

Susanne Renner

The volume and whereabouts of Humboldt and Bonpland's botanical collections

ZUSAMMENFASSUNG

Oft heißt es, Humboldt und Bonpland hätten 60 000 Pflanzenexemplare von 6 000 Arten gesammelt. Hier überprüfe ich Humboldts Angaben zum in Amerika gesammelten Material, diskutiere dessen Verbleib und erläutere die Schwierigkeit, die Zahl der Exemplare und Arten zu schätzen, v. a. wegen unzureichender Nummerierung von Duplikaten. Dies führte u. a. zur Doppelbeschreibung von mindestens 250 Arten. Laut Feldbuch machten Humboldt und Bonpland 4 528 Aufsammlungen, idealerweise mit drei Duplikaten. Davon sind 3 525 im Pariser Bonpland-Herbarium erhalten, weitere im Generalherbarium. Andere Herbarien sind noch nicht vollständig digitalisiert. Humboldts Schätzung (um 1800) von 4 200 Arten erscheint hoch, doch die Beschreibung neuer Arten ist noch nicht abgeschlossen.

ABSTRACT

Humboldt and Bonpland are often said to have collected 60,000 plant specimens representing 6,000 species. I review Humboldt's estimates of the material collected in the Americas, discuss its whereabouts, and explain the difficulty in estimating specimen and species numbers due to problems with duplicate numbering. This led to at least

250 species being described twice. Based on field notes, they made 4,528 collections, aiming at three duplicates each. Of these, 3,525 survive in the Paris Bonpland herbarium, plus an unknown number in the general herbarium. Other herbaria are not yet fully digitized. Humboldt's estimate (around 1800) of 4,200 species seems high, but the description of new species remains incomplete.

RESUMEN

A menudo se afirma que Humboldt y Bonpland recolectaron 60.000 especímenes de plantas de 6.000 especies. Reviso las estimaciones de Humboldt sobre el material recolectado en las Américas, analizo su paradero y explico la dificultad de estimar el número de especímenes y especies debido a problemas con la numeración de duplicados. Esto llevó a que al menos 250 especies se describieran dos veces. Según sus notas de campo, realizaron 4.528 colecciones, con tres duplicados cuando fue posible. De ellas, 3.525 se conservan en el herbario Bonpland de París, más un número desconocido en el herbario general. Otros herbarios aún no están completamente digitalizados. La estimación de Humboldt (hacia 1800) de 4.200 especies parece alta, pero la descripción de nuevas especies sigue incompleta.



Introduction

The literature concerning the travels of Alexander von Humboldt (1769–1859) and Aimé Bonpland (1773–1858) is enormous. Despite this extensive scholarship, we do not know the current whereabouts nor current scientific names of many of their botanical collections, which also means we do not know where precisely plants were collected nor how many species the collections may represent. Why is this?

In this note, I review the volume and current deposition of Humboldt and Bonpland's botanical collections (referring to dried plant specimens), coming to this question as a systematist with a particular interest in Humboldt's material and collecting areas (Renner, 1989, 1990, 1993, 1994 a, b, Renner et al., 2023 a, b). The data provided here explain why the oft-repeated claim that Humboldt and Bonpland collected 60,000 specimens representing 6,000 species (Botting, 1973; Egerton, 2009; Jackson, 2009; Götz, 2024) is wrong. Note that the number 60,000 may derive from a typographical change of 6,000 to 60,000. The number of 6,000 dried plants comes from Humboldt himself (below). Humboldt and Bonpland also brought back an unknown number of seeds, some of which were successfully cultivated in the botanical garden in Berlin and the Malmaison Garden near Paris and which later were used to make the dried specimens required to describe new species (Lack, 2018: t. 22, 26).

People not familiar with collecting and herbaria often confuse the terms “specimen,” “collection,” and “species.” The first term, botanical specimen, refers to one dried plant. A collection comprises all duplicates made from that plant. For trees and shrubs, it is usually possible to cut several branches from the same individual, which allows sending duplicates to colleagues and herbaria worldwide. Professional collectors traditionally tried to make numerous duplicates (10 or 12) because their income depended on selling sets of their collections. For small plants, such as grasses or orchids, making duplicates from one individual is not possible, and the collector therefore tries to collect duplicates nearby, labeling them with the same collection number. If a collector has the slightest doubt about whether two individuals represent the same species, specimens receive different collection numbers. The third technical term, species, refers to a mental construct. There are taxonomic species, which have received a Latin name following the study of (ideally) numerous collections representing a particular group of plants. Taxonomists hope that taxonomic species match biological species, which consist of populations that are more or less reproductively isolated from other populations as inferred from morphological, physiological, ecological, and genetic traits or behaviors. Biological species do not need to have formal Latin names. The perceived boundaries between species depend on methods, data (number of collections), and scientific paradigms. That species numbers will never be final was entirely clear to Humboldt and his younger colleague Karl Sigismund Kunth: “How many plant species there are on earth, and how many of them there are in each plant family, can never be determined because the term species is understood very differently by botanists both in general and within different families” (Kunth, 1849, cited in Müller-Wille und Böhme, 2021; translated by SSR).

Humboldt's own statements about the botanical collections made between 1799 and 1804

In a letter written from South America in October 1800 (English version reproduced in Lubrich and Nehrlich, 2025), Humboldt talks about 6,000 plant collections made by Bonpland and himself, each with duplicates, with the 6,000 collections perhaps representing 4,200 species, a number not knowable until the collections had been studied back in Europe, as he pointed out. In an account that appeared in the *Literary Magazine* in 1804 (reproduced in Lubrich and Nehrlich, 2025), the 6,000 collections have become 6,000 species, possibly due to a confusion of collections and species. Humboldt had little, if any, opportunity to review the translations of his letters and publications that appeared in the media worldwide (Lubrich and Nehrlich, 2025). The estimate of 6,000 species, if true, would imply that Bonpland and Humboldt, during their years-long journey, never collected the same species twice, which is implausible and would have been counterproductive since it would have prevented any insight into the natural geographic ranges of species, a topic on Humboldt's mind since his student days and one of the explicit questions during his travels.

Customs declarations had to be submitted for the return journey, and one of these gives further information from Humboldt himself. On May 24, 1804, Humboldt testified for the American authorities that, in addition to boxes with clothing and bedding, he was carrying 27 boxes with collections, including minerals, (a few) zoological specimens, artifacts, and dried plants (<https://search.amphilsoc.org/collections/view?docId=ead/Mss.B.H88-ead.xml>). On August 1, 1804, after his ship arrived in Bordeaux, Humboldt wrote to Johann Carl Freiesleben: "I return laden with 30 chests and botanical, astronomical, and geological treasures ..." (Moheit, 1993, p. 310; translated from the original German by SSR). On August 3, he wrote to Karl Sigismund Kunth that he had 35 boxes of collections with him (Minguet, 1989, p. 120). Most importantly, he wrote to the Paris Herbarium on 18 December 1804 that he wanted to hand over about 6,000 dried plants in 45 boxes (Minguet, 1989, p. 122–123).

As the years passed, Humboldt's estimates increased. Thus, on 3 February 1805, he wrote to Marc-Auguste Pictet (Paris) that he and Bonpland had collected 6,000 species, of which 1,500 to 1,800 were certainly new to science (Minguet, 1989, p. 126). And in his foreword to the *Essai sur la Géographie des Plantes* (Humboldt, 1807, p. 56), written in Rome in 1805, he states that Bonpland and he had collected 6,200 "species of equinoctial plants – in South America, Mexico, and the island of Cuba."

Still later, on May 17, 1810, Humboldt wrote to his friend and botany teacher Carl Ludwig Willdenow that he wanted to participate in the processing of his plant collections, which he thought might comprise 5,000 species (Müller-Wille and Böhme, 2021). Note that Humboldt gave only 3,360 of his American specimens to Berlin (below). Lastly, Humboldt's (1851) obituary for Kunth states that 4,500 species were collected, close to his estimate of 4,200 species made 50 years earlier.

Besides Humboldt's own estimates, one can turn to the numbers shown in the *Journal Botanique* (Bonpland, 1799–1804), a set of seven bound field books mostly written by Bonpland and now in the Bibliothèque Centrale, Muséum National d'Histoire Naturelle de Paris in Paris. These field books have been fully digitized. They show short descriptions of 4,528 collections (each consisting of a single dried plant or, wherever possible, three or more duplicates) (Brunel, 1871; Lack, 2004a, b; Stauffer et al., 2012; Moret et al., 2019: cf. the section below on their goal of making three duplicates per collection). The continuous numbering of collections in a field

book is one of Humboldt's innovations and has been attributed at least partly to his 8-month training at the Trade Academy in Hamburg. Bonpland, however, did not number all collections (Rankin and Greuter, 2001), and the field books show some jumps. For example, No. 1919 is followed by No. 2000. Conversely, some numbers are assigned twice (Lack, 2004a). Based on the writing and the condition of the paper, it also appears that Bonpland transcribed some parts of the field notes (perhaps because they got wet or were otherwise illegible) when the opportunity arose, such as during a 3-month stay in Bogota (Lack, 2004a).

A well-documented example of the discrepancies between entries in the *Journal Botanique* and the surviving herbarium specimens comes from Humboldt and Bonpland's collecting in the Ecuadorean mountains. Humboldt's text and illustration of the vegetation of the Chimborazo (Humboldt, 1807a, b) are entirely inconsistent with the data collected in the field (Moret et al. 2019a, b; Renner et al., 2023b).

Humboldt and Bonpland's method of numbering and labeling their plants

The division of labor between Humboldt and Bonpland when pressing plants in the evening after a day of collecting was that Bonpland inserted the material between the paper and also made most of the entries in the field book (Lack, 2004b). The more or less humid collections were then stored in large, specially made wooden boxes and transported on pack animals. A bottleneck for this work, and any decisions about how many duplicates to make on any one day, was the necessary dry paper. On the question of duplicates and of transporting, shipping, and safeguarding their plant collections, Humboldt wrote to Willdenow: "We have divided the plants into 3 collections, since we have doubles and triplets of everything. We carry a herbarium in a smaller format with us around the world in order to compare. A second one (belonging to Bonpland [,] with whom I of course share everything) has already left for France, and the third (in 2 boxes with cryptogamists and grasses, containing 1600 different species, mostly from the unknown part of the Parime and Guiana between the Río Negro and Bresil where we were last spring) I am sending today via Charleston to London through reproduction." (Havana, February 21, 1801, <https://edition-humboldt.de/briefe/detail.xhtml?id=H0001181>).

Because Humboldt was so interested in height above sea level and other physical location parameters, he kept these data in his own diary, not in the *Journal Botanique*, except for the sixth volume (Lack, 2004a). For most of the voyage, the *Journal Botanique* therefore contains almost no ecological location information and not even collection dates (!).

Today's whereabouts of Bonpland and Humboldt's plant specimens

A map of the shipping of the dried plants from the first leg of their journey, that is, Venezuela and Cuba, shows how complex the logistics were (Stauffer et al., 2012: Fig. 7). At least two shipments of plants were lost in shipwrecks (Stauffer et al., 2012). These successive shipments meant that Willdenow in Berlin began describing new species (collected in Venezuela) before Humboldt and Bonpland themselves had returned to Europe (Lack, 2025).

Shortly after Humboldt and Bonpland returned to Europe in 1804, they split their plant collections (recall that each collection comprised one to three specimens), with each receiving

an unknown number, perhaps 6000 for each of them (Stauffer et al., 2012). In November 1816, Bonpland took his set to Argentina, where he decided to settle in Santa Ana. It is not known how, where and when precisely Bonpland packed the material for the sea voyage. It cannot have been an easy undertaking, and it would be humanly understandable if Bonpland perhaps kept unique and/or flowering specimens of plant groups that particularly interested him, such as the Melastomataceae, as he would have needed such material for his further research.

It is clear that the division of the material did not involve strict separation of duplicates because as early as 1806, Humboldt begged Bonpland in at least three letters to return specimens belonging to what he considered his set (Stauffer et al., 2012). During Bonpland's long, eventful life and again after his death (11 May 1858), the Paris Herbarium sent petitions and emissaries to Argentina to reclaim the material. This resulted in two repatriations, in 1832 and 1858 (Brunel, 1871; Stauffer et al., 2012). The returning material was integrated into the general herbarium in Paris without a list having been made (Stauffer et al., 2012). Large specimens, for example palm trees with their huge fronds and large fruits, remained missing, and only 14 of the 24 palm species that Kunth described (in Bonpland et al., 1815–1825) are now in Paris (Stauffer et al., 2012). The material that remained in Argentina was largely eaten by insects and destroyed forever (Brunel, 1871, p. 183).

From his own set, Humboldt gave 3,525 specimens to the herbarium in Paris. Since 1805, this set has been stored separately as the herbarium P-Bonpland. The material was fully digitized in 2017 (Le Bras et al., 2017). Humboldt gave another 3,360 specimens to Willdenow in Berlin, presumably mostly duplicates of the specimens given to Paris (but see below). Different from much other material in the Berlin herbarium, Humboldt's material survived World War II because the Willdenow herbarium was kept as a separate collection and evacuated (Hiepko, 1987, 2006; Stauffer et al., 2012). By contrast, Allied bombing destroyed Humboldt specimens deposited in the general herbarium in Berlin, and today they only survive in the form of black-and-white photos made by the American taxonomist J. F. Macbride shortly before the war (<http://fieldmuseum.org/explore/our-collections/berlin-negatives>).

From the labels of specimens in Paris and Berlin that show collection numbers, it can be inferred which of the 3,525 and 3,360 specimens in the two herbaria are duplicates of the same collection. However, due to the three divisions of the American collections (Paris, Berlin, and Bonpland/Argentina), there are many collections that only exist in unicate either in Paris or in Berlin and perhaps at one time also in Argentina (Lack, 2004b; Stauffer et al., 2012).

The university herbarium in Halle also contains Humboldt and Bonpland plants, including 400 type specimens, i.e., specimens that were the basis for the description of new species (Tkach et al., 2019). High-resolution digital images of these documents with additional information are available online (<https://www.jacq.org/>). Most of the specimens in Halle are probably duplicates from the Willdenow herbarium, but the collection numbers are missing on the Halle specimens (Tkach et al., 2019).

A few (?) specimens from Humboldt and Bonpland's South American voyage are found in other European and American herbaria (Stauffer et al., 2012, provide a list), where they were sent to specialists working in those herbaria. It is not possible at this time to give precise numbers or to estimate which of these specimens are duplicates of the specimens in Paris, Berlin, or Halle.

An analysis of the 350 collections of monocotyledonous plants (including palms and orchids) collected in Venezuela showed that 336 of the specimens are unicates, while 14 have dupli-

cates (Stauffer et al., 2012: including a list of the 350 collections and the names of the herbaria housing the unique specimens or the duplicates). Similar findings of discrepancies between specimens mentioned in publications and those surviving in herbaria come from detailed analyses of Humboldt and Bonpland's collecting on the Chimborazo (Moret et al. 2019a, b; Renner et al., 2023b) and in Tenerife (Renner et al., 2023a). The *Journal Botanique* lists 16 collections made in Tenerife, but only five have been found in extant herbaria.

Numbers of taxonomic and biological species described based on Humboldt and Bonpland's American material

How many biological species may be represented by the 4,528 almost continuously numbered collections of the *Journal Botanique* (above) depends on the level of taxonomic knowledge and the extent of variation accepted within a species (Introduction). During the long journey, Humboldt and Bonpland collected widespread species multiple times, perhaps once flowering, once fruiting, and from locations hundreds of kilometers apart and therefore ecologically different, with accompanying variation in hairiness or leaf size. Since there was little comparative material and since Kunth was under pressure from Humboldt to publish rapidly, he made many errors. Also, while Kunth was working on the specimens in Paris, he had no access to the Berlin material (presumably duplicates, but see above), and from 1816 onwards he no longer had access to the material taken to Argentina by Bonpland. The unclear or lacking numbering of duplicates led to over 250 species being described at least twice (with different Latin names and by different authors), once based on Paris material, and once based on Berlin material (Hiepko, 2006; Stauffer et al., 2012).

A further important complication stems from Kunth not citing the collection numbers from the *Journal Botanique* in the descriptions of the 3,462 new species he described in the *Nova Genera et Species Plantarum* (Bonpland et al., 1815–1825; IPNI, 2025). The reasons for Humboldt and Kunth's decision not to include the collection numbers from the *Journal* in the published descriptions are not clear from the correspondence known to date (Lack, 2004a, b). Nor do the collection numbers appear on all duplicates in the various herbaria (Lack, 2004a, b; Stauffer et al., 2012; Renner, pers. obs.). Part of the reason probably lies in the scarcity of paper (during the actual fieldwork) and later, after the return to Europe in 1804, the laborious manual transcription of information from one label to the next.

The – by today's standards – insufficient labels of Humboldt and Bonpland's plants, which lack collection dates and height above sea level, represent a major problem when evaluating their material and when trying to differentiate species or to use their material in studies of changing plant distributions or flowering times under climate change (Moret et al., 2019a, b; Renner et al., 2023a, b).

In contrast to the unclear and forever changing number of biological species represented by Humboldt and Bonpland's collection, the number of taxonomic names published based on their material is known exactly. The reason is the existence of a database in which all new descriptions of vascular plants since 1753 are recorded with precise bibliographic information (IPNI, 2025). The numbers in this database concern all proposed names, including possible or certain synonyms. Possible synonyms (so-called taxonomic synonyms) are based on different plant individuals, while certain synonyms (nomenclatural synonyms) are based on duplicates in different herbaria. The 250 species described twice by different botanists based on Paris and Berlin duplicates are examples of nomenclatural synonyms.

Together, Humboldt and Bonpland proposed 493 new species names (IPNI, 2022), almost all of which were only validly published later by other authors. Bonpland alone proposed another 748 new species names, of which he validly published 255 himself, while the rest were validated by later authors. And as reported above, Kunth described 3,462 new species from their material. Taken together, this brings us to 4,702 species names, a number that is higher by 174 than the number of 4,528 collections listed in the *Journal Botanique*. This discrepancy is explained by the aforementioned double descriptions based on Paris and Berlin duplicates, as well as different views on species boundaries (above). The number of 4,702 species names is also higher than the specimens given by Humboldt to the herbaria in Paris and Berlin (3,525 and 3,360), proving that many of these specimens must be unicates, not duplicates.

Quite a few of Humboldt and Bonpland's collections have not yet been confidently assigned to species. This is either because their labels (as described) lack location information, collection dates, and altitudes. An example is the orchid *Oncidium ornithorhynchum* Kunth. The label and Kunth's text indicated Mexico as the location, but all other known collections of this species and closely related species come from Colombia. When DNA from Humboldt's specimen was sequenced, it was revealed that this orchid must have been collected in Colombia, not in Mexico (Contreras-Ortiz et al., 2019).

The future of Humboldt and Bonpland's plant collections

The increasing digitization of herbarium collections facilitates research on Bonpland and Humboldt's material. However, since Humboldt's diary and the *Journal Botanique* are difficult to read, the date, location, and elevation of most of the collections cannot be determined readily.

Using image-recognition tools to analyze the labels of digitized herbarium specimens combined with machine-learning tools will improve detection and understanding of Bonpland and Humboldt specimens, as well as better georeferencing of their collecting localities. The value of these collections for research up until now has been severely compromised by their inadequate labels, but the high proportion of type specimens in the Humboldt and Bonpland material ensures the continued taxonomic, nomenclatural, and biological significance of their plant material.

Acknowledgements

I thank [three anonymous] reviewers and Pierre Moret, Petr Sklenár, Marc Pignal, and Larry Dorr for their comments on an early version of this note.

Bibliography

Bonpland, A. J. A. (1799–1804): *Registre de notes botaniques prises par Aimé Goujaud, dit Bonpland (1773–1858) et Alexander von Humboldt (1769–1859) pendant leur voyage en Amérique du Sud, de 1799 à 1804*. Manuscrit et archive numérisés. <https://scite.ai/reports/the-origin-of-humboldt-and-LZJRNwL>. Ebenso Ms 1332, Ms 1333, Ms 53, Ms 54.

Bonpland, A. J. A./Humboldt, A. von/Kunth, C. S. (1815–1825): *Nova Genera et Species Plantarum*, 3 vol., Lutetiae Parisiorum, Paris.

- Botting, D. (1973): *Humboldt and the Cosmos*. Harper & Row, New York.
- Brunel, A. (1871): *Biographie d'Aimé Bonpland*. L. Guérin & Cie, Paris.
- Contreras-Ortiz, N./Rodríguez-García, T./Quintanilla, S./Bernal, J. E./Mandriñán, S./Gómez, A. (2019): The origin of Humboldt and Bonpland's holotype of *Oncidium ornithorhynchum*, clarified using +200-year-old DNA. *Taxon* 68, pp. 471–480. DOI: <http://dx.doi.org/10.30972/bon.2914436>.
- Egerton, F. N. (2009): A History of the Ecological Sciences (Part 32: Humboldt, Nature's Geographer). *Bulletin of the Ecological Society of America* 90, pp. 253–282.
- Götz, C. (2024): Linnés Normen, Willdenows Lehren und Bonplands Feldtagebuch. Die Pflanzenbeschreibungen in Alexander von Humboldts erstem Amerikanischen Reisetagebuch. edition humboldt digital, hg. v. Ottmar Ette. Berlin-Brandenburgische Akademie der Wissenschaften, Berlin. Version 10 dated July 2, 2024. <https://editionhumboldt.de/v10/H0016429> (accessed January, 13 2025).
- Hiepko, P. (1987): The collections of the Botanical Museum Berlin-Dahlem (B) and their history. *Englera* 7, pp. 219–252.
- Hiepko, P. (2006): Humboldt, his botanical mentor Willdenow, and the fate of the collections of Humboldt & Bonpland. *Botanische Jahrbücher für Systematik* 126, pp. 509–516.
- Humboldt, A. von (1807a): *Essai sur la géographie des plantes, accompagné d'un tableau physique des régions équinoxiales*. Paris: Levrault, Schoell. Available online at: botanicus.org/title/b12218212 (accessed November 1, 2015).
- Humboldt, A. von (1807b): *Ideen zu einer Geographie der Pflanzen nebst einem Naturgemälde der Tropenländer*. Cotta, Tübingen.
- Humboldt, A. von (1851): Personal-Notizen [Nekrolog von Carl Sigismund Kunth]. *Botanische Zeitung* (Berlin) 9, pp. 427–432.
- Humboldt, A. von/Bonpland, A. J. A. (1816 und 1823): *Monographie des Mélastomacées*. Librairie-Grecque-Latine-Allemande, Paris.
- IPNI (2025). International Plant Names Index. Published on the Internet <http://www.ipni.org>, The Royal Botanic Gardens, Kew, Harvard University Herbaria & Libraries and Australian National Herbarium (retrieved on September 10, 2025).
- Jackson, S. T. (ed.) (2009): *Essay on the geography of plants: Alexander von Humboldt and Aimé Bonpland*. University of Chicago Press, Chicago, IL.
- Lack, H. W. (2004a): The botanical field notes prepared by Humboldt and Bonpland in tropical America. *Taxon* 53, pp. 501–510.
- Lack, H. W. (2004b): Botanische Feldarbeit: Humboldt und Bonpland im tropischen Amerika (1799–1804). *Annalen des Naturhistorischen Museums Wien*, B 105, pp. 493–514.
- Lack, H. W. (2018). *Alexander von Humboldt and the botanical exploration of the Americas*, ed. 2. London.
- Lack, H. W. (2025): The great synthesis: Willdenow's *Species plantarum* (1797–1810) and his herbarium. *Archives of Natural History* 52, pp. 185–205.
- Le Bras, G./Pignal, M./Jeanson, M. L./Muller, S./Aupic, C./Carré, B./Flament, G./Gaudeul, M./Gonçalves, C./Invernón, V. R./Jabbour, F./Lerat, E./Lowry, P. P./Offroy, B./Pimparé, E. P./Poncy, O./Rouhan, G./Haeversmans, T. (2017): The French Muséum national d'histoire Naturelle vascular plant herbarium collection dataset. *Scientific Data* 4:170016, DOI: <https://doi.org/10.1038/sdata.2017.16>.

- Lubrich, O./Nehrlich, T. (eds.) (2025): *Alexander von Humboldt: Writings in English*, 2 vols. Philadelphia, PA: American Philosophical Society Press, 2025, pp. 680 and 760.
- Minguet, C. H. (ed.) (1989): Alejandro de Humboldt, cartas americanas. Biblioteca Ayacucho, Caracas. Available online at: <https://cupdf.com/document/alejandro-de-humboldt-cartas-americanas.html> (accessed at on 30 April 2026).
- Moheit, U. (ed.) (1993): Briefe aus Amerika 1799–1804. Alexander von Humboldt. Beiträge zur Alexander-von-Humboldt-Forschung 16. Akademie-Verlag, Berlin.
- Moret, P./Muriel, P./Jaramillo, R./Dangles, O. (2019a): Humboldt's Tableau Physique revisited. Proceedings of the National Academy of Sciences, USA 116: 12889–12894, <https://www.pnas.org/doi/10.1073/pnas.1904585116>, DOI: <https://doi.org/10.1073/pnas.1904585116>.
- Moret, P./P. Muriel, Jaramillo, R./Dangles, O. (2019b): Humboldt's historical data are not messy, they just need expert examination. Proceedings of the National Academy of Sciences, USA 116: 21348–21349, <https://doi.org/10.1073/pnas.1914132116>.
- Müller-Wille, S./Böhme, K. (2001): "Jederzeit zu Diensten". Karl Ludwig Willdenows und Carl Sigismund Kunths Beiträge zur Pflanzengeographie Alexander von Humboldts. In: edition humboldt digital, hg. v. Ottmar Ette. Berlin-Brandenburgische Akademie der Wissenschaften, Berlin. Version 7 dated September 7, 2021. Available online at: <https://edition-humboldt.de/v7/H0017685> (accessed on 30 April 2026).
- Renner, S. S. (1989): Systematic studies in the Melastomataceae: *Bellucia*, *Loreya*, and *Macairea*. Memoirs of the New York Botanical Garden 50, pp. 1–112.
- Renner, S. S. (1990): A revision of *Rhynchanthera* (Melastomataceae). Nordic Journal of Botany 9, pp. 601–630.
- Renner, S. S. (1993): A history of botanical exploration in Amazonian Ecuador (1738–1988). Smithsonian Contribution in Botany 82, pp. 1–39.
- Renner, S. S. (1994a): A revision of *Pterolepis* (Melastomataceae: Melastomeae). Nordic Journal of Botany 14, pp. 73–104.
- Renner, S. S. (1994b): Revisions of *Pterogastra* and *Schwackaea* (Melastomataceae: Melastomeae). Nordic Journal of Botany 14, pp. 65–71.
- Renner, S. S./Otto R./Martín-Esquível, J. L./Marrero-Gómez, M. V./Fernández-Palacios, J. M. (2022): Vegetation change on Mt. Teide, the Atlantic's highest volcano, inferred by incorporating the data underlying Humboldt's Tableau Physique des Iles Canaries. Journal of Biogeography 50(2), pp. 251–261, DOI: <https://doi.org/10.1111/jbi.14503>.
- Renner, S. S./Päbler, U./Moret, P. (2023): "My reputation is at stake." Humboldt's mountain plant geography in the making (1803–1825). Journal of the History of Biology 56, pp. 97–124, DOI: <https://doi.org/10.1007/s10739-023-09705-z>.
- Rodriguez R., R./Greuter, W. (2001): Humboldt, Willdenow, and *Polygala* (Polygalaceae). Taxon 50, pp. 1231–1247, DOI: <https://doi.org/10.1002/j.1996-8175.2001.tb02618.x>.
- Stauffer, F. W./Stauffer, J./Dorr, L. J. (2012): Bonpland and Humboldt specimens, field notes, and herbaria; new insights from a study of the monocotyledons collected in Venezuela. Candollea 67: 75–130, DOI: <https://doi.org/10.15553/c2012v671a10>.
- Tkach, N./Braun, U./Röser, M. (2019): Alexander von Humboldts und Aimé Bonplands Pflanzen im Herbarium der Universität Halle-Wittenberg. In: *HiN – Alexander von Humboldt im Netz. Internationale Zeitschrift für Humboldt-Studien*, 20(39), pp. 45–52, DOI: <https://doi.org/10.18443/287>.

