single pore, pollen in long strings, and pendulous fruiting structures all accord.

Additional specimens examined (paratypes)

MALAYSIA. Sarawak, Sri Aman, Lubok Antu, Nanga Segerak, Ulu Sungai Engkari, Lanjak Entimau W.S., Sungai Serjanggut, 1°24'41.7"N 112°00'24.9"E, 380 m asl., 17 Mar 2015, *Wong Sin Yeng, P.C.Boyce & Bada ak Chendai AR-5160* (SAR).

REFERENCES

Alderwerelt van Rosenburgh CRWK van. 1922. New or noteworthy Malayan Araceae II. Bulletin du Jardin Botanique de Buitenzorg. III 4: 163-229.

Boyce PC, Wong SY. 2015. Studies on Schismatoglottideae (Araceae) of Borneo L - *Schismatoglottis meriraiensis*, a new limestone-obligated species with viviparous leaves. Telopea. 18: 443-450.

Hay A, Yuzammi. 2000. Schismatoglottideae (Araceae) in Malesia I — *Schismatoglottis*. Telopea. 9: 1-177.

Hotta M. 1966. Notes on Schismatoglottidinae of Borneo. II. Memoirs of the College of Science, University of Kyoto, ser. B. 32: 223-238.

Hutchinson CS. 1989. Geological Evolution of South-East Asia. Malaysia: Oxford University Press.

Hutchinson CS. 2005. Geology of north-west Borneo: Sarawak, Brunei and Sabah. Elsevier, The Netherlands.

Low SL, Wong SY, Boyce PC. 2018. Naming the chaos: generic redelimitation in Schismatoglottideae (Araceae). Webbia. 72(2): 1-100.

Tate RB. 2001. The Geology of Borneo Island CD-ROM. Persatuan Geologi Malaysia: Geological Society of Malaysia.

Wong SY, Boyce PC. 2011. Studies on Schismatoglottideae (Araceae) of Borneo XVI: A new species and a further new informal taxon (Multinervia Complex) of *Schismatoglottis* from Sarawak. Acta Phytotaxonomica et Geobotanica. 60(3): 131-137.

Wong SY, Boyce PC. 2014. Studies on Schismatoglottideae (Araceae) of Borneo XXXX: *Schismatoglottis petradoxa* and *S. tseui*, new shale-obligate rheophytes of uncertain affinity. Aroideana. 37E(2): 17-25 2014

Wong SY, Boyce PC, Kartini S. 2019. Studies on Schismatoglottideae (Araceae) of Borneo LXV: *Schismatoglottis porpax*, a new species of the *Schismatoglottis* Multinervia Complex, and a new Complex record for Sabah. Annales Botanici Fennici 56: 295-299.

Wong SY, Hay A, Boyce PC. 2018. An annotated checklist for *Schismatoglottis*. Aroideana. 41(2-3): 34-200.

WEBBIA Journal of Plant Taxonomy and Geography

Firenze University Press
www.fupress.com/webbia

OPEN ACCESS

Citation: Ian M. Turner, Anand Kumar (2022) Prain's *Erycibe* (Convolvulaceae) types. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 169-172. doi: 10.36253/jopt-12014

Received: September 9, 2021

Accepted: October 14, 2021

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Peter C. Boyce

Prain's *Erycibe* (Convolvulaceae) types

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Abstract. The typification of 14 species names authored by Prain in *Erycibe* (Convolvulaceae) is reviewed. The species range from Myanmar to Taiwan and New Guinea, with most from the Malay Peninsula. For 12 of the names, lectotypes in CAL were designated by Hoogland without seeing the specimens. Either through failure to find the designated specimen, or location of more than one specimen in the designated herbarium, we make 12 new lectotype designations, nine of which are at the second stage.

Keywords: Asia, *Erycibe*, Hoogland, Prain, typification.

INTRODUCTION

Sir David Prain (1857—1944) was a member of that band of medically trained Scots who made their mark studying the botany of India, and was the only one to become both the Director of the Royal Botanic Garden Calcutta and Director of the Royal Botanic Gardens Kew. Prain published three papers relating to the Convolvulaceae of India and surrounding regions during his period based at the herbarium of the Royal Botanic Garden Calcutta (CAL – now the Central National Herbarium). These included descriptions of a number of new species of the genus *Erycibe* Roxb. Roughly a half century later, Hoogland (1953) reviewed the genus. Despite making it clear that he had not seen the material in CAL, he lectotypified Prain's names to specimens in CAL. Hoogland's choice is reasonable given that Prain made it clear in all the papers that his studies were based on specimens in CAL, but typifying without seeing specimens is problematic if more than one specimen is present, or specimens have been lost. Despite the potential uncertainties no subsequent workers have investigated Prain's *Erycibe* types. Therefore, we decided to look into this.

METHODS

The *Erycibe* material in CAL was searched systematically for Prain's type material. This proved successful and specimens matching the designations

made by Hoogland (1953) were found for the majority of the names. Actually in most cases more than one duplicate specimen was found. This means that a second-step lectotypification is required to designate the type and this is done here. In the few cases where there is only a single specimen in CAL, it might be considered that this represents the holotype of the name. This is unlikely to be so for collections, such as those by King's Collector and H.O. Forbes, that were distributed from CAL to other herbaria. For collections distributed to CAL, such as those by A. Henry and F. Hellwig, Prain probably only saw one specimen in his home institution, but the possibility of his seeing material on visits to BM, K or E cannot be entirely discounted. We therefore maintain Hoogland's approach of considering lectotypification a requirement.

Erycibe aenea Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 63(2): 85. 1894

Type: Peninsular Malaysia, Perak, Gunung G.B., March 1885, *King's Collector 7337* (CAL barcode CAL0000018441, lectotype designated at the first step by Hoogland (1953: 343), and at the second step here; isolectotypes B (barcode B100272283); BM (barcode BM001014546); CAL (barcode CAL0000033893); G (barcode G00227176,); K (barcode K000545454, K000545455); L (barcode L0004119); SING (barcode SING0052330).

Notes

Two specimens matching Hoogland's designation were located in CAL. Therefore a second-step lectotypification is made here to choose the better specimen as lectotype.

Erycibe albida Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 63(2): 87. 1894

Type: Peninsular Malaysia, Perak, Gunung Boobo, March 1885, *King's Collector 7373* (CAL barcode CAL0000018479, lectotype designated at the first step by Hoogland (1953: 344), and at the second step here; isolectotypes B (barcode B100272282); BM (barcode BM001014545); CAL (barcode CAL0000033894); G (barcode G00227175); K (barcode K000545463); L (barcode L0004122).

Notes

Two specimens matching Hoogland's designation were located in CAL. Therefore a second-step lectotypification is made here to choose the better specimen as lectotype.

Erycibe citriniflora Griff., Notul. 4: 284. 1854

Type: Burma, Mergui, *W. Griffith 390* (K barcode K000830563, lectotype selected by Hoogland (1953: 345); possible isolectotypes CAL (barcode CAL0000018474); K (barcode K000830564); P (barcode P00260088).

(=) *Erycibe glomerata* Wall. ex Choisy, Ann. Sci. Nat., Bot. sér. 2, 1: 224. 1834, *nom. illegit*., non *E. glomerata* Blume (1826). – *Erycibe wallichii* Prain & Hallier f., Bull. Herb. Boissier 5(5): 382. 1897.
Type: Burma, Moalmyn, 26 January 1827, *N. Wallich s.n.* (EIC 1338), G-DC (barcode G00146610), lectotype selected by Hoogland (1953: 345).

Notes

Prain and Hallier in Hallier (1897) realised *Erycibe glomerata* Wall. was a later homonym of *E. glomerata* Blume and proposed *Erycibe wallichii* as a replacement name. Choisy had validated Wallich's *Erycibe glomerata*, so *Erycibe wallichii* Prain & Hallier f. is legitimate, though it has been reduced to a synonym of *E. citriniflora* Griff.

Erycibe festiva Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 63(2): 87. 1894

Type: Peninsular Malaysia, Perak, Larut, August 1884, *King's Collector 6445* (CAL barcode CAL0000018438, lectotype designated at the first step by Hoogland (1953: 347), and at the second step here; isolectotypes B (barcode B100272273); BM (barcode BM001014540), CAL (barcode CAL0000018439, CAL0000033900); G (barcode G00227174); K (barcode K000545457); L (barcode L0004130); P (barcode P00260159); SING (barcode SING0052314).

Notes

Three specimens matching Hoogland's designation were located in CAL. Therefore a second-step lectotypification is made here to choose the best specimen as lectotype.

Erycibe forbesii Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 73(1): 15. 1904

Type: Sumatra, Lampongs, 5 August 1880, *H.O. Forbes 1454* (CAL barcode CAL0000018480, lectotype selected by

Hoogland (1953: 347); isolectotypes A (barcode A00054397, A00054398); B (barcode B100272269, B100272270); BM (barcode BM001014539); BRI (barcode BRI-AQ0277125); FI (barcode FI013062); G (barcode G00227179); GH (barcode GH00054399); K (barcode K000830626); L (barcode L0004132, L0867547); P (barcode P00608656, P00608655); SING (barcode SING0052316, SING0052315, SING0052317); US (barcode US00111194).

Notes

A specimen matching Hoogland's designation was located in CAL and is considered to be the lectotype of Prain's name. The duplicate in K was distributed from CAL in 1904, indicating that it was likely Prain saw more than one specimen of Forbes's collection.

Erycibe hellwigii Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 63(2): 84. 1894

Type: New Guinea, Kaiser Wilhelmsland, 2 August 1888, *F. Hellwig 87* (CAL barcode CAL0000018455, lectotype selected by Hoogland (1953: 349), isolectotypes B (barcode B100279256); BM (barcode BM001014535); K (barcode K000830604).

Notes

A specimen matching Hoogland's designation was located in CAL and is considered to be the lectotype of Prain's name.

Erycibe henryi Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 73(1): 15. 1904

Type: Formosa (Taiwan), Takow, Ape's Hill, *A. Henry 1884* (CAL barcode CAL0000018478, lectotype selectedby Hoogland (1953: 350); isolectotypes A (barcode A00054379); BM (barcode BM001014554); E (barcode E00433746); NY (barcode NY00318953).

Notes

A specimen matching Hoogland's designation was located in CAL and is considered to be the lectotype of Prain's name.

Erycibe leucoxyloides King ex Ridl., J. Straits Branch Roy. Asiat. Soc. 33: 116. 1900

Type: Singapore, Bukit Timah, 1895, *H.N. Ridley 6897* (SING barcode SING0052324, lectotype designated here; isolectotype K (barcode K000545462).

(=) *Erycibe leucoxyloides* Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 73(1): 16. 1904, *nom. illegit*., non *E. leucoxyloide*s King ex Ridl. (1900).
Type: Singapore, Bukit Timah, 1895, *H.N. Ridley 6897* (K barcode K000545462, lectotype designated here; isolectotype SING (barcode SING0052324).

Notes

Ridley published this name before Prain. While Ridley's description is very brief – 'A small-leaved climber, flowers white sweet.' It is sufficient to validate the name. As no specimen of *Ridley 6897* referred to by Hoogland (1953) was located in CAL, a duplicate in K is designated lectotype for Prain's name here. As Ridley mentioned Bukit Timah in his protologue, a duplicate in SING is selected as lectotype for Ridley's name.

Erycibe magnifica Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 73(1): 18. 1904

Type: Peninsular Malaysia, Perak, Larut, October 1882, *King's Collector 3454* (CAL barcode CAL0000018461, lectotype designated at the first step by Hoogland (1953: 351), and at the second step here; isolectotypes BM (barcode BM001014531); CAL (barcode CAL0000018462, CAL0000033895, CAL0000033896); E (barcode E00433798); K (barcode K000545464); SING (barcode SING0052325).

Notes

Four specimens matching Hoogland's designation were located in CAL. Therefore a second-step lectotypification is made here to choose the best specimen as lectotype.

Erycibe praecipua Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 63(2): 86. 1894

Type: Peninsular Malaysia, Penang, July 1890, *C. Curtis 911* (CAL barcode CAL0000018466, lectotype designated here).

Notes

No specimen matching Hoogland's designation of *Curtis 911*, July 1896, was located in CAL. A new lectotypification is therefore made here to match the details of a good specimen in CAL.

Erycibe rheedei Blume, Bijdr. Fl. Ned. Ind. 16: 1047. 1826, as 'rheedii'.

Type: Java, *C.L. Blume 648* (L barcode L0004156, lectotype designated at the first step by Hoogland (1953: 355), and at the second step here; isolectotypes L (barcode L0004155, L0004157, L0004158).

(=) *Erycibe angulata* Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 63(2): 84. 1894
Type: Peninsular Malaysia, Perak, near G. Boobo, March 1885, *King's Collector 7379* (CAL barcode CAL0000018446, lectotype designated at the first step by Hoogland (1953: 355) and at the second step here; isolectotypes B (barcode B100279236); BM (barcode BM001014525); CAL (barcode CAL0000018443, CAL0000018444); G (barcode G00227303); K (barcode K000545453); L (barcode L0004154); P (barcode P00260248); SING (barcode SING0052331, SING0052332).

Notes

Three specimens matching Hoogland's designation for *Erycibe angulata* Prain were located in CAL. Therefore a second-step lectotypification is made here to choose the best specimen as lectotype. The name is now considered a synonym of *Erycibe rheedei* Blume. Hoogland proposed a Blume collection in L as lectotype for this name, but there are actually four specimens present, so we designate the best of them as lectotype at the second step here.

Erycibe sapotacea Hallier f. & Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 73(1): 16. 1904

Type: Peninsular Malaysia, Penang, Government Hill, *C. Curtis 772* (CAL barcode CAL0000018465, lectotype selected by Hoogland (1953: 355).

Notes

A specimen matching Hoogland's effective designation was located in CAL and is considered to be the lectotype of Prain's name. It seems likely material of this species was sent on loan from CAL to Hoogland as there is a determination slip by him on the sheet labelled 'holotype' which is here confirmed as lectotype.

Erycibe stapfiana Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 63(2): 87. 1894

Type: Peninsular Malaysia, Perak, Larut, March 1883, *King's Collector 4015* (CAL barcode CAL0000018436, lectotype designated at the first step by Hoogland (1953: 356), and at the second step here; isolectotypes CAL (barcode CAL0000018435, CAL0000033909, CAL0000033910); K (barcode K000545456); SING (barcode SING0052318, SING0052319).

Notes

Four specimens matching Hoogland's designation were located in CAL. Therefore a second-step lectotypification is made here to choose the best specimen as lectotype.

Erycibe strigosa Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 65(3): 536. 1896

Type: Peninsular Malaysia, Perak, Thaiping, February 1886, *King's Collector 8461* (CAL barcode CAL0000018457, lectotype designated at the first step by Hoogland (1953: 356), and at the second step here; isolectotypes B (barcode B100279233); BM (barcode BM001014524); CAL (barcode CAL0000018456, CAL0000033904); G (barcode G00227299); K (barcode K000545460); L (barcode L0004161); SING (barcode SING0069590).

Notes

Three specimens matching Hoogland's designation were located in CAL. Therefore a second-step lectotypification is made here to choose the best specimen as lectotype.

ACKNOWLEDGEMENTS

We thank the Director, Botanical Survey of India (BSI), Kolkata, and Head of Office, Central National Herbarium, BSI, for facilitating this research.

REFERENCES

Hallier H. 1897. Bausteine zu einer Monographie der Convolvulaceen. Bull Herb Boissier. 5(5): 366-387.

Hoogland RD. 1953. A review of the genus *Erycibe* Roxb. Blumea. 7: 342-361.

Prain D. 1894. Noviciae indicae VIII. Some additional species of Convolvulaceae. J Asiat Soc Bengal, Pt 2, Nat Hist. 63(2): 83-115.

Prain D. 1896. Noviciae indicae XIII. Further notes on Indian Convolvulaceae with descriptions of three additional species. J Asiat Soc Bengal, Pt 2, Nat Hist. 65(3): 536-538.

Prain D. 1904. Some new plants from Eastern Asia. J Asiat Soc Bengal, Pt 2, Nat Hist. 73(1): 14-21.

WEBBIA Journal of Plant Taxonomy and Geography

Firenze University Press
www.fupress.com/webbia

OPEN ACCESS

Citation: Imitiyaz A. Hurrah, Vijay V. Wagh (2022) Typification of *Geranium arnottianum* Steud. (Geraniaceae). *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 173-176. doi: 10.36253/jopt-12406

Received: December 8, 2021

Accepted: February 16, 2022

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Carlos Aedo

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Typification of *Geranium arnottianum* Steud. (Geraniaceae)

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Abstract. Nomenclature issue of *Geranium arnottianum* is here discussed. The comparison of *G. arnottianum* with its allied species is also discussed for its easy identification.

Keywords: Geraniaceae, *Geranium,* nomenclature, Peninsula India Orientalis, typification.

INTRODUCTION

Geranium L. (1753) comprises c. 325 species (Aedo 2017) and is distributed in temperate regions (Aedo et al. 1998). Twenty-seven species are known from India (Malhotra 1997; Wagh et al. 2015). During the course of ongoing revisionary studies on *Geranium* from India, we found that the typification of *Geranium arnottianum* Steud. *(*1840) is incomplete and needs to be updated. *G. arnottianum* is the only species of the genus with distribution restricted to Peninsular India (Steudel 1840; Wight and Arnott 1834), contrary to *Geranium nepalense* Sweet and *Geranium ocellatum* Jacquem. ex Cambess. which are also reported from Himalaya (Wagh et al. 2015). *Geranium affine* Wight & Arn., the replaced synonym of *G. arnottianum,* was first described by Wight (1834) in his *Prodromous*. Robert Wight contributed immensely to the study of Indian plants spending about 1/3rd of his life in India from 1819 to 1853. Shortly after his arrival he showed ample devotion towards the study of Indian flora, especially the peninsular India, which is portrayed in his exhaustive botanical classic *'Icones Plantarum Indiae Orientalis'* (1838-1853). He distributed a great number of duplicates among other celebrated botanists in Britain and Europe during his life time (Basak 1981). Not being a learned botanist but a surgeon by profession, Wight met and collaborated with the established botanists of his time like R. Graham, W. Hooker, G.W. Arnott (his school and university friend), R. Brown, J. Lindley, J.F. Royle (Noltie 2006). Before leaving India in 1853 he presented important Indian collections

of over 4000 species to Kew Herbarium (K) just before his death, containing the type specimens of the names of the taxa described by him. Besides Kew (K) Herbarium as the main repository of his type specimens, some important sets are housed also at Geneva (G), Glasgow (GL) Leningrad (LE) and Paris (P) and various duplicates at the Calcutta (CAL), Madras-Coimbatore (MH) and Dehradun (DD) herbaria (Stafleu 1967; Basak, 1981).

This work is based on a comprehensive study of relevant literature, protologues and original material. The herbaria BR, E, G, GL, K, LE, NY, P, were surveyed online and BSD, CAL, MH in person to locate the original material (acronyms according to Thiers, 2020 continuously updated). In this communication, we designate the lectotype of *G. arnottianum* in accordance with Article 7.4, and 9.12 of Shenzhen Code (Turland et al. 2018).

Geranium arnottianum Steud., Nomencl. Bot., ed. 2, 1: 677. 1840

(≡) *G. affine* Wight & Arn. (1834: 133), *nom. illeg*., non Poir. (1812: 757), nec Ledeb. (1831: 229)

Type: India: Peninsula Ind. Orientalis, 1834, Herb. Wight. Propr. n. 438, (E, E00174280, digital image!) lectotype designated here. Figure 1.

Geranium arnottianum is the replacement name (Steudel 1840) of *G. affine* Wight & Arn., non Poir. (1812: 757) nec. Ledeb. (1831: 229). The replaced synonym *Geranium affine* described by Wight and Arnott in *Prodromous Florae Peninsulae Indiae Orientalis* is an illegitimate later homonym of *G. affine* Ledeb. *G. arnottianum* is a perennial herbaceous species with fascicled roots. The diffuse and procumbent stem provides a showy distinction while glabrous staminal filaments augment its demarcation from its allies, *G. sibiricum* L*, G. nepalense* and *G. thunbergii* Siebold ex Lindl. & Paxton, which exhibit decumbent and erect or ascending stems and staminal filaments with hairy base. Even the characteristic fascicled roots have not been reported in any of these three taxa. In addition, *G. arnottianum* is characterised by leaves with middle segment ovate, peduncles with 2 pedicellate flowers and petals twice the length of sepals in contrast to *G. sibiricum* which has leaf middle segment rhomboid-obtrullate, peduncle bearing a single pedicellate flower and petals about as long as sepals. Other demarcating characters include absence of roots at nodes (present in *G. nepalense* and *G. thunbergii*) and lanceolate stipules (*vs.* ovate, acuminate stipules in *G. thunbergii*).

The type of *G. arnottianum* is to be chosen within Wight's collection of *G. affine* from Indian Peninsula. Wight was extremely imprecise in the localities he gave on the specimens, these having been collected by his largely unsupervised collectors. This is probably the reason why the protologue does not bear any information about the type locality, rather cited *Wight! Cat. n*. 438, 439. These catalogue numbers represent the species number, not the collection number in his *Prodromous*. Following these numbers, we traced 10 herbarium sheets not from a single herbarium but housed in five different international herbaria viz. BR (1), E (5), GZU (1), NY (2) and P (1), possibly because a great number of duplicates were distributed among the celebrated botanists in Britain and Europe by Wight during his life time. In addition, one more specimen was examined in-person at MH (barcode MH00005619) with a handwritten number WC 439, but lacking the printed annotation "Peninsula Ind. Orientalis". All these specimens bear the same printed note "Peninsula Ind. Orientalis" (except the one at MH), in addition to corresponding species number "Herb. Wight. Propr. *n* 438 or 439", hence qualify as the syntypes of *G. arnottianum*. Nevertheless, Noltie (2005) while providing the type details of *G. affine*, cited the collections deposited at E only, as syntypes (sheet A & D) and isosyntypes (sheet B, C & E). According to article 9.3 and 9.4 of the ICN (Turland et al. 2018) the lectotype is to be designated from the syntypes. Among all these, the specimens housed at E are possibly the ones utilised by the authors and therefore have precedence over others as indicated by Noltie (2005), since Wight's herbarium collection used by Arnott as the basis for his work on *Wight's Catalogue, Wight's Contribution to the Botany of India* and *Prodromus Florae Peninsulae Indiae Orientalis,* is deposited at Royal Botanic Garden, Edinburgh. As a matter of fact, *Prodromous Florae Peninsulae Indiane Orientalis* was prepared during Wight's furlough (which he spent in Edinburgh to work on his material for the *Prodromus*) between 1831-1834, together with Arnott, based mainly on Wight's specimens (Noltie 2006). His furlough expired before the completion of the first volume and it was Mr. Arnott at Glasgow university during W. Hooker's time, who edited and published the *Prodromous* (http://www.microscopy-uk.org.uk/mag/artjan11/bs-arnott.html). Subsequently, the huge plant material received by Arnott from Wight was later placed on permanent loan to E with the foreign herbarium of Glasgow University in 1966 (https://websites.rbge.org.uk/wight/). The collection at E after keen observation however appears to be an amalgamation and the component herbaria from which the specimens had been received can be identified. In other words, the specimens of *G. aff-*

Figure 1. Lectotype of *Geranium arnottianum* Steud. (E00174280) ©Royal Botanic Garden, Edinburgh.

ine housed at E had not been received from Arnott only, but from R.K. Greville herbarium (sheet C), from University of St. Andrews (sheet B & E) actually sent by Wight to Graham, the professor of botany at Edinburgh (Cleghorn 1873) and only two from Glasgow University (sheet A & D). The latter two specimens thus represent the most plausible choice for typification. Although both comply appropriately with the protologue, the specimen on sheet A with barcode E00174280 provides marked exhibition of the diagnostic characters of *G. arnottianum:* peduncles much longer than leaves, stipules lanceolate with acuminate apex, leaf segments cuneate, ovate and villous on the nerves beneath, petals twice as long as the sepals. Therefore, among all the original materials, E00174280 is here selected as the lectotype of *G. arnottianum*.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, CSIR-National Botanical Research Institute, Lucknow, India for encouragement and facilities to conduct the research work. We are grateful to the Curators of CAL, LWG, MH and BSD herbaria for allowing us to study the specimens and Curators of BM, BR, E, GZU, NY and P for providing access to digital images of herbarium specimens. Thanks to Department of Science and Technology, Government of India, New Delhi, India for financial assistance (Grant no. SERB- EEQ/2016/000271). NBRI communication number: NBRI_MS/2020/05/20

REFERENCES

Aedo C. 2001. The genus *Geranium* L. (Geraniaceae) in North America. II. Perennial species. Anales Jardin Botánico de Madrid. 59: 3–65

Aedo C. 2017. Taxonomic revision of *Geranium* Sect. *Ruberta* and *Unguiculata* (Geraniaceae). Annals of the Missouri Botanical Garden. 102: 409–465. https://doi.org/10.3417/D-16-00016A

Aedo C, Garmendia M, Pando F. 1998. World checklist of *Geranium* L. (Geraniaceae) Anales Jardin Botánico de Madrid. 56(2): 211–252. http://dx.doi.org/10.3989/ajbm.1998.v56.i2.230

Basak RK. 1981. Robert Wight and his botanical studies in India. Taxon. 30(4): 784–793.

Cleghorn H. 1873. Obituary notice of Dr Robert Wight. Edinburgh: Neill and Co.

Ledebour CF. 1831. Flora Altaica Vol. 3. Berlin. 229 pp.

Linnaeus C. 1753. Species Plantarum 2. Salvinus, Stockholm. 681 pp.

Malhotra CL. 1997. Geraniaceae. In: *Flora of India,* vol. IV. Botanical Survey of India, Calcutta, 62–94 pp.

Noltie HJ. 2005. The botany of Robert Wight. Ruggell: A.R.G. Gantner Verlag. A catalogue of the names of flowering plants published by Wight (with details of their types). Introductory chapters include a bibliography of Wight's works, a chronology of his life, a gazetteer of his collecting localities and biographical details of his collaborators.

Noltie HJ. 2006. Robert Wight and the Illustration of Indian Botany. Blackwell.

Poiret JLM. 1812. In: Lamarck M. et al., Encyclopédie Méthodique. Botanique. Suppl. 2: 757. H. Agasse, Paris.

Stafleu FA. 1967. Botanical works of R. Wight in 'Taxonomic Literature: A selected guide to botanical publications with dates, commentaries and types'. Regnum Vegetabile 52: 501–502 (1412–1417*)*. Int. Bur. Pl. Tax. & Nom., Utrecht.

Steudel ET. 1840.Nomenclator botanicus, seu, synonymia plantarum universalis: enumerans ordine alphabetico nomina atque synonyma, tum generica tum specifica, et a Linnaeo et a recentioribus de re botanica scriptoribus plantis phanerogamis imposita. 2nd ed., Vol. 1. Sumtibus J.G. Cottae, Stuttgartiae et Tubingae. 677 pp.

Thiers B. 2020 continuously updated. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available from: https://sweetgum.nybg.org/ih/ (accessed 09 July 2020).

Turland NJ, Wiersema JH, Barrie R, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Kusber WH, Li DZ, Marhold K, May TW, McNeill J, Monro AM, Prado J, Price MJ, Smith GF. 2018. International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile. 159. Glashütten: Koeltz Botanical Books. https://doi.org/10.12705/Code.2018

Wagh VV, Datt B, Hussain T. 2015. An assessment of the diversity of genus *Geranium* L. (Geraniaceae) in India with special emphasis on Indian Himalayan region. Journal of Biodiversity Management and Forestry. 4: 2. https://doi.org/10.4172/2327-417.1000140.

Wight R, Arnott GAW. 1834. Prodromus Florae Peninsulae Indiae Orientalis Vol. 1. Parbury, Allen & Co., London. 133 pp.

WEBBIA Journal of Plant Taxonomy and Geography

Firenze University Press
www.fupress.com/webbia

OPEN ACCESS

Citation: Guilherme Medeiros Antar, Roberto Baptista Pereira Almeida, Marco Antonio Palomares Accardo-Filho, Rafael Gomes Barbosa-Silva (2022) Tracking Brazil's Colonization Footprints: First record of the tea plant (*Camellia sinensis* (L.) Kuntze - Theaceae) naturalized in the Atlantic Forest Hotspot. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 177-183. doi: 10.36253/jopt-12854

Received: March 3, 2022

Accepted: April 11, 2022

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Riccardo M. Baldini

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Tracking Brazil's Colonization Footprints: First record of the tea plant (*Camellia sinensis* (L.) Kuntze – Theaceae) naturalized in the Atlantic Forest Hotspot

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Abstract. The colonization of Brazil by Portugal left deep marks in Brazil's current society and economy. The same applies to the country's biodiversity, with several introduced plants persisting as naturalized or invasive species. Among these, the tea plant, *Camellia sinensis*, is a notable case. The species was first cultivated in Rio de Janeiro state during the 19th century, but the crops were later abandoned mostly due to the presence of parasite fungi in cultivations, so that the species' cultivation continued in other states only. During recent fieldwork in the Atlantic Forest in the municipality of Petrópolis, Rio de Janeiro state, naturalized individuals of the tea plant were discovered. This finding, alongside ecological evidence, highlights a new threat to the biodiversity of an area of high species endemism. We provide historical information on the introduction of the species in Brazil and discuss the threats it imposes to the flora in a world hotspot. Our finding adds *C. sinensis* to the list of naturalized plants of Flora do Brasil 2020 and emphasizes the importance of monitoring the invasive potential of the species in the area, given its allelopathic potential on the germination of other species and competition with native plants.

Keywords: conservation monitoring, endemism, naturalization, plant introduction, protected areas.

INTRODUCTION

The colonization of Brazil by the Empire of Portugal left deep permanent marks in the country's society and economy, such as the Portuguese as

national language, and agriculture as main economic activity. There are long-standing marks in the country's biodiversity as well, with many exotic plants introduced, intentionally or not, during the colonization period (Zenni and Ziller 2011). Some of them are now part of the 700 naturalized or invasive land plant species recorded in the country (Flora do Brasil 2020). These plants were brought mostly as a source of food or beverages, such as the coffee plant (*Coffea arabica* L.) and the jack tree (*Artocarpus heterophyllus* Lam.), both naturalized in the Atlantic Forest, or for medicinal use, including the castor oil plant (*Ricinus communis* L.), now an invasive species in disturbed areas across the country (Zenni and Ziller 2011; Flora do Brasil 2020). Another plant that was brought by the Portuguese during the colonial period due to its value as a drink (Namita et al. 2012) is the tea plant (*Camellia sinensis* (L.) Kuntze. – Theaceae).

Camellia sinensis is native to China, Northeast India, South Japan, South Korea, Laos, Myanmar, Thailand, and Vietnam in subtropical humid forests (Tianlu Min and Bartholomew 2007). In the past 4000 years, the species was domesticated as a medicinal plant at least three independent times in southern China and northern India (Meegahakumbura et al. 2016), and its use as a beverage dates back to 5000 years ago (Majumdar et al. 2012). Since the mid-16th century, Europeans began to drink it, leading to a worldwide consumption of what would become the most popular non-alcoholic beverage nowadays. Tea contains terpenes, phenolics, and nitrogen-containing metabolites that can provide health benefits as antioxidant, besides having anti-cancer, anti-allergic and anti-cardiovascular disease properties (Xiu et al. 2020).

In Brazil, *Camellia sinensis* was brought for cultivation in the early 19th century and was established as a regular crop in some areas, mostly in Minas Gerais and São Paulo states, and later in Paraná. However, crops were later abandoned in other areas, especially in Rio de Janeiro state (Bediaga 2007). Although the cultivation of *C. sinensis* in Brazil dates to two centuries ago, the species has never been regarded as naturalized or invasive in the country (BFG 2015; Flora do Brasil 2020). In an unpublished study on the Theaceae from Rio de Janeiro state (Accardo-Filho 2004), the species was considered potentially naturalized, but the author stressed that more evidence was needed. During recent fieldwork in Petrópolis municipality, Rio de Janeiro state, reproductive and seedling individuals of *C. sinensis* were found in a natural, well-preserved area of Atlantic Forest. Here we report this finding, providing a brief history of the introduction of *C. sinensis* in Brazil, and highlighting the invasive potential of the species in the Atlantic Forest hotspot.

MATERIAL AND METHODS

A field expedition to Abismo Institute (22°32'50"S, 43°12'07"W), Petropolis municipality, was carried out in September 2019. The area presents Atlantic Forest vegetation in advanced stage of recovery, with no previous record of agricultural activity. The collected specimens were prepared using the standard botanical protocols described by Fidalgo and Bononi (1989) and then deposited in the herbarium of the University of São Paulo (SPF), in São Paulo, Brazil.

The species was first identified by Msc. Bianca Schindler using photos and later by specimen comparison in SPF herbarium, together with specialized literature (Accardo-Filho 2004; Ming and Bartholomew 2007).

In addition, the BHCB, GUA, R, RB, SAMES, and SPF herbarium collections (acronyms follow Thiers, continuously updated) were examined together with the SpeciesLink (2022), Reflora Herbário Virtual (2022), Tropicos (2022), and GBIF (2022) databases to verify other possible records of naturalized *Camellia sinensis* in the country.

The map was prepared with the software QGIS (QGIS Development Team 2020), using the shapefile of SOS Mata Atlântica to represent the remnants of the Brazilian Atlantic Forest (Fundação SOS Mata Atlântica & INPE 2015).

Historical research about *Camellia sinensis* introduction in Brazil was primarily based in Bediaga (2007) and Bediaga and Drummond (2007) with further references consulted in original documents available at the digital collection of the National Library of Brazil (http://bndigital.bn.gov.br/) and the newspaper library of the National Library of Brazil (http://bndigital.bn.gov.br/hemeroteca-digital/), using and combining key words "chá", "thea", "plantação", "Rio de Janeiro", "Jardim Botânico", "Brazil", and restricting the searched timespan between 1810 and 1900.

RESULTS AND DISCUSSION

Historical view

The origin of the first tea plantations in Brazil is unclear. One possibility is that they were arranged by the Chief of Division Luiz de Abreu, who brought seeds from Reunion Island, in the first decade of the 19th century, to be acclimatized in the Botanical Garden of Rio

de Janeiro (JBRJ) (Junqueira 2018). Another study indicates Macau and the year of 1812 as the origin of the Tea's seeds brought to Brazil (Bediaga and Drummond 2007). It is known that between 1810 and 1812, two noblemen and politicians, Conde da Barca and Conde de Linhares, arranged the immigration of Chinese workers from Hubei to work on the acclimatization and future tea plantations in Brazil. The original plan was to use the JBRJ as an acclimatization site from where the seedlings would be transferred to the Royal Farm. This locality is in the borough of Santa Cruz, in Rio de Janeiro city, in a place that would be known later as Morro do Chá (Tea Hill, in English) (Freitas 1987).

At the beginning of the 19th century, the JBRJ was commanded by the imperial administration, and the arrival of Chinese workers in the colony was one of the several incentives given by prince regent D. João VI – later King of the United Kingdom of Portugal, Brazil, and the Algarves – to produce tea (Dean 1989). In 1812, this effort took c. 300 Chinese workers to Rio de Janeiro to work in tea production at both JBRJ and Royal Farm (Rugendas 1835). However, with the end of the Napoleonic war in 1815 and the increase of political tensions in Portugal, D. João VI returned to Lisbon, Portugal, in 1821. His departure weakened tea production efforts in Brazil. In 1824, the newly appointed Director of the JBRJ, Frei Leandro do Sacramento, found the tea plant cultivation in poor condition, and made efforts to revitalize the crop (Gama 1869). His efforts were praised by the Business Secretary of the Empire, Marquês de Olinda, who, in speech before the Parliament in 1828, reported the harvest of 50 arrobas of tea from JBRJ alone in the last three years (Lima 1828), and 33 more in the following two years (Rodrigues 2017). Under Sacramento's management, seedlings were successfully introduced in provinces such as Pará, Pernambuco, Bahia, and São Paulo (Cerdan 2019), focusing on exporting to the emerging European market.

The press covered with enthusiasm the early success of newly established tea farms in Brazil. The editor of *Diário Fluminense*, in 1830, praised the tea plantation in São Paulo and the recent experiences in Minas Gerais, and considered the possibility of making tea an expanding and economically viable alternative to more traditional crops such as coffee, albeit for internal supply (Artigos de Offício 1830). Although tea production in these two provinces would prove to be a lasting success, accounting for almost all the tea consumed in the country until the 21st century, the situation was different in Rio de Janeiro state. There, production steadily declined, likely due to infestations by fungi of the genus *Ceratobasidium* D.P.Rogers, which damages young leaves and shoots, the main parts used in tea production (Silva 2013). This fact ended the experimental cultivation in JBRJ in the 1840s (Bediaga 2007), where few individuals of *Camellia sinensis* remain nowadays (JABOT 2022).

Camellia sinensis and Petrópolis-RJ

Decades later, Francisco Werneck started a profitable tea plantation in Paty de Alferes, countryside of Rio de Janeiro state, and published his results, methods, observations, and innovations (Werneck 1863) largely based on the previous experiences of Frei Leandro. He also recommended that tea, rather than coffee, was planted along the old Commerce Road because of the suitable climate; the Commerce Road crossed both the Vale do Paraíba, where his farms were located, and the Serra dos Órgãos, passing through Petrópolis municipality and finally reaching the city of Rio de Janeiro.

In the municipality of Petrópolis, the tea plant was cultivated mainly by the Royal Family House, which remained there throughout the colonial period, until Independence was declared in 1822. The period when the Royal family resided in Petrópolis contributed to the city's development and, with that, the tea plant was brought in, and its cultivation promoted. Indeed, the remaining individuals of *Camellia sinensis* in Petrópolis are probably descendants of old crops planted to supply the imperial court, but which were abandoned in the Republic.

Petrópolis has two Protected Areas that house the highest diversity of endemic species in the state of Rio de Janeiro: the Parque Nacional da Serra dos Orgãos has 175 endemic plant species, and the Área de Proteção Ambiental de Petrópolis has 245 endemic plant species (Loyola et al. 2018). This is a region of extreme conservation priority regarding endemic flora, as most species are in Endangered or Critically Endangered conservation status. As for the number of threatened species, Petropolis ranks third among the municipalities in the state of Rio de Janeiro, with 122 threatened species recognized in the municipality (Martinelli et al. 2018).

Here we report the first unequivocal record of naturalization of a *Camellia sinensis* population in the municipality of Petrópolis, Rio de Janeiro state, amid a forest in advanced stage of recovery (Figure 1). In fact, *C. sinensis* was one of the dominant species in the forest understory and presented individuals in different stages of development, e.g., reproductive individuals and recently established seedlings (Figure 1 C-E). After careful review of herbarium collections and database search, several possibly naturalized specimens of *C. sinensis* were found, indicating that this species likely occurs in

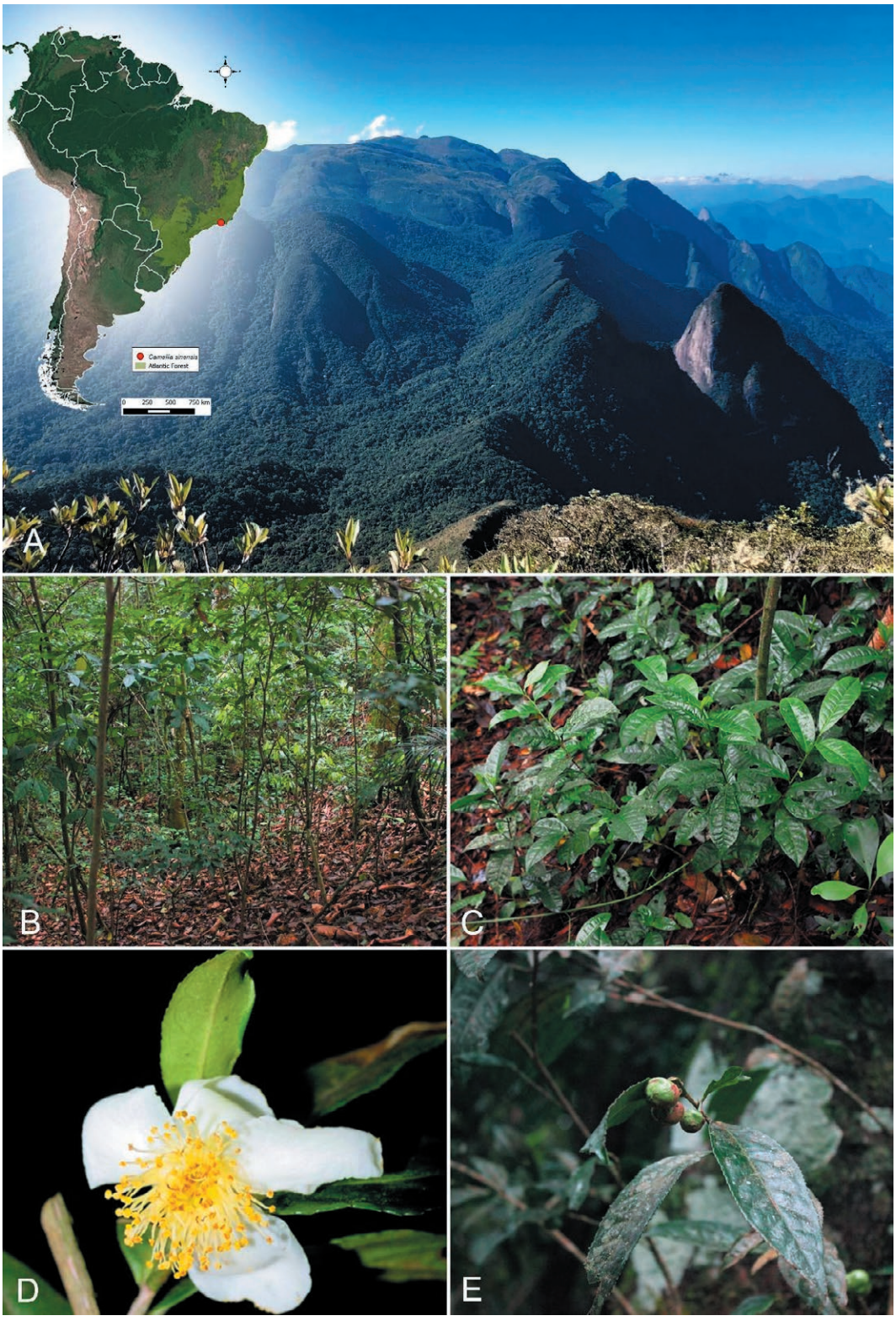

Figure 1. A. View of the landscape of the Atlantic Forest hotspot in the municipality of Petrópolis. The red dot at the upper left map denotes the first record of naturalized *Camellia sinensis* in Brazil. B. The understory of the Atlantic Forest where *C. sinensis* is reproducing in Petrópolis. C. Regeneration of *C. sinensis*. D. *C. sinensis* flower. E. *C. sinensis* fruit. Photos: H. Bernandes (A), G.M.A. (B-C and E), M.A.P.A-F. (D).

naturalized form in other states. The first known collection of this species dates from 1832 (*Gaudichaud s.n.* [P05286346]), but this record is probably of a cultivated individual from Rio de Janeiro municipality. Unfortunately, based on the information provided in the specimen label from this and other records, it is not possible to accurately determine whether the case at hand is from a naturalized or invasive population of *C. sinensis*, or from cultivated individuals or crop remnants.

Camellia sinensis as a naturalized species and invasiveness potential

Camellia sinensis found a favorable environment for survival and reproduction in the Atlantic Forest of Petrópolis. We observed Euglossineae bees visiting flowers of *C. sinensis*, herbivory in leaves, and autocorous fertile fruits and seeds that, due to the large number of seedlings, have high viability. The species is behaving like a semi-ciophile species and can be replacing native species that are important for the plant diversity in the Atlantic Forest. Some genera of Rubiaceae (e.g., *Faramea, Palicourea, Rudgea*), Piperaceae (*Piper*), Gesneriaceae (*Besleria*), and Melastomataceae (*Miconia*), all of which are very diverse in the Atlantic Forest, have habits similar to *C. sinensis*. Thus, if *C. sinensis* proves to act as an invasive species, native species of similar niche may be excluded locally by competitive exclusion. Thus, we argue that the presence of *C. sinensis* must be monitored carefully in the Atlantic Forest of Petrópolis, including populational and phytosociological studies.

Furthermore, tea leaf litter is known to inhibit the sprouting and development of seedlings of concurrent species by releasing its own chemical compounds into the soil (Rezaeinodehi et al. 2017; Sha et al. 2020). Mature plants of *C. sinensis* can dominate their surroundings by preventing other species from growing around them, while allowing tea seeds to germinate and grow in compact formations (Ciccurza and Kokotos 2007). In addition, *C. sinensis* has already been identified as naturalized in Argentina (Keller et al. 2011) and Tanzania (Ciccurza and Kokotos 2007). Therefore, considering that individuals of *C. sinensis* have the potential to survive in natural areas, it is very important to monitor the natural habitats where tea crops have already been found.

Finally, the presence of well-established populations of tea plant in Petrópolis allows us to speculate on the possibility of commercial tea production in the region. The constant increase in global demand, the continuous saturation of land suitable for tea cultivation, and the depletion of these lands by climate change are factors that favor a shift from traditional cultures to tea production, particularly in regions where the plant can be grown successfully (FAO 2018). If done sustainably ¾ e.g., in an agroforestry system, accompanied by long-term studies to avoid the species propagation to natural areas ¾ this could represent an economic opportunity for the municipality.

Specimens examined

BRAZIL: Rio de Janeiro, Petrópolis, Fundação Abismo, 22°32'50"S, 43°12'07"W, 872 m, 21 Sep. 2020, *G.M. Antar et al. 3104* (SPF, RB).

Other possible naturalized specimens

BRAZIL: Minas Gerais, Mercês, 1957, *J.M. Pinheiro-Sobrinho 2226* (BHCB); [Ouro Preto], lower slopes of Pico de Itacolomí, ca. 3 km S. of Ouro Preto, 31 Jan. 1971, *Irwin et al. 29513* (NY, UB, US); Ouro Preto, Parque Estadual do Itacolomi, 20°24'29"S, 43°30'25"W, 13 May 1998, *J.A. Lombardi 2274* (BHCB); idem, desvio da estrada de Ouro Preto para Lavras Novas, 5 km após o trevo, na margem da estrada, 7 km após a entrada do desvio, *L.L. Giacomin & L.H.Y. Kamino 26* (BHCB); idem, estrada para o Morro de São João, 6 May 2009, *G.D. Colleta et al. 68* (ESA, SPF); idem, Parque Estadual do Itacolomi, 30 Apr. 2018, *F.R.S. Tabosa et al. 68* (BHCB). **Paraná**, Castro, PCH Rio Iapó, Fazenda Marumbi, 24°44'14"S, 50°07'12"W, 980 m, 14 Feb 2016, *J.M. Silva et al. 9224* (HCF, MBM).

ACKNOWLEDGEMENTS

We thank the curators of the herbaria consulted; Thiago Rocha-Pitta, André Rossetti, and Luiz Montes for their help in the fieldwork; Fundação Abismo for permitting access to the area; and Bianca Schindler for helping to identify the species. This study was partially funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) under the funding code 001. GMA thanks CAPES for financial support; RBPA thanks CNPq and INCT for financial support.

REFERENCES

Accardo-Filho MAP. 2004. Theaceae no Estado do Rio de Janeiro [dissertation]. Rio de Janeiro (RJ): Universidade Federal do Rio de Janeiro, Museu Nacional.

Artigos de Offício. 1830. Império do Brasil; Diário Fluminense, Rio de Janeiro, 13 de novembro de 1830. 15th ed. vol. 116. Rio de Janeiro (RJ). [Acessed 2021 Oct. 29] http://memoria.bn.br/DocReader/DocReader.aspx?bib=706744.

Bediaga B 2007. Conciliar o útil ao agradável e fazer ciência: Jardim Botânico do Rio de Janeiro – 1808 a 1860. História, Ciências, Saúde-Manguinhos. 14: 1131–1157.

Bediaga B, Drummond RP. 2007. Cronologia: Jardim Botânico do Rio de Janeiro. Rio de Janeiro (RJ): Instituto de Pesquisas Jardim Botânico do Rio de Janeiro.

BFG- Brazilian Flora Group 2015. Growing knowledge: an overview of seed plant diversity in Brazil. Rodriguésia. 66: 1085–1113.

Cerdan MA. 2019. O cultivo do chá: breves considerações a partir do município de Itu - século XIX. Semina: Ciências Sociais e Humanas. 40(1): 121–138.

Cicciza D, Kokotos S. 2007. The invasive potential of tea: naturalization and spread of *Camellia sinensis* in natural and logged forests of the Amani Nature Reserve. [accessed 2021, Sep. 16]. http://www.tropical-biology.org/admin/documents/pdf_files/ Tanz_abstracts/1_Daniele%20&%20Stef_Final.pdf

Dean W. 1989. A Botânica e a Política Imperial: Introdução e Adaptação de Plantas no Brasil Colonial e Imperial. Instituto de Estudos Avançados da Universidade de São Paulo, São Paulo. 20 p. [accessed 2022 Jan. 4]. https://antigo.mdr.gov.br/images/stories/ArquivosSNPU/Biblioteca/ReabilitacaoAreasUrbanas/Historia_Botanica_Politica_Imperial.pdf

Flora do Brasil 2020. Jardim Botânico do Rio de Janeiro. [accessed 2022, Jan. 22]. http://floradobrasil.jbrj.gov.br/.

Fidalgo O, Bononi VLR. 1989. Técnicas de coleta, preservação e herborização de material botânico. Reimpressão. Instituto de Botânica, São Paulo. 62p

[FAO] Food and Agriculture Organization 2018. Global tea consumption and production driven by robust demand in China and India. New report also warns of climate change threat to tea production. Rome. 16 p.

Freitas B. 1987. Santa Cruz: fazenda jesuítica, real e imperial: vice-reis e reinado (1760-1821). Rio de Janeiro: Asa Artes Gráficas. 2.

Fundação SOS Mata Atlântica e Instituto Nacional de Pesquisas Espaciais (INPE). 2015. Atlas dos remanescentes florestais da Mata Atlântica: período de 2014–2015. [accessed: 2022, Jan. 20]. http://mapas.sosma.org.br.

Gama JS. 1869. Biografia do botânico brasileiro Fr. Leandro do Sacramento. Memória lida no Instituto Histórico perante S. M. o Imperador. Revista do Instituto Histórico e Geográfico Brasileiro, tomo XXXII – Parte Segunda: p. 181-230. [accessed 2020 Oct 29] <https://www.ihgb.org.br/publicacoes/revista-ihgb/item/107732-revista-ihgb-tomo-xxxii-parte-segunda.html>.

GBIF.org (2022) GBIF Home Page. [accessed 2022 Jan. 10]. https://www.gbif.org

JABOT. JBRJ - Instituto de Pesquisas Jardim Botânico do Rio de Janeiro. Jabot - Banco de Dados da Flora Brasileira. [accessed 2022, Jan. 22]. http://jabot.jbrj.gov.br/.

Junqueira MCC. 2018. O primeiro e único Conde da Barca Um iluminado na corte de Dom João [Ph.D thesis]. Rio de Janeiro (RJ). Universidade Federal do Rio de Janeiro.

Keller HA, Delucchi G, Romero HF. 2011. *Camellia sinensis* (Theaceae) en la Argentina: naturalización y usos locales. Boletín de la Sociedad Argentina de Botánica. 46: 145–150.

Lima PA. 1828. Discurso. Annaes do Parlamento Brasileiro, Rio de Janeiro, 3 de junho de 1828. Ed. 00002, p. 17–20 [accessed 2020, Oct 29]. http://memoria.bn.br/DocReader/DocReader.aspx?bib=132489

Loyola R, Machado N, Ribeiro BR, Martins E, Martinelli G. 2018. Áreas prioritárias para conservação da flora endêmica do estado do Rio de Janeiro. Graficci, Rio de Janeiro. 60p

Martinelli G, Martins E, Moraes M, Loyola R, Amaro R. 2018. Livro Vermelho da Flora Endêmica do estado do Rio de Janeiro. Andrea Jakobsson estúdio, Rio de Janeiro. 456p.

Majumdar A, Bera B, Rajan A. 2012. "Tea Statistics: The Chinese Scenario", The International Journal of Tea Science. 8(1): 73–75. [accessed 2021, Sept. 15]. http://teaboard.gov.in/pdf/Tea%20Statistics-The%20Chinese%20Scenario.pdf

Meegahakumbura MK, Wambulwa, MC, Thapa KK, Li MM, Möller M, Xu JC, Yang JB, Liu BY, Ranjitkar S, Liu J, Li DZ, Gao KM. 2016. Indications for Three Independent Domestication Events for the Tea Plant (*Camellia sinensis* (L.) O. Kuntze) and New Insights into the Origin of Tea Germplasm in China and India Revealed by Nuclear Microsatellites. PLOS ONE 11(5): e0155369. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0155369.

Ming TL, Bartholomew B. 2007. Theaceae. In: Wu ZY, Raven PH, Hong DY, editors. Flora of China 12. p. 366– 478. Beijing: Science Press; St. Louis: Missouri Botanical Garden Press.

Namita P, Mukesh R, Vijay KJ. 2012. *Camellia sinensis* (green tea): a review. Global Journal of Pharmacology. 6(2): 52–59.

Reflora - Herbário Virtual 2022. [accessed: 2022, Jan. 22]. http://reflora.jbrj.gov.br/reflora/herbarioVirtual/

Rezaeinodehi A, Khanghol S, Aminidehaghi M, Kazemi H. 2017. Allelopathic potential of tea (*Camellia sinensis* (L.) Kuntze) on germination and growth of *Amaranthus retroflexus* L. and *Setaria glauca* (L.) P.Beauv. Journal of Plant Diseases and Protection, Special Issue 20: 447–454.

Rodrigues JB. 2017. Hortus fluminensis. Revista Do Serviço Público. 40(4): 209–224.

Rugendas JM. 1835. Voyage pittoresque dans le Bresil. Paris, Lith. de G. Engelmann. 190 p.

Sha J, Chen Q, Miao Y, Qu R, Tang X, Fang W, 2020. Journal of Nuclear Agricultural Sciences 6: 1327-1336. [accessed: 2021, Sept. 16] http://www.hnxb.org.cn/EN/abstract/abstract13274.shtml.

Silva RB. 2013. Biologia de *Ceratobasidium* spp. associada à doença queima dos fios no chá (*Camellia sinensis* L.) [dissertation]. Botucatu (SP). Universidade Estadual Paulista, Faculdade de Ciências Agronômicas de Botucatu.

SpeciesLink 2022. [acessed: 2022, Jan. 11]. http://www.splink.org.br.

Thiers B, continuously update. Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. [accessed: 2022, Jan. 2].

Tropicos.org 2022. Missouri Botanical Garden. Available from. [accessed 2021 Sep. 9].

Werneck FPL. 1863. Memória sobre a fundação de uma fazenda na Província do Rio de Janeiro, Rio de Janeiro, Eduardo e Henrique Loemmert, 2 ed., 252 pp. [accessed: 2021 Nov. 30]. https://play.google.com/books/reader?id=4kU7AAAAcAAJ&hl=pt

Zenni RD, Ziller SR. 2011. An overview of invasive plants in Brazil. Brazilian Journal of Botany. 34(3): 431–446.

WEBBIA Journal of Plant Taxonomy and Geography

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www.fupress.com/webbia

OPEN ACCESS

Citation: Emmanuel Chukwudi Chukwuma, Kehinde Adegoke Adeniji, Luke Temitope Soyewo, Temitope Omoniyi Oyebola, Oluwaseun Adeniyi Osiyemi (2022) Micro-morphological studies in the genus *Balanites* Del. in West Africa. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 185-199. doi: 10.36253/jopt-12026

Received: August 10, 2021

Accepted: September 26, 2021

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Editor: Alessio Papini

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Micro-morphological studies in the genus *Balanites* Del. in West Africa

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Abstract. We examined the two species of the genus *Balanites* in West Africa for their foliar and pollen micro-characters. Fresh and herbarium specimens were used for this study. Results showed that the species have overlapping characteristics. Epidermal cells were generally anisodiametric or polygonal; anticlinal walls straight-curved while stomata were anomocytic and surrounded by large guard cells in both species. Trichomes were tectorial and only observed in *B. aegyptiaca*. Pollen grains were generally single, isopolar, tricolporate, and oblate spheroidal in shape, ranging from 23-23.5µm in *B. aegyptiaca* and 22-23µm in *B. wilsoniana,* in length. The exine was generally finely reticulate with indistinct lumina and thin in both species while pollen shape was oblate spheroidal in *B. aegyptiaca* and prolate spheroidal in *B. wilsoniana*. Ecological data showed that the species are allopatric but sometimes may be found in same ecological zone. Although the present study supports the co-existence of the taxa as sister species, the overlapping characters as observed also suggest the need for further taxonomic studies to ascertain beyond reasonable doubt, the recent infra-generic classification within the Zygophyllaceae.

Keywords: *Balanites,* conservation, leaf anatomy, pollen, West Africa, Zygophyllaceae.

INTRODUCTION

Balanites Del. is a genus of flowering plants in the family Zygophyllaceae (Dresler et al. 2014) comprising deciduous or semi-evergreen spiny trees or shrubs with simple or branching spines which are derived from the distal of two or more buds, axillary or at a varying distance above the subtending leaf (Sands 2001). Studies on several species in the genus have been published by many authors based on floral characters (Van Tieghen 1906; Sprague 1913; Mildbraed and Schlechter, 1914) and revised by Engler (1931). Sands (2001) recognised 9 species and 11 infra-specific taxa based on bud and inflorescence position, as well as characters associated with spines, which remain on the plants even when the fruits, flowers, and leaves are absent. In West Africa, the genus comprises only two species - *Balanites aegyptiaca* (L.) Del. and *B. wilsoniana* Dawe & Sprague (Hutchinson and Dalziel 1958; Keay 1989).

B. aegyptiaca popularly called 'desert date' is a highly drought-tolerant, evergreen, multi-branched, small tree up to l0 m high, with greenish stems and flexible drooping branches which bears long alternately set thorns; and yellow edible fruits. On the other hand, *B. wilsoniana* is described as an upper canopy tree reaching about 38 m in height and over 3 m in girth, and produces fruits that are greenish-brown in colour (Hutchinson and Dalziel 1958; Hall and Walker 1991; Chapman et al. 1992; Arbonnier 2002; Orwa et al. 2009). Keay (1989) reported that *B. aegyptiaca* is a savanna species easily recognized by long straight greenish spines arranged spirally along all the branches, either bearing flowers or not, while *B. wilsoniana* is a large forest tree distinguished by its larger leaves and lack of spine on the flowering branches. Sands (2001) noted that in *B. aegyptiaca,* the spines are simple or with subordinate branches and fruits usually less than 5 cm long, whereas in *B. wilsoniana* the spines are forked or branching several times and fruits 8-12 cm long. In his studies, Sands (2001*)* further separated the latter into 3 varieties: *glabripetala*, *mayumbensis,* and *wilsoniana*) based on pedicel length and hairiness of petals.

Balanites species have diverse uses in West Africa. The fruits of *B. aegyptica* are rich in edible oil (Newinger 1996) and used to brew alcoholic drinks, while the flowers are used as an ingredient in dawadawa (Hausa); and a food prepared from *Parkia filicoidea* Welw. ex Oliv. and the young leaves of *B. aegyptiaca* is eaten as vegetable in Chad, Nigeria and Sudan (Burkill 1985). As a thorny tree, *B. aegyptiaca* is useful for fencing while the wood is easily worked and made into spoons, handles, stools, and combs. In traditional medicine, the roots are used to treat malaria, oedema, chest pain, heart burn, etc. Although, the species is used as firewood, it is considered one of the most neglected tree species in arid regions (Burkill 1985; Hall and Walker 1991; Orwa et al. 2009). The seeds of *B. wilsoniana* are edible and oil bearing (Burkill 1985) while the wood is suitable for general construction (Irvine 1961). The bark contains a copious quantity of scented gum which is used in Ghana in the production of cosmetics; the ointment is also applied to newborn babies.

Over the years, foliar micro-morphological characteristics such as epidermal cell length, stomatal size, absence or presence of trichome etc., have provided valuable supplementary evidences and are of prospective taxonomic value (Soladoye and Crane 1985; Baronova 1992; Chukwuma et al. 2014; Chukwuma et al. 2017). Morphological characters of pollen grains have also been useful in taxonomic studies of plants (Erdtman 1952, 1969; Soladoye and Crane 1985; Pehlivan et al. 2009), and the ability to identify plants from their pollen has enabled botanists and ecologists to reconstruct past assemblages of plants and identify periods of environmental change (Faegri and Iversen 1989).

Despite the numerous information available on *Balanites* species including their ecology, distribution and uses, the current taxonomic placement of the genus has triggered a lot of interest among taxonomists. Sarma and Rajo Rao (1991) suggested a total separation of *Balanites* from Simourabaceae and a further creation of Balanitoideae as a subfamily within the Zygophyllaceae. This argument supports earlier opinion of Parvathi and Narayana (1978), who had noted that although *Balanites* differs from Zygophyllaceae and Simourabaceae, the genus should rather be retained within the Zygophyllaceae but as a sub-family Balanitoideae based on chemical evidences. In furtherance, studies had earlier reported the micromorphological characteristics (Ndoye et al. 2004; Usama 2007; Bhupendra et al. 2017; Mohammed et al. 2020) and genetics (Ram et al. 2008) of *B. aegyptiaca*, but non has provided similar details for *B. wilsoniana.* Comparative study on these species is also lacking. Consequently, our study focuses on the foliar and pollen micro-characters of the two West African species of *Balanites*, with a view to providing additional details which would complement existing diagnostic characters for identification of the taxa. We also provide information as to their current distribution within the region based on herbarium records, available literatures and online resources.

MATERIALS AND METHODS

Plant material

Fresh and herbarium specimens of *B. aegyptiaca* were used for the present study. The fresh specimens were collected from the arboretum of the Forestry Research Institute of Nigeria (FRIN), Ibadan and Usmanu Danfodiyo University, Sokoto, Nigeria, and carefully identified at the Forest Herbarium Ibadan (FHI) (Holmgren et al. 1990) prior to micro-morphological examinations. On the other hand, only herbarium specimens were used for *B. wilsoniana* because fresh samples where difficult to obtain at the time of this study. All herbarium specimens studied were those deposited at Forest Herbarium Ibadan (FHI) and University of Ibadan Herbarium (UIH) (Appendix I).

Leaf epidermal study

We examined 4 representatives of *B. aegyptiaca* and 5 samples of *B. wilsoniana* for their leaf epidermal charac-

teristics (Tables 2 and 3). Specifically, pieces of 2–5 cm^2 of the leaves of each representative (Chukwuma et al. 2017) were cut and soaked in concentrated trioxonitrate (v) acid (HNO_3) in well covered Petri dishes for about two to three hours to macerate the mesophyll. Upon the disintegration of tissues as indicated by the presence of bubbles on the leaves, the specimens were carefully transferred unto clean Petri-dish and rinsed thoroughly with distilled water before the epidermal surfaces were separated using forceps. Tissue debris was carefully cleared off the epidermis with fine Carmel® hair brush, and the isolated epidermal layers were adequately rinsed in distilled water. The epidermises were then transferred in to another Petri-dish containing 50% ethanol for 1–2 minutes, thereby allowing hardening of cells. Afterwards, tissues were stained with Safranin O for five minutes and then rinsed again in distilled water to remove excess stain. They were thereafter mounted in 25% glycerol on clear microscopic glass slides, covered with cover-slip and the edges of the cover slip were ringed with nail varnish to prevent dehydration. Five slides per specimen were prepared for each epidermis of the two species. Leaf epidermal descriptions followed those of Radford et al. (1974), Khatijah and Zaharina (1998) and Adedeji (2004) while stomata architecture was described following Carpenter (2005).

Pollen morphology

Fresh flowers of *B. aegyptiaca* and dried samples from herbarium specimens of *B. wilsoniana* were used for this purpose following acetolysis method described by Erdtman (1960). Pollen descriptions are in accordance with Erdtman (1943), Sowunmi (1973) and Sowunmi (1995).

All prepared slides were examined under Olympus® light microscope with ×40 objective lens. All photo micrographic images were taken using an attached ScopeImage® 9.0 camera mounted on the same microscope, at the Forest Herbarium Ibadan (FHI) while all measurements were obtained with a micrometer eyepiece. Each character was measured in twenty-five replicates.

Scanning electron microscopy

Small pieces (about 6 mm^2) of the dried leaf samples were fixed on a Aspex 3020 scanning electron microscope stubs with a double-sided tape and sputter coated with gold. The structural patterns of the leaf surfaces were carefully observed and photo-micrographic images were taken at an accelerating potential of 20.0kV at the Department of Material Science and Engineering, Faculty of Engineering, Kwara State University, Malete, Nigeria.

Species distribution

Records from Global Biodiversity Information Facility (GBIF) database (GBIF.org) and previously collected specimens of *Balanites* species deposited at FHI and UIH were utilized for this aspect. In addition, fresh specimens of *B. aegyptiaca* collected during the present study were also included. Geographic locations and coordinates of these specimens were carefully retrieved and thereafter used to produce a distributional map of the species in West Africa (Figure 1), using ArcGis 10.3.1.

Statistical analysis

All quantitative data were subjected to descriptive statistics and further analysed using PAST (PAlaeontological STatistics) version 4.02 (Hammer et al. 2001) to generate a UPGMA (Unweighted Pair-Group Method with Arithmetic Mean) based dendrogram.

RESULTS AND DISCUSSION

The quantitative and qualitative foliar micro-characters of all examined specimens of *Balanites* species are presented in Tables 1–4. Comparatively, epidermal cells are generally anisodiametric or polygonal with thick, straight-curved anticlinal walls (Table 1, Figure 5). The species are amphistomatic, but more abundant on the adaxial surfaces than on the abaxial. However, stomata were fewer in specimens of *B. wilsoniana* collected from Cameroon (Tables 2 & 3). On the average, stomatal size in *B. aegyptiaca* were larger (271.9μm^2 – abaxial; 313.0μm^2 – adaxial) than the epidermal cells (104.3μm^2 – abaxial; 122.2μm^2 – adaxial), whereas in *B. wilsoniana,* the stomata were smaller, measuring 153.9μm^2 on the abaxial and 203.3μm^2 on the adaxial, while epidermal cells were averaged 156.7μm^2 on the abaxial and 206.3μm^2 on the adaxial surface (Table 4). All specimens of *B. aegyptiaca* examined showed similar epidermal characteristics (Figures 2 A–H) and they have thicker epidermal cell walls than those of *B. wilsoniana* (Figures 3 A–J). Trichomes were generally tectorial and unicellular (Table 1; Figure 4), up to 259.2μm in length and 22.4μm in width as observed on the adaxial surface of *B. aegyptiaca* collected in Ibadan, Nigeria while specimens obtained from Freetown in Sierra Leone and Sokoto in Nigeria, were void of trichomes (Table 2).

Sands (2001) treated Kennedy 1658 (Figures 3 A & B), Kennedy 1949 (Figures 3 C & D) and Odedoyin's 1959 collection (Figures 3 E & F) as *B. wilsoniana* var.

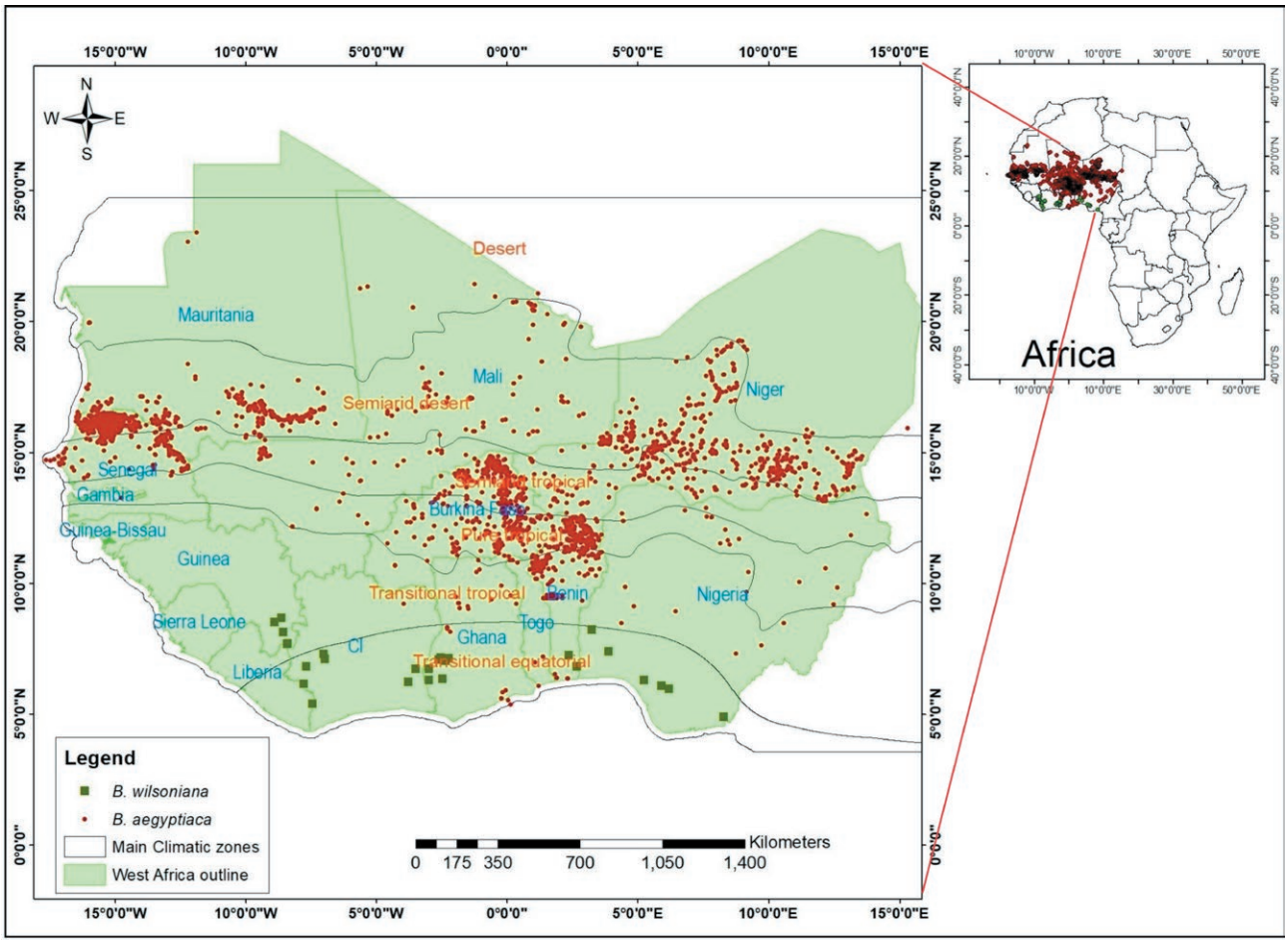

Figure 1. Distribution of *Balanites* species in West Africa.

grabipetala (loc cit. Pg 29); and Keay's 1950 collection (Figures 3 G & H) as *B. wilsoniana* var. *wilsoniana*. In our study, there was little or no difference in the foliar epidermises of Odedoyin's collection of 1959 (Figures 3 E & F) and that of Keay in 1950 (Figure 3 G & H). However, Kennedy's collections (FHI 9055 & 9056) showed distinct epidermal features as shown in Figure 3 (A-D). Following this observation, further study may reveal Odedoyin's collection as var. *wilsoniana* similar to that of Keay (FHI 28198). Additionally, a specimen from Cameroon (Figures 3 I & J) showed similar features with those of Odedoyin (Figures 3 E & F) and Keay (Figures 3 G & H) from Nigeria, suggesting that they could be of the same variety within *B. wilsoniana* complex.

As reflected through the dendrogram, variation even among same species is possible, and such variation may be brought about by alterations in ecological and climatic conditions. While specimens of *B. aegyptiaca* collected from Savane Palmraie, Burundi (FHI 101464) and Sokoto, Nigeria (FHI 111228) appear to be distinctly unique in epidermal characteristics, others share some attributes. For instance, abaxial surfaces of *B. wilsoniana* collected from Sapoba, Nigeria (sample F; FHI48385) and Kumba, Cameroon (sample G; FHI8496) are the most similar surfaces but also share some resemblance with abaxial surface of the one collected from Ikom, Nigeria (Sample E; FHI28198). More specifically, the studied taxa are divided into three main clusters (Figure 6a). As illustrated, both surfaces of samples F, G and the abaxial of E appear as the first goup; surfaces of A, B, C, H and I formed the second group in the central position, while the two surfaces of sample D and adaxial surface of E occupy the extreme end of the dendrogram as the third group. While *B. aegyptiaca* collected from Sokoto (FHI 111228) appears to occupy an isolated position of the scatter plot (Figure 6b) within component 1, others are clustered together at the other end of the plot within component 2. This further reflects the phylogenetic relationship between the species understudied and the overlapping of taxonomic characters within collections.

Table 1. Summary of qualitative foliar characteristics of *Balanites* species studied.

Species	Surface	Epidermal cell type/shape	Anticlinal cell wall pattern	Stomata type (s)	Trichome type (s)
B. aegyptiaca	Abaxial	Anisodiametric / polygonal	Straight - curved	Anomocytic	Tectorial, unicellular
	Adaxial	Anisodiametric / polygonal	Straight – curved	Anomocytic	Tectorial, unicellular
B. wilsoniana	Abaxial	Anisodiametric / polygonal	Straight – curved	Anomocytic, cyclocytic	Absent
	Adaxial	Anisodiametric / polygonal	Straight – curved	Anomocytic	Absent

Table 2. Quantitative foliar characteristics of *B. aegyptiaca* studied.

Specimen (location/voucher nos.)	Surfcae	ECL (µm)	ECW (µm)	ECS (µm^2)	CWT (µm)	No. St (per mm^2)	St. L (µm)	St. W (µm)	ST.S (µm^2)	No. tr (per mm^2)	Tr. L (µm)	Tr. W (µm)	Tr. D
Savane Palmraie, Burundi/ FHI 101464	Abaxial	6.5-10.8 8.5±0.4	2.9-6.6 4.8±0.3	25.9-61.1 41.1±3.6	1.0-1.3 1.1±0.0	61-91 72.4±2.6	11.7-20.1 15.5±0.9	8.4-18.1 11.6±1.1	98.4-364.6 187.8±29.0	3-13 7.6±0.9	45.4-160.5 78.7±10.3	8.8-16.7 11.9±0.8	15.3-66.2 38.7±4.8
	Adaxial	7.1-9.6 8.4±0.3	3.2-6.8 5.3±0.4	27.4-61.2 44.4±4.0	0.7-1.7 1.3±0.1	61-92 77.6±2.9	15.0-19.2 18.0±0.5	11.7-16.0 15.4±0.2	185.0-307.0 250.1±13.2	6-10 7.9±0.6	35.4-113.9 73.1±7.9	8.1-14.6 11.9±0.6	30.6-56.0 40.2±2.9
Freetown, Sierra Leone/ UIH 10260	Abaxial	7.7-15.2 12.0±0.8	4.8-11.7 7.3±0.6	49.3-151.7 88.2±10.9	0.5-2.4 1.7±0.2	51-78 68.8±2.3	10.1-19.5 16.5±0.8	11.2-15.2 13.3±0.4	153.3-262.6 217.4±11.0	Absent	Absent	Absent	Absent
	Adaxial	8.5-11.7 10.1±0.3	4.3-7.0 5.9±0.3	36.3-69.6 59.7±3.2	0.8-2.3 1.7±0.2	54-76 65.1±2.1	16.4-19.6 17.9±0.3	12.2-16.8 14.9±0.5	207.7-317.9 267.4±12.6	Absent	Absent	Absent	Absent
Sokoto, Nigeria/ FHI111227	Abaxial	9.7-15.7 13.7±0.6	7.2-9.4 7.9±0.4	71.7-127.1 107.5±7.0	0.9-1.7 1.3±0.1	54-61 56.7±0.8	12.5-18.0- 15.9±0.5	10.6-15.6 13.5±0.4	158.5-280.8 215.5±11.6	Absent	Absent	Absent	Absent
	Adaxial	11.8-18.6 14.6±0.8	7.2-11.6 8.9±0.4	85.1-179.2 130.6±8.7	0.5-2.0 1.3±0.1	40-47 43.7±0.7	14.9-19.1 16.7±0.5	11.7-16.0 14.1±0.5	191.8-284.4 235.2±10.1	Absent	Absent	Absent	Absent
Ibadan, Nigeria/ FHI111228	Abaxial	16.0-19.2 17.0±0.5	9.6-12.8 10.6±0.5	153.6-245.8 180.2±12.3	1.9-5.2 3.8±0.3	40-64 50.8±2.2	22.4-25.6 24.3±0.5	16.0-22.4 19.2±0.5	409.6-573.4 466.9±15.8	0-3 1.6±0.3	67.2-240.0 109.1±16.1	6.4-12.8 8.6±0.7	0-10.2 8.1±1.7
	Adaxial	16.0-22.4 19.5±0.7	9.6-16.0 13.1±0.7	184.3-358.4 254±14.4	2.3-3.6 3.0±0.2	46-58 50.0±1.2	22.4-25.6 23.7±0.5	16.0-25.6 21.1±1.1	409.6-655.4 498.7±25.4	1-5 2.9±0.4	108.8-259.2 160.0±16.9	9.6-22.4 14.7±1.2	5.1-25.5 14.8±1.9

Key: ECL- epidermal cell length; ECW- epidermal cell width; ECS- Epidermal Cell Size; CWT- epidermal cell wall thickness; No. St- number of stomata: St.L- stomata length; St. W- stomata width; ST.S- Stomatal Size; No. Tr- number of trichome; Tr.L- trichome length; Tr.W- trichome width; Tr.D- trichome density.
All measurements expressed as minimum – maximum above, mean ± standard error beneath.

Table 3. Quantitative foliar characteristics of *B. wilsoniana* studied.

Specimen (Location / voucher nos.)	Surfcae	ECL (μm)	ECW (μm)	ECS (μm²)	CWT (μm)	No. St (per mm²)	St. L (μm)	St. W (μm)	ST.S (μm²)
Cross-Rivers, Nigeria/ FHI 28198	Abaxial	16.4-24.4 20.7±0.9	7.5-14.6 10.9±0.7	175.5-270.6 220.0±3.6	0.8-3.3 2.0±0.2	31-59 44.6±2.9	12.2-15.4 13.9±.4	9.8-13.8 11.2±0.4	130.3-211.6 157.0±8.5
	Adaxial	20.6-30.5 26.7±1.1	12.9-20.7 16.8±0.7	364.4-552.8 446.0±22.5	2.3-5.1 3.9±0.3	5-17 9.5±1.2	19.6-22.8 21.2±0.4	17.4-18.6 17.8±0.2	324.5-418.5 377.0±8.5
Sapoba, Nigeria/ FHI 48385	Abaxial	13.0-25.2 18.4±1.2	7.0-12.9 10.6±0.5	142.0-236.7 192.0±10.7	1.1-3.2 2.0±0.3	40-60 49.0±2.0	11.1-18.4 13.7±0.6	8.1-12.4 9.7±0.5	107.4-228.3 134.0±12.1
	Adaxial	11.5-25.6 18.2±1.2	7.6-12.8 10.4±0.6	87.2-227.8 165.0±19.8	1.1-2.7 2.0±0.2	7-15 10.7±0.9	12.8-16.9 15.1±0.4	10.4-12.8 11.6±0.3	142.3-212.3 175.0±7.2
Kumba, Cameroon/ FHI 8496	Abaxial	12.4-23.5 18.8±1.2	9.0-13.7 10.7±0.5	131.4-265.7 198.0±12.7	0.7-2.4 1.4±0.2	33-44 38.7±1.1	12.5-18.4 14.5±0.7	8.4-11.7 10.1±0.3	105.3-209.9 148.0±10.8
	Adaxial	13.1-25.7 20.4±1.1	10.0-14.2 12.0±0.5	167.0-301.3 245.0±15.3	1.1-2.7 2.1±0.2	0-2 1.0±0.2	12.7-17.7 15.4±0.5	9.3-12.5 10.5±0.3	132.5-222.2 162.0±8.0
Sapoba, Nigeria/ FHI9056	Abaxial	9.9-14.6 12.8±0.4	1.1-9.4 6.6±0.8	10.7-120.2 86.2±10.4	1.4-2.5 1.8±0.1	79-114 102.2±10.1	13.4-24.1 16.1±1.0	11.1-14.1 12.0±0.3	149.2-338.8 194.0±17.7
	Adaxial	9.6-17.0 12.3±0.7	7.2-9.7 7.9±0.4	54.4-116.1 96.0±6.5	0.7-1.7 1.2±0.1	50-70 59.9±2.0	9.8-15.9 12.4±0.5	9.6-13.3 10.9±0.3	93.4-162.5 136.0±7.7
Sapoba, Nigeria/ FHI9055	Abaxial	10.9-14.9 13.0±0.5	4.9-9.8 6.7±0.5	59.1-116.1 86.5±6.8	0.6-1.7 1.4±0.1	71-110 89.3±4.0	11.9-16.4 13.4±0.5	8.4-12.4 10.1±0.3	98.9-203.6 136.0±8.7
	Adaxial	10.6-14.3 12.1±0.3	4.5-8.4 6.6±0.4	52.4-106.9 79.7±5.8	1.0-2.6 1.6±0.1	46-62 53.8±1.8	10.9-15.0 13.0±0.4	11.3-14.8 12.7±0.4	138.1-213.7 166±7.6

Key: ECL- epidermal cell length; ECW- epidermal cell width; ECS- Epidermal Cell Size; CWT- epidermal cell wall thickness; No. St- number of stomata: St.L- stomata length; St.W- stomata width; ST.S- Stomatal Size. All measurements expressed as minimum – maximum above, mean ± standard error beneath.

Table 4. Summary of quantitative foliar micro-characters of *Balanites* species studied (mean ± standard error).

Characters	*B. aegyptiaca*		*B. wilsoniana*	
	Abaxial	Adaxial	Abaxial	Adaxial
ECL (μm)	*12.8±0.6	**13.2±0.7	*16.7±0.6	**17.9±0.9
ECW (μm)	7.6±0.4	8.3±0.5	9.1±0.4	10.5±0.6
ECS (μm²)	*104.3±9.1	**122.2±13.9	*156.7±9.4	**206.3±20.2
CWT (μm)	2.0±0.2	1.8±0.1	1.7±0.1	2.1±0.2
No. St (per mm²)	*62.2±1.7	**59.1±2.3	*64.8±4.3	**26.9±3.6
St. L (μm)	*18.1±0.7	**18.9±0.5	*14.3±0.3	**15.4±0.5
St. W (μm)	*14.4±0.6	**16.1±0.6	*10.6±0.2	**12.7±0.4
St.S (μm²)	*271.9±20.2	**313.0±18.9	*153.9±6.0	**203.3±13.0
No. tr (per mm²)	2.3±0.6	2.7±0.5	Absent	Absent
Tr. L (μm)	6.9±8.9	58.3±11.5	Absent	Absent
Tr. W (μm)	5.1±0.9	6.6±1.1	Absent	Absent
Tr. D	11.7±2.8	13.8±2.8	Absent	Absent

P≤ 0.05.

* = significance in abaxial surface; ** = significance in adaxial surface?

Key: ECL: epidermal cell length; ECW: epidermal cell width; ECS: epidermal cell size; CWT: epidermal cell wall thickness; No. St: number of stomata: St.L: stomata length; St. W: stomata width; St.S: stomatal size; No. Tr: number of trichome; Tr. L: trichome length; Tr. W: trichome width; Tr. D: trichome density.

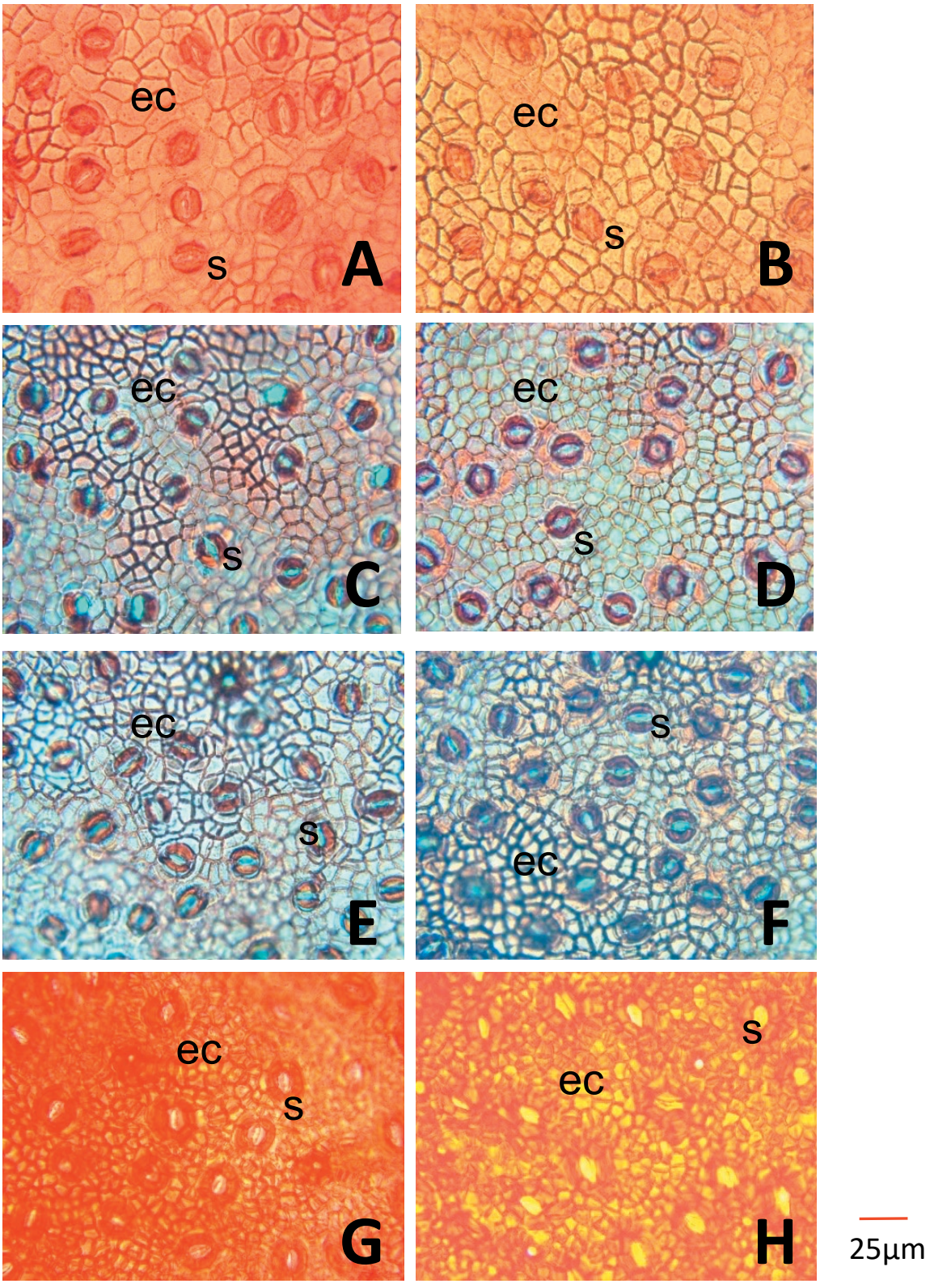

Figure 2. Photomicrographs (Light microscope) of the foliar epidermises of *B. aegyptiaca* studied. Mg. X400. **A&B** - Ibadan, Nigeria; **C&D** - Sokoto, Nigeria; **E&F** - Freetown, Sierra Leone; **G&H** - Savane Palmraie, Burundi. **A, C, E, G**: abaxial surface; **B, D, F, H**: adaxial surface. ec- epidermal cell; s- stoma.

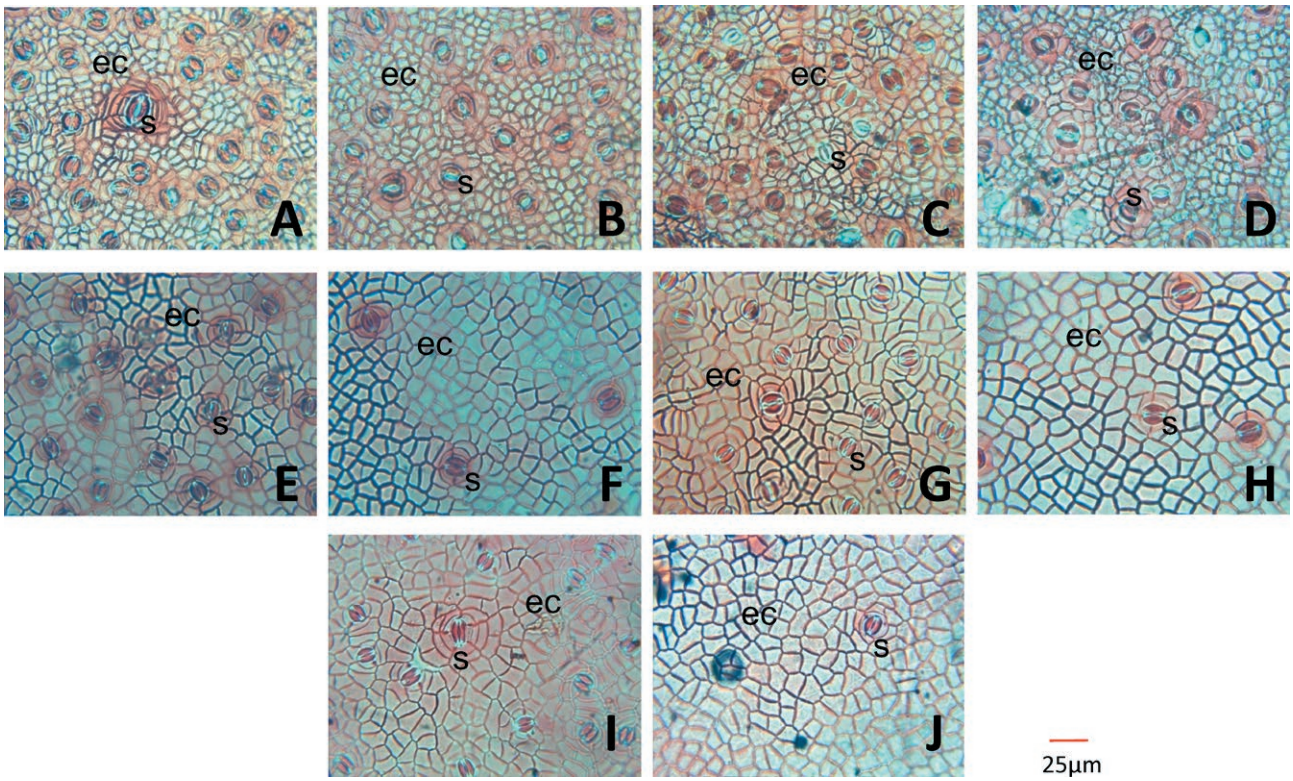

Figure 3. Photomicrographs of the foliar epidermis of *B. wilsoniana* studied. Mg. X400. **A&B** - Sapoba, Edo State, Nigeria; **C&D** - Sapoba, Edo State, Nigeria; **E&F** - Sapoba, Edo State, Nigeria; **G&H** - Ikom, Cross-Rivers State, Nigeria; **I&J** - Kumba division, Cameroon. **A, C, E, G, I**: abaxial surface; **B, D, F, H, J**: adaxial surface. ec- epidermal cell; s- stoma.

Sama and Rajo Rao (1991) noted a combination of polygonal and anisodiametric epidermal cells in *B. aegyptiaca* with anomocytic stomata. This was also the case as observed in our study. Stomata were mostly anomocytic, with some associated cyclocytic ones (as noticed in Keay's collections and that from Cameroon), and densely distributed on abaxial and adaxial epidermal surfaces of the species studied. Variation in stomatal size as observed in the present study could be linked to water stress, which has been reported to be responsible for the reduction in leaf size and also a reduction in the proportion of epidermal cells responsible for the formation of stomata and increased trichomes (Quarrie and Jones 1977; Usama 2007). Quantitative genetic studies have indicated ample genetic variation for trichome number and trichome density (Mauricio and Rausher 1997; Roy et al. 1999; Clauss et al. 2006). Perez-Estrada et al. (2000) in their study noted that trichome density decreased during the rainy season and increased during the dry season; and further opined that plants growing in sun exposed areas tend to have higher trichome densities than those in shady environment. It is also noteworthy that, the number of trichomes and density may also vary genetically within and among species on one hand, and even within populations of the same species on the other hand; since evolution does not take place in the same organ at the same time or even at the same rate. Hence, the presence or absence of trichome in certain species or specimens as noticed in the present study could be attributed to environmental factors. For instance, the specimen collected in Ibadan (fruiting and flowering every year), a rain forest zone, contradicts earlier reports that *B. aegyptiaca* is a typical savanna species. There was also little significant difference in the trichome density which was only recorded in *B. aegyptiaca* and absent in *B. wilsoniana*. However, the trichome type observed in our study is in tandem with the submissions of previous authors (Sarma and Rajo Rao 1991; Usama 2007; Bhupendra et al. 2017). Although, in their study on Simaroubaceae-Zygophyllaceae complex, Sarma and Rajo Rao (1991) recorded a total of eight trichome types, mostly unicellular in Zygophyllaceae and a combination of unicellular and uniseriate in Simourabaceae, they clearly reported that *Balanites* possess some unique epidermal characteristics including only one trichome type (unicellular). Likewise, Usama (2007) and Bhupen-

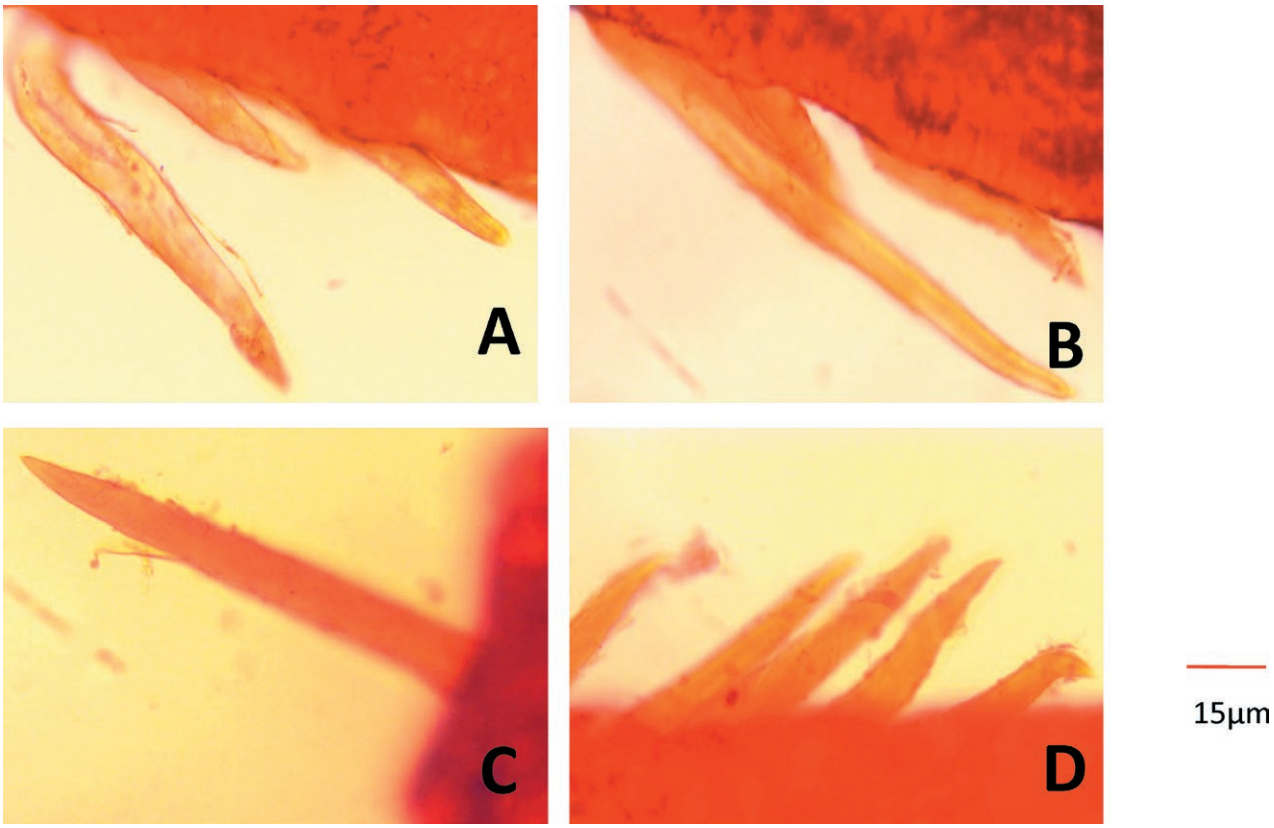

Figure 4. Trichomes in *B. Aegyptiaca.* Mg. x400. **A, B :** abaxial surfaces; **C, D :** Adaxial surfaces.

Table 5. Pollen characteristics of *Balanites* species studied.

	B. aegyptiaca	*B. wilsoniana*
Exine Pat.	Finely reticulate	Finely reticulate
Exine (µm)	2.1-2.5	2.0-2.3
Ora size	Large	Large
Ora size (h x w)	5.2-8.0 X 5.0-7.0	7.1-8.1 x 7.0
Apertures	3-colporate	3-colporate
Polar diameter (µm)	25.0-28.0	26.0-30.0
Equatorial diameter (µm)	26.0-30.0	22.5-29.0
Colpi (µm)	23.0-23.5	22.0-23.0
Shape	Oblate spheroidal	Prolate spheroidal

dra et al. (2017) also reported this trichome type in *B. aegyptiaca*.

Pollen description

Balanites aegyptiaca: Pollen grains are single, isopolar and oblate spheroidal in shape. Polar diameter ranged from 25.0µm to 28.0µm with an average of 26.5µm, while equatorial diameter ranged from 26.0µm to 33.0µm with an average of 28.0µm. Pollen grains are 3-colporate; colpi are with margo 23-23.5µm in length, and taper towards the poles. Ora are lolongate, spheroidal in shape, 5.2-8.0µm long and 5.0-7.0µm wide. Exine is generally thin; 2.1-2.5µm thick; exine is finely reticulate (Table 5, Figure 7 A & B).

Balanites wilsoniana: Pollen grains generally similar to those of *B. aegyptiava*. They are single, isopolar and prolate spheroidal in shape. Polar diameter 26.0-30µm with an average of 28.0µm; equatorial diameter 22.5-29.0µm with an average of 25.7µm. Pollen grains 3-colporate; colpi are also with margo and about 22-23µm in length, also taepering towards the poles. Ora are lolongate, oblate in shape; 7.1-8.1µm long and 7.0µm wide. Exine is generally thin; 2.0-2.3µm thick; exine is also finely reticulate with indistinct lumina (Table 5, Figure 7 C & D).

Species distribution

Although, herbarium specimens studied support that the species are allopatric in distribution – *B. aegyp-*

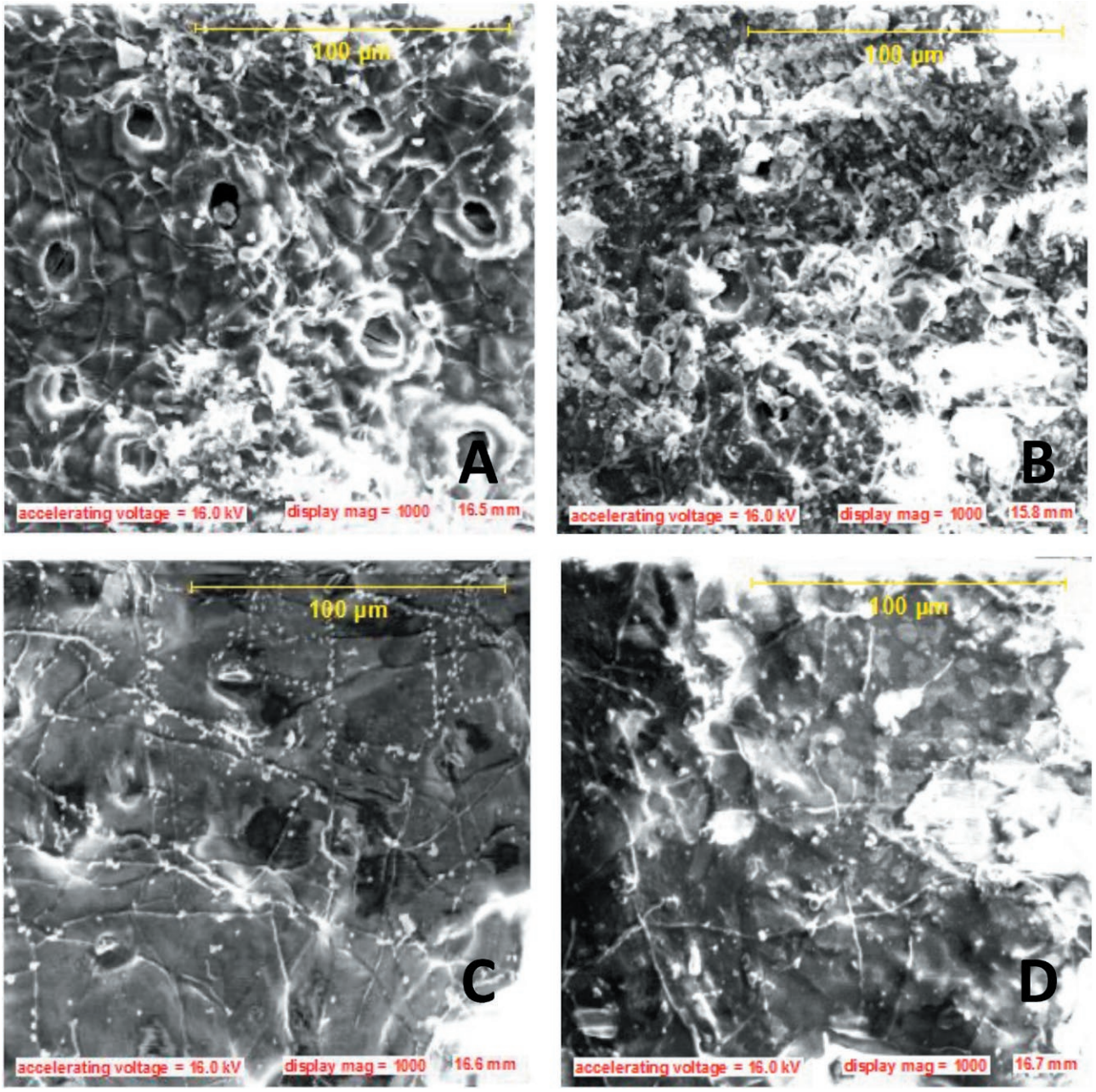

Figure 5. Photomicrographs (Scanning Electron Microscopy) of epidermal surfaces. Mg. x1000. **A**: *B. aegyptiaca* (Abaxial); **B**: *B. aegyptiaca* (Adazial); **C**: *B. wilsoniana* (Abaxial); **D**: *B. wilsoniana* (Adaxial)

tiaca is widespread in the dry areas of West Africa and *B. wilsoniana* occurs in the forest zones, further observations during the collection of plant materials for this study showed that the former can also thrive in forest areas. Hutchinson and Dalziel (1958) had earlier reported *B. aegyptiaca* to be found in 8 West African countries (Benin, Ghana, Guinea-Bissau, Mali, Mauritania, Nigeria, Senegal and Togo), while *B. wilsoniana* occurred only in 4 (Benin, Cote D' Ivoire, Nigeria and Ghana). A recent study by Hassler (2017) reported 12 countries for *B. aegyptiaca,* and maintained those 4 countries for *B. wilsoniana*. In our study however, based on herbarium assessments, field visits, and online data sourced from GBIF, we identified that *B. aegyptiaca* is widespread across the semiarid desert, semiarid tropical, pure tropical and transitional tropical climatic zones of West Afri-

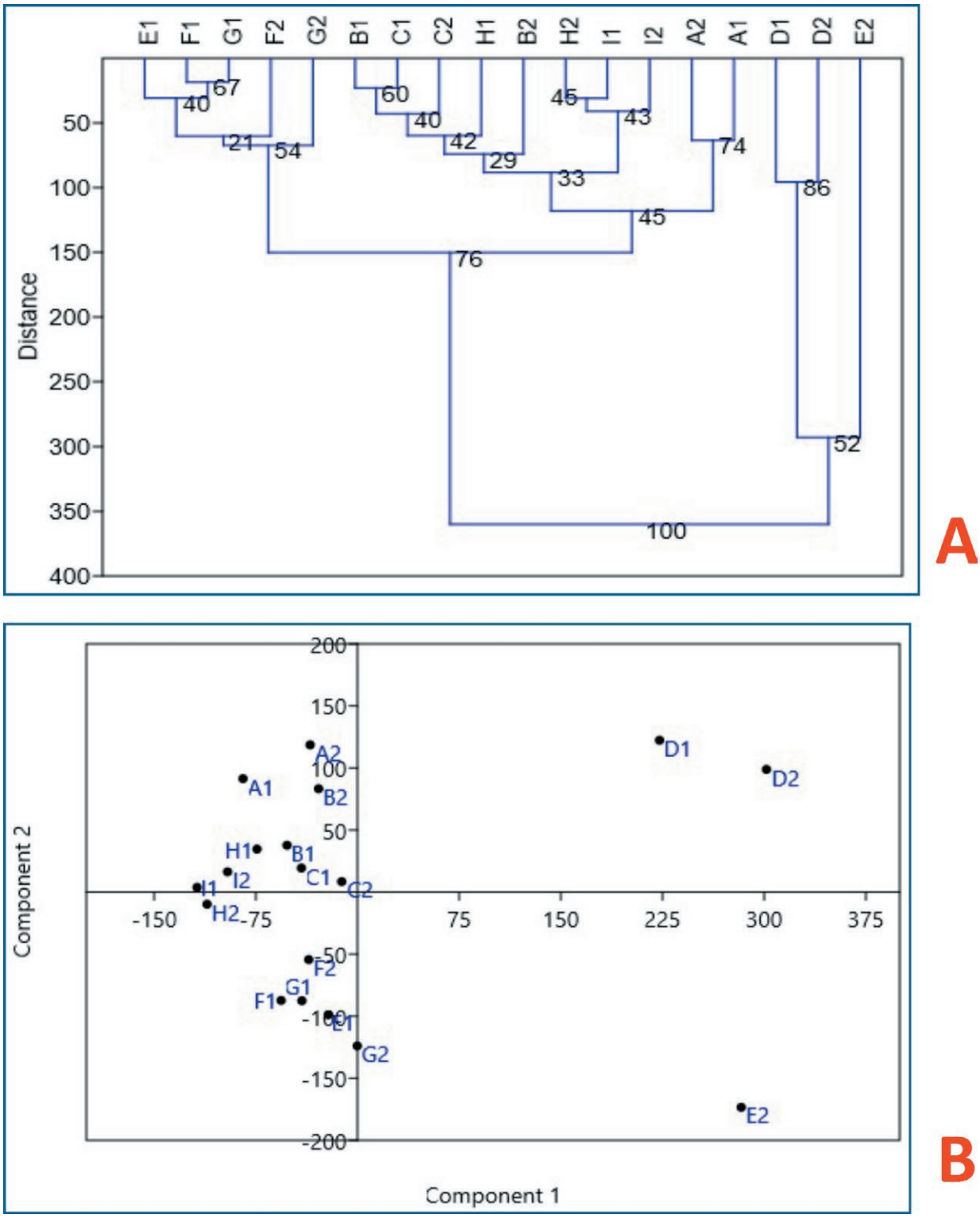

Figure 6. A - Dendrogram (UPGMA, Euclidean distance) showing degree of resemblance within *Balanites* collections. **B** - Component plot of species in rotated space. Samples **A-D**: *B. aegyptiaca*; **E-I**: *B. wilsoniana*. **A** - FHI101464; **B** – UIH10260; **C** – FHI111227; **D** – FHI111228. **E** - FHI28198; **F** – FHI48385; **G** – FHI8496; **H** – FHI9056; **I** – FHI9055. **1**- abaxial surface ; **2** – adaxial surface.

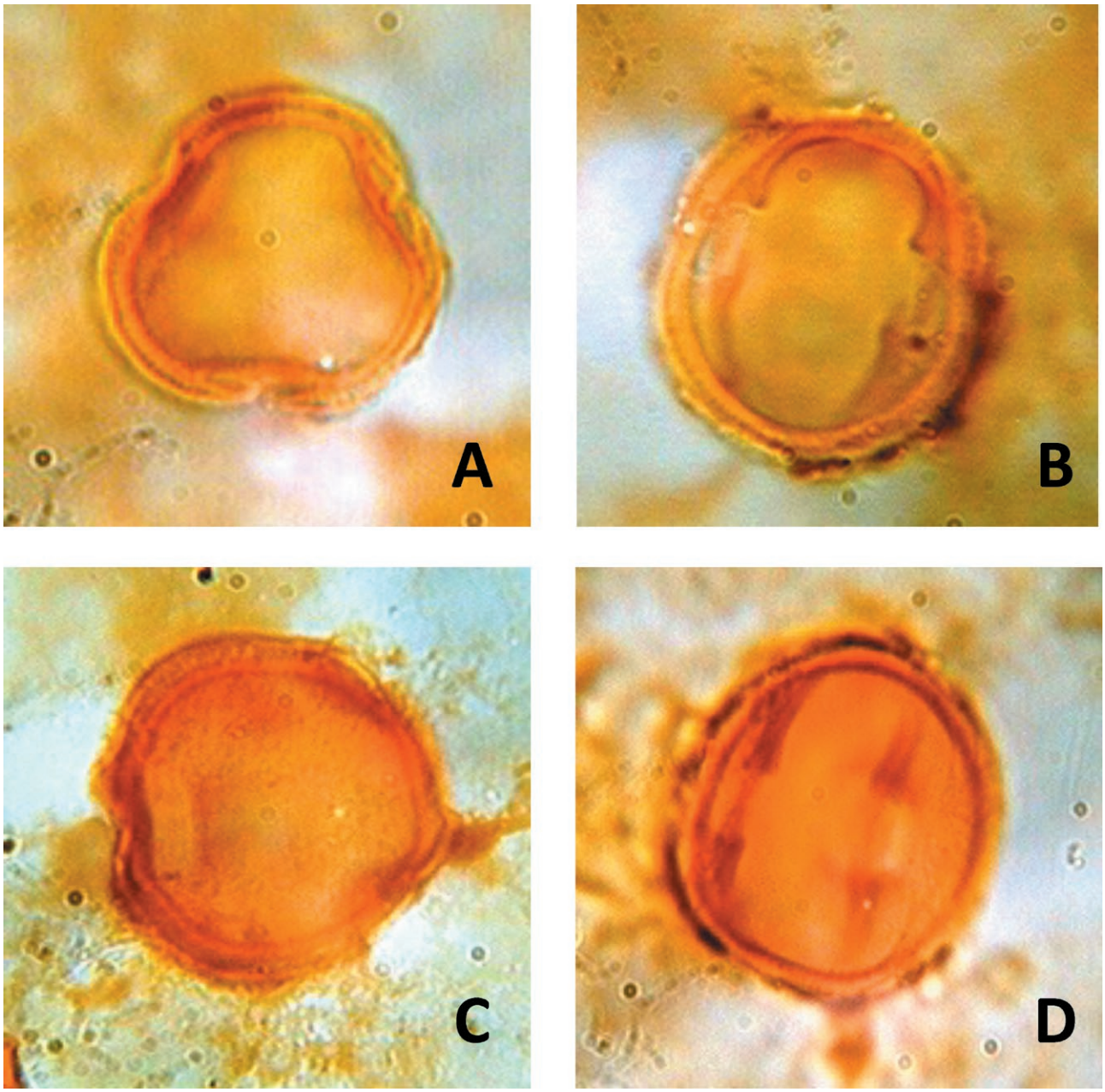

Figure 7. Photomicrographs of the pollen of *Balanites* species studied X400. **A&B** - *B. aegyptiaca*; **C&D** - *B. wilsoniana*. **A&C**- equatorial view; **B&D** - polar view.

ca while *B. wilsoniana* occupies the transitional equatorial belt and extends into the transitional tropical areas (Figure 1), yet their conservation status is poorly known. This trend thus calls for immediate attention towards protecting the species and many others whose statuses are also unknown, as a way of ensuring their sustainable collection and use, and also a step towards the restoration of our degraded ecosystems.

CONCLUSIONS

The present study has shown that the West African *Balanites* species share a number of overlapping anatomical characteristics, yet they can be distinguished from each other using some foliar and pollen microcharacters such as number of stomata, presence or absence of trichome, pollen/equatorial ratio etc. Field studies also opposed previous reports that the spe-

cies are allotropic in distribution, but suggest that the species may either be sympatric or allopatric depending on the region of occurrence. Although, the present study agrees with the co-existence of the two species, it also suggests a further re-evaluation of the present day Zygophyllaceae in an attempt to ascertain the current infra-generic re-classification of *Balanites* and other related species.

ACKNOWLEDGMENTS

The authors are grateful to the management of Forest Herbarium Ibadan (FHI) and University of Ibadan Herbarium (UIH), for the free access to herbarium specimens used for this study.

REFERENCES

Adedeji O. 2004. Leaf epidermal studies of *Emilia* Cass. (*Senecioneae, Asteraceae*) in Nigeria. Botanica Lithuanica. 10(2): 121-133.

Arbonnier M. 2002. Trees, shrubs and lianas of West African dry zones: 573pp. MARGRAF Publishers GMBH, MNHN.

Baranova M. 1992. Principles of comparative stomatographic studies of flowering plants. Botanical Review. 58: 1-99. http://www.jstor.org/stable/4354182

Bhupendra KK, Ashish S, Tarachand. 2017. Microscopical evaluation of leaf of *Balanites aegyptiaca*. World Journal of Pharmaceutical Research. 6(4):1697-1712. DOI: 10.20959/wjpr20174-8309

Burkill HM. 1985. The useful plants of West Tropical Africa, Vol 1 ed.2 (Families A–D). 242-247. London.

Carpenter KJ. 2005. Stomatal Architecture and evolution in Basal Angiosperms. American Journal of Botany. 92(10): 1595–1615. DOI: 10.3732/ajb.92.10.1595

Chapman LJ, Chapman CA, Wrangham RW. 1992. *Balanites wilsoniana*: Elephant Dependent Dispersal? Journal of Tropical Ecology. 8(3): 275-283. DOI: 10.1017/S0266467400006519

Chukwuma EC, Soladoye MO, Abdus-Salaam KRP. 2014. Taxonomic value of the leaf micro-morphology and quantitative phytochemistry of *Clitoria ternatea* and *Centrosema pubescens* (*Papilionoideae, Fabaceae*). Phytologia Balcanica.20(1): 3-8.

Chukwuma EC, Soyewo LT, Okanlawon TF, Ugbogu OA. 2017. Foliar and petiole anatomy of *Pterygota* (Sterculioideae; Malvaceae) species and their distribution in Nigeria. Anales de Biología. 39: 103-109. DOI: 10.6018/analesbio.39.12

Clauss MJ, Dietel S, Schubert G. and Michell-Olds T. 2006. Glucosinolate and trichome defenses in a natural *Arabidopsis lyrata* population. Journal of Chemical Ecology. 32(11): 2351-2373. DOI: 10.1007/s10886-006-9150-8

Dressler S, Schmidt M, Zizka G. 2014. "*Balanites*". *African plants – a Photo Guide*. Frankfurt/Main: Forschungsinstitut Senckenberg, Frankfurt.

Engler HGA. 1931. Zygophyllaceae. In: H. G. A. Engler and H. Harms (eds). Die Natfirlichen Pflanzenfamilien, 2,19a: 144-184. W. Engelmann, Leipzig.

Erdtman G. 1943. An Introduction to Pollen Analysis. – Waltham Mass.

Erdtman G. 1969. Hand book of Palynology-An Introduction to the Study of Pollen Grains and Spores. - Copenhagen.

Erdtman G. (ed.). 1952. Pollen Morphology and Plant Taxonomy - Angiosperms: 539 pp. The Chronica Botanica Co. Walthan, Mass. Almquist Wiksell, Stockholm, Sweden.

Erdtman G. l960. The Acetolysis Method. A revised description. Svensk Bot. Tidskr. 54: 561-564.

Faegri K, Iversen, J. (eds.). 1989. Textbook of Pollen Analysis. New York.

GBIF.org (06 June 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.2c2jmj

GBIF.org (06 June 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.2er75r

Hall JB, Walker DH. 1991. *Balanites aegyptiaca* Del. - A Monograph. School of Agricultural and Forest Science, University of Wales. Banger.

Hammer Ø, Harper DAT, Ryan PD. 2001. PAST - Palaeontological Statistics Software Package for Education and Data Analysis. Palaentologia Electronica. 4(1): 9pp. http://palaeo-electronica.org/2001_1/past/issue1_01.htm

Hassler M. 2017. World Plants: Synonymic Checklists of the Vascular Plants of the World (version Jan 2017). In: Roskov Y, Abucay L, Orrell T, Nicolson D, Bailly N, Kirk P, Bourgoin T, Dewalt R.E, Decock W, De Wever A, Nieukerken E, Van. Zarucchi J Penev L. (eds.). 2017. Species 2000 and ITIS Catalogue of Life, 27th February 2017.

Holmgren PK, Keuken W, Schofield EK. 1990. *Index Herbariorum* Part I. The Herbaria of the World. 8th ed. Reg. Veg. New York.

Hutchinson J, Dalziel JM. 1958. Flora of West Tropical Africa (Vol. 1 Part 2). Crown Agents for Oversea Governments and Administrations, Millbank: 363-364. London.

Irvine, F.R. 1961. *Woody plants of Ghana*. Oxford University Press: 209-210. London.

Keay RWJ. 1989. Trees of Nigeria. Oxford University Press: 146-147. New York.

Khatijah HH, Zaharina MS. 1998. Comparative leaf anatomical studies of some *Sterculia* L. species (*Sterculiaceae*). Botanical Journal of the Linnean Society. 127(2): 159-174. DOI: 10.1111/j.1095-8339.1998.tb02094.x

Mauricio R, Rausher MD. 1997. Experimental manipulations of putative selective agents provides evidence for the role of natural enemies in the evolution of plant defence. Evolution. 51(5) :1435-1444. DOI: 10.1111/j.1558-5646.1997.tb01467.x

Mildbraed J, Schlechter R. 1914. Beiträge zur Kenntnis der Gattung *Balanites* Del. Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie. 51: 156-163.

Mohammed MG, Foong SY, Dai L, Goh TL, Nasrollahzadeh S. 2020. Morphological study of pollen from three Ecozones in Nigeria. Journal of Critical Reviews. 7(6): 1083-1092. DOI: 10.31838/jcr.07.06.189

Ndoye M, Diallo I, Gassama-Dia YK. 2004. Reproductive biology in *Balanites aegyptiaca* (L.) Del., a semi-arid forest tree. African Journal of Biotechnology. 3(1): 40-46. DOI: 10.5897/AJB2004.000-2007

Neuwinger HD. 1996. African Ethnobotany: Poisons and Drugs: 884-890. Chapman and Hall, London.

Orwa C, Mutua A, Kind R, Jamnadass R, Anthony S. 2009. Agroforestry Database: a tree reference and selection guide version 4.0.

Parvathi A, Narayana LL. 1978. Systematic position of *Balanites* Delile. Current Science. 47: 968-970.

Pehlivan S, Baser B, Cabi E. 2009. Pollen morphology of 10 taxa belonging to *Prangos* Lindl. and *Ekimia* H. Duman and MF. Watson (Umbelliferae) from Turkey and its taxonomic significance. Bangladesh Journal of Plant Taxonomy. 16(2): 165-174. DOI: 10.3329/bjpt.v16i2.3929

Perez-Estrada LB, Canon-Santana Z, Oyama K. 2000. Variation in leaf trichomes of *Wigandia urens*: environmental factors and physiological consequences. Tree Physiology. 20(9): 629-632. DOI: 10.1093/treephys/20.9.629

Quarrie SA, Jones HG. 1977. Genotypic variation in leaf water potential, stomatal conductance and abscisic acid concentration in spring wheat subjected to artificial drought stress. Annals of Botany. 44(3): 323-332. DOI: 10.1093/oxfordjournals.aob.a085736

Radford AE, Dickson WC, Massey JR, Bell CR (eds.). 1974. Vascular Plant Systematics: 167-210. Harper and Row Publishers, New York.

Ram H, Kumar A, Sharma SK, and Rao SR. 2008. Genetic Variation and Chromosomal Mosaicism in the Natural Populations of *Balanites aegyptiaca* (L.) Del. from Rajasthan, India. Journal of Sustainable Forestry. 26(4): 328-343. DOI: 10.1080/10549810701879776

Roy BA, Stanton ML, Eppley SM. 1999. Effects of environmental stress on leaf hair density and consequences for selection. Journal of Evolutionary Biology. 12: 1089-1103. DOI: 10.1046/j.1420-9101.1999.00107.x

Sama V, Raja Rao, SS. 1991. Taxonomic importance of epidermis in Simaroubaceae-Zygophyllaceae with special reference to position of *Balanites*. Feddes Repertorium. 107(7-8):579-585. DOI: 10.1002/fedr.19911020706

Sands MJS. 2001. The Desert Date and Its Relatives: A Revision of the Genus *Balanites*. Kew Bulletin. 56(1): 1-128. DOI: 10.2307/4119431

Soladoye MO, Crane PR. 1985. Systematic palynology of *Baphia* (Sophoreae, Papilionoideae). Grana. 24(3): 145-160. DOI: 10.1080/00173138509431003

Sowunmi MA. 1973. Pollen grains of Nigerian plants. 1. Woody species. Grana. 13(3): 145-186. DOI: 10.1080/00173137309429891

Sowunmi MA. 1995. Pollen of Nigerian plants. 11. Woody species. Grana. 34(2): 120-141. DOI: 10.1080/00173139509430002

Sprague TA. 1913. Manduro: a new oil-yielding tree from Portuguese East Africa. Kew Bulletin. 4: 131-141. DOI: 10.2307/4107486

Usama AAR. 2007. Photosynthetic and Leaf Anatomical Characteristics of the Drought-resistant *Balanites aegyptiaca* (L.) Del. seedlings. American-Eurasian J Agric and Environ Sci. 2(6): 680-688.

Van Tieghem PEL. 1906. Sur les Agialidacees. Ann Sci Nat Bot Biol Vég. 9(4): 223 -260.

Supplementary file. Voucher specimens used for the foliar microscopic study of *Balanites* species.

Species	Voucher number	Collector	Locality	Habitat	Collector's number	Date
B. aegyptiaca	FHI94202	Ekwuno	School of Wildlife, New-Bussa, Niger state, Nigeria	Savanna	-	27/01/1981
	FHI101464	Reekman, M	Bubanza, Plaine Rusizi, Km 14, Savane Palmraie, Burundi	Savanna	Reekman 9416	10/08/1980
	FHI31341	Chapman, J.D	Jimeta G.R.S, Benue Valley, Niger State, Nigeria	Savanna	Chapman 2604	14/11/1971
	UIH10260	Gledhiel, D.	Tower hill, Freetown, Sierra Leone	Savanna	-	Jan. 1967
	FHI111228	Chukwuma, E.C	Forestry Research Inst. of Nigeria, Ibadan, Nigeria	Secondary forest	-	21/06/2017
	FHI111227	Chukwuma, E.C	Usmanu Danfodiyo University, Sokoto, Nigeria	Savanna	-	05/07/2017
B. wilsoniana	FHI8496	Dundas	South of Banga between R Mungo & Kumba-Victoria, Kumba division, Cameroon	Old high forest	-	27/11/1945
	FHI48385	Odedoyin, R.O	Compartment 121, Sapoba Reserve, Sapob, Edo State, Nigeria	Rain forest	-	06/03/1959
	FHI9056	Kennedy, J.D	Sapoba, Edo State, Nigeria	Rain forest	Kennedy 1658	
	FHI48386	Odedoyin, R.O	Jameson river, 7 miles from Sapoba labour camp, Sapoba, Edo State, Nigeria	Rain forest	-	11/03/1959
	FHI9055	Kennedy, J.D	Sapoba, Edo State, Nigeria	Rain forest	Kennedy 1949	02/12/1931
	FHI44149	Adebusuyi, J.K	Oban Group Forest Reserve, Calabar, Cross-Rivers state, Nigeria	Rain forest	-	15/03/1961
	FHI28198	Keay, R.W.J	Afi River Forest Reserve, near Aboabam, Ikom, Cross-Rivers state, Nigeria	Rain forest	-	09/12/1950

FHI- Forest Herbarium Ibadan; UIH – University of Ibadan Herbarium.

WEBBIA Journal of Plant Taxonomy and Geography

Firenze University Press
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Citation: Riccardo M. Baldini (2022) Review: Ib Friis, Paulo van Breugel, Odile Weber, Sebsebe Demissew. The Western Woodlands of Ethiopia. A study of the woody vegetation and flora between the Ethiopian Highlands and the lowlands of the Nile Valley in the Sudan and South Sudan. *Webbia. Journal of Plant Taxonomy and Geography* 77(1): 201-203. doi: 10.36253/jopt-13039

Received: March 1, 2022

Accepted: March 30, 2022

Published: April 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

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Review

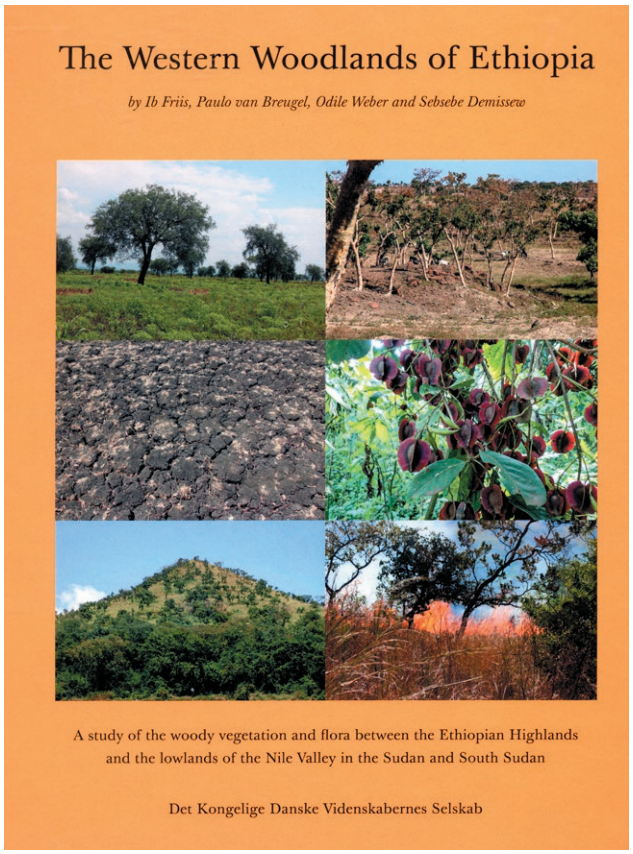
Ib Friis, Paulo van Breugel, Odile Weber, Sebsebe Demissew

The Western Woodlands of Ethiopia. A study of the woody vegetation and flora between the Ethiopian Highlands and the lowlands of the Nile Valley in the Sudan and South Sudan

Scientia Danica. Series B, Biologica. Vol. 9: 1-521 (2022)
ISSN 1904-5484
ISBN 978-87-7304-440-7
Price: 450 DKK (ca. 61.00 €). Available from 'Gads Forlag' (distributor) in Copenhagen.

Since the start of the Ethiopian Flora project in the 1980s, the study of the flora and vegetation on the Horn of Africa has resulted in many, much-needed publications, considering the importance of the Horn as one of the significant biodiversity hot spots in the world. With this great publication, Ib Friis and his collaborators have given us the first monograph on the woodlands of western Ethiopia. The bulky text of this new book is complex, but well-articulated, beginning with information on topography, geology and climate, mostly focused on the western slopes of the Ethiopian highlands, but where suitable also providing a wider African framework. The western escarpment of Ethiopia has important run-off of water to the Nile, particularly through the Blue Nile but also through 10 or more other rivers running to the Nile. The new Ethiopian GERD reservoir will cover significant areas studied for this book. Some aspects of the ethno-demographic situation of western Ethiopia are also addressed, pointing out the ethnic diversity and the considerable variation in the population density of the area. Previous studies, especially Italian studies in the 1930s, the phytogeographic syntheses of Pichi Sermolli (1957), and British studies on the Sudan border, all summarized by White (1983), form the basis for subsequent investigations and more recent studies utilizing computer analyses, but until now based on too little information.

It is not the first time the lead author and his co-authors have formed an inclusive vision of Ethiopian flora and vegetation, partly based on observations made during the many years, when Ib Friis and Sebsebe Demissew worked together on the Ethiopian Flora project. A first result was a more general work by Ib Friis, Sebsebe Demissew and Paulo van Breugel, "Atlas of the potential vegetation of Ethiopia" Royal Danish Academy of Sciences and Letters. Biologiske Skrifter 58 (2010), which has given inspiration to research in the present work. Also inspiring was a study by the same group, that time led by Paulo van Breugel, which investigated dry-season grass fires; that



study showed that the distribution of grass fires in western Ethiopia almost completely agrees with the western woodland vegetation.

The two largest parts of the new volume are made up of descriptions of the vegetation of 16 profiles from the highlands to the lowlands along the entire western escarpment of Ethiopia from the border with Eritrea in the north to the border with Kenya in the south, and an accurate atlas of the distribution in the whole of Ethiopia of 169 woody species that have been observed in the western woodlands. The profiles of the various vegetation types are commented on in detail and are accompanied by nearly 100 excellent original colour photographs, showing the varying physiognomy of the western woodlands. The atlas-chapter includes distribution maps of 169 woody species, based on their occurrence in the 151 relevés studied and on information derived from herbarium specimens in Addis Ababa, Kew, Firenze and elsewhere.

In two following chapters it is attempted to divide the western woodlands into phytochoria and to analyse the distribution of various adaptations to environment. Both chapters conclude that neither the phytogeographical differentiation, nor the adaptations to the environment show clearly marked patterns. Geographical variation in the ecological adaptation of the woody species is limited, and there are no sharp discontinuities in species diversity. Also the floristic richness shows limited variation (but the richest flora is along the Blue Nile). Particular interesting is a following chapter dedicated to analyses of twelve indicator species of the western woodlands, the distributions of which are here seen in both an African and an Ethiopian context, accompanied by a clearly coloured cartography. It is shown that almost all species reach from western Ethiopia to the Atlantic Ocean, but usually with the widest north-south distribution in western Ethiopia.

The environmental parameters and floristic contents of the 151 relevés have been analysed with clustering methods and ordinations, the work of Paulo van Breugel, in attempts to discover plant associations and relation between species distributions and environmental parameters. This is not an easy task; the clustering analyses generate a large number of small and rather similar clusters but most of the small clusters of the western Ethiopia escarpment can be combined into two weakly defined plant associations, the *Anogeissus leiocarpa-Pterocarpus lucens-Acacia hecatophylla-Sterculia africana* and the *Combretum collinum-Bridelia scleroneura-Terminalia schimperiana-Annona senegalensis* woodlands. Many environmental factors are found to explain parts of the variation from relevé to relevé; the most important are latitude, altitude, climate and soil types, while slope, fire frequency and other parameters seem to be less important.

The concluding chapter attempts to answer central research questions of the book, partly derived from the group's 2010-publication on the vegetation of Ethiopia. Should the western woodlands be subdivided? As appears from the above, the western woodland form a rather homogenous entity or at least an entity with continuous variation. Was the delimitation of the western woodland in the 2010-publication correct? Yes, except for a few modifications in the south. Further research questions relate to conservation of the woodland formations and the species. The general idea behind the work is clearly to report on status quo, showing how our knowledge of the area has improved over time, but also to provide solid information about the current vegetation for use in the future. Perhaps the most valuable general result of the work is the surprising floristic and ecological uniformity or continuity from lowest to highest altitudes and from northern limit (Eritrean border) to southern limit (Kenyan border), a distance of nearly 1200 km and almost 10° latitude. The book concludes with a number of appendices documenting the observa-

tions. Of particular use for future studies are the lists of species seen in the 151 investigated relevés.

All observations are here presented with a precise scientific rigor not always found in tropical botanical literature. The work is a trustworthy contribution to the understanding of the ecological and environmental uniqueness of this area, hopefully supporting its preservation and the general respect of it as a unique asset of Mankind. The mapping and analyses are made with modern, but well tested methods (including DIVA-GIS, ArcMap, Q-GIS, UPGMA, and various ordination methods). This book will undoubtedly be a landmark in the knowledge of that vast western part of Ethiopia, which until now has been so little studied and so scarcely documented in the literature.

Finally, a strong note of approval should also go to the appearance of the book, the excellent level of editing, the clear and elegant lay-out and the general production of all texts, maps and photographic work.

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June 2022
Vol. 77 - n. 1

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