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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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Editorial

By next November 2025 I will be retired with issue 80 of 2025 after 33 years since I began working for Webbia as an Assistant Editor. This year also celebrates the 120 years since foundation of Webbia in 1905.

It is not easy to write this editorial addressed to all those who, especially in recent years, have supported Webbia with their scientific contributions. I still remember when I began working on the journal in 1992: those were still years in which composition and printing did not use particular technologies and managing a magazine was still a very patient and delicate approach. A world where editorial predation was unknown.

Those were the years when scientific journals were not yet crushed by the inexorable logic of editorial metrics and that "*devilish number*" called Impact Factor, which led to a real extinction of many historical journals. It was a world where scientific production looked more at quality than quantity with often related consequences on the global academic world. Everything changed and not only for intrinsic reasons, but also for lack of experience, and many historical magazines became extinct giving space to other more pervasive and predatory editorial initiatives.

Webbia represents one of the pillars in the global scientific publishing scenario and that since its foundation, Webbia has represented a place of internationalization appreciated not only in Europe but particularly overseas.

The last decade has certainly been very challenging and has tested those who write with the aim of saving and improving a journal. All this was possible thanks to the experience of publishers like Taylor & Francis that for 6 years allowed an international improvement and was later followed by the current publisher Firenze University Press (FUP) that understood the potential of the journal.

I must recognize the role of those who believed, mainly from abroad, in the task that FUP and I had promised to accomplish. And in particular the synergy with the Centro Studi Erbario Tropicale that I personally managed for two terms of 4 years each in which it was possible to promote the journal also on the occasion of three International Symposia dedicated to Tropical Botany in Florence which attracted partecipants from the most important researchers in Tropical Plant Taxonomy.

In particular, I would like to express my gratitude to all the authors who have trusted and supported Webbia in the last decade, especially the young ones from abroad, and to the reviewers, not always available, who have made their cultural and scientific skills available to improve the quality of Webbia.

I can say that my experience with Webbia has not been easy, met often with critical moments, but it was worth fighting to make it a tool for taxonomic dissemination at an international level. I could not have worked productively without the help of the staff of FUP from the management to the fruitful collaboration with the copyediting staff that I sincerely thank Fulvio Guatelli, Alessandro Pierno and Riccardo Petrini who have always been present even in periods like the pandemic in which we have never stopped publishing punctually. An outstanding team truly! And what to say of the outcome performances obtained and supported by the OpenAccess accessibility guaranteed by FUP, making the journal more available for those who cannot afford to pay often excessive charges to obtain the dissemination of their papers especially in the developmental countries.

What to expect for the future? I hope that Webbia can continue to be a point of reference for many scholars of Plant Taxonomy and History of Botany, the basic botanical fields that, among other things, are suffering in the current scientific scenario made up above all of excessive specialization, with the loss of a global vision of plant diversity finalized for future generations in terms of knowledge and communication.

I sincerely hope to have contributed to giving editorial space and a support to the reserchers in Plant Taxonomy, in particular to the young ones, who from Europe, Asia, through Africa to the Americas have demonstrated that there is hope for a rebirth of global Plant Taxonomy for a better future.

I would like to express my gratitude to all those who have been close to me in this professional experience. Thanks indeed!

….all that remains is to say and wish Webbia:

AD MAIORA SEMPER!

Riccardo Maria Baldini
Assistant Editor of Webbia (1992-2008)
Editor in Chief of Webbia (2008-2025)

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Travels of European botanists of the 16th-18th centuries in search of Mediterranean plants described by Dioscorides and Theophrastus

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Abstract. To Renaissance botanists, the correct identification of plants described by Dioscorides and Theophrastus was often problematic: descriptions are often insufficient to ensure correct identification and nomenclature is often inconsistent. Even more serious, the ancient authors described plants of the Eastern Mediterranean flora, which is different from the flora of the countries that hosted the Renaissance revival of botany. Modern botanists needed to see those plants in their native places and habitats. The first botanical expeditions to the Levant are from the first half of the sixteenth century. Best documented is Leonhard Rauwolf's journey, whose herbarium is preserved to this date. Fragmentary and often indirect is instead the evidence about botanizing in Eastern Mediterranean countries by Anguillara and Guilandinus, the first two prefects of the Padua botanical garden. Botanical research trips to the Eastern Mediterranean gradually gave many of the plants described by ancient authors a precise identity, an effort eventually culminating with Sibthorp's *Flora Graeca*.

Keywords: Anguillara, Guilandinus, Rauwolf, Tournefort, plant collecting in the Levant.

INTRODUCTION

Among the works of classical antiquity that have survived into modern times, those dealing with plants, especially those of interest to medicine, occupy a special place. Along the centuries, the authority of Dioscorides, Theophrastus and Galen is not questioned; nevertheless, the precise interpretation of their texts appears increasingly problematic (e.g., Reeds 1976, 1991; Walter 2009). Descriptions are generally short and poorly informative, thus often insufficient to ensure correct species identification. Nomenclature is also far from certain, as one and the same plant has often been called by different names and, conversely, the same name may have been used by different authors for plants that are little related to each other.

In addition to these problems, and perhaps even more serious, the plants referred to by the ancient authors are mainly those of Greece, including the islands of Crete and Rhodes, or more generally belong to the flora of the

Eastern Mediterranean, while the revival of European botany in the Renaissance is centered on Germany, Switzerland, France, the Netherlands and north-central Italy, countries that host a flora other than the one described in the works of antiquity. Early modern authors try to match the names found in ancient texts to the plants of their countries, but sooner or later difficulties arise, and this contradiction calls for a solution. Moreover, it cannot be always be taken for granted that the old texts can be trusted in all and any of their contents. Modern botanists become aware of these problems, witness the following excerpt from a letter of Melchior Wieland (Guilandinus) to Ulisse Aldrovandi:

> I find so many errors, & lies in the writers of all times, [...] the Balsam is not native to Egypt [...]. I also have clear evidence about the Baharab root, the Sitthim wood, the Cedar, the Currant, the Henne, the Persea, and the tree from which Moses uproot his so famous rod, & of many other very noble plants, which grow in those countries, such as you will appreciate in detail in the fifth book *susceptæ a Guilandino peregrinationis*[1].

It was therefore not enough to get a copy of the ancient works of Dioscorides and Theophrastus and more recent authors such as Serapion, Averroes and Ratzes[2]. Modern botanists needed to see those plants in their native places and habitats:

> From my youth I had the strong desire to go to foreign lands, especially those of the Orient, as these were more famous and more fruitful than the others [...] but also much more to discover and to learn to know the beautiful plants and herbs described by Theophrastus, Dioscorides, Avicenna, Serapion, etc. in the location and places where they grow so that their habitus, especially of those that are more foreign and unknown, would become more familiar and understandable to me and partly also allow the pharmacists and also those who need them / to recognize them.[3]

By mid-sixteenth century, European botanists had already made significant progress with original works based largely on direct observation of plants of their local flora, and of some foreign plants in cultivation, rather than mere copying or translating the pages of classical authors. Of particular importance are Otho Brunfels' *Herbarum vivae eicones* (Brunfels 1530) and Leonhard Fuchs' *De historia stirpium commentarii insignes* (Fuchs 1542). How much value the latter author placed on the direct observation of plants is shown by the fact that he gave a place of honor to the artists who produced the book's magnificent plates by mentioning their names and even including their portraits. Illustrations are particularly beautiful in the copies with hand-colored engravings. The artists who worked for Fuchs were the painter Albrecht Meyer, who drew the plants from nature, Heinrich Füllmaurer, who copied the drawings onto wooden blocks, and Veit Rudolf Speckle, who engraved them. Conrad Gessner's *Historia plantarum* (1541) is also important, but it was published without illustrations: the numerous plates that the author had begun to prepare for it would only appear much later in a collection (Gessner 1751, 1771) enriched by contributions of other botanists (Funk 2018).

TRAVELS AND PILGRIMAGES

Among these impressive sixteenth-century works, Pietro Andrea Mattioli's bulky treatise occupies a prominent position, not only because of the extraordinary success of this book, written in the form of a commentary to Dioscorides and published in several languages, and the rich iconography that accompanies it, but also because of Mattioli's awareness of the importance of field research to be undertaken in the countries whose plants were described by the ancient authors:

> I certainly would not have shunned the hardships and dangers of travelling to make long pilgrimages to different and distant parts of the world or to cross the seas (as Galen did) to reach Crete, Cypros, Lemnos, Syria, Egypt and other more distant countries of the world to see and find plants, minerals and other simple medicines, if I had not been hindered by domestic care, the bond of marriage, the obligation to heal the sick, and my very weak constitution, which could hardly have withstood the dis-

[1] *ritrovo tanti errori, & busie nelli scrittori d'ogni tempo, [...] il Balsamo non nasce in Egipto [...]. Sono anchora chiaro, della radice Baharab, del legno Sitthim, del Cedro, del Ribes, del Henne, della Persea, del arbore dal quale dispicò Moisè quella sua verga tanto famosa, & di molte altre piante nobilissime, che nascono in quelli paesi, come ampiamente intenderà la Ch.ma M. V. nel libro quinto susceptæ a Guilandino peregrinationis.* (Letter dated *Del Cairo alli 9 di Giugno 1559*, as transcribed by Fantuzzi 1774, p. 220).

[2] For an early printed collection, see Serapion *et al.* (1531).

[3] *Als Ich gar nahe von Jugendt auff sondere Begierde gehabt / in ferne Landschaften zu ziehen / fürnemlich aber in die Morgenländer / als die für andere mehr berühmt unnd fruchtbar seind / ... / sonder auch und vilmehr die schöne Gewächse und Kreuter vom Theophrasto, Dioscoride, Avicenna, Serapione, &c. beschrieben / an den enden und orten / da sie wachssen / zu erkündigen / und zu erkennen / damit mir jre Beschreibungen in ansehung und betrachtung deren sonderlich aber der mehr frembden und unbekannten zum theil bekanntlicher und verstendlicher würden / zum theil auch den Apothekern ursach gebe / ferrner auch denen / die ihnen zu haben von nöten / zutrachten* (Rauwolf 1582, p. 1-2). An English translation of these lines, largely but not literally followed here, was given by Dannenfeldt (1978, 9. 31), and republished in part by Findlen (1994, p. 158).

> comfort, the hardships and the great dangers to which one is very often exposed on long voyages by ship and long journeys between lands[4].

The literature is unclear as to who were the first modern botanists who travelled to Eastern Mediterranean countries[5] with similar purpose, but the earliest substantial evidence of botanical expeditions comes from the first half of the sixteenth century (Nicolas 2007; Egmond 2018).

In a recent edition of Dioscorides' work accompanied by an extensive historical analysis and a rich bibliographical apparatus, it is stated that,

> Johann von Cube, a German physician, travelled to the East to find the plants of Dioscorides and other masters. In 1485 he published *Hortus Sanitatus* [sic], one of the earliest printed herbals (Dioscorides 2000, pp. xxxvi-xxxvii)

but this is wrong and misleading. Apart from the obvious typo (*Sanitatus* pro *Sanitatis*), this short sentence about Johann von Wonnecke Caub or Johannes de Cuba (1430–1503) is based on two false assumptions. First, the plant book first published in 1485 and currently known as *Gart der Gesundheit* was written in German rather than in Latin. Second, and more important, the fact that Johann Wonnecke von Kaub contributed to the *Gart der Gesundheit* does not qualify him as a voyager through the Levant. The issue has been recently fixed in the following terms (Rudolph 2020). The *Gart der Gesundheit* was published anonymously, but three authors have been identified as contributing to it. Cuba wrote the descriptive part, including the many factsheets about plants, whereas the introduction was written by Bernhard von Breydenbach (ca. 1440–1497), canon of the cathedral of Mainz, who enrolled Cuba as author of the descriptive part of the book, and the Flemish painter Erhard Reuwich for the drawings. There is no evidence that these illustrations reflect observations on living plants, although the painter had opportunity to see examples of the East Mediterranen flora during the journey to the Holy Land in which he accompanied von Breydenbach; the recit of this journey is the subject of another book, *Peregrinatio in Terram Sanctam* (von Breydenbach 1486), of which von Breydenbach was the sole author and Reuwich again the illustrator. Thus, the person who mentions his travel in the Levant in the first pages of the *Gart der Gesund* is not Cuba, who probably never left Germany, but von Breydenbach.[6]

Like Bernhard von Breydenbach, the French apothecary and naturalist Pierre Belon (1517–1564) exemplifies the pilgrim's twin habits of curiosity and devotion (Oosterhoff 2023). He was well aware of the importance of critically comparing the plants personally collected in distant lands with the descriptions found in the old books: in Chapter II of *Les observations de plusieurs singularitez et choses memorables trouvées en Grèce, Asie, Judée, Égypte, Arabie et autres pays estranges* (Belon 1553) he explains with fitting examples

> That one should not trust too much in the names of things, even if they are commonly named, if they do not correspond well to the descriptions of the ancients, and are suitable to the thing that is being described[7].

However, his catalogue of singular objects worth of record includes a few items not found in nature, such as the winged dragon, and his botanical illustrations are of a naivety that cannot be justified solely by the technical limitations of the woodcut.

LUIGI ANGUILLARA

It is certain instead that Luigi Anguillara (c. 1512-1570), who later became the first prefect of the botanical garden in Padova, traveled not only through Italy,

[4] *Non mi sarebbe certamente rincresciuto, ne sarei restato per fatiche, ne per pericoli di far lunghi pellegrinaggi a diverse longinque parti del mondo, ne di passare i mari (come faceva Galeno) per andarmene in Candia, in Cipri, in Lemno, in Soria, in Egitto, & in altri piu longinqui paesi del mondo, per vedere, & ritrovare, & piante, & minerali, & altri semplici medicamenti, che ne mancano, se non mi havessero impedito prima le cure domestiche, il vincolo del matrimonio, il carico di curare gl'infermi, & con ciò la mia assai debile complessione di tutto il corpo, laquale invero malamente harebbe possuto star salda alli incommodi, travagli, & pericoli grandi, che si patiscono ben spesso nelle lunghe navigationi, & ne i lunghi viaggi fra terr*a (Mattioli 1568, unnumbered p.).

[5] In those years other European botanists were travelling through the Western Mediterranean countries, where Carolus Clusius (1526-1609) gathered important informations not only through field research, but also through exchange of experiences with colleagues in Montpellier and Salamanca (Clusius 1576). Clusius' contributions to the renaissance of botany in the second half of the sixteenth century and the first decade of the seventeenth has been illustrated in a monograph by Egmont (2010).

[6] *Nam ich mitt mir eÿnen maler von vernunfft vnd handt subtil vnd behende. Und so wir von teütschēm landēn gereÿßet haben durch wälhische landt Histriam vnd darnach die Schlauonei oder windische landt- Croatien Albaneÿ-Dalamacien- Auch durch die krÿechischen lande Corfon Moream Candiam- Rodiß und Cÿprien – bÿß in das gelobet lande unnd auch so in die heÿligen stat Jherulsalem vnd von dannen durch klein arabien gegen den bergen sÿnai – von den bergen sÿnai gegen den roten moere, gegen calcair – Babylonien vnd auch Allexandriam in egipten vnd von dannen wider in Candiam… Ich mit fleisse mich erfahren habe der kreüter daselbst und die in jren rechten farben und gestalten lassen kunterfeÿen vnd entwerffen* (von Breydenbach *et al.* 1485, fol. 2v).

[7] *Qu'on ne se doibt trop fier aux appellations des choses, encor qu'elles soyent vulgairement nommées, si elles ne sont bien correspondantes aux descriptions des anciens, & convenantes a la chose qu'on descrit* (Belon, 1553, p. 1v).

but also the Balkans and Greece, as vaguely referred to in the letter to Nicolò da S. Michiele that introduces the fifth series of *pareri* (opinions) in his book (Anguillara 1561). After confirming that he had

> not forgotten that a few days ago, when I was in Venice, Your Excellency asked me for my opinion on some plants of the Greeks, Arabs and Latins[8],

he went on confessing that

> this great desire I have always had and still have to help the world as much as possible [...] has caused me many times to undertake long and dangerous journeys by sea and land, and to abandon my life to the power of the Turks and other barbarians without ever receiving a reward from anyone[9].

As noted by Herrmann (2015), the physician and anatomist Sanmichiele also collected plants in Greece and in Crete, and Anguillara got from him information about plants of those regions:

> The Apios, which is called ιχάς by Theophrastus in the book 9. chap. 10. is called today Pirraria in Greece, & in Candia. The Most Excellent Messer Nicolò da San Michele Comasco was the discoverer of this plant & first brought it to Italy on his return from those regions[10].

However, the only source of information about his field activity is Anguillara's book *I semplici* (Anguillara 1561), and some doubts remains if we take his text literally.

Most of the references to plants personally observed by him can be traced back to species cultivated in the Botanical Garden of Padua[11], or from different localities in Italy[12], but he also mentioned collecting in Provenza, Corsica, Croatia, Albania, and Crete[13]. Thus, De Toni's (1911a) remark, that we do not know if Anguillara travelled further afield, is exceedingly dismissive. True, many times Anguillara mentions plants e.g. from Crete[14], without saying that this is based on his personal observations. More important, some important information about Greek plants does not derive from Angullara's personal observations, but from fresh information and specimens he got from his correspondents:

Now I say that the true and legitimate Scylla is today found in Candia and in Cephalonia, very white in color and not too large, and can be eaten. And the common one is called Cepolla canina & those people throw it away as something poisonous, while we expect it to be used in medicines. The Magnificent M. Donato Barbi, a gentleman from Padua, was the one who discovered this mistake by sending me both kinds from Cephalonia, where he was at the time. And this was in the year 1548[15].

Anguillara was cautious in identifying with those described by the old authors his plants, especially those observed in Italy rather than in the Balkans or in Greece. For example,

> To this day I have not known any plant which corresponds to Dioscorides' description of Cyclamen II[16].
> Second lonchitis [a fern] - In 1545, I was in the hills of Monte Nero near Pisa picking herbs in the company of the Reveren. Monsignor of Cesena, I found a plant, which

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[8] *Non mi sono scordato che Vostra Eccellenza alli giorni passati essendo in Vinegia mi domandò il parer mio sopra alcune piante di Greci, Arabi, & Latini* (Anguillara 1561, p. 88).

[9] *quel desiderio grandissimo, che sempre ho avuto, & hò, di giovar al mondo in quanto per me si può [...] mi ha indotto molte volte a far lunghi, & pericolosi viaggi, così per mare, come per terra, & a por la mia vita nel potere de1 Turchi, & altri barbari senza mai riceverne premio da alcuno* (Anguillara 1561, p. 89).

[10] *L'Apios, che è chiamato da Theofrasto nel lib. 9. cap. 10. Ιχάς hoggi nella Grecia, & in Candia si chiama Pirraria. Lo Eccellentissimo Messer Nicolò da San Michele Comasco fu lo inventore di questa pianta & primo la portò in Italia nel suo ritorno che fece da quelle parti* (Anguillara 1561, p. 298).

[11] E.g., *Il Cipero così descritto da Teofrasto, come quel di Dioscoride è notissimo in Italia, & ambedue sono nel giardino pubblico di Padova* [*The cyperus, both the one described by Theophrastus and the one by Dioscorides, is very well known in Italy and both are in the public garden of Padua*] (Anguillara 1561, p. 21).

[12] Anguillara mentions his botanical observations in many regions of Italy: Lombardia, Veneto, Friuli, Emilia, Romagna, Toscana, Umbria, Lazio, Abruzzo, Puglia.

[13] *Spina Bianca –– Holla trovata io al principio della Schiavonia passato il Quarnaro […] e anco in Candia nel monte di Iuppiter* [*Spina Bianca –– I found it at the beginning of Schiavonia past the Quarnaro [...] and also in Candia on the mountain of Iuppiter*] (Anguillara 1561, p. 142-43).

[14] *I platani non nascono da per se in Italia; ma ben in Candia nascono Copiosissimi ne' luoghi vicini alli fiumi.* [*Plane trees are not native to Italy; but in Candia they are very abundant in places close to rivers*] (Anguillara 1561, p. 49). *L'halimo … si mangia in Candia* (ibid..,p. 57). [*Halimo… is eaten in Candia*]. *Scordio […] Il secondo si trova per le ripe della Pescara fiume in Abruzzo, con foglie larghe, simili alla Melissa, over al Calamento della prima specie. L'istesso si vede ancora in Candia, & per la Grecia, & in altri luoghi: ne è dissimile dal primo nell'odore, & qualità.* [*The second species of scordio [probably, one of the species of* Teucrium*, English germander], is found on the banks of the Pescara river in Abruzzo, with broad leaves, similar to Melissa, or to the Calamento of the first species. The same is also seen in Candia, & in Greece, & in other places: it is like the first in smell and quality*] (ibid., p. 226). *Le specie de' Bulbi, che si mangiano, sono copiose molto in Candia, à Corfù, al Zante, & parimente in Itali*a [*Edible species of bulbs are very abundant in Candia, Corfu, Zakynthos, and likewise in Italy*] (ibid., p. 119).

[15] *Hor dico, che la vera, & legitima Scilla hoggi si trova in Candia, & nella Ceffalonia, di colore bianchissima e non tropo grande, & mangiasi. Et la commune si chiama Cepolla canina. & quei popoli la gettan via per cosa velenosa, e noi altri comportiamo, che si usi nelle medicine. Il Magnifico M. Donato Barbi gentil'huomo Padovano fu quello, che mi scoperse questo errore co'l mandarmi dalla Ceffalonia, ove egli era allhora, l'una, & l'altra. E questo fu nell anno 1548.* (Anguillara 1561, p. 119).

[16] *Fino al giorno d'oggi non ho conosciuta pianta, che si confaccia alla descrittione di Dioscoride del Ciclamino secondo* (Anguillara 1561, p. 176).

is a species of branched Citrach; and then I thought that it was the second Lonchitis, and therefore I took it to the Most Excellent Master Luca Ghini. & ever since then that plant has been held for the second Lonchitis. But since I then found another much more corresponding one in Dalmatia, Greece, & Zakynthos, I cannot say that the one from Monte Nero is the true one: because that one is not τρακύτερα [quite rough], like this other one[17]

Possible corruptions of the old text was sometimes indicated by him as a cause of potential misidentification:

Hogweed of Asclepius – Born on the island of Candia, & in Sicily [...] Where we read in Dioscorides small root, the text is incorrect; because instead of μικρά one should read μακρά[18].

MELCHIOR WIELAND (GUILANDINUS)

Compared to Anguillara's field work in the countries East of Italy, evidence about the travels of Melchior Wieland (Guilandinus) (c. 1520–1589), his successor as prefect of the Padua botanical garden, is still more fragmentary[19]. His correspondence with Ulisse Aldrovandi indicates that he formed a herbarium[20] and collected extensive notes intended for a publication to be issued on his return from Cairo[21], but he was captured by Algerian pirates in the port of Cagliari and lost all his specimens and notes.

In a previous letter to Ulisse Aldrovandi, dated 4 January 1555 (De Toni 1911b), Guilandinus mentions plants he collected in the Levant, demonstrating that even before leaving for Cairo in 1558, he had already collected plants in the East. In that letter, Guilandinus regrets not being ready to send to Aldrovandi the plants he requested, including

the Catanance [a plant of the daisy family native to dry meadows in the Mediterranean region] which with greater urgency than the other things you request, but patience, since my misfortune wanted it this way, so that my compatriot M. Roperto, who has all those things with him that I brought from the East, left Vinetia without letting me hear a word[22].

Another questionable point is the putative official nature of Guilandinus' mission to Cairo. According to Herrmann (2015, pp. 4-5),

Wieland [...] was officially commissioned by the University of Padua and the Republic of Venice to carry out a comprehensive research trip to Asia Minor and North Africa in order to collect plant samples there and in this way to test the theses of the ancient naturalist Dioscorides[23].

Herrmann (2015) seems to derive this from Siraisi (2007), but the latter clearly says (p. 236) that

Guilandinus' journey to various parts of the Eastern Mediterranean and Egypt had been supported by a Venetian senator who was a member of the Riformatori dello Studio, the Venetian magistracy in charge of the University of Padova.

This does not imply an official involvement of the institutions of which his patron was a member. The lack of any official charge or planning for the journey he started when leaving for Cairo in 1558 is clear in the words he wrote to Ulisse Aldrovandi shortly before leaving Egypt:

I will leave for Lisbon without any doubt at the end of August; However, I would like Your Excellency to require me, for the few days that I have to stay in Egypt, to do

[17] *Lonchite seconda - Nel 1545, essendo io per le colline di Monte nero di Pisa a cogliere herbe in compagnia del Reveren. Monsignore di Cesena, trovai una pianta, la quale è specie di Citrach ramoso; e allora pensai, che ella fosse la Lonchite seconda, & per tale la portai all'Eccellentissimo Maestro Luca Ghini. & sempre da inde in quà quella piana è stata tenuta per Lonchite seconda. Ma per averne io poi trovato per Dalmatia, in Grecia, & al Zante un'altra molto più corrispondente, non posso dire, che quella di Monte nero sia la vera: percioche quella non è τρακύτερα, come quest'altra.* (Anguillara 1561, p. 241).

[18] *Panace di Asclepio – Nasce nell'isola di Candia, & in Sicilia [...] Ove si legge in Dioscoride radice piccola, il testo è scorretto; perciocche in vece di μικρά si dee leggere μακρά* (Anguillara 1561, p. 210).

[19] Scattered references to his travels are found in his later work *Papyrus* (Guilandinus 1572).

[20] *La lettera ... del 4 gennaro 1555... menziona le raccolte di piante in Levante, ciò che pone in luce un fatto, finora ignorato a quanto mi consta, ossia che il Guilandino, anche prima di recarsi al Cairo [in 1558], aveva già erborizzato in Oriente* [*The letter ... of 4 January 1555 ... mentions collecting plants in the Levant, which highlights a fact, hitherto ignored to my knowledge, namely that Guilandino, even before travelling to Cairo [in 1558], had already been collecting plants in the Levant*] (De Toni 1911b, p. 152).

[21] *come ampiamente intenderà la Ch.ma M. V. nel libro quinto* susceptæ a Guilandino peregrinationis. Letter from Guilandino to Ulisse Aldrovandi, from Cairo, dated 9 June 1559; Fantuzzi 1774, p. 220).

[22] *la Catanance [a plant of the daisy family native to dry meadows in the Mediterranean region] la qual con maior instanza delle altre cose richiedete, ma pacienza, poi che la mia disgrazia ha voluto così, per che M. Roperto mio paiesano, il qual ha tutte quelle cose apresso de se che portai di levante, si ha partito di Vinetia senza farme intender parola.* (Letter from Guilandino to Ulisse Aldrovandi, dated 4 January 1555; published by De Toni 1911b, p. 159).

[23] *Offiziell wurde Wieland [...] von der Universität von Padua und der Republik Venedig beauftragt, eine umfassende Forschungsreise in Kleinasien und Nordafrika durchzuführen, um dort Pflanzenproben zu sammeln und auf diese Weise Thesen des antiken Naturforschers Dioskurides zu überprüfen.*

something of the kind that can be committed to someone of such small fortune and such little experience as I am[24]

It was only after the journey and its adventurous sequel until Guilandinus was eventually rescued, that his previous experience with the Eastern Mediterranean flora offered a good argument for his appointment to the Padua botanical garden.

Last in the number of would-be prefects of the Padua botanical garden to travel to East Mediterranean countries, including Corfu, Zakynthos and Crete, Prospero Alpini (1553-1617) spent three years in Egypt, and on his return published two works on the Egyptian plants (Alpini 1591, 1592) where he described the coffee plant, until then unknown to Europeans, but also numerous plants whose names had reached Europe through the Arab medicinal-botanical tradition. For these reasons his botanical contributions are more popular than those of his two predecessors[25].

LEONHARD RAUWOLF

Leonhard Rauwolf[26] (1535?–1596) dedicated an entire volume (Rauwolf 1583) of his extensive travelogue to the plants of the Eastern Mediterranean countries he visited. Before him, no other author had systematically taken the trouble to identify them based on ancient works, especially those of Dioscorides. Apparently, he often succeeded, as in the case of *Christianwurtzel, which is the right* Astragalus *Dioscoridis*[27]. However, many other plants presented difficulties, so that Rauwolf' remained to varying degrees in doubt as to their identification, for example

A thorny herb which is held for the right *Silybum* Diosc. and *Hacub alcardeg* Serapionis.
An unknown plant called *Morgsani*, which is considered to be *Andirian* Rhazis and *Ardifuigi* Auicennae.
A foreign herb which can be taken for the right *Chrysogonum* Dioscor:
An unknown tall herb, which is considered to be the right *Medium* Diosco: and *Mindium* Rhasis.
A wild thorny shrub, which is considered to be the right *Lycium* Diosc:, whose stem also retains the same name in apothecaries. Arabic: *Hadhadh*.
Baccharis Diosc: which herb is called by some Lady's glove.
A very wild thorny shrub, which the Moors call *Bellan*. *Hippophaës* Diosc:
A free unknown herb, which is considered to be the right *Gnigidium* Diosc:[28]

How close Rauwolf came to correctly identifying the plants he collected can be verified with great accuracy today, because the herbarium of plants he collected between 1573 and 1575 has survived to this date (Ghorbani et al. 2018).

JOSEPH PITTON DE TOURNEFORT

The last botanist whose journey to the Eastern Mediterranean we must mention is Joseph Pitton de Tournefort (1656-1708). He undertook this voyage as an official mission by order of king Louis XIV and his report was expected to cover issues as different as geography, botany, antiquities, but also history, religion, institutions and economy of local populations (Trivisani-Moreau 2016). However, by reading through his *Relation d'un voyage du Levant* (Tournefort 1717), it is clear that

[24] *Io mi partirò per Lisbona senza dubio veruno alla fine de Agosto; però vorrei che la M. V. me imponesse per quelli pochi dì, che ho da stare in Egypto, a fare qualche cosa di quelle, che si possano comettere a uno di sì piccola fortuna, & di sì puoca sperienza come sono io.* (Letter from Guilandino to Ulisse Aldrovandi, from Cairo, dated 9 June 1559; published by Fantuzzi 1774, p. 221).

[25] On Alpino's work, see Ongaro (2009); on his Egyptian plants, see Cappelletti and Cassina (2009).

[26] On Rauwolfs life and travels, see Dannenfeldt (1968); Herde and Walter (2010).

[27] *Christianwurtzel, welches ist der rechte* Astragalus *Dioscoridis* (Rauwolf 1583, plate numbered 111). Based on Rauwolf's herbarium specimen (see next footnote), this corresponds to the legume species *Astragalus brachystachys* DC.

[28] Here are the original figure legends, with the corresponding plate numbers and followed by the current name of the plant as established by Walter et al. (2021), based on Rauwolff's original specimens preserved in his herbarium at the Naturalis Biodiversity Centre in Leiden (Ghorbani et al., 2018):
Dornkraut welches für das rechte Silybum *Diosc. und* Hacub alcardeg *Serapionis zuhalten* (plate n. 74) – *Gundelia tournefortii* L. [Compositae]
Ein unbekanntes Gewächs Morgsani *genannt, welches für* Andirian *Rhazis unnd* Ardifuigi *Auicennae zuhalten* (plate n. 113) – *Zygophyllum fabago* L. [Zygophyllaceae]
Ein fremdes Kraut, welches für das rechte Chrysogonum *Dioscor: zuhalten (*plate n. 119) – *Bongardia chrysogonum* (L.) Spach [Berberidaceae]
Ein unbekannts hohes Kraut, welliches für das rechte Medium *Diosco: und* Mindium *Rhasis zuhalten (*plate n. 284): – *Michauxia campanuloides* L'Hér. [Campanulaceae]
Frembde Dornstauden, welche für das rechte Lycium *Diosc: zuhalten, dessen Safft in Apotecken auch gleichen namen behaltet. Arab:* Hadhadh (plate n. 285) – *Rhamnus punctata* Boiss. [Rhamnaceae]
An Baccharis *Diosc: welches Kraut etliche under* Frawen-Handschuch *gennent* (another plate also n. 285) – *Helichrysum sanguineum* (L.) Kostel. [Compositae]
Ein gar frembde Dornstauden, welliche die Moren Bellan *nennent. An* Hippophaës *Diosc:* (plate n. 287) – *Sarcopoterium spinosum* (L.) Spach [Rosaceae]
Ein frembdes unbekannts Kreutlein, das für das rechte Gnigidium [sic, pro *Gingidium*] *Diosc: zuhalten* (another plate also n.: 287) – *Artedia squamata* L. [Apiaceae]

the author's main interest rested with the Greek flora. For example, when Tournefort and his fellow travelers reached the island of Makronisos near the coast of Attica,

> The only pleasure we had on this island was botanizing; it is the most pleasant for plants in the whole archipelago; they are even bigger, fresher and more beautiful there than on the other islands: We observed many there that we had not seen since we left France[29].

Elsewhere, collecting activity was more intense and focused:

> when we returned to the ruins of the city, we discovered there an admirable species of *Sphondylium*, which at first we took for the *Panacea Herakleia* of Dioscorides: but the flowers of our plant are white, those of Dioscorides' plant yellow[30].

Another day, they called to

> a monastery of Armenian monks, where we had dinner. Their courtyard is full of the beautiful species of cress that Zanoni had no reason to believe was the first species of *Thlaspi* of Dioscorides[31].

MORE TRAVELS, LINNAEAN NAMES, AND JOHN SIBTHORP'S *FLORA GRAECA*

These botanical research trips to the Eastern Mediterranean gradually made it possible to give many of the plants described by Dioscorides and other ancient authors a precise identity. To many, but certainly not all. The efforts of these botanical travelers gradually found a point of reference in the great works in which the classification of the entire plant kingdom took shape, where each species finally found a place and a scientific name that would be recognized by all.

Of fundamental help on this path was the meticulous compilation of Caspard Bauhin (1560-1624), who collected the citations of the previous authors in one large work (Bauhin 1596) and attempted to identify the synonyms, not always easily recognizable, among the different names attributed to the same plant by different authors and often even by one and the same author. While the *Phytopinax* of 1596 was an *enumeratio plantarum ab herbarijs nostro seculo descriptarum*, the much bulkier posthumous edition titled *Pinax theatri botanici* (Bauhin 1623) was an index in *Theophrasti Dioscoridis Plinii et botanicorum qui à seculo scripserunt opera plantarum*, linking the texts of the ancients with the growing production of modern botanists.

Eventually, the system of plants and the binomial nomenclature introduced by Linnaeus (1753) provided the framework to organize the knowledge of the Greek flora that has been collected over more than two thousand years. John Sibthorp[32] (1758–1796) accomplished this task with his magnificent *Flora Graeca* (Sibthorp, 1806-40) which was continued after his death by James Edward Smith (1759-1828) and finally completed by John Lindley (1799–1865). Smith made a special effort to translate once and for all the names of Dioscorides into modern scientific nomenclature, noting that

> The synonyms of [the plants described by] Dioscorides come from Sibthorp's manuscript, which he wrote mostly in Vienna, where he came across the most famous ancient codex decorated with painted plates. I have compared all these synonyms with the best editions of Dioscorides[33].

Six genera (*Dioscorea*, *Bellonia*, *Clusia*, *Alpinia*, *Rauvolfia* and *Tournefortia*) first named by Plumier (1703) for Dioscorides, Belon, Clusius, Alpini, Rauwolff and Tournefort, respectively, were retained by Linnaeus (1737, 1753) and are thus conserved to this date. Linnaeus created also a genus *Sibthorpia*, but this was not to honour the would-be monographer of Greek plants, but his father, Humphry Waldo Sibthorp (1713-1797), Sherardian Professor of Botany at the University of Oxford from 1747 to 1783.

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29 *Le seul plaisir que nous eûmes dans cette Isle fut celui d'herboriser, c'est la plus agréable de tout l'Archipel pour les plantes; elles y sont même plus grandes, plus fraîches & plus belles que dans les autres Isles: nous y en observâmes beaucoup que nous n'avions pas encore vues depuis nôtre départ de France* (Tournefort 1717, 2, p. 19).

30 *en revenant vers le ruines de la ville, nous y découvrîmes une espèce admirable de* Sphondylium *nous primes d'abord pour la* Panacée d'Heraclée *de Dioscoride: mais les fleurs en sont blanches, au lieu que celles de la plante de Dioscoride doivent être jaunes* (Tournefort 1717, 3, p. 15).

31 *dans un Couvent de Moines Arméniens où nous dînâmes. Leur cour est toute pleine de cette belle espèce de Cresson que Zanoni a pris, sans raison, pour la première espèce de Thlaspi de Dioscoride* (Tournefort 1717, 3, p. 186). This plant is treated by Zanoni (1675) on pp.191-196 of his *Istoria botanica*.

32 On Sibthorp's exploration of Greece, see Strid (2020). On the genesis of *Flora Graeca*, see Lack and Mabberley (1999).

33 *Synonyma Dioscoridis sumuntur ex manuscripto Sibthorpiano quod Viennae plerumque conscripserat, ubi in codicem veterem celeberrimum, tabulis pictis ornatum, incidit. Omnia haec synonyma cum optimis editionibus Dioscoridis comparavi* (Smith in Sibthorp 1806-, 1, p. xiv). The codex mentioned by Smith is *Codex Vindobonensis Medicus Graecus 1*, the wonderful document of the Early VI century also known as *Codex Aniciae Julianae*.

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David Fairchild as a naturalist and advocate for tropical biology research: his 1924 trip to Panama

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Abstract. Plant explorer David Fairchild (1869–1954) and four prestigious American zoologists [Nathan Banks (1868–1953), Curt P. Richter (1894–1988), William M. Wheeler (1865–1937), and James Zetek (1886–1959)] gathered at the newly established Barro Colorado Island Laboratory in Panama to conduct field studies from late July to early August 1924. This visit occurred just weeks after this field station's official inauguration. Fairchild traveled to Panama with his son, Graham B. Fairchild (1906–1994), and while returning from Panama to the U.S. aboard the *SS Ulua*, he prepared a 21-page handwritten narrative of this trip. This unpublished manuscript is housed at Fairchild Tropical Botanic Garden and has been transcribed here with annotations. A large component of the manuscript focuses on entomological findings, along with Fairchild's advocacy and support for tropical biology studies. The document includes philosophical reflections that Fairchild made on human behavior and biological processes inspired by his entomological observations and discussions he had with biologists at the station. The document shows Fairchild as a broad-based naturalist who played a key role in the initial establishment of one of the most famous tropical field stations in the world. Fairchild carried plant material from Cuba (5 accessions, 5 species) and Panama (23 accessions, 20 species) on his trip back to the U.S. His narrative discusses technical challenges involved in transporting living material in Wardian cases. Entomological findings were published in two papers by Wheeler upon his return to the U.S. Fairchild delivered a talk on mangosteens (*Garcinia* sp., Clusiaceae) in Ancon a few days before his departure from Panama. During his stay in Panama, Fairchild also met with the curator of living collections of Summit Gardens, Holger P. Johansen (1898–1935), along with Panama Canal Zone governor Jay J. Morrow (1870–1937), orchid specialist and horticulturist Charles Wesley Powell (1854–1927), and Chief Sanitary Inspector J. B. Shropshire. A total of 46 photos taken by Fairchild were located during this study. In addition to these photographs, our research involved looking into newspaper reports from Panama and Cuba, as well as USDA germplasm inventories from 1924. The main botanical highlights recorded by Fairchild concern insect-plant interactions found between ants and the legumes *Inga* sp. and *Vachellia melanoceras* (Beurl.) Seigler & Ebinger, as well as the pollination biology of the orchid *Catasetum viridiflavum* Hook.

Keywords: Smithsonian Tropical Research Institute, botanical history, Central America, tropical forests, Neotropics.

INTRODUCTION

Famous plant explorer David Fairchild (1869–1954; Fig. 1) conducted extensive fieldwork in the tropics between 1898 and 1948 (Fairchild undated, 1928, 1930; Korber 2016). His first expeditions as a plant hunter took place between January 6, 1898 (San Francisco, California) and August 13, 1903 (Liverpool, England) and were funded by the wealthy American philanthropist Barbour Lathrop (1847–1927), as described by Fairchild (undated, 1938) and Douglas (1973). Fairchild's last botanical expedition took place from March to April of 1948, targeting Venezuela and Colombia (Korber et al. 2016). Among these voyages he visited Central America six different times: in 1899, 1921, 1924, 1933, 1941, and 1944 (Fairchild undated; Lisio et al. 2024). Two previous undergraduate student research projects from Florida International University carried out by Lisio et al. (2024) and Burgos Soler et al. (in press) provide insights on his 1941 (Panama and Guatemala) and 1944 (Guatemala and Honduras) visits to this region, respectively.

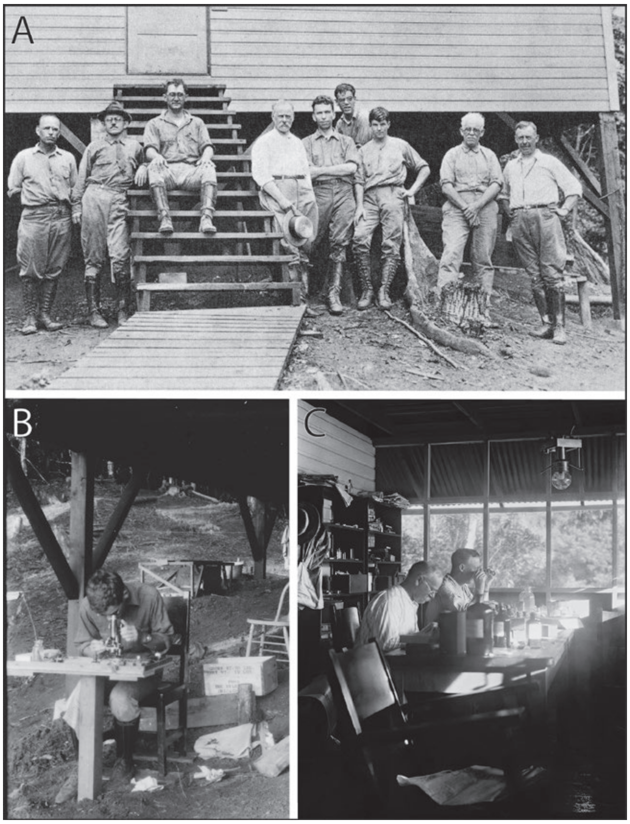


Figure 1. Participants hosted in the Barro Colorado Island Laboratory during the 1924 trip of Fairchild to Panama. (A) From left to right: Gordon Stanhope Dodds, James Zetek, Ignacio Molino, Nathan Banks, George C. Wheeler, Graham Bell Fairchild, Frederick Burgess, David Grandison Fairchild, and William Morton Wheeler, at Barro Colorado Island, courtesy of Smithsonian Institution Archives. Image # 92-12929.– Record Unit 9559, Box 1, Graham Bell Fairchild Oral History Interview. All people depicted in this photograph except Dodds are mentioned in Fairchild's (1924a) report. (B) Graham B. Fairchild examining specimens (Photo 00078), (C) Nathan Banks (foreground) and William M. Wheeler (background) preparing insect specimen (Photo 00080). Further details for individuals posing in these photographs are found in Table 3. B and C: Courtesy of Fairchild Tropical Botanic Garden.

Here, we present the results of a research project focused on the voyage Fairchild made to Panama in 1924 (Fig. 1). The research involved (1) examining documents and photographs found in the Archives and Library of Fairchild Tropical Botanic Garden (ALFTBG), (2) reviewing plant collection records in the USDA National Germplasm System, and (3) analyzing newspaper articles from Havana and the Panama Canal Zone from 1924. This work is part of an undergraduate student research program jointly supported by two units of Florida International University: the Global Learning Medallion program and the Kimberly Green Latin American and Caribbean Center. Preliminary findings of this study were presented as a poster displayed during the "Barro Colorado Island 100 Years" symposium held June 16–20, 2024, celebrating the centennial of the Barro Colorado Laboratory, Smithsonian Tropical Research Institute (Elton et al. 2024; Fig. 2).

ARCHIVAL AND BIBLIOGRAPHIC RESEARCH RESULTS

The main finding of our research was an unpublished 21-page handwritten notebook by Fairchild, housed in the ALFTBG (Fairchild 1924a), where he detailed his 1924 trip. A facsimile of this report is shown

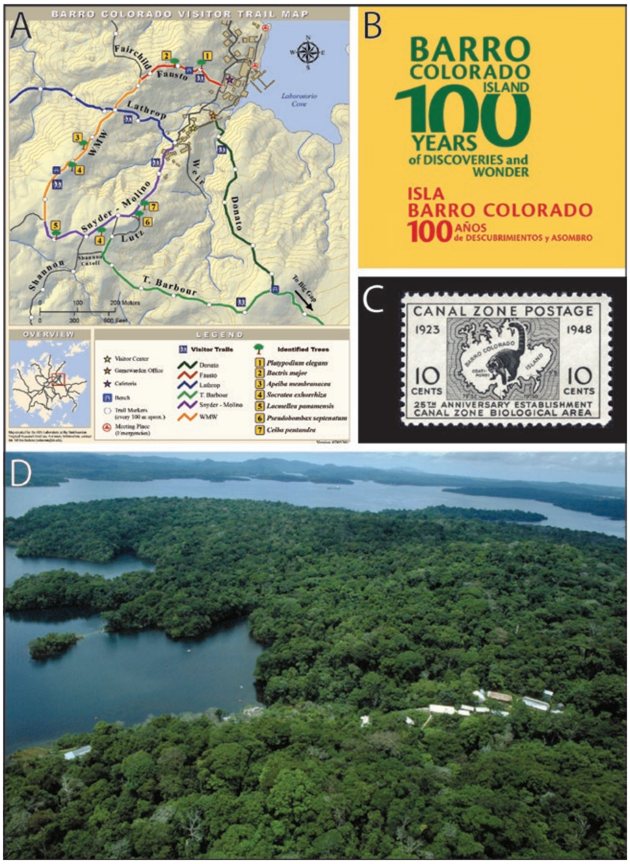


Figure 2. Images pertinent to the Barro Colorado Island Laboratory, Smithsonian Tropical Research Institute. (A) Barro Colorado Island map showing the visitor trails. (B) Flyer celebrating the 100-year anniversary of this laboratory in 2024. (C) Postage stamp issued by the Panama Canal Zone in 1948 celebrating the 25-year anniversary of the establishment of the biological reserve on this island (see relevant correspondence in Fig. 3). (D) Aerial view of Barro Colorado Island showing the laboratory facilities, 2024. (A), (B), and (D) courtesy of Smithsonian Tropical Research Institute.

in Online Supplementary Appendix 1, and an annotated transcript of this manuscript is presented in Appendix 1. Additionally, a total of 42 photographs were located (Table 1) in the ALFTBG and are shown in Online Supplementary Appendix 2. Four more photographs by Fairchild were published by Wheeler (1924, 1925) concerning entomological observations (Table 1). Fairchild had a broad interest in natural history, and in the early 1910s, he designed a special camera he called Long Tom, that could capture close-up photographs of specimens (Fairchild and Fairchild 1914; Mosely 2012; Tasker 2014; Fig. 3). He carried this camera to Panama (Fairchild 1924a: 3; caption of Photo 00078), using it to obtain 15 photos of a tarantula (*Sericopelma* sp.), fungus-growing ant nests (eight photos), an insect pupae, three species of insects, and two plant species (Fig. 3, Table 1). Taxonomic indexes for the invertebrates (Appendix 2) and plants (Appendix 1) encountered by Fairchild are also provided. This required us to update the scientific names reported by him, so throughout this paper we utilize the current accepted names that are used to identify these organisms.

We also reviewed relevant correspondence and documents by Fairchild housed in the ALFTBG that could provide insights on the preparation and objectives of this voyage. This search yielded a total of 17 letters and 2 documents written between December 1923 and August 1924 (Figs. 4–5). These documents are part of the "Barro Colorado Laboratory" folder, in the cabinet files at ALFTBG, which contain Fairchild's manuscripts sorted by topics of significance to him. Two additional letters that Fairchild wrote to Barbour Lathrop from Panama (dated July 22 and August 10, 1924) gather further details regarding this trip. These two letters are located in a folder labeled "Lathrop, Barbour 1924–1927", inside the correspondence box "Lathrop 1924–1927 – Lion".

As part of our bibliographic studies, through the Interlibrary Loan Service of the University of Florida Library, we obtained microfilms for the 1924 issues of the *Star & Herald*, a newspaper from Panama, mentioned in Fairchild's (1924a: 21) travel report[1]. We aimed to assess the extent to which Fairchild's activities during his visit were covered by Panama's local media. This bibliographic research shows that seven short news-notes published between July 19 and August 8 reported aspects of Fairchild's trip. Scans of these news-notes are presented in Online Supplementary Appendix 3. Fairchild's report (1924a: 4, 19) mentions a visit to Cuba during his voyage from the U.S. to Panama, as well as this island as a source of plant material that was carried with him during his trip from Cristobal, Panama to New York. To confirm that Cuba was part of Fairchild's itinerary to or from Panama, we consulted the issues of the Havana newspaper *Diario de La Marina* for July–August 1924, accessible on one of the webpages of the *Ministerio de Cultura y Deporte* of Spain. This newspaper provided daily records for vessels that called at Havana on their routes. Last, we examined the USDA's online germplasm database and inventory reports to determine which plant materials collected during this voyage reached the plant material repositories of the federal agency. The internet addresses for the three online supplementary appendixes, along with other relevant websites, are listed in Table 2.

[1] Page 21 of Fairchild's (1924a) report includes a clipping of a news-note published in this newspaper that highlights a talk on mangosteens to be delivered by Fairchild in Balboa.

Table 1. Photographs pertinent to the visit made to Panama by David Fairchild in 1924.

Photo description	Locality	Date	Photo number in Fairchild Tropical Botanic Garden records / Figure number in this paper
Graham Fairchild at the Celotex microscope table. To the right is shown the end of the Long Tom Camera. It was near this camera end that I [David Fairchild] killed a fer de lance 3 feet long late one afternoon	Barro Colorado	Undated	00078 / 1
Interior of Barro Colorado Island Laboratory, dormitory. William M. Wheeler is eating his early banana. Frederick Burgess peering over his shoulder. Graham fast asleep	Barro Colorado	Undated	00079 / -
Interior of Barro Colorado Island Laboratory. Nathan Banks foreground, William M. Wheeler background. Preparing insect specimen in the early morning	Barro Colorado	July 29	00080 / 1
Early morning scene of forest near Barro Colorado Island Laboratory	Barro Colorado	Undated	00533 / -
**Catasetum viridiflavum* Hook. (Orchidaceae) pollinia, found on old stump	Gatun Lake	Undated	00534 / -
Liana which is producing new roots. This giant liana I [David Fairchild] could not identify because I did not collect flowers or leaves. It had sent out roots which were pushing down at the rate of two inches or so a day and when I [David Fairchild] left were within 2 1/2 feet of touching the ground.	Barro Colorado	July 29	00535 / -
Wingless chicken	Unknown	Undated	00536 / -
*Tarantula [*Sericopelma* sp., Araneae, Theraphosidae]	Barro Colorado	July	00537 / 3
Wingless chicken	Unknown	Undated	00538 / -
Colony of warrior ants	Unknown	Undated	00539 / -
Boys swinging on the roots of a giant philodendron (*Philodendron lacerum* (Jacq.) Schott,[a] identified as *Philodendron* cf. *radiatum* Schott by T. Croat (Missouri Botanical Garden, Araceae)	Barro Colorado	Undated	00540 / -
**Apterostigma fairchildii*[b] (Hymenoptera, Formicidae, Attini) mushroom garden	Unknown	Undated	00541 / -
**Apterostigma collare* (Hymenoptera, Formicidae, Attini), fungus-growing ant. Petri dish nest of this species. Collected and arranged by W.M. Wheeler	Barro Colorado	Undated	00542 / -
*Fungus-growing ant *Trachymyrmex*[c] (Hymenoptera, Formicidae, Attini) mushroom garden.	Barro Colorado	July 29	00543 / -
*Fungus garden made by ant	Barro Colorado	July 31	00544 / -
*Fungus-growing ant *Trachymyrmex*[c] (Hymenoptera, Formicidae, Attini) mushroom garden.	Barro Colorado	July 29	00545 / -
**Cyphomyrmex strigosus* (Hymenoptera, Formicidae, Attini).[c,d] Fungus garden	Barro Colorado	August 2	00546 / -
Stingless bee nest. *Trigona* (Hymenoptera, Apidae, Meliponini)	Unknown	Undated	00547 / -
The devil's ant tree or bull horn acacia. *Acacia multiglandulosa* Schenck (accepted name *Vachellia melanoceras* (Beurl.) Seigler & Ebinger, Fabaceae). Views of the leaf tips, thorns, trees and of William M. Wheeler and James Zetek examining the trees	Marajal Jungle	July 27	00548 / -
*Leaf-cutting ant. *Atta cephalotes* (Hymenoptera, Formicidae, Attini)	Barro Colorado	July 29	00549 / 3
*Fungus garden in Petri Dish. *Sericomyrmex* (Hymenoptera, Formicidae, Attini) species of ant	Unknown	Undated	00550a / -
*Pupa of undetermined insect. It resembles a dead leaf in a most remarkable way with its peculiar leafy appendages. The living caterpillar feeds on a Convolvulaceae.	Barro Colorado	Undated	02038 / -
The devil's ant tree or bull horn acacia. *Acacia multiglandulosa* Schenck (accepted name *Vachellia melanoceras* (Beurl.) Seigler & Ebinger, Fabaceae).	Marajal Jungle near France Field	July 27	11794 / -
The devil's ant tree or bull horn acacia. *Acacia multiglandulosa* Schenck (accepted name *Vachellia melanoceras* (Beurl.) Seigler & Ebinger, Fabaceae).	Unknown	Undated	12321 / 11
The devil's ant tree or bull horn acacia. *Acacia multiglandulosa* Schenck (accepted name *Vachellia melanoceras* (Beurl.) Seigler & Ebinger, Fabaceae).	Unknown	Undated	12322 / -

(Continued)

Table 1. (Continued).

Photo description	Locality	Date	Photo number in Fairchild Tropical Botanic Garden records / Figure number in this paper
The devil's ant tree or bull horn acacia. *Acacia multiglandulosa* Schenck (accepted name *Vachellia melanoceras* (Beurl.) Seigler & Ebinger, Fabaceae).	Unknown	Undated	12325 / -
The devil's ant tree or bull horn acacia. *Acacia multiglandulosa* Schenck (accepted name *Vachellia melanoceras* (Beurl.) Seigler & Ebinger, Fabaceae).	Unknown	Undated	12326 / -
Trail through jungle	Barro Colorado	Undated	12327 / -
The devil's ant tree or bull horn acacia. *Acacia multiglandulosa* Schenck (accepted name *Vachellia melanoceras* (Beurl.) Seigler & Ebinger, Fabaceae).	Unknown	Undated	12328 / -
Insect nest [negative has deteriorated]	Unknown	Undated	12329 / -
Entrance to a nest of the kelep ant (*Ectatomma*[e] *tuberculatum*, Hymenoptera, Formicidae, Ectatommini)	Barro Colorado	July 20	00551[f] / -
Trail through jungle on Barro Colorado Island	Barro Colorado	July 19	00552[g] / -
Liana producing new root systems	Barro Colorado	July 29	00553 / -
Inga sp. (Fabaceae) showing extrafloral nectaries	Barro Colorado	July 29	00554[h] / -
*Leaf-cutting ant. *Atta cephalotes* (Hymenoptera, Formicidae, Attini). An *Atta* queen and her young nest in tin box arranged by William M. Wheeler slightly enlarged	Barro Colorado	Undated	00660 / -
Colony of warrior ants. *Eciton*[e] *hamatum* (Hymenoptera, Formicidae, Dorylinae)	Unknown	Undated	00662 / -[i]
Wingless fowl	Unknown	Undated	00663 / -
Catasetum viridiflavum Hook. Orchid which throws its pollen.	Unknown	Undated	00664 / 9
Hura[j] *crepitans* L. (Euphorbiaceae). Dead sand box tree. Destruction caused by termites. The tree was so eaten up by termites as to look like a gigantic honeycomb	Barro Colorado	August	00965 / -
Manicaria saccifera Gaertn. Remarkable forest of monkey cap palms. Graham Fairchild and Frederick Burgess posing	Near Clear Water River, Fort Sherman	August 7	01537 / 10
Wingless chicken. This specimen has no wings, and its thorax is reduced to a mere fraction of what one would expect to find in a bird of its size but the keel is still present	Balboa	July	02036 / -
Manicaria saccifera Gaertn. Monkey cap palms, Mr. Shropshire standing	Fort Sherman	August 7	12681 / -
*Courtship of the calobatas[k]	Barro Colorado	Undated	NA / -
*Saucers of honey. Extrafloral nectaries of young and just unfolded leaf of *Inga* sp.[l]	Barro Colorado	Undated	NA / -
*Soldier and small worker of *Eciton hamatum*[m]	Barro Colorado	Undated	NA / -

* Photos taken with the Long Tom camera.
[a] This is a Caribbean Island endemic. The species was misidentified by Fairchild (see Appendix 1, note 3).
[b] We could not locate the specific epithet "*fairchildii*" in the consulted literature. This genus of fungus-growing ants is not mentioned in Fairchild's (1924a) report.
[c] This genus of fungus-growing ants is not mentioned in Fairchild's (1924a) report.
[d] We could not locate the specific epithet *strigosus* in the consulted literature. It appears that Fairchild was referring to a species of the *C. strigatus* complex (Kempf 1964); accepted name *Mycetophylax strigatus*; however, this species does not reach Central America.
[e] This genus of ants is not mentioned in Fairchild's (1924a) report
[f] Photo published by Wheeler (1924: Fig. 8).
[g] Photo published by Wheeler (1925: Fig. 1).
[h] Photo published by Wheeler (1924: Fig. 8).
[i] Photo published by Wheeler (1925: Fig. 3).
[j] This genus of plants is not mentioned in Fairchild's (1924a) report.
[k] Photo published by Wheeler (1924: Fig. 10).
[l] Photo published by Wheeler (1924: Fig. 9).
[m] Photo published by Wheeler (1925: Fig. 4).

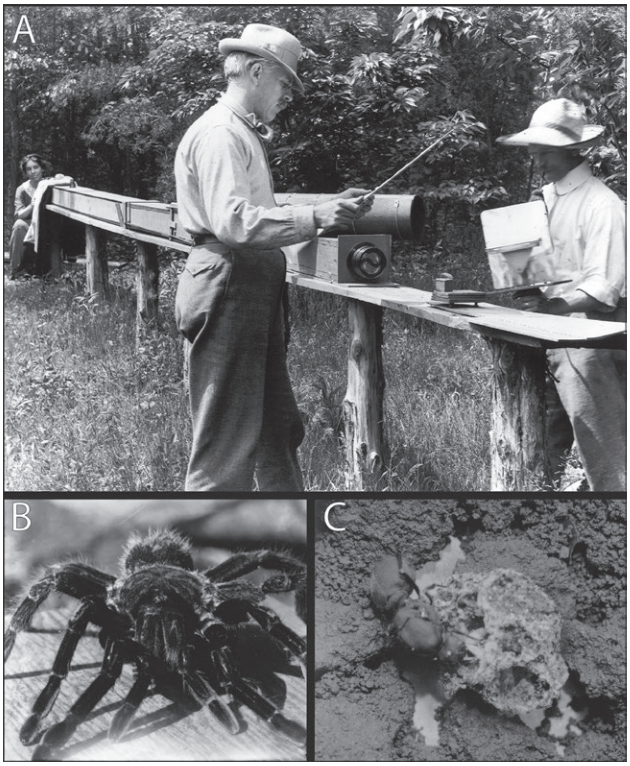
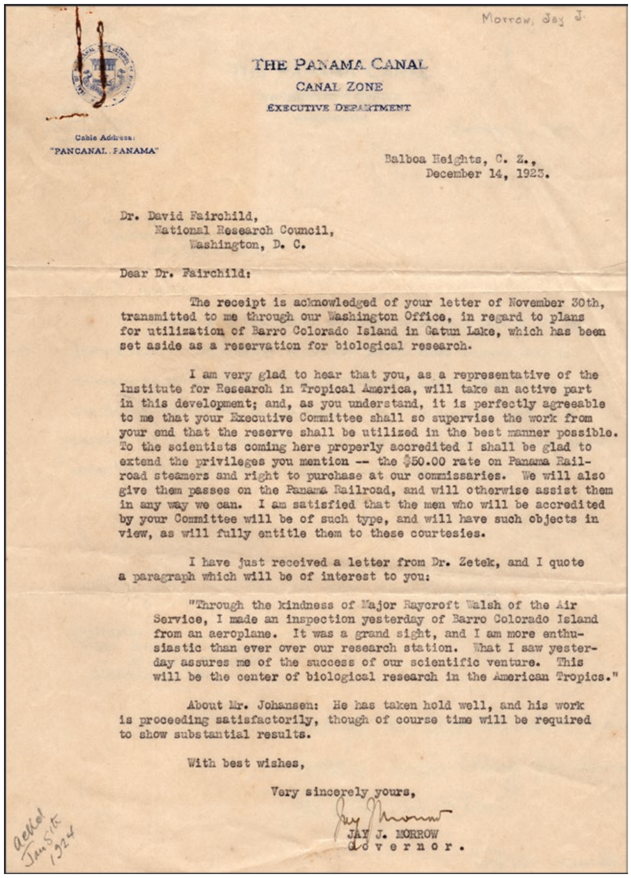


Figure 3. Images pertinent to the Long Tom Camera that was carried to Panama (year 1924) to take close-up images of organisms. (A) View of the camera as it was used in Bethesda, Maryland, unknown date. From left to right Marian Fairchild, David Fairchild, and Wills (Photo 00473). (B) *Sericopelma* tarantula, Barro Colorado Island (Photo 00537). (C) *Atta cephalotes* leaf-cutting ant (Photo 00549). Courtesy of Fairchild Tropical Botanic Garden.



Morrow, Jay J.

THE PANAMA CANAL
CANAL ZONE
EXECUTIVE DEPARTMENT

Cable Address:
"PANCANAL, PANAMA"

Balboa Heights, C. Z.,
December 14, 1923.

Dr. David Fairchild,
National Research Council,
Washington, D. C.

Dear Dr. Fairchild:

The receipt is acknowledged of your letter of November 30th, transmitted to me through our Washington Office, in regard to plans for utilization of Barro Colorado Island in Gatun Lake, which has been set aside as a reservation for biological research.

I am very glad to hear that you, as a representative of the Institute for Research in Tropical America, will take an active part in this development; and, as you understand, it is perfectly agreeable to me that your Executive Committee shall so supervise the work from your end that the reserve shall be utilized in the best manner possible. To the scientists coming here properly accredited I shall be glad to extend the privileges you mention -- the $50.00 rate on Panama Railroad steamers and right to purchase at our commissaries. We will also give them passes on the Panama Railroad, and will otherwise assist them in any way we can. I am satisfied that the men who will be accredited by your Committee will be of such type, and will have such objects in view, as will fully entitle them to these courtesies.

I have just received a letter from Dr. Zetek, and I quote a paragraph which will be of interest to you:

"Through the kindness of Major Raycroft Walsh of the Air Service, I made an inspection yesterday of Barro Colorado Island from an aeroplane. It was a grand sight, and I am more enthusiastic than ever over our research station. What I saw yesterday assures me of the success of our scientific venture. This will be the center of biological research in the American Tropics."

About Mr. Johansen: He has taken hold well, and his work is proceeding satisfactorily, though of course time will be required to show substantial results.

With best wishes,

Very sincerely yours,

Jay J. Morrow
JAY J. MORROW
Governor.

ackd Jan 5th 1924

Figure 4. Letter (December 14, 1923) sent to Fairchild (as representative of the Institute for Research in Tropical America) by Panama Canal Zone governor J. Morrow. The letter indicates that Barro Colorado Island has been declared a reserve for biological research. Courtesy of Fairchild Tropical Botanic Garden.

DAVID FAIRCHILD'S ACTIVITIES

Itinerary

Unfortunately, Fairchild's (1924a) report does not specify the dates of his arrival and departure to and from Panama or his visits to particular sites. Therefore, we have used indirect evidence, such as the dates of his photographs, information found in his letters, and newspaper articles to make a timeline of his trip.

Fairchild arrived in Panama from Havana on board the *SS Cartago* (Fig. 6) sometime during the third week of July (Fairchild 1924a: 4). This ship was one of the "Great White Fleet" that was owned and operated by the United Fruit Company Steamship Service. Vessels belonging to this fleet not only transported passengers but also moved cargo between the U.S. and the Caribbean (Stephens 2023: 22–27). The *SS Cartago* anchored at the Santa Clara docks (Havana port) between July 8 and 10 before cruising to Panama, having come from New Orleans (*Diario de La Marina Edición de la Tarde* Year 92 (139): 3; *Diario de La Marina Edición de la Mañana* Year 92 (190): 13).

Regarding his return, Fairchild's (1924a: 1) account was written aboard the *SS Ulua* on August 16. This ship, also part of the Great White Fleet (Fig. 6), was reported in Havana on August 14 and 15 (*Diario de La Marina Edición de la Mañana* Year 92(225): 3; Year 92(226): 3, 11) en route to New York. Therefore, Fairchild wrote down his observations on his visit to Panama while sailing from Cuba to the U.S. Although we are uncertain of the date that the *SS Ulua* departed from the Caribbean port of Cristobal, evidence from the *Star and Herald* (Volume 25 (21017): 4) and the two letters sent to Lathrop (July 22: page 41; August 10: page 53), suggests that by August 11, Fairchild was already sailing back from Central America.

Despite the brevity of Fairchild's visit in Panama, he still was able to travel between the Caribbean and Pacific

Table 2. Internet resources available to the project, including online supplementary appendices.

Description	Website address	Notes
Online Supplementary Appendix 1	https://archive.org/details/fairchild-panama-1924-report/page/n11/mode/2up	Handwritten account produced by Fairchild regarding his 1924 visit to Panama[a]
Online Supplementary Appendix 2	https://archive.org/details/fairchild-panama-1924-photos	Photos made by Fairchild during his 1924 visit to Panama[a]
Online Supplementary Appendix 3	https://archive.org/details/star-herald-panama-fairchild-1924	*Star & Herald* newspaper (Panama): articles regarding his 1924 visit of Fairchild to Panama
Diario de La Marina	https://prensahistorica.mcu.es/es/publicaciones/ficha_pub.do?idPublicacion=1001922	*Diario de La Marina* newspaper (Havana)
US National Plant Germplasm System Database	https://npgsweb.ars-grin.gov/gringlobal/search?q=PI+98769	Database of germplasm introduced in the U.S. through the USDA
USDA Germplasm Inventory publications	https://www.ars.usda.gov/northeast-area/beltsville-md-barc/beltsville-agricultural-research-center/national-germplasm-resources-laboratory/docs/plant-inventory-books/	Pdf files with brief collection reports

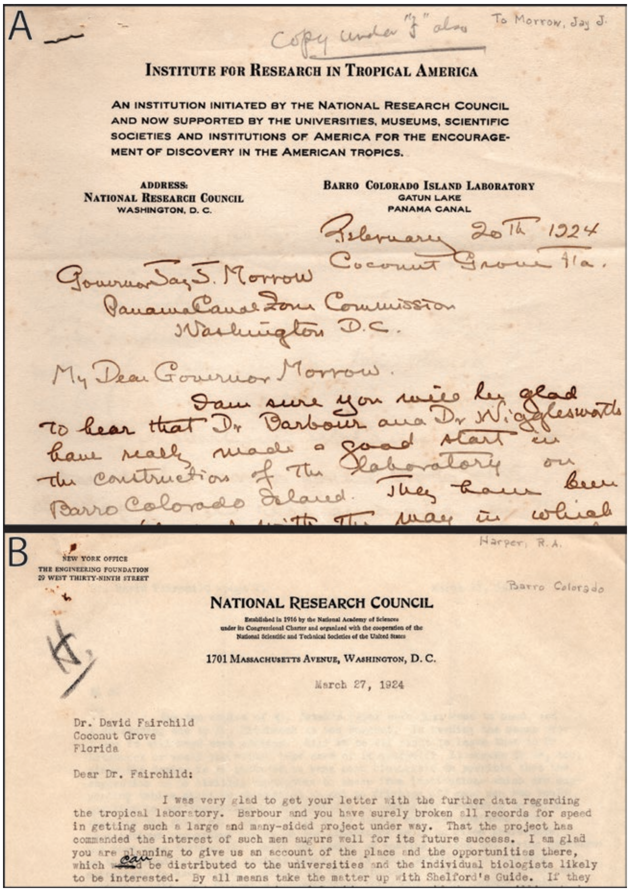
[a] Courtesy of Archives and Library of Fairchild Tropical Botanic Garden.

coasts visiting different sites (Fig. 7). These included the Summit Municipal Park (Fairchild 1924a: 2; thereafter the Summit Gardens)[2]. The second letter that Fairchild sent to Lathrop from Panama indicates that in this garden he met its director, Holger P. Johansen (Table 3), highlighting that among the plants encountered there were three accessions of fiberless mango (cultivars '*Alphonse*,' '*Amini*,' and '*Packria*') that were part of the germplasm collections Fairchild and Lathrop had gathered during their 1902 plant exploration trip to India (Pieters 1905: 196, 199, 200). Fairchild also visited (1) the Barro Colorado Island (BCI) Laboratory (currently known as the Smithsonian Tropical Research Institute Laboratories on BCI; Fairchild 1924a: 5; Fig. 2); (2) Balboa, where he and W. Wheeler (Table 3) delivered talks on mangosteen and ants, respectively (Online Supplementary Appendix 3; Fairchild 1924a: 3, 21); and (3) natural areas adjacent to Fort Sherman (photos 00548, 11794) or Marajal (Fairchild 1924a: 19–20). Furthermore, Fairchild went to Ancon to meet Governor Jay J. Morrow (Table 3), probably as a follow-up to correspondence they had exchanged before Fairchild's trip (Fairchild to Lathrop, July 22: 35). While in Ancon he also interacted with J. B. Shropshire, the chief sanitary inspector of the Panama Canal Zone (Table 3; letter of Fairchild to Lathrop, July 22: 36). Shropshire, an expert on local invertebrates, was known for assisting naturalists who visited the region (e.g., Dodds 1926; Curran 1930).

Trip participants and references to the previous 1921 visit

Alexander ("Sandy") Graham Bell Fairchild (Fig. 1, Table 3), David Fairchild's son, also joined this expedition (Fairchild 1924a: 4). Like his father, Graham was an avid naturalist, who later pursued his undergraduate and Ph.D. degrees at Harvard University. By 1938, he was working at the Gorgas Memorial Laboratory in Panama City, where he specialized in the study of horseflies (Tabanidae). In 1970 Graham retired from this institute and moved to the University of Florida, Gainesville, where he had an honorary appointment (Burger 1999). Frederick ("Freddie") Burgess (Fig. 1), a friend of Graham's, traveled with him and his father as well (Fairchild 1924a: 4); however, there is no further information on Burgess apart from references to his presence and help mentioned by Wheeler (1924, 1925). Interestingly, James Zetek (Fig. 1, Table 3), together with his wife and daughter, also cruised with the Fairchilds on the *SS Cartago* (Fairchild 1924a: 4). The vessel departed from New Orleans and made a layover in Cuba before its arrival in Panama, as indicated by *El Diario de la Marina* records (*Diario de La Marina Edición de la Tarde* Year 92 (139): 3; *Diario de La Marina Edición de la Mañana* Year 92 (190): 13). Zetek was the first director of the BCI Laboratory and a relevant figure in the establishment of this research facility (Sapp 2016).

[2] See Elton et al. (2023) for details of the history of Summit Gardens. During Fairchild's visit they were known as the Canal Zone Plant Introduction Gardens; in 1929 they were renamed the Canal Zone Experimental Gardens. In 1985 the gardens were transferred to the Panama Municipality, and since then have been called Summit Municipal Park. Here we refer to them as Summit Gardens.



A

Copy under "J" also

To Morrow, Jay J.

INSTITUTE FOR RESEARCH IN TROPICAL AMERICA

AN INSTITUTION INITIATED BY THE NATIONAL RESEARCH COUNCIL AND NOW SUPPORTED BY THE UNIVERSITIES, MUSEUMS, SCIENTIFIC SOCIETIES AND INSTITUTIONS OF AMERICA FOR THE ENCOURAGEMENT OF DISCOVERY IN THE AMERICAN TROPICS.

ADDRESS:
NATIONAL RESEARCH COUNCIL
WASHINGTON, D. C.

BARRO COLORADO ISLAND LABORATORY
GATUN LAKE
PANAMA CANAL

February 20th 1924
Coconut Grove Fla.

Governor Jay J. Morrow
Panama Canal Zone Commission
Washington D.C.

My Dear Governor Morrow.

I am sure you will be glad to hear that Dr Barbour and Dr Wigglesworth have really made a good start on the construction of the laboratory on Barro Colorado Island. They have been ... the way in which

B

NEW YORK OFFICE
THE ENGINEERING FOUNDATION
29 WEST THIRTY-NINTH STREET

Harper, R. A.

Barro Colorado

NATIONAL RESEARCH COUNCIL

Established in 1916 by the National Academy of Sciences under its Congressional Charter and organized with the cooperation of the National Scientific and Technical Societies of the United States

1701 MASSACHUSETTS AVENUE, WASHINGTON, D. C.

March 27, 1924

Dr. David Fairchild
Coconut Grove
Florida

Dear Dr. Fairchild:

I was very glad to get your letter with the further data regarding the tropical laboratory. Barbour and you have surely broken all records for speed in getting such a large and many-sided project under way. That the project has commanded the interest of such men augurs well for its future success. I am glad you are planning to give us an account of the place and the opportunities there, which ~~would~~ can be distributed to the universities and the individual biologists likely to be interested. By all means take the matter up with Shelford's Guide. If they

Figure 5. Correspondence relevant to Fairchild's involvement in the establishment of the Barro Colorado Island Laboratory. (A) Letter (February 20, 1924) sent to Panama Canal Zone governor J. Morrow by Fairchild highlighting initial developments in this site, as well as the active involvement of herpetologist Thomas Barbour (1884–1946, director of the Museum of Comparative Zoology of Harvard University) and geologist Edward Wigglesworth (1885–1945, director of the Museum of the Boston Society of Natural History). (B) Letter (March 27, 1924) sent to Fairchild by botanist Robert A. Harper (1862–1946, Torrey Professor of Botany at Columbia University and chairperson of the National Research Council) discussing potential academic and research developments on this site. Courtesy of Fairchild Tropical Botanic Garden.

The first pages of Fairchild's (1924a: 1–2) report reference his earlier trip to Panama in 1921 (Fairchild 1921, 1922), during which he interacted with, among others, four individuals from the Canal Zone: J. H. K. Humphrey, Hugh White, Lewis Anthony Byrnes, and Alfred Friedrich Marti. Fairchild's (1924a: 1) report also refers to Palemon H. Dorsett (1862–1943), a field botanist of the USDA. Table 3 and Fig. 8 provide additional biographical details and photos of these individuals. The images presented in Fig. 8 were included in Fairchild's (1921) unpublished account of his 1921 voyage to Panama.

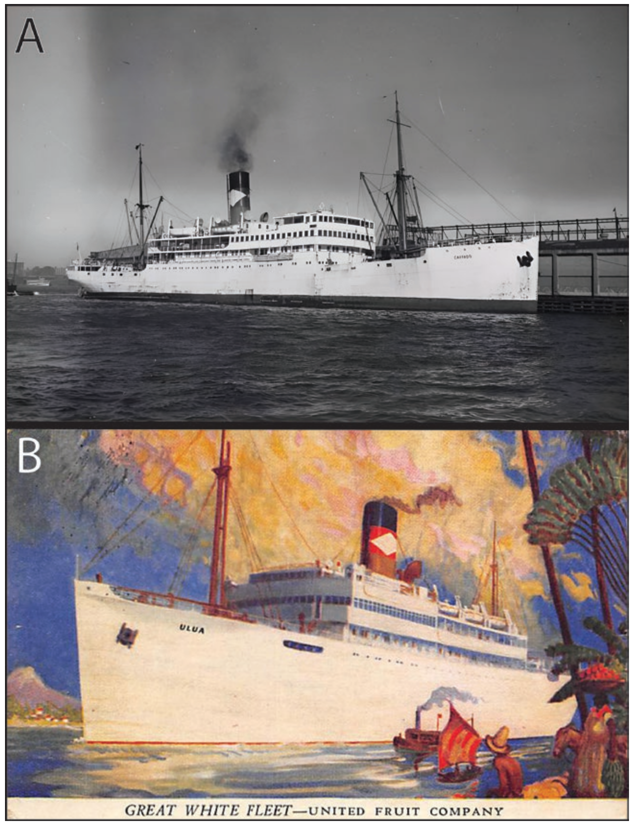


Figure 6. Vessels of the Great White Fleet, United Fruit Company Steamship Service, on which David Fairchild traveled to and from Panama in 1924. (A) *SS Cartago*: Fairchild took this ship on his outward voyage from New Orleans to Panama (Cristobal) in late July. Courtesy of the Mariners' Museum and Park, Newport News, Virginia, archive # P0001.003/01-#PB14455. (B) *SS Ulua*: Fairchild traveled on this ship for his return trip from Panama (Cristobal) to New York. Courtesy of Archives of Montgomery Botanical Center.

These initial pages of Fairchild's (1924a: 2–3) account also praise the botanical and ecological research being performed in the Canal Zone during this period. For the Summit Gardens he states: "Today I find a Plant Introduction Garden at Summit where $21,000 a year has been spent and which is better planned than many of our own gardens" (Fairchild 1924a: 2). Similarly, he expressed admiration for the progress made at the BCI Laboratory, addressing its transformation from a place with little botanical interest into a thriving center for plant studies (Fairchild 1924a: 3).

Barro Colorado Island Laboratory

Barro Colorado Island, located in Gatun Lake, formed when the Panama Canal was built, is an artificial island that is home to one of the most famous tropical

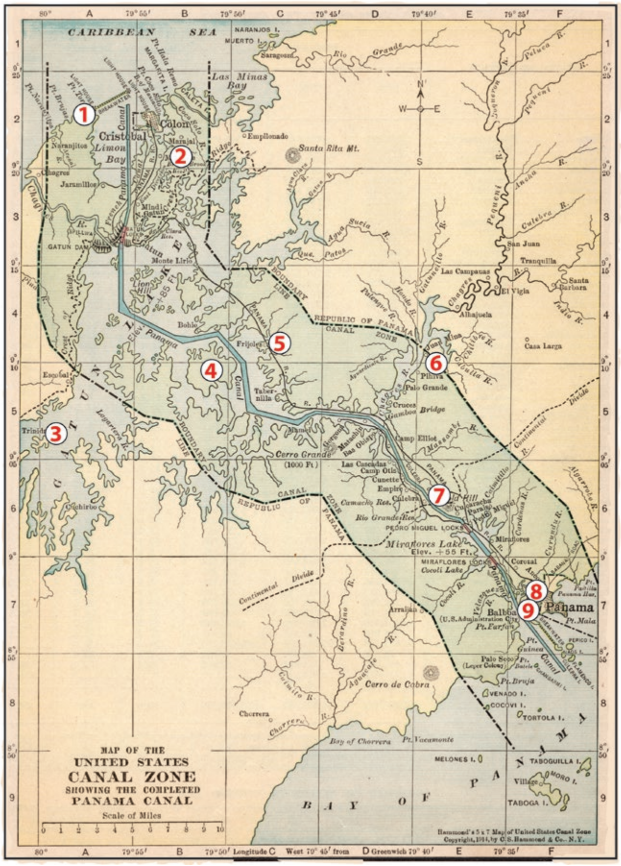


Figure 7. Sites Fairchild visited during his 1924 trip to Panama or that are mentioned in his trip report (Fairchild 1924a). Sites coded as 1. Fort Sherman and Clear Water River; 2. Marajal jungle; 3. *Isla Hormiga; 4. Barro Colorado Island; 5. *Frijoles; 6. *Juan Mina; 7. Summit Gardens; 8. Ancon; 9. Balboa. Asterisks refer to sites that were visited in 1921 and are mentioned in Fairchild's (1924a) report, but we are not certain if they were part of the 1924 itinerary. Map reproduced from *Hammond's Atlas of the World*. Year 1914. C.S. Hammond & Co. Publisher. Courtesy of Archives of Montgomery Botanical Center.

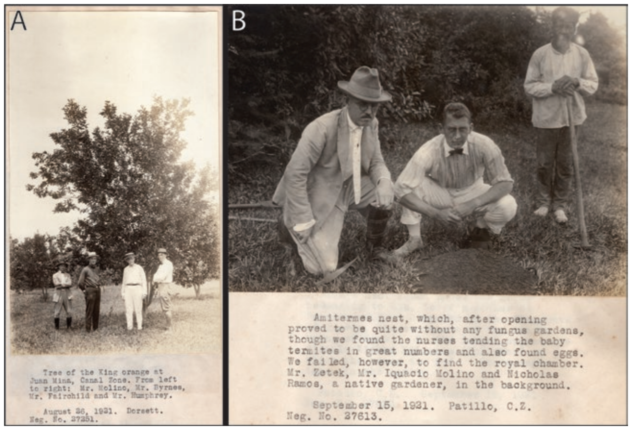


Figure 8. Individuals Fairchild met during his 1921 expedition to Panama who are mentioned in Fairchild's (1924a) report. Photos are included in the account Fairchild wrote for his 1921 trip to Panama. (A) From left to right: Ignacio Molino, Lewis Anthony Byrnes, David Fairchild, and J.H.K. Humphrey posing in Juan Mina (Fairchild 1921: 19). (B) From left to right: James Zetek, Ignacio Molino, and Nicolás Ramos posing at an unknown site in the Panama Canal Zone (Fairchild 1921: 106). Field assistant Nicolás Ramos is not mentioned in Fairchild's (1924a) report. Table 3 provides further details about individuals posing in these photographs. Courtesy of Fairchild Tropical Botanic Garden.

biology research stations and field laboratories worldwide (Leigh 2009; Raby 2015, 2015; Fig. 2). The first buildings of this station were opened on March 29, 1924 (Hagen 1990; Raby 2015), four months before Fairchild visited these laboratories for the first time. During this period, the site was administered by the Institute for Research in Tropical America, an entity sponsored by the National Research Council of the United States that was formed in 1916 (Raby 2017: 97; Wright 2020).

As stated on page 3 of his report, most of Fairchild's stay in Panama was spent on BCI. From information found with his photos, it is certain that he was stationed on this island between July 19 and 29. During this short period four other distinguished American naturalists also converged on the island: entomologists N. Banks and the aforementioned W. Wheeler and J. Zetek, and neurobiologist C. P. Richter (Fig. 1, Table 3). Their gathering was highlighted by the *Star & Herald* newspaper (Online Supplementary Appendix 3), probably as a collective initiative to promote BCI as a center for tropical biology research, given that the station had only recently opened.

Fairchild was one of the most relevant supporters and advocates for the creation of this field station (Fairchild 1924b; Hagen 1990; King 2001). As a "representative of the Institute for Research in Tropical America" he had an active involvement in planning and establishing the station's infrastructure (Figs. 4-5). The two letters he sent to Lathrop indicate that the latter provided funding for the laboratory's initial development. In recognition for this sponsorship, one of the first trails made on the island was named after him (Fig. 2), as noted in the letter Fairchild sent on August 10.

Terrestrial invertebrate accounts

Insect and spider observations were relevant components of Fairchild's encounters with the biota of this island. A total of 12 species of insects and 1 tarantula were recorded in his photos or handwritten report (Appendix 2). Notably, Fairchild was the only botanist staying on BCI, while the other naturalists were zoologists, most of them leading entomologists. Once on BCI,

Table 3. Personalities mentioned in Fairchild's (1924a) report, already known or met during the trip.

Name	Biographical note / Reference	Figure number in this paper / Fairchild Tropical Botanic Garden photo number	Page number in Fairchild's (1924a) report
Nathan Banks (1868–1953)	Entomologist from Harvard University / Carpenter & Darlington 1954	1 / 00079, 00053	5, 7
Alexander Graham Bell Fairchild (1906–1994)	Son of David Fairchild who eventually joined the Gorgas Memorial Laboratory, Panama City, as an entomologist in 1938 / Burger 1999	1 / 00078, 00079, 00540, 01537	4–5, 13–14
Theodor Boveri (1862–1915)[a]	German zoologist specialized in cytology and embryology / Maderspacher 2008	- / -	4
Frederick Burgess	Friend of Graham Bell Fairchild	1 / 00079, 01537	4–5, 13–14, 20
Lewis Anthony Byrnes (1884–1933)[a]	Supervisor for the Panama Canal Company / Anonymous without date; Fairchild 1921: 18, 19	8 / -	2
Palemon Howard Dorsett (1862–1943)[a]	Field botanist of the Section of Foreign Seed and Plant Introduction of the USDA / Anonymous 1932; Fairchild 1936	- / -	1
J. H. K. Humphrey[a]	Superintendent of the Cattle Industry Division, Cristobal, Panama / Fairchild 1921: 18	8 / -	1–2
Holger P. Johansen (1898–1935)	First curator of living collections at Summit Gardens / Anonymous 1939: 6; Elton et al. 2023	- / -	2–3
Alfred Friedrich (Fritz) Marti (? – 1956)[a]	Swiss native who was one of the canal employees / Anonymous 1956	- / -	1
Ignacio Molino	Panamanian lawyer who assisted James Zetek establishing the Barro Colorado Island laboratories / Anonymous 2024	1, 8 / -	4
Jay J. Morrow (1870–1937)[b]	Governor of the Panama Canal Zone between 1921 and 1924 / Anonymous 1937	- / -	-
Charles Wesley Powell (1854–1927)	Self-taught horticulturalist and orchid specialist, established the first large-scale collection of Panamanian orchids / Anonymous 1928	- / -	14
Curt P. Richter (1894–1988)	Neurobiologist from Johns Hopkins Medical School / Schulkin 2005	1 / -	5, 11, 14
J.B. Shropshire[c]	Chief Sanitary Inspector, U.S. Army, Panama Canal Zone / Barbour 1925	- / 12681	-
George C. Wheeler (1897-1991)	Entomologist from Syracuse University / Trager 1988	- / -	-
William M. Wheeler (1865–1937)	Entomologist from Harvard University / Carpenter 1938	1 / 00079, 00080, 00548	3–8, 11
Hugh White[a]	Unknown / Fairchild 1921: 103	- / -	1
James Zetek (1886–1959)	Entomologist who was one of the founders, and the first director of the Barro Colorado Island Laboratory until his retirement in 1956 / Snyder et al. 1959; Hagen 1990	1, 8 / 00548	4

[a] Individual mentioned in Fairchild (1924a) who did not participate in the 1924 visit of Fairchild to Panama.
[b] Individual mentioned in letter sent to Lathrop by Fairchild (July 22, page 35).
[c] Individual mentioned in letter sent to Lathrop by Fairchild (July 22, page 36).

Fairchild was influenced by their field research on this site. From his account, he was clearly attracted by the biology and ecology of the BCI terrestrial invertebrates, particularly of the fungus-growing ants belonging to the tribe Attini. He made photos or written accounts for 6 species belonging to this group of insects (Appendix 2). Early in his career, when he was working in Java (1896), Fairchild also showed an interest in nest-building insects that exhibit mutualism with fungi. At that time, he performed field studies on fungus-growing termites (subfamily Macrotermitinae). His findings are reported in his autobiography (Fairchild 1938: 66–70, 64D, 64E). On BCI, he also documented three other ant species (Appendix 2), including the notorious bullet-ant (*Paraponera clavata*), famous for its extremely painful bite, and the army ant (*Eciton hamatum*). He photographed a kelep ant (*Ectatomma tuberculatum*) nest, the stingless bee *Trigona* sp., and the antlike fly *Cardiacephala* *arthritica*. Fairchild's interests in terrestrial arthropoda came not only from his termite observations in Java; ten years before this trip to Panama, he and his wife published a book with many photos of spiders (17 species), insects (92 species), myriapods (2 species), and crustaceans (1 species) captured with the Long Tom camera (Fairchild and Fairchild 1914). This work includes descriptive texts for the species that they depicted.

Interestingly, part of the entomological research conducted by Wheeler during this visit to BCI resulted in two papers he published upon his return to Harvard, both of which mention Fairchild (Wheeler 1924, 1925). One of these works concerns the army ant (*Eciton hamatum*) and aims to locate and describe the queen of these social insects (Wheeler 1925), while the other focuses on male courtship features of the antlike fly *Cardiacephala arthritica* (identified as *C. myrmex* by Wheeler). Fairchild (1924a: 7–8) also provides a detailed description of the mating behavior of the latter species. Such observations, coupled with the several discussions that Fairchild had with the other naturalists, led him to articulate several insights on aspects of life and human biology, found on pages 9–12 of his trip report. Regarding these philosophical writings, later, in 1948, in a margin note written in Nova Scotia, Canada, Fairchild stated: "This reflection on life is the best I ever wrote and now Sept 1, 1948—24 years after it was written, I read it with a feeling of wonder" (Fairchild 1924a: 9).

Fairchild's (1924: 1, 6) manuscript has reflections on race and society, including an anthropomorphic comparison between the behavior of fungus-growing ants, indicating that ant and fungi "live together as peacefully as the negroes do among us whites" (Fairchild 1924a: 6). Fairchild's views on the separation of races are well documented (Fairchild 1930: 272); those pertinent to eugenics have been discussed by Harris (2015: 158–159, 164), and more recently they were also highlighted by Watson (2024: 73) in a study on early twentieth century horticulture developments in Miami. Fairchild lived in a period in which racial segregation was the norm in the United States, and this historical and social setting influenced his thinking, as reflected in some of his writings.

Botanical accounts

In previous studies in which we have examined Fairchild's expedition reports, we have found that those documents focus primarily on botanical observations; however, his handwritten account of the 1924 trip to Panama emphasizes entomological observations, as well as the promotion of tropical biological research facilities. For instance, his descriptions of the plants found in the forest of BCI cover only four species, including (1) unidentified lianas forming what Fairchild called "aerial roots" (Fairchild 1924a: 12; photos 000535, 00553), (2) an unknown species of *Philodendron* that he misidentified as the Caribbean island endemic *P. lacerum* and that exhibited huge aerial roots (Fairchild 1924a: 12; photo 00540),[3] (3) an undetermined species of *Inga* that displayed extrafloral nectaries along its leaf rachis to attract ants as protection agents (Fairchild 1924a: 13; Photo 00554),[4] and (4) the functionally dioecious epi-

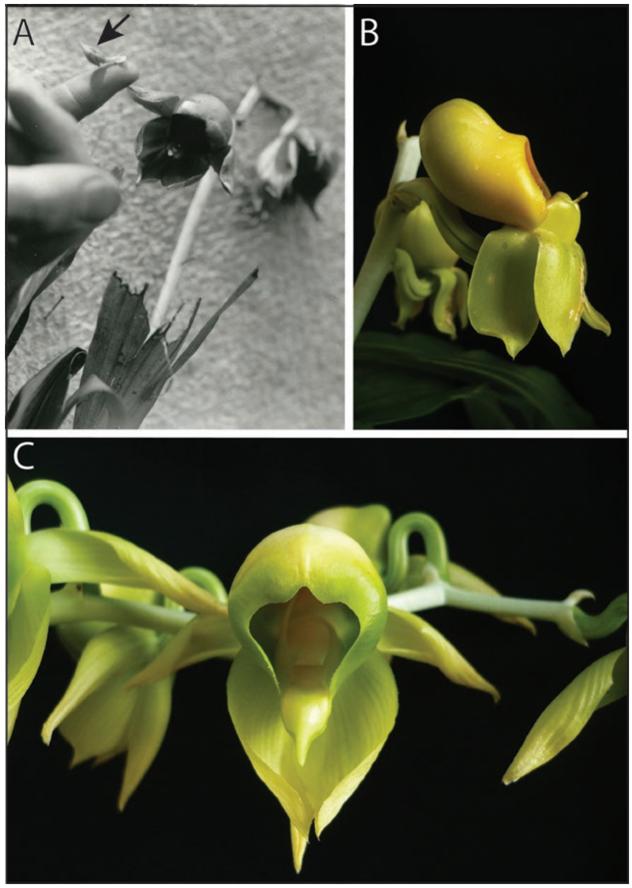


Figure 9. *Catasetum viridiflavum* Hook. (Orchidaceae). (A) Detail of an individual from Barro Colorado Island showing the pollinium (indicated with an arrow). Photo taken by David Fairchild during his 1924 trip to Panama (Photo 00664). Courtesy of Fairchild Tropical Botanic Garden. (B) Female flower, from a wild individual growing in Panama City. (C) Male flower, from wild individual growing in Panama City. (B) and (C): photos by Mabelin Santos.

[3] Tom Croat (Missouri Botanical Garden) has kindly pointed out to us that the only *Philodendron* on BCI with pinnately lobed leaves is *P. radiatum* Schott. We follow this taxonomic interpretation here.

[4] Terry Pennington (Royal Botanic Gardens, Kew) has kindly indicated that the depicted individual "has an unusual combination of features—the apparently large and round nectaries with one located at the base

Figure 10. *Manicaria saccifera* Gaertn. (Arecaceae) in habitat. (A) In Fort Sherman, Graham B. Fairchild (left) and Frederick Burgess (right) posing. Photo taken by David Fairchild during his 1924 trip to Panama (Photo 01537). Courtesy of Fairchild Tropical Botanic Garden. (B) In Damani-Guariviara Wetlands, Panama. Photo by A. Ibáñez.

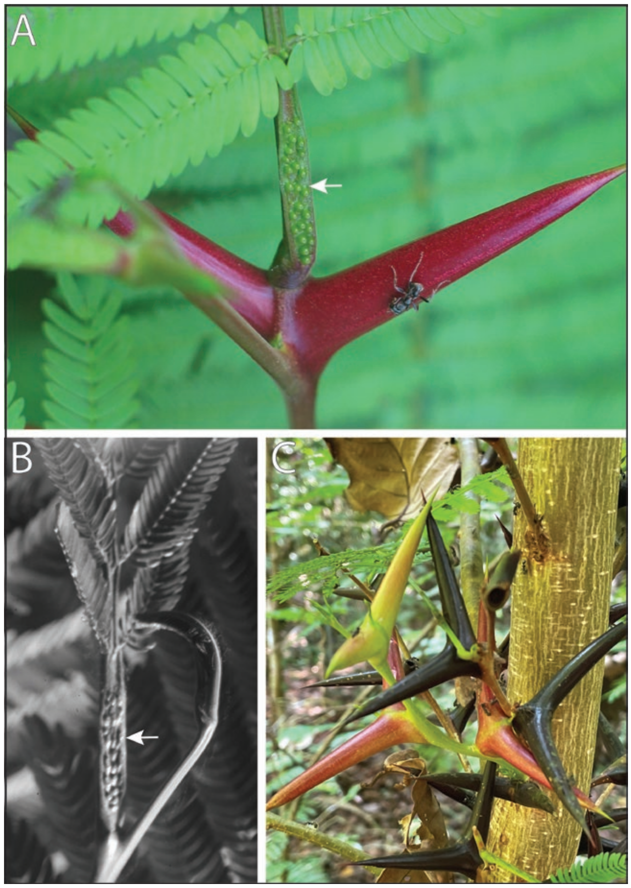


Figure 11. *Vachellia melanoceras* (Beurl.) Seigler & Ebinger. (Fabaceae). (A) Leaf petiole and basal spines, in habitat in San Lorenzo National Park, Panama. Nectaries are indicated with a white arrow. (B) Detail of leaf petiole showing leaf nectaries (indicated with an arrow). Photo taken by David Fairchild during his 1924 trip to Panama (Photo 12321), from an unknown locality. Courtesy of Fairchild Tropical Botanic Garden. (C) Detail of trunk showing its large spines, in habitat in San Lorenzo National Park, Panama. (A) and (C): photos by Sabrina Amador.

phytic orchid *Catasetum viridiflavum* (Fig. 9), which, he noticed, throws its pollinia large distances when touched (Fairchild 1924a: 14; Photo 00664). This pollination mechanism ensures that the plant's single pollinator, *Eulaema cingulata* (Euglossini, Apidae), can move effectively among pollen to female flowers (Murren 2003).

Other plant species encountered in the Canal Zone are briefly mentioned, including mangos, bamboos, and *Senna siamea* trees in Summit Gardens (Fairchild 1924a: 2). The archival record identified 3 plant species that are not mentioned in his report but found in photographs, including *Manicaria saccifera* (photos 01537, 12681) from Fort Sherman (Fig. 10), plants of *Vachellia melanoceras* (Fig. 11) from Marajal (photos 00548, 11794), and the trunk of a *Hura crepitans* (Fig. 12) tree damaged by termites (Photo 00965). Finally, there are five photos (numbers 12321, 12322, 12325, 12326, 12328) of *V. melanoceras* for which there are no details on where they were taken.

Fairchild transported a total of 28 living plant collections (27 species) back to the U.S. aboard the *SS Ulua* (Fairchild 1924a: 19–21). Twenty-three of these collections (20 species) are reported as from Panama (Appendix 3). Interestingly, 5 of the transported accessions (for 5 species) are stated to have Cuban provenance, although Fairchild's report does not explain how they were acquired. We cannot rule out that these plants may have been loaded in Havana on August 14 (*Diario de La Marina Edición de la Mañana* Year 92 (225): 3; Year 92 (226): 3, 11) as Fairchild was sailing from Havana to New York. A second possibility is that these plants were initially transported from Cuba to Panama on board the *SS Cartago* when Fairchild made his trip from the U.S. to Panama in 1924. Previous research (Montes Espín et al. 2021) has shown that Fairchild facilitated moving plant material from Cuba to Panama (mostly to Summit Gardens) during his expeditions; therefore, a third explanation would be that these Cuban plants had already been propagated in Panama when he arrived in the Canal Zone in late July. Fairchild's plans were for the plants carried aboard the *SS Ulua* to be propagated in the USDA station at Chapman Field, Miami, as indicated on page 47A (verso) of the August 10 letter that he sent to Lathrop. According to the USDA inventory reports,

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of the petiole and the thick hairy leaflets and unwinged rachis" make it difficult to provide a taxonomic identification for this particular plant.

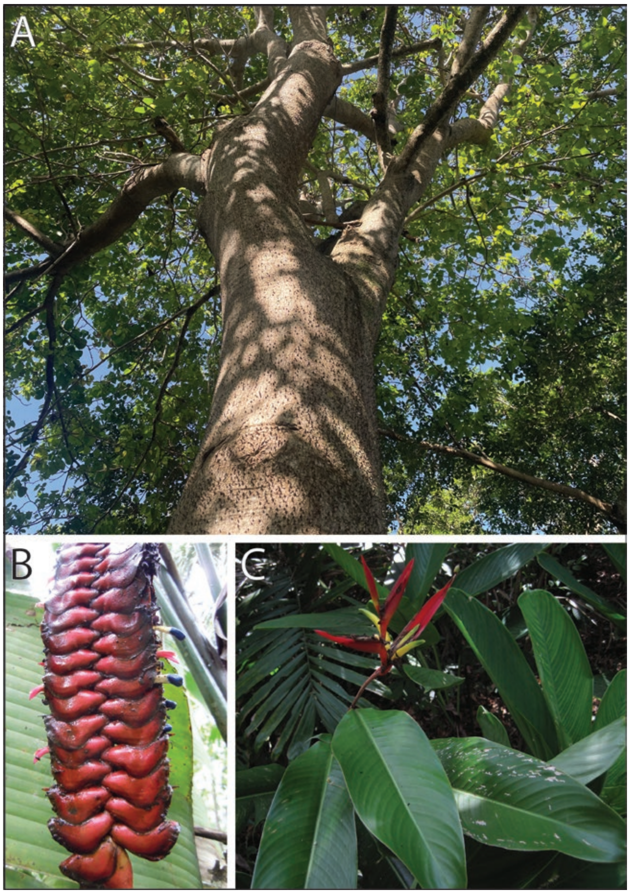

Figure 12. Images of plant species encountered by Fairchild during his 1924 trip to Panama. (A) *Hura crepitans* L. (Euphorbiacee), cultivated in Fairchild Tropical Botanic Garden. (B) *Heliconia mariae* Hook.f. (Heliconiaceae), in habitat in Soberanía National Park, Panama. (C) *H. vaginalis* Benth., in habitat in San Lorenzo National Park, Panama. (A) Photo by J. Francisco-Ortega. (B) Photo by Mark Fishbein. (C) Photo by A. Ibáñez.

Figure 13. Two of the legume species encountered by Fairchild during his 1924 trip to Panama. (A) *Cojoba rufescens*, specimen collected in habitat in Chiriquí, Panama. (B) *Prioria copaifera*, in habitat in Barro Colorado Island. Photos by Ricardo Brenes.

none of these accessions were ever recorded as being part of the germplasm collections of this federal agency (Appendix 3), except for those of *Garcinia humilis* (USDA accession number 61631) and *Manicaria saccifera* (USDA accession number 61629). The USDA records indicate that samples from five species [i.e., *Chamaedorea* sp., *Citrus* × *aurantifolia*, *Cojoba rufescens* (Fig. 13), *Elaeis guineensis*, and *Prioria copaifera* (Fig. 13)] that were not reported as transported by Fairchild as he traveled from Cristobal to New York were sent to the USDA by him, and they eventually reached the USDA germplasm collections (Appendix 3).

The collected plants were placed inside zinc propagation boxes (page 54A verso in August 19 letter of Fairchild to Lathrop), and we are not certain if Wardian cases were used during this trip. Pages 15–19 of Fairchild's (1924a) account are devoted to how to overcome the many technical difficulties of transporting living material inside different types of containers, particularly as they must be placed on ship decks. Twelve different items/recommendations, pertinent to his experience with this transportation practice, are listed and marked in this report. Two of Fairchild's previous works (Fig. 14) had already stressed how important it is to properly transport living material during plant-collecting endeavors, particularly when Wardian cases are used (Fairchild 1913, 1921: 1). This part of Fairchild's report highlights the challenges of plant-hunting trips during this period, as specimens had to be transported from the tropics to germplasm repositories in the temperate countries via long maritime journeys. These voyages took place on vessels that lacked specialized facilities for transporting living plant material. Interestingly, undergraduate research by Camas et al. (2020) shows that Fairchild also sometimes shipped the collected germplasm through airfreight services while he was travelling and exploring. This was the case during his 1932 expedition to the Caribbean Islands (Dorsett 1936).

Appendix 3 provides a taxonomic index of the plants that were encountered during the 1924 trip. Their biogeography and use by humans show that only eight of the species are native to the region (*Chamaedorea* sp., *Cojoba rufescens*, *Heliconia vaginalis*, *Hura crepitans*, *Manicaria saccifera*, *Philodendron* sp., *Prioria copaifera*, and *Vachellia melanoceras*), and were apparently encountered in their habitat; the rest of the species are from the Old World or other regions of the Americas.

Fairchild was a promoter of science education, and he wrote many popular botanical articles, mainly for *National Geographic* magazine (e.g., Fairchild 1922). He pioneered documentary filmmaking during his expeditions (Francisco-Ortega et al. 2020). As indicated

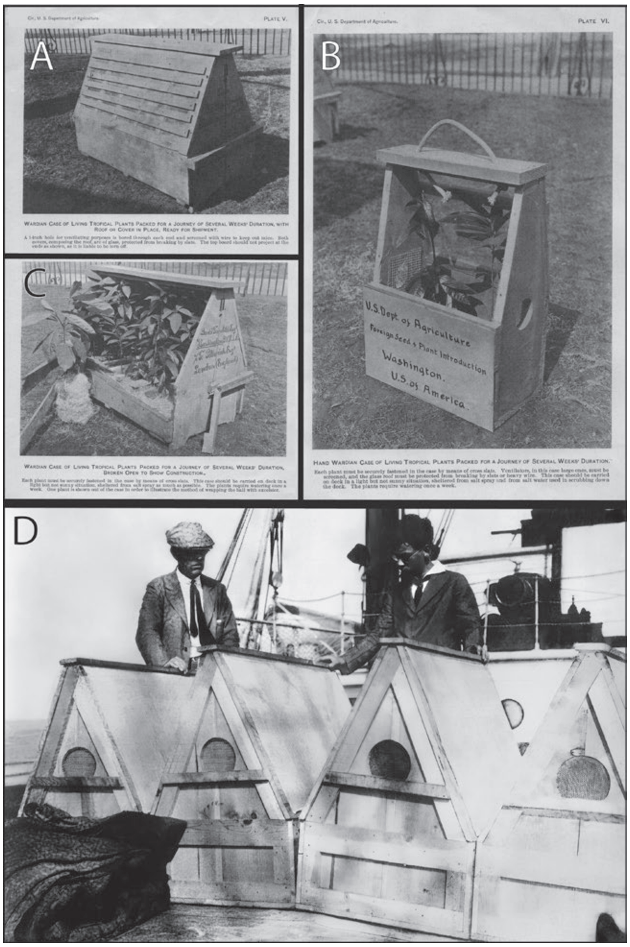

Figure 14. Wardian cases used by Fairchild during his plant-hunting expeditions. (A)–(C) As published in Fairchild (1913). Courtesy of the University of Illinois at Urbana-Champaign Library. (B) As published by Fairchild (1921: 1). Courtesy of Fairchild Tropical Botanic Garden.

above, in Panama (at the Community House of Balboa) he delivered a popular talk on mangosteens for which he used "lantern slides" (Fairchild 1924a: 3; *Star & Herald* 25(21017): 4; August 8, 1924; Online Supplementary Appendix 3). Furthermore, the same year he visited BCI he published a popular article highlighting the value of the island's habitats and field research facilities for studying neotropical biology (Fairchild 1924b).

Previous studies on Fairchid's legacy (e.g., Pauly 2007, Harris 2015, Stone 2018) have primarily highlighted his achievements as a plant collector, advocate for economic botany, and supporter for plant genetic resource research. Our study of Fairchild's unpublished account of the brief visit that he made to Panama in 1924 documents that he also was a well-rounded naturalist and supporter of tropical biology research. Clearly, in the early development of the BCI research laboratory, he played a key role in its emergence as a leading center for biological studies in the tropics.

ACKNOWLEDGMENTS

This paper pays homage to the trajectory of the Barro Colorado Island Laboratory, Smithsonian Tropical Research Institute, in promoting tropical biology research. We join other naturalists to celebrate its recent 100th anniversary (Fig. 2). Valeria Morey was supported by an FIU Kimberly Green Latin American and Caribbean Center–Global Learning Medallion Research Fellowship made possible by the center's U.S. Department of Education National Resource Center Grant. Javier Francisco-Ortega thanks support from Montgomery Botanical Center to conduct summer research. Andrés Delgado helped with the layout of photographs. Edgardo Civallero guided us with protocols to reproduce documents housed in the Smithsonian Institution; and Linette D. Dutari and Milton Solano helped us to locate some of these documents. Galey Williams provided guidance to locate relevant newspapers. Tom Croat helped with questions on the flora of BCI. Jeffrey Wells and Amy Zanne helped with initial questions on termite taxonomy. We are grateful to the following colleagues, who graciously shared with us details and bibliography on biogeography and taxonomy of some of the species encountered in on our research, Stephany Arizala (*Sericopelma*), Carla Black (*Heliconia vaginalis*), Ron Liesner, Terry Pennington (*Inga*), Monica Moraes (*Garcinia humilis*), and Gustavo Romero (*Catasetum viridiflavum*). Brett Jestrow kindly facilitated the study of documents and photos housed in ALFTBG, and located relevant species grown in the FTBG living collections, as well as identifying mango cultivars. Clyde Stephens helped with insights pertinent to the history of the United Fruit Company Steamship Service. The following individuals kindly provided plant photos shown in this contribution: Sabrina Amador (*Vachellia melanoceras*), Ricardo Breenes (*Cojoba rufescens*, *Prioria copaifera*), Mark Fishbein (*Heliconia mariae*), and Mabelin Santos (*Catasetum viridiflavum*). Thanks to the Centro Studi Erbario Tropicale (Herbarium FT) of the University of Florence (Italy) for sponsoring the publication and Riccardo M. Baldini (Editor in Chief of Webbia).

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APPENDIX 1

Transcript of Fairchild's (1924a) handwritten report pertinent to his 1924 voyage to Panama. Facsimile of this document is presented in Online Supplementary Appendix 1.

[Cover page]
FIELD BOOK of David Fairchild. Begun on the high seas en route Panama to New York August 16th 1924.
Closed in Utrecht Holland November 6th 1924
"Vol I" in "Index" at close of volume

[Page 1]
1924 August 16th Saturday
S.S. ULUA[5]
of United Fruit Co Line

Before the remarkable impressions of the visit to Panama fade, I want to jot some of them down. Even though I was so tired after each day of excitement that I couldn't do much with writing at the time.

I could hardly believe that the Sum[6] was the same place Horticulturally as the place which Dorsett[7] and I visited 3 years ago.[8] Let me draw the comparison.

Three years ago we landed with our Wardian cases,[9] were met by the cattle man Mr. Humphrey[10] who sent one case to a miserable place in Colon watched over by a colored man who had a collection of straw hats and who knew or cared nothing about plants. We went to Juan Mina[11] a neglected place also under negro management or rather mismanagement and we stayed in Marti's[12] house at Gamboa. There were no grafted avocado or mango trees in the Zone and I took off my coat and put in buds into private seedlings there in several people's back yards. White's[13] and Wilson's[14] for example

[Page 2]
and together with Humphrey + Burees[15] put in some buds at Frijoles.[16] Today I find a Plant Introduction Garden at Summit[17] where $21,000 a year has been spent and which is better planned than many of our own gardens. A dripless lath house full of plants. A propagating box in action. Large nurseries of successfully grafted mango + budded mango seedlings from which will be distributed thousands of fiberless mangos and good varieties of avocados. I find a very intelligent man in charge, Johansen,[18] and his assistants who have been well trained.
I find the specimen trees on all the driveways labeled as in no other place I have visited in the Tropics and I find an awakened interest in plants which I never suspected could be built up so quickly in Panama.
To all this is added the growth of all the trees into shady

[5] Postcard of the *SS Ulua* is shown in Fig. 6. The vessel belonged to the United Fruit Company Steamship Service, also known as the Great White Fleet, a company that was composed of ships that transported cargo and passengers mostly between the United States and the Caribbean, but that also reached Central and South America. Based on information found in the *Diario de La Marina* (morning edition 92 (225): 3, 1924), the *SS Ulua* made one call at Havana on August 14, 1924. Therefore, this handwritten report was prepared when Fairchild was cruising from Havana to New York.
[6] Abbreviation for Summit Gardens.
[7] USDA plant explorer Palemon Howard Dorsett (1862–1943), one of the most famous field botanists of the Section of Foreign Seed and Plant Introduction of the USDA. This federal organization was founded by David Fairchild in 1898 (Hodge and Erlanson 1956). Dorsett retired in 1932 (Anonymous 1932), and received the Frank N. Meyer Medal in 1936 (Fairchild 1936).
[8] A trip that Fairchild and his son, Alexander Graham Bell Fairchild (1906–1994), made with Dorsett to Panama in 1921 (Lisio et al. 2024).
[9] This is the name given among horticulturists to the containers that were commonly used to transport living plants, mostly on ships (Keogh, 2020; Fig. 14).
[10] J. H. K. Humphrey (Fig. 8) was the superintendent of the Panama Canal Zone Cattle Industry Division, Cristobal (Fairchild 1921: 18).
[11] Juan Mina is a site located on the bank of the Chagres River.
[12] Alfred Friedrich (Fritz) Marti (?–1956), from Switzerland, an employee on the canal (Anonymous 1956).
[13] Probably Hugh White, whom Fairchild met during the 1921 trip to Panama (Fairchild 1921: 103)
[14] We could not identify this person.
[15] It is likely that this word is a spelling error by Fairchild, and it refers to Lewis Anthony Byrnes (1884–1933; Fig. 8) who was supervisor for the Panama Canal Company (Fairchild 1921: 18, 19).
[16] Frijoles is a site on the Panama Canal railway, the station from which to access BCI by boat.
[17] See Elton et al. (2023) for details of the history of Summit Gardens.
[18] Holger P. Johansen (1898–1935), the first curator of living collections at Summit Gardens (Elton et al. 2023).

avenues, the bamboo into great clumps 40–50 feet tall and the flowering of such species of tree as *Cassia siamea* [Lam., accepted name *Senna siamea* (Lam.) H.S. Irwin Barneby, Fabaceae][19] along the driveways.

[Page 3]
This change is truly spectacular enough but when you add to all this a laboratory on Barro Colorado Island [thereafter BCI on footnotes] where I spent two or more weeks in company with three of the most brilliant and accomplished scientific men in America—in the very midst of the gorgeous tropical jungle—taking photographs with my long Tom camera[20] and working with my microscopes—the transformation from a place where there was no special interest in plants at all to one where a wide circle of people are getting to know about it—is very surprising—and all in 3 years' time.

To make the contrast seen more remarkable, I was privileged to hear in a packed house Dr. Wheeler[21] give a masterly discourse on ants. He said as he left me and went to bed, "I suppose that will be my last lecture on ants. I'm tired talking about them."

I was asked to give a lecture on "Mangosteens and Quarantine"[22] and I did—with lantern slides. See newspaper clippings in previous notebook.[23] At this lecture I showed fruits of *Garcinia tinctoria* [(Choisy) W. Wight, accepted name *Garcinia xanthochymus* Hook.f. ex T. Anderson, Clusiaceae[24]], which Johansen gathered for me from the tree of this species in the driveway.

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Wheeler of Bussey[25] came over to Cristobal to meet us at the steamer and we took the train at once for Panama. From this start off—the glorious green scenery of that ride across the Isthmus is an unforgettable thing anyway—to the last day on this steamer in New York the personality of Wheeler has taken a part—yes, the major part. For of all the persons I have traveled with I think he has proven by far the most excitingly interesting intellectually. His range of erudition is from Goethe and the French authors to the nomenclature of flagellated protozoans or the latest mathematical philosophy or the behavioristic hypothesis of psychiatrists or the principles of the Catholic Church—He is a most amazing personality with the widest range of any I have met in my life I think.

He has a way too as he said Boveri[26] once told him of "getting to the bottom of things."

On this first ride across with Zetek[27] + his wife + daughter who went with us from Havana to Panama on the S.S. Cartago,[28] Molino[29], the active interested young Panamanian assistant who took charge of the boys[30] in the back of the car and Wheeler, I realized that we were in for an

[Page 5]
intellectual treat and it has been one. I am ashamed that so few of Wheeler's remarkable ideas will be found in these notes for I was too busy hearing them to jot many of them down.

We went to the Annex of the Tivoli Hotel,[31] where Wheeler was staying and the first evening took dinner

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[19] This is an introduced species from Southeast Asia (Kumar et al. 2017). Common names: Siamese cassia, kassod tree, cassod tree, or cassia tree. The species has been used for its medicinal properties. In some parts of Asia its leaves and flowers are eaten as vegetables.

[20] A special camera designed by Fairchild to take close-up photos of specimens (Fig. 3). See additional details in Fairchild and Fairchild (1914), Mosely (2012), and Tasker (2014).

[21] Entomologist William M. Wheeler (1865–1937; Fig. 1) from Harvard University was an authority on ant biology and taxonomy (Carpenter 1938). He should not be confused with George C. Wheeler (1897-1991), an entomologist from Syracuse University who also joined Fairchild during his visit to BCI (Fig. 1).

[22] Fairchild highly valued the mangosteen, and he promoted the cultivation of this fruit from Tropical Asia in the Canal Zone (Lisio et al. 2024). See note 85.

[23] Page 21 of this expedition report attaches a clipping from the *Star & Herald* newspaper (from August 6, 1924) announcing the talk (see also Online Supplementary Appendix 3). The *Star and Herald* was a Panamanian daily newspaper, published in English and Spanish, from 1920. Today it is still published, but only in Spanish.

[24] A relative of the mangosteen from Tropical Asia (from eastern India and Bangladesh to Taiwan; Ngernsaengsaruay et al. 2023) whose edible fruit can be used to make vinegar and preserves. The dried sap makes the pigment gamboge, used as a dye and in watercolor painting. Common names: False mangosteen, gamboge, yellow mangosteen, Himalayan garcinia, or sour mangosteen.

[25] Bussey Institute, a biological institute at Harvard University. Named after Benjamin Bussey (1757–1842), a wealthy businessman who contributed to the establishment of the Arnold Arboretum.

[26] Theodor Boveri (1862–1915), German zoologist specializing in cytology and embryology.

[27] James Zetek (1886–1959; Figs. 1, 8), entomologist, was one of the founders and first director of the BCI research station until 1956, when he retired (Snyder et al. 1959; Hagen 1990).

[28] The *SS Cartago* (Fig. 6) was operated by the United Fruit Company, and it provided service between New Orleans and Panama with a stopover in Havana. The vessel was at the Havana docks on July 8, 1924 (*Diario de La Marina*. Evening edition 92 (139): 3, 1924). The joint trip that Fairchild made with Zetek from Cuba to Panama on board the *SS Cartago* is also reported in the *Star & Herald* (25(20997): 1,9; July 19; 1924 (Online Supplementary Appendix 3).

[29] Ignacio Molino (Figs. 1, 8) was a Panamanian lawyer who assisted James Zetek in establishing the BCI laboratories (Anonymous 2024). We could not locate additional biographical details of this naturalist.

[30] Graham Fairchild (Fig. 1) and Frederick Burgess (Fig. 1). The latter was a friend of Graham's, and his involvement during this expedition is mentioned by Wheeler (1924, 1925).

[31] A grand hotel run by the Panama Canal Company that was located in Ancon, Panama City. It was the main hub for social events in the Canal Zone.

with Wheeler at a downtown restaurant. We got our meals at the Commissariat Restaurant where their food was very good and very cheap, meals ranging from 35 to 75¢ each. The Annex rate was $1.50 per day for rooms.

The next day we went out to Barro Colorado Island and left the boys with Banks[32] who was already out there. Two days later we came back and the show was then on in full swing. Later Curt Richter[33] came and then the play of intellectual interest was simply like the play of fireworks. Once in a while Wheeler would go and lie down saying

"This is too exciting too exciting." We all bunked in the same room and

[Page 6]
in the morning like a lot of school girls sat on each other's bunks and discussed biological problems at a rate which was to me simply great.
Let me jot down some of the exciting things that I remember.

Wheeler discovered every day or two some new fungus-cultivating ant. He showed me this new ant *Wheeleromyrmex*[34] which lives with a fungus cultivating ant a *Sericomyrmex* [Hymenoptera, Formicidae, Attini][35] (I think it is) as a friend. He described how he saw one of the host ants licking one of these Wheeler ants all over. The Wheeler ant lay back and let itself be licked. He thinks they have a coating of some kind which the host ants like and this is why they tolerate it in the nest. The Wheeler ant tends its own young, eats the mushroom hyphae and goes about just like the host ants.
These live together as peacefully as the negroes do among us whites.[36]
He called my attention to the behavior of the stingless bees. Some of them smell like

[Page 7]
rancid coconut oil. There was one evening a swarming of a whole nest of females. Brown Trigonas [genus *Trigona*, Apidae, Hymenoptera, Meliponini].[37] Young females which came out about dusk and "danced" for 15 minutes violently in the air and like sheep[38] disappeared one by one back into their nest in a hollow tree. There were no males present.

The trails were swarming with interesting insects. Banks brought in about 30,000 I judge and put them in bottles. He and Wheeler both say that the thing which amazed them was the extraordinary number of species represented by only a few individuals of a single kind. Whereas in the North you find myriads of individuals of the same species.

The Calobata[39] [Diptera, Micropezidae, Taeniapterinae] performance which Banks discovered and which we all studied[40] was an amazing thing and one which must affect any theory of heredity which anyone gets up. As Wheeler says the trouble with our studies of biology is that we are animals—a part of biology. The mathematicians +

[Page 8]
physicists + chemists can go far in their study of phenomena for they can get away completely in their studies of things from themselves whereas we continually anthropomorphize—and cannot seem to help it. We view everything alive as though it had emotional value of some kind or other like we have ourselves.

But these Calobatas not over ¾ in long!

Their courtship is as complicated even more so than that of most of the so-called higher animals.

Wheeler says that in some species the male catches an insect and feeds it to the female before mating with it. In others it presents her with a bit of stick or leaf. In others it blows a bubble with its mouth and presents that. In the Calobata it regurgitates a drop of fluid and deposits it on the side of the female's head and she takes it off with her foreleg and puts it in her mouth.

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I cannot feel that it is an imaginary analogy with which we have to deal here. It means that before we can understand

[32] Entomologist Nathan Banks (1868–1953; Fig. 1) from Harvard University (Carpenter Darlington 1954).
[33] Neurobiologist Curt P. Richter (1894–1988; Fig. 1) from Johns Hopkins Medical School, who conducted studies in BCI (Schulkin 2005).
[34] This word is a spelling error by Fairchild, and it refers to *Wheelerimyrmex*; accepted name *Magalomyrmex*, a genus that is native from southern Mexico to South America, reaching BCI (Longino 2010).
[35] This is a neotropical genus with eleven species. Two of them occur in BCI (Ješovnik Schultz 2017).
[36] Fairchild expressed the mainstream views of white people in the U.S. of his time.
[37] *Trigona* is a genus of stingless bees. According to Roubik (2023), this genus has eight species on BCI.
[38] The text gives a simile for the way the insects left; they disappeared one by one like sheep, going to their barn.
[39] *Cardiacephala arthritica* (Borges Ferro 2019).
[40] Wheeler (1924) published a research paper on this insect's behavior based on studies he made when Fairchild was visiting BCI.

the phenomena of the living organisms around us we must stop this way we have of measuring things statically.

Everything is moving. Every attempt to interpret is an attempt to stop the whirling things and take a mental photograph of them. It might be compared to the photograph of a horse in motion, jumping. We discuss everything in nature by comparing these abstractions which are purely static things.

Try to think for example of Man and then discuss his attributes. He is first just two half nuclei in two other individuals—then he is a collision of these two daughter nuclei in the uterus. Then he is a whirling storm of ions, dividing nuclei, splitting chromosomes, cell walls, streaming protoplasm, forming proteins + decaying substances, around that storm center.
[Side note written in the margin by David Fairchild: "This reflection on life is the best I ever wrote and now Sept 1 1948—24 years after it was written, I read it with a feeling of wonder. D. F. Baddeck N. S. (Nova Scotia)."]
Then he

[Page 10]
is visible as a thing large enough for the eye to see—reflecting light + appearing to the eyes of other creatures who have gone through the same performance earlier as a round ball. Later he appears as having a form which resembles the matur[t]er thing. In time he leaves the darkness of the mother "cell" and is thrown out into the light with the habits of his prenatal existence fixed on him. From birth on he is a familiar sight to others of his kind but he is traveling up to puberty + the reproductive stage and then down to senility and old age—always changing—never for a moment stopping in his swift flight from conception to the grave.
It is from this standpoint of a peek into the mysteries of existence that the *Calobata* should be viewed—not by trying merely to think of these flies as though they were tiny human beings.
Is it not marvelous that creatures no larger than a pin should court one another with as remarkable a courtship—yes a more ceremonious courtship by far than that of a monkey—yes than that of millions of human beings? What does it mean? Either the behavior of

[Page 11]
humans is a cosmic thing fixed by cosmic laws and not as man is so fond of believing, a thing controlled by our wills, or these tiny creatures are controlled by their wills and their loves and are like the lovers which we admire in our human existence.

Standing there in the jungle with the sunlight playing on the leaves of a species of Piper + watching these creatures with Wheeler of Harvard and Richter of Johns Hopkins will long remain in my memory as one of the most amazing things I have ever done. It was like peeking over into a new field of wonders which had heretofore been hidden from my view so that I did not even suspect its existence. The dance of the male before the female, the waiting posture of the female, the first kiss of the male, and the periodic regurgitations of the male wiped off by the forelegs of the female are facts of peculiar significance

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if viewed from the standpoint of the behaviorist who is trying to explain sex.

Then too there are the snout beetles [Curculionidae] of which the male has a special pair of pincers with which it pulls the female out when it gets its bill stuck in the wood when it is trying to make a hole in which to lay its egg. I did not see this process but did the pincers of the male which are of very peculiar construction.

The amazing lianas along the trails interested me. The ability of a tendril of one of these to grasp the very tip of a bamboo leaf and hold fast to it and pull itself up was amazing to me. It does it by folding its slender length back + forth over the tip of the leaf. I found it impossible to detach its tendril without har[m]ing the leaf [drawing of liana tendril attached to the tip of a leaf is shown on the right side of this text].

[Page 13]
The growth of aerial roots from the cut end of a giant liana in its attempt to reach the soil, I
photographed and measured (see previous notes).[41]

The strength of the aerial roots of what I take to be *Philodendron lacerum* [(Jacq.) Schott, identified as *Philodendron* cf. *radiatum* Schott (Araceae)][42] which hung from plants perched in the top branches of tall forest trees was such that Graham and Freddy hung + swung on them (see photos).[43]

The extrafloral nectaries of the Ingas [genus *Inga*,[44] Fabaceae] were tremendous—on very young leaves. Ants

[41] See photos 00535 and 00553 (Table 1).
[42] See note 3.
[43] See Photo 00540 (Table 1). However, the photo located in ALFTBG is not of good quality.
[44] *Inga* is a Neotropical genus, well known for having extrafloral nectaries (Koptur 1994).

were drinking from them as horses would from great flat broad fountains. Nectar drops gathered + filled these nectars at night + I found them full to overflowing in the morning.

The fights of ants + termites which we witnessed were as exciting as the cock fights we saw in Panama. The attas [genus *Atta*, Hymenoptera, Formicidae, Attini] refused to fight—simply stalked about among the

[Page 14]
termites[45] like a large St. Bernard dog does among a lot of puppies. Certain small active ants fought the termites to the death. I watched one hang on for 15 minutes to the antenna of a worker termite. How much longer he might have hung I don't know.

I am convinced that one could go to B.C.I. [Barro Colorado Island] + spend months studying these ant termite reactions toward each other.

The orchid *Catasetum viridiflavum* [Hook.],[46] which the boys found on a stump in the lane has the characteristic of throwing its pollinia[47] some distance when touched. Mr. Powell[48] told me he had seen it thrown 2 feet from the flower. This pollinia is of large size and it sticks to the hand so firmly that it takes quite a pull to detach it.

Richter observed that the weeds and shoots coming up from the

[Page 15]
stumps around the house have grown with less rapidity than weeds and water sprouts grow in the North. I am inclined to think he is right about it.

Of course[,] the days were short 12 hours only[,] and there were many very cloudy days so that the amount of sun's energy expended was little in comparison with the sunlight on a summer day of 16 hours in the north.

The most amazing ant on the place was the *Paraponera clavata* [Hymenoptera, Formicidae, Paraponerinae],[49] a jet-black stinging species which comes right out of its nest and attacks you. See photo.[50]

Experiences with Plant Propagating Box[51]

a) The Zinc Plant Propagating Box has the advantage of being air tight. The idea of Leet of enclosing the wooden box completely in zinc + glass is a good one. It permits quick

[Page 16]
access to the box without letting too much air escape. I think side ventilating holes are unnecessary. I have not opened them and unless more heat develops than has on board ship so far I don't think they would be necessary.
(B) A method of labeling the plants is required for one will want to pile it full of seeds, seedlings and cuttings as well as economize space and labels would make this difficult
(C) The method of cooling with damp burlap is all right and the top tank to hold water is O.K. I think
(D) The danger of upsetting the plants when in the box and the cuttings falling out is great. I have not solved the problem of how to hold the sphagnum down. Slats which would be movable might do—or burlap full of many

[Page 17]
holes. Possibly by watching to see that the box is kept always level is the best way.

(E) The danger from shade while the box is in a freight shed turned out not to be so serious as I thought it would. Plants will stand a good deal of shade I find

(F) The chief trouble has been that the sun's heat is not enough to keep a high temperature at night. An electric apparatus or some other small heater will be necessary to supplement the sun's heat or the plants will not strike from cuttings even though they may callous.

(G) Some such collecting case for cuttings which I can carry on shore when we stop ashore and collect is essential. Since there is no electricity in Java['s] rotten hotels[52]

[45] There are at least ~60 species of termites on BCI; however, to our knowledge there is no overall study of the termite fauna of the island.
[46] This is a Panama endemic (Fig. 9). Reports on the occurrence of this species elsewhere need further study (Gustavo Romero, Harvard University pers. comm.).
[47] Fairchild used the term *pollenodium* in this report.
[48] Charles Wesley Powell (1854–1927), a self-taught horticulturalist and orchid specialist, established the first large-scale collection of Panamanian orchids (Anonymous 1928).
[49] *Paraponera* is a monotypic genus, and *P. clavata* (known as *hormiga bala* or bullet ant because of its painful bites) has its natural distribution from Central to South America (Pérez et al. 1999).
[50] We could not locate this photo.
[51] We are not certain if during this trip Wardian cases (see note 9, Fig. 14) were used to transport living plants from Panama to the U.S. As an alternative to this kind of container Fairchild makes arguments in favor of zinc and glass propagation boxes.
[52] Fairchild had previously lived in Java for a few months in 1896 (Fairchild 1938: 59–81; Lawrence 1964), where among other topics he studied "fungus gardens of the white ants [termites]" (Fairchild 1930: 385,

I think an alcohol lamp will be necessary though at night there temperatures of 80 at night are common

[Page 18]

(H) Some wedges or metal clamps for making legs to level up the box on a sloping roof of a hatch are necessary.

(I) Better access to the box than the present wire lock is necessary.

(J) A slat shade for the plant box itself would be an advantage.

(K) Some way to use the sides of the box for sprouting seeds would be an advantage

(L) It is entirely too heavy! Must be lighter

At BC [Barro Colorado] Lab. I kept the box just outside the lab and filled stuff into it, and it remained about +80° most of the time and to my surprise many of the plants retained their leaves quite turgescent. Little sunlight. Not more than once did the temp. go to over 90 °F. I had little difficulty in keeping a differential

[Page 19]
between the prop. box and the sun box, by wetting down the burlap.
I put the following things in it in Cuba. Some have calloused and others died and been thrown out.

Cuba:[53]
Annona purpurea [Moc. Sessé ex Dunal (Annonaceae)][54] died (Soncoya). Cuttings
Bread fruit cuttings[55]. Died
Momordica cochinchinensis [(Lour.) Spreng. (Cucurbitaceae)][56] cuttings
still alive + calloused.
Sterculia virginica [Malvaceae][57] seedlings in seed pod, one large with cotyledons green. Some still alive now.
Citrus hystrix [DC. (Rutaceae)[58] Cuttings held color many days but failed to
callous and finally after 4 weeks died.

Panama:

Unidentified liana with thick leaves, rooted plant

Bread fruit (seedless) from Frijoles.[59]
Heliconia hirsuta ? [L.f., *Heliconia vaginalis* Benth, Heliconiaceae][60] B.C. Isl. [Barro Colorado Island]. Lathrop trail.[61] Single plant.
Rheedia lateriflora [L., accepted name *Garcinia humilis* (Vahl) C.D. Adams, Clusiaceae][62] Seeds
Undetermined large flat seeds 2 1/2 inches across
Manicaria saccifera [Gaertn. (Arecaceae)][63] Monkey Cap Palm. Large round dark pollen, seeds

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1938: 66–70, 64D, 64E). Subsequently to the 1924 visit to Panama he traveled to this Indonesian island again in 1926 as part of the Allison Vincent Armour Expeditions for the USDA (Fairchild 1927, 1928: 99–101, 1930: 382–444; Francisco-Ortega et al. 2020).

[53] It is not clear why Fairchild provides this list of material from Cuba in this report. One possibility would be that on his way back to the U.S. when the *SS Ulua* made a call in Havana on August 14 (*Diario de La Marina*. Morning edition 92 (225): 3, 1924) these plants were loaded; however, we cannot rule out that these Cuban plants were already grown in Panama in 1924. Previous research (Montes Espín et al. 2021) has shown that Fairchild facilitated moving plant material from Cuba to Panama (mostly to Summit Gardens). A third possibility is that these plants were initially transported from Cuba to Panama on board the *SS Cartago* when Fairchild made this trip from New Orleans to Cristobal in 1924.

[54] The native range of this tree species (common name soncoya) is from Mexico to Venezuela. It has edible fruit, and it is occasionally cultivated (Topete-Corona et al. 2020). In Panama this species is known as tagua

[55] *Artocarpus altilis* (Parkinson) Fosberg, Moraceae.

[56] The native range of this perennial climber (known under the common name of gac), which produces edible fruit, is from China to the Indian subcontinent (Do et al. 2019).

[57] We could not locate the specific epithet *virginica* in the consulted taxonomic literature and databases.

[58] This species (common names: Kaffir lime, makrut lime) is from Southeast Asia and cultivated for the culinary value of its fruit and leaves, particularly in Thai cuisine (Agouillal et al. 2017).

[59] See note 55.

[60] It appears that Fairchild was not certain about the taxonomic identity of this species. *Heliconia hirsuta* L.f. has not been recorded on BCI (Croat 1978). It seems that Fairchild confused it with *H. vaginalis*, which is the most common species of the genus on this island. The latter is native from Mexico to Ecuador (Croat 1978; Kress 2001).

[61] Most of the walking trails on BCI are named after personalities associated with the history of its station (Fig. 2). This particular trail honors Barbour Lathrop (1847–1927), the wealthy philanthropist who was a key person in the early development of Fairchild's plant-hunting and economic botany career and expeditions (Harris 2015: 15–68). During this visit Fairchid sent a letter to Lathrop (August 10) indicating that this was the first trail created on the island in recognition of his sponsorship in establishing the field research facilities there.

[62] The achachairú is a tree with edible fruit (Tome et al. 2019). Regarding its biogeography, reports suggesting that it is a Bolivia endemic (e.g., Tome et al. 2019) need to be revisited as the species is not listed in the most recent floristic catalogue for that country (Jørgensen et al. 2014).

[63] The native range of this palm is Trinidad to Central and South America (Read 2001; Hammel et al. 2003). The species has been reported to have at least 36 ethnobotanical uses. Among them, it provides a source for fiber, edible fruit, and materials for thatching and basketry (Copete et al. 2018). Common names: Napa, cabecinegro, monkey cap.

germinating.[64] from Fort Sherman.[65]
Monkey Fruit.[66] Undetermined
Prosopis [Fabaceae][67]– with red pods. from B. C. [Barro Colorado] Lab.
Isola de las Hormigas [Isla Hormiga][68]

[Page 20]
Rheedia edulis [(Seem.) Planch. Triana, accepted name *Garcinia intermedia* (Pittier) Hammel,
Clusiaceae][69]. Small seeded small
fruited species in tin box

Heliconia mariae ? [Hook.f. (Heliconiaceae)][70] Dark seed in tin box
Heliconia(?)[71] with white flowers in larger
bract. blue in color

in tin box [drawings of (1) a rounded structure with wavy marks and (2) an elliptical structure without any decorations are shown at the right side of this text].

Heliconia sp. ? see painting[72] + specs.
long lax flower cluster [drawings of what appears to be a lax inflorescence is shown at the right
side of this text].

Cahon de Elephante[73]. Large rugose seed. ¾ inch
Immense flat seed. Undetermined.

Seed size of a small saucer

Alpinia [L., likely to refer to *Renealmia* L., Zingiberaceae][74] with pink fruits from Fort
Sherman. Small fine seeds [drawing of what appears to be three seeds is shown as part of the
text]. See photo by Freddy[75]

Spondias lutea [L., accepted name *Spondias mombin* L., Anacardiaceae].[76] Single young plant
with pinnate compound leaves
Heliconia mariae [Hook.f. (Heliconiaceae)][77] seedling etiolated
but may pull through

Acacia multiglandulosa [Schenck, accepted name Vachellia melanoceras (Beurl.) Seigler Ebinger,
Fabaceae][78] in tin box. may live!

I propose to put below in the sun box the following 6 potted seeds.
Pots 1 + 4 *Rheedia lateriflora* [L., accepted name *Garcinia humilis* (Vahl) C.D. Adams, Clusiaceae].[79]
[Drawing of a rounded structure without any decorations is shown at the right side of this text]. Probably not this species but *R. madruno* [(Kunth) Planch. Triana, accepted name *Garcinia madruno* (Kunth) Hammel][80] as evidenced by Lee's Herb. specimen see p. 219 of their book.

2-3-5 *Heliconia* [Heliconiaceae] (sp. see painting[81])

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[64] The content of this text is not easy to interpret. The pollen of this species it is not black; however, the seeds have this color and are relatively large (~5 cm in diameter).
[65] Fort Sherman was a military base located at the Caribbean end of the Panama Canal, on the west bank. Most easily accessed from BCI by boat across Gatun Lake.
[66] *Artocarpus lakoocha* Wall ex Roxb. (Moraceae) is also known by the common names: monkeyjack and lakoocha. It has a native range from India to South-East Asia. Its bark is used to treat skin ailments, and it bears edible fruit (Jagtap Bapat 2010).
[67] *Prosopis sensu lato* is native to the Old and New Worlds and includes the mesquites and New World algarrobos. Recent phylogenetic studies support the genus is actually split into six genera, with *Prosopis* L. *sensu stricto* found in the Old World. The Central American species of this group are currently accommodated in *Neltuma* Raf. (Hughes et al. 2022); however, none of the species of this group has been reported as growing naturally on BCI (Croat 1978).
[68] Small island located near BCI, Colon Province, now in Colon Province, though in the Canal Zone until 1979.
[69] This species has a native range from Mexico to Panama (Andrés-Agustín et al. 2021). It is sometimes cultivated for its edible fruit. It is known under the common names lemon drop mangosteen, cherry mangosteen, limoncello, and toronjil. The species also has medicinal properties.
[70] This species' native range is from Guatemala to Colombia and Venezuela (Kress 1984; Kress et al. 2004; Rangel Marquina et al. 2016). Common names: Platanillo or beef steak (Fig. 12).
[71] The genus *Heliconia* (~100 species) is native to the Neotropics, Pacific Islands, and Tropical Asia.
[72] Pencil drawing made by Fairchild is shown adjacent to this text.
[73] Interpreted as *Dillenia indica* L., Dilleniaceae (common names: Elephant apple, ou tenga). Its fruit is used to make curries and jams, and it is native from India to Borneo (Oldfield 2020).
[74] *Alpinia* does not grow naturally in Panama and we interpreted that Fairchild was referring to *Renealmia*, a genus with ~150 species, with a natural distribution in the Neotropics and Tropical Africa.
[75] We could not locate this photo.
[76] This species bears the common names yellow mombin and hog plum, and has its native range from Mexico to Brazil (Mitchell Daly 2015). It has various medicinal uses.
[77] See note 70 (Fig. 12).
[78] This is a Panamanian endemic (common name Cachito; Fig. 11), and one of the species of the genus with large stipular spines that host aggressive ants, belonging to the *Pseudomyrmex ferrugineus* group, Hymenoptera, Formicidae, Pseudomyrmecinae (Seigler Ebinger 1995; Ward Branstetter 2017).
[79] See note 62.
[80] This is a species native from Central to South America. Common names: Charichuela, canime, currucay, or palo de aceite.
[81] See note 71.

6 *Heliconia mariae* [Hook.f. (Heliconiaceae)][82]

[Page 21]
Large seed of Ivory Nut Palm[83] loose
in sphagnum 3 cornered [+ sketch].

Large seed of *Lucuma mam[m]osa*[84] [accepted name *Pouteria sapota* (Jacq.) H.E.Moore Stearn, Sapotaceae for *Sapota mammosa* Mill.] rough yellow

[Newspaper clipping announcing the talk on mangosteens that Fairchild delivered. Handwritten text by David Fairchild on this clip reads: "Aug. 6th, Star Herald."][85]

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[82] See note 70 (Fig. 12).
[83] *Phytelephas seemannii* O.F. Cook., this is a palm native to Colombia and Panama whose seeds are used for crafting. The seeds were also used for making buttons before plastic. The species is known as tagua in Panama.
[84] We could not find the name "*Lucuma mammosa*" in the taxonomic literature, and it appears that Fairchild was referring to *Sapota mammosa* (Accepted name *Pouteria sapota*). *Pouteria sapota* is considered to have a native distribution from southern Mexaco to Nicaragua (Pennington 1990). It has the common names mamey zapote, mamey, and zapote; and it is widely cultivated for its edible fruit.
[85] See note 22.

APPENDIX 2

Terrestrial invertebrate taxonomic index: Insect and spider species reported by David Fairchild during the 1924 trip to Panama.

Accepted species name	Native distribution	Photo number in Fairchild Tropical Botanic Garden records / Figure number in this paper	Page number in Fairchild's (1924a) report
Apterostigma collare, Formicidae, Attini	Costa Rica and Panama	00542 / -	
Apterostigma sp., Formicidae, Attini	Mexico to South America	00541 / -	
Atta cephalotes, Formicidae, Attini	Mexico to Argentina	00549, 00660 / 3	13
Cardiacephala arthritica, Micropezidae, Taeniapterinae [*Calobata* sp.][a]	Belize to Venezuela	- / -	7, 8, 10
Eciton hamatum, Formicidae, Dorylinae	Mexico to Brazil	00662 / -	
Ectatomma tuberculatum, Formicidae, Ectatommini	Mexico to Argentina	00551 / -	
Magalomyrmex, Formicidae, Solenopsidini	Mexico to Argentina		6
Mycetophylax strigatus complex, Formicidae, Attini	Central to South America	00546 / -	
Paraponera clavata, Formicidae, Paraponerinae	Honduras to Argentina	- / -	15
Sericomyrmex sp., Formicidae, Attini	Mexico to Brazil	00550a / -	6
Sericopelma sp., Araneae, Theraphosidae	Central America	00537 / 3	
Termitoidae sp., Isoptera	Worldwide	- / -	13, 114
Trachymyrmex sp., Formicidae, Attini	United States to Argentina	00443, 00545 / -	
Trigona sp., Apidae, Meliponini	Mexico to Argentina	00547 / -	7

[a] The species reported by Fairchild (1924a) as *Calobata* sp. was identified as *Cardiacephala myrmex* [accepted name *C. arthritica*] by Wheeler (1925).

APPENDIX 3

Plant taxonomy index: Species reported/collected by David Fairchild during the 1924 trip to Panama. Plants from Cuba or Panama that were transported on board the *SS Ulua* are indicated with one or two asterisks respectively.

Accepted species name[a]	Native distribution	Photo number in Fairchild Tropical Botanic Garden records / Figure number in this paper	Page number in Fairchild's (1924a) report	USDA germplasm accession number
**Annona purpurea* Moc. & Sessé ex Dunal, Annonaceae	Mexico to Venezuela	- / -	19	
*, ***Artocarpus altilis* (Parkinson) Fosberg, Moraceae	Malaysia and Philippines	- / -	19	
***Artocarpus lakoocha* Wall. ex Roxb., Moraceae	Tropical Asia	- / -	19	
Catasetum viridiflavum Hook., Orchidaceae	Panama[b]	00534, 00664 / 9	14	
Chamaedorea sp., Arecaceae	Mexico to South America	- / -		61626
Citrus × *aurantiifolia* (Christm.) Swingle, Rutaceae	Southeast Asia	- / -		61312
**Citrus hystrix* DC., Rutaceae	Southeast Asia	- / -	19	
Cojoba rufescens (Benth.) Britton & Rose [*Inga rufescens* Benth.], Fabaceae	Central America to Ecuador	- / 13		61628
***Dillenia indica* L., Dilleniaceae	Tropical Asia	- / -	20	
Elaeis guineensis Jacq. [*E. melanococca* Gaertn.], Arecaceae	Tropical Africa	- / -		61627
***Garcinia humilis* (Vahl) C.D.Adams [*Rheedia lateriflora* L.], Clusiaceae	Neotropical	- / -	19, 20	61631
***Garcinia intermedia* (Pittier) Hammel [*Rheedia edulis* (Seem.) Planch. & Triana], Clusiaceae	Mexico to Panama	- / -	20	

(Continued)

Accepted species name[a]	Native distribution	Photo number in Fairchild Tropical Botanic Garden records / Figure number in this paper	Page number in Fairchild's (1924a) report	USDA germplasm accession number
Garcinia madruno (Kunth) Hammel [*Rheedia madruno* [(Kunth) Planch. & Triana], Clusiaceae	Central to South America	- / -	20	
Garcinia xanthochymus Hook.f. ex T. Anderson [*G. tinctoria* [(Choisy) W. Wight], Clusiaceae	Tropical Asia	- / -	3	
***Heliconia* cf. *mariae* Hook.f., Heliconiaceae	Guatemala to Colombia and Venezuela	- / 12	20	
** *Heliconia vaginalis* Benth. [*Heliconia hirsuta* L.f.[c]], Heliconiaceae	Mexico to Ecuador	- / 12	19	
***Heliconia* sp., Heliconiaceae	Tropical America, to Malaysia and Pacific	- / -	20	
Hura crepitans L., Euphorbiaceae	Caribbean Islands, and from Central to South America	00965 / 12		
Inga sp., Fabaceae	Mexico to South America	00544 / -	13	
***Manicaria saccifera* Gaertn., Arecaceae	Trinidad, and Central to South America	01537 / 10	19	61629
**Momordica cochinchinensis* (Lour.) Spreng., Cucurbitaceae	Tropical Asia and Australia	- / -	19	
Philodendron cf. *radiatum* Schott [*P. lacerum* (Jacq.)] Schott,[d] Araceae	Mexico to Colombia	00540		
***Phytelephas seemannii* O.F. Cook, Arecaceae	Colombia and Panama	- / -	21	
** *Pouteria sapota* (Jacq.) H.E.Moore & Stearn [*Lucuma mammosa*[e]], Sapotaceae	Mesoamerica	- / -	21	
Prioria copaifera Griseb., Fabaceae	Jamaica and Nicaragua to Colombia	- / 13		61630
***Prosopis* sp. *sensu lato*, Fabaceae	Tropics and subtropics	- / -	19	
***Renealmia* sp. [*Alpinia* sp.], Zingiberaceae	Tropical Africa and Americas	- / -	20	
Senna siamea (Lam.) H.S. Irwin & Barneby [*Cassia siamea* Lam.], Fabaceae	Southeast Asia	- / -	2	
***Spondias mombin* L. [*S. lutea* L.], Anacardiaceae	Mexico to Brazil	- / -	20	
Sterculia sp., Malvaceae	Tropics and Subtropics	- / -		61632
**Sterculia* virginica,[f] Malvaceae	Unknown	- / -	19	
***Vachellia melanoceras* (Beurl.) Seigler & Ebinger, [*Acacia multiglandulosa* Schenck], Fabaceae	Costa Rica and Panama	00548, 11795, 12321, 12322, 12325, 12326, 12328 / 11	20	

[a] Name provided by David Fairchild is shown in brackets when it differs from the accepted name.
[b] This is a Panama endemic; reports on the occurrence of this species elsewhere need further study (Gustavo Romero, Harvard University pers. comm.).
[c] *Heliconia hirsuta* L.f. has not been recorded on BCI (Croat 1978). It sems that Fairchild confused it with *H. vaginalis* Benth., which is the most common species of the genus on this island.
[d] *Philodendron lacerum* is a Caribbean Island endemic. The species was misidentified by Fairchild (see note 3).
[e] We could not locate the specific epithet *mammosa* in the consulted taxonomic literature and databases. It seems that Fairchild was referring to *Sapota mammosa* Mill.
[f] We could not locate the specific epithet *virginica* in the consulted taxonomic literature and databases.

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Microlicia geraizeira (Melastomataceae, Lavoisiereae): A newly discovered species from northern Minas Gerais, Brazil

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Abstract. One-third of Brazilian melastomes occur in Minas Gerais, the most floristically diverse state in the country. In this paper, we introduce *Microlicia geraizeira*, a new species of Melastomataceae exclusively collected in the Serra Nova e Talhado State Park, northern Minas Gerais. The new species has leaves, hypanthia, and sepals densely covered with spherical glands mixed with glandular trichomes, elliptic-lanceolate to oblong-lanceolate leaf blades, urceolate hypanthia, triangular to narrowly triangular sepals, pentamerous flowers, dimorphic and concolor androecium, tetrasporangiate anthers, and five locular ovaries. We compare *M. geraizeira* to *M. gentianoides*, *M. indurata*, *M. macrantha*, *M. mellobarretoi*, *M. pilosa*, and *M. septentrionalis*. Also, we provide an illustration plate, field images, an occurrence map, and an identification key for closely similar species.

Keywords: *Campo rupestre*, conservation area, endemism, Espinhaço Range, Gerais.

INTRODUCTION

Brazil has the highest Melastomataceae Juss. diversity in the world, with approximately 1,500 species (Ulloa Ulloa 2022; Goldenberg et al. 2024). Minas Gerais is the most plant-diverse state in Brazil, housing 14,786 species of angiosperm (Flora & Funga do Brasil 2024) and is home to one-third of the Brazilian melastomes (Goldenberg et al. 2024). Among the neotropical melastomes, *Microlicia* D.Don is the second largest genus, with nearly 300 species (Versiane et al. 2021; Pacifico and Almeda 2022), mainly occurring in grasslands and *campo rupestre* areas of Minas Gerais (Pacifico et al. 2020).

This unique diversity in Minas Gerais results from the state's distinctive landscapes and environments directly influenced by its topography and soil characteristics (Drummond et al. 2009). The state hosts more than 300 conservation units managed by government authorities (MMA 2024), which are crucial to preserving and safeguarding its biodiversity. One such conservation unit is the Serra Nova and Talhado State Park (SNTSP), created in 2008 and located at the extreme north of the Espinhaço Range (IEF 2024). The park represents an ecotone of the Caatinga and Cerrado domains with enclaves of the Atlantic Forest, and its vegetation includes *campo limpo*, *campo rupestre*, *cerrado*, *floresta estacional semidecidual*, and *floresta estacional decidual* (IEF 2024). It encompasses part of the municipalities of Rio Pardo de Minas, Serranópolis de Minas, Mato Verde, Porteirinha, and Riacho dos Machados (IEF 2024).

The northern region of the Espinhaço Range in Minas Gerais remains botanically underexplored, especially compared to other areas such as the Diamantina Plateau, Serra do Cipó, and the Iron Quadrangle. During our studies of Melastomataceae in this region, we discovered a new species of *Microlicia* from the SNTSP. This species has been identified as *Microlicia gentianoides* (DC.) Versiane & R.Romero (see Martins and Almeda 2017, as *Lavoisiera gentianoides* DC.), however, careful analysis revealed it to be an undescribed species. Here, we provide a morphological description, an illustration plate, field images, an occurrence map, and comparisons with its morphological relatives.

MATERIAL AND METHODS

This study was based on morphological examination of *Microlicia* specimens deposited at BHCB, CESJ, HUFU, RB, NY, M, MCCA, MBM, and UPCB herbaria (Thiers 2024) and online specimen images on Reflora Virtual Herbarium (2024), speciesLink (2024), and JSTOR Global Plants (2024). The morphological terminology follows Radford et al. (1986), and the trichome descriptions follow Versiane and Romero (2022). The occurrence map was prepared using QGIS software version 3.28.2-A Coruña (QGIS, 2022). The extent of occurrence (EOO) and area of occupancy (AOO) were calculated using the GeoCAT tool (Bachmann et al. 2011) to access the preliminary conservation status (IUCN 2022).

TAXONOMIC TREATMENT

Microlicia geraizeira Versiane & R.Romero, **sp. nov**. (Figures 1, 2).

Type: Brazil, Minas Gerais, Serranópolis, Parque Estadual Serra Nova, cachoeira Sete Quedas, cânion do Talhado, 15°48’40”S, 42°46’23”W, 895 m, 03 Apr 2022 (fl.), *M. Verdi et al.* 8683 (holotype RB; isotypes HUFU, NY).

Diagnosis

Microlicia geraizeira is morphologically similar to *M. gentianoides* but easily recognized by its leaves densely covered with spherical glands mixed with glandular trichomes (vs. glabrous or only margins sparsely setose in *M. gentianoides*), hypanthia entirely covered with spherical glands mixed with glandular trichomes (vs. glabrous at the base and with setose or glandular trichomes at the apices or upper half, rarely entirely glabrous).

Description

Shrubs, 1–4 m tall, erect, branched, slender, and dichotomous. Younger and older branches terete, not winged, brownish when dry, densely covered with glandular trichomes mixed with spherical glands, trichomes 0.2–0.4 mm long, leafy only at the ends of branches; nodes with conspicuous semi-circular horizontal scars; internodes 3–12 mm long, corky, with knobby thickenings that persist where a leaf has fallen away, covered with spherical glands mixed with glandular trichomes. Leaves horizontal to slightly ascending, imbricate, semiamplexicaul, concolor, green-yellowish when dry, sessile; blades 22–60 × 7–19 mm, chartaceous, elliptic-lanceolate to oblong-lanceolate, apices acute, bases slightly rounded to attenuate, margins entire, flat, not callose, sometimes slightly hyaline, covered with glandular trichomes; both surfaces densely covered with glandular trichomes mixed with spherical glands, trichomes 0.3–0.6 mm long; 7–9-veined, primary and secondary veins visible on the abaxial surfaces, secondary veins inconspicuous at the apices, tertiary veins absent. Flowers aggregated at the branch apices, 5-merous, sessile; hypanthia 8–12 × ca. 4 mm, urceolate, constricted distally above the ovary, not costate, green-yellowish when dry, densely covered with glandular trichomes 0.4–0.6 mm long; calyx tubes ca. 0.5 mm long; sepals 4–12 × 1–2 mm, triangular to narrowly triangular, apices acute, with a terminal glandular trichome ca. 0.5 mm long, green-yellowish when dry, both surfaces densely covered with glandular trichomes; petals 18–24 × 8–15 mm, white to rarely light pink with conspicuous translucent venation, oblong, apices rounded, acute or retuse, with a glandular trichome up to 0.5 mm long, margins entire, glabrous; androecium dimorphic, concolored, stamens 10, anthers tetrasporangiate; antesepalous stamens 5, larger, filaments 9–10 mm long, yellow, anthers ca. 7.5 mm long (including beaks), oblong, yellow, beaks 1 mm long, yellow, pedoconnectives 3.7–5.8 mm long,

Figure 1. *Microlicia geraizeira* Versiane & R.Romero. A. Branches. B. Detailed branch glandular trichomes. C. Adaxial leaf surface. D. Detailed glandular trichomes on adaxial leaf surface E. Abaxial leaf surface. F. Detailed glandular trichomes on abaxial leaf surface. G. Flower. H. Hypanthium and sepals. I. Detailed hypanthium glandular trichomes. J. Petal. K. Smaller stamen (antepetalous) on the left, larger stamen (antesepalous) on the right. L. Ovary and style. M. Ovary cross-section showing five locules. N. Old capsules with disintegrating hypanthium and persisting vascular strands. O. Seed. (Drawn by Klei Sousa from *Verdi et al. 8683*).

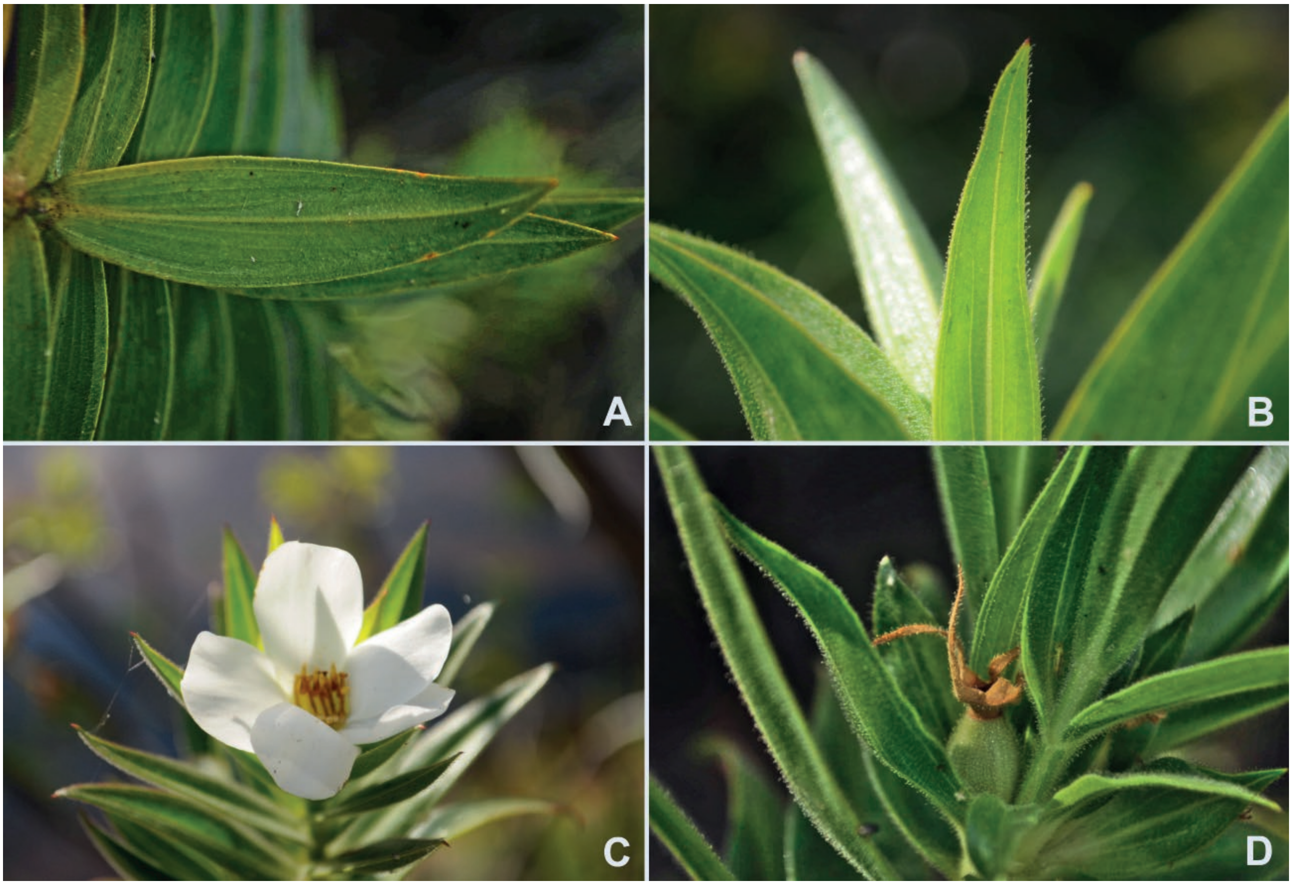

Figure 2. *Microlicia geraizeira* Versiane & R.Romero. A-B. Leaf blades. C. Flower. D. Immature fruit. Photos by Pablo B. Meyer (voucher *P.B. Meyer 3739*).

yellow, ventral appendages 0.8–1.7 mm long, yellow, apices slightly bilobed; antepetalous stamens 5, smaller, filaments 7–8 mm long, yellow, anthers ca. 5.5 mm long (including beaks), yellow, beaks ca. 0.6 mm long, yellow, pedoconnectives 1.7–2 mm long, yellow, ventral appendages 0.3–0.8 mm long, yellow, apices rounded or slightly bilobed; ovaries 6–7 × 2.7–4 mm, 5-locular, globose, superior, glabrous; styles 9–10 mm long, cream, straight or slightly curved, stigmas punctiform. Capsules 7–10 × 4–4.5 mm, oblong, brownish, entirely covered by the hypanthia, dehiscence acropetal, vascular strands persisting after capsule walls have fallen away, columellas deciduous. Seeds ca. 0.9 × 0.4 mm, testa foveolate, slightly curved to one side.

Etymology

The specific epithet honors the *geraizeiros*, traditional communities (see Decree nº 8.750/2016) inhabiting northern Minas Gerais, where this new species is endemic. The term comes from the region known as *Gerais,* which is in the transitional zone between the Cerrado and Caatinga biomes (Dayrell 1998). The *geraizeiros* have long fought to protect the *Gerais*' biodiversity, but since the 1970s, it has been severely threatened by *Eucalyptus* sp. monocultures, mining, and cattle ranching (Dayrell 1998; Nogueira 2009; Magalhães and Amorim 2015).

Distribution, habitat & phenology

Microlicia geraizeira occurs in humid areas in the SNTSP, northern Minas Gerais (Fig. 3). It was collected with flowers and fruits in March, April, and October, only with fruits in December.

Assessment of conservation status

Microlicia geraizeira has a restricted Area of Occupancy (AOO = 16 km²), an Extent of Occurrence (EOO = 30 km²), and a population of few individuals. However, since it occurs exclusively within a protected area, ensuring its preservation, we consider this species as

Least Concern (LC) (see IUCN 2012). We emphasize the importance of maintaining conservation units and creating new ones to protect and conserve our rich, sometimes rare, biodiversity.

Comments and affinities

Microlicia geraizeira is morphologically similar to *M. gentianoides*, *M. indurata* Almeda & R.B.Pacifico, *M. macranta* Versiane & R.Romero, *M. mellobarretoi* (Markgr.) Versiane & R.Romero, *M. pilosa* Versiane & R.Romero, and *M. septentrionalis* Almeda & R.Pacifico. Except for *M. gentianoides*, which occurs in Minas Gerais and Bahia states, *Microlicia macrantha* in Distrito Federal, Goiás, Minas Gerais, and São Paulo, and *M. indurata* endemic to Goiás, all remaining species are restricted to Minas Gerais (see Martins and Almeda 2017; Almeda et al. 2023) (Fig. 3).

Microlicia geraizeira has been identified as *M. gentianoides* probably due to both species having sessile and semi-amplexicaul leaves, elliptic-lanceolate to oblong-lanceolate leaf blades with acute apices, pentamerous flowers with white petals, triangular sepals, yellow stamens, and fruits with acropetal dehiscence. Nevertheless, *M. geraizeira* is distinguished in having leaves green-yellowish when dry (vs. brown in *M. gentianoides*), both leaf surfaces densely and entirely covered with trichomes (vs. glabrous adaxial surfaces or sparsely setose only at the margins, glabrous or inconspicuously punctate abaxial surfaces), hypanthia and sepals entirely covered with glandular trichomes mixed with spherical glands (vs. glabrous at the apices and bases, or with glandular trichomes below the constricted neck or the upper half, rarely totally glabrous). Apart from the type collection (*Martius 1375*) and the specimens *Pohl s.n.* and *1288* made in Minas Gerais, all recent records of *M. gentianoides* are from Abaíra and Rio de Contas in the Chapada Diamantina, Bahia (Martins and Almeda 2017) (Fig. 3).

Microlicia geraizeira and *M. macrantha* have sessile and large leaves (20–60 mm long), flowers aggregated at the apex of branches, androecium dimorphic with yellow stamens, and fruits with vascular strands persisting after capsule dehiscence. However, *M. geraizeira* differs by its leaves covered with glandular trichomes mixed with spherical glands (vs. glabrous adaxial surface and covered with spherical glands on abaxial surface in *M. macrantha*), pentamerous flowers (vs. hexamerous), cylindric-tubulose hypanthia (vs. cylindric-oblong and suburceolate), triangular to narrowly triangular sepals (vs. subulate to triangular), five locular ovaries (vs. six).

Microlicia geraizeira and *M. indurata* have branches, leaves, hypanthia, and sepals covered with glandular trichomes and spherical glands, elliptic-lanceolate leaf blades, sessile and chartaceous leaves, white petals, and yellow stamens. But *M. geraizeira* differs by its pentamerous flowers (vs. hexamerous in *M. indurata*), cylindric-tubulose hypanthia (vs. campanulate), triangular to narrowly triangular sepals (vs. oblong to lanceolate), five locular ovaries (vs. six). *Microlicia indurata* is endemic to the Serra dos Pireneus, Goiás (Almeda et al. 2023).

Microlicia geraizeira and *M. mellobarretoi* have sessile and semi-amplexicaul leaves, elliptic-lanceolate to oblong-lanceolate leaf blades, pentamerous flowers, yellow stamens, five locular ovaries, and capsules with acropetal dehiscence. However, *M. geraizeira* has leaves densely covered with glandular trichomes mixed with spherical glands (vs. glabrous, sometimes adaxial surfaces with sparsely long glandular trichomes or only at the bases in *M. mellobarretoi*), not callose margins (vs. callose), chartaceous leaves (vs. coriaceous), hypanthia entirely covered with glandular trichomes (vs. glandular trichomes only at the middle region), and white to rarely light pink petals (vs. pink to lavender with a yellow base). *Microlicia mellobarretoi* is endemic to northern Minas Gerais in Grão Mogol (Martins and Almeda 2017), Itacambira, and Botumirim municipalities (Fig. 3).

Microlicia geraizeira and *M. pilosa* have leaves, hypanthia, and sepals covered with glandular trichomes, elliptic-lanceolate leaf blades, entire margins, and yellow stamens. However, *M. geraizeira* differs by its sessile leaves (vs. short-petiolate [ca. 1 mm long] in *M. pilosa*) and chartaceous leaf blades (vs. membranaceous), pentamerous flowers (vs. hexamerous), cylindric-tubulose hypanthia (vs. cylindric to campanulate), triangular to narrowly triangular sepals ([4–12 mm long] vs. short-triangular [1–1.5 mm long.]), white to rarely light pink petals (vs. pink with greenish-yellow base), five locular ovaries (vs. six), capsules with acropetal dehiscence (vs. basipetal). *Microlicia pilosa* is endemic to the Pico do Itambé State Park, in Santo Antônio do Itambé, Minas Gerais (Martins and Almeda 2017) (Fig. 3).

Microlicia geraizeira and *M. septentrionalis* have sessile and semi-amplexicaul leaves, triangular sepals, pentamerous flowers, yellow stamens, and five locular ovaries. But *M. geraizeira* differs in having both leaf surfaces covered with glandular trichomes mixed with spherical glands (vs. glabrous or abaxial surfaces rarely punctate in *M. septentrionalis*), elliptic-lanceolate to oblong-lanceolate leaf blades (vs. ovate-lanceolate), not callose margins (vs. callose), and cylindric-tubulose hypanthia (vs. campanulate) entirely covered with glandular trichomes (vs. glabrous bases with glandular trichomes ring at the apices). *Microlicia septentrionalis* occurs only in Pico da Formosa, Monte Azul, northern Minas Gerais (Almeda et al. 2023) (Fig. 3).

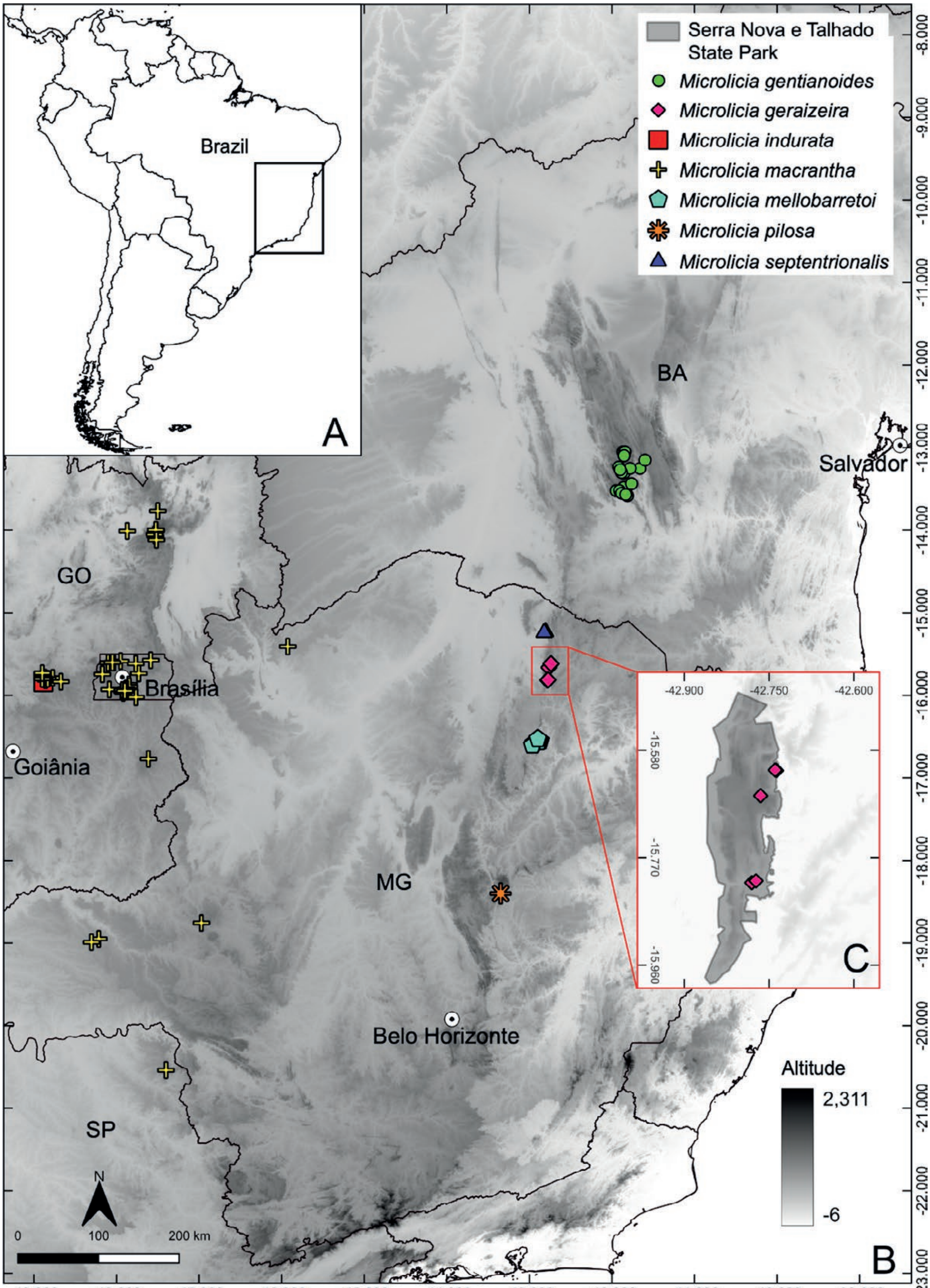

Figure 3. A. South America map. B. Distribution of *Microlicia geraizeira* Versiane & R.Romero and its morphologically similar species in Brazil. C. Occurrence of *M. geraizeira* in the Serra Nova State Park, Minas Gerais.

Identification key of *Microlicia geraizeira* and its morphologically similar species

1. Leaves with both surfaces glabrous or with spherical glands on abaxial surfaces or adaxial surfaces sparsely setose in the margins or bases **2**

   Leaves with both surfaces covered with glandular trichomes mixed or not with spherical glands **4**

2. Leaves with adaxial surfaces glabrous or with setose trichomes, abaxial surfaces with spherical glands **3**

   Leaves with both surfaces glabrous or sometimes adaxial surfaces with glandular trichomes or abaxial surfaces only with spherical glands at the apices, petals pink or lavender with a yellow base **4**

3. Flowers pentamerous with entirely white or yellowish-green petals, hypanthia glabrous at the apices and bases, or with glandular trichomes below the constricted neck or the upper half, rarely totally glabrous ...... ***M. gentianoides***

   Flowers hexamerous with pink petals with a yellow base or white to yellowish-white with a yellow base, hypanthia covered with spherical glands .... ***M. macrantha***

4. Leaves ovate-lanceolate, hypanthia campanulate with glandular trichomes only at the apices; Pico da Formosa, MG .. .. ***M. septentrionalis***

   Leaves oblong to elliptic, hypanthia subcylindric to suburceolate with glandular trichomes only at the middle region; Grão Mogol, MG .... ***M. mellobarretoi***

5. Leaves petiolate, sepals 1–1.5 mm long................. ***M. pilosa***

   Leaves sessile, sepals 4–12 mm long **6**

6. Flowers pentamerous, hypanthia cylindric-tubulose, sepals triangular to narrowly triangular, ovaries five locular; SNTSP, MG .... ***M. geraizeira***

   Flowers hexamerous, hypanthia campanulate, sepals oblong to lanceolate, ovaries six locular; Serra dos Pireneus, GO .... ***M. indurata***

Additional specimens examined (paratypes)

BRAZIL: **Minas Gerais:** Porteirinha, Parque Estadual de Serra Nova e Talhado, 06 Nov 2019 (fl.), *P.B. Meyer & P.A. Junqueira 3739* (BHCB). Rio Pardo de Minas, Serra Nova, Chapadão de Santana, 08 Oct 1995 (fl., fr.), *F.R.S. Pires et al. s.n.* (CESJ, RB); idem, Parque Estadual Serra Nova, 15°39'37.5"S, 42°45'53.7"W, 1000–1230 m, 13 Mar 2007 (fl., fr.), *A. Salino et al. 11744* (BHCB, RB); idem, trilha para o escorregador no Córrego da Velha, 15°36'53.9-57.3"S, 42°44'20.6-5.6"W, 834–858 m, 21 Mar 2012 (fl.), *J.A. Lombardi 9037* (UPCB); idem, trilha do escorregador, 15°36'57"S, 42°44'12"W, 21 Mar 2012 (fl.), *M. J. R. Rocha et al. 431* (BHCB, HUFU, NY, RB); idem, trilha de acesso a casa de apoio, 27 Aug 2019 (fl.), *R. Nichio-Amaral et al. 944* (HUFU, MCCA, VIES). Serranópolis de Minas, Sete Quedas, 17 Apr 2007 (fl.), *O.S. Ribas & J.M. Silva* 7733 (UPCB); idem, Parque Estadual de Serra Nova e Talhado, 15°48'52"S, 42°46'50"W, 886 m, 26 Apr 2013 (fr.), *Barboza et al. 3874* (MBM).

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Alpinia arachniformis (Zingiberaceae): a new species from New Ireland, Papua New Guinea

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Abstract. During explorations of the ginger flora of the Bismarck Archipelago in 2013 and 2023, we made collections of the ginger genus *Alpinia* sensu lato, some of which had unusually elongated cincinni composed of distichously arranged bracteoles and in the present paper we conclude that these collections document a distinct species new to science, *Alpinia arachniformis* A.D.Poulsen. The choice of epithet refers to the spider-like appearance of the inflorescence. Similar morphology of the cincinni is found in other lineages of *Alpinia*, but our molecular analysis using the Internal Transcribed Spacer (ITS) marker established a close relationship with *A. oceanica* from which the new species differs by having cincinni with more flowers and linear labellum. An ink drawing and colour plates, information on distribution and habitat, and provisional conservation status are provided for the new species as well as a key to species of *Alpinia* in the Bismarck Archipelago.

Keywords: *Alpinia oceanica, Alpinia vittata,* Bismarck Archipelago, ITS, Zingiberaceae.

INTRODUCTION

The knowledge of the family Zingiberaceae in Papua New Guinea has been gradually updated in the past few decades as a few species were recently discovered (Poulsen and Bau 2017; Lofthus et al. 2020), rediscovered (Poulsen et al. 2022) or re-evaluated (Poulsen et al. 2024a). Papua New Guinea, along with its offshore islands, is home to around 130 species within 10 genera of gingers. The largest genus is *Riedelia* Oliv. with 47 species, followed by *Alpinia* Roxb. with 29 species, and *Pleuranthodium* (K.Schum.) R.M.Sm. with 20 species (Newman et al. 2005 onwards), all of which await confirmation being monophyletic and revision based on the latest high-quality collections including pickled reproductive parts and silica-dried leaves for DNA extraction.

One of the biogeographically interesting areas of the region is the Bismarck Archipelago comprising approximately 76 islands off the north-eastern coast of mainland New Guinea. Major islands include New Britain, New Ireland, New Hanover, the St. Matthias Group, the Admiralty Islands (also called Manus), and others in the far west (Loffler and Fairbridge 1975). Together with the Solomon Islands and Vanuatu, they form the East Melanesian Islands, which is one of the most interesting areas on Earth for geologists because of its islands of varying ages and geology (Hall 2002). This has led to the isolation and adaptive radiation of different organisms (McCullough et al. 2022). It is estimated that a total of 8,000 vascular plant species (c. 3,000 endemic) are found in the East Melanesian Islands, making it a biodiversity hotspot where deforestation is, unfortunately, increasing due to agriculture, coastal development, overharvesting of species, and mining activities in the past decades (Aalbersberg et al. 2012).

Alpinia, as currently delimited, is the largest genus of Zingiberaceae with ca. 260 species occurring in tropical and subtropical Asia, Australia, and the Pacific (Smith 1990; Newman et al. 2005 onwards). Phylogenetic studies using ITS and *mat*K/*trn*K regions, however, revealed that the genus is polyphyletic (Kress et al. 2005, 2007; De Boer et al. 2018; Docot et al. 2019a,b; Poulsen et al. 2024b) consisting of five clades scattered throughout the tribe Alpinieae. Only the clade containing the type species, *A. galanga* (L.) Willd., will retain the genus name *Alpinia*, and revisions continue to progress as more taxa are added into the phylogenetic tree of the tribe Alpinieae (e.g., reinstatement of *Adelmeria* Ridl. from *Alpinia* by Docot et al. 2019b).

Peekel (1984) published the flora of the Bismarck archipelago, which includes 15 species of Zingiberaceae, four of which were placed in *Alpinia*. The present paper aims to understand and describe an unusual species collected by A.D. Poulsen and collaborators in New Ireland, Papua New Guinea in 2013 followed up by additional surveys on this island in 2023. Historic collections were also studied in herbaria mostly hitherto identified as *Alpinia oceanica* Burkill, a common species in the Bismarck Archipelago. The unusual species has telescopically extended cincinni in which the bracteoles are distichously arranged; a trait found in three other separate lineages within *Alpinia* sensu lato (the *carolinensis*, *eubractea*, and *rafflesiana* clades; sensu Kress et al. 2005). Therefore, phylogenetic analyses were performed to ascertain the placement of the collections from the Bismarck Archipelago with the unusual inflorescence structure.

MATERIALS AND METHODS

Recent materials used in this study were collected during expeditions in 2013 and 2023 conducted in New Ireland, Papua New Guinea following international and national regulations. A wide range of specimens of relevant species especially *Alpinia* species with telescopically extended cincinni and distichously arranged bracteoles deposited at A, AAU, BISH, BM, BO, BRI, C, CANB, CNS, E, FI, G, GH, K, L, LAE, MEL, NSW, NY, P, PRC, SING, UC, and US including types were examined. Acronyms of herbaria follow Index Herbariorum (Thiers continuously updated). Protologues of relevant species and taxonomic revisions of *Alpinia* (e.g., Smith 1975, 1990) were also scrutinised.

The total genomic DNAs of the samples used in this study were extracted using DNeasy Plant Mini Kit (Qiagen®, Germany) following the manufacturer's protocol. The ITS region, which is one of the best DNA barcode candidates for identifying species within Zingiberaceae (Shi et al. 2011; Tan et al. 2020), was amplified using Docot et al. (2019b) PCR mix and thermal profile. PCR products were sent to Macrogen© (Seoul, Korea) for purification and sequencing services.

The newly generated sequences were assembled and edited in Geneious Prime v. 2025.03 (https://www.geneious.com) and were aligned using Muscle 3.7 (Edgar 2004) in the CIPRES portal (Miller et al. 2010) resulting in the data matrix used in this study. We reconstructed the phylogeny of the tribe Alpinieae using 109 ITS accessions representing 97 taxa (see Appendix 1 for the complete accession details of the sequences).

Maximum-likelihood (ML) and Bayesian inference (BI) phylogenetic trees were constructed using RAxML-HPC2 on ACCESS v. 8.2.12 (Stamatakis 2014) and MrBayes on ACCESS v. 3.2.7a (Huelsenbeck & Ronquist 2001) respectively, both of which performed in CIPRES portal (Miller et al. 2010). A general time reversible model (GTR+I+Γ) was used for both Maximum likelihood and Bayesian inference analyses as indicated on the Akaike information criterion (AIC) implemented in Modeltest v. 3.06 (Posada & Crandall 1998). Bootstrap support values were obtained by running 1000 replicates. Four Markov Chain Monte Carlo (MCMC) chains were performed for 10 million generations with trees sampled every 1000th generation. To confirm convergence, values for potential scale reduction factor (PSRF) and standard deviation of the split frequencies between two runs were considered. Tracer v. 1.7.1 (Rambaut et al. 2018) was used for an additional convergence test to check if each parameter had an effective sample size (ESS) >100. Trees saved prior to convergence were discarded as burn-in

(10,000 trees), creating a 50% majority-rule consensus tree constructed from the remaining trees. The data matrix used and trees produced have been deposited in Zenodo (https://doi.org/10.5281/zenodo.15046066).

The extent of occurrence (EOO) and area of occupancy (AOO) were calculated using the Geospatial Conservation Assessment Tool (GeoCAT) (Bachman et al. 2011: www.geocat.kew.org/) and were then assessed using the International Union for Conservation of Nature (IUCN) criteria (IUCN Standards and Petitions Subcommittee 2024). The distribution map produced in this study was generated using SimpleMappr (Shorthouse 2010).

RESULTS AND DISCUSSION

Our molecular phylogenetic results, both in the ML and BI trees, found the five clades of *Alpinia* (Fig. 1) inside the tribe Alpinieae and the topologies are congruent with each other and those found in previous studies (e.g., Kress et al. 2005, 2007; Docot et al. 2019a,b). The four samples of the new species appeared within the *Alpinia eubractea* clade and formed a monophyletic group in a sister relationship to a clade composed of samples of *A. oceanica* and *A. vittata* W.Bull. Together with *A. purpurata* (Vieill.) K.Schum., these constitute the *Guillainia* subclade sensu Docot et al. (2019b). The *Guillainia* subclade is native in the Bismarck Archipelago and Western Pacific but not wild on mainland New Guinea (Smith 1975).

Based on molecular data, most *Alpinia* sensu lato species with telescopically extended cincinni, in which the bracteoles are distichously arranged, belong to the *Alpinia carolinensis* clade, which includes species from the *Alpinia* sect. *Myriocrater* K.Schum. and *Alpinia* subsect. *Pycnanthus* R.M.Sm. sensu Smith (1990). Telescopically extended cincinni are, however, also observed in species within the *Alpinia rafflesiana* clade (e.g., *A. rufa* (C.Presl) Náves) and in the *Alpinia eubractea* clade (e.g., *A. eubractea* K.Schum.) where the new species is placed. This indicates that this character is likely convergent within the tribe Alpinieae and not a diagnostic synapomorphy unique to one clade.

The new species formed a sister relationship with *Alpinia oceanica* and *A. vittata* and have overlapping distributions. The possibility that the latter two species are conspecific was discussed by Smith (1975) based on herbarium material. Specimens with reproductive parts from the type locality of *A. vittata* (New Ireland, Papua New Guinea) are yet to be made and will be critical to address this hypothesis. Until this has been resolved, *A. vittata* can at least easily be distinguished from *A. oceanica* by its variegated lamina. As the new species has plain green leaves, it is therefore most similar to *A. oceanica* (see Table 1 for a complete morphological comparison), although it sufficiently differs from it by other characters as elaborated below.

TAXONOMIC TREATMENT

Alpinia arachniformis A.D.Poulsen **sp. nov.** (Figures 2, 3 & 5).

Type: Papua New Guinea, New Ireland Province, Karu Forestry station, 2013; 3°28’15.4”S 152°13’58.5”E; 10 m elevation; 29 April 2013; *A.D. Poulsen, Ø. Lofthus & B. Sule 2893* (holotype LAE; isotypes BO, E + spirit, L, O, SING).

Diagnosis

Similar to *Alpinia oceanica* Burkill in the vegetative characters but differs by the erect inflorescence (vs mostly pendulous); exposed distal peduncle (vs hidden within sheaths); cincinni laxly arranged (5–8 mm apart) along the rachis, 3–11 cm long with 2 mm long stalk at base and composed of up to 15 flowers (vs congested, 3–7 cm long, sessile, up to 7); and linear labellum with a retuse apex (vs narrowly triangular, apex truncate).

Description

Terrestrial herb in loose clump, sometimes covering several square metres. Rhizome 1–2 cm diameter, white to cream internally, stilt roots absent; scales chartaceous, 9 × 18 mm, light brown, glabrous, apex acute. Leafy shoots 11–12 cm apart, pseudostem 1.6–3 m long, base 2.7–3.5 cm diameter; sheath light green with paler longitudinal lines, striate when dry, glabrous to slightly pubescent; ligule entire, 9–11 × 7–10 mm (when flattened), mid-green to light brown, densely pubescent, apex rounded; lamina sessile, narrowly ovate, 38–60 × 7–13 cm, plicate, mid-green above, light green beneath, glabrous on both sides, midrib beneath with scattered hairs, base cuneate, margin entire, glabrous, apex acute. Inflorescence terminal to the leafy shoot, a panicle, 15–25 cm long; inflorescence bracts 2–3: basal one clasping, white, brown with age, glabrous, apex sometimes with foliaceous mucro, the second (and third) similar to floral bracts; distal peduncle 4.5–7 cm long (measured from the lowermost inflorescence bract to the lowermost fertile bract), ± exposed, white or greenish white, densely pubescent; rachis 6–15 cm long, white or greenish white, densely pubescent, with 15–30 cincinni each with up to 15 flowers; cincinni 5–8 mm apart and alternately arranged along rachis, ± perpendicular, 2.8–11 cm long,

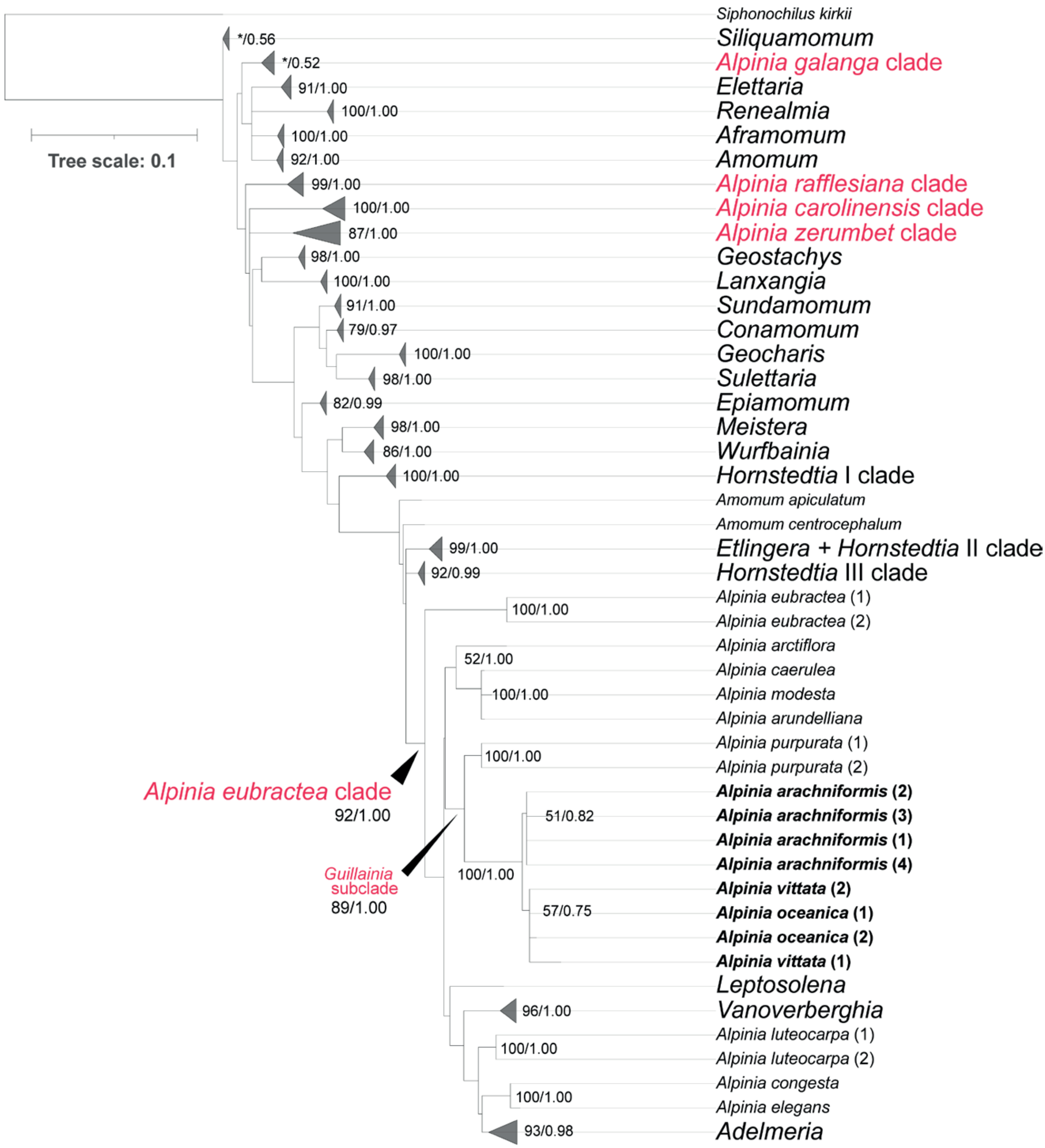

Figure 1. Maximum likelihood phylogenetic tree of the tribe Alpinieae based on ITS sequence data. Genera and clades within the tribe Alpinieae were collapsed, and the five clades of *Alpinia* defined by Kress et al. (2005, 2007), as well as the *Guillainia* subclade, are in red font. Bootstrap values obtained from Maximum likelihood and posterior probabilities from Bayesian inference are provided on the branches. An asterisk (*) denotes posterior bootstrap supports and probability values < 50/0.5. Taxa included in this study for the first time are marked in bold, while additional material downloaded from GenBank is in normal font.

elongating with age, stalk c. 2 mm long; fertile bracts ovate, 17–30 × 15–20 mm, white or greenish white, glabrous, base slightly pubescent, apex rounded; bracteoles tubular, 9–13 mm long, membranous, white, pinkish white when young, brown and decaying when mature, glabrous except the pubescent upper margin, V-shaped

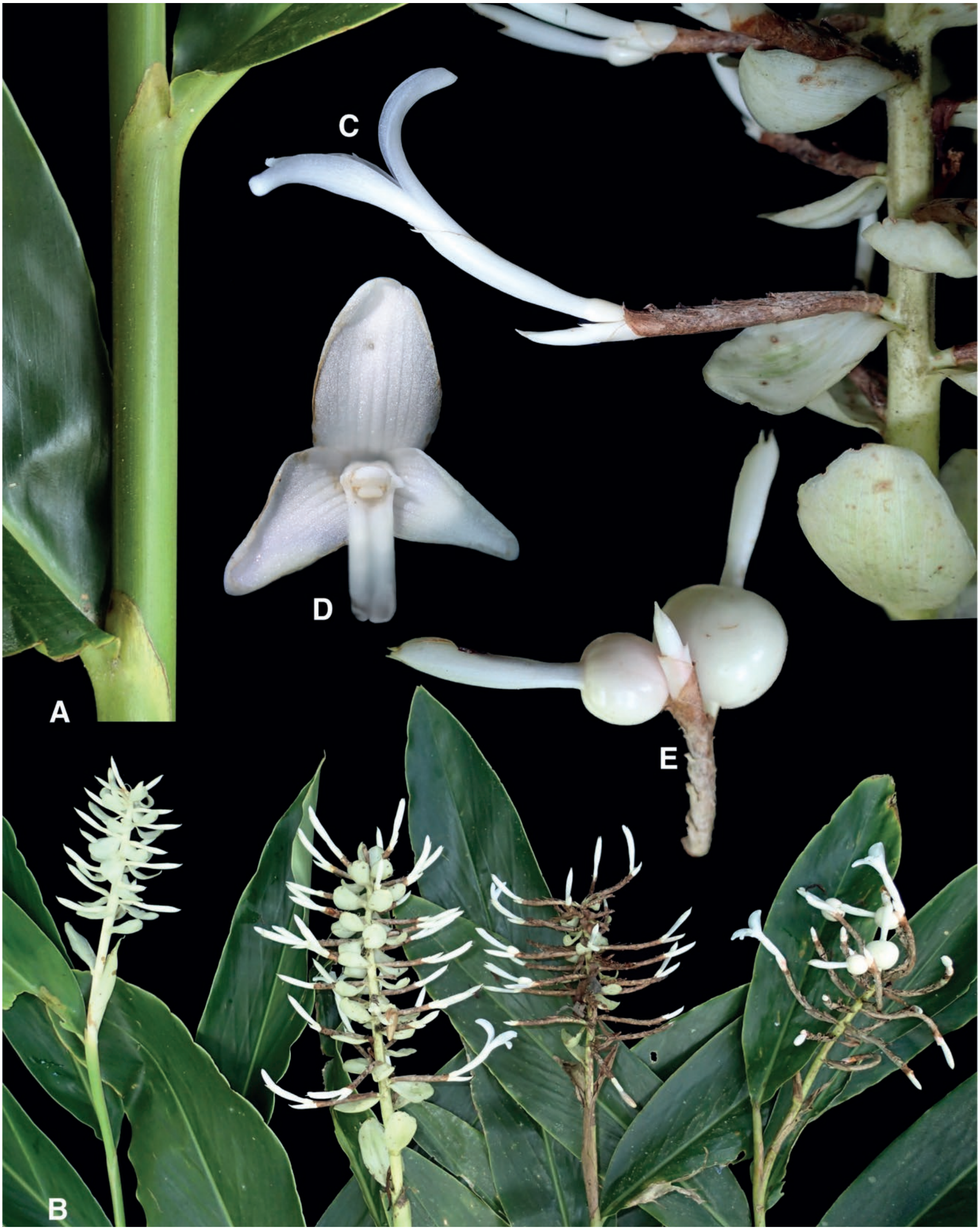

Figure 2. *Alpinia arachniformis* A.D.Poulsen **A.** Pseudostem showing the sheaths and ligules. **B.** Inflorescences in different stages. **C.** Cincinnus with supporting bract. **D.** Flower (front view). **E.** Fruits. Based from *A.D. Poulsen et al. 2893* (type). Photos: A.D. Poulsen.

incision c. 3 mm long, apex acute, mucronate; flowers 5–8 cm long, white; pedicel 9–13 mm long, white, glabrous to slightly pubescent; calyx tubular, 20–26 mm long, white, glabrous except the pubescent 3-dentate apex, incision 3–4 mm long; floral tube 20–26 mm long, narrow, slightly widening towards apex, white, glabrous outside and inside; dorsal corolla lobe narrowly ovate, 13–22 × 5–9 mm, white, glabrous, apex cucullate; lateral corolla lobes narrowly ovate to oblong, 14–21 × 4–5 mm, white, glabrous, apex cucullate; staminal tube 3–4 mm long, white, glabrous; labellum 9–15 mm long, linear, glabrous, white, 7.5–13 × 1.5–2.5 mm, fleshy, curved, held flat to the stamen, apex retuse, 1.5–2 × 1.5–2.5 mm, petaloid; lateral staminodes connate basally to the labellum, free part flattened, tooth-like, c. 15 mm long diverging c. 5–7 mm above the base of the labellum; stamen subsessile (filament < 1 mm long), 9–11 mm long; anther 8–12 × 2–4 mm, connective white, pubescent throughout or only laterally; anther crest rounded, 1–2 × 1.5–3 mm, white, glabrous, apex truncate; thecae 10–12 × 1–1.8 mm, white, glabrous, dehiscing through their entire length, base slightly spur-like; style 34–35 mm long, white, glabrous, pilose near apex; stigma clavate, c. 2 mm wide, white, pubescent, apex truncate, ostiole transverse, narrowly elliptic, facing downwards, lower margin ciliate; epigynous gland c. 1 mm long, yellow, glabrous, partially encloses the style; ovary partially or entirely exposed above bracteole, obovoid, 4–6 × 3–4 mm, red or white, glabrous, trilocular, placentation axile. Fruits globose, 26–29 × 25–30 mm, white, sometimes tinged faintly pink at base, glabrous, calyx persistent; seeds c. 3 mm wide and long, ovoid and angular, dark brown (in spirit), glabrous, arillate.

Etymology

The elongated cincinni suggest a spider-like resemblance.

Local names and uses

Gorgor (Pidgin English / Tok Pisin language) and ngu-ngau (Konomalu language).

Phenology

Flowering and fruiting throughout the year.

Distribution and habitat

Alpinia arachniformis has only been documented in the islands of New Ireland and New Hanover (Fig, 4) and is thus endemic to the province of New Ireland, Papua New Guinea. The species grows in the lowlands (0–10 m a.s.l., in open coastal forests (as close as 10 m to the beach) but is often found in disturbed vegetation in garden areas or along roads.

Proposed conservation assessment

Based on the IUCN red list categories and criteria (IUCN Standards and Petitions Committee, 2024), *Alpinia arachniformis* is provisionally assessed as Vulnerable (VU B2ab(iii), D). The area of occupancy (AOO) is estimated to be less than 2,000 km^2 (total AOO is 32 km^2) while the extent of occurrence (EOO) is estimated to be less than 20,000 km^2 (total EOO is 5,202.04 km^2). Only three out of eight sites were visited by the authors and an estimated 20 mature individuals were observed. Threats include logging and conversion of forests into agricultural and residential gardens but this species thrives in disturbed areas, such as roadsides. The assessment shall be updated as more information becomes available on *A. arachniformis* as well as its habitat.

Notes

Based on the collections we have examined, the inflorescence of *A. oceanica* is most often pendulous. This character can be used to distinguish the new species initially as it is always erect. In *A. arachniformis*, the distal part of the peduncle is always exposed (6–7 cm long) which is always hidden within the leaf sheaths in *A. oceanica*. Whereas the inflorescence is up to 7 cm long in *A. oceanica*, it may elongate up to 11 cm long with age in *A. arachniformis* (Fig 2B). Moreover, the cincinni of *A. arachniformis* are laxly arranged (5–8 mm apart) along the rachis with 2 mm long stalks, which produce up to 15 flowers whereas *A. oceanica* has sessile cincinni arranged tightly along the rachis with up to five flowers. According to Smith (1975), the floral bracts of *A. oceanica* vary from mid-green to mid-green with pink streaks (appearing pinkish-green), and white but most of the time, the floral bracts are of one colour only. In *A. arachniformis,* the floral bracts are consistently white or greenish-white. Moreover, the bracteoles of *A. oceanica* are split up to ¾ its length from apex (incision is c. 16 mm long) whereas the incision is only 3 mm long in *A. arachniformis*. The fruit colour of *A. oceanica* is also highly variable ranging from white, greenish-white, pink, to red. In *A. arachniformis* the fruit is always white, sometimes slight tinged pink.

Smith (1975) discussed the variation of the labellum of *Alpinia oceanica* based on several collections including specimens from New Ireland (*A.N. Millar NGF 23820* and *M.J.E. Coode & P. Katik NGF 40107*) that have a more or less linear labellum with prominent lateral teeth (the lateral staminodes) whereas material from

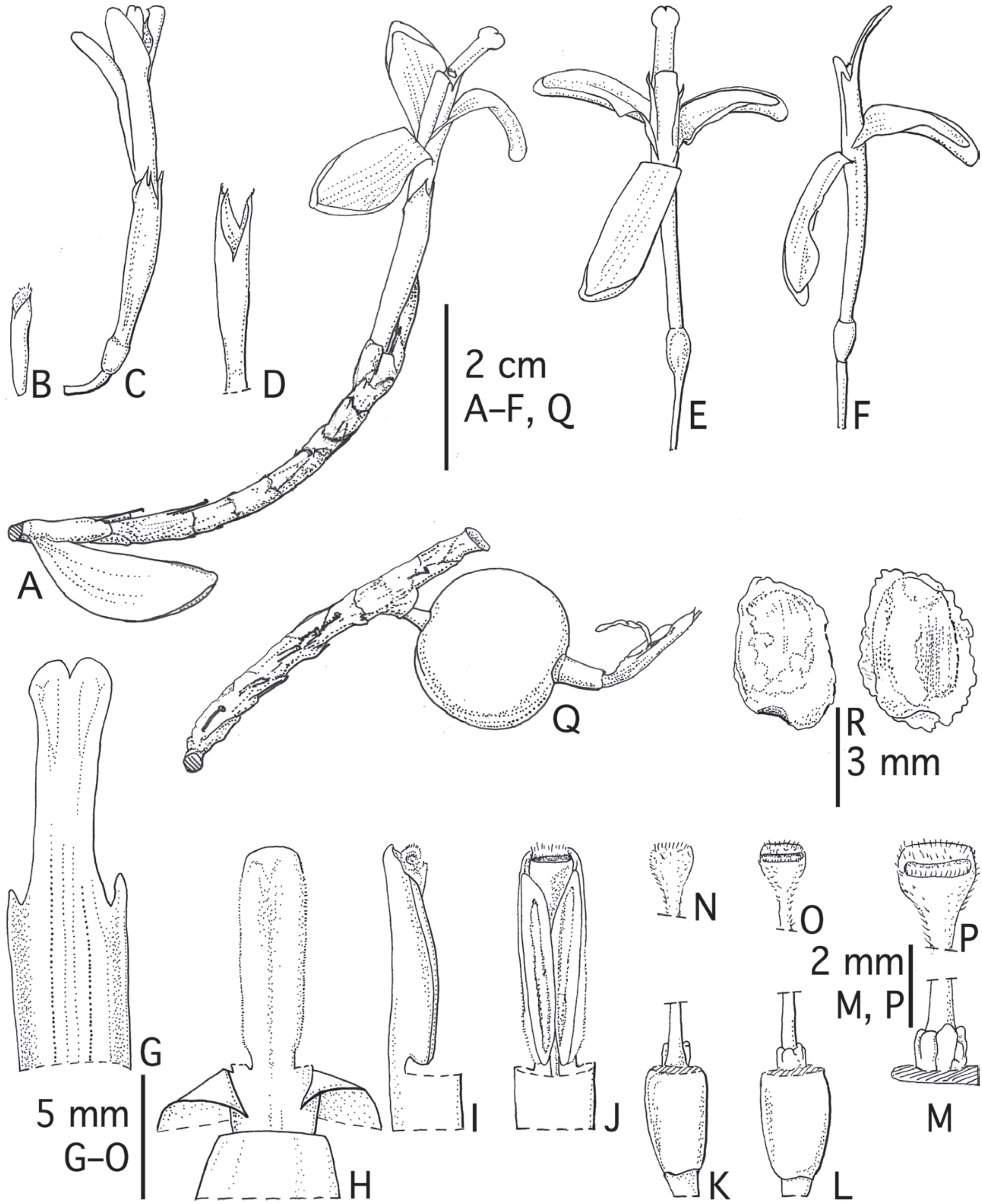

Figure 3 *Alpinia arachniformis* A.D.Poulsen. **A.** Cincinnus with supporting bract. **B.** Bracteole. **C.** Flower, bracteole removed. **D.** Calyx. **E.** Flower, calyx removed, dorsal view. **Figure 3.** Flower, calyx removed, lateral view. **G.** Labellum, flattened. **H.** Stamen, dorsal view. **I.** Stamen lateral view. **J.** Stamen ventral view. **K.** Ovary and epigynous gland, dorsal view. **L.** Ovary and epigynous gland, ventral view. **M.** Epigynous gland. **N.** Stigma, dorsal view. **O–P.** Stigma, ventral view. **Q.** Infructescence. **R.** Seeds with aril. Drawn from the type (*A.D. Poulsen et al. 2893*) by A.D. Poulsen.

elsewhere had a more or less triangular labellum only occasionally with lateral teeth. The characters observed in the cited collections above match a few other collections we have examined from New Ireland that we identified as representing *A. arachniformis*. If spirit material is available, these characters are also useful to distinguish the *A. arachniformis* from *A. oceanica*.

Interestingly, a 3–4 mm long staminal tube was observed in *Alpinia arachniformis* as well as in *A. oceanica* and *A. vittata* which is the first time this is documented within the *Alpinia eubractea* clade. The staminal tube is a diagnostic character of the genus *Etlingera* Giseke, which in molecular-based analyses (e.g., Kress et al. 2007; De Boer et al. 2018) is sister to the *Alpinia eubractea* clade that includes the three species (Fig. 1).

During the fieldwork in 2023, a collection was made (*A.D. Poulsen et al. 3313*) of a stand of *Alpinia* where the inflorescence had short cincinni (up to 3–4 cm long) some of which were bearing fruits (Fig. 5B). The local people insisted that this collection represented a different species than *A. arachniformis* collected with them nearby on the same date (*A.D. Poulsen et al. 3314*). In the phylogenetic tree of the present study, however, both collections grouped with the type of *A. arachniformis* and one other sample of a collection also having long cincinni (Fig. 1). As we examined collections from several herbaria, we found a few matching the morphology of *A.D. Poulsen et al. 3313*. We compared these specimens to the type of *A. arachniformis* but no other differences than the shorter cincinni were found. Because of that, all the specimens mentioned are identified here as *A. arachniformis*. The alternative options would be to treat the short-cincinni plants at a subspecies, a variety, or as a hybrid of *A. arachniformis* and *A. oceanica*, which occurs sympatrically. Our interpretation is that the cincinni will elongate during the season and probably also with the age of the plant. Future studies using population genetic methods may cast light on the underlying causes of the variation in elongation of the cincinnus, as well as potential hybridization. Meanwhile, we believe that the fruits may set at various points along the cincinnus, and long-term observation of the development of the inflorescence is needed to establish at what stage the fruits are produced.

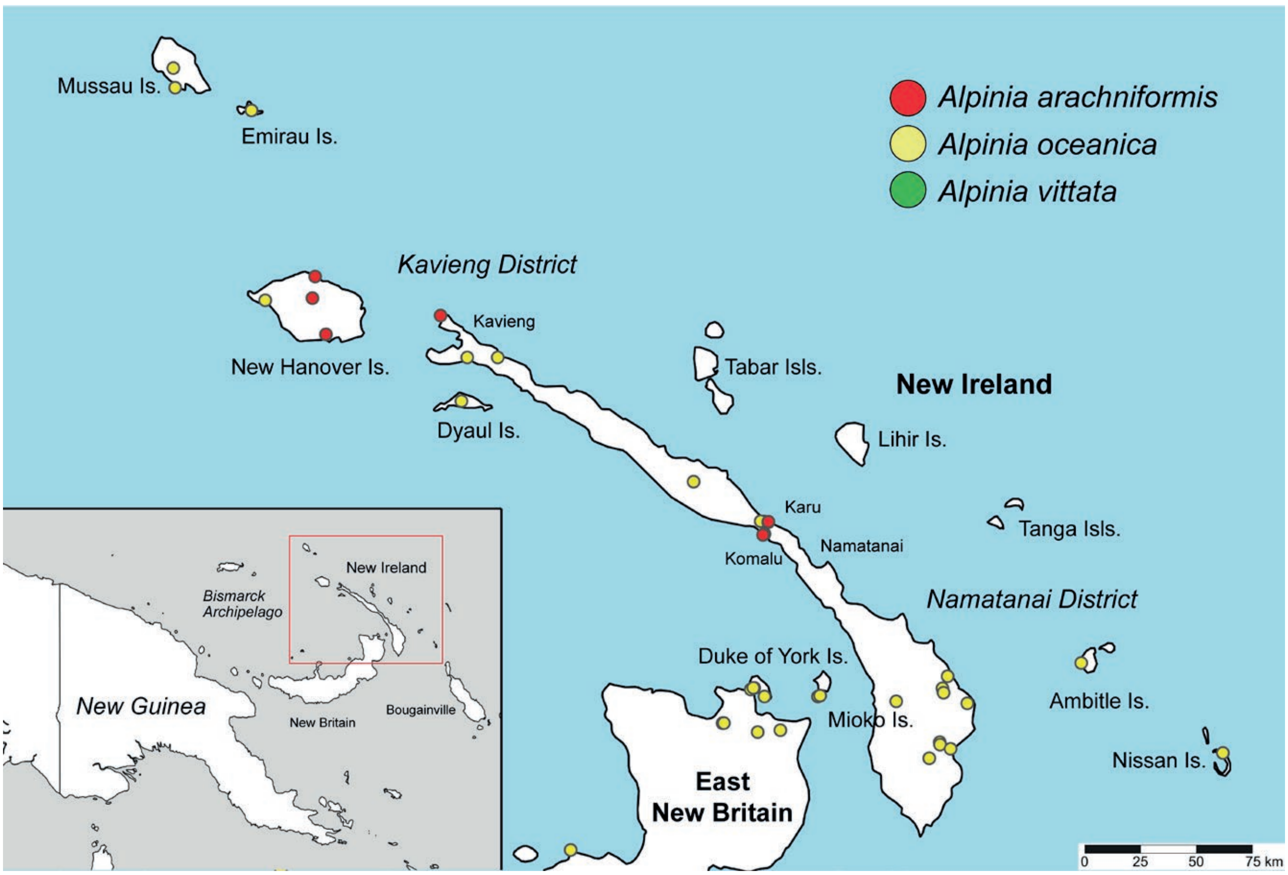

Figure 4. Distribution map of *Alpinia arachniformis* A.D.Poulsen (red circles), *A. oceanica* (yellow), and *A. vittata* (green, cultivated).

Table 1. Comparison between *Alpinia arachniformis, Alpinia oceanica*, and *Alpinia vittata.*

Morphological characters	*Alpinia arachniformis*	*Alpinia oceanica*	*Alpinia vittata*
Sheath	glabrous to slightly pubescent	glabrous	glabrous
Ligule	pubescent	glabrous to pubescent	densely pubescent
Petiole	sessile	sessile to c. 5 mm long	2–3 mm long
Lamina	mid-green above, light green beneath; apex acute	mid-green above, light green beneath; apex caudate	variegated with cream to white lines, lighter beneath; apex obtuse
Inflorescence	erect	mostly pendulous, rarely erect	pendulous
Distal peduncle	exposed part 6–7 cm long	hidden within the sheaths	hidden within the sheaths
Cincinni	with 2 mm stalk; 3–11 cm long; laxly arranged along the rachis; with up to 15 flowers	sessile; up to 3–7 cm long; tightly or laxly arranged along the rachis; with up to 5 flowers	sessile; 6–7 cm long; laxly arranged along the rachis; with up to 6 flowers
Floral bract	white or white with green streaks; margin glabrous	green, green with pink streaks (appearing pinkish green), and white; margin pubescent	light green; margin pubescent
Bracteole and its V-shape incision	9–12 mm long (incision c. 3 mm long)	10–23 mm long (incision c. 16 mm long)	14–15 mm long; (incision c. 10 mm long)
Staminal tube	3–4 mm long	2–3 mm long	6–7 mm long
Labellum	linear; apex retuse	narrowly triangular; apex truncate	narrowly triangular; apex truncate
Lateral staminodes	always present as flattened tooth-like structures	occasionally present as flattened tooth-like structures	absent
Fruit	white, tinged faintly pink	white, light green, or pale red	not observed

Additional specimens examined

Papua New Guinea. New Hanover Island, north coast, 2°55'S, 150°10'E, 20 October 1955, *J.S. Womersley & A.C. Richardson NGF* 7969 (LAE); Lavongai subdistrict, Lamet, 2°23'S, 150°10'E, 12 October 1974, *J.R. Croft LAE 65551*, (A, BISH, BRI, CANB, E, L, LAE); edge of Taskul airstrip, 2°33'S, 150°28'E, 10 m a.s.l., 25 September 1979, *O. Gideon LAE 76077* (LAE). New Ireland Island, Kavieng District, sea level, 31 October 1964, *A.N. Millar NGF 23820* (BRI, CANB, GH, K, L, LAE); Namatanai District, near Komalu village, 3°31'19"S, 12°58'6"E, 50 m a.s.l., 2 October 2023, *A.D. Poulsen et al. 3313* (E, L, LAE, SING); Kabohbok, 3°31'35.1"S, 12°36"E; 10 m a.s.l., 2 October 2023, *A.D. Poulsen et al. 3314* (E, LAE, SING); Karu Forestry Station, 3°28'6.4"S, 14°1.8"E, 2 m a.s.l., 2 October 2023, *A.D. Poulsen et al. 3316* (E, LAE).

Key to *Alpinia* species of the Bismarck Archipelago

The first attempt of a checklist of *Alpinia* of the Bismarck Archipelago is by Peekel (1984) but did not include a key. Here we provide the first key to the *Alpinia* species of the archipelago.

1a. Floral bract persistent **2**

1b. Floral bract deciduous or absent **5**

2a. Lamina sessile; corolla exerted from the calyx less than ¼ its length; floral bracts ovate; lateral staminodes tooth-like or absent **3**

2b. Lamina petiolate; corolla exerted from the calyx more than ¾ its length; floral bracts obovate; lateral staminodes ovate .... ***A. purpurata***

3a. Sheath pubescent; ligule pubescent; lamina apex acute; inflorescence always erect; cincinni 3–11 cm long with up to 15 flowers; labellum linear .... ***A. arachniformis***

3b. Sheath glabrous; ligule glabrous; lamina apex caudate; inflorescence mostly pendulous; cincinni 2–4 cm long with up to 5 flowers; labellum narrowly triangular **4**

4a. Lamina mid-green above; fruits globose .... ***A. oceanica***

4b. Lamina variegated with cream to white lines; fruits unknown .... ***A. vittata***

5a. Lamina oblong; labellum petaloid, broadly triangular-ovate, yellow and red .... ***A. novae-pommeraniae***

5b. Lamina narrowly ovate; labellum fleshy, quadrilobed, white tinged pink .... ***A. pulchella***

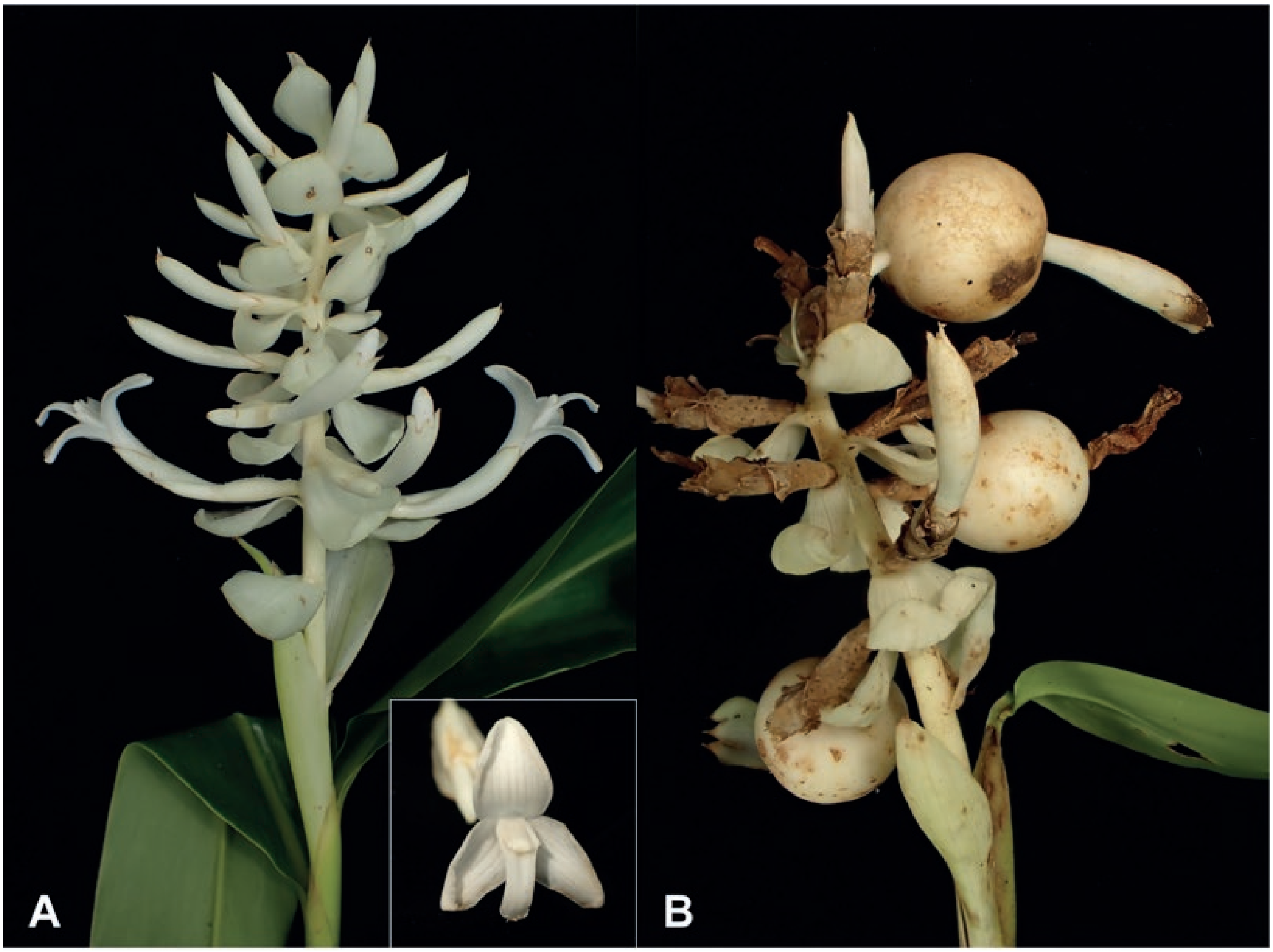

Figure 5. *Alpinia arachniformis* A.D.Poulsen with short cincinni. **A.** Inflorescence (inset: frontal view of a flower). **B.** Almost mature inflorescence. Photos: A.D. Poulsen of *A.D. Poulsen et al. 3313* (not the type).

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Appendix I. List of taxa sampled with GenBank accession numbers (ITS, *trn*K/*mat*K) and voucher information. GenBank accession numbers in **bold font** were generated for this study.

Species	ITS	Country/Region of origin	Reference / Voucher
Tribe Alpinieae			
Adelmeria alpina Elmer	LT717096	Philippines	R.V.A. Docot 0051a (USTH)
Adelmeria dicranochila Docot & Banag	LT717101	Philippines	R.V.A. Docot 0048 (USTH)
Adelmeria gigantifolia (Elmer) Elmer	LT717097	Philippines	R.V.A. Docot 0037 (USTH)
Adelmeria isarogensis Docot & Banag	LT717102	Philippines	R.V.A. Docot 0065 (USTH)
Adelmeria leonardoi Docot & Banag	LT717103	Philippines	R.V.A. Docot 0075 (USTH)
Adelmeria oblonga Merr.	LT717098	Philippines	R.V.A. Docot 0056 (USTH)
Adelmeria paradoxa (Ridl.) Merr.	LT717099	Philippines	R.V.A. Docot 0048 (USTH)
Adelmeria pinetorum (Ridl.) Ridl.	LT717100	Philippines	R.V.A. Docot 0030 (USTH)
Adelmeria undulata Docot & Banag	LT717104	Philippines	R.V.A. Docot 0071 (USTH)
Aframomum angustifolium (Sonn.) K.Schum.	AF478704	Madagascar	W.J. Kress 92-34`03 (US)
Aframomum cereum (Hook.f.) K.Schum.	AF478706	Gabon	W.J. Kress 98-6268 (US)
Alpinia aenea B.L.Burtt & R.M.Sm.	AY742351	Indonesia	G. Argent 0016 (E)
Alpinia arachniformis A.D.Poulsen (1)	**PQ165160**	Papua New Guinea	A.D. Poulsen et al. 2893 (E)
Alpinia arachniformis A.D.Poulsen (2)	**PQ165161**	Papua New Guinea	A.D. Poulsen et al. 3313 (E)
Alpinia arachniformis A.D.Poulsen (3)	**PQ165162**	Papua New Guinea	A.D. Poulsen et al. 3314 (E)
Alpinia arachniformis A.D.Poulsen (4)	**PQ165163**	Papua New Guinea	A.D. Poulsen et al. 3316 (E)
Alpinia arctiflora (F.Muell.) Benth.	AY742336	Australia	A. Rangsiruji 48 (E)
Alpinia argentea (B.L.Burtt & R.M.Sm.) R.M.Sm.	AY742337	Malaysia	CS 02-303 (HLA)
Alpinia arundelliana (F.M.Bailey) K.Schum.	AY742338	Australia	A. Rangsiruji 49 (E)
Alpinia boia Seem.	AY742340	Fiji	see Rangsiruji et al. (2000)
Alpinia brevilabris C.Presl	AY742341	Philippines	see Rangsiruji et al. (2000)
Alpinia caerulea (R.Br.) Benth.	AY742342	Australia	A. Rangsiruji 50 (E)
Alpinia calcarata (Haw.) Roscoe	AF478710	China	W.J. Kress 94-3657 (US)
Alpinia capitellata Jack	KJ507890	Malaysia	-
Alpinia carolinensis Koidz.	AF478711	Micronesia	W.J. Kress 94-5254 (US)
Alpinia coeruleoviridis K.Schum.	AY742343	Indonesia	A. Rangsiruji 240 (E)
Alpinia congesta Elmer	LT717106	Philippines	R.V.A. Docot 0018 (USTH)
Alpinia cylindrocephala K.Schum.	AY742345	Indonesia	M.F. Newman & J. Škorničková 1467 (E)
Alpinia elegans (C.Presl) K.Schum.	AF478713	Philippines	W.J. Kress 99-6412 (US)
Alpinia eubractea K.Schum. (1)	AY742347	Indonesia	529 (E, Leiden)
Alpinia eubractea K.Schum. (2)	LT717108	Indonesia	A.D. Poulsen et al. 2739 (E)
Alpinia foxworthyi Ridl.	AF478714	Philippines	see Rangsiruji et al. (2000)
Alpinia galanga (L.) Willd. (1)	AF478715	ex hort. Hawaii	Lyon Arbor. 83.505 (HLA)
Alpinia galanga (L.) Willd. (2)	AY424739	ex. hort. E	A. Rangsiruji 3 (E)
Alpinia haenkei C.Presl	AY742354	Philippines	L-82.0072 (HLA)
Alpinia javanica Blume	AY742358	Malaysia	A. Rangsiruji 53 (E)
Alpinia ligulata K.Schum.	AY742361	Malaysia	see Rangsiruji et al. (2000)
Alpinia luteocarpa Elmer (1)	AF478717	Philippines	W.J. Kress 99-6403 (US)
Alpinia luteocarpa Elmer (2)	LT717110	Philippines	R.V.A. Docot 0028 (USTH)
Alpinia melichroa K.Schum.	KY438060	Indonesia	A.D. Poulsen & Sharp 2834 (E)
Alpinia monopleura K.Schum.	KY438054	Indonesia	S.M. Scott 02-101 (E)
Alpinia murdochii Ridl.	KY438007	Malaysia	O. Šída, T. Fér & E. Záveská M-11-1 (PR)
Alpinia nigra (Gaertn.) Burtt	KJ946272	India	M.R. Vinitha 92522 (CALI)
Alpinia nutans (L.) Roscoe	AY742369	Malaysia, Thailand	L-91.0066, CS 02-337 (HLA)
Alpinia oceanica Burkill (1)	**PQ165165**	Papua New Guinea	A.D. Poulsen et al. 3307 (E)
Alpinia oceanica Burkill (2)	**PQ165164**	Papua New Guinea	A.D. Poulsen et al. 3309 (E)

(Continued)

Appendix I. (Continued).

Species	ITS	Country/Region of origin	Reference / Voucher
Alpinia officinarum Hance	AF478718	China	W.J. Kress 00-6614 (US)
Alpinia oxyphylla Miq.	AY74372	China	Liao 020707 (SCIB)
Alpinia purpurata (Vieill.) K.Schum.	AY742375	Melanesia	A. Rangsiruji 9 (E)
Alpinia purpurata (Vieill.) K.Schum.	KY438102	Solomon Islands	A.D. Poulsen 2467 (E)
Alpinia rafflesiana Wall. ex Baker	AY742376	Malaysia	Ibrahim & Jong s.n. (Kress 97-6119) (E)
Alpinia rufa (C.Presl) Náves	LT717109	Philippines	R.V.A. Docot 0063 (USTH)
Alpinia sibuyanensis Elmer	AY742381	Philippines	L-99.0098 (HLA)
Alpinia vittata W.Bull (1)	**PQ165159**	Papua New Guinea	A.D. Poulsen et al. 3315 (E)
Alpinia vittata W.Bull (2)	**PQ165158**	Papua New Guinea	A.D. Poulsen et al. 3317 (E)
Alpinia warburgii K.Schum.	AY742388	Indonesia	SUL02-169 (E)
Alpinia zerumbet (Pers.) B.L.Burtt & R.M.Sm.	AY742389	ex. hort. E	A. Rangsiruji 18 (E)
Alpiniua modesta F.Muell. ex K.Schum.	AY742364	Australia	A. Rangsiruji 51 (E)
Amomum apiculatum K.Schum.	KY438083	Indonesia	A.D. Poulsen & Hatta 2275 (ANDA)
Amomum centrocephalum A.D.Poulsen	KY438010	Indonesia	A.J. Droop 29 (E)
Amomum maximum Roxb.	AY351995	China	Y.M. Xia 725 (HITBC)
Amomum subulatum Roxb.	KY438086	India	J. Mood 3218 (ASSAM)
Amomum trianthemum K.Schum.	KY438090	Indonesia	M.F. Newman et al. 118 (E)
Conamomum cylindrostachys (K.Schum.) Škorničk. & A.D.Poulsen	AB097240	Malaysia	S. Sakai 357 (KYO)
*Conamomum xanthophlebium (*Baker) Škorničk. & A.D.Poulsen	KY438018	Indonesia	A.J. Droop 81 (E)
Elettaria cardamomum (L.) Maton	KY438100	Malaysia	J. Leong-Škorničková JLS-432 (SING)
Elettaria floribunda Thwaites	AY742334	Sri Lanka	A. Weerasooriya s.n. (K)
Elettaria involucrata Thwaites	AY742348	Sri Lanka	A. Weerasooriya s.n. (K, PDA)
Epiamomum angustipetalum (S.Sakai & Nagam.) A.D.Poulsen & Škorničk.	AB097245	Malaysia	S. Sakai 389 (KYO)
Epiamomum roseisquamosum (S.Sakai & Nagam.) A.D.Poulsen & Škorničk.	AB097246	Malaysia	S. Sakai 188 (KYO)
Etlingera corrugata A.D.Poulsen	KY438084	Malaysia	J. Leong-Škorničková JLS-220 (SING)
Etlingera fimbriobracteata (K.Schum.) R.M.Sm.	KY438005	ex hort. SBG	J. Leong-Škorničková GRC-362 (SING)
Etlingera yunnanensis (T.L.Wu & S.J.Chen) R.M.Sm.	AY352014	China	Y.M. Xia 738 (W.J. Kress 95-5511) (HITBC)
Geocharis fusiformis (Ridl.) R.M.Sm.	AF414487	Malaysia	L.B. Pedersen 1141 (C)
Geocharis macrostemon (K.Schum.) Holttum	KY438104	Indonesia	A.J. Droop 19 (E)
Geostachys densiflora Ridl.	KY438011	Malaysia	O. Šída, T. Fér & E. Záveská M-11-2 (PR)
Geostachys megaphylla Holttum	AY351987	China	Y.M. Xia 721 (HITBC)
Hornstedtia hainanensis T.L.Wu & S.J.Chen	AF478766	China	W.J. Kress 97-5769 (US)
Hornstedtia leonurus (J.Koenig) Retz.	KY438012	Singapore	J. Leong-Škorničková et al. SNG 72 (SING)
Hornstedtia sanhan M.F.Newman	AY769844	Vietnam	M.F. Newman 202 (E)
Hornstedtia scyphifera (J.Koenig) Steud.	KY438021	Singapore	J. Leong-Škorničková et al. SNG-21 (SING)
Hornstedtia cf. *scyphifera* (J.Koenig) Steud.	KY620235	Indonesia	A.J. Droop 4 (E)
Hornstedtia tomentosa (Blume) Bakh.f.	KY438074	ex hort. SBG	J. Leong-Škorničková GRC-169 (SING)
Lanxangia coriandriodora (S.Q.Tong & Y.M.Xia) M.F.Newman & Škorničk.	KY438067	Indonesia	A.J. Droop 76 (E)
Lanxangia tsaoko (Crevost & Lemarié) M.F.Newman & Škorničk.	AY352007	China	Y.M. Xia 734 (HITBC)
Leptosolena haenkei C.Presl	AY742331	Philippines	Funakoshi & Co 2006 (US)
Meistera echinocarpa (Alston) Škorničk. & M.F.Newman	KY438068	Laos	V. Lamxay 1315 (E)
Meistera koenigii (J.F.Gmel.) Škorničk. & M.F.Newman	KY438112	Laos	V. Lamxay 2078 (NLS)
Meistera propinqua (Ridl.) Škorničk. & M.F.Newman	AY351999	Philippines	Lyon Arbor. 93.0558 (HLA)

(Continued)

Appendix I. (Continued).

Species	ITS	Country/Region of origin	Reference / Voucher
Plagiostachys sp.	KY438024	ex hort. SBG	J. Leong-Škorničková JLS-1882 (SING)
Renealmia alpina (Rottb.) Maas	AF478778	Tropical America	W.J. Kress 99-6407 (US)
Renealmia thyrsoidea (Ruiz & Pav.) Poepp. & Endl.	AF478783	Tropical America	W.J. Kress 99-6406 (US)
Sulettaria anomala (R.M.Sm.) A.D.Poulsen & Lofthus,	KY438106	Malaysia	A.D. Poulsen & al. 2033 (AAU)
Sulettaria longipilosa (S.Sakai & Nagam.) A.D.Poulsen & Lofthus	AB097229	Malaysia	S. Sakai 380 (KYO)
Sundamomum durum (S.Sakai & Nagam.) A.D.Poulsen & M.F.Newman	JF715470	Malaysia	S. Sakai 362 (KYO)
Sundamomum hastilabum (Ridl.) A.D.Poulsen & M.F.Newman	KY438067	Indonesia	A.D. Poulsen & al. 2262 (E)
Vanoverberghia diversifolia Elmer	LT717105	Philippines	R.V.A. Docot 0034 (USTH)
Vanoverberghia rubrobracteata Docot & Ambida	MH270333	Philippines	R.V.A. Docot 0118 (USTH)
Vanoverberghia sasakiana Funak. & H.Ohashi	MH270332		Sekiguchi 23 (TI)
Vanoverberghia sepulchrei Merr.	AF478798	Philippines	Kress #95-5562 (US)
Vanoverberghia vanoverberghii (Merr.) Funak. & Docot	LT717107	Philippines	R.V.A. Docot 0005 (USTH)
Wurfbainia glabrifolia (Lamxay & M.F.Newman) Škorničk.& A.D.Poulsen	KY438049	Laos	V. Lamxay 2068 (NLS)
Wurfbainia uliginosa (J.Koenig) Škorničk. & A.D.Poulsen	KY438071	Laos	V. Lamxay 1021 (E)
Wurfbainia vera (Blackw.) Škorničk. & A.D.Poulsen	KY438099	Indonesia	A.J. Droop 10 (E)
Incertae cedis			
Siliquamomum oreodoxa N.S.Lý & Škorničk.	KY438093	Vietnam	S. Hul & N.S. Lý 3583 (E)
Siliquamomum tonkinense Baill.	KY438088	Vietnam	J. Leong-Škorničková et al. JLS-846 (SING)
Tribe Siphonochileae			
Siphonochilus kirkii (Hook.f.) B.L.Burtt	AF478794	East Africa	W.J. Kress 94-3692 (US)

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Two new species of *Psychotria* L. (Psychotrieae-Rubiaceae) from Dinagat Island, Philippines

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Abstract. *Psychotria alejandroi* and *P. nitidifolia*, two new species from Dinagat Island, Philippines, are described and illustrated. Both species belong to the Pilosella species group sensu Sohmer and Davis (2007), characterized by inflorescences with defined axes bearing sessile flowers and fruits. *Psychotria alejandroi* is similar to *P. pilosella* but can be distinguished by having truncate, lobed stipules with its inner lobes extending into long aristae, lanceolate to narrowly ovate leaves that are coriaceous and scabrous, longer inflorescences (2–4 cm long), bracts with entire margins, 5- to 6-merous flowers, and weakly ribbed pyrenes with weakly ruminate endosperms. *Psychotria nitidifolia* resembles *P. castroi* but differs by its smaller habits (0.6–1.5 m), shorter petioles ((0.8)1.3–1.7 cm), smaller leaves ((4.0)9.2–11.2 cm × (1.5)3.2–3.9 cm), blades drying dark khaki brown, monochotomous to trichotomous inflorescences, prolate fruits with smaller, obscure calyx lobes (0.2–0.3 mm), and strongly ridged pyrenes with weakly ruminate endosperms. Field images, a distribution map, and an identification key to the *Psychotria* species (Pilosella group) occurring on Dinagat Island are also provided. Based on the IUCN categories, the two new species are evaluated as critically endangered (CR). The discovery of these species highlights the urgency for further biological explorations and to conserve the remaining forested habitats of Dinagat Island, as this area serves as the only sanctuary for a multitude of narrowly endemic species.

Keywords: Cagdianao, narrow endemic, Rubioideae, taxonomy, threatened taxa, ultramafic soils.

INTRODUCTION

Psychotria L. (Rubiaceae) is one of the largest plant genera, comprising ca. 1,645 species of primarily understory shrubs to small trees with a vast geographical spread (Sohmer 1978; Frodin 2004; Davis et al. 2009; POWO 2024). The genus contributes abundantly to tropical and subtropical rainforests, particularly in Africa, the Americas, Asia, and Oceania, and their fleshy fruits serve as an essential food source for many frugivorous animals and attract a wide variety of animal dispersers (Snow 1981; Herrera 1989; Gentry 1990). The genus is generally characterized by having caducous stipules, white to yellow small flowers in terminal inflorescences, colorful drupaceous fruits, and seeds with ethanol-soluble pigments in their seed coats (Nepokroeff et al. 1999; Andersson 2002). Its sheer diversity challenges taxonomists, evolutionary biologists, and conservationists to study it in its entirety, especially in biodiversity hotspots like the Philippines.

The Philippine archipelago boasts an astounding diversity of 113 known species of *Psychotria*, of which 106 are endemic (Sohmer and Davis 2007; Pelser et al. 2011 onwards; Bautista et al. 2024). However, more than half of these are either presumably extinct or threatened (vulnerable to critically endangered) and have never recollected since their first collection (Sohmer and Davis 2007), dating back decades to over a century ago, particularly those found in the meridional Philippines. Continuous efforts to study *Psychotria* are slowly being made, with rediscoveries of species previously thought to have gone extinct (e.g., Ordas et al. 2019; Biag and Alejandro 2020; 2022; Batuyong et al. 2021), the revision of taxon names (Berger 2023), and the description of novel species (Bautista et al. 2024). With numerous species considered extinct in the wild, further studies are needed in this period of rapid biodiversity decline.

Dinagat Island is the third-largest island in the Mindanao biogeographic region, situated in the northeastern tip of Mindanao (Fig. 1). A comprehensive plant survey of the island by Lillo et al. (2019) revealed that it is characterized by six forest habitat types having a unique floral assemblage, with over 400 native species, of which 10% are island endemics. Over recent years, several new micro-endemic species from the island were described (Robinson et al. 2019; Amoroso et al. 2023; Tamayo et al. 2023). However, many of the island's forested areas have not been explored and are currently threatened by anthropogenic activities, necessitating urgent research and exploration.

Fieldwork in the municipality of Cagdianao, Dinagat Island, led to the collection of two enigmatic *Psychotria* species thriving in forests on ultramafic soils. Examination of the specimens revealed that both species belong to the Pilosella group, characterized by monochotomous or trichotomous inflorescences with defined axes and branches, terminated by clusters of sessile flowers and fruits (Sohmer and Davis 2007). Hence, we hereby describe in detail two new species of *Psychotria* from Dinagat Island, Philippines.

MATERIAL AND METHODS

The descriptions of the new species were based on living and preserved specimens collected in August 2023 from the ultramafic forests of Cagdianao, Dinagat Island, Philippines (Fig. 1). Initial identification of the material was carried out by utilizing the taxonomic keys and descriptions by Sohmer and Davis (2007) and through protologues, with the comparison of *Psychotria* specimens from USTH and digitized types from international herbaria (e.g., A, HUH, K, NY, and US). The herbaria acronyms follow Thiers (2025). Morphological examinations of specimens were performed using an Olympus SZ51 dissecting microscope and metric vernier caliper, and character-state terminologies were based on Beentje (2016). The materials were deposited in USTH and FEUH. Georeferenced data based on these collections, personal observations, and the records of Pelser et al. (2011 onwards) were used to generate distribution maps and compute the area of occupancy (AOO) using the Geospatial Conservation Assessment Tool (GeoCAT; Bachman et al. 2011).

TAXONOMIC TREATMENT

Psychotria alejandroi Ordas, Chen, & Odulio **sp. nov.** (Figures 2, 4A–C)

Type: Philippines, Dinagat Island Province, Municipality of Cagdianao: Barangay Legazpi, 10°09'12" N 125°39'12" E, 60 m, on ultramafic soils of open canopy forests, 30 Aug 2023, *Odulio, Zamudio, et al. DIN23-026* (holotype USTH, isotypes USTH, incl. spirit, FEUH).

Diagnosis

Psychotria alejandroi is similar to *Psychotria pilosella* Elmer but is distinct in having truncate, lobed stipules with its inner lobes extending into long aristae (vs. unlobed, ovate stipules with acute cleft apices), lanceolate to narrowly ovate leaves (vs. obovate to narrowly oblanceolate leaves) that are coriaceous and scabrous (vs. chartaceous to subcoriaceous), 2–4 cm long inflorescences (vs. 0.7–2.7 cm long), bracts with entire margins (vs. serrate to laciniate), 5- to 6-merous flowers (vs. 4- to 5-merous), weakly ribbed pyrenes with weakly ruminate endosperms (vs. ribbed to ribbed-ridged pyrenes with distinct ruminate endosperms).

Description

Tree ca. 3.0–3.5 m tall. Young stems hispid; internodes 0.4–1.0 cm long, defoliated at lower branches.

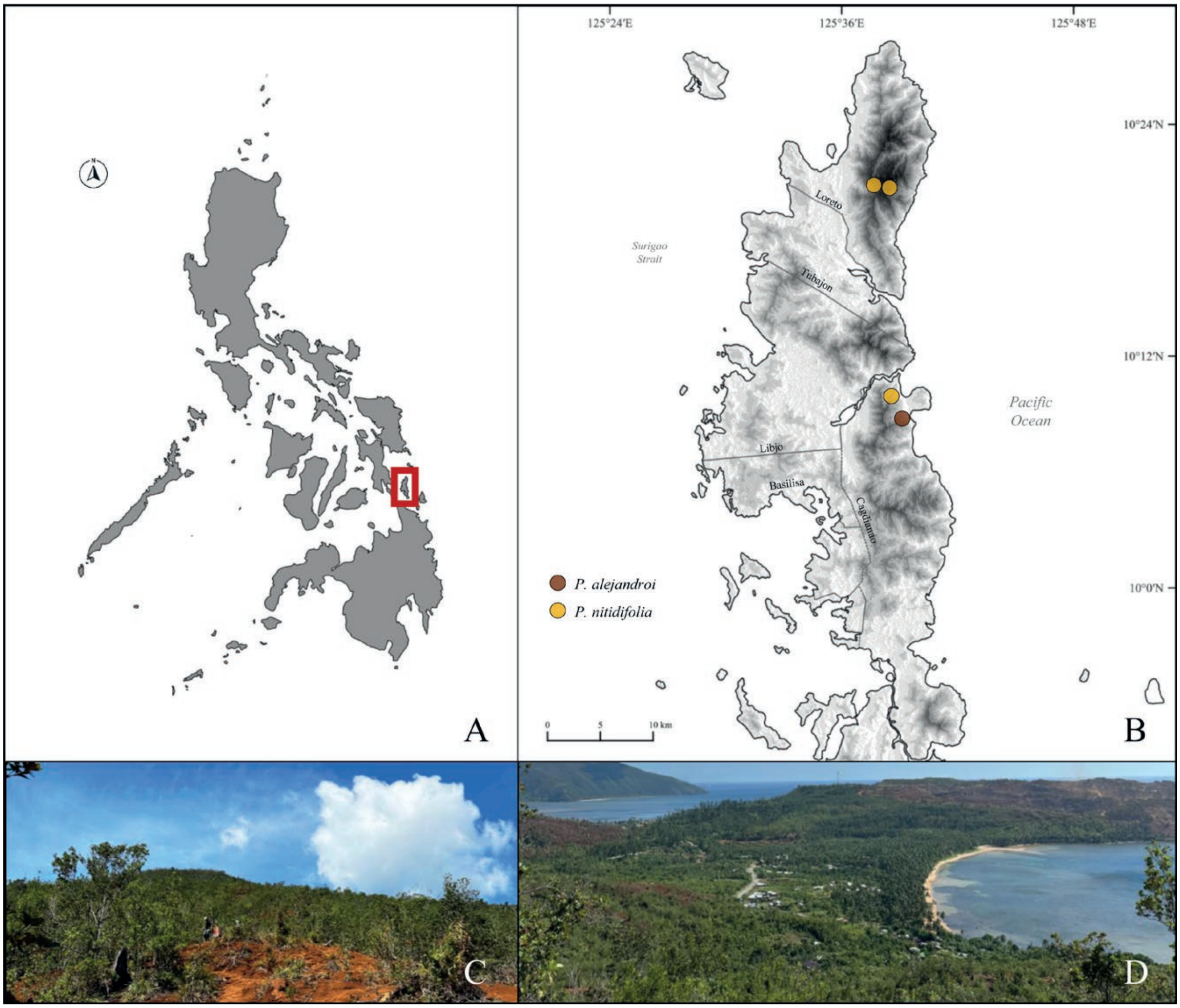

Figure 1. Map of Dinagat Island, Philippines, with known occurrence records of *Psychotria alejandroi* Ordas, Chen, & Odulio and *P. nitidifolia* Ordas, Chen, & Alfeche: A. Map of the Philippines showing the location of Dinagat Island (red box). B. Distribution of *Psychotria alejandroi* (brown) and *P. nitidifolia* (gold) on Dinagat Island. C. Open canopy forests with ultramafic soils in Cagdianao. D. Locality of Barangay Legazpi, Cagdianao.

Stipules caducous, valvate, truncate, divided into 6 to 8 linear lobes, 10 mm × 4 mm, hispid outside, apex of the inner lobes having two tips drawn out into long aristae. Leaves opposite-decussate, petioles 0.8–2.4 cm long, hispid; leaf blades lanceolate to narrowly ovate, (4.3)8.5–14.5 cm × (1.3)3.4–5.3 cm, coriaceous and scabrous, adaxially sparsely hirsute but indumentum denser on midrib, abaxially hispid but indumentum denser on midrib and lateral veins, bright green but drying reddish brown; lateral veins 9–18 on each side of the midrib, visible on adaxial surface, very prominent on abaxial surface; tertiary venation manifest on abaxial surface; base attenuate to cuneate; apex attenuate to acuminate. Inflorescences/infructescence monochotomous to trichotomous, erect, 2–4 cm long, tomentose, with each branch terminated by 3–10 sessile flowers and fruits; principal axis of trichotomous inflorescences 0.7–2.0 cm long, with the middle axis frequently having a primary node, supporting three branches, 1.2–1.8 cm long; principal axis (peduncle) of monochotomous inflorescences 0.5–0.8 cm long, sometimes with one primary node supporting three branches, 1.0–1.1 cm long; bracts and bracteoles persistent, ovate, 1.0–1.5 mm long, densely hispid outside, margins entire, apex widely acute. Flowers ses-

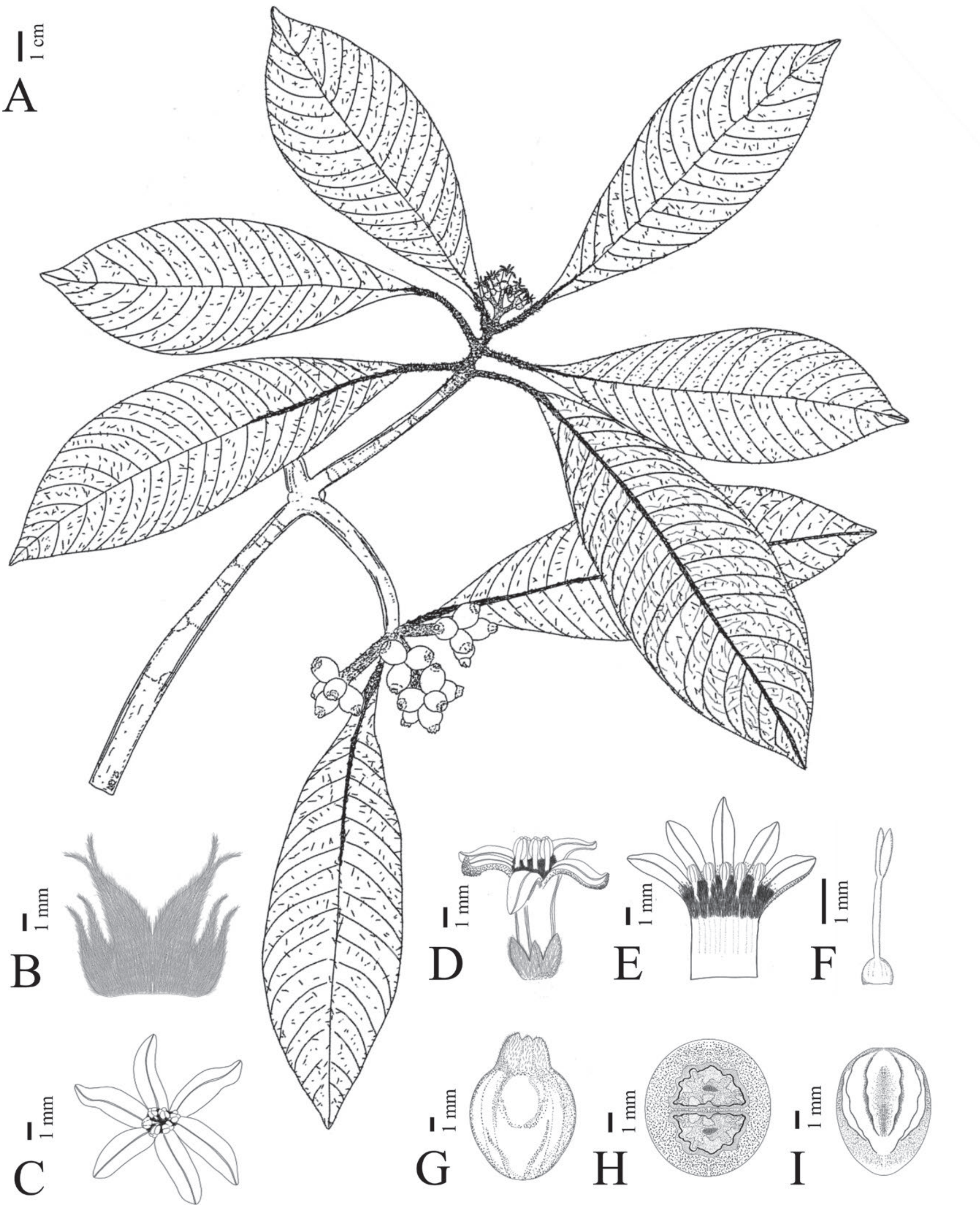

Figure 2. *Psychotria alejandroi* Ordas, Chen, & Odulio: A. Flowering and fruiting branch. B. Stipule. C. 6-merous flower (top view). D. 5-merous flower. E. 5-merous flower dissected. F. Gynoecium. G. Fruit. H. Fruit cross-section. I. Pyrene. Illustrated by G.N.G. Cortez.

sile, 5- to 6-merous; calyx (incl. hypanthium) cupuliform, 3.0–3.5 mm long, green, hispid outside; calyx lobes deltoid, 1.0–1.25 mm long, hispid outside, apex acute to obtuse; corolla white, salver-shaped; corolla tube 5 mm long, glabrous outside, densely hispid at throat within; corolla lobes oblong, slightly involute at the apex, 5 mm long, glabrous adaxially, echinate abaxially, apex acute; stamens 3.0–3.2 mm long, exserted from the corolla ca. 1 mm; filaments 2 mm long; anthers 1.0–1.2 mm long; carpels 4 mm long; ovary 0.7–1.0 mm long; style 2 mm long; stigma bifid, 1 mm long. Fruits sessile, subglobose to prolate, 8–10 mm x 5–7 mm in both fresh and dry state, smooth, slightly ribbed when dry, light russet (reddish brown), very sparsely hispid on top; calyx persistent, prominent, 2.0–3.5 mm long, green, truncate, limb 2.0–2.5 mm, lobes 0.5–1.0 mm, acute to obtuse; pyrenes oval, weakly ribbed, 6–7 mm × 5 mm; endosperm weakly ruminate.

Etymology

The species is named in honor of Dr. Grecebio Jonathan D. Alejandro, who has contributed significantly to the systematics of the Rubiaceae family in the Philippines.

Distribution, habitat, and phenology

Psychotria alejandroi is only known from its type locality (Fig. 1), occurring on ultramafic soils in open scrubby vegetation. The open dry forests of the type locality are prone to forest fires. Notable species in the area include *Alpinia brevilabris* C.Presl. (Zingiberaceae), *Ampelocissus madulidii* Latiff (Vitaceae), *Bikkia montoyae* Mejillano, Santor & Alejandro (Rubiaceae), *Chewlunia auriculata* (Merr.) P.K.Hoo & Junhao Chen (Rubiaceae), *Osmoxylon yatesii* (Merr.) Philipson (Araliaceae), *Psychotria pilosella*, *Sararanga philippinensis* Merr. (Pandanaceae), *Scaevola micrantha* C.Presl (Goodeniaceae), *Timonius finlaysonianus* (Wall. ex G.Don) Hook.f. (Rubiaceae), *Xanthostemon verdugonianus* Náves ex Fern.-Vill. (Myrtaceae), and several *Nepenthes* L. (Nepenthaceae) species. This new species was collected in flower and fruit in November. Hence, its flowering season is expected to be around May to November and fruiting from November to January.

Notes

Psychotria alejandroi is morphologically similar to *P. pilosella*, an endemic species from the Pilosella group with a wide Philippine distribution, as both species occur as trees with dense pubescence on their vegetative structures, inflorescences that are both monochotomous and trichotomous, and similar flowering and fruiting features. However, *P. alejandroi* is easily distinguished from *P. pilosella* by its stipules divided into 6 to 8 linear lobes, resembling fingerlike projections, with the inner lobes extending into long aristae. On the other hand, the stipules of *P. pilosella* are unlobed, ovate, and have acute cleft apices. The leaves of *P. alejandroi* are lanceolate to narrowly ovate, whereas it is obovate to narrowly oblanceolate in *P. pilosella*. In addition, the scabrous nature of the leaves in *P. alejandroi*, giving it a rough sandpaper-like texture, separates it from *P. pilosella*, as this feature is observed only in *Psychotria scaberula* Merr., a Dinagat Island endemic, and sometimes in *Psychotria surigaoensis* Sohmer & A.P.Davis. Differences in inflorescences, including length, bract margin shape, and flower merosity, separate the two species. Lastly, the pyrenes and the presence of ruminations in the endosperms are essential characters for delimiting *Psychotria* species (Sohmer & Davis 2007). The pyrenes of *P. alejandroi* are only weakly ribbed, possessing endosperms with weak ruminations in contrast to *P. pilosella* bearing ribbed to ribbed-ridged pyrenes with distinct ruminate endosperms.

Proposed conservation status

Few mature individuals of this species have been observed within the site, but further exploration in undisturbed forests within Cagdianao forests may reveal stable populations. With an estimated area of occupancy of AOO = 4 km^2 and its habitat susceptible to occasional forest fires and anthropogenic impacts such as mining and land conversion, *Psychotria alejandroi* is assessed as critically endangered (CR) under criterion B2ab. Fortunately, Cagdianao Mining, Inc. has taken steps toward conservation by designating a portion of the type locality's forests to be protected and under strict surveillance, similar to that in Mt. Redondo by Krominco, Inc.

Psychotria nitidifolia Ordas, Chen, & Alfeche **sp. nov.** (Figures 3, 4D–F)

Type: Philippines, Dinagat Island Province, Municipality of Cagdianao: Barangay Legazpi, 10°10'11" N, 125°38'50" E, 105 m, on ultramafic soils in open canopy forest, 30 Aug 2023, *Ordas, Alfeche, et al., DIN23-119* (holotype USTH; isotypes USTH incl. spirit, FEUH).

Diagnosis

The new species is comparable to *Psychotria castroi* Merr. & Quisumb. ex Sohmer & A.P.Davis but is distinguished in having a smaller habit (0.6–1.5 m vs. 2.0–7.0 m), shorter petioles ((0.8)1.3–1.7 cm vs. 1.7–3.0 cm), smaller leaves ((4.0)9.2–11.2 cm × (1.5)3.2–3.9 cm

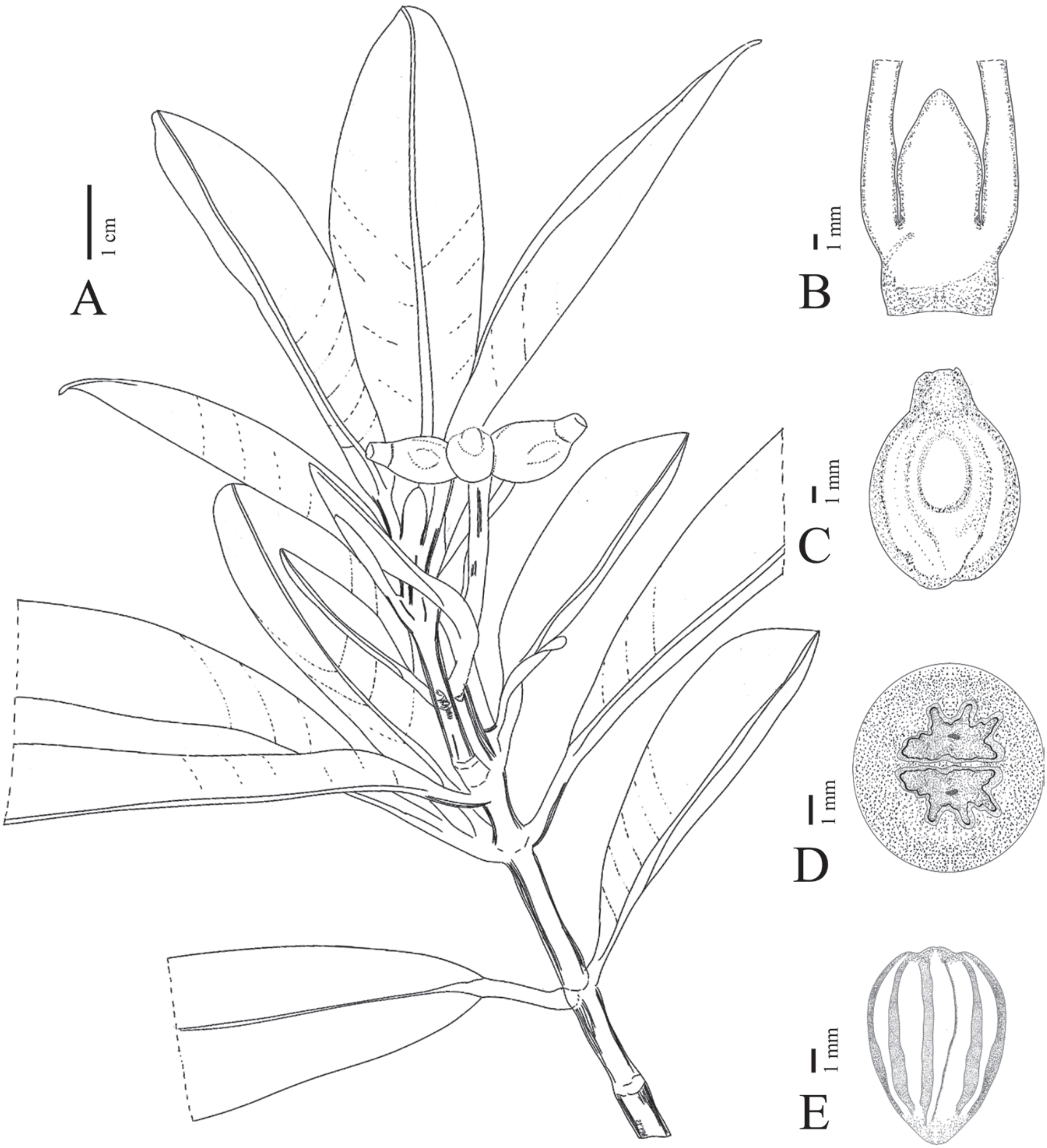

Figure 3. *Psychotria nitidifolia* Ordas, Chen, & Alfeche: A. Fruiting branch. B. Terminal bud enclosed in stipules. C. Fruit. D. Fruit cross-section. E. Pyrene. Illustrated by G.N.G. Cortez.

vs. 10–15 cm x 4.8–6.2 cm) drying dark khaki brown (vs. dark brown or reddish brown), monochotomous to trichotomous inflorescences (vs. monochotomous only), prolate fruits (vs. turbinate) with smaller, obscure calyx lobes (0.2–0.3 mm vs. 0.5–0.7 mm), strongly ridged pyrenes with weakly ruminate endosperms (vs. weakly ribbed pyrenes with distinct ruminate endosperms).

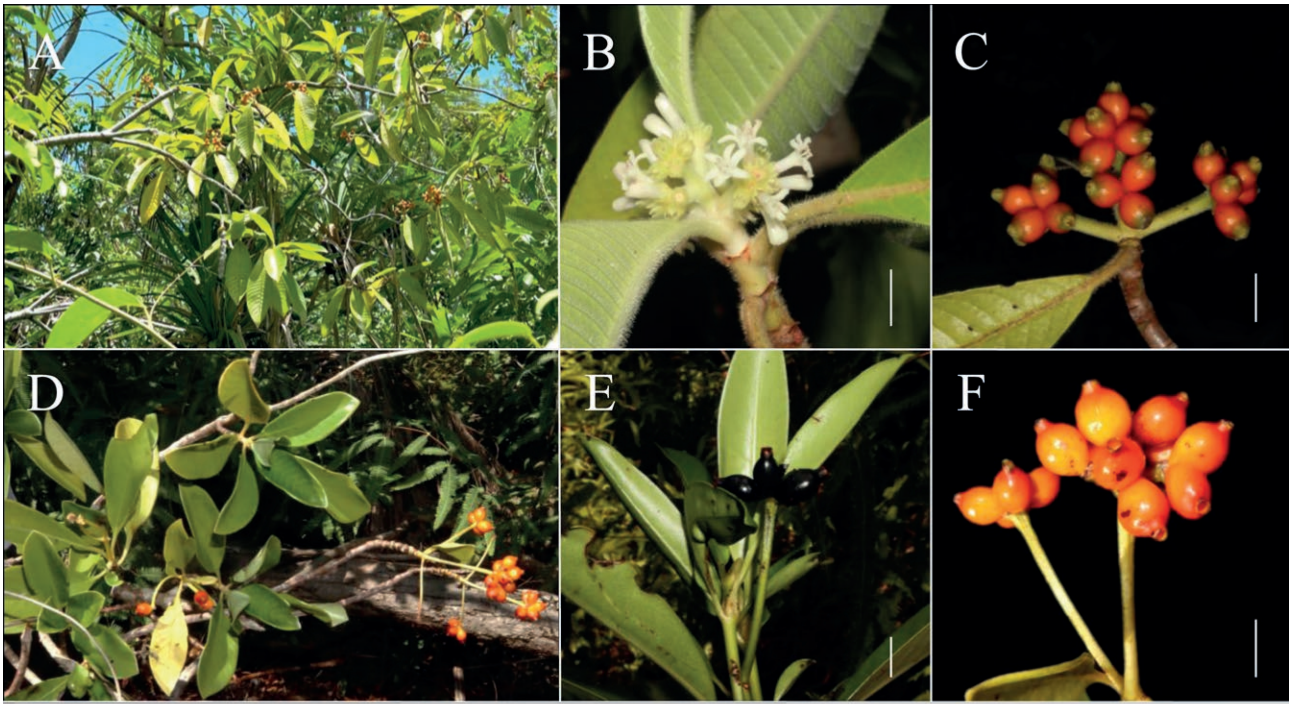

Figure 4. *Psychotria alejandroi* Ordas, Chen, & Odulio (A–C) and *Psychotria nitidifolia* Ordas, Chen, & Alfeche (D–F; D & F taken from specimen DIN23-119, E taken from specimen DIN23-133): A. Habit. B. Flowering branch. C. Fruiting branch. D. Habit. E–F. Fruiting branch. Scale = 1 cm.

Description

Shrub 0.6–1.5 m tall. Young stems glabrous; internodes 0.4–2.0 cm long, defoliated at lower branches. Stipules caducous, valvate, elliptic, 6–9 mm × 3–6 mm, glabrous outside, apex acute. Leaves opposite-decussate, petioles (0.8)1.3–1.7 cm long, glabrous; leaf blades oblanceolate, (4.0)9.2–11.2 cm × (1.5)3.2–3.9 cm, very coriaceous, glabrous on both surfaces, bright green but drying dark khaki brown; lateral veins 5–17 on each side of the midrib, somewhat visible on the adaxial surface, obscure on the abaxial side; tertiary venation inconspicuous; base cuneate to attenuate; apex acute to broadly acuminate. Inflorescences/infructescences monochotomous to trichotomous, erect, 4–6 cm long, glabrous, with each branch terminated by 1–10 sessile flowers and fruits; principal axis of trichotomous inflorescences 2.6–4.9 cm long, unbranched; principal axis (peduncle) of monochotomous inflorescences 1.3–3.2 cm long, with one primary node supporting three branches 1.5–3.0 cm long; bracts caducous, ovate, 3–6 mm long, glabrous outside, margins entire, apex acute to obtuse; bracteoles caducous, valvate, rounded to obtuse, 1–2 mm long, margins repand, apex acute to obtuse. Flowers unknown. Ovary and calyx in flowering stage unknown, in fruiting stage calyx 1.0–3.3 mm long, truncate, limb 1–3 mm long, lobes 0.2–0.3 mm long, deltate, obscure, apex rounded. Fruits sessile or very rarely pedicellate (then pedicels 3–6 mm long and very sparsely pilose), subglobose to prolate, 12–13 × 8–9 mm and smooth but 9–10 × 4–6 mm and longitudinally ribbed when dry, orange and dark purple, with distinct sheen on exocarp, glabrous; at least calyx persistent and prominent, orange, white, to purple, rarely green, glabrous outside; pyrenes obovate, strongly ridged on outer surface, 6.3–8.0 mm × 4.0–5.0 mm; endosperm weakly ruminate.

Etymology

The epithet of this new *Psychotria* species is based on its shiny, light green, very coriaceous leaves.

Distribution, habitat, and phenology

Psychotria nitidifolia is endemic to Dinagat Island, thriving on ultramafic soils in open, scrubby, and pygmy forests from ca. 105 to 850 m asl (Fig. 1). *In-situ* observations by the first author were recorded for this species in pygmy vegetation at the summit (ca. 850 m) of Mt. Redondo in the municipality of Loreto, which comprises a population of highly stunted variants of not more than 50 cm tall. This was also recorded by P. Pelser and J. Barcelona (Pelser et al. 2011 onwards) and Robinson et al. (2019), under the name *Psychotria surigaoensis*. The new species was observed in fruit from June to November. The flowering season is expected to be from January to May.

Proposed conservation status

This species is only known to occur in two ultramafic areas in Dinagat Island: in Cagdianao forest and the Mt. Redondo Natural Bonsai Forest. With an estimated area of occupancy of AOO = 8 km^2, this species could be assessed as critically endangered (CR). Mining and land conversion have impacted portions of Dinagat Island's ultramafic forests, threatening this species' habitat. However, we recommend further explorations on other ultramafic forests of Dinagat Island to enhance understanding of the range and population dynamics of *Psychotria nitidifolia*.

Notes

Psychotria nitidifolia is a distinct species easily recognized from other species in the Pilosella group by its small glabrous habit, very coriaceous leaves, and fruits possessing a distinct sheen on their exocarps. Based on its features, it is closely allied to *P. castroi*, a Samar Island endemic last collected in 1969, as both have entirely glabrous habits and somewhat similar vegetative and fruit morphology. However, *P. nitidifolia* has smaller habit sizes ranging from short to highly stunted shrubs (vs. shrubs to small trees 2–7 m tall) and smaller leaf morphologies with sclerophyllous features. These characteristics are evident for plants that are well-adapted to serpentine soils in open canopy forests with high levels of sun exposure (Brady et al. 2005). In addition, the leaves of *P. nitidifolia,* when dried, are dark khaki brown in contrast to *P. castroi,* which is dark to reddish brown, an important character to separate the two species as the leaf color upon herbarium specimen preparation is significant to distinguish *Psychotria* species (Sohmer & Davis 2007). The inflorescences of *P. nitidifolia* occur as both monochotomous and trichotomous, whereas it is only monochotomous for *P. castroi* and are somewhat smaller (4.0–6.0 cm vs. 5.5–7.5 cm). The fruits of *P. nitidifolia* and *P. castroi* are subglobose, but the former has primarily prolate fruits, whereas the latter has turbinate fruits. In addition, the calyx lobes of *P. nitidifolia* in its fruiting stage are less distinct and obscure than *P. castroi.* Lastly, the strongly ridged pyrenes of *P. nitidifolia* possessing weak rumination in its endosperms distinguish it from *P. castroi*, which bears weakly ribbed pyrenes and a distinct ruminate endosperm.

Other specimens examined

Philippines, Dinagat Island Province, Municipality of Cagdianao: Barangay Legazpi, 10°10'11" N, 125°38'50" E, 120 m, on ultramafic soils of open canopy forest, 30 Aug 2023, *Ordas, Alfeche, et al.*, *DIN23-133*, USTH; *DIN23-134*, USTH.

The two new species occur with other *Psychotria* species of the Pilosella group on Dianagat Island, namely *P. pilosella*, *P. scaberula,* and *P. surigaoensis*. Erroneous identification could happen if specimens are not examined carefully. Hence, a key to the known *Psychotria* species of the Pilosella group on Dinagat Island is provided to facilitate identification.

Key to the *Psychotria* species (*Pilosella* group) of Dinagat Island

1. Plant densely pubescent to hispid; stipules lobed or with cleft apices 2

1. Plant glabrous to sparsely pubescent; stipules with single acute apices 3

2. Stipules ovate to narrowly ovate, unlobed, apex acute but with a cleft; bracts 4–6 mm long, margins serrate to laciniate; flower 4- to 5-merous; fruits sparsely to densely pubescent or glabrous; pyrenes ribbed-ridged .... ***P. pilosella***

2. Stipules truncate, divided into 6 to 8 lobes, apex of inner lobes having two tips drawn out into long aristae; bracts 1.0–1.5 mm long, margins entire; flower 5- to 6-merous; fruits chiefly glabrous but very sparsely hispid on top; pyrenes weakly ribbed .... ***P. alejandroi***

3. Leaf blades strongly scabrous, especially below; fruits globose to obovoid .... ***P. scaberula***

3. Leaf blades smooth; fruits turbinate to prolate 4

4. Leaf blades chartaceous to subcoriaceous; inflorescences 1.5–2.8 cm long, puberulous to pubescent; principal axis (peduncle) of monochotomous inflorescences 0.3–0.9 cm long; bracts ca. 1 mm long, puberulous outside; fruits turbinate .... ***P. surigaoensis***

4. Leaf blades thickly coriaceous; inflorescences 2.6–4.9 cm long, glabrous; principal axis (peduncle) of monochotomous inflorescences 1.3–3.2 cm long; bracts 3–6 mm long, glabrous outside; fruits prolate .... ***P. nitidifolia***

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Begonia ebo sp. nov. (Sect. *Filicibegonia*-Begoniaceae), endangered in Ebo, a highly threatened forest in Littoral Region, Cameroon

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Abstract. *Begonia ebo* H.Lockwood sp. nov., a terrestrial herb endemic to Cameroon cloud forest, is described, mapped and illustrated. It is the first species of *Begonia* Section *Filicibegonia* known to have yellow flowers (vs pink or white), to have inflorescences that are epiphyllous, appearing to emerge from the upper leaf surface (vs ordinarily axillary) and, also, the first species of the section known to be endemic to Cameroon. It is also endemic to the Cross-Sanaga River Interval. In contrast, six of the nine species of Sect. *Filicibegonia* are endemic to the interval between the Sanaga River of Cameroon and the Congo River. So far *Begonia ebo* is only known from inside or adjacent to the Ebo forest, Littoral Region, Cameroon, apart from a single record from the Chaine de Nkohom in Central Region c. 60 km distant. In view of the massive ongoing threats of industrial logging to the Ebo Forest, the stronghold and main centre of this species on current evidence, the conservation status of *Begonia ebo* is provisionally assessed as Endangered, EN B1 ab(iii) +B2ab(iii).

Keywords: Cross-Sanaga River interval, epiphyllous, yellow-flowered.

INTRODUCTION

On the 13th September 2008, during 6 months botanising in the forest of Ebo, Littoral Region, Cameroon, the first author came across plants of a *Begonia* L. species that appeared to be new to science (*Lockwood* 61, K, YA, Fig. 1). Since it has upright stems, papery, indehiscent or irregularly dehiscent fruits, it clearly falls in sect. *Filicibegonia* A.DC. This was confirmed after study by microscope dissection in the herbarium when the following characters used in the global key to *Begonia* sections (Doorenbos et al. 1998: 60) led to Sect. *Filicibegonia*: locules 3, placental branches 1 per locule (vs 2 to 4), female flowers with 2 perianth segments (vs 3 to 6), anthers dehiscent with unilateral longitudinal anther slits, apex hooded, stems upright, wings subequal in fruit; fruit pendulous; venation pinnate; inflorescence monochasial, axes strongly reduced; androecium zygomorphic, filaments unequal, anthers longer than the filaments; styles fused less than halfway, 2-lobed,

Figure 1. *Begonia ebo.* Habit showing male and female flower. *Lockwood* 61 (K, YA). Photo by H. Lockwood.

caducous in fruit, stigma kidney-shaped, in a band and not spiralled.

Filicibegonia consists of "8 species (and probably some un-described ones)" and is restricted to Tropical Africa "from Guinea to eastern Dem. Rep. Congo and south to Angola." (Doorenbos et al. 1998). The centre of diversity is Gabon which has all but one of the described species, including three endemics. The known species of Sect. *Filicibegonia* are: *B. aspleniifolia* Hook.f. ex A.DC. (Gabon), *B. auriculata* Hook.f. (Gabon), *B. elatostemmoides* Hook.f. (Cameroon to DRC), *B. gossweileri* Irmscher (Republic of Congo and Cabinda), *B. macrocarpa* Warb. (W & C Africa), *B. minutifolia* N. Hallé (Gabon), *B. sciaphila* Gilg ex Engl. (Cameroon, Gabon, Cabinda) and *B. sessilifolia* Hook. f. (Cameroon to Congo including Bioko).

Lockwood 61 appeared to be a new species to science because it is the first known species of section *Filicibegonia* to have yellow flowers (vs pink or white), to have inflorescences that are epiphyllous, resting on and appearing to emerge from the upper leaf blade. Within *Filicibegonia,* using the key to *Filicibegonia* species in de Wilde et al. (2009), it keys out nearest to *B. sessilifolia* due to the 3-winged fruits, the entire (non-pinnate) leaf blades that are glabrous adaxially and >5 cm long, the narrowly oval (in fact elliptic-oblong) to rectangular bracts, petioles 2–20 mm long. It also has similarities with *B. gossweileri* of Republic of Congo and Cabinda, the only species of the section not included in de Wilde et al. (2009). See Table 1 for diagnostic differences between these species. In this paper we describe and name the new species as *Begonia ebo,* assess its extinction risk status, map and illustrate it, and discuss it in the context of other highly threatened species in the Ebo forest.

This species was only seen at one location during the first author's 6 months botanical survey at Ebo indicating that it is infrequent. Following the conclusion of the field visit, the specimen was matched with five other specimens from nearby in Ebo including one collected by the last author seven years later, and also with two other collections made outside the Ebo forest.

Begonia ebo is the first new species of the genus to be described from Cameroon for more than twenty years (IPNI continuously updated), the most recent being the point endemic *Begonia montis-elephantis J.J. de Wilde* (de Wilde 2001).

The genus *Begonia* is the fastest growing genus known among plants, with additions being made yearly (Ardi et al. 2022). The total count currently stands at 2151 species (Hughes et al. 2015–). In the years 2014 to 2019 an average of 60 new species were published in *Begonia* each year. The steepest increases in new species have been in SE Asia, with very few from tropical Africa (Hughes in Cheek et al. 2020). The genus is pantropical, and evidence supports tropical Africa as the origin of the genus, since the earliest branching lineages occur here (Forrest et al. 2005).

In Cameroon 49 species of *Begonia* are recorded (Onana 2011), while in neighbouring Gabon 55 species are listed, yet over 100 Gabonese specimens remain undetermined to species (Sosef et al. 2006).

MATERIALS & METHODS

This study is based on the study of live plants in natural habitat at Ebo by the authors, and herbarium specimens at K and YA. In the absence of a Flore du Cameroun account, the Flore du Gabon volume for Begoniaceae (de Wilde et al. 2009) was the principal reference work used to determine the identification of the specimens of what proved to be the new species. The material cited in this paper was also compared at the Kew herbarium (K) with specimens of all other species of its section. All specimens cited have been seen by us unless indicated as "n.v.". The methodology for the surveys in which most of the specimens were collected in Ebo is given in Cheek & Cable (1997). Herbarium citations follow Index Herbariorum (Thiers *et al.* continuously updated), nomenclature follows Turland *et al.* (2018) and binomial authorities follow IPNI (continuously updated). Technical terms follow Beentje & Cheek (2003). The conservation assessment was made in accordance with the categories and criteria of IUCN (2012). Herbarium mate-

Table 1. Diagnostic features separating *Begonia ebo* from *B. gossweileri* and *B. sessilifolia.* Data for *B. gossweileri* from Irmscher (1961) and from *J.J.F.E de Wilde et al.* 11050 and 11054. Data for *B. sessilifolia* from de Wilde *et al.* (2009) and numerous specimens at K.

	Begonia ebo	*Begonia gossweileri*	*Begonia sessilifolia*
Stem branching (No. orders)	2–4	0	0(–1)
Leaf margin (nature and number of lobes/teeth on each side of the blade)	Slightly crenate to slightly denticulate/7–15	Dentate/5(–7)	Entire, sinuous to crenellate-denticulate distally/7–18
Leaf margin, dimensions of lobes/ teeth (mm long)	0.5(–2)	(1–)2–3	0–1
Bract dimensions (mm)/apex shape	(1.25–)4–5 × (0.1–)0.7/rounded or acute, bristles absent	2.5–3 × 0.5/acute with bristles	4–8 × 1–1.25/acute or with 2–3 bristles
Perianth colour	Yellow with red markings	White with basal red spot	White
Male pedicel length (mm)	3–5	6–7	5–7
Anther length (mm)	0.7–1.25	1.5–1.8	1.75–2
Style column length (mm)	0.5	1.5	1.5(–2)
Fruit, overall dimensions (2D, length x breadth, mm)	16–20 × 11–13	10–14 × 3.5–6	9–22 × 9–22
Fruit rostrum (mm)	0–1	3–4	3

rial was examined with a dissecting binocular microscope fitted with an eyepiece graticule measuring in units of 0.025 mm at maximum magnification. The map base data was sourced from Diva-GIS.org and compiled through ArcGIS (ESRI).

TAXONOMIC TREATMENT

Begonia ebo H.Lockwood **sp. nov.**

Type: Cameroon, Littoral Region, near Yabassi and Yingui, Ebo Forest, at plot on new trail to Masseng from Bekob camp, 04° 21’ 50” N, 10° 25’ 20” E, fl. fr. 18 Feb. 2006, *Cheek* 13052 (holotype K000593389; isotypes FT, YA). (Figure 1–3).

LSID:77349864-1

Diagnosis

Begonia ebo differs from all known species of *Begonia* Sect. *Filicibegonia* due to its yellow (not white or pink) perianth lobes, and also in the peculiar posture of the inflorescence, which lie along the groove of the adaxial petiole leaf-blade midrib, the flowers appearing superficially to arise from the middle of the leaf-blade (vs inflorescence sessile, or held above or below the leaf blades).

Description

Erect, perennial herb 25–50 cm tall, 10–30 cm wide, primary stems terete, 1.5–3.0 mm diam. at base, branching from the base or with a single stem from the base branching in the upper part, orders of branching 1–3, with 2 to 8 ultimate leafy branches per plant, leafy branches diverging at 60–70° from each other, each with 4–8 leaves, (Fig. 2A) sometimes with short, single-internode branches, internodes 0.4–1 cm long (flowering stems) or to 2 cm long (vegetative stems), epidermis pale brown, with fine longitudinal ridges, the distal 5–6 leafy internodes 80–100% covered in mid brown simple, multicellular (transversely banded), mainly adpressed hairs 0.55–1.10 mm long, 0.075 mm diam. at base, gradually tapering to a rounded or pointed apex, the distal ¼ to ½ of each hair sinuous, sometimes u-shaped or spreading; proximal stem nodes glabrescent. Stipules persisting for 4–6 nodes from the apex, narrowly oblong-elliptic, (1.5–)3–5 × (1.0–)1.5–2(–3) mm (largest at the stem apex), apex acute, terminating in a filament 0.3–1 mm long, margins entire or each side with 1–3 patent bristle-like teeth to 0.8 mm long, glabrous, brown. Leaves alternate, distichous, not peltate (Fig 2A); *petiole* terete, (1–)4 × 1 mm, often extending further to the blade on one side than the other, 20–50% covered in hairs, hairs as stem. *Leaf blade* held in a more or less horizontal position, upper surface dark green, contrasting with the purple-red midrib and secondary nerves, glossy; lower surface pale green, matt, asymmetric, slightly dimidiate, with one side wider and extending up to several mm further down the petiole than the other, lanceolate or narrowly oblong-elliptic, 4.7–9.5(–10) × 1.7–3.7(–5.3) cm, long-acuminate, base deeply to shallowly cordate on one side and obtuse or cuneate on the other, less usually subsymmetric and obtuse, margin slightly crenate to slightly denticulate, the lobes 7–15 on each side, lobes shallowly convex or rarely triangular, c. 0.5(–2)

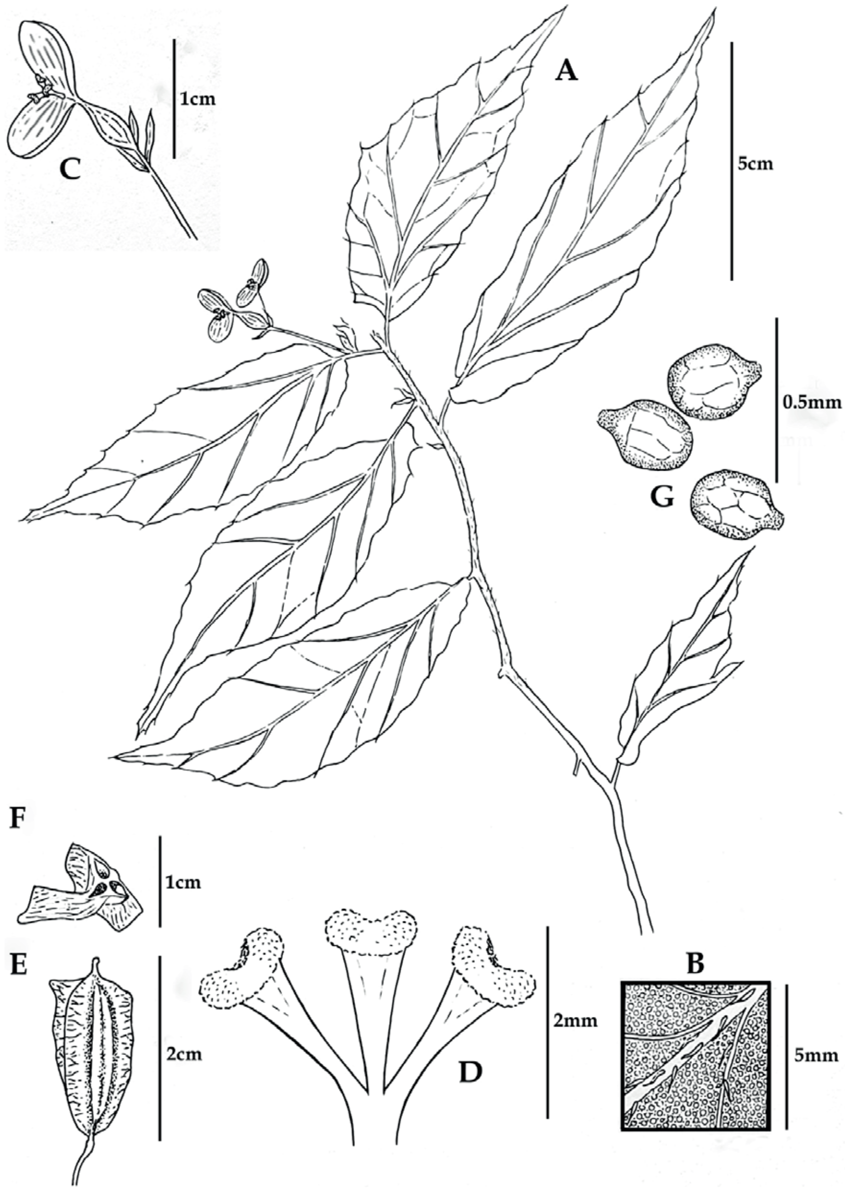


Figure 2. *Begonia ebo.* A habit, flowering stem; B. detail of abaxial blade surface showing midrib and hairs; C. female flower and inflorescence; D. style and stigmas; E fruit, side view showing unequal dorsal wing; F. fruit, transverse section showing locules; G. seeds, side view. All from *Lockwood* 61 (K). Drawn by H. Lockwood.

mm long, midrib and secondary nerves sunken above, prominent on lower surface; secondary nerves pinnate (3–)4(–6) on each side, arising at 40–60° from the midrib, straight, sometimes forked at midlength, terminating in a marginal tooth 0.2–0.25(–0.5) mm long, tertiary nerves indistinct, not prominent, hairs stiff, mainly adpressed, 1.0–1.2 mm long, as the stems, but white with a dark brown-red base, midrib 20–30 % covered, secondary nerves very sparsely hairy (Fig. 2B). Inflorescence axillary, one per axil, often in 2–3(–4) successive axils, monochasial, appearing to emerge from near the centre of the adaxial surface of the leaf-blade, pedunculate, rhachis unbranched, developing 1–22 male flowers and 1 final female flower. Peduncle lies along the adaxial surface of the petiole and proximal midrib of the subtending leaf and sometimes clasped in the sinus of the leaf-base, terete, 7.5–18.0 × 0.25 mm, red-brown, glabrous; rhachis angled at 40–60° from and above the peduncle, dorsiventrally flattened, 0.5–8 x 0.5 mm, glabrous, flowers borne on the adaxial surface on each side in two ranks, ranks angled apart 40–50°, pedicel bases c. 0.3 mm apart, each subtended by a bract. Bracts erect, green, narrowly oblong-elliptic (1.25–)4–5 × (0.1–)0.71 mm, apex long acuminate (rarely rounded), entire, glabrous, persisting for a while after the flower has fallen (usually 3–6 bracts present at one time). Flowers developing in succession, with 1–2 flowers at anthesis at one time, and several more in bud, flowers falling soon after anthesis (except the female); all flowers are male, apart from the final female flower which terminates further inflorescence growth; flowers are held ±horizontally at anthesis. Male flower pedicel 3–5 mm long, red-brown, glabrous. Perianth segments 2, opening at c. 90° from each other, elliptic-obovate, apex rounded, base cuneate, 5.0–6.0 × 2.7–3.0 mm, yellow-orange both sides, with the centre of the upper segment turning orange-red in flower, the lower only slightly so, the inside of both segments with slightly darker orange nerves. Androecium zygomorphic, with 10–15 forward-facing stamens; filament column 0.1–1.3 × 0.25 mm; free filaments unequal in length, 0.5 mm (frontal stamens) to 2 mm (rear) long; anthers basifixed, elliptic-oblong, 0.7–1.25 × 0.9 mm long, yellow, apex retuse, dehiscing by lateral longitudinal slits. Female flower (Fig. 2C) similar to the male but pedicel 0.25 mm long, perianth segments orbicular to broadly elliptic-ovate, 7.0 × 2.9–6.0 mm, apex rounded, base cuneate. Styles 3, erect, 2.5–3.5 mm long, the proximal parts united in a column c.0.5 mm long; distal parts separated from each other by 40–50°, stigmata 'U'-shaped, c.1 mm wide, stigmatic band papillate, yellow (Fig. 2D). Ovary in outline ±narrowly elliptic-obovate to narrowly elliptic-ovate in side view, 3-winged, 5.17–7.2 × 2.07–2.4 mm, medium green-brown, glabrous, separated from the perianth by a rostrum c. 0.5 × 0.5 mm; wings unequal, the dorsal wing largest, c. 2.2 mm high, variably asymmetric, ±convex in profile, widest distally, distally truncate or nearly so, proximally tapering cuneately to the pedicel; the two ventral wings equal, symmetric, held at c. 180° from each other, and 90° from the dorsal wing, shallowly convex, c. 0.9 mm high. Fruit one per infructescence, long persistent, indehiscent until after decay starts, pale brown, glossy, papery, dry, 16–20 × 11–13 mm, wings accrescent, dorsal wing 5–7 mm high, ventral wings 2–3 mm high, longitudinal ridges 3, 1 equidistant between each wing, each 1 mm wide, raised by 0.5 mm; locular area elliptic-oblong c. 14 × 3 mm (in side view, measured on ventral surface) in transverse section equilaterally triangular, 3-locular, placentae minute, unbranched; rostrum 0–1 mm long. Seeds brown, numerous, straight, shortly ellipsoid, 0.3 × 0.2 × 0.2 mm, hilum end obconical, chalazal end rounded, surface coarsely reticulate.

Etymology

Named as a noun in apposition for the forest of Ebo, Littoral Region, whence most of the known specimens were found.

Distribution

Cameroon (Littoral and Centre Regions). Map 1.

Habitat & ecology

Understory of primary, lower submontane evergreen rainforest with closed canopy and sparse understory vegetation. Found on steep slopes, 750–1170 m altitude. Infrequent.

Phenology

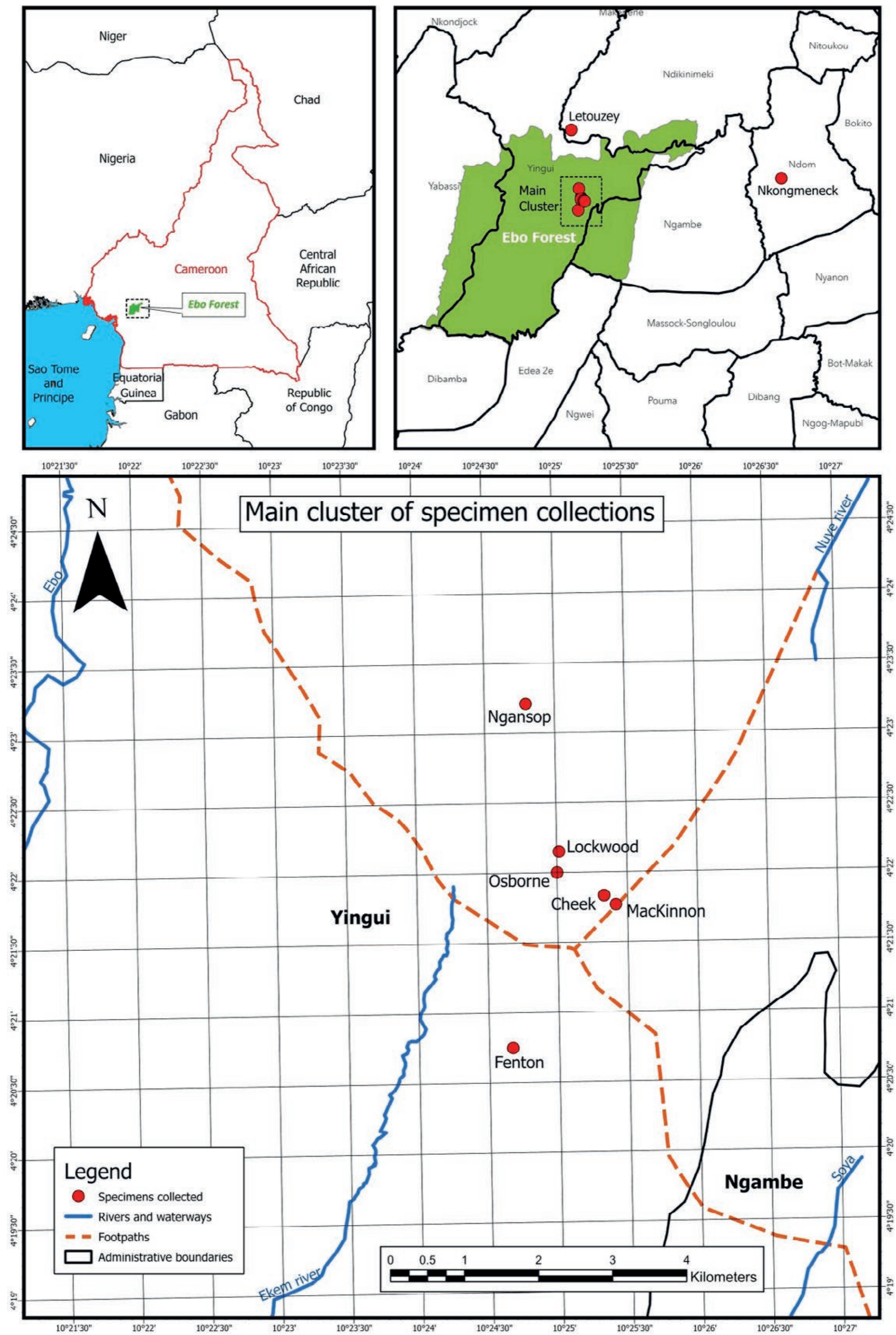
Flowering plants have been collected in most months from September to February inclusive, and plants in fruit from November to February inclusive.

Conservation status

Six of the eight known specimens of *Begonia ebo* are confined to the Ebo Forest of Littoral Region. Of the other two, *Letouzey* 11000 is immediately adjacent to the north, while a single record, *Nkongmeneck* 575 is c. 60 km to the east at Chaine de Nkohom. It is possible that the species will be found in other areas, however, extensive botanical surveys for conservation management to the SW, W, NW and NE of this area (Cheek et al. 1992; Cheek et al. 1996; Cable & Cheek 1998; Cheek et al. 2000; Maisels et al. 2000; Chapman & Chapman 2001; Harvey et al. 2004; Cheek et al. 2004; Cheek et al. 2006; Cheek et al. 2010; Harvey et al. 2010; Cheek et al. 2011), resulting in many thousands of specimens, have so far failed to uncover additional records.

If *Begonia ebo* occurs elsewhere than is recorded in this paper, that is perhaps in the Bakossi area to the west of Ebo in SW Region, especially Mt Kupe since several threatened range-restricted species are confined to these two areas, e.g. *Costus kupensis* Maas & H. Maas (Maas-van der Kamer et al. 2016), *Coffea montekupensis* Stoff. (Stoffelen *et al.* 1997), *Microcos magnifica* Cheek (Cheek 2017) and *Impatiens frithii* Cheek (Cheek and Csiba 2002). However, since Mt Kupe has been intensively collected, we consider this unlikely.

It is considered by the authors that the known range may be close to reality. If so, the best hope for the survival of the species is likely at Ebo, where almost all the population has been recorded to date. However, plants at this location are severely threatened by logging, followed by plantation agriculture (Authors pers. obs. 2006–2023). At the Chaine de Nkohom location (*Nkongmeneck*



Map 1. *Begonia ebo.* Global distribution. Prepared by T. Lockwood.

575) the site for the species, near the village of Ndom (viewed on Google Earth Pro July 2024 using the time slider function), large areas of intact forest are being encroached by habitation from the direction of Yaoundé (from the east). It is only at the third location (*Letouzey* 11000) that habitat appears intact for the moment, however since the adjacent Ebo forest is threatened by logging and this location is less protected, it also cannot be considered safe from destruction from logging followed by plantation agriculture, likely oil palm. The area of occupancy is calculated as 20 km^2 using IUCN required 2 km x 2 km cells, and the extent of occurrence is calculated as 323 km^2 using the Google Earth polygon function. Since there are three locations, two with imminent major threats, we here assess *Begonia ebo* as Endangered, EN B1ab(iii) + B2ab(iii).

Within the Ebo forest *Begonia ebo* is known from six collections made from 2006–2013. These equate to four sites, two of the sites with two points separated by c. 100 m from each other. The first author only saw the species in only one location occupying c. 3 m x 3 m during a period of 6 months. At another site, at which it has been found in Ebo (*Cheek* 13052) it occupied about 8 m x 8 m (Cheek pers. comm. to Lockwood 2008) and was also only seen once by that collector over the course of visits to Ebo over several years and seasons. It is possible that the species also qualifies as Endangered under Criteria D of IUCN (2012) since there may be less than 150 mature individuals observed by collectors, however, the authors have not been able to contact all the collectors to verify the estimate.

Numerous other Cameroon species of *Begonia* are localised and threatened (Onana and Cheek 2011).

Notes

Within Ebo *Begonia ebo* may be confused with two other species of Sect. *Filicibegonia*, *B. sessilifolia* and *B. macrocarpa,* differing from both in the yellow not white to pink petals, and in that the aerial stems are branched, sometimes several times (vs unbranched). It further differs from the last species in having a moderately to densely hairy stem and petiole (vs glabrous), and in the bracts being oblong-elliptic with a bristle tipped acute apex (vs ± orbicular, apex rounded, entire). Additional differences with *B. sessilifolia* are given in Table 1.

Variation occurs in the species, *Ngansop* 192 having stem indumentum that is only moderately dense, covering about 50% of the surface (vs 90–100% in other specimens), and fruits with the larger, dorsal wing much more strongly asymmetric than in the other specimens. While all the specimens show branching, *Osborne* 49 was the most highly branched, with eight ultimate branches. However, this may be a function of the age of the plant, since this was also the tallest individual (c.50 cm tall).

Additional specimens examined

CAMEROON. **Littoral Region:** near Yabassi, Ebo forest, North Transect, 1176 m from Bekob camp, 04° 22' 09" N, 10° 25' 00" E, fl. 13 Sept. 2008, *Lockwood 61* (K001243603, YA); ibid, route Bekob-Locndeng, en allant vers la village Locndeng, 04° 23' 12.6" N, 10° 24' 47.7" E, fl. fr. 5 Dec. 2013, fl.fr. *Ngansop* 192 (K001243604, P, WAG, YA); ibid, 5200 m Wadja, 04° 20' 45.0" N, 10° 24' 40.0" E, fl. fr. 5 Nov. 2007, *Fenton 224* (K000745895, WAG n.v., YA n.v.); ibid, West transect - 1590m along transect, 04° 22'N, 10° 25' E, fl.12 Sept. 2006, *Osborne 49* (K000593388, WAG n.v., YA); ibid, at plot on new trail to Masseng from Bekob camp, 04° 21' 50" N, 10° 25' 20" E, fl. fr. 18 Feb. 2006, *Cheek 13052* (holo. K (K000593389); iso. FT, YA); ibid., Muokaka-Mbom Trail 850 m from Bekob Trail, 04° 21' 46" N, 10° 25' 25" E, fl. 7 May 2008, *MacKinnon 129* (YA); Yingui, 15 km ESE, Massouan to Mosse, 04° 30'N, 10° 24' E, fl.15 Jan. 1972, *Letouzey 11000* (P n.v., WAG n.v., YA). **Central Region:** Chaine de Nkohom a 42 km SSW Ndiki, near rock Massa Makin Ntom, 04° 24'N, 10° 48' E, fl. 14 Nov. 1983, *Nkongmeneck 578* (P n.v., WAG n.v, YA).

DISCUSSION

In a phylogenetic analysis (Forrest et al. 2005), Sect. *Filicibegonia*, represented by *Begonia aspleniifolia* Hook.f. is sister to the yellow-flowered refuge *Begonia* Sections *Loasibegonia* A.DC. and *Scutobegonia* Warb. That *Begonia ebo* is the sole yellow-flowered species in Sect. *Filicibegonia* suggests that this character may be plesiomorphic and may indicate a basal position within the section. Molecular phylogenetic analysis with more comprehensive sampling of Sect. *Filicibegonia* is needed to test this hypothesis.

Within Sect. *Filicibegonia*, the affinities of *Begonia ebo* are difficult to discern. In only *B. macrocarpa, B. sciaphila* and perhaps the poorly known *B. gossweileri* do the number of flowers per inflorescence also exceed 10 (up to 23 in *B. ebo*). In only *B. auriculata* and *B. macrocarpa* does the pedicel of the male flowers also generally exceed 10 mm in length (in other species it is generally <5 mm long or nil), while only in *B. aspleniifolia* and *B. minutifolia* are the aerial stems often branched several times (in other species branching does not occur or is rare).

Biogeography

Begonia ebo is the first and only Cameroon-endemic species of Sect. *Filicibegonia*. However, neighbouring Gabon has three endemic species in this sect., all also restricted to highly species-diverse highland forested areas e.g. Monts de Cristal.

While Sect. *Filicibegonia* is widespread from Guinea in the west (Gosline et al. 2023) to eastern DRC in the east, all but one species (*Begonia macrocarpa*) is confined to Lower Guinea sensu White (1983), i.e. from the Cross River of SE Nigeria to the River Congo. Although the Cross-Sanaga interval has the highest plant species and generic diversity per degree square in all tropical Africa (Barthlott et al. 1996; Dagallier et al. 2020), with a very high number of endemics (Cheek et al. 2001), this is the first species of Sect. *Filicibegonia* that is endemic to the interval. The other species are either widespread within Lower Guinea (2/9 species) or endemic to the Sanaga-Congo interval (5/9 species).

The importance of the Ebo forest for plant conservation

The Ebo Forest, a former proposed National Park, covers c. 1,400 km² of lowland and submontane (cloud) forest, including important inselberg and waterfall areas, with an altitudinal range of 130–1115 m alt. and a rainfall of 2.3–3.1 m per annum (Abwe and Morgan 2008; Cheek et al. 2018a, Stone et al. 2023). Intensive botanical surveys at Ebo only began in 2005. Despite this, to date, over 100 globally threatened plant species have been documented including 23 species new to science, of which ten are globally narrowly endemic to Ebo, with many more near endemic (Murphy et al. 2023). These include species of large canopy trees e.g. *Crateranthus cameroonensis* (Lecythidaceae, Prance & Jongkind (2015) and *Talbotiella ebo* (Leguminosae, Mackinder et al. (2010); understorey trees e.g. *Piptostigma submontanum* (Annonaceae, Ghogue et al. (2017), Couvreur et al. 2022), *Kupeantha ebo* (Rubiaceae, Cheek et al. (2018b) and *Uvariopsis dicaprio* (Annonaceae, Gosline et al. (2022); climbers, *Dichapetalum korupinum* (Dichapetalaceae, Breteler (1996); large herbs e.g. *Pseudohydrosme ebo* (Araceae, Cheek et al. (2021); creeping herbs of the forest floor, *Ardisia ebo* (Primulaceae, Cheek & Xanthos (2012); inselberg herbs e.g. *Impatiens banen* (Balsaminaceae, Cheek et al. (2023a) and rheophytes of waterfalls, *Inversodicraea ebo* (Podostemaceae, Cheek et al. (2017).

Ebo was recently evidenced (Kew Science News, 2020) as an Important Plant Area (IPA). Of the 49 IPAs in Cameroon, Ebo has the highest number (23) of documented Critically Endangered (CR) plant species (IUCN global assessments), i.e. those with the highest level of global threat and closest to extinction, after the Ngovayang (Bipindi) IPA which has 24 (Murphy et al. 2023: 23, table 3). With the forthcoming publication of *Memecylon ebo* (Melastomataceae, Stone et al. 2023) and *Cryptacanthus ebo* (Acanthaceae, Darbyshire et al. in press) both also strictly endemic to Ebo and provisionally assessed as CR, Ebo will surpass Ngovayang in this respect. Additional endemic species in the course of preparation for publication from Ebo include those in the genera *Ardisia* Sw., *Chassalia* Comm. ex Poir., *Cola* Schott & Engl., *Keetia* E.Philipps and *Mitriostigma* Hochst. These will likely increase the number of CR species of Ebo further, possibly to the highest for any IPA in all of tropical Africa.

The publication in this paper of a further rare, localised and threatened plant species for the Ebo forest emphasises further the global importance of Ebo for conservation. No other site in Cameroon has more Critically Endangered plant species now than Ebo.

Cameroon has the highest number of globally extinct plant species of all countries in continental tropical Africa (Humphreys et al. 2019). The global extinction of Cameroonian species such as *Oxygyne triandra* Schltr. (Thismiaceae, Cheek et al. 2018c) and *Afrothismia pachyantha* Schltr. (Afrothismiaceae, Cheek and Williams 1999; Cheek et al. 2019; Cheek et al. 2023b) are well known examples, recently joined by species such as *Vepris bali* Cheek (Rutaceae, Cheek et al. 2018d). However, another 127 potentially globally extinct Cameroon species are documented (Murphy et al. 2023: 18–22).

It is critical now to detect, delimit and formally name species as new to science, since until they are scientifically recognised, they are invisible to science, and only when they have a scientific name can their inclusion on the IUCN Red List be facilitated (Cheek et al. 2020). Most (77%) species named as new to science in 2023 were already threatened with extinction (Brown et al. 2023).

If further global extinction of plant species is to be avoided, effective conservation prioritisation, backed up by investment in protection of habitat, ideally through reinforcement and support for local communities who often effectively own and manage the areas concerned, is crucial. Important Plant Areas (IPAs) programmes, often known in the tropics as TIPAs (Darbyshire et al. 2017; Murphy et al. 2023) offer the means to prioritise areas for conservation based on the inclusion of highly threatened plant species, among other criteria. Such measures are vital if further species extinctions are to be avoided of narrowly endemic, highly localised species such as *Begonia ebo*.

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Begonia gigang (section *Petermannia*: Begoniaceae), a new species from Zamboanga Peninsula, Mindanao Island, Philippines

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Abstract. A new species of *Begonia* from Zamboanga del Norte, Mindanao Island, Philippines, is described. *Begonia gigang* is morphologically similar to *Begonia corazoniae* but can be distinguished by having smaller leaves which are hirsute on both surfaces, longer panicles and peduncles, shorter pedicels for both staminate and pistillate flowers, and trigonous-ellipsoid ovary. *Begonia gigang* is assessed as Endangered under the IUCN Red List Categories and Criteria. A detailed description, photographs and ecological notes are provided.

Keywords: *Begonia corazoniae*, *Begonia tinuyopensis,* endangered, endemic, taxonomy.

INTRODUCTION

The genus *Begonia* L. is one of the most rapidly expanding genera of Angiosperm, comprising approximately 2167 species in the tropical and subtropical regions (Hughes et al. 2015; Moonlight et al. 2018). In the Philippines, a total of 177 species of *Begonia* were reported, and the region of Zamboanga Peninsula harbors 22 taxa (Mazo et al. 2024; Pelser et al. 2011).

A field survey was conducted in the municipality of President Manuel A. Roxas (PMAR), and Katipunan in 2023 and 2024 (Fig. 1). During the survey, specimens of *Begonia* with a decumbent habit, obliquely ovate leaves with light green to yellowish spots occurring at the branching of veins, and terminal inflorescences were documented. The specimens belong to *Begonia* section *Petermannia* because of their erect to suberect habit, 3-locular ovary, and axillary or terminal inflorescences where staminate flowers are distal and pistillate flowers basal, two to four-tepaled staminate flowers and five-tepaled pistillate flowers (Rubite 2012). Based on the observation of its morphological characters, comparisons with related species, and a thorough review of the literature, it is proposed that the taxon in question represents an undescribed species.

This paper describes a new species of *Begonia* from Zamboanga del Norte, Philippines under morphological species concept (Cronquist 1978). This discovery raises the number of *Begonia* species known from the Zamboanga Peninsula region to 23.

MATERIALS AND METHODS

The specimens of *Begonia gigang* were collected under Wildlife Gratuitous Permit (GP) No. IX-2023-11 issued by the Department of Environment and Natural Resources (DENR) Region 9 and deposited at PNH and FEUH. Morphological observations and measurements were conducted using both fresh specimens and photographic images captured in situ. Specimens of *Begonia* section *Petermannia* from the Philippines and neighboring countries, including recent publications on the genus, were thoroughly examined. The conservation assessments of species were made following the IUCN Standards and Petitions Subcommittee (2022).

TAXONOMIC TREATMENT

Begonia gigang Mazo & Rubite, **sp. nov.** (Fig. 2); Section *Petermannia*

Type: Philippines. Mindanao, Zamboanga del Norte, municipality of President Manuel A. Roxas, Barangay Sebod, 290 m a.s.l., 4 June 2023, *K.R.F. Mazo 112* (holotype PNH; isotype FEUH).

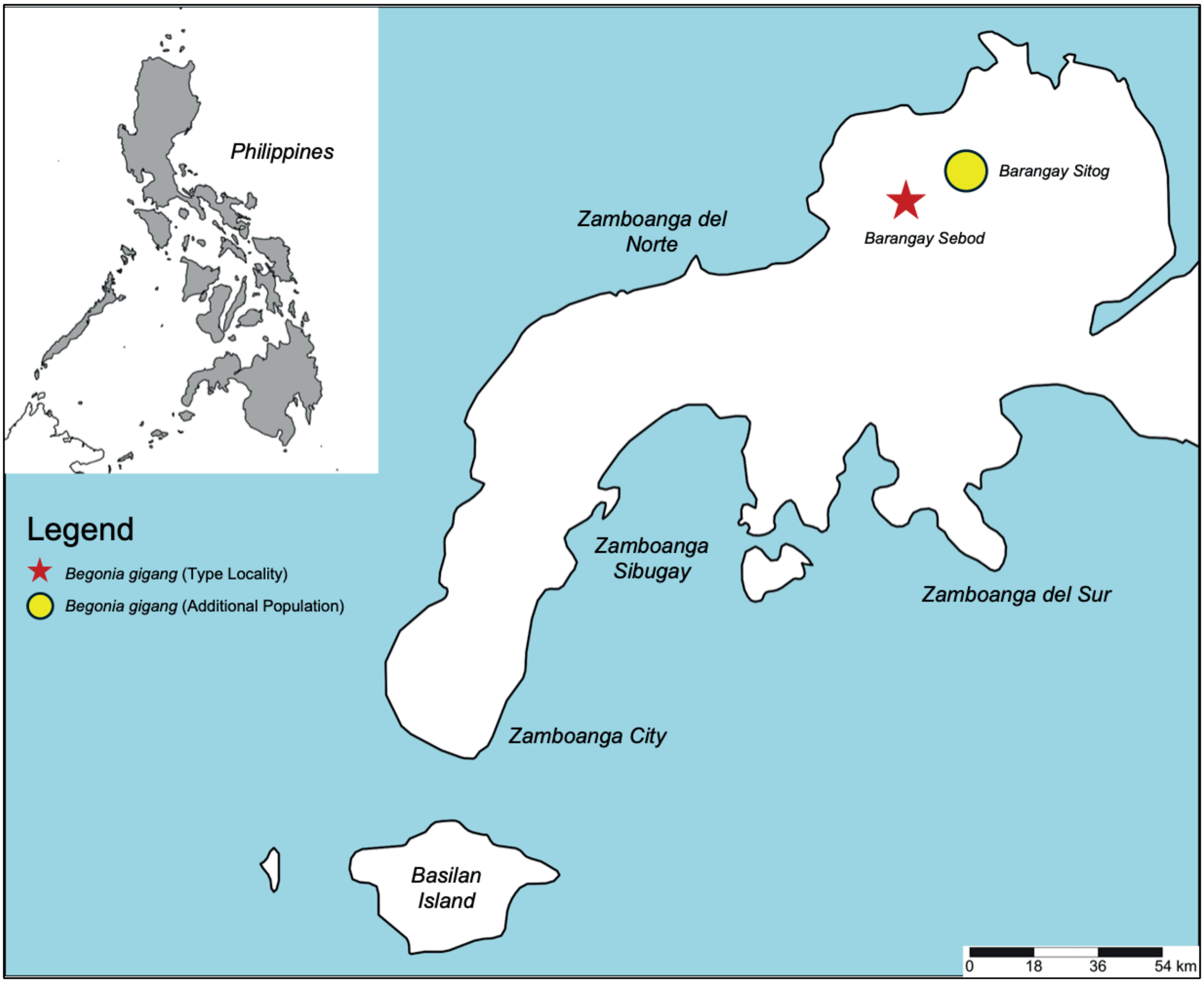

Figure 1. Distribution map of *Begonia gigang* Mazo & Rubite.

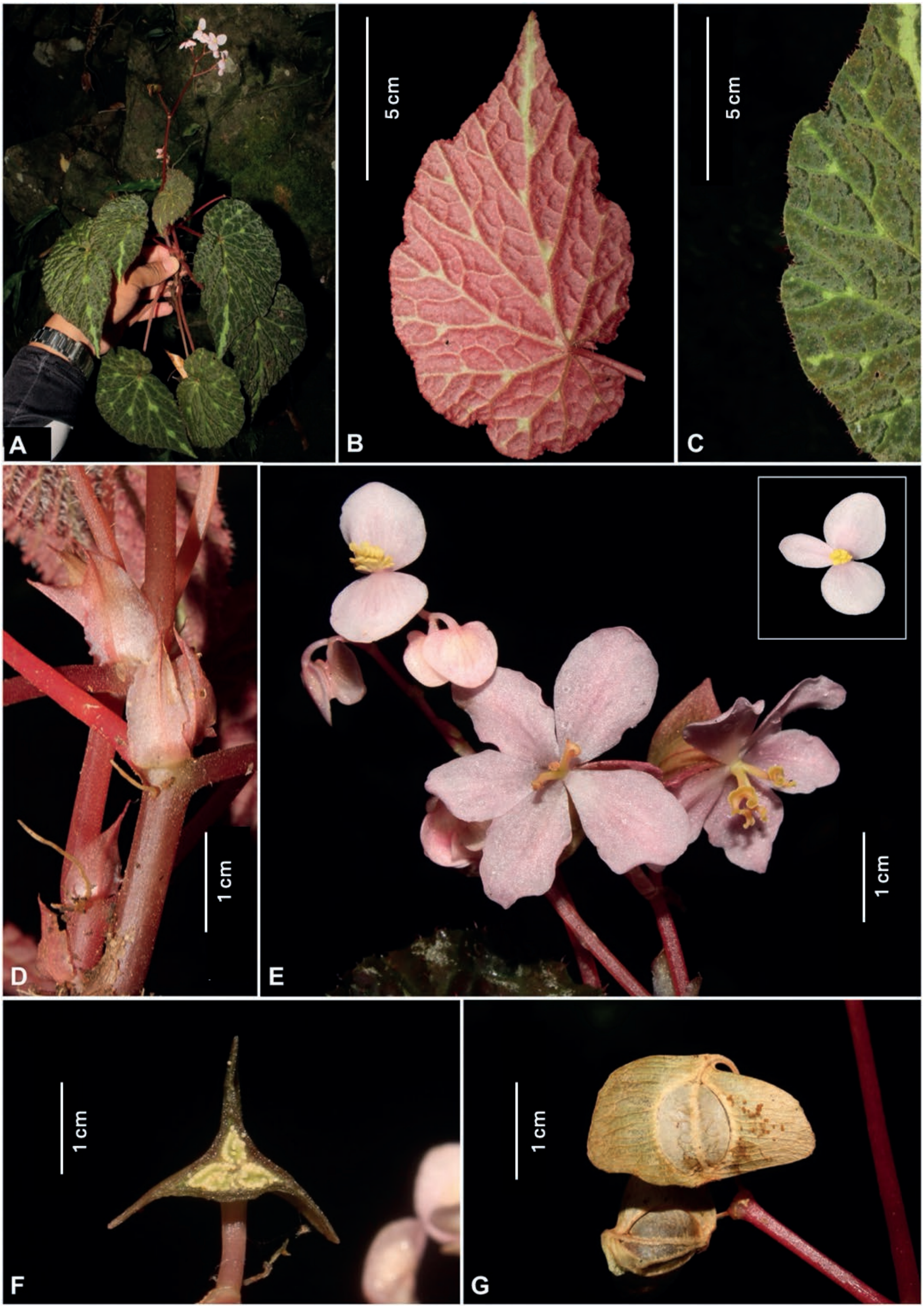

Figure 2. *Begonia gigang* Mazo & Rubite. A. Habit; B. Leaf adaxial surface; C. Leaf abaxial surface showing leaf margin; D. Stem and stipules; E. Staminate and pistillate flowers, inset 3-tepaled staminate flower; F. Cross-section of the ovary; G. Capsules. *All from K. R. F. Mazo 112.*

Diagnosis

A species similar to *Begonia corazoniae* Naive (Naive et al. 2024) in having lamina with greenish to yellowish spots and variegations on the veins but differs in having smaller leaves (10.0–14.5 × 5–7 cm vs. up to 21 × 10.0–13.3 cm) which are hirsute on both surfaces (vs. glabrous), longer panicles and peduncles (15–23 cm vs. 8–13 cm; 9–12 cm vs. up to 4 cm), shorter pedicels for both staminate and pistillate flowers, and trigonous-ellipsoid ovary (vs. trapezoid to obovoid).

Description

Herb monoecious, perennial, terrestrial, or lithophilic, up to 20 cm tall. Stem decumbent stem, 4–6 mm in diameter, reddish maroon, glabrous, internodes 1.0–3.5 cm long, rooting at the lower nodes. Stipules persistent, triangular to broadly ovate, 13–19 × 7.5–9.5 mm, pinkish red, glabrous, margin entire, keeled, apex aristate, arista up to 3.5 mm long. Leaves alternate; petiole terete, 6.5–15 cm long, 3–5 mm in diameter, reddish maroon, sparsely pilose, hairs denser near the leaf base; lamina asymmetric, basifixed, ovate, 10.0–14.5 × 5–7 cm, base obliquely cordate to rounded, lobes rounded, overlapping, margin distantly crenate, ciliate with maroon trichomes (up to 1.2 mm long); apex acuminate; adaxially dark green with light green spots occurring at the branching of veins, reddish brown hirsute, abaxially maroon with yellowish spots occurring at the branching of veins, reddish brown hirsute, dense on the primary and secondary veins; venation palmate, primary veins 6–7, sunken adaxially and raised abaxially, branching dichotomously. Inflorescence terminal or in the upper axils, bisexual, protogynous; panicle 15–23 cm long, few-flowered; peduncle 9–12 cm long, pinkish red, glabrous; pistillate flower 1–3, arising from the base of inflorescence; staminate flower distal, on cyme branching up to 3 times, producing up to ca. 10 flowers. Bracts caducous, pinkish white, glabrous; lowermost bract lanceolate, 6–7 × 2–3 mm, margin entire, apex apiculate; uppermost bract oblanceolate, 3–4 × 1.5–2.0 mm, margin entire, apex rounded. Staminate flower pedicel 2–6 mm long, pinkish or white, glabrous; tepals 2 (rarely 3), ovate to broadly ovate, 6–11 × 7.0–10.5 mm, pinkish, glabrous on both surfaces, margin entire, apex rounded; androecium zygomorphic, stamens 15–20, filaments fused at base; anthers broadly elliptic, apex retuse, dehiscing through 2 slits. Pistillate flower pedicel 10–15 mm long, pinkish, glabrous; tepals 5, pinkish, glabrous; outer tepals 2, elliptic to obovate, 10.5–13.3 × 6–8 mm, apex rounded to obtuse; inner tepals 3, obovate, 9–13 × 6.5–9.0 mm, apex obtusely rounded; styles 3, yellow, apically bifid, 4.7–5.6 mm long, stigmas in spiral band and papillose all around. Ovary trigonous-ellipsoid, 7.5–10 × 5.0–6.7 mm (wings excluded), brownish red to yellowish green, glabrous, wings three, subequal, brownish red to yellowish green, truncated distally, 7–12.5 × 5.3–10 mm; locules 3, placenta bilamellate. Capsule nodding, trigonous-ovate, 10–13 × 16–20 mm; pedicel recurved, 11–13 mm long; wings three, subequal, truncate distally, unequal proximally, 10–14 mm long, 5.5–11 mm wide.

Etymology

The specific epithet is derived from the Subanen dialect refers to the rock formations where the new species was found.

Phenology

Observed flowering and fruiting from February to June.

Distribution and ecology

Begonia gigang is endemic to Zamboanga Peninsula, and known only from barangay Sebod, President Manuel A. Roxas, and barangay Sitog, Katipunan, Zamboanga del Norte (Fig. 2). It grows on rocks near water bodies in full and partially shade areas at 250–400 m elevation.

Notes to similar species

In the region of Zamboanga Peninsula, island of Mindanao, southwestern Philippines, *B. gigang* is similar to *B. tinuyopensis* Mazo et al. (2021) in having a decumbent stem, persistent stipules, obliquely ovate leaves, terminal inflorescences with 2-tepaled staminate and 5-tepaled pistillate flowers, and 3 subequal winged capsules. However Table 1 shows that it differs from *B. tinuyopensis* by having puberulent stems (vs. glabrous), larger stipules (5–7 mm × 2.5–3 mm vs. 13–19 × 7.5–9.5 mm), longer petioles (6.5–15 cm vs. 1.8–4.5 cm), larger leaves (10.0–14.5 cm × 5–7 cm vs. 3.8–6.4 cm × 2.5–4.5 cm) with distantly crenate margins (vs. irregularly doubly-serrate to serrate), with light green to yellowish spots occur at the branching of veins, longer panicles (15–23 cm vs. 3–8 cm), lanceolate to oblanceolate bracts (vs. ovate to orbicular) and capsules that are unequal proximally (vs. obtusely rounded).

Proposed conservation assessment

Begonia gigang is known from the two municipalities in Zamboanga del Norte: President Manuel A. Roxas and Katipunan. In the type locality, about 10 populations with 6–15 individuals, and within the municipality

Table 1. Morphological comparison of *B. gigang, B. corazoniae* and *B. tinuyopensis.*

Characters	*Begonia gigang*	*B. corazoniae*	*B. tinuyopensis*
Stipule			
Duration	persistent	persistent	persistent
Dimension (mm)	13–19 × 7.5–9.5	18–22 × 10–13	5–7 × 2.5–3
Leaves			
Petiole length (cm)	6.5–15	up to 18	1.8–4.5
Petiole vestiture	sparsely pilose	glabrous	hirsute
Lamina dimension (cm)	10.0–14.5 × 5–7	up to 21 × 10.0–13.3	3.8–6.4 × 2.5–4.5
Vestiture	hirsute at both surfaces	glabrous at both surfaces	hirsute at both surfaces
Adaxial color	dark green with light green spots occurring at the branching of veins	green to dark purplish green with dull greenish-yellow spots and variegation on the veins	adaxially green or dark green to reddish brown
Abaxial color	maroon with yellowish spots occurring at the branching of veins	purplish-red with reddish-green veins	abaxially light red to maroon
Margin	distantly crenate	erose and ciliate	irregularly doubly-serrate to serrate
No. of primary veins	6–7	8–9	5–6
Inflorescence			
Panicle length (cm)	15–23	8–13	3–8
Peduncle length (cm)	9–12	up to 4	1.8–2.9
Peduncle vestiture	glabrous	glabrous	puberulous
Bract shape	lanceolate to oblanceolate	broadly ovate	orbicular and ovate
Bract dimension (mm)	3–7 × 1.5–3	7–11 × 9–10	3–4 × 3–4.3
Staminate flower pedicel length (mm)	2–6	13	3–11
Pistillate flower pedicel length (mm)	10–15	up to 35	7–10
Ovary shape	trigonous-ellipsoid	trapezoid to obovoid	trigonous-ellipsoid

of Katipunan, about 20 populations with 10–15 individuals were observed. The populations in the two municipalities are near waterfalls and coconut plantations. During the fieldwork, threats such as agricultural expansion, land conversion, and tourism development were observed. Given these threats, we proposed *B. gigang* be classified as Endangered (EN, D) following the IUCN Standards and Petitions Committee (2022).

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Homalomena pistioides: a new small-sized lithophytic species of Sumatran Aroid

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Abstract. *Homalomena pistioides* A.S.D.Irsyam, M.R.Hariri & Raynalta represents a recently identified species within the Aroid family, hailing from the region of Sumatra, Indonesia. The newly identified species is a lithophytic plant distinguished by its rosette leaf arrangement, short petiole, obovate leaf blade, spongy leaf texture, erect-spreading inflorescence, and slender peduncle. The species is promoted by Sumatran horticulturists and enthusiasts as *Homalomena* "Dolphin" on social media.

Keywords: Araceae, Homalomeneae, ornamental, Sumatra.

INTRODUCTION

Homalomena of Sumatra presents a compelling area for further investigation and classification. A total of 33 distinct species have been documented from the region of Sumatra (POWO 2024). Recent investigations have focused on the Sumatran *Homalomena*, specifically within the 'Chamaecladon group'. In the past 12 years, numerous novel species within the clade have been identified from the island (Boyce and Wong 2012; 2013; 2016a; 2016b; Wong et al. 2020b).

In July 2024, our fieldwork led to the discovery of a new lithophytic species of *Homalomena* in North Sumatra. By October 2024, the authors realized that the species had been available for quite some time as an ornamental plant on social media, referred to as *Homalomena* "Dolphin". The plant exhibits distinctive characteristics when compared to other Sumatran *Homalomena* species. This manuscript provides a comprehensive formal description of the newly identified species.

MATERIALS & METHODS

The field study took place in Bohorok Subdistrict, Langkat, North Sumatra, in July 2024. Additionally, we examined the herbarium specimens at Herbarium Bogoriense (BO) for additional specimens that corresponded to the new species. The morphological traits of the plant material were analysed, and inflorescences were documented using the Dinolite digital microscope at the Bogor Botanic Gardens.

TAXONOMIC TREATMENT

Homalomena pistioides A.S.D.Irsyam, M.R.Hariri & Raynalta, **sp. nov.** (Fig. 1).

Type: North Sumatra Province, Langkat Regency, Bohorok, 27 July 2024, *D Karo Karo s.n.* (holotype FIPIA; isotype BO).

Diagnosis

Homalomena pistioides is similar to *H. mobula* P.C. Boyce & S. Y. Wong by having highly condensed stem and rosette leaves, but it differentiated by its smaller stem, to 3‑4 mm height (vs 10 cm height), very short petiole, 1‑2 mm long (vs 4–6 cm long), reddish brown coloured petiole (vs dark green with flushed reddish), leaf blade with shorter length, to 3.5‑6.2 cm long (vs 13–23 cm long), obovate shape (vs oblanceolate), obtuse to cuneate leaf base (vs cordate), spathe with shorter length to 8.8 mm long (vs 2 cm long), smooth surface (vs longitudinally ribbed), and reddish yellow colour (vs deep red), globose pistils (vs globose-lageniform), ovoid staminode (vs spherical), and staminate flower zone with stout-conic shape (vs slender-conic) and blunt apex (vs acute).

Description

Herbs lithophytic, small, 8‑12 mm height, forming leaf rosettes. Stem highly condensed, 3‑4 mm long; internodes obscured by overlapping leaf bases. *Leaves* 6–8 per crown; sheath fully adnate to petiole, 3‑4 mm long, reddish brown; petiole short, 1–2 mm long, canaliculate, reddish brown; leaf blade obovate, 3.5‑6.2 × 2.2‑3.4 cm, base obtuse to cuneate, margin entire, apex truncate, rounded or mucronate, flat, adaxial leaf surface blueish green, brownish green to green, colliculate, abaxial leaf surface pale green, with thin hyaline layer; midrib green or reddish adaxially, raised abaxially; primary lateral veins 2–3 on each side. Inflorescences erect-spreading; peduncle slender, 14‑29 mm long, red. Spathe oblong with asymmetric apex, without constriction, 6‑8.8 × 3‑3.2 mm, yellowish, reddish at base, apex blunt with a terminal mucro to 0.45 mm long. Spadix sessile, ca. 6.9 mm long, 2.4 mm diam., fertile to tip; pistillate flower zone ca. 1.5 mm long, shorter than the male zone; pistils few, in two whorls, globose, 0.6–0.8 mm height, 0.7–0.8 mm diam., white, stylar region white; stigma sessile, 0.2–0.4 mm diam.; staminode 1 each pistillate flower, ovoid, sessile, 0.2–0.4 mm height, ca. 0.2 mm diam., white; staminate flower zone ca. 5.5 mm long, stout-conic, apex blunt; staminate florets densely arranged, 0.7–1.1 mm long, consisting of two stamens, trapezoid to hexagonal in plan view, yellowish. Fruits and seeds not observed.

Etymology

The nomenclature originates from *Pistia*, which is a genus within the family of aquatic aroids, combined with the suffix *-oides*, signifying a likeness or resemblance. The observation pertains to the similarity in the leaf morphology of the newly identified species to that of *P. stratiotes* L.

Distribution and ecology

The species is recognised exclusively from the type locality. In its original locality, *H. pistioides* exhibits lithophytic growth on moss-laden cliffs at elevations not exceeding 500 meters above sea level.

Proposed conservation assessment

The status of the species is currently classified as undetermined according to the criteria set forth by the IUCN Red List. In light of the limited information available, it is prudent to categorise it as Data Deficient (DD). Nevertheless, within its type locality, *H. pistioides* demonstrates a vulnerability to overexploitation, thereby warranting a thorough evaluation of its conservation status.

Notes

In terms of its morphological characteristics, *H. pistioides* is classified within the ‘Chamaecladon group’ owing to several distinctive features: a non-constricted spathe, exhibits two stamens in each staminate flower, staminodes in the pistillate zone. The newly identified species possesses an oblong spathe measuring 8.8 mm in length (max).

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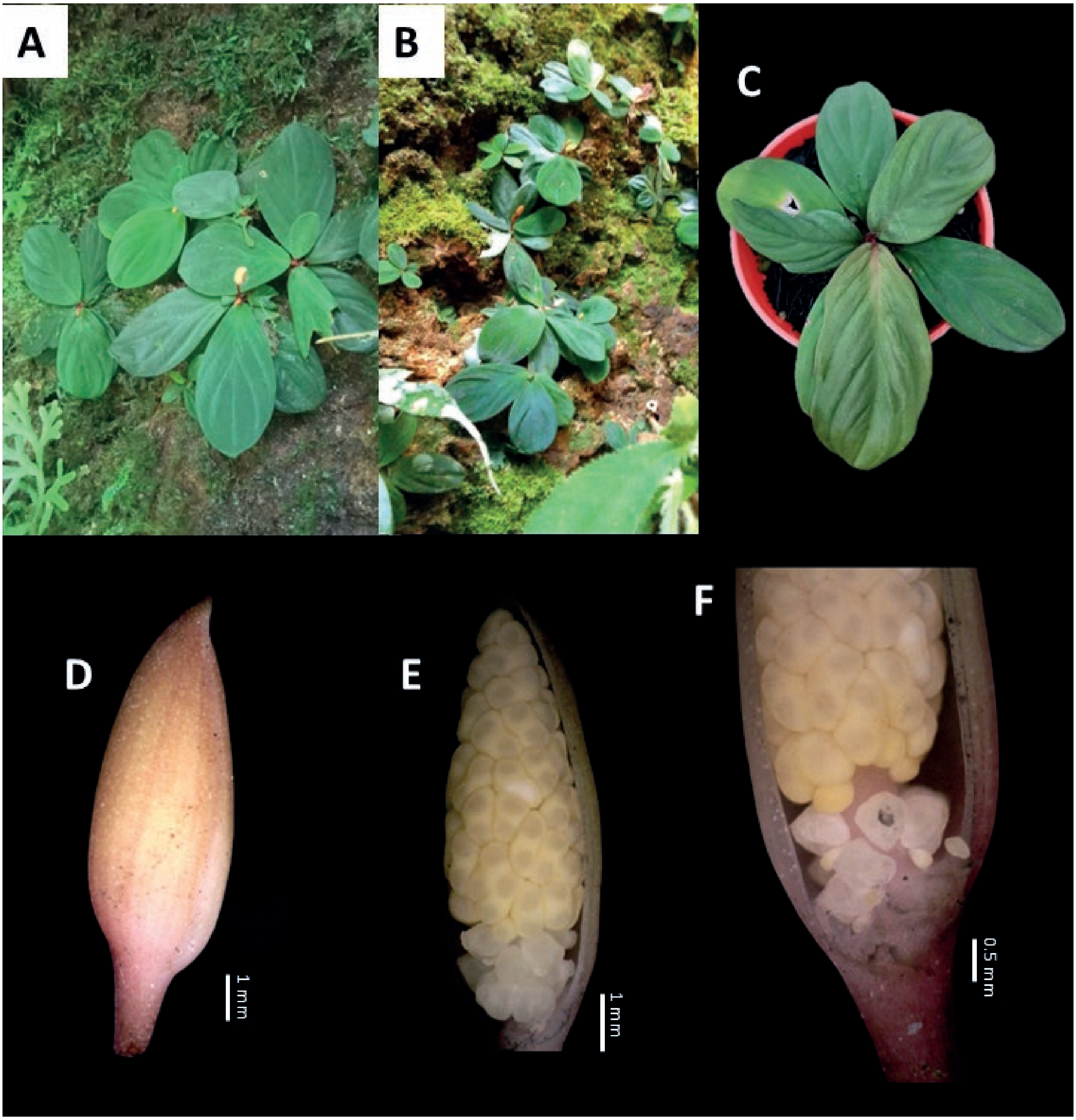

Figure 1. *Homalomena pistioides*. A-B. Habitat; C. Habit; D. Spathe (31.6×); E. Spadix with half of spathe removed artificially (51.3×); F. Part of lower-half spadix showing pistillate flower zone (67.9×).

The authors extend their sincere appreciation to the Directorate for Scientific Collections Management - BRIN for granting access to the Herbarium Bogoriense. The Dinolite instruments were provided by The Arcadia - Millenium Seed Bank Partnership, under the guidance of Dr. Dian Latifah, M.App.Sc, enabling the macromorphological examination of *H. pistioides*. The authors express their gratitude to the editor and reviewers for their insightful and invaluable suggestions.

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Nomenclatural changes and new species in Malesian *Homalomena* (Araceae)

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Abstract. The genus *Furtadoa* M. Hotta (Araceae) is reviewed, with its morphological characteristics compared to those of *Homalomena* Schott, and its molecular phylogenetic position analyzed in relation to other *Homalomena* species. A comparative assessment of molecular data supports the reclassification of *Furtadoa* within *Homalomena*, resulting in the establishment of two new combinations. Two species names are changed: *H. indrae* for *F. indrae* and *H. sumatrensis* for *F. sumatrensis*. In this paper, we also describe a new species of '*Furtadoa*-like' *Homalomena* from Riau, Sumatra, *H. chikmawatiae* A.S.D.Irsyam & M.R.Hariri. This new species is readily identified by its peltate leaves and large sterile appendix at the spadix.

Keywords: Aroid, *Homalomena*, internal transcribed spacer, Malesia, Sumatra.

INTRODUCTION

The genus *Furtadoa* M.Hotta was published in 1981 by Mitsuru Hotta (1935–2015). The genus was previously distinguished by its basal placentation, the presence of a pistillode in each staminate flower, and the male florets each consisting of a single, transversely orientated stamen (Hotta 1981; Mayo et al. 1997). In contrast, the genus *Homalomena* is characterized by parietal and axile placentation, the absence of pistillodes, and possesses 2–4 stamens in each staminate flower (Mayo et al. 1997; Boyce and Wong 2015). It comprised three species in Western Malesia: *F. indrae* P.C.Boyce & S.Y.Wong, *F. mixta* (Ridl.) M.Hotta, and *F. sumatrensis* M.Hotta (Hotta 1981; Hotta 1985; Boyce and Wong 2005). *Furtadoa mixta* is indigenous to Peninsular Malaysia, while the other two species are endemic to Sumatra.

Recent molecular analysis carried out by Haigh et al. (2023) and Vasconcelos et al. (2023) indicates that the genus *Furtadoa* is polyphyletic, implying that its species do not share a single common ancestor and are instead distributed across multiple evolutionary lineages within *Homalomena*. This finding necessitates a critical reassessment of the taxonomic placement of

Furtadoa. In this study, we address this taxonomic inconsistency by proposing the reclassification of *Furtadoa* as a synonym of *Homalomena*. This decision is also supported by our molecular phylogenetic evidence comparisons, which demonstrate closer evolutionary relationships between *Furtadoa* species and certain clades within *Homalomena*. By integrating these findings, this reclassification provides a more accurate representation of the evolutionary relationships within the *Homalomena* and underscores the importance of revisiting traditional classifications in light of molecular data.

Moreover, in July 2024, we observed an unusual aroid obtained from Sumatra. It is clearly classified as a '*Furtadoa*-like' *Homalomena* due to its resemblance in having unistaminate male florets, pistillodes, and basal placentation. The plant possesses a larger size than the three previously identified *Homalomena* with '*Furtadoa*-type' spadices. After a meticulous morphological examination, we considered this distinct specimen as a new species. This publication establishes *H. chikmawatiae* A.S.D.Irsyam & M.R.Hariri as the fourth species of *Homalomena* with '*Furtadoa*-type' spadix in Malesia.

MATERIALS & METHODS

The morphological description was based on living specimens from a private nursery in Bogor, West Java. The plant was initially collected in March 2022 by local people in Riau Province, Sumatra. The morphological features were examined and photographed using the Dinolite digital microscope at the National Research and Innovation Agency (BRIN), Cibinong. Morphological data were compared to the taxonomic literature on Malesian *Furtadoa* (Hotta 1981; Hotta 1985; Boyce and Wong 2005). The preliminary conservation status was assessed using the IUCN Standards and Petitions Committee's (2024) guidelines.

The DNA was extracted from the leaf of the new species using the TianGen Plant Genomic DNA Kit, manufactured by TIANGEN Biotech, Beijing. The internal transcribed spacer sequence following Sun et al. (1994) was amplified using the universal primers for ITS. A 50 µl reaction mixture was utilized for the PCR reaction. This mixture contained 10 ng of DNA template, 5 µM each of forward and reverse primers, 25 µl of MyTaq HS Red Mix (Bioline, USA), and 11 µl of distilled water. The amplification procedure involved an initial pre-denaturation step at 94°C for 5 minutes, followed by 35 cycles of denaturation at 94°C for 15 seconds, annealing at 58°C for 15 seconds, and extension at 72°C for 15 seconds. A final post-extension step was performed at 72°C for 5 minutes to complete the process. The PCR products were then visualized utilizing a Bio-Rad GelDoc imaging system after electrophoresis on a 1% florosafe stained-agarose gel. The PCR product was sequenced at 1st Base in Malaysia, utilizing the PT Genetika Science service.

Sequencing data were meticulously processed using MEGA 11 (Tamura et al. 2021). Sequence data for *Homalomena* and *Furtadoa* were retrieved from the NCBI database, complemented by additional *Homalomena* species identified through BLAST searches to ensure a good representation of the genus. To root the phylogenetic tree, *Philodendron* and *Adelonema* were included as an outgroup, given its taxonomic proximity to *Homalomena* within the Araceae family. The phylogenetic tree was constructed using the Maximum Likelihood method implemented in IQ-TREE, with the TIM2+F+R2 substitution model selected based on the best-fit Bayesian Information Criterion (BIC). Visualization of the resulting tree was performed using the Interactive Tree of Life v7 (iTOL) web platform (Trifinopoulos et al. 2016; Letunic and Bork 2024).

TAXONOMIC TREATMENT

Homalomena Schott, in H.W.Schott & S.L.Endlicher, Melet. Bot.: 20 (1832).

Type species: *Homalomena cordata* Schott, lectotype designated by Nicolson (1967: 517).

Furtadoa M.Hotta, Acta Phytotax. Geobot. 32: 142 (1981), **syn. nov.**

Type species: *Furtadoa sumatrensis* M.Hotta

New combinations

Homalomena indrae (P.C.Boyce & S.Y.Wong) M.R.Hariri & A.S.D.Irsyam, **comb. nov.**

Bas.: *Furtadoa indrae* P.C.Boyce & S.Y.Wong, Aroideana 39(1): 15 (2016).
Type: Indonesia, Sumatra: Riau, Kuantan Singingi Regency, Kuantan Tengah Subdistrict, Taluk Kuantan, c. 0°31'55.06"S 101°34'58.44"E, c. 50 m asl, 16 Apr 2015, *Indra AR-5196* (holotype ANDA; isotype BO, BOKR, SAR).

Homalomena sumatrensis (M.Hotta) M.R.Hariri & A.S.D.Irsyam, **comb. nov.**

Bas.: *Furtadoa sumatrensis* M.Hotta, Acta Phytotax. Geobot. 32(5&6): 142 (1981).

Type: Indonesia, Sumatra: West Sumatra, Ulu Gadut, about 15 km east from Padang city, alt. 350 m, on wet rocks along the stream, Feb. 22 1981, *M. Hotta 25000* (holotype KYO).

New species

Homalomena chikmawatiae A.S.D.Irsyam & M.R.Hariri, **sp. nov.** (Fig. 1)

Type**:** Indonesia, Java, cultivated in a private nursery from material collected in the wild ex Indonesia: Sumatra, Riau Province (*orig. coll.* March 2022, *anonymous s.n.*), voucher 27 July 2024, *MR Hariri & ASD Irsyam s.n.* (holotype FIPIA; isotype BO).

Diagnosis

Homalomena chikmawatiae is readily distinguishable from other *Homalomena* species with '*Furtadoa*-type' spadices by its clearly peltate leaves and the conspicuous sterile appendix at the upper $^2/_5$ of the spadix.

Description

Medium mesophytic herb up to 34 cm height. Stem ca. 1.5 mm diam.; internodes obscured by overlapping leaf bases. Leaves ca. 8 per crown; wing of sheath fully adnate to petiole, 1.5–2.7 mm long, red; petiole terete, 15.5–22.0 cm long, 3–4 mm diam., curved, aromatic, reddish to green; leaf blade ovate, peltate, 10.2–13.2 × 5.8–9.3 cm, base weakly cordate, margin entire, apex acute to mucronate, adaxial leaf surface olive green to dark green, abaxial leaf surface pale green; midrib yellowish green adaxially, raised abaxially; primary lateral veins 7–8 on each side. Inflorescences paired, subtended by a short red prophyll; peduncle short, ca. 4 mm long, terete, exceeding the leaves, reddish. Spathe ca. 3 cm long, ca. 7 mm diam., unconstricted, pale amber to pale rose, greenish at the apex, creamy inside. Spadix cylindrical, obtuse at the apex, ca. 19 mm long, including stipe; stipe ca. 1.3 mm long, creamy white; pistillate flower zone cylindric, ca. 6.7 mm long, shorter than the male zone; *pistils* globose to bottle-shaped, 0.9–1 mm height, 0.6–0.8 mm diam., creamy white, stylar region white; stigma button-like, 0.4–0.5 mm diam., white; staminode 1 per pistillate flower, globose, 0.4–0.5 mm diam., creamy white; staminate flower zone ca. 11 mm long (including appendix), cylindrical, with a sterile appendix at the upper two fifths of the spadix, obtuse at apex; staminate flowers consisting of a solitary transverse stamen and a pistillode; stamens 0.8–1.2 mm diam., pores on the ventral side of the flower with respect to the spadix axis, creamy white; pistillodes comprised of an atrophied ovary and a well-developed style topped with a vestigial stigma, 0.70–0.85 mm long, creamy white. Fruiting spathe, fruits, and seeds not observed.

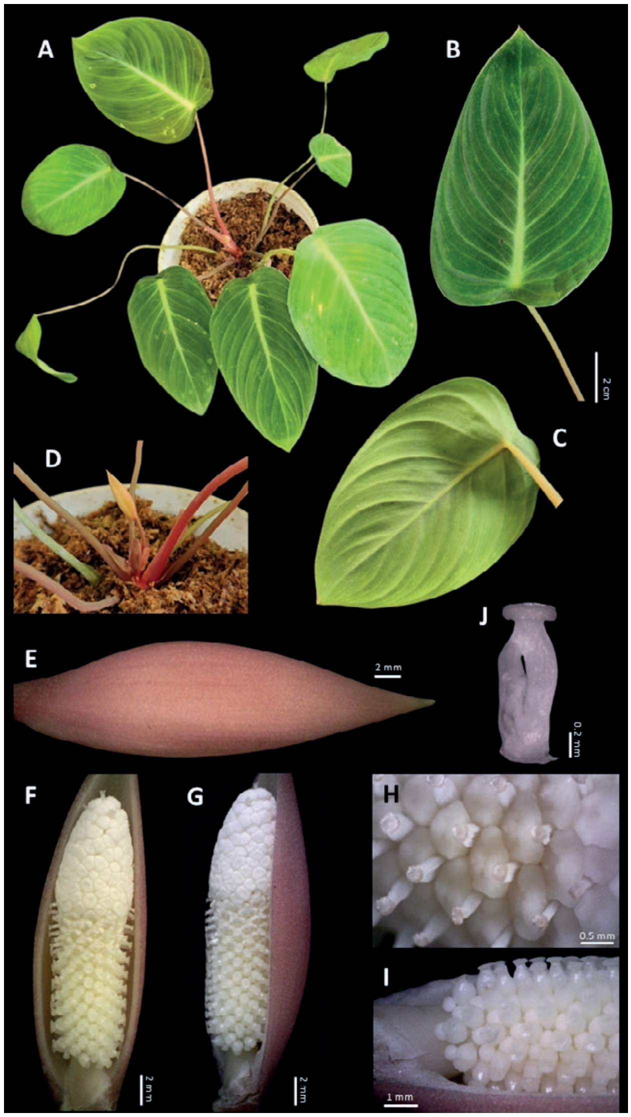

Figure 1. *Homalomena chikmawatiae*. A. Habit; B. Adaxial leaf surface; C. Abaxial leaf surface; D. Inflorescence; E. Spadix; F, G. Spadix with half of spathe removed artificially showing huge sterile spadix appendix; H. Part of upper spadix showing staminate flowers and pistillodes; I. Part of lower-half spadix showing pistillate flowers and staminodes; J. Pistil with basal placentation.

Etymology

The species epithet *chikmawatiae* is dedicated to Prof. Dr. Ir. Tatik Chikmawati, M.Si., an Indonesian academic from Biology Department - IPB University renowned for her contributions to the study on plant biosystematics of Indonesian flora.

Distribution and ecology

The new species is only known from Riau, Sumatra.

Proposed conservation assessment

Currently, only one population of the new species with an unclear number of individuals observed. *Homalomena chikmawatiae* distribution is only known from its single locality, but we speculate that there may be other populations of this new species. Due to not enough field investigations, the natural range of this species in the wild is unclear. As a result, we recommend this species placement in the 'Data Deficient' (DD).

Note

Slightly peltate leaves are also present in robust individuals of *H. mixta* Ridl. However, that species is distinguished by the absence of a sterile spadix appendix (see Boyce & Wong 2015). Another Sumatran species, *H. monandra* M.Hotta, also exhibits monandrous male florets with single transverse stamens, similar to *H. chikmawatiae*. Nevertheless, *H. monandra* lacks pistillodes.

Building upon the findings of Haigh et al. (2023) and Vasconcelos et al. (2023), it is evident that *Homalomena* should be reclassified within the Philodendreae (*Philodendron* clade) rather than being retained within the Homalomeneae, which ought to be treated as a synonym of Philodendreae. This reclassification is underpinned by robust molecular and morphological evidence, emphasizing the necessity for a comprehensive revision of the genus's taxonomic placement to reflect its evolutionary relationships more accurately.

The phylogenetic analysis provides significant insights into the genetic diversity and evolutionary relationships within *Homalomena*, offering a more nuanced understanding of its taxonomy and interspecific dynamics. Notably, the analysis indicates that *F. mixta* (now returned to *Homalomena* as *H. mixta* Ridl.) and *F. sumatrensis* (here transferred to *Homalomena* as *H. sumatrensis*) are not monophyletic but are instead nested within *Homalomena* in distinct clades (Fig. 2), consistent with the findings of Wong et al. (2016), Haigh et al. (2023), and Vasconcelos et al. (2023). Given that the necessary taxonomic revisions have yet to be implemented, it is proposed that species currently classified under *Furtadoa* be formally transferred to *Homalomena*.

Homalomena mixta is resolved within the Chamaecladon Supergroup (SG), while *H. sumatrensis* is posi-

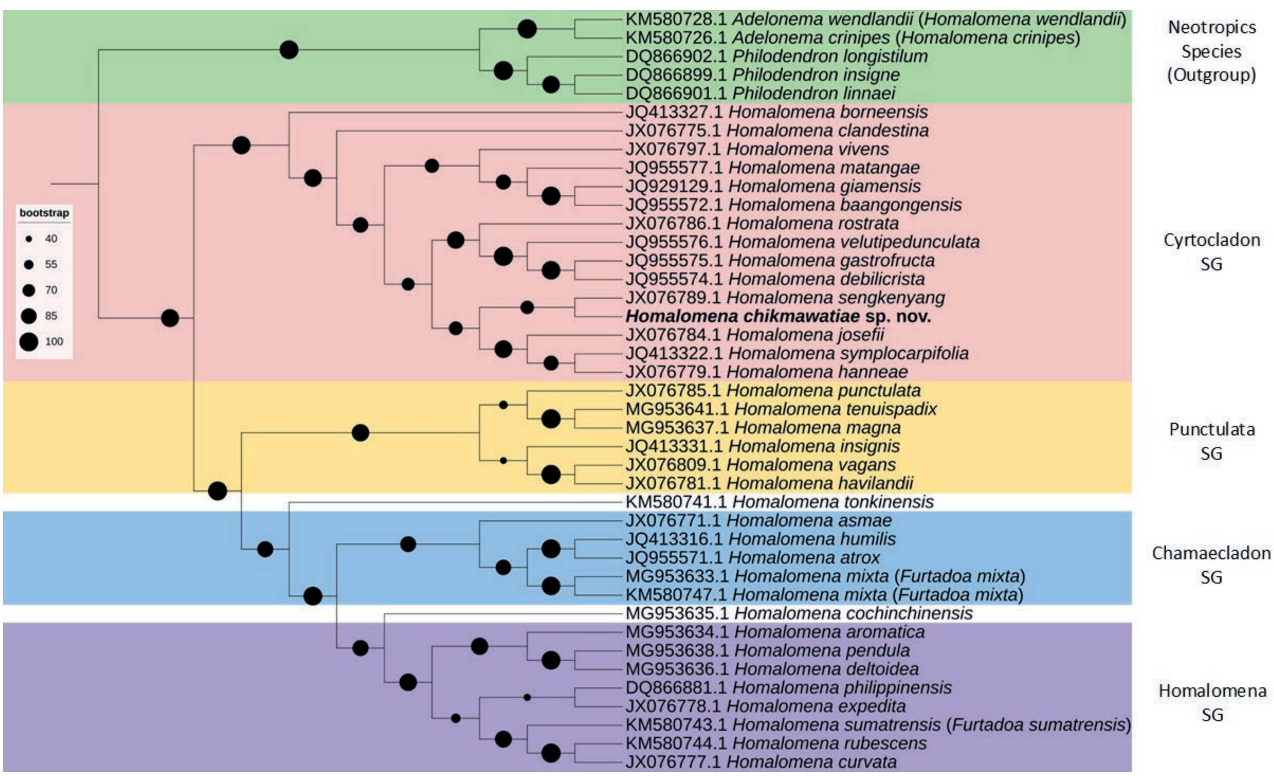

Figure 2. Phylogenetic tree of *Homalomena* based on ITS sequence showing the disparate positions of *Homalomena chikmawatiae* and two other species previously under the genus *Furtadoa*.

tioned within the Homalomena SG. Interestingly, our newly identified species occupies a separate clade, distinct from other species exhibiting the '*Furtadoa*'-type spadix morphology, and is placed within the Cyrtocladon SG. Further investigation, including molecular data for *F. indrae* (here transferred to *H. indrae*), is essential to clarify its phylogenetic position and to better understand its placement within the broader *Homalomena* genus.

The Cyrtocladon SG represents a distinct and well-supported clade within *Homalomena*, characterized by its prominent morphological features. These include large inflorescences with a spathe that is distinctly divided into two regions: a basal portion and an upper limb. Inflorescences during anthesis with complex spathe and spadix movements and oftenspadix elongation (Kiaw et al. 2011). These defining traits, however, are absent in *H. chikmawatiae*. Unlike other members of Cyrtocladon SG, *H. chikmawatiae* possesses a unique combination of features, including a pistillate flower zone containing interpistillar staminodes — a characteristic commonly observed in Cyrtocladon SG. Despite this similarity, *H. chikmawatiae* is distinctively having uncommon peltate leaves, large sterile appendix at the spadix, and unilocular ovary, with basal placentation, setting it apart from the typical species of this supergroup.

The novel species is positioned within the Cyrtocladon SG in the phylogenetic tree constructed based on ITS sequence data. However, morphologically, the characteristics exhibited by *H. chikmawatiae* differ significantly from the typical traits observed within the supergroup, especially the presence of sterile appendix which is unusual to this genus. This suggests that the morphological diversity within Cyrtocladon SG is broader than previously understood, with certain traits potentially representing outliers. Wong et al. (2013) previously reported similar findings, noting the absence of staminodes in *H. vivens* P.C.Boyce, S.Y.Wong & Fasih., a characteristic typically associated with Homalomena SG and Punctulata SG, rather than Cyrtocladon SG.

Additionally, the number of stamens per staminate flower exhibits considerable variation across species. While the general range for Cyrtocladon SG is 2–4 stamens, *H. chikmawatiae* is characterized by having only a single stamen per flower (Wong et al. 2013). This trait is reminiscent of *H. mixta* and *H. sumatrensis*, species that are distributed across two different supergroups, namely Homalomena SG and Chamaecladon SG based on the phylogenetic tree. The presence of such unique morphological features in *H. chikmawatiae* underscores the complexity and variability within the genus *Homalomena*. These findings highlight the challenges in establishing robust morphological groupings within this genus, which is recognized as one of the largest and most taxonomically complex groups within the family Araceae.

To address these complexities, further comprehensive studies are required to unravel the relationships among species within *Homalomena*. These investigations should integrate both molecular and morphological approaches to provide a more holistic understanding of species delimitation and phylogenetic relationships. Ultimately, such studies may necessitate a reorganization of the genus, potentially leading to the establishment of new SG that better reflect the evolutionary and morphological diversity of *Homalomena*.

Based on the findings of this study, an updated taxonomic key for the *Homalomena* species resembling the '*Furtadoa*-like' group in Western Malesia has been developed and is presented below. This updated key serves as a comprehensive and systematic tool for identifying species within this morphologically complex group. The revision incorporates both newly described species and re-evaluated diagnostic traits in previous identification frameworks.

Updated key to the species of *Homalomena* with '*Furtadoa*' spadix morphology (modified from Boyce & Wong, 2015)

1. A. Mesophytic herb, peduncle short (c. 6–9 × as long as spathe), pistils white 2

   B. Rheophytic herb, peduncle long (at most 3 × as long as spathe), pistils greenish 3

2. A. Inflorescences in fascicles of up to 7, spadix sessile, pistillodes conical, sterile appendix absent .... ***Homalomena mixta***

   B. Inflorescence in pair, spadix stipitate, pistillodes bottle-shaped, sterile appendix present .... ***Homalomena chikmawatiae***

3. A. All staminate flowers associated with a pistillode; pistils bottle-shaped, rich green; stigma ¼ diam. of pistil; leaf blades thinly membranous on short (¼ leaf blade length) petioles .... ***Homalomena indrae***

   B. Terminal portion of spadix comprised of staminate flowers lacking pistillodes; pistils globose, pale cream; stigma ½ diam. of pistil; leaf blades coriaceous on a long (¾ to exceeding leaf blade length) petioles .... ***Homalomena sumatrensis***

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Vepris viridis (Rutaceae), a new name for the most frequent and widespread unifoliolate African *Vepris* sp.

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Abstract. We show that the name *Vepris simplex* Cheek (Rutaceae) intended to replace the illegitimate *V. simplicifolia* (Engl.) Mziray, is itself a nom. illeg. & nom. superfl. according to the *Code*. Therefore, we make the new combination *Vepris viridis* (I.Verd.) Cheek, Q.Luke & Gereau for the most widespread and frequent species of unifoliolate *Vepris* in continental Africa, which occurs in the E African rift from Ethiopia to Malawi and is ecologically important as a food plant for elephants.

Keywords. *Teclea simplicifolia, Toddalia simplicifolia, Vepris simplex, Vepris simplicifolia.*

INTRODUCTION

In our synopsis of the unifoliolate species of continental Africa (Cheek and Luke 2023) a new name, *Vepris simplex* Cheek, was published for the most widespread and frequent species, previously known as *Vepris simplicifolia* (Engl.) Mziray (Mziray 1992: 75). This seemed necessary because we had discovered that the name *Vepris simplicifolia* had already been used (*Vepris simplicifolia* Endl. (Endlicher 1833: 89)) and so Mziray's name was a *hom. illeg.*

However, we overlooked the fact that the epithet of a name that we had listed as a synonym of this taxon is available. This is *Teclea viridis* I. Verd. (1926: 410), the epithet of which has not been taken up in *Vepris*. This means that *Vepris simplex* Cheek is both a nom. illeg. and a nom. superfl. according to Art. 52.1 of the *Code* (Turland et al. 2018), as pointed out by IPNI (continuously updated) and by the third author. Therefore, we hereby make the new combination needed and reduce *Vepris simplex* to synonymy.

TAXONOMIC TREATMENT

Vepris viridis (I.Verd.) Cheek, Q.Luke & Gereau, **comb. nov.**

Bas.: *Teclea viridis* I. Verd. (1926: 410). Type: Kenya, Nairobi Forests, 5500 ft, fl. Feb. 1914, *Battiscombe* 867 (Holotype K barcode 000199480!; isotype EA)

Syn: *Toddalia simplicifolia* Engl. (Engler 1895: 228), *Teclea simplicifolia* (Engl.) I. Verd. (1926: 410; Kokwaro 1982: 25; Gilbert 1989: 427; Friis 1992: 183; Beentje 1994: 369), *Vepris simplicifolia* **(**Engl.) Mziray **(**Mziray 1992: 75) *hom. illegit*. (non *Vepris simplicifolia* Endl. (Endlicher 1833 : 89), *Vepris simplex* Cheek (Cheek and Luke 2023: 488) *nom. illeg., nom. superfl.*

Type: Tanzania, "Hochwaldes" (indicated as Usambara Mts on EA isotype), 1300-1600 m, Sept. 1892, *Holst* 3801 (holotype B, probably destroyed; isotype EA barcode EA000003191!; epitype (designated in Cheek and Luke 2023) Tanzania, Tanga Province, Lushoto Distr., Manola, 6,600 ft, fl. 16 June 1953, *Parry* 222 (K barcode K000593353!).

Vepris viridis is an ecologically important montane species, being locally frequent and a preferred fodder plant of elephants (Cheek and Luke 2023). It occurs from the Ethiopian Highlands in the vicinity of Addis Abeba southwards along the E African rift mountains through the highlands of Kenya, and Tanzania to the Mafinga Mts of northern Malawi (Cheek & Luke 2023).

To the thirteen species of continental African *Vepris* species accepted by Cheek and Luke (2023), a fourteenth, *V. usambarensis* Ciambrone & Cheek was added by Ciambrone et al. (2024).

CONCLUSION

This article corrects the long overdue nomenclatural error of accepting the illegitimate later homonym *Vepris simplicifolia* (I.Verd.) Mziray, which has been in use since its publication (Mziray 1992) until the present. Its immediate publication will stop continued misapplication of the wrong name to the species in question.

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Verbenaceae in Emas National Park (Goiás state, Central Brazil), with a focus on chromatic variation in the corollas of *Lippia filifolia*

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Abstract. Emas National Park is a critical region for the conservation of biodiversity in the Cerrado domain, yet its flora remains insufficiently studied from a taxonomic perspective. To enhance taxonomic and biogeographic knowledge of Verbenaceae in the Brazilian Central Plateau and to support ongoing conservation efforts, we provide a synopsis, photographs, and an identification key for the taxa occurring in this protected area. In total, 12 taxa belonging to three genera were recorded, with *Lippia stachyoides* var. *guajajarana* being endemic to the Park. This study focused on documenting the chromatic variation in the corollas of *Lippia filifolia*. While specimens from the Espinhaço Range and Serra da Canastra (Minas Gerais state) exhibit yellow corollas, those from Emas National Park (Goiás state) display red coloration, an uncommon trait within the genus.

Keywords: Cerrado, Lantaneae, protected areas, taxonomy.

INTRODUCTION

Our current knowledge about biodiversity stems from the extensive efforts by naturalists and, more specifically, taxonomists, who have historically undertaken and continue to carry out field expeditions to explore nature and describe new taxa, offering crucial information on the ecology, evolution and distribution of species (Godfray and Knapp 2004; Löbl et al. 2023). In the 21st century, human activities have become the main threat to biodiversity's accelerated decline, and many species are at risk of extinction (Brooks et al. 2002; Pimm et al. 2014; Lughadha et al. 2020). Notably, the success of conservation strategies is closely linked to the expansion of taxonomic knowledge (McNeely 2002).

Data on species richness, endemism, rarity, and extinction risk are crucial for identifying priority areas for conservation and result from comprehensive taxonomic research and exploratory collection efforts (Mace 2008; Morrison et al. 2009; Mittermeier et al. 2004). In this context, megadiverse countries like Brazil, where Linnaean and Wallacean deficits are particularly pronounced, rely heavily on basic taxonomic research to develop effective conservation strategies (Martinelli 2007; Fonseca and Venticinque 2018).

Verbenaceae are an important component of the Brazilian flora, represented by 15 genera and 301 species, 194 of which are exclusive (Salimena et al. 2024). Several species within this family have fascinated naturalists over the centuries due to the striking beauty of their inflorescences and flowers, such as *Duranta erecta* L., *Lantana camara* L., and *Petrea volubilis* L., which are widely cultivated for ornamental purposes (Lorenzi and Souza 2001). *Lippia alba* (Mill.) N.E.Br. ex Britton & P.Wilson stands out as one of the most popular species of the family, and it is widely utilized in the pharmaceutical industry and popular medicine (Aguiar 2005; Costa et al. 2017). However, most species in the family are unknown or poorly known in terms of their potential uses, and this is partly due to their restricted distributions, primarily in remote and hard-to-access areas, such as the *campos rupestres* (rupestrian grasslands) of the Espinhaço Range (Cardoso et al. 2024a; Salimena et al. 2024).

Floristic studies on Verbenaceae have been conducted mainly in protected areas of Brazil's Southeast region, particularly those characterized by the presence of *campos rupestres* and *campos de altitude* (high-altitude grasslands), which are key habitats with the highest concentration of species (e.g., Salimena-Pires and Giulietti 1998; Cruz and Salimena 2017; Cardoso et al. 2020a; Santiago et al. 2020; Ribeiro et al. 2022; Silva et al. 2023). Furthermore, taxonomic treatments have been carried out at a regional level, including for the Distrito Federal (Salimena et al. 2015), the states of Goiás and Tocantins (Salimena et al. 2016), and the state of Espírito Santo (Cardoso et al. 2021). Such studies have provided essential data for the systematics and biogeography of Verbenaceae, besides contributing to advancing conservation efforts in the areas studied. The taxonomic treatment of Verbenaceae in the Serra da Canastra National Park in Minas Gerais state, for example, led to the discovery and description of a new species, *Stachytarpheta grandiflora* P.H.Cardoso & Salimena (Cardoso et al. 2019a, 2020b). Similarly, the taxonomic treatment for the Caparaó National Park, situated on the border between the states of Minas Gerais and Espírito Santo, resulted in the discovery of *Lantana caudata* P.H.Cardoso & Salimena and *Lippia mantiqueirae* P.H.Cardoso & Salimena (Cardoso et al. 2019b, c, d). Additionally, the study of Verbenaceae in Serra Negra, in the state of Minas Gerais, extended the distribution of *Stachytarpheta mexiae* Moldenke, with its first record in the Atlantic Forest domain (Cardoso et al. 2018).

Continuing the floristic studies on Verbenaceae in Brazil, we present here a synopsis of the taxa found in Emas National Park (hereafter ENP), emphasizing the record of *Lippia filifolia* Mart. & Schauer with red corollas. Previously, this species was documented only with yellow corollas (Salimena et al. 2016; Salimena & Cardoso 2024). This study includes description of the diagnostic characteristics of each taxon, an identification key, photographs, and a map displaying the updated distribution of *Lippia filifolia*. ENP stands out as a critical area for botanical research, underscored by the discovery of several taxa within its boundaries (Filgueiras et al. 1999; Arbo 2002; Devecchi et al. 2018; Moreira et al. 2018; Cardoso et al. 2020c). Despite its recognized biological importance, the flora of the Park remains taxonomically underexplored. In this context, Batalha and Martins (2002), who conducted the first vascular flora survey in ENP, stated: "We emphasize the need for more floristic survey in which the frequently overlooked herbaceous component should also be sampled."

MATERIALS AND METHODS

The ENP, created in 1961, is a fully protected area within the Cerrado domain (Batalha and Martins 2002; MMA 2004). It is situated on the Brazilian Central Plateau, spanning 131.864 hectares between the latitudes 17°49' and 18°28'S, and longitudes 52°39' and 53°10'W (Figure 1A, B), with altitudes that do not exceed 900 meters. The Park covers parts of the municipalities of Mineiros and Chapadão do Céu in the southeastern portion of Goiás state, as well as the municipality of Costa Rica in the state of Mato Grosso do Sul (MMA 2004). Open cerrado physiognomies – *campo limpo*, *campo sujo* (a shrub savanna), and *campo cerrado* (a savanna woodland) are the most common types of vegetation in the ENP, covering about 80% of the total area, but it also includes Seasonal Semideciduous Forest and wetland ecosystems, such as *veredas* and floodplain grasslands (*campos úmidos*) (Batalha and Martins 2002; MMA 2004; Batalha and Martins 2007; França et al. 2007). The geological features of the ENP consist of uniform sediment deposits interspersed with volcanic rocks, all part of the Paraná sedimentary basin (MMA 2004). The soils comprise sandstone or basalt, predominantly dark-

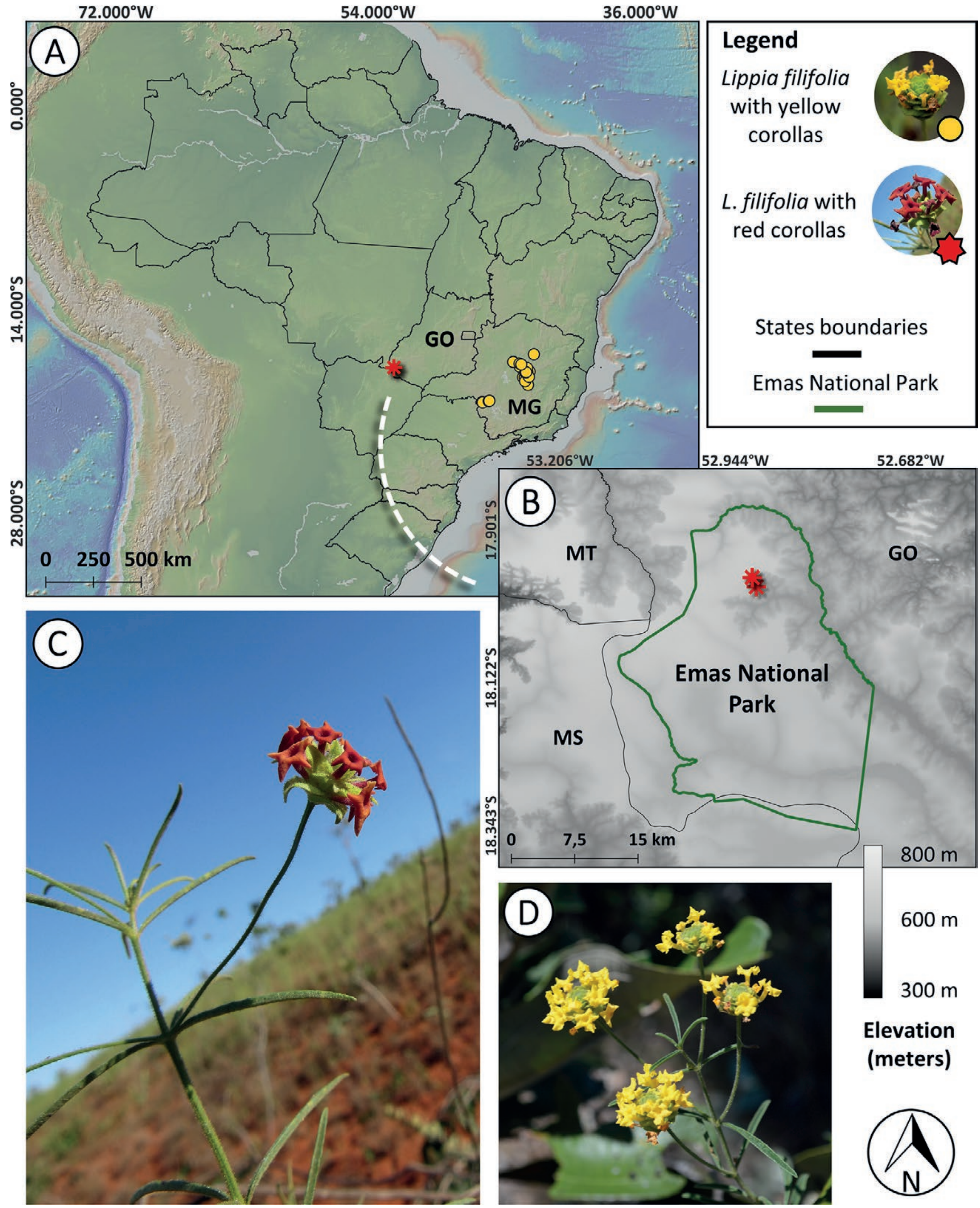

Figure 1. Geographic distribution of *Lippia filifolia* and boundaries of Emas National Park. (A) displays the overall distribution of *Lippia filifolia* in Brazil (GO = Goiás state and MG = Minas Gerais state). (B) shows the occurrence of *Lippia filifolia* in Goiás state within Emas National Park (GO = Goiás state, MT = Mato Grosso state, and MS = Mato Grosso do Sul state). (C and D) photographs of *Lippia filifolia* individuals showcasing the variation in corolla color. Photo C by Isa Lucia de Morais and D by Vinicius Dittrich.

red latosols, red-yellow latosols, quartz sands, lithologic and cambisoles (MMA 2004). According to Köppen classification, the climate of the ENP is characterized as wet tropical savanna (Aw), marked by distinct wet and dry seasons, with a rainy summer and a dry winter lasting approximately six months (Ramos-Neto and Pivello 2000). The annual precipitation ranges from 1,200 to 2,000 mm, concentrated between September and March, with an average annual temperature of 24.6°C (Ramos-Neto and Pivello 2000; MMA 2004).

The last author conducted field expeditions in the ENP from June 2023 until September 2024, with intervals of one to two months between them. Each expedition spanned three consecutive days of collections. Various areas of the Park were explored using a non-systematic walking method (Filgueiras et al. 1994), with open cerrado physiognomies being the main vegetation types surveyed. The collected specimens were deposited at JAR herbarium (acronyms following Thiers 2024). For the synopsis of Verbenaceae, we examined high-resolution images of herbarium specimens available through the REFLORA (http://reflora.jbrj.gov.br) and the *species*Link (http://splink.cria.org.br), along with physical collections from the CESJ, JAR, RB, SP, and SPF herbaria (acronyms following Thiers 2024). The first author carried out taxonomic identifications by analyzing protologues, type specimens, and key literature of Verbenaceae. Descriptive terminology was based on Harris and Harris (2003), Gonçalves and Lorenzi (2007), Beentje (2010) and in the Verbenaceae key literature. Information on the species' distribution was based on field observations, specimen labels and literature (e.g. Salimena et al. 2016; Cardoso et al. 2020c; Salimena et al. 2024). The identification key was developed by analyzing specimens collected within the Park and field observations, supplemented by key literature and examining additional specimens.

RESULTS AND DISCUSSION

In Emas National Park, Verbenaceae are currently represented by 12 taxa included in three genera: *Casselia* Nees & Mart. (1 sp.), *Lippia* L. (9 taxa), and *Stachytarpheta* Vahl (2 spp.). Batalha and Martins (2002) surveyed the vascular flora of the ENP based on gatherings made between November 1998 and October 1999, documenting 601 species belonging to 303 genera and 80 families. The authors recorded 13 species of Verbenaceae: *Aegiphila lanata* Moldenke, *Aegiphila lhotzkiana* Cham., *Amasonia hirta* Benth, *Casselia chamaedryfolia* Cham., *Lippia hirta* (Cham.) Meisn. ex D. Dietr., *Lippia hoehnei* Moldenke, *Lippia lupulina* Cham., *Lippia martiana* Schauer, *Lippia primulina* S.Moore, *Lippia stachyoides* Cham., *Lippia turnerifolia* Cham., *Stachytarpheta maximilianii* Schauer, and *Stachytarpheta simplex* Hayek. However, the first three species are now classified under Lamiaceae, with *Aegiphila lanata* and *Aegiphila lhotzkiana* currently regarded as synonyms of *Aegiphila verticillata* Vell. (França 2024). Furthermore, based on the analysis of the vouchers, some species represent misidentifications: *Casselia chamaedryfolia* was reidentified as *Casselia glaziovii* (Briq. & Moldenke) Moldenke; the specimen identified as *Lippia hirta* is the holotype of *Lippia stachyoides* var. *guajajarana* P.H.Cardoso & Salimena; *Lippia lupulina* was reidentified as *Lippia primulina* S.Moore; and *Lippia turneraefolia* as *Lippia nana* Schauer. Additionally, *Stachytarpheta maximilianii* and *Stachytarpheta simplex* are heterotypic synonyms of *Stachytarpheta cayennensis* (Rich.) Vahl and *Stachytarpheta gesnerioides* Cham., respectively.

Most of the Verbenaceae taxa recorded in the present study are endemic to the Cerrado domain in Brazil (Salimena et al. 2024), with *Lippia stachyoides* var. *guajajarana* being endemic to the Park, known from only two gatherings, and likely threatened with extinction (Cardoso et al. 2020c). However, some species, such as *Lippia origanoides* Kunt and *Stachytarpheta cayennensis*, exhibit a wide distribution across the Americas (Salimena et al. 2024). *Lippia origanoides* was not documented in the ENP by Batalha and Martins (2002). It is an intriguing species complex, currently with 29 heterotypic synonyms, and requires further investigation to reevaluate its taxonomic boundaries (O'Leary et al. 2012; Cardoso and Santos-Silva 2022). The same applies to *Lippia stachyoides*, which currently encompasses three varieties. These taxa belong to the *Lippia* sect. *Goniostachyum* Schauer, which is characterized by having tetrastichous floral bracts (Schauer 1847; O'Leary et al. 2012). Future taxonomic studies aiming to delimit taxa within this section may uncover new arrangements, potentially reshaping the diversity of Verbenaceae in the ENP.

Another taxon not recorded in ENP by Batalha and Martins (2002) is *Lippia filifolia*. It is a sticky subshrub or shrub densely covered by glandular trichomes, with filiform leaves, entire at margins, hypodromous venation, many-flowered inflorescences, green and ovate bracts, and yellow corollas that sometimes can turn slightly orange after maturity (Salimena et al. 2016; Salimena and Cardoso 2024, Fig 1D). This species has been recorded from various localities in Minas Gerais state, particularly along the Espinhaço Range and in the Serra da Canastra region (Cardoso et al. 2020a,b; Salimena and Cardoso 2024, Fig. 1A). However, Salimena et al. (2016) reported its first occurrence in the state of

Goiás based on a single specimen from the ENP (*T.S. Filgueiras 2314*), collected in 1992. Notably, this record expanded the known distribution of *Lippia filifolia* to its westernmost limit (Fig. 1A). It is important to emphasize that the label of this specimen includes the following field note: "erect herb with reddish flowers. Locally rare." Despite this, Salimena et al. (2016) described the corollas of *Lippia filifolia* as yellow, overlooking the red coloration observed in the species. Furthermore, the distribution of *Lippia filifolia* in Goiás state has not been documented by Salimena and Cardoso (2024). Recently, a subpopulation of *Lippia filifolia* from ENP was found, and new gatherings were made (voucher *I.L. Morais 10092*). This subpopulation contained dozens of individuals with red corollas (Fig. 1C), as previously reported on the label of the specimen *T.S. Filgueiras 2314*. However, until then, this trait had not been included in taxonomic descriptions of the species (Salimena et al. 2016; Salimena and Cardoso 2024).

The observation of *Lippia filifolia* with red corollas in ENP holds both taxonomic and ecological significance, offering new insights into the species' variation and potentially its adaptation to local environments. Within *Lippia*, red corollas are uncommon. To date, only *Lippia macrophylla* Cham. is known to have red bracts and corollas (Salimena and Cardoso 2024). Overall, the presence of red corollas is more common within *Lantana* L., as seen in *Lantana camara*, *Lantana caudata*, and *Lantana tiliaefolia* Cham. (Cardoso et al. 2021; Silva et al. 2024). Regarding this, it is important to note that both *Lantana* and *Lippia* are not monophyletic, and in the future, they may be treated as a single genus, or several smaller genera could be segregated (Lu-Irwing et al. 2021). The significant morphological similarity shared between these two genera, along with the difficulty in separating them, suggests that a single, larger genus might be more taxonomically appropriate.

Casselia glaziovii, *Lippia hoehnei*, *Lippia nana*, and *Lippia primulina* have xylopodium and were collected after the passage of fire in the ENP. According to Ramos-Neto and Pivello (2000) and França et al. (2007), the biodiversity within ENP, as it exists today, reflects a long history of coexistence with fire. This ecological phenomenon is highly complex, influenced by historical processes, demographic and phenological traits of plant populations, nutrient and water dynamics, and the physical characteristics of the environment (Coutinho 1982; Antar et al. 2022). While natural fire plays an important role in promoting biodiversity within the Cerrado domain, human-induced fires can lead to local biodiversity loss (Durigan and Ratter 2015). Between 1973 and 1994, large-scale anthropogenic fires dominated in the ENP, with uncontrollable fires affecting its entire area in both 1978 and 1994 (França et al. 2007). Currently, controlled fire is frequently employed in the ENP as a management tool (I.L. Morais, personal observation). This underscores the importance of conducting periodic collections of the park's flora to document its species richness and advancing conservation efforts aimed at maintaining its ecological integrity.

TAXONOMIC TREATMENT

Identification key for the taxa of Verbenaceae in the Emas National Park

1. Flowers pedicellate; corollas funnelform, with purplish nectar guides; fruits partially covered by the persistent and enlarged calyx .... ***Casselia glaziovii***

1'. Flowers sessile; corollas tubulose, usually with a coloured throat; fruits fully covered by the persistent and enlarged calyx 2

2. Flowers with conspicuous calyces; corollas not bilabiate; androecium with 2 fertile stamens and 2 staminodes, thecae divergent 3

2'. Flowers with inconspicuous calyces; corollas bilabiate; androecium with 4 fertile stamens, thecae parallel 4

3. Branches not winged; calyces 4-toothed, immersed in the depressions of the rachis; corollas barely exserted from the calyces, tube 0.5–1 cm long, slightly curved, with a lilac or white throat .... ***Stachytarpheta cayennensis***

3'. Branches usually winged; calyces 5-toothed, free; corollas well-exserted from the calyces, tube 1.3–2 cm long, bent, with a yellow throat .... ***Stachytarpheta gesnerioides***

4. Corollas yellow, orange, or red 5

4'. Corollas pink, lilac, white, or cream 6

5. Monoecious subshrubs or shrubs 0.5–1 m tall; leaf blades filiform with hyphodromous venation .... ***Lippia filifolia***

5'. Dioecious subshrubs up to 20 cm tall; leaf blades oblanceolate or obovate with pinnate venation ….. ***Lippia nana***

6. Inflorescence 1-2 per leaf axil or forming panicles; bracts spiraled and broad (> 0.6 cm wide), all free 7

6'. Inflorescences 2 or more per leaf axil; bracts tetrastichous and narrow (< 0.5 cm wide), the basal ones connate 9

7. Leaves petiolate, concentrated at the apex of the branches, strongly bullate on adaxial surface .... ***Lippia lindimanii***

7'. Leaves sessile or subsessile, well distributed along the branches; slightly bullate on adaxial surface 8

8. Shrubs 1–1.7 m tall; inflorescences 1-2 per leaf axil or forming panicles; bracts with acute, acuminate, or caudate apices .... ***Lippia hoehnei***

8'. Shrubs ca. 0.4 m tall; inflorescences 1 per leaf axil; bracts with obtuse or rounded apices .... ***Lippia primulina***

9. Leaves opposite, with similar size along the branches, with those subtending the inflorescences not reduced .... ***Lippia origanoides***

9'. Leaves 3-4-verticillate and opposite, decreasing in size from the base towards the apex, with those subtending the inflorescences becoming reduced 10

10. Branches densely lanate-tomentose; bracts lanceolate or linear, 0.5–0.7 cm long, apices acuminate or caudate; corolla tubes 0.6–0.8 cm long .... ***Lippia stachyoides*** var. ***stachyoides***

10'. Branches sparsely or densely strigose; bracts ovate or broad-ovate, 0.25–0.3 cm long, apices acute or obtuse; corolla tubes 0.25–0.45 cm long 11

11. Leaf blades cuneate at bases, both surfaces minutely strigose or puberulent, abaxial surface not canescent .... ***Lippia stachyoides*** var. ***guajajarana***

11'. Leaf blades cordate, rounded, obtuse, or truncate at bases, adaxial surface velutinous, abaxial surface tomentose-canescent .... ***Lippia stachyoides*** var. ***martiana***

1. *Casselia glaziovii* (Briq. & Moldenke) Moldenke, Phytologia 5: 132. 1955. (Fig. 2A).

It is characterized by its subshrub habit with xylopodium; strigose-pubescent branches; entire leaf blades, conspicuously dentate or crenate-serrate at margins; racemes with 4 or less flowers, well-distributed along the branches, with peduncles measuring 0.8–1.2 cm in length, these not surpassing the leaves; pedicellate flowers; calyx teeth measuring 0.15–0.25 cm in length; funnelform, lilac corollas adorned with purplish nectar guides; and drupaceous fruits partially covered by the persistent and enlarged calyces. It is endemic to Brazil, occurring in the Distrito Federal, Goiás, and Minas Gerais, within the Cerrado domain (O'Leary et al. 2024; Cardoso et al. 2024b). In ENP, *Casselia glaziovii* was found in burned *campo limpo*.

Specimens examined

BRAZIL. Goiás. Chapadão do Céu, Parque Nacional das Emas, 1 km do portão Jacuba, 11 October 2006, *J. Paula-Souza et al. 8391* (SPF); Chapadão do Céu, Parque Nacional das Emas, 5 October 1999, *M.A. Batalha 3908* (CESJ); Mineiros, Parque Nacional das Emas, 3 km do portão Jacuba (17º55'05,42" S, 53º00'27,04" W), 08 September 2023, *I.L. Morais 8898* (JAR), 13 km do portão Jacuba (17º54'34,99" S, 53º00'13,37" W), 3 October 2023, *I.L. Morais 9006* (JAR), 25 km do portão Jacuba (18º00'16,57" S, 52º56'31,97" W), 19 April 2024, *I.L. Morais 9765* (JAR).

2. *Lippia filifolia* Mart. & Schauer, Prodr. [A. P. de Candolle] 11: 586. 1847. (Figs. 1C, 2B).

It is characterized as monoecious subshrubs or shrubs 0.5–1 m tall, with abundant glandular trichomes on branches, leaves, and bracts; sticky, sessile leaves; filiform leaf blades, entire at margins, with hypodromous venation; spikes 1 per leaf axil; bracts measuring 0.3–4 × 0.3 cm, spiraled, free, green, ovate, acute or obtuse at apices; sessile flowers with inconspicuous calyces; bilabiate, tubulose, yellow, orange or red corollas, androecium with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. It is endemic to Brazil, occurring in the states of Goiás and Minas Gerais, within the Cerrado domain (Salimena et al. 2016; Salimena and Cardoso 2024). In ENP, *Lippia filifolia* was found with red corollas growing in *campo limpo* and *campo sujo*.

Specimens examined

BRAZIL. Goiás. Mineiros, Parque Nacional das Emas, 27 April 1992, *T.S. Filgueiras 2314* (CESJ, IBGE, RB); Mineiros, Parque Nacional das Emas, 25 km do portão Jacuba (18º00'16,57" S, 52º56'31,97" W), 22 June 2024, *I.L. Morais 10092, 10095, 10103, 10104* (JAR).

Additional specimens examined

BRAZIL. Minas Gerais Buenópolis, Parque Estadual da Serra do Cabral, Lapa Pintada, 12 October 2002, *F.R.G. Salimena 4134* (CESJ); Delfinópolis, Condomínio de Pedras, 17 May 2003, *R.A. Pacheco et al. 611* (HUFU); Diamantina, 25 January 2004, *J.R. Pirani 5279* (SPF); Diamantina, estrada Conselheiro da Mata, 3 March 2012, *A.I.M.R. Machado et al. 91* (HUFU); Itacambira, 8 January 1986, *M. Meguro CFCR9069* (SPF); Joaquim Felício, Serra do Cabral, *T.B. Cavalcanti CFCR8042* (SPF); São Roque de Minas, trilha para a cachoeira da Casca D'Anta, Guarita 3, 22 November 1995, *R. Romero 3201* (CESJ, HUFU); Santana de Pirapama, Serra do Cipó, 24 March 1982, *I. Cordeiro CFSC9417* (SPF).

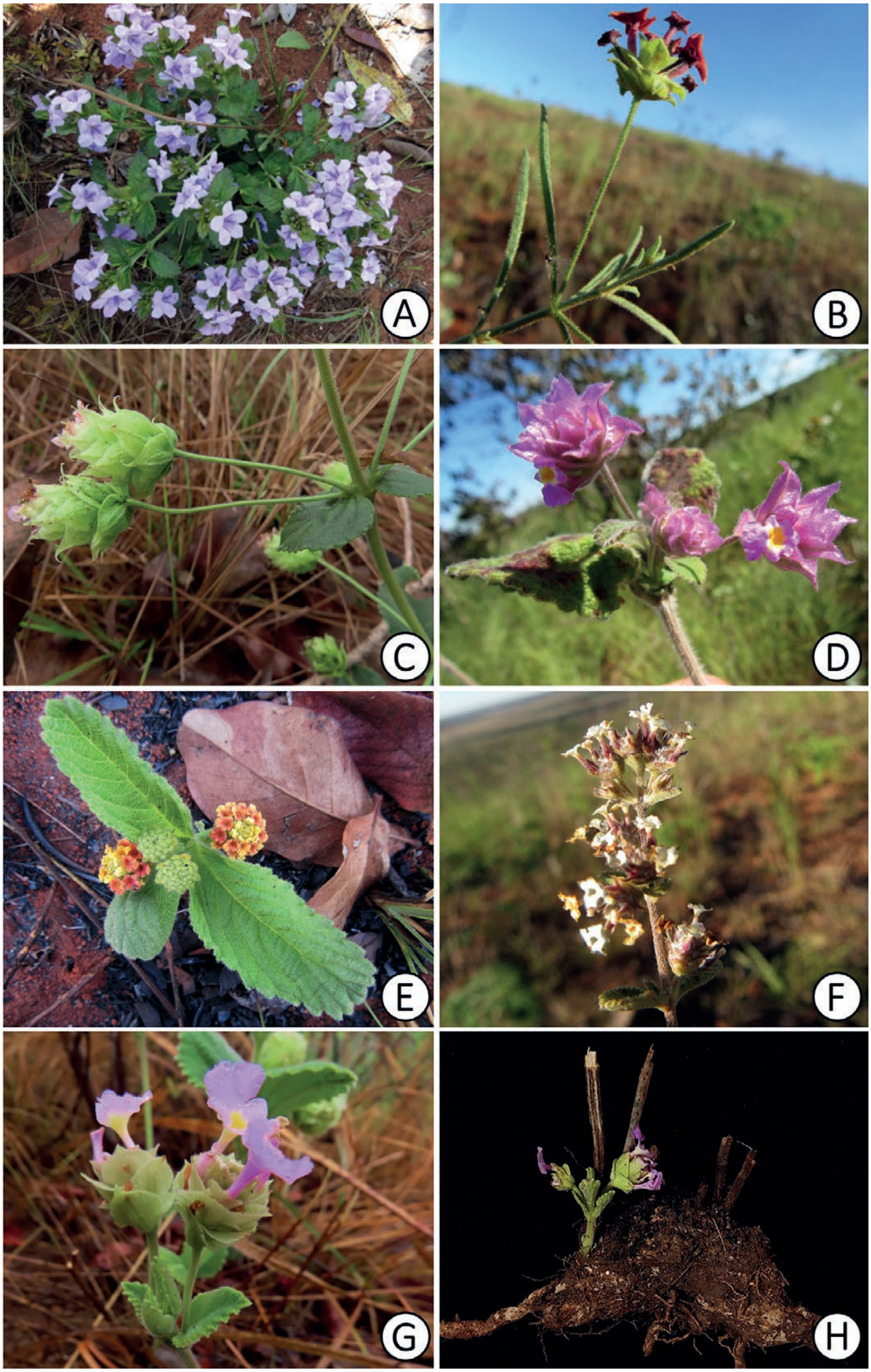

Figure 2. Photographs of Verbenaceae taxa occurring in Emas National Park, Goiás state, Brazil. (A) *Casselia glaziovii*. (B) *Lippia filifolia*. (C) *Lippia hoehnei*. (D) *Lippia lindmanii*. (E) *Lippia nana*. (F) *Lippia origanoides*. (G and H) *Lippia primulina*. Photos by Isa Lucia de Morais.

3. *Lippia hoehnei* Moldenke, Phytologia 1: 467. 1940. (Fig. 2C).

It is characterized as monoecious shrubs 1–1.7 m tall, with xylopodium; leaves well distributed along the branches, sessile or subsessile; ovate or elliptic, coriaceous leaf blades, serrate or crenate at margins, slightly bullate on adaxial surface, reticulate veined and foveolate on abaxial surface; spikes 1-2 per leaf axil or forming panicles; bracts measuring 0.7–1 × 0.8 cm, spiraled, free, pink or green, membranaceous, ovate, acute, acuminate, or caudate at apices; sessile flowers with inconspicuous calyces; bilabiate, tubulose, pink corollas, with yellow throat, androecium with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. It is endemic to Brazil, occurring in the states of Goiás, Mato Grosso, and Mato Grosso do Sul, within the Cerrado and Amazon Forest domains (Salimena et al. 2016; Salimena and Cardoso 2024). In ENP, *Lippia hoehnei* was found with green bracts growing in burned *campo limpo*.

Specimens examined

BRAZIL. Goiás. Chapadão do Céu, Parque Nacional das Emas, 1 km do portão Jacuba, 11 October 2006, *J. Paula-Souza et al. 8298* (SPF); Chapadão do Céu, Parque Nacional das Emas, 3 November 1998, *M.A. Batalha 2248* (UEC); Mineiros, Parque Nacional das Emas, 17 July 1990, *H.D. Ferreira 2315* (UFG); Mineiros, Parque Nacional das Emas, 27 km do Portão Jacuba (17º58'04,46" S, 52º54'52,43" W), 30 May 2024, *I.L. Morais 9977, 9993* (JAR); 40 km do Portão Jacuba, próximo ao ponto Y (18º15'19,907" S, 52º53'16,636" W), 12 October 2024, *I.L. Morais 10728* (JAR).

4. *Lippia lindmanii* Briq., Ark. Bot. 2, no. 10: 20. 1904. (Fig. 2D).

It is characterized as monoecious shrubs 0.8–3 m tall; with leaves concentrated at the apex of the branches, petiolate; ovate-elliptic or subrotund, chartaceous or coriaceous leaf blades, crenate at margins, strongly bullate on adaxial surface, often canescent on abaxial surface; spikes 1 per leaf axil; bracts measuring 0.8–1.5 × 0.8–1 cm, spiraled, free, pink, membranaceous, ovate or ovate-elliptic, acute or obtuse at apices; sessile flowers with inconspicuous calyces; bilabiate, tubulose, pink corollas, with yellow throat, androecium with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. It is endemic to Brazil, occurring in the states of Goiás, Mato Grosso, and Mato Grosso do Sul, within the Cerrado and Amazon Forest domains (Salimena et al. 2016; Salimena and Cardoso 2024). In ENP, *Lippia lindmanii* was found in burned *campo limpo*.

Specimens examined

BRAZIL. Goiás. Mineiros, Parque Nacional das Emas, 36 km do portão Jacuba (17º59'56,278" S, 52º55'19,776" W), 21 June 2024, *I.L. Morais 10079, 10083* (JAR); 12 October 2024, *I.L. Morais 10753* (JAR).

5. *Lippia nana* Schauer, Prodr. [A. P. de Candolle] 11: 582. 1847. (Fig. 2E).

It is characterized as dioecious subshrubs up to 20 cm tall, with xylopodium; pubescent branches; opposite and sessile leaves; oblanceolate or obovate, chartaceous leaf blades, with pinnate venation; spikes 1 per leaf axil; bracts measuring 0.3–0.5 × 0.2 cm, spiraled, free, green, membranaceous, lanceolate or ovate, acute at apices; sessile flowers with inconspicuous calyces; bilabiate, tubulose, yellow or orange corollas, staminate flowers with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. It is endemic to Brazil, occurring in the Distrito Federal, Goiás and Minas Gerais, within the Cerrado domain (Cardoso et al. 2020b; Salimena and Cardoso 2024). In ENP, *Lippia nana* was found in burned *campo sujo* with sandy-clay soil.

Specimens examined

BRAZIL. Goiás. Chapadão do Céu, Parque Nacional das Emas, 11 October 2006, *J. Paula-Souza 8342* (SPF); Mineiros, Parque Nacional das Emas, próximo ao portão Jacuba, 23 October 2021, *J. Paula-Souza 11876* (FLOR); Mineiros, Parque Nacional das Emas, 28 km do Portão Jacuba (18º00'16,65" S, 52º56'34,64" W), 19 April 2024, *I.L. Morais 9754* (JAR); 32 km do Portão Jacuba (17º57'50,42" S, 52º54'36,37" W), 31 May 2024, *I.L. Morais 10012* (JAR).

6. *Lippia origanoides* Kunth, Nov. Gen. Sp. [H.B.K.] 2: 267. 1818. (Fig. 2F).

It is characterized as monoecious shrubs 1–2.5 m tall; opposite leaves, well distributed along the branches, petiolate; chartaceous leaf blades, with similar size along the branches, with those subtending the inflorescences not reduced; spikes 2-10 per leaf axil; bracts measuring 0.3–0.5 × 0.15–0.2 cm, tetrastichous, ovate or lanceolate, green or green-reddish, membranaceous, the basal ones connate; sessile flowers with inconspicuous calyces; bilabiate, tubulose, white or cream corollas, base of the tubes sometimes reddish, usually with yellow throat, androecium with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. It has a wide distribution across the Americas (O'Leary et al. 2012; Salimena and Cardoso 2024). In ENP, *Lippia origanoides* was found in *campo sujo*.

Specimens examined

BRAZIL. Goiás. Mineiros, Parque Nacional das Emas, 13 July 1990, *H.D. Ferreira 2513* (UFG); Mineiros, Parque Nacional das Emas, 20 km do Portão Jacuba (17º59'58,04" S, 52º56'29,84" W), 20 April 2024, *I.L. Morais 9781, 9783* (JAR); 28 km do Portão Jacuba (18º0'3,964" S, 52º55'59,357" W), 31 May 2024, *I.L. Morais 10014, 10021, 10038, 10045* (JAR); 25 km do Portão Jacuba (17º57'56,34" S, 52º54'50,55" W), 02 August 2024, *I.L. Morais 10330* (JAR).

7. *Lippia primulina* S.Moore, Trans. Linn. Soc. London, Bot. ser. 2, 4: 436 (1895). (Fig. 2G, H).

It is characterized as monoecious shrubs ca. 0.4 m tall, with xylopodium; leaves well distributed along the branches, subsessile; ovate or subrotund, subcoriaceous leaf blades, crenate-serrate at margins, slightly bullate on adaxial surface; spikes 1 per leaf axil; bracts measuring 0.7–1.2 × 0.8–1.5 cm, spiraled, free, green or pink, membranaceous, ovate or subrotund, obtuse or rounded at apices; sessile flowers with inconspicuous calyces; bilabiate, tubulose, pink corollas, with yellow throat, androecium with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. In ENP, *Lippia primulina* was found with green bracts growing in burned *campo limpo*.

Specimens examined

BRAZIL. Goiás. Mineiros, Parque Nacional das Emas, 28 km do Portão Jacuba (18º0'11,209"S, 52º55'54,378" W), 31 May 2024, *I.L. Morais 10039* (JAR); 25 km do portão Jacuba, 21 September 2024, *I.L. Morais 10627, 10647* (JAR); 35 km do portão Jacuba, 10 October 2024, *I.L. Morais 10708, 10709, 10710, 10714, 10727* (JAR).

8. *Lippia stachyoides* var**. *guajajarana*** P.H.Cardoso & Salimena, Phytotaxa 447(4): 284. 2020.

It is characterized as monoecious shrubs ca. 0.6 m tall, with the main branches developing secondary branches apically; sparsely strigose branches; 3-verticillate and opposite leaves, decreasing in size from the base towards the apex, with those subtending the inflorescences becoming reduced; oblong or narrow-elliptic leaf blades, cuneate at bases, minutely strigose or puberulent on both surfaces; spikes 4-5 per leaf axil; bracts measuring 0.25–0.3 × 0.1–0.2 cm, tetrastichous, green, membranaceous, ovate or broad-ovate, the basal ones connate, acute or obtuse at apices; sessile flowers with inconspicuous calyces; bilabiate, tubulose, white corollas, tubes 0.25–0.35 cm long, androecium with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. It is endemic to the ENP, Cerrado domain (Cardoso et al. 2020c). In ENP, *Lippia stachyoides* var. *guajajarana* was found in *campo sujo*.

Specimens examined

BRAZIL. Goiás. Chapadão do Céu e Mineiros, Parque Nacional das Emas, 10 December 1998, *M.A. Batalha 2415* (CESJ); Chapadão do Céu e Mineiros, Parque Nacional das Emas, 4 February 1999, *M.A. Batalha 2922* (SP).

9. *Lippia stachyoides* var. ***martiana*** (Schauer) Salimena & Múlgura, Bot. J. Linn. Soc. 170(2): 215. 2012. (Fig. 3A).

It is characterized as monoecious shrubs 0.8–2 m tall, with the main branches developing numerous secondary branches apically; densely strigose branches; 3-verticillate and opposite leaves, decreasing in size from the base towards the apex, with those subtending the inflorescences becoming reduced; ovate, broad-ovate, subrotund, or rarely oblong leaf blades, cordate, rounded, obtuse, or truncate at bases, velutinous on adaxial surface and tomentose-canescent on abaxial surface; spikes 3-8 per leaf axil; bracts measuring 0.2–0.3 × 0.2–0.3 cm, tetrastichous, green, membranaceous, broad-ovate, the basal ones connate, acute at apices; sessile flowers with inconspicuous calyces; bilabiate, tubulose, white corollas, tubes 0.3–0.45 cm long, androecium with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. It is endemic to Brazil, found in Distrito Federal, Goiás, and Minas Gerais, within the Atlantic Forest and Cerrado domains (O'Leary et al. 2012; Salimena and Cardoso 2024). In ENP, *Lippia stachyoides* var. *martiana* was found in *campo sujo*.

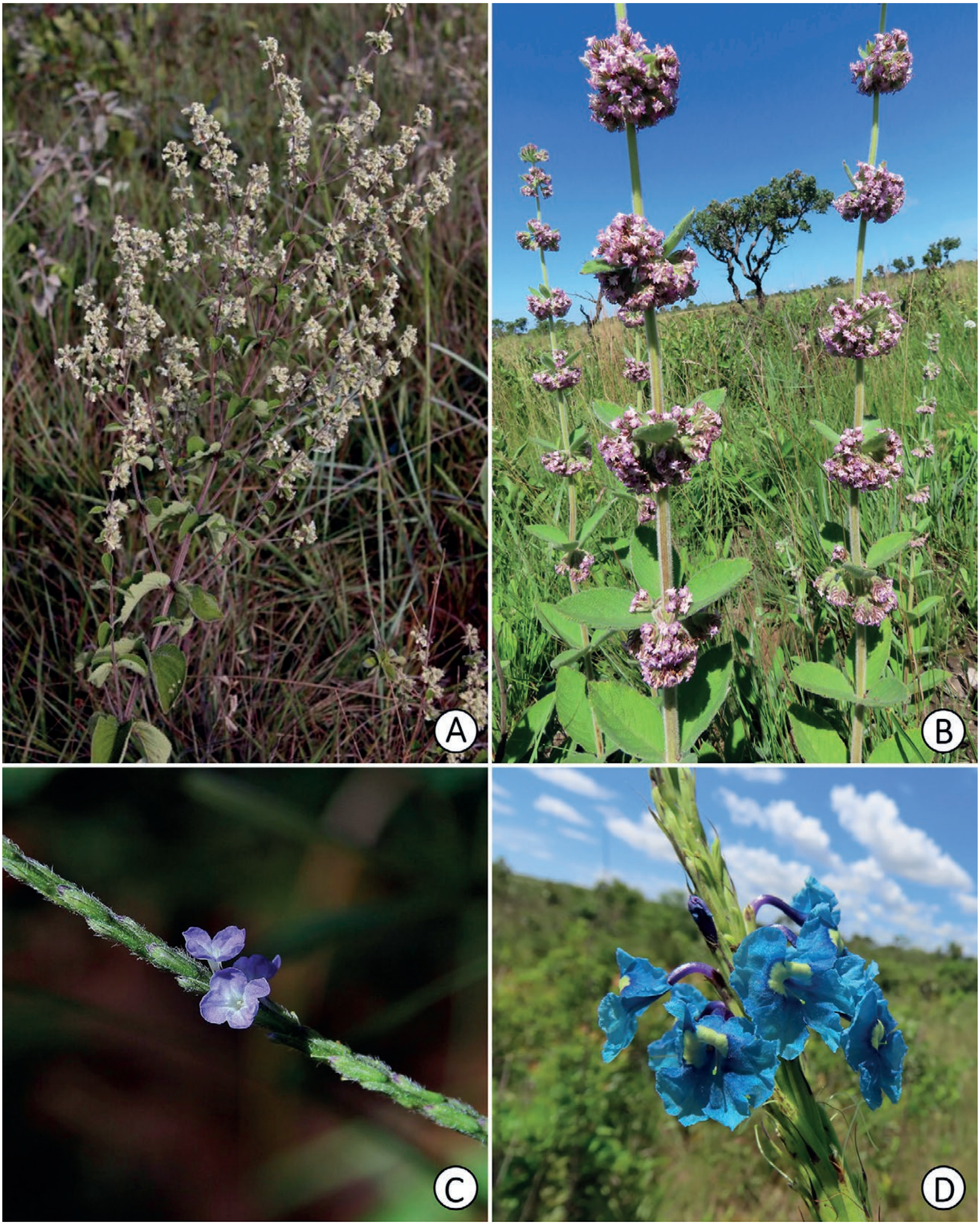

Figure 3. Photographs of Verbenaceae taxa occurring in Emas National Park, Goiás state, Brazil. (A) *Lippia stachyoides* var. *martiana*. (B) *Lippia stachyoides* var. *stachyoides*. (C) *Stachytarpheta cayennensis*. (D) *Stachytarpheta gesnerioides*. Photos A and C by Maurício Mercadante, B and E by Isa Lucia de Morais.

Specimens examined

BRAZIL. Goiás. Chapadão do Céu e Mineiros, Parque Nacional das Emas, 3 November 1998, *M.A. Batalha 2254* (CESJ). Mineiros, Parque Nacional das Emas, 18 February 1990, *H.D. Ferreira 2519* (UFG).

10. *Lippia stachyoides* Cham. var. ***stachyoides***, Linnaea 7(2): 227. 1832. (Fig. 3B).

It is characterized as monoecious shrubs 0.3–1 m tall, often unbranched; densely lanate-tomentose branches; 3-4-verticillate and opposite leaves, decreasing in size from the base towards the apex, with those subtending the inflorescences becoming reduced; ovate or elliptic leaf blades, cuneate or attenuate, rarely obtuse at bases, lanate-tomentose on adaxial surface and densely lanate-tomentose and canescent on abaxial surface; spikes 4-12 per leaf axil; bracts measuring 0.5–0.7 × 0.05–0.15 cm, tetrastichous, green-purplish, membranaceous, linear or lanceolate, the basal ones connate, caudate at apices; sessile flowers with inconspicuous calyces; bilabiate, tubulose, often lilac or purplish, rarely white corollas, tubes 0.6–0.8 cm long, androecium with 4 fertile stamens, parallel thecae; and schizocarp fruits fully covered by the persistent and enlarged calyx. It is endemic to Brazil, occurring in the states of Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, and São Paulo, within the Cerrado domain (O'Leary et al. 2012; Salimena and Cardoso 2024). In ENP, *Lippia stachyoides* var. *stachyoides* was found in *campo sujo*.

Specimens examined

BRAZIL. Goiás. Mineiros, Parque Nacional das Emas, 8 km do Portão Jacuba (17º55'40,40"S, 52º58'04,72" W), 16 February 2024, *I.L. Morais 9513* (JAR).

11. *Stachytarpheta cayennensis* (Rich.) Vahl, Enum. Pl. [Vahl] 1: 208. 1804. (Fig. 3C).

It is characterized by its not winged branches; opposite and petiolate leaves; membranaceous leaf blades; terminal spikes; sessile flowers with conspicuous calyces, immersed in the depressions of the rachis, 4-toothed; 5-lobed, not bilabiate corollas, tubes 0.5-1 cm long, slightly curved, barely exserted from the calyces, lilac or white with a lilac or white throat, androecium with 2 fertile stamens and 2 staminodes, thecae divergent; and schizocarp fruits fully covered by the persistent and enlarged calyx. It has a wide distribution across the Americas (Atkins 2005). In ENP, *Stachytarpheta cayennensis* was found in anthropized areas.

Specimens examined

BRAZIL. Goiás. Chapadão do Céu e Mineiros, Parque Nacional das Emas, 10 December 1998, *M.A. Batalha 2401* (CESJ).

12. *Stachytarpheta gesnerioides* Cham., Linnaea 7(2): 245. 1832. (Fig. 3D).

It is characterized by its winged branches; opposite and sessile leaves; coriaceous leaf blades; terminal spikes; sessile flowers with conspicuous calyces, not immersed in the depressions of the rachis, 5-toothed; 5-lobed, not bilabiate corollas, tubes 1.3-2 cm long, bent, with a yellow throat, well-exserted from the calyces, blue with a yellow throat, androecium with 2 fertile stamens and 2 staminodes, thecae divergent; and schizocarp fruits fully covered by the persistent and enlarged calyx. It occurs in South America (Atkins 2005). In ENP, *Stachytarpheta gesnerioides* was found in *campo limpo*.

Specimens examined

BRAZIL. Goiás. Chapadão do Céu e Mineiros, Parque Nacional das Emas, 7 March 1999, *M.A. Batalha 2968* (CESJ); Mineiros, Parque Nacional das Emas, próximo ao Rio Formoso, 15 February 1995, *J.B. Cassimiro 30* (CESJ); Mineiros, Parque Nacional das Emas, 30 October 2001, *H.D. Ferreira et al. 2515* (UFG); Mineiros, Parque Nacional das Emas, 6 km do Portão Jacuba (17º55'32,30"S, 52º58'10,26" W), 27 January 2024, *I.L. Morais 9308* (JAR); 8 km do Portão Jacuba (17º55'40,40"S, 52º58'04,72" W), 16 February 2024, *I.L. Morais 9513* (JAR); 5 km do Portão Jacuba (17º55'29,55"S, 52º58'16,52" W), 17 February 2024, *I.L. Morais 9551* (JAR).

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Review

Ib Friis, Mats Thulin. Scientific plant names derived from the surname of Pehr Forsskål – their history, orthography, legitimacy, and current use

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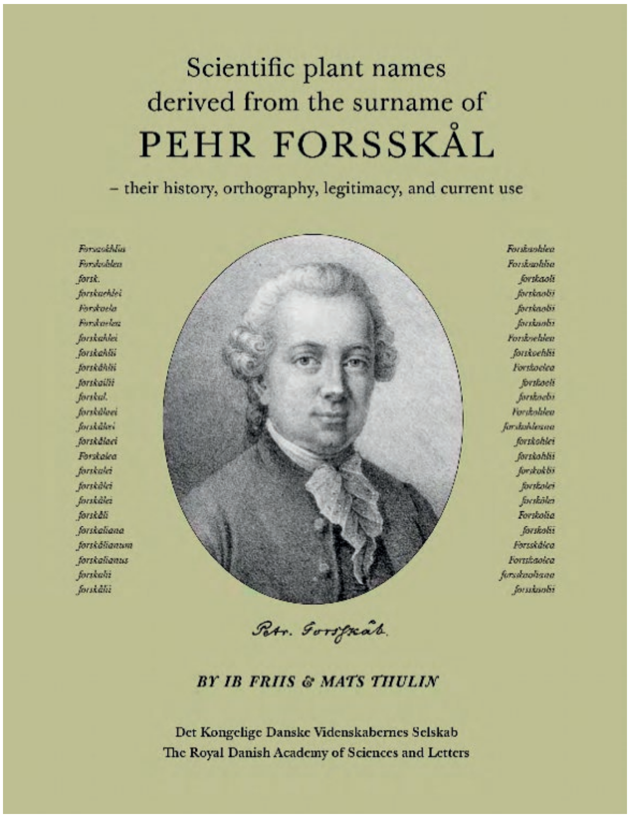
In 1761, the King of Denmark sent an expedition to Egypt and the countries around the Red Sea, particularly Yemen, to report on the geography, natural history, languages and ethnology of the countries. The ultimate purpose was to provide scholarly evidence for the background of the Bible. The expedition consisted of the geographer, surveyor and astronomer Carsten Niebuhr, who also became an ethnologist on the expedition, the naturalist Pehr Forsskål, a highly competent student of Linnaeus, the philologist Frederik Christian von Haven, who should also collect ancient manuscripts, the medical doctor Christian Carl Kramer, the artist Georg Wilhelm Baurenfeind, and a servant. Von Haven and Forsskål died already in Yemen in 1763, but Niebuhr, the only member of the expedition who returned to Denmark, managed to bring Forsskål's collections and manuscripts to Copenhagen in 1767. After Niebuhr had managed to publish his own works from the expedition, he hired an anonymous helper with knowledge of natural history and posthumously published Forsskål's Flora Aegyptiaco-Arabica in 1775, 12 years after Forsskål had died, almost entirely based on Forsskål's manuscript as written in the field. It was not updated regarding to what had happened in science in the meantime. The manuscript contained information about ca. 660 new species of plants and consisted of a floristically arranged first part and a descriptive second part, with longer descriptions of the plants than was normal at the time of Linnaeus.

Later authors often misunderstood the text and provided more than 10% of Forsskål's new but already named species with new scientific plant names derived from Forsskål's surname (eponyms). There were these main reasons for later authors finding problems with Forsskål's published manuscript:

– Forsskål's new species might have been discovered and described by others elsewhere between 1763 (when the manuscript was written) and 1775 (when it was published). Because of this, some Forsskål names became synonyms.



- Some species described by others between 1763 and 1775 were given names identical with those proposed by Forsskål in his manuscript, but completely unrelated to Forsskål's species. Because of this, some Forsskål names became homonyms.
- Forsskål might – in the field and when writing his manuscript – have misidentified new species from the Middle East with species described by Linnaeus from elsewhere. By that, these Forsskål names became misidentifications / misapplied names.
- Forsskål provided descriptions of new species in the second part of the book, but sometimes without a name for the plant there, but names (usually correct) were provided in the floristic first part of the book. The later botanists did not discover this connection, and therefore they renamed the new species with the apparently nameless description.

Cases in these four categories (illustrated by Friis and Thulin in their Figs. 2-8) were differently interpreted by later botanists from the 18^{th} century and up to now. When later botanists assumed that they had discovered a fault in Flora Aegyptiaco-Arabica, they proposed a new name for Forsskål's species and frequently followed Linnaeus' suggestion to name a species after the person who had made the essential original observations on it, thus naming the plant after Forsskål, providing an eponym for him.

Seventy-three Forsskål eponyms have been proposed for plants, but the spelling of Forsskål's surname often caused difficulties for non-Scandinavian scholars. The Forsskål eponyms have been called "an amazing series of orthographic variations", with 34 different variants of epithets based on Forsskål's surname in original botanical publications and many more in secondary publications. Niebuhr, also in 1775, published Forsskål's zoological manuscripts, with the result that a slightly larger number of Forsskål eponyms have been published in zoological literature than in botany, mainly names for marine animals, but they are only briefly accounted for by Friis and Thulin.

Misspellings of Forsskål's eponyms accumulated in the nomenclatural indices in the 18th and 19th century, the botanical ones to some extent accumulated in the Index Kewensis (1893), from where many orthographic variants were transferred to the International Plant Names Index (IPNI; https://www.ipni.org/) that replaced the Index Kewensis and a number of other indices.

The International Code of Nomenclature for Algae, Fungi and Plants (ICN) requests that the spelling of Forsskål's eponyms in the original publications must be retained, apart from corrections proscribed in the ICN, particularly in its Art. 60–61, thereby preventing radical standardisation on the many eponyms based directly on Forsskål's surname as he himself wrote it (reproduced in Fig. 1 by Friis and Thulin). Being asked by the IPNI staff to help with this, Friis and Thulin discussed what to correct under the ICN and what not, reviewed the original eponyms in the more than 100 original publications, tried to identify the correct orthography, also discussing if the eponyms were valid and legitimate under ICN. The most common original orthographic variants are forms with one or two letters, s or ss, or a letter h before the final l in Forsskål's name, as well as complications in the way the special Swedish letter å was transliterated. Here Friis and Thulin have strictly followed Art. 60 in the ICN, transcribing an original å to ao. They encountered a problem when the typographers of the original publication did not have a letter å available but had to fit a home-made letter together from what was available, as illustrated in Friis and Thulin's Fig. 9-11. There is no rule about this in the ICN, so Friis and Thulin decided that these home-made letters had to be considered orthographic errors for the letter å, which then in agreement with Art. 60 then had to be transcribed to ao.

The analyses as made in Friis and Thulin's work show that of the eponyms based on Forsskål's surname, seven are not validly published, 30 are illegitimate, and 36 are legitimate (of which one was rejected by the XVIII International Botanical Congress and one currently proposed for rejection). Of the legitimate eponyms, 19 provide epithets for currently accepted names of taxa.

This contribution is not only a tribute to a great botanist but also the demonstration of a detailed historical and nomenclatural study conducted by the two Authors focussed on the relationship between the History of Botany and Plant Taxonomy. Friis and Thulin confirm the importance of the correct application of names following an accurate analysis and taxonomic, nomenclatural knowledge supported by robust philological study of the scientific production of P. Forsskål.

Once again Webbia has the honour of commenting and disseminating a further initiative in which the importance of botanical Nomenclature and Taxonomy is emphasized as an essential basis of Plant Systematics.

Riccardo M. Baldini
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