



The rediscovery of an Amazonian species of *Garcinia* (Clusiaceae) after 130 years reveals underestimated diversity in the genus

Thiago Mouzinhos¹ , Katell Uguen² , Lucas Cardoso Marinho³ & Leandro Lacerda Giacomini⁴

Summary. This study presents the rediscovery of *Garcinia annulata*, a new name proposed here for *Rheedia rostrata*. The species was described based on the collection of the naturalist Richard Spruce in the Brazilian Amazon during the 19th century. During an excursion in the municipality of Iranduba, Amazonas (Brazil), a specimen fitting the typical morphological pattern of *G. annulata* was found. Upon analysis, the main diagnostic characteristic detected in this species is the annular nectary disk fused to the fruit, which had not been considered relevant for Neotropical species of *Garcinia*. Here, we present a morphological description, illustrative plates and discussions of the putatively related species *G. madruno* (Kunth) Hammel, *G. ieda-amaralae* Mouzinhos & M.L.Soares and *G. guttifolia* Mouzinhos & L.Marinho.

Key Words. Amazon, Negro River, *Rheedia rostrata*, Richard Spruce.

Introduction

In the 19th century, the Amazon was the focus of investigations by the English naturalist Richard Spruce (1817 – 1893), whose travels resulted in significant taxonomic, ethnological, linguistic and geographical information about the Amazonian region (Schultes 1983). The area encompassing the Uaupés River (Brazil and Colombia) was a source of important plant specimen collections by Richard Spruce, many of which were described as new species [e.g., *Pourouma apiculata* Spruce ex Benoist (Urticaceae), *Pouteria lucens* (Mart. & Miq.) Radlk (Sapotaceae) and *Sciaphila purpurea* Benth. (Triuridaceae)] (Spruce 1908). One of these records was a gathering of materials labelled *Spruce* 2609 and collected in the state of Amazonas (Brazil). This collection was identified as *Verticillaria rostrata* by Miers in the K and P herbaria, a name not effectively published (*mss. in sched.*). Later, in Engler (1888; Martius' *Flora Brasiliensis*), materials of these specimens were treated as part of his concept of *Rheedia floribunda* (Miq.) Planch. & Triana. Vesque (1893); however, did not agree with the species boundaries proposed by Engler (1888) and described this set of materials as a distinct species, *R. rostrata* Vesque. It is worth noting that the species was known only from the set of type specimens (*Spruce* 2609).

In the subsequent taxonomic revision of *Rheedia* L. for Brazil after Engler's treatment, van den Berg (1979) considered *R. floribunda* and *R. rostrata* to be synonyms of *R. acuminata* (Ruiz & Pav.) Planch. & Triana. Later, Hammel (1989) established new combinations for some Neotropical species of *Rheedia* into *Garcinia* L., and he proposed *R. acuminata* and *R. madruno* Planch. & Triana as synonyms, adopting the name *G. madruno* (Kunth) Hammel. Recently, Mouzinhos *et al.* (2024) investigated the morphology of aspects in specimens recognised as *G. madruno* in the Brazilian Amazon, and distinct morphotypes were detected. Based on the new evidence obtained, some of these morphotypes were segregated, which led to the proposal of three new species and the reestablishment of *G. floribunda* Miq. (Mouzinhos *et al.* 2024).

During a recent excursion along the banks of the Negro River, which includes the municipality of Iranduba, Amazonas state, Brazil, a specimen was collected, which fits the typical morphological pattern of *Rheedia rostrata*. Here, based on the sampled specimens, we reinstate *R. rostrata* as a distinct species and propose a new name to accommodate it in the genus *Garcinia*. A synopsis of its morphology is presented, and its relationship with *G. guttifolia* Mouzinhos & L.Marinho, *G. ieda-amaralae* Mouzinhos & M.L.Soares and *G. madruno* is discussed.

Accepted for publication 7 July 2025. Published online: 28 March 2026

¹ Instituto Nacional de Pesquisas da Amazônia – INPA, Laboratório de Taxonomia Vegetal, Av. André Araújo, 2936, Petrópolis, Manaus, Amazonas 69060–001, Brazil. e-mail: thiagomouzinshobio@gmail.com

² Universidade do Estado do Amazonas – UEA, Av. Djalma Batista, 3578, Flores, Manaus, Amazonas 69050-010, Brazil

³ Departamento de Biologia, Universidade Federal do Maranhão – UFMA, Centro de Ciências Biológicas e da Saúde, Av. dos Portugueses, 1966, Bacanga, São Luís, Maranhão 65080-805, Brazil

⁴ Universidade Federal da Paraíba – UFPB, Centro de Ciências Exatas e da Natureza, Departamento de Sistemática e Ecologia, Campus I, João Pessoa, Paraíba 58051-900, Brazil

Materials and Methods

For this study, we analysed type and historical specimens via high-resolution images from the following herbaria: BR, F, G, K and P (acronyms according to Thiers 2025, updated continuously). Material from INPA as well as other herbaria cited in Mouzinhos *et al.* (2024) was also analysed. The study area encompasses the municipality of Iranduba, district of Paricatuba (Amazonas, Brazil), located along the banks of the Negro River, similar to what is cited for the specimen *Spruce* 2609. Along the Negro River, the area constitutes an “igapó” formation (annually flooded forest, associated with black and clear water rivers; Sioli 1956). The type specimen of *Rheedia rostrata* (*Spruce* 2609) was borrowed from the NY herbarium. The terminology adopted for the morphological description were those of Radford *et al.* (1974) for the vegetative characters and those of Gonçalves & Lorenzi (2011) for the reproductive ones, in addition to Mouzinhos *et al.* (2024). The distribution map was created using SimpleMappr (Shorthouse 2010).

Taxonomic Treatment

***Garcinia annulata* Mouzinhos, nom. nov.**

<http://www.ipni.org/urn:lsid:ipni.org:names:77377230-1>

[non *Garcinia rostrata* (Hassk.) Miq., *Ann. Mus. Bot. Lugduno-Batavi* 1 (7): 209 (Miquel 1864)]. ≡ *Rheedia rostrata* Vesque, *Epharmosis*. ii. tab. LXXII (1889); DC. *Monogr. Phan.* viii. 24: 510 1889 [1893]. Type: Brazil. Amazonas: province Panurú ad Rio Uaupés, Oct. 1852 – Jan. 1853, (fr.), *R. Spruce* 2609 (lectotype, **designated here**: P barcode P04701208 photo!; isoelectotypes: BR barcode BR0000005912469 photo!; F 2-sheets barcodes F0054520F photo!, F0054521F photo!; G 2-sheets barcodes G00354892 photo!, G00355061 photo!; K 2-sheets barcodes K000488552 photo!, K000488550 photo!; NY barcode NY00688705!, P barcode P04701212 photo!). Figs 1 – 2.

Trees up to 10 m tall, DBH c. 10 cm. Stem with a fissured whitish bark, lenticellate, exudate yellowish-green, darkens to dark yellow when oxidised; sapwood and heartwood yellowish. *Branches* striated, sub-cylindrical *in sicco*, slightly warty texture *in sicco*. *Petioles* 14.3 – 27 × 2.4 – 3.5 mm, slightly transversely striated *in sicco*; base dilation of the petioles evident *in sicco*; exudate yellowish-green. *Leaf blades* 12.5 – 22.6 × 4.4 – 7.5 cm, chartaceous, discolorous, greenish *in sicco*, generally opaque on the abaxial surface *in sicco*, elliptic to elliptic-ovate, apex acuminate to attenuate, base acute, attenuated to rounded; secondary veins slightly curved; intersecondary veins parallel to the secondary ones, 2

– 3 pairs per intercostal area; intramarginal vein inconspicuous; exudate canals blackened on the abaxial surface *in sicco*. *Inflorescences* and *flowers* not seen. *Berries* with muricate epicarp, ovoid, sepals, staminodes, and stigmas persistent; when immature 21.6 – 36.5 × 12.3 – 18.3 mm, green; nectariferous disc 2.5 – 4.3 × 5 – 5.7 mm, annular (Fig. 2F), conspicuous even *in sicco*, green; rostrum 5.1 – 10 mm long, apex truncated; concrescent stigma 2.1 – 2.6 mm diam., nigrescent, trilobed, slightly capitate; pedicels 9.4 – 22 × 1.4 – 2.5 mm, reddish *in vivo* (Fig. 2E – F); senescent sepals 3.3 – 4 × 2.3 – 2.9 mm, senescent staminodes approximately 30, arranged around the disc in 3 series. *Seeds* 3, 20.6 – 23 × 7 – 8.8 mm, ellipsoid.

DISTRIBUTION AND CONSERVATION STATUS. *Garcinia annulata* is known only from the Brazilian Amazon, being restricted to the Negro River basin in the state of Amazonas (Map 1). Given the two collections known to date, we emphasise the need for expeditions in localities with similar environmental conditions, especially in the many poorly explored localities in the Negro River basin, to be able to confirm the conservation status of the species. According to the IUCN criteria, the species should be considered as data deficient (DD) (IUCN 2012), as only one specimen besides the type collection is known to date. Currently, the region of Iranduba is the target of exploitation of areas associated with real estate speculation, a real threat to the conservation of the local flora.

ADDITIONAL SPECIMEN EXAMINED. BRAZIL. Amazonas: Municipality Iranduba, distrito de Paricatuba, Sítio Bom Futuro, Rio Negro, 3°04'48.0"S 60°14'56.4"W, 26 March 2023, fr., *T. M. Mouzinhos et al.* 321 (HUAM, INPA).

ETYMOLOGY. The epithet refers to the annular disc in the fruits (from Latin, *annulata* = ring-shaped).

NOMENCLATURAL NOTE. The specimen *Spruce* 2609, collected in the state of Amazonas (Brazil), was annotated as *Verticillaria rostrata* by Miers in the K and P herbaria, a designation that is not effectively published (*mss. in sched.*). Later, Vesque (1889) cited *Spruce* 2609 materials as a distinct species, creating the name *Rheedia rostrata* Vesque for the first time. Although a description or diagnosis was not presented, an illustration and anatomical diagnostic characters were provided (see *Epharmosis* 2 tab. LXXII by Vesque 1889). Therefore, the species should be considered validly published based on article 38.8 of the ICN (Turland *et al.* 2018), since an illustration is available, constituting an illustration with analysis (see article 38.9 of the ICN for the definition of analysis). Later, a full description was presented by Vesque in his treatment of the Guttiferae for Candolle's *Monographie Phanerogamarum* (Vesque 1893).

Vesque was a technician at the National Museum of Natural History in Paris and later became Maitre de



Fig. 1. Lectotype of *Garcinia annulata* (Spruce 2609) housed at P herbarium (barcode P04701208). Available at: Muséum national d'Histoire naturelle, Paris (France).



Fig. 2. *Garcinia annulata*. **A** exudate; **B** branches, highlighting the abaxial region of the leaf blade; **C** petioles; **D – E** immature fruit; **F** fruit showing the staminodes and the persistent nectariferous disc. PHOTOS: **A – C** TATIJANA MACEDO, **D – F** THIAGO MOUZINHO.



Map 1. Distribution of *Garcinia annulata* showing the type locality (red circle) and the new record (black star).

Conference at the University of Paris (1884 – 1895). The specimens deposited in herbarium P should be considered original material, although duplicates of *Spruce* 2609 are observed in many herbaria (see protologue). There are two specimens numbered as *Spruce* 2609 at the P herbarium, P04701208 and P04701212, both morphologically informative, which we presume have been studied by Vesque by the time he published his anatomical studies. We designate the specimen P04701208 as a lectotype for *Rheedia rostrata* ($\equiv$ *Garcinia annulata*), since it presents more information on the attached labels, these coinciding with tab. 72, including a label (“*Rheedia rostrata* Vesque”) that matches Vesque’s handwriting.

ECOLOGICAL NOTE. *Garcinia annulata* occurs in the annually flooded forests, popularly known as igapó forests (Sioli 1956), but allegedly exclusive to black water systems. The phenomenon known as the flood pulse causes a cycle of flooding and drying in the riverbanks in the Amazon basin, which affects the establishment and growth of several plant species (Piedade *et al.* 2015). The presence of lenticels on the trunk of *G. annulata* is an adaptive characteristic of the flooded forests, and these are responsible for facilitating gas exchange between the tissue and the atmosphere, thus allowing development and survival during periods of low oxygen supply (Cavalcante *et al.* 2015) during the flooding season.

Discussion

Garcinia annulata is related to *G. madruno* due to its shared pattern of ornamented fruits but differs in having ovoid berries (vs globose in *G. madruno*), muricate exocarp (vs echinate in *G. madruno*), rostrate fruits (vs non-rostrate in *G. madruno*) with a conspicuous annular nectariferous disc (vs inconspicuous in *G. madruno*). *Garcinia annulata* may be confused with *G. guttifolia* since both occur in flooded forests and share similarities in vegetative characters; however, *G. annulata* differs in having yellowish sapwood (vs reddish in *G. guttifolia*), fruits with a conspicuous annular nectariferous disc (vs inconspicuous in *G. guttifolia*) with approximately 30 senescent staminodes (vs approximately 20 in *G. guttifolia*). Due to the muricate fruits, *G. annulata* can be misidentified as *G. ieda-amaralae*, but differs from this by the fruits with a conspicuous annular nectariferous disc (vs inconspicuous in *G. ieda-amaralae*), with approximately 30 senescent staminodes (vs approximately 20 in *G. ieda-amaralae*) and a rostrum with a truncated apex (vs obtuse in *G. ieda-amaralae*) (Fig. 3).

The concept of *Rheedia rostrata* changed over the years in the different treatments of *Rheedia* species from Brazil. In Vesque’s work (1893), when presenting the complete description of *R. rostrata*, he mentioned a close relationship with the species *R. floribunda* (Miq.) Planch. & Triana. The fruits of *R. floribunda* were unknown to Vesque, which led the author to consider the possibility of the taxa being

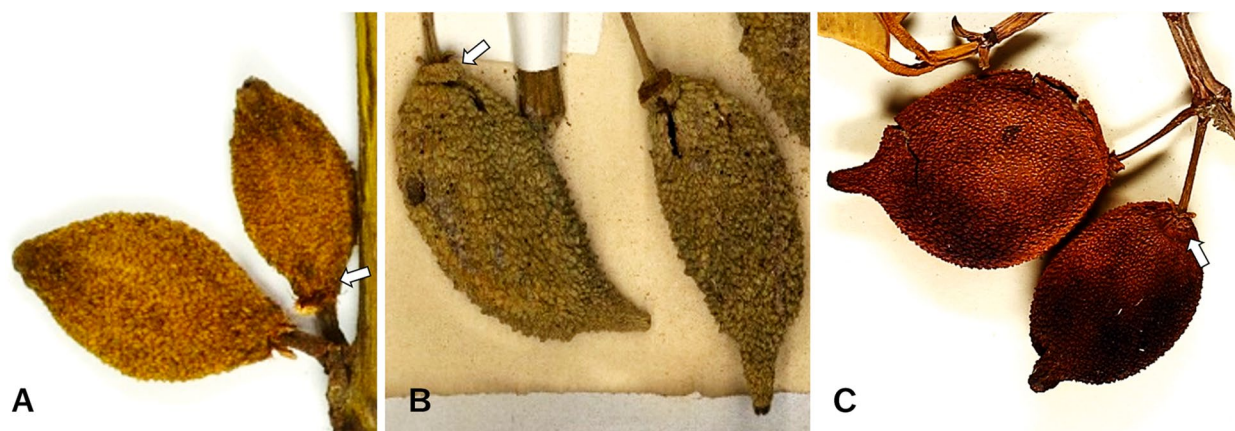


Fig. 3. Comparison of ornate fruits. **A** *Garcinia ieda-amaralae* (C. Zartman 9500 – HUEFS); **B** *Garcinia annulata* (Spruce 2609 – K); **C** *Garcinia guttifolia* (O. C. Nascimento 638 – MG). Location of the annular nectariferous disc (arrow).

conspecific, based on aspects of leaf anatomy and venation patterns. This concept of *R. floribunda* reported by Vesque (1893) was likely reinforced by an Engler determination in the *Flora Brasiliensis* treatment (Engler 1888), where the specimen Spruce 2377, from the state of Amazonas (municipality of São Gabriel da Cachoeira), was considered as *R. floribunda* together with the type of *R. rostrata* (Spruce 2609), and both specimens are in fact very similar vegetatively. The specimen Spruce 2377 was later recognised as part of a different species, nevertheless, named *G. guttifolia* Mouzinho & L. Marinho (Mouzinho *et al.* 2024). In the revision of Brazilian species of *Rheedia*, van den Berg (1979) treated *R. rostrata* and *R. floribunda* as synonyms of *R. acuminata* (Ruiz & Pav.) Planch. & Triana. This concept of van den Berg is not accepted here since *G. floribunda* Miq. was reestablished by Mouzinho *et al.* (2024), considering the type specimen from Surinam (Hostmann 593a, S) and a northeastern Amazonian distribution, close to the equatorial coast. On the other hand, *R. acuminata* is treated as a synonym of *G. madruno*, a western Amazonian species (see Mouzinho *et al.* 2024 for details).

The epicarp is an important characteristic for recognising species groups but cannot be used as the sole characteristic for recognising taxa. From the analysis of *Garcinia annulata*, we emphasise that the conspicuous annular nectar disc can be considered a new and promising characteristic for the taxonomy of Neotropical *Garcinia* species (Fig. 3). This work reinforces that there is an underestimated diversity in *Garcinia* in the Brazilian Amazon, which is due to a low availability of specimens and the lack of an integrative study to elucidate the taxonomy of the group. The recognition of species complexes and the difficulty in dealing with them without an integrated set of evidence has proven to be a factor

that hinders the understanding of the real diversity of Amazonian tree species (Bacon *et al.* 2022). The lack of a study that reveals the actual diversity contained in *Garcinia* jeopardises effective conservation initiatives, especially in environments that have been subject to recent land use changes, such as areas along large rivers, which have been suffering from intense real estate speculation. We emphasise the need for better sampling in these areas, as well as an integrated analysis of the materials available in herbaria. Actions like these depend on funds and investments devoted to field activities, especially in areas considered as priority as well as training of qualified human resources, policies that have been disincentivised in countries like Brazil in recent years.

Acknowledgements

The authors thank the Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM) for granting the doctoral scholarship to the first author, the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), and the International Association for Plant Taxonomy (IAPT) for the funding provided (Biodiversity Challenge 2022/2023). Our thanks also go to the Instituto Nacional de Pesquisas da Amazônia (INPA/PPGBOT, Brazil) for the use of its infrastructure, to Mr Jander Vieira, owner of Sítio Bom Futuro, for granting access to the study area, to Tatijana Macedo for the photographs, to the curators of the NY herbarium, Emily Sessa and Matthew Pace, for the loan of the type specimen, to the Biological Sciences class (2020/1) of the Universidade do Estado do Amazonas (UEA) for collaboration in the field and to the research group “Taxonomia da Flora Amazônica” for its support and access to the Laboratório de Taxonomia Vegetal – INPA.

Declarations

Funding The Article Processing Charge (APC) for the publication of this research was funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) (ROR identifier: 00x0ma614). Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM); Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES); International Association for Plant Taxonomy (IAPT).

Conflicts of interest The authors declare that there are no conflicts of interest regarding the manuscript.

Data Availability The authors confirm that the data supporting the findings of this study are available within the article.

Authors' contributions TM and LLG contributed to conceptualisation; TM prepared the original draft; TM, KU, LCM and LLG have contributed to methodology and investigation; LCM and LLG reviewed and edited the manuscript; TM contributed to data curation; LCM and LLG contributed to supervision. All authors have read and agreed to the published version of the manuscript.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Bacon, C. D., Hill, A., ter Steege, H., Antonelli, A. & Damasco, G. (2022). The impact of species complexes on tree abundance patterns in Amazonia. *Amer. J. Bot.* 109 (10): 1525 – 1528. <https://doi.org/10.1002/ajb2.16069>
- Cavalcante, H. L. *et al.* (2015). Como funcionam as árvores das florestas inundáveis da Amazônia?, pp 117 – 128. In: A. Lopes & M. T. F. Piedade (eds), *Conhecendo as áreas úmidas amazônicas: uma viagem pelas várzeas e igapós*. Editora INPA, Manaus.
- Engler, H. G. A. (1888). Guttiferae: *Rheedia*. *Flora brasiliensis* 12: 457 – 466. Apud Frid. Fleischer, Lipsiae.
- <https://www.biodiversitylibrary.org/item/9638#page/321/mode/1up>
- Gonçalves, E. G. & Lorenzi, H. (2011). *Morfologia Vegetal: organografia e dicionário ilustrado de morfologia de plantas vasculares*. 2nd. ed. Instituto Plantarum de Estudos da Flora, São Paulo.
- Hammel, B. (1989). New combinations and taxonomies in Clusiaceae. *Ann. Missouri Bot. Gard.* 76: 927 – 929. <https://doi.org/10.2307/2399657>
- IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1. Second edition*. IUCN, Gland and Cambridge. Available at: <http://www.iucnredlist.org/technical-documents/categories-and-criteria> [Accessed 10 Sept. 2023].
- Miquel, F. A. W. (1864). Observaciones de Clusiaceis. *Ann. Mus. Bot. Lugduno-Batavi* 1 (7): 209. <https://www.biodiversitylibrary.org/page/652212#page/234/mode/1up>
- Mouzinho, T. M., Marinho, L. C., Silva, T. A. M., Souza, L. M. S., Cabral, F. N. & Soares, M. L. C. (2024). Unravelling *Garcinia madruno* (Kunth) Hammel (bacuri-de-espinho) (Clusiaceae) in the Amazon: a reestablishment of one species and three new species. *Acta Bot. Brasil.* 38: e20230271. <https://www.scielo.br/j/abb/a/cGN4RBXZTRHrZP7hQHj6Bgs/?format=pdf&lang=en>
- Piedade, M. T. F. *et al.* (2015). *Iniciando a viagem pelas Áreas Úmidas Amazônicas*, pp 15 – 22. In: A. Lopes & M. T. F. Piedade (eds), *Conhecendo as áreas úmidas amazônicas: uma viagem pelas várzeas e igapós*. Editora INPA, Manaus.
- Radford, A. E., Dickison, W. C., Massey, J. R. & Bell, C. R. (1974). *Vascular Plant Systematics*. Harper & Row Publishers, New York.
- Schultes, R. E. (1983). Richard Spruce, an early ethnobotanist and explorer of the northwest Amazon and northern Andes. *Ethnobiology* 3 (2): 139 – 147.
- Sioli, H. (1956). As águas da região do alto Rio Negro. *Bol. Técn. Inst. Agron. N.* 32 :117 – 163.
- Shorthouse, D. P. (2010). *SimpleMappr*, an online tool to produce publication-quality point maps. Available from: <http://www.simplemappr.net> [Accessed 13 Sept. 2023].
- Spruce, R. (1908). *Notes of a botanist on the Amazon & Andes: being records of travel on the Amazon and its tributaries, the Trombetas, Rio Negro, Uapés, Casiquiari, Pacimoni, Huallaga and Pastaza*. 2nd. ed. Cambridge University Press. <https://www.biodiversitylibrary.org/item/57318#page/7/mode/1up>
- Thiers, B. (2025 continuously updated). *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. Available from: <http://sweetgum.nybg.org/science/ih/>. [Accessed 2 Feb. 2025].
- Turland, N. J., Wiersema, J. H., Barrie, F. R., Greuter, W., Hawksworth, D. L., Herendeen, P. S., Knapp, S., Kusber, W. H., Li, D. Z., Marhold, K., May, T. W., McNeill, J., Monro, A. M., Prado, J., Price, M. J. & Smith, G. F. (eds) (2018). *International Code of*

- Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. *Regnum Veg.* 159. Koeltz Botanical Books, Glashütten.
- van den Berg, M. E. (1979). Revisão das espécies brasileiras do gênero *Rheedia* L. (Guttiferae). *Acta Amazonica* 9: 43 – 74. <https://doi.org/10.1590/1809-43921979091043>
- Vesque, J. (1889). *Epharmosis, sive, Materiae ad instruendam anatomiam systematis naturalis*. Vol. 2. Delapierre, Paris. <https://www.biodiversitylibrary.org/bibliography/828>
- (1893). Guttiferae. In: A. De Candolle & C. De Candolle, *Monographiae Phanerogamarum*, Vol. 8. Sumptibus G. Masson, Paris. <https://www.biodiversitylibrary.org/item/100277#page/4/mode/1up>

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.