Bonpland and Humboldt specimens, field notes, and herbaria; new insights from a study of the monocotyledons collected in Venezuela

Fred W. Stauffer, Johann Stauffer & Laurence J. Dorr

Abstract

STAUFFER, F. W., J. STAUFFER & L. J. DORR (2012). Bonpland and Humboldt specimens, field notes, and herbaria; new insights from a study of the monocotyledons collected in Venezuela. *Candollea* 67: 75-130. In English, English and French abstracts.

The monocotyledon collections emanating from Humboldt and Bonpland's expedition are used to trace the complicated ways in which botanical specimens collected by the expedition were returned to Europe, to describe the present location and to explore the relationship between specimens, field notes, and descriptions published in the multi-volume "Nova Genera et Species Plantarum" (1816-1825). Collections in five European herbaria were searched for monocotyledons collected by the explorers. In Paris, a search of the Bonpland Herbarium (P-Bonpl.), the most important repository of the expedition's botanical collections, uncovered about 350 specimens of monocotyledon and more or less the same number of species. The Venezuelan material represents 86 species belonging to 57 genera and 19 families. Curiously, 235 species of monocotyledon described in the "Nova Genera et Species Plantarum" are not represented now by specimens in the Bonpland Herbarium although 32 of these 235 are represented by illustrations (i.e., grisailles). No material whatsoever could be found for 203 species of monocotyledon that were expected to be documented by specimens in this herbarium. In Berlin, the Willdenow Herbarium (B-W) holds at least 126 specimens of monocotyledon from Venezuela, corresponding to the same number of species distributed in 64 genera and 26 families.

Résumé

STAUFFER, F. W., J. STAUFFER & L. J. DORR (2012). Echantillons de Bonpland et Humboldt, carnets de terrain et herbiers; nouvelles perspectives tirées d'une étude des monocotylédones récoltées au Venezuela. *Candollea* 67: 75-130. En anglais, résumés anglais et français.

Les collections de Monocotylédones provenant des expéditions de Humboldt et Bonpland sont utilisées ici pour retracer les cheminements complexes des spécimens collectés lors de leur retour en Europe. Ces collections sont utilisées pour établir la localisation actuelle et la composition d'importants jeux de matériel associés à ce voyage, ainsi que pour explorer les relations existantes entre les spécimens, les notes de terrain et les descriptions parues dans les divers volumes de «Nova Genera et Species Plantarum» (1816-1825). Les collections de cinq herbiers européens ont été investiguées pour identifier les spécimens de monocotylédones récoltés par les deux explorateurs. A Paris, un examen de la collection Bonpland (P-Bonpl.), dépositaire de la plus importante partie des collections botaniques de l'expédition, a révélé environ 350 spécimens de Monocotylédones et approximativement le même nombre d'espèces parmi lesquelles 86 spécimens du Venezuela appartenant à 57 genres et 17 familles. Curieusement, 235 espèces de Monocotylédones décrites dans «Nova Genera et Species Plantarum» ne sont actuellement pas représentées par des spécimens dans l'herbier de Bonpland, toutefois 32 de ces 235 espèces y figurent comme illustrations (p.e. grisailles). Il demeure qu'aucun matériel n'a pu être trouvé pour 203 espèces de Monocotylédones supposées avoir des spécimens dans cet

Addresses of the authors: FWS: Conservatoire et Jardin botaniques de la Ville de Genève, Université de Genève, laboratoire de systématique végétale et biodiversité, CP 60, CH-1292 Chambésy, Switzerland. Email: **fred.stauffer@ville-ge.ch**

JS: Feldstrasse 5, CH-4950 Huttwil, Switzerland.

LJD: Department of Botany, National Museum of Natural History, MRC-166, Smithsonian Institution, P. O. Box 37012, Washington, DC 20013-7012, USA.

Submitted on October 31, 2011. Accepted on December 12, 2011.

 © CONSERVATOIRE ET JARDIN BOTANIQUES DE GENÈVE 2012

The Berlin herbarium (B) received expedition collections when it purchased the herbarium of Karl Sigismund Kunth. We discovered several specimens of monocotyledon from Venezuela in the herbarium HAL, and they are duplicates of specimens in the Willdenow Herbarium that were removed by D. F. L. von Schlechtendal. No monocotyledon material tied to Humboldt and Bonpland was discovered in the herbarium MA-CAV even though there is evidence that seed was sent by the explorers from Venezuela, cultivated in Madrid, and on occasion these garden-grown plants vouchered as herbarium specimens. Similarly, no monocotyledon material was found in the herbarium LR, despite evidence in correspondence that Bonpland sent specimens to his older brother. We believe that evidence contained in the field books favors describing the botanical collections as being made by "Bonpland and Humboldt" and not "Humboldt and Bonpland", as is commonly done. The same field books, correspondence, and the introduction to "Nova Genera et Species Plantarum" favor a collective authorship such as "Kunth, Bonpland & Humboldt" rather than "Kunth in H.B.K." for taxa described in this work. This seems particularly appropriate for those taxa described in these volumes that are not vouchered now by specimens or illustrations in P-Bonpl.

Key-words

Monocotyledons – Bonpland and Humboldt exploration – Neotropics – Venezuela – Botanical history – Herbarium collections

herbier. A Berlin, l'herbier Willdenow (B-W) détient au moins 126 spécimens du Venezuela correspondant au même nombre d'espèces distribuées en 64 genres et 26 familles. L'herbier de Berlin (B) a reçu des collections de l'expédition par le biais de l'achat de l'herbier de Karl Sigismund Kunth. Nous avons découverts plusieurs spécimens de Monocotylédones du Venezuela dans l'herbier HAL, qui sont des doubles des spécimens de l'herbier Willdenow soustraits par D. F. L. von Schlechtendal. Aucun matériel lié à Humboldt et Bonpland n'a été découvert dans l'herbier MA-CAV bien que l'on sache que des graines provenant du Venezuela et cultivées à Madrid, accompagnées parfois par des spécimens d'herbier, aient été envoyées par les deux explorateurs. De même, aucun matériel du Venezuela n'a été localisé dans l'herbier LR, et ce, malgré les évidences dans la correspondance que Bonpland aurait envoyé des spécimens à son frère aîné. En ce qui concerne le travail de terrain de l'expédition, la lecture attentive des notes contenues dans les carnets de terrain nous amène à penser que la description des collections botaniques a été faite par «Bonpland et Humboldt» et non par «Humboldt et Bonpland» comme cité de manière courante. L'analyse de ces carnets de terrain et de la correspondance, ainsi que l'introduction à «Nova Genera et Species Plantarum» suggèrent que la description des taxa de cette publication serait à attribuer plutôt à «Kunth, Bonpland & Humboldt» qu'à «Kunth in H.B.K.». Cela semble particulièrement le cas pour les taxa qui ne sont pas représentés aujourd'hui par des spécimens ou des illustrations dans P-Bonpl.

Introduction

McVaugh (1955) asserted that "The most important botanical collections made in tropical America, from the perspective of taxonomy, were probably those made by Alexander von Humboldt and Aimé Bonpland, from 1799 to 1804". These two explorers, during the course of a 15,000 km long journey, visited Spanish territories in what are now the independent countries of Venezuela, Cuba, Colombia, Ecuador, Peru and Mexico, explored many parts of the American tropics never before seen by European naturalists, and gathered an impressive number of plant specimens that included a very large number of new species completely unknown to their contemporaries.

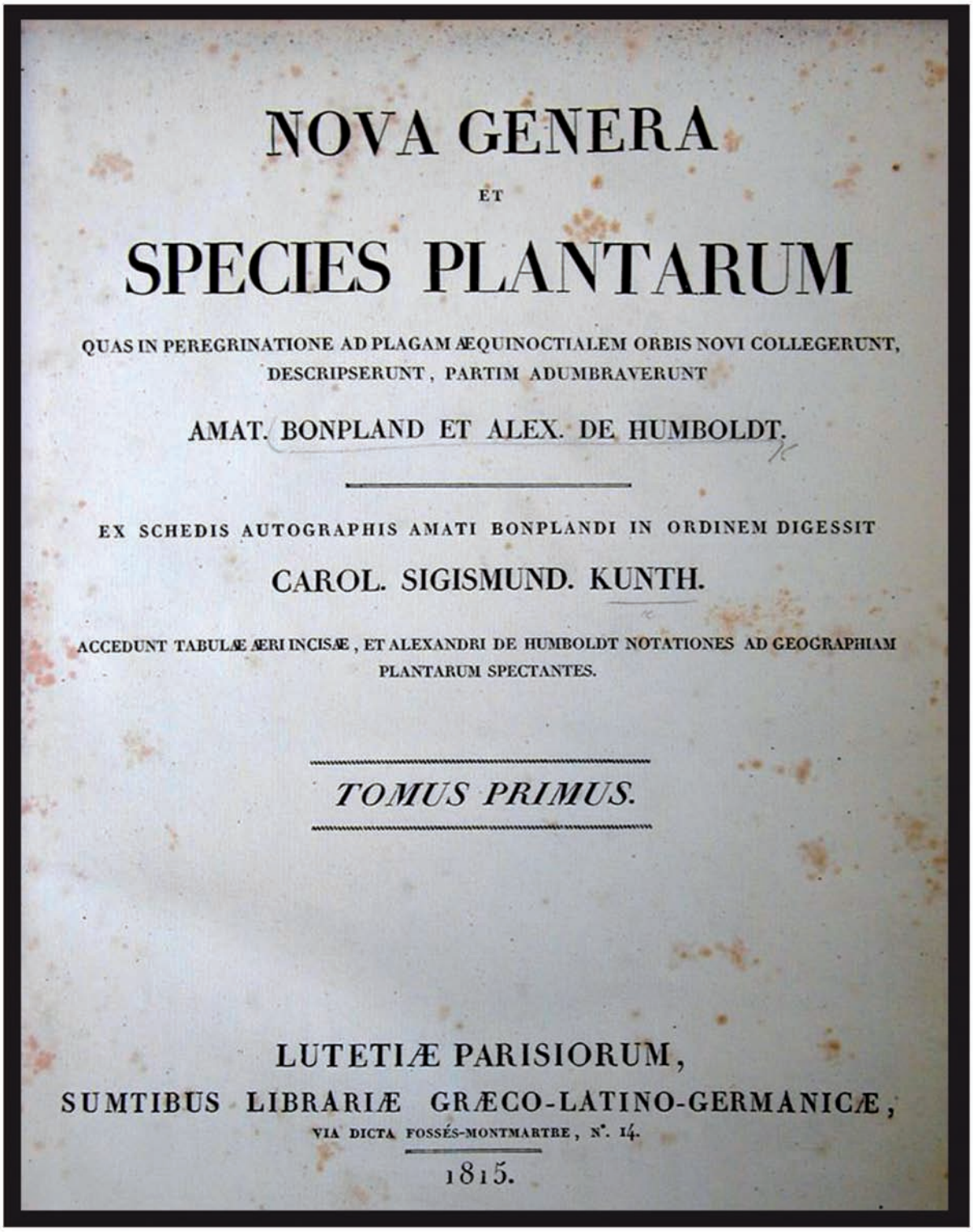
The literature concerning the travels in the New World of Friedrich Heinrich Alexander von Humboldt (1769-1859) and Aimé Jacques Alexandre Goujaud Bonpland (1773-1858) is enormous and the impact of these explorers on a wide range of biological disciplines such as taxonomy, floristics, ecology, and biogeography has been detailed in hundreds of scientific papers (see Stearn, 1968; Stafleu & Cowan, 1979). Of greater interest to us are recent studies that have focused on the botanical collections Bonpland and Humboldt gathered during their journey (Hiepko, 1987, 2006; Lack, 2003, 2009), the field notes associated with these collections (Lack, 2004a, 2004b), and illustrations of the plants they collected, including the "self impressions" of a number of these plants (Lack, 2001). The study of particular taxonomic groups has provided important insights into the way in which these collections were handled and distributed. Hence, studies of *Amaryllidaceae* (Arroyo-Leuenberger & Leuenberger, 1996; Leuenberger & Arroyo-Leuenberger, 2006), *Asteraceae* (Hind & Jeffrey, 2001), *Polygalaceae* (Rankin Rodríguez & Greuter, 2001), *Rubiaceae* (Delprete, 2001), and *Solanaceae* (Granados Tochoy & al., 2007; Knapp, 2007) have addressed in different ways the complexities of understanding from a taxonomic perspective the Bonpland and Humboldt collections and underscored the continuing importance of these collections for Neotropical taxonomy.

Present-day Venezuela was the starting point for the tropical botanical explorations of Humboldt and Bonpland and therefore the country that provided them with their first glimpses of the great diversity characterizing tropical American plants. As pointed out by Humboldt in his field diary (Faak, 2000), the death from fever of a passenger on the "Pizarro", the Spanish ship that carried them from Europe, forced the two explorers to land in Venezuela instead of Cuba as originally had been planned. Sandwith (1925) described in detail their itinerary in Venezuela, which lasted 16 months, and Faak (2000), who transcribed critical notes directly from Humboldt's original travel diaries, added further details about this portion of their travels. Before Humboldt and Bonpland's arrival in Venezuela, this portion of New Grenada had only been explored botanically by the Linnaean disciple Pehr Löfling (1729-1756) (Dorr & Wiersema, 2010), the botanist Nicolaus Joseph Jacquin (1766-1806) (Knuth, 1928: 735-758), and the Viennese gardeners Franz Bredemeyer (1758-1839), Josef (or Joseph) Schücht (fl. 1785-1788), and possibly Franz Boos (1753-1832) (Lindorf, 2004). These botanists mostly collected in the northern part of the country focusing on the Coastal Cordillera, and with the exception of Löfling they left the llanos and the Guayana, the majority of the territory of present-day Venezuela, almost completely unexplored.

From the beginning, the botanical activity of Humboldt and Bonpland in Venezuela was intense and this can be confirmed by some of the impressive figures included in the first letters Humboldt sent to Europe (see Minguet, 1989). For example, in a letter to the astronomer Jérôme LeFrançais de Lalande (1732-1807), Humboldt stated that five months after their arrival more than 1600 plants had been dried and about 500 described in manuscript. A mere two months later Humboldt wrote in a letter to the chemist Antoine-François de Fourcroy (1755-1809) that an astounding 4000 specimens had been dried and more than 800 species described. In fact, by the end of the Venezuelan portion of their journey more than 1200 new or rare species had been described (Moheit, 1993: 116 [letter nr. 38]).

The results of the prodigious botanical effort by Humboldt and Bonpland in Venezuela was summarized in two lists of plants that Karl Sigismund Kunth (1788-1850) appended to the end of volume seven of Humboldt & al. (1816-1825), the monumental, multi-volume summary of their plant taxonomic work (Fig. 1). Although the first volume is dated 1815, the various parts appeared between 29 January and late August 1816. Monocotyledons are treated in volume one and in an appendix to volume seven, which was published in 1825. These lists of plants were entitled "Flora Provinciarum Novæ Andalusiæ, Venezuelæ, nec non Planitiei Barcinonensis" (Humboldt & al., 1816-1825, vol. 7: 281-312) and "Flora Orinoci et Fluminis Nigri" (Humboldt & al., 1816-1825, vol. 7: 314-332) and can be considered to be among the earliest checklists for the Venezuelan flora. The lists give a comprehensive overview of two local floras and include plants collected in almost all of the vegetation types visited by Humboldt and Bonpland (e.g., savanna, deciduous and semi-deciduous forest, cloud forest, and subpáramo).

Kunth, who played a critical role in preparing the collections of Bonpland and Humboldt for publication, came to the attention of Humboldt through a family connection. He was the nephew of Gottlob Johann Christian Kunth (1757-1829), tutor of Humboldt and his older brother Wilhelm (1767-1835). The younger Kunth, who had developed an interest in botany, was recommended by his uncle and others to assist Humboldt and in 1813, when Kunth was a mere 25 years old,



NOVA GENERA

ET

SPECIES PLANTARUM

QUAS IN PEREGRINATIONE AD PLAGAM ÆQUINOCTIALEM ORBIS NOVI COLLEGERUNT, DESCRIPSERUNT, PARTIM ADUMBRAVERUNT

AMAT. BONPLAND ET ALEX. DE HUMBOLDT.

EX SCHEDIS AUTOGRAPHIS AMATI BONPLANDI IN ORDINEM DIGESSIT

CAROL. SIGISMUND. KUNTH.

ACCEDUNT TABULÆ ÆRI INCISÆ, ET ALEXANDRI DE HUMBOLDT NOTATIONES AD GEOGRAPHIAM PLANTARUM SPECTANTES.

TOMUS PRIMUS.

LUTETIÆ PARISIORUM,

SUMTIBUS LIBRARIÆ GRÆCO-LATINO-GERMANICÆ,

VIA DICTA FOSSÉS-MONTMARTRE, N°. 14.

1815.

Fig. 1. – Title page of Humboldt & al. "Nova Genera et Species Plantarum", vol. 1.
[© Conservatoire et Jardin botaniques de la Ville de Genève]

he was invited to Paris to study and organize the large botanical collection amassed by Bonpland and Humboldt (Stearn, 1968). Kunth eventually dedicated 17 years of his life to this work, producing among other botanical monographs the multivolume of "Nova Genera et Species Plantarum" (Humboldt & al., 1816-1825).

Today, over 200 years later, it is impossible to study Venezuelan plants without consulting the collections and publications that resulted from Humboldt and Bonpland's journey. We are familiar with many of the Venezuelan localities visited by Humboldt and Bonpland, and have in different ways been concerned with the study of the new taxa that issued from their expedition. In order to better understand the impact of Humboldt and Bonpland on Venezuelan plant taxonomy, we undertook a study of a plant group for which we have some familiarity, the monocotyledons. We believe that this taxonomic group can serve as a model to improve our understanding of the circumstances related to the gathering of specimens in the field by Bonpland and Humboldt, the shipment and later distribution of these specimens among European herbaria, and the current representation of these specimens in the main sets of collections associated with the expedition. However, from the beginning of our investigation it was apparent that in order to be successful critical information also would have to be obtained from the monocotyledon specimens collected by Bonpland and Humboldt in the other American countries that they visited, which naturally greatly increased the complexity of our project.

The goals of our research were to: 1) inventory the monocotyledon specimens collected by the two explorers in Venezuela and trace how these specimens were returned to Europe; 2) characterize the physical distribution of the different sets of specimens assembled by the expedition; 3) characterize the collections of Venezuelan monocotyledons through a study of the botanical field notes (i.e., the "Journal Botanique" [cote 'MS 1332', Bibliothèque Centrale, Muséum National d'Histoire Naturelle, Paris]) compiled by Bonpland and Humboldt in Venezuela; and 4) explore the relationship between the "Journal Botanique", the specimens studied, and the descriptions published in the "Nova Genera et Species Plantarum". This last objective was intended also to gain insight into how authorship should be ascribed to taxa published in Humboldt & al. (1816-1825).

Material and methods

Herbarium specimens

The study of a large number of specimens gathered by the Humboldt and Bonpland expedition and entries in the "Journal Botanique" compiled by the two explorers have convinced us that Aimé Bonpland played the more significant role in the botanical work of the expedition and that Humboldt merely contributed a limited number of collections and field notes (see also Sarton, 1943). Consequently, we believe that the botanical specimens emanating from this expedition should be attributed to "Bonpland and Humboldt", and not "Humboldt and Bonpland" as is commonly done in the botanical literature. The major sets of the collections gathered by the two explorers are thought to be deposited in a limited number of herbaria (see Lanjouw & Stafleu, 1954, 1957; Stafleu & Cowan, 1976, 1979; Hiepko, 2006) of which the two most important sets always have been considered to be the ones deposited in the Muséum National d'Histoire Naturelle in Paris (P-Bonpl.) and in the Botanischer Garten und Botanisches Museum Berlin-Dahlem (B-W). These two collections are also the only ones that continue to be maintained as separate, historical herbaria within their respective institutions. As P-Bonpl. and B-W contain the most comprehensive sets of the original group of specimens gathered by the two explorers we have focused our investigations on them. Additional searches were made in P, P-JU, B, and LR. An electronic search was conducted for HAL. Similarly, the microfiche of MA-CAV was scanned for relevant collections. Given the heterogeneous nature of these different sets of specimens, the specific methodology employed for our investigation of each one is described below.

The Bonpland herbarium (P-Bonpl.), Paris

P-Bonpl. (Fig. 2A, 2B) was studied over the course of five visits from 2002 to 2009. All of the monocotyledon specimens from the Humboldt and Bonpland expedition that were deposited in this herbarium were inventoried and each specimen was compared to the description of the corresponding species in the first volume of Humboldt & al. (1816-1825), which treats the monocotyledons, or to the supplementary treatment of monocotyledons published in the seventh volume of Humboldt & al. (1816-1825). Monocotyledons collected in Venezuela were identified according to one or more of the following criteria: 1) the collection number on the label could be attributed unequivocally to the Venezuelan portion of the journey when compared to collection numbers cited in the "Journal Botanique"; 2) the specimen label lacked a collection number, but clearly indicated a locality in Venezuela; or 3) the specimen label lacked all useful data (e.g., collection number, date of collection, etc.) but the only specimen cited and associated with the species described in Humboldt & al. (1816-1825) had a Venezuelan locality. Specimens that failed to meet any of these criteria were considered to have been collected elsewhere. Critical data on the original Bonpland labels or the labels copied by Kunth (see below) were recorded.



Fig. 2. – Herbarium of the Muséum National d'Histoire Naturelle, Paris. **A.** General view of the main building of the herbarium ; **B.** Representative specimens corresponding to the monocotyledon collection of P-Bonpl.

The general phanerogamic (P) and Jussieu (P-JU) herbaria, Paris

Humboldt and Bonpland split the large collection of specimens they gathered in the Americas shortly after they returned to Europe. The portion of the collection that Bonpland kept for himself has traditionally been called Bonpland's "private" herbarium and the exact number of specimens involved remains unknown. Bonpland kept this private collection with him when he returned to South America in 1816 (SARTON, 1943; LOURTEIG, 1977). However, before Bonpland's departure for South America Kunth had requested that Bonpland provide him with these specimens and the "Journal Botanique", but as discussed by LACK (2003, 2004a) "The problem at Le Havre" very nearly brought the publication of the botany of the expedition to a halt. In November 1816, Kunth failed to reclaim the specimens Bonpland decided to take back to South America as these specimens were already stowed in the ship on which Bonpland was about to depart from the port of Le Havre, but Kunth did recover the field notes. Kunth's lack of access to Bonpland's "private" herbarium greatly reduced the number of specimens available to him for his challenging task of describing the Bonpland and Humboldt collections.

In 1832, Bonpland sent his "private" herbarium from Argentina to France and it was integrated into the general phanerogamic herbarium (P) in Paris the following year. According to LACK (2009), Bonpland continued to retain an unknown number of specimens with him in South America, which after his death in 1858 also were conveyed to Paris and ultimately also intercalated into the general phanerogamic herbarium. Physically locating these specimens that were once part of Bonpland's private collection represents a Sisyphean task as today more than eight million specimens are deposited in the general phanerogamic herbarium. Consequently, our analysis of these specimens is based on searches initiated through the specimen database of the Muséum National d'Histoire Naturelle, Paris (http://coldb.mnhn.fr/).

According to our research, the possibility that specimens gathered by the expedition might be found in other historic herbaria (e.g., P-JU, P-LA) deposited in the Muséum National d'Histoire Naturelle was suggested by the close relationship Bonpland maintained with his botanical mentors. Antoine-Laurent de Jussieu (1748-1836), Jean Baptiste Antoine Pierre Monnet de Lamarck (1744-1829), René-Louiche Desfontaines (1750-1833), and André Thouin (1747-1824), all professors associated with the Muséum, appear to have contributed to Bonpland's botanical education during his medical studies in Paris from 1795 to 1797. Accordingly we focused our search for specimens gathered by the expedition in P-JU because it, as with the general herbarium, could be searched electronically.

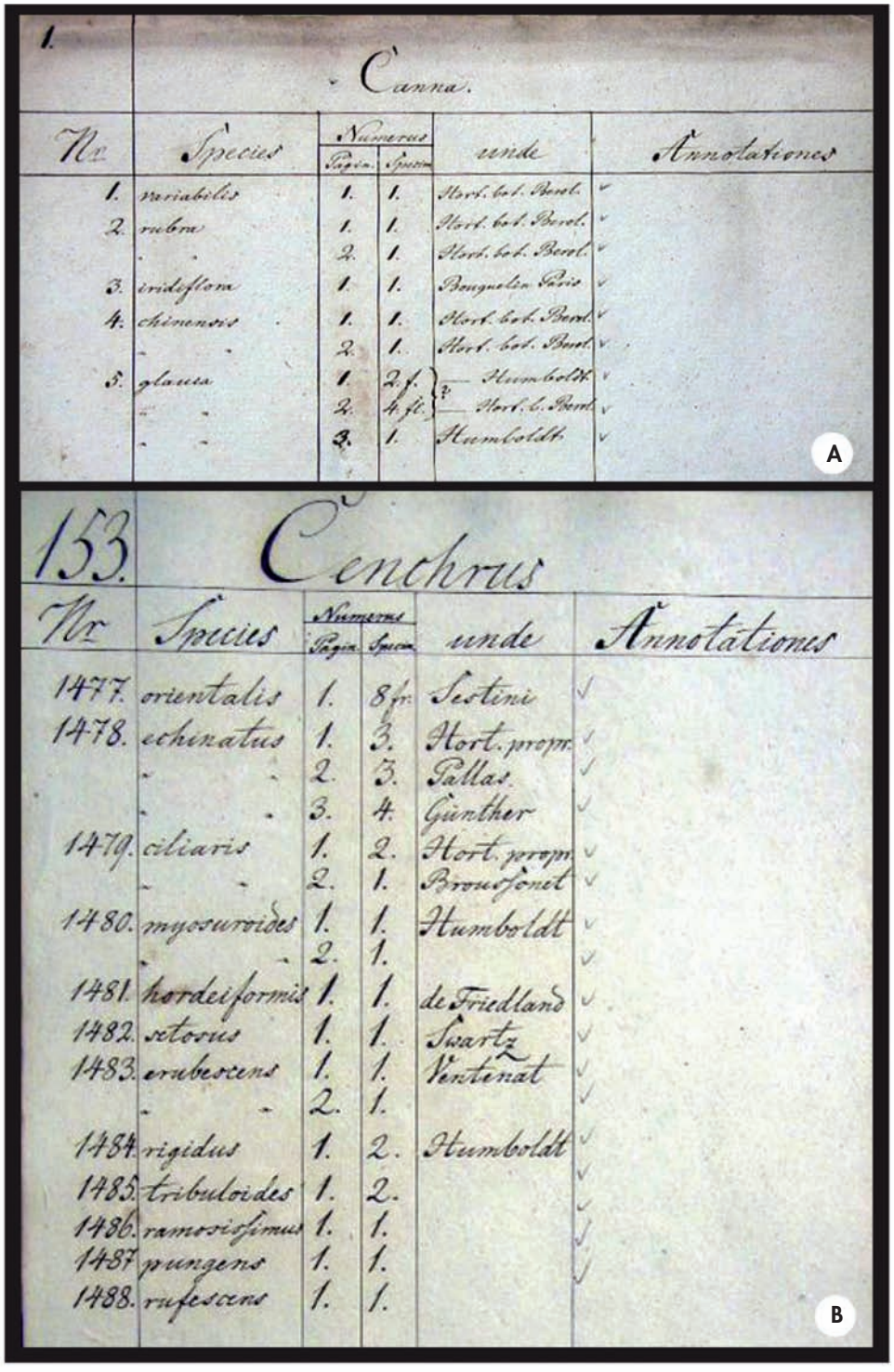
The Willdenow herbarium (B-W), Berlin-Dahlem

More than anyone else the renowned Prussian botanist Carl Ludwig Willdenow (1756-1812) was responsible for introducing Humboldt to botany. Their on-going and close friendship encouraged Humboldt to share with his principal mentor an important number of specimens gathered during the expedition to the New World. According to URBAN (1916), a set of ca. 3360 specimens collected by Bonpland and Humboldt in the Americas was sent to Willdenow and the specimens in this set are now kept separately in B-W (Fig. 3A, 3B). This collection was studied during a visit to Berlin by FWS and JS in April 2006. Since this herbarium has an unique physical arrangement that is not tied to a single publication, locating Bonpland and Humboldt specimens deposited in it was carried out via a complex procedure that can be summarized as follows: 1) all of the monocotyledon genera present in the herbarium were identified by making use of an alphabetical list of the herbarium's contents compiled by HIEPKO (1972); 2) specimens of monocotyledon filed under the genera included in Hiepko's list were identified and studied in the microfiche edition of B-W (IDC, 1971) and a preliminary list of specimens that might have been collected by the Humboldt and Bonpland expedition was created; and 3) all the material identified in the second step was physically examined to determine whether or not a given specimen was in fact collected by Bonpland and Humboldt. It was possible to recognize specimens as emanating from the Humboldt and Bonpland expedition because Diederich Franz Leonhard von Schlechtendal (1794-1866), who curated the collection from 1819 to 1833, annotated the bottom right-hand corner of herbarium sheets with the word "Humboldt" and "W", the "W" signifying Willdenow. Identification of the species in the collection was only possible through Schlechtendal's catalogue (also included in the microfiches of B-W), which assigns reference numbers to all species contained in the Willdenow collection (Fig. 4A, 4B [note the name "Humboldt" is associated with the species *Cenchrus myosuroides* Kunth and *C. rigidus* Willd., *nom. illeg*.]). These reference numbers were retained by HIEPKO (1972) in his catalogue of the microfiches and used by us to locate specimens of concern. Additional information relating to Bonpland and Humboldt specimens was compiled through a search of the on-line database of B-W (RÖPERT, 2009).

Specimens of Venezuelan monocotyledon in B-W were identified according to the same criteria utilized in searching P-Bonpl. (see above). We are aware that according to HIEPKO (1972) one cannot always trust the names of collectors written on labels by Schlechtendal. However, for practical reasons we decided that specimens with the name "Humboldt" written on their labels would be considered part of the original set of plants that the two explorers sent to Willdenow.



Fig. 3. – Herbarium of the Botanischer Garten und Botanisches Museum Berlin-Dahlem. **A.** General view of the museum building ; **B.** Representative specimens corresponding to the monocotyledon collection of B-W.



1.

Canna.

Nr	Species	Numerus Pagin.	Numerus Specim.	unde	Annotationes
1.	variabilis	1.	1.	Hort. bot. Berol.	✓
2.	rubra	1.	1.	Hort. bot. Berol.	✓
	" "	2.	1.	Hort. bot. Berol.	✓
3.	iridiflora	1.	1.	Bonpland. Paris	✓
4.	chinensis	1.	1.	Hort. bot. Berol.	✓
	" "	2.	1.	Hort. bot. Berol.	✓
5.	glauca	1.	2 f.	Humboldt.	✓
	" "	2.	4 fl.	Hort. b. Berol.	✓
	" "	3.	1.	Humboldt.	✓

A

153. Cenchrus

Nr	Species	Numerus Pagin.	Numerus Specim.	unde	Annotationes
1477.	orientalis	1.	8 fr.	Sestini	✓
1478.	echinatus	1.	3.	Hort. prom.	✓
	" "	2.	3.	Pallas.	✓
	" "	3.	4.	Günther	✓
1479.	ciliaris	1.	2.	Hort. prom.	✓
	" "	2.	1.	Broussonet	✓
1480.	myosuroides	1.	1.	Humboldt	✓
	" "	2.	1.		✓
1481.	hordeiformis	1.	1.	de Friedland	✓
1482.	setosus	1.	1.	Swartz	✓
1483.	erubescens	1.	1.	Ventenat	✓
	" "	2.	1.		✓
1484.	rigidus	1.	2.	Humboldt	✓
1485.	tribuloides	1.	2.		✓
1486.	ramosissimus	1.	1.		✓
1487.	pungens	1.	1.		✓
1488.	rufescens	1.	1.		✓

B

Fig. 4. – Extracts of D. F. L. von Schlechtendal's catalogue of B-W. The first column at left corresponds to the number under which the taxon is filed in the herbarium. **A.** List of *Canna* L. *(Cannaceae)* taxa in the herbarium; note the name "Humboldt" is associated with *Canna glauca* L.; **B.** List of *Cenchrus* L. *(Poaceae)* taxa in the herbarium.

[© Botanischer Garten und Botanisches Museum Berlin-Dahlem]

The general herbarium (B), Berlin-Dahlem

B was studied by FWS and JS during their April 2006 visit. A number of Bonpland and Humboldt specimens, especially type specimens, were deposited in this herbarium in the 19th century, but many of them subsequently were destroyed by Allied bombing during World War II (Merrill, 1943; Grimé & Plowman, 1986; Hiepko, 1987). Some groups in the original Kunth herbarium (e.g., ferns, lobelias, etc.) survived this bombing (Lack, 2009). Fortunately, J. Francis Macbride (1892-1976) of the Field Museum of Natural History, Chicago, photographed type specimens in Berlin from 1929 to 1933 and these images are available electronically (http://fieldmuseum.org/explore/our-collections/berlin-negatives). Using these images we were able to record data from specimens that are no longer extant.

Unlike B, B-W was evacuated to a bank vault at the beginning of World War II (Hiepko, 1987) and therefore was not in the museum during the Allied bombing. Consequently B-W survived World War II intact and the Bonpland and Humboldt specimens deposited in it can still be studied, while the Bonpland and Humboldt specimens that were deposited in the general herbarium (with the exceptions noted above) only can be studied now by the proxy of Macbride's images.

The herbarium (HAL), Halle

Although Lanjouw & Stafleu (1957) reported the presence of Bonpland and Humboldt collections in HAL, it was a poster presented by Tkach & al. (2009) that made us realize that this herbarium held a greater quantity of specimens collected by the two explorers than generally reported. We used an online database (http://herbarium.univie.ac.at/database/index.php) to search for and analyze Bonpland and Humboldt specimens in this collection.

The Cavanilles Herbarium (MA-CAV), Madrid

Humboldt's correspondence with Willdenow (Moheit, 1993: 129 [letter nr. 41]) indicates that shortly after the arrival of Humboldt and Bonpland in the New World and later during the Mexican portion of their journey an unknown quantity of seed of interesting plants was shipped to the Spanish botanists Casimiro Gómez Ortega (1740-1818) and Antonio J. Cavanilles (1745-1804). Accordingly, the microfiche of MA-CAV (IDC, 1994) was systematically searched for specimens that might be associated with this type of transaction.

The "Bonpland" herbarium (LR), La Rochelle

Humboldt's correspondence with Willdenow (Moheit, 1993: 122 [letter nr. 41]) also suggested the presence of expedition collections in LR. Accordingly, FWS and JS visited this herbarium in November 2009. All monocotyledon specimens present in LR that was assembled by Michel-Simon Goujaud Bonpland (1770-1850), Aimé Bonpland's older brother, were examined in an effort to locate any specimens that could be attributed to the Humboldt and Bonpland expedition. In addition, letters received by Michel-Simon, which are now kept in the archives of the Muséum d'Histoire Naturelle, were examined. Finally, the Médiathèque Michel Crépeau, La Rochelle was visited by FWS and JS in January 2011 in an effort to locate original documents or correspondence relating to Aimé Bonpland or his brother.

The "Journal Botanique" of Bonpland and Humboldt

The "Journal Botanique" (Fig. 5, 6) was examined by FWS and JS on two visits (November 2006 and 2008) to the Bibliothèque Centrale, Muséum National d'Histoire Naturelle, Paris. Original entries in these manuscript field notes pertaining to Venezuelan monocotyledons were compared to descriptions of corresponding taxa in Humboldt & al. (1816-1825), as well as to the lists of specimens that were compiled on earlier visits by FWS and JS to P-Bonpl. and B-W. Additional information concerning the "Journal Botanique" was obtained from Lack (2004a, 2004b).

Bibliographic research

Data relating to Venezuelan monocotyledons also were abstracted from several of the principal botanical publications associated with the expedition, notably Humboldt & Bonpland (1808-1809) and Humboldt & al. (1816-1825). Secondary sources providing information on the dates and itineraries of the expedition, and the collections and their fate (e.g., Sandwith, 1925; McVaugh, 1955; Biermann & al., 1968; Stearn, 1968; Hiepko, 2006) also were studied. Additional information about Venezuelan monocotyledons was obtained from the published correspondence of Humboldt (Moheit, 1993) and his Venezuelan diaries (Faak, 2000).

Results

Shipment and distribution of the Venezuelan specimens

Details as to how specimens collected by Bonpland and Humboldt in Venezuela were shipped to Europe can be gleaned from letters that Humboldt sent from Havana to Europe as well as from letters that Humboldt sent to Bonpland and Willdenow shortly after the South American explorers themselves returned home. Venezuelan specimens appear to have arrived in Europe by at least three different means (Fig. 7, this flow chart is based on original data and information extracted from Lanjouw & Stafleu, (1954), and Hiepko, (2006). First, after the explorers had completed the Venezuelan leg of their journey and before

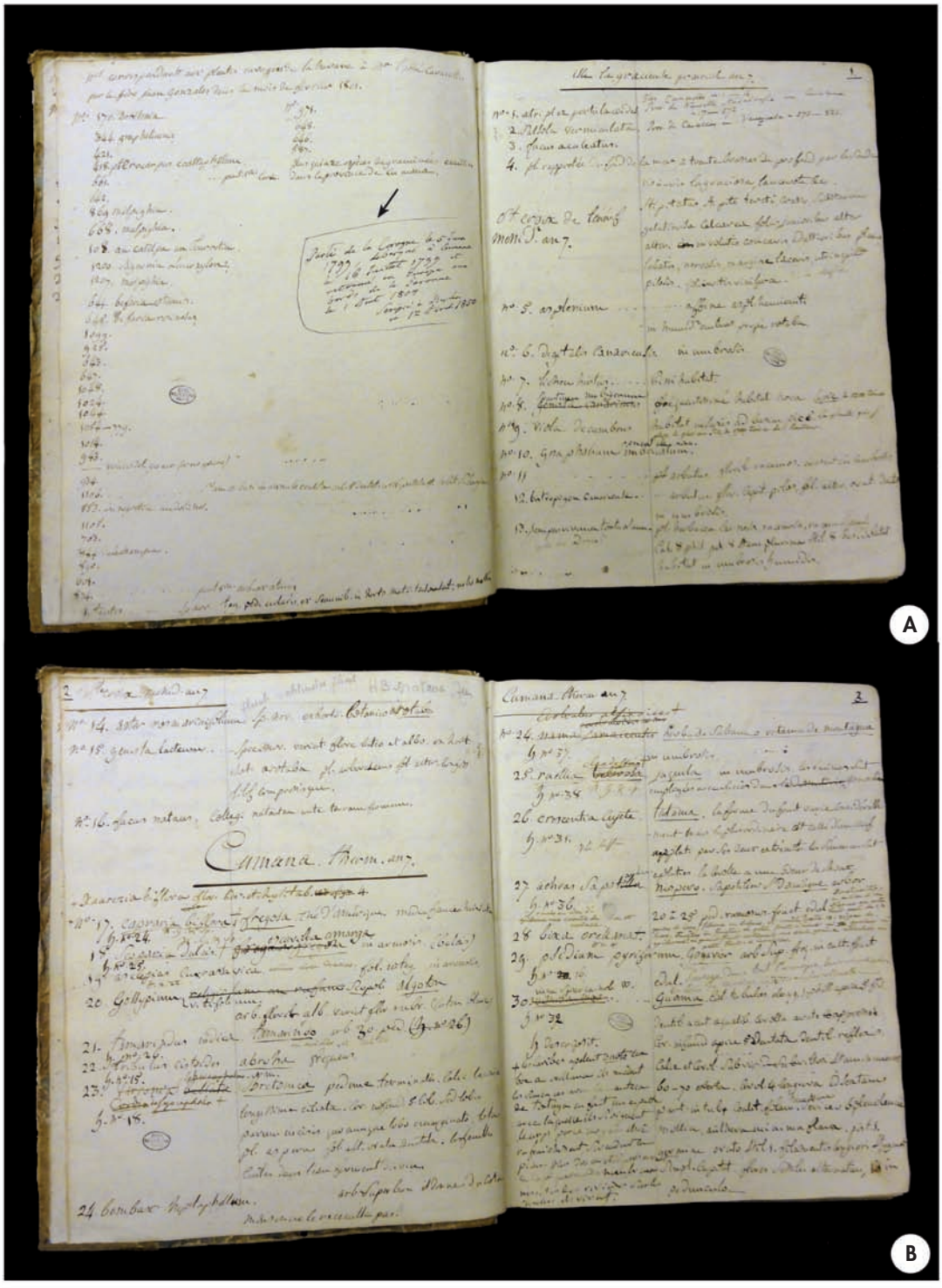


Fig. 5. – Pages from the "Journal Botanique" of Bonpland and Humboldt. **A.** Left-hand page lists plants sent to Cavanilles, the arrow points to an annotation by Humboldt; right-hand page lists some plants gathered in the Canary Islands; **B.** First pages detailing the first collections made in Venezuela.

[© Bibliothèque Centrale, Muséum National d'Histoire Naturelle, Paris]

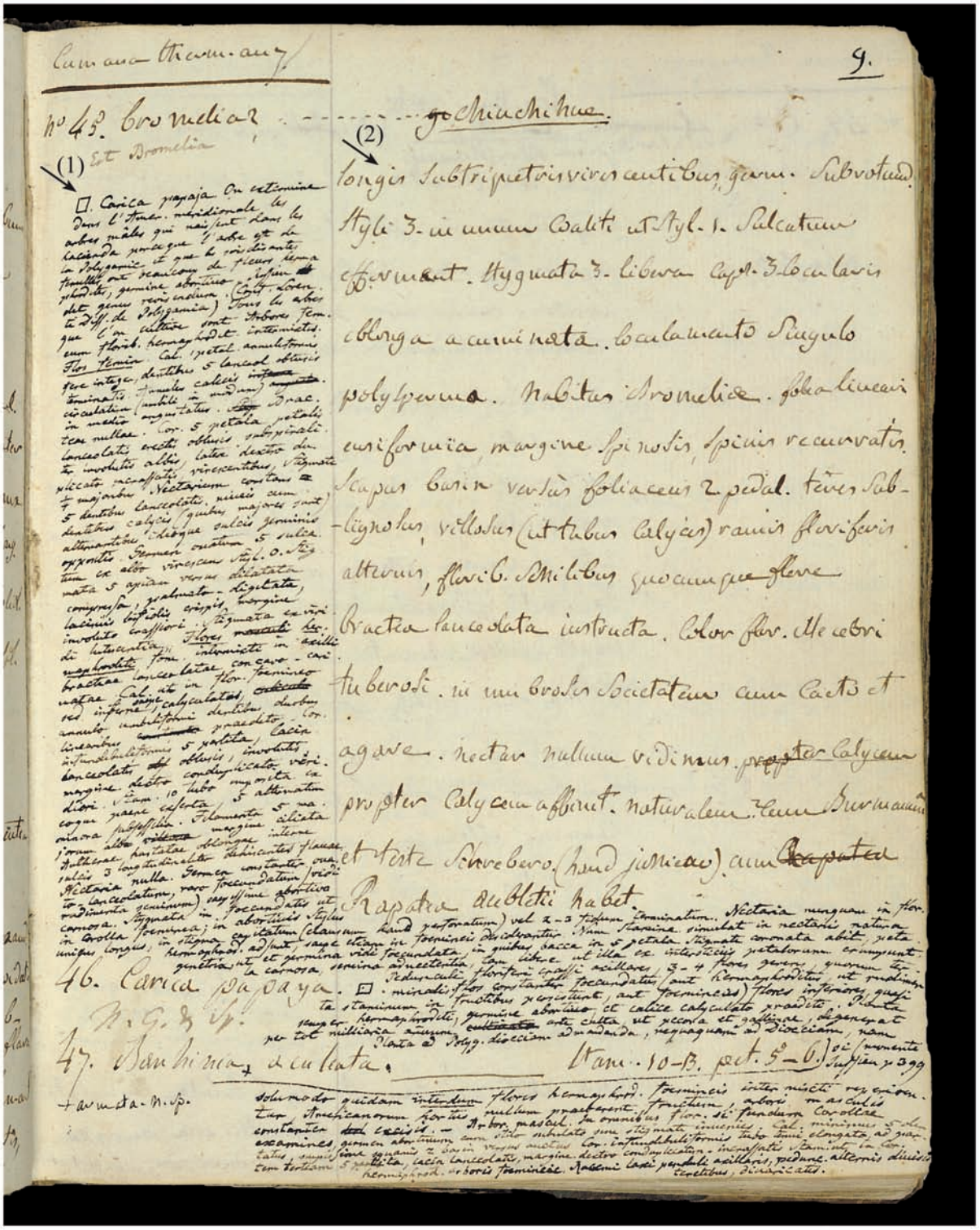


Fig. 6. – A page from the "Journal Botanique" of Bonpland and Humboldt. Humboldt's handwriting can be recognized on the left-hand side of the page (arrow 1); Bonpland's handwriting can be recognized on the right-hand side of the page (arrow 2).

[© Bibliothèque Centrale, Muséum National d'Histoire Naturelle, Paris]

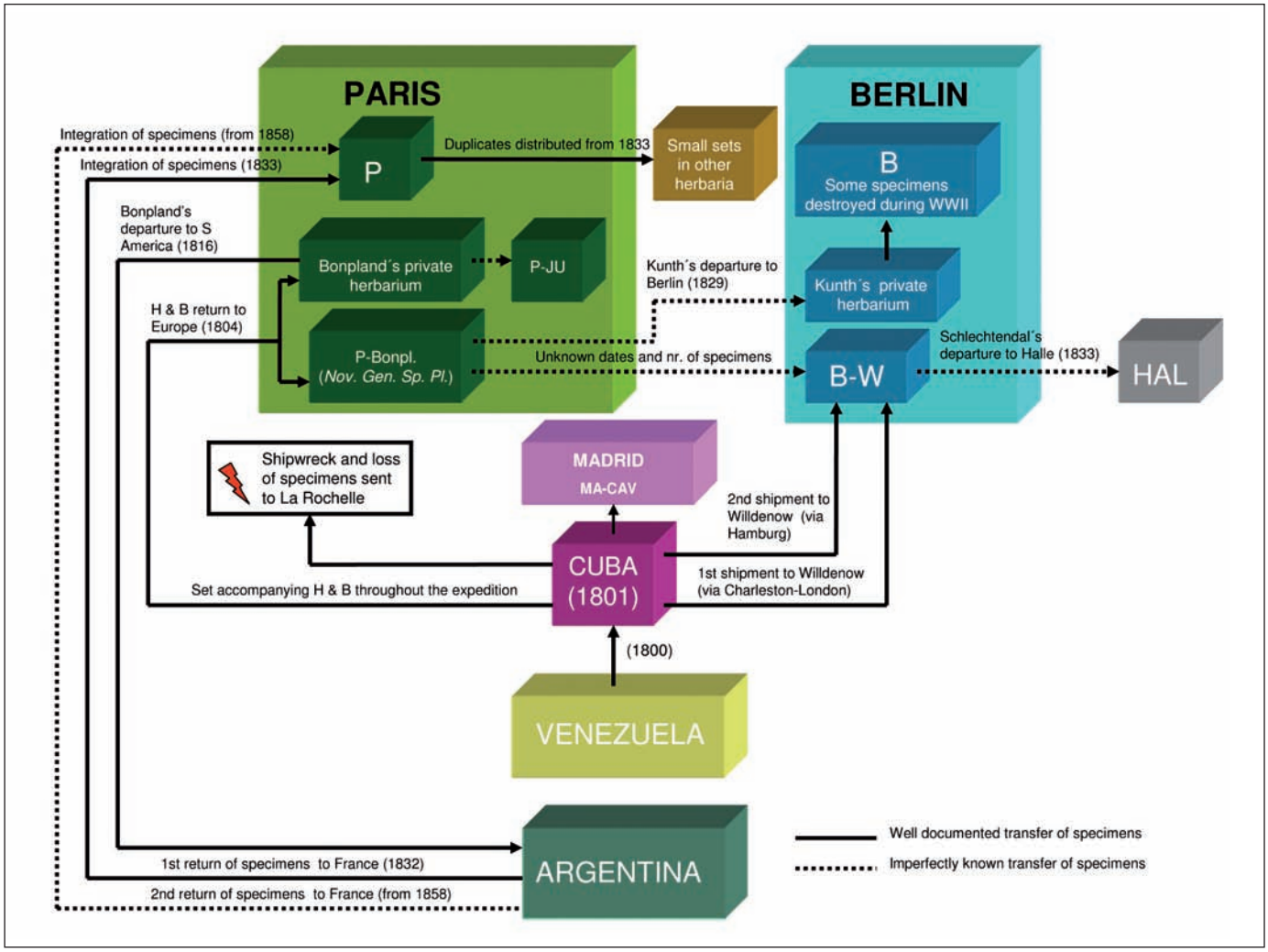


Fig. 7. – Main pathways by which monocotyledon specimens collected by Bonpland and Humboldt in Venezuela (1799-1800) were distributed to individuals and herbaria.

they continued on to other parts of South America specimens were sent in two different shipments from Havana to Berlin. The vast majority of specimens, however, appears to have remained in the custody of Humboldt and Bonpland throughout their five-year long journey and these specimens were part of the baggage they brought back with them to Europe. Finally, a set of specimens that Bonpland had kept in his possession was shipped by him in 1832 to France from Argentina where Bonpland had settled following his return to South America.

Indeed, in late February 1801 Humboldt stated in a letter to Willdenow (Moheit, 1993: 122 [letter nr. 41]) that the plants collected in Venezuela had been distributed in three sets; a first and apparently small format set ("Ein Herbarium in kleinem Format …") that would accompany the two explorers throughout their journey; a second set, that Humboldt described as Bonpland's set, which had already been shipped to France; and a third set containing about 1600 species, sent to Willdenow on 21 February 1801 through the courtesy of John Fraser (1750-1811) from Charleston, South Carolina via London. Fraser was a Scottish nurseryman then engaged in his own botanical explorations of North America and who also had a nursery in Chelsea near London. In a letter dated 1 April 1801 (Moheit, 1993: 136 [letter nr. 43]) that Humboldt sent to his brother Wilhelm he also mentioned another set of collections that had been left in Havana, Cuba. We have been unable to trace this set and its fate remains unknown. Humboldt collections have been reported as being present in HAC

(Holmgren & al., 1990; see also http://sweetgum.nybg.org/ih/), but the basis of this report is unknown and this Cuban herbarium has never had Humboldt collections (L. Regalado Gabancho & P. Herrera, *pers. comm.*). Humboldt's decision to send the first specimens and seeds that Bonpland and he had collected in the New World to Willdenow and to Cavanilles can be attributed to the close relationship that Humboldt had established with these two prominent botanists prior to leaving Europe. Humboldt had become a close personal friend of the slightly older Willdenow after first meeting him 12 years earlier when he sought Willdenow's help in identifying a plant using Willdenow's "Flora Berolinensis" (Stearn, 1968; Hiepko, 2006). Cavanilles had been of great value in helping to organize the expedition and may have played a role in advancing the interests of the explorers before the Royal Court of Spain.

Also in late February 1801 (Moheit, 1993: 125 [letter nr. 41]) Humboldt indicated that in a fortnight he would send Willdenow an additional set of 200 "very selected" specimens. These would be shipped directly to Hamburg. There is a list of specimens sent to Willdenow that is included on the inner front cover of the "Journal Botanique", but we have been unable to establish whether or not this list enumerates specimens sent in the first or second shipment. These two shipments, which did not exceed 1800 specimens, were the only herbarium material collected by the explorers that was available to Willdenow until Humboldt returned from the New World (Hiepko, 2006). In the same volume of the "Journal Botanique" and before the description of the first collections, a similar list is provided of specimens sent to Cavanilles in Madrid. These too were shipped from Havana in February 1801 (Lack, 2004a). Humboldt and Bonpland evidently also wanted to send specimens to Bonpland's brother in La Rochelle under the care of the Franciscan monk Juan Gonzáles (fl. 1799-1801), who had accompanied the explorers in their Venezuelan travels. However, as stated in a letter (Moheit, 1993: 249 [letter nr. 113]) from Cumaná dated 22 August 1803, the colonial treasurer Manuel de Navarrete (1751-1819) informed Humboldt that neither Gonzales nor the specimens had survived a shipwreck off the coast of Spain.

Ultimately the largest set of plant specimens amassed by the two explorers remained with them throughout their journey and was brought by them back to Europe. We know from a letter dated 1 August 1804 (Moheit, 1993: 310 [letter nr. 160]) that Humboldt sent to his friend [Johann] Karl Freiesleben (1774-1846) that the prodigious amount of natural history material that Bonpland and Humboldt gathered, including the specimens collected in the Venezuelan portion of their journey, arrived in Europe packed in 30 boxes.

Representation of Venezuelan monocotyledons in several important herbaria

Hiepko (2006) presented a general overview of the complicated fate of the principal sets of Bonpland and Humboldt plant collections. He pointed out that when Kunth left Paris in 1829 there were four large sets of the expedition's plant collections of more than 5000 species. The main set (P-Bonpl.) was in the Muséum in Paris (Fig. 2A, 2B). A second set, retained by Bonpland, had been taken back to South America by Bonpland in 1816 (Fig. 7), but its precise size was unknown. A third set of ca. 3360 specimens was in B-W in Berlin (Fig. 3A, 3B), and it included both material sent from Cuba to Willdenow and material given to Willdenow by Humboldt after the expedition's return. The fourth and final set of ca. 3000 specimens was given by Humboldt to Kunth shortly before the former left Paris for Berlin.

In addition to these important sets, there are smaller sets, sometimes merely fragments of specimens removed from the principal sets, found now in many herbaria, including B, BM (grasses, at least), CGE, COL (ex P), E (cryptogams, at least), F, FI, G and G-DC (ca. 100 specimens; Burdet, 2008), H, HAL, K (fungi, at least; see Roberts, 2011), KIEL, L, LE (grass fragments ex B-W in the Trinius Herbarium, but specimens not otherwise in the South American collections; N. Imchanitzkaja, *pers. comm.*), LINN, LR, M (H. Esser, *pers. comm.*), MA (M. Velayos, *pers. comm.*), MA-CAV, MEDEL, MO (*Juncus* fragments ex P in Engelmann Herbarium), MPU (ex Dunal), NY, P, P-JU, PC, PH (Smith, 1962; Mears, 1981), S (specimens and type fragments ex P), and US (grass fragments and other specimens ex P) (Lanjouw & Stafleu, 1954, 1957; Stafleu & Cowan, 1979). The reports by Lanjouw & Stafleu (1954, 1957) of Bonpland and Humboldt specimens in W evidently are incorrect (Lack, 2004a) as no specimens are found there now and the basis of these reports is unknown. Furthermore, W. H. Lack *(pers. comm.)* does not believe that Bonpland orchid collections in Vienna, which were reported by Lanjouw & Stafleu (1954), ever existed and therefore were not among the collections destroyed during World War II.

We suspect that Bonpland and Humboldt specimens are in additional herbaria or collections as Wurdack (1971) noted that Bonpland had indicated in the "Journal Botanique" (Fig. 5A, 5B, 6) that specimens of *Melastomataceae* were given to Aylmer Bourke Lambert (1761-1842) in the summer of 1814 and to Robert Brown (1773-1858) in 1815. The Lambert herbarium was broken up and sold at auction and a lot with Bonpland material appears to have gone to G, but the contents of the lot were not recorded (Miller, 1970; see also Burdet, 2008). The *Melastomataceae* specimens given to Brown have not been traced, but should be sought in BM. A report by Solomon (1982) of a "Humboldt & Bonpland" specimen of

Epilobium denticulatum Ruiz & Pav. *(Onagraceae)* from Ecuador in RJ [sic] has not been confirmed; the specimen probably is deposited in RB.

We provide information below on what we were able to learn in searching the main sets of specimens now in Paris and Berlin, and we present new information on several less well-known sets assembled by the expedition that are now in Halle, Madrid, and La Rochelle.

The P-Bonpl. herbarium

On 18 December 1804, Humboldt wrote to the authorities of the Muséum in Paris and formally expressed his wish to deposit there a herbarium containing more than 6000 specimens packed in 45 boxes (Minguet, 1989). The Muséum currently holds ca. 3560 of these 6000 specimens in P-Bonpl., which it maintains as a separate historic herbarium (Fig. 2A, 2B, 8). The specimens contain a small label reading "Herb. Mus. Paris. Herbier Humboldt & Bonpland. Amérique Équatoriale" (Fig. 8). This collection is considered to represent the principal set of collections emanating from the Humboldt and Bonpland expedition (Hiepko, 2006). As explained below, the balance of the original deposit (ca. 3000 specimens) was offered by Humboldt to Kunth (Hiepko, 2006). The monocotyledon species present in the Bonpland Herbarium are arranged in exactly the same order as they appear in the first volume of Humboldt & al. (1816-1825) (Fig. 1). Additional taxa of monocotyledons published in the seventh volume (Humboldt & al., 1816-1825) were intermixed later in the same group of specimens.

Humboldt and Bonpland spent most of their time in Venezuela traveling together and as a consequence the collections in the Bonpland Herbarium should be attributed to both of them, but there is one notable exception. When they went from Cumaná to Caracas, a segment of their Venezuelan itinerary clearly described by Bonpland as the "Voyage de Cumaná à Caracas" ("Journal Botanique"), we know that they traveled separately. Humboldt sailed from Cumaná to the port of La Guaira and reached Caracas by the main road, whereas Bonpland, who did not like traveling by boat (Sandwith, 1925), left their ship well to the east of Caracas in the coastal region currently known as Barlovento (Miranda state) and reached the capital by land. Collections originating in these separate itineraries can be recognized from the localities on specimen labels.

The monocotyledon collections deposited in the Bonpland Herbarium (P-Bonpl.) were studied by Kunth and to a lesser extent by Willdenow. The collections do not seem generally to have been made available to other contemporary botanists for study. One exception, however, was the French botanist Louis Claude Marie Richard (1754-1821) who worked closely with Bonpland on the publication of Humboldt & Bonpland (1806-1823). Elsewhere Richard described *Elodea orinocensis* Rich. *(Hydrocharitaceae)* from a collection gathered during the Venezuelan portion of the Humboldt and Bonpland expedition and we surmise that his access to this and other expedition specimens was facilitated by his professional friendship with Bonpland.

For reasons that are unknown to us most of the original labels handwritten by Bonpland were replaced by Kunth and these replacement labels usually contain only the species name and very rarely the original number assigned to the collection and recorded in the "Journal Botanique" (Fig. 9C-F). Bonpland's labels are less frequently encountered than those of Kunth, but when found they contain more details such as the collection number, locality, date of collection (following the French Republican calendar) (Fig. 9A, 9B), and occasionally a common name. The infrequent inclusion of collection numbers on the replaced labels is from our current perspective a bit surprising, since this was the only way by which Kunth could unequivocally link a given specimen to a description in the "Journal Botanique" (Fig. 5A, 5B, 6). Admittedly, the citation of collection numbers was not a common practice in the 18th and early 19th centuries, but Kunth's decision to replace the original labels nonetheless is unfortunate. In early October 1814, one year before the publication of the first volume of Humboldt & al. (1816-1825), Bonpland commented upon this numbering practice in a letter sent to Humboldt (Hamy, 1906: 7 October 1814): "je ne vois aucune utilité à citer le numéro du Manuscrit. Nous ferions en cela ce qu'aucun voyageur et ce qu'aucun auteur n'ont fait et cette innovation serait en pure perte … Nous avons à cet égard à suivre ce qu'ont fait Desfontaines et les autres botanistes, c'est-à-dire nous devons garder nos manuscrits pour nous" [I do not see any utility in citing the manuscript numbers (making reference to the "Journal Botanique"). Doing so, we would do what no traveler and no author has ever done and this innovation would be a pure loss … We have followed in this respect what has been done by Desfontaines and other botanists, that is to say, we must keep our manuscripts for ourselves].

The entire monocotyledon collection, including species from all of the present-day countries visited during the journey of Humboldt and Bonpland, contains about 350 specimens and more or less the same number of species. There are 86 specimens of monocotyledon from Venezuela and these represent 86 species belonging to 57 genera and 19 families (Table 1). In almost all cases monocotyledon specimens deposited in P-Bonpl. are represented by a single sheet. In fact, we found only 14 species, half of them orchids, represented by more than one sheet. We suspect that the paucity of duplicates can be attributed to the fact that extra material probably was distributed by Willdenow, Kunth, and even Humboldt or given to Kunth.



Fig. 8. – Representative specimen of the monocotyledon collection deposited in P-Bonpl. The example is *Heliconia psittacorum* L. f. *(Heliconiaceae)* collected in the region of Caripe, northeastern Venezuela.

[© Herbarium, Muséum National d'Histoire Naturelle, Paris]



Fig. 9. – Examples of labels associated with the monocotyledon specimens at P-Bonpl. **A-B.** Original labels with Bonpland's handwriting (i.e., collector's number and locality) and subsequent determinations made by Kunth ; **C-F.** Replacement labels with only Kunth's handwriting.

[© Herbarium, Muséum National d'Histoire Naturelle, Paris]

Table 1. – Venezuelan specimens of monocotyledon deposited in P-Bonpl.

Taxon[1]	**Locality on label**	**Locality in Humboldt & al. (1816-1825)**[2]
Aroideae (Araceae)		
Pothos canniformis Kunth, nom. illeg.	Cumaná	Prope Santa Cruz (Prov. Cumanensi)
Pothos crassinervius Jacq.	sine loc.	Montis Cocollar (Prov. Cumanensi)
Pothos cordatus Willd.	Caracas, La Silla	Montis Avilae seu Silla de Caracas
Pothos flexuosus Kunth	Montaña de Yavita	Inter Atures et Maypures ; Fluminis Nigri et Tuamini, prope Javitam
Gramineae (Poaceae)		
Reimaria acuta Flüggé	Orenoque	Prope Atures, San Fernando de Atabapo et Ventuarii ostia
Paspalum pulchellum Kunth	Orinoco, Atures, in pratis	Inter Atures et Raudal de Javariveni
Eriochloa distachya Kunth	Orinoco, inter Santa Barbara et Esmeralda	Inter Santa Barbara et Esmeraldam
Oplismenus burmannii (Retz.) P. Beauv.	Orinoco, prope Carichana	Prope Carichana
Oplismenus polystachyus Kunth	sine loc.	Prope Maypure, Montis Cumadaminari
Setaria glauca (L.) Beauv.	Cumaná	Prope Carichana ; juxta Caripe
Setaria composita Kunth	Bordones	Prope Cumaná et Bordones ; juxta Esmeralda
Setaria disticha (Lam.) Kunth	sine loc.	Prope Bordones
Cenchrus echinatus L.	sine loc.	Juxta Cumaná
Cenchrus pilosus Kunth	sine loc.	Llanos de Nueva Barcellona ; juxta Villa del Pao
Echinolaena scabra Kunth	Orinoco	Atabapo juxta San Balthasar
Aristida spadicea Kunth	sine loc.	Prope Carichana
Podesemum alpestre Kunth	sine loc.	Monte Silla de Caracas
Vilfa virginica (L.) P. Beauv.	sine loc.	Juxta Cumaná et Punta Araya
Gynerium saccharoides Bonpl.	Venezuela, Cumaná	Prope Cumanam
Poa maypurensis Kunth	sine loc.	Inter Cataractam Sancti Josephi Maypurensium et confluentem Sipapum
Poa ciliaris L.	sine loc.	Cumaná. Araya (the two localities are cited for two different varieties, α and β)
Eleusine indica (L.) Gaertn.	sine loc.	Cumaná (locality for variety α)
Dactyloctenium aepyptium (L.) Willd.	sine loc.	Cumaná
Pariana campestris Aubl.	Rio Atabapo, Rio Negro	Atabapo, Cassiquiare, Orinoco et Guainia
Saccharum dubium Kunth	sine loc.	Cocollar, Turimiquiri et Caripe Cumanensium
Anthistiria foliosa Kunth	sine loc.	San Fernando Cumanensium et Cuchilla de Guanaguana
Elionurus ciliaris Kunth	sine loc.	Prope Esmeraldam
Bambusa latifolia Bonpl.	Rio Casiquiare	Cassiquiare
Cyperaceae (Cyperaceae)		
Cyperus monostachyus L.	sine loc.	Montis Turimiquiri Cumanensium
Kyllinga monocephala Rottb.	sine loc.	Planitie Caracasana, in Los Llanos de Calabozo
Kyllinga odorata Vahl	sine loc.	Bordones, Cumanacoa, Cocollar, Caripe ; Apure inter San Fernando et El Diamante
Mariscus laevis Kunth	sine loc.	Orinoco, prope Carichana et Esmeralda
Hypolytrum argenteum (Vahl) Kunth	sine loc.	In ripa Orinoci, inter ostia Ventuarii et Conucos de Siquita
Isolepis leucostachya Kunth	sine loc.	In sylvis Orinocensibus Maypurem inter et insulam Tomo
Isolepis vahlii (Lam.) Kunth	sine loc.	In arenosis Orinoci inter ostia fluminis Apure et villam El Capuchino
Isolepis asperula Kunth	sine loc.	In ripa Orinoci, prope San Rafael de Puruey
Isolepis junciformis Kunth	sine loc.	Montanis prope speluncam Guachari et villam Cocollari

[1] Modern families correspond to APG III (2009) ;

[2] Humboldt & al. (1816-1825) was published in quarto and folio editions, but the text and localities cited are thesame irrespective of format ;

[3] Page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Coll. n°	Vol n°: page n° (species n°)[3]	Observations
397	1: 76(4)	The Kunth name seems to be a renaming of *Pothos cannifolius* Sims
s.n.	1: 76(5)	The Hooker homonym was published in 1830
s.n.	1: 77(7)	
978	7: 151(13)	
s.n.	1: 84(1)	
s.n.	1: 90(16)	
s.n.	1: 95(1)	
s.n.	1: 106(1)	
s.n.	1: 107(4)	
s.n.	1: 109(2)	
s.n.	1: 111(5)	
s.n.	1: 112(7)	
s.n.	1: 114(1)	
s.n.	1: 116(4)	
s.n.	1: 118(1)	
s.n.	1: 123(6)	Species also cited for Ecuador and Mexico
s.n.	1: 131(11)	Duplicate found at P and fragment at US
s.n.	1: 137(3)	Species also cited for Peru
s.n.	1: 149(1)	Two duplicates at BM (seen in the TROPICOS database)
s.n.	1: 161(14)	
s.n.	1: 162(15)	Variety α also cited for Mexico
s.n.	1: 165(1)	Species also cited for Colombia, Ecuador and Peru
s.n.	1: 170(1)	Species also cited for Mexico
1023	1: 181(1)	
s.n.	1: 183(4)	Species also cited for Colombia
s.n.	1: 191(2)	
s.n.	1: 193(2)	Species also cited for Colombia
1090	1: 200(2)	
s.n.	1: 203(3)	Species also cited for Colombia
s.n.	1: 211(1)	
s.n.	1: 211(2)	
s.n.	1: 214(5)	
s.n.	1: 218(1)	
s.n.	1: 220(1)	
s.n.	1: 221(5)	
s.n.	1: 221(6)	Species also cited for Colombia and Ecuador
537	1: 222(8)	Duplicate found at P

Table 1. – Cont.

Taxon[1]	**Locality on label**	**Locality in Humboldt & al. (1816-1825)**[2]
Isolepis gracilis Kunth	sine loc.	In ripa arenosa Orinoci prope confluentem Araucam et pagum Carichana
Isolepis dichotoma (L.) Kunth	sine loc.	Prope cataractam Aturensium
Scirpus elegans Kunth	sine loc.	In ripi rivi Tucutunemo prope Villa de Cura, prope La Victoria
Schoenus spadiceus (Lam.) Vahl	sine loc.	Montis Sillae de Caracas
Chaetospora capitata Kunth	sine loc.	Prope montem Duidae et pagum Esmeraldam
Chaetospora pterocarpa Kunth	sine loc.	Prope Atures
Scleria capitata Willd.	Rio Atabapo	Ripa Atabapi, prope Guarinumae cataractam
Scleria hirtella Sw.	sine loc.	Sylva Javitensi, prope fluminis Tuamini
Scleria reflexa Kunth	Bordones	Prope Cumaná et Bordones
Butomeae (Alismataceae)		
Limnocharis humboldtii Rich., nom. illeg. superf.	Quebrada de Tacagua, Caracas	Juxta Caracas in covalle Tacaguensi
Restiaceae (Xyridaceae)		
Xyris vivipara Kunth	Orinoco, inter Ventuari et Guaviare	In ripa Orinoci inter ostia Ventuarii et Guaviares
Commelineae (Commelinaceae)		
Commelina caripensis Kunth	Caripe	Convalle Caripensi prope speluncam Guachari
Tradescantia undata Willd	Caripe, Puerto La Cruz	Montium Cumanensium, inter Caripe et Santa Cruz
Campelia zanonia (L.) Kunth	Caripe	Montium Cumanensium, inter Caripe et Santa Cruz
Asparageae (Xanthorrhoeaceae)		
Dianella dubia Kunth	Silla de Caracas	Montis Silla de Caracas
Asparegeae (Smilacaceae)		
Smilax maypurensis Willd.	Orinoco, Maypures	In ripa Orinoci prope Maypure
Smilax lappacea Willd.	Río Anauco, Caracas	Prope Caracas ad fluvium Anaouco
Smilax siphilitica Willd.	Rio Casiquiare	Fluminis Cassiquiare inter Mandavaca et San Francisco Solano
Smilax scabriuscula Willd.	Caracas, Rio Anauco	In convalli Caracasana propter ripam Anauci
Smilax cumanensis Willd.	Bordones	Prope Cumaná et Bordones
Dioscorinae (Dioscoreaceae)		
Dioscorea alata L.	Trapiche de D. Felix Farreras	Colitur fere ubique in America aequinoctiali
Dioscorea aspera Willd.	Isla de Pararuma, Orinoco	In Orinoci insula Pararumo inter ostia Sinaruci et Metae
Dioscorea cuspidata Willd.	Yavita	In ripa fluminis Tuamini prope Javita
Dioscorea polygonoides Willd.	Orinoco	In ripa Orinoci inter Carichana et confluentem Metam
Dioscorea trifoliata Kunth	Quebrada de Catuche, Caracas	In arcta convalle Catoche, prope Caracas
Asphodeleae (Asparagaceae)		
Phalangium ciliatum Kunth	sine loc.	Prope Caracas
Amaryllideae (Amaryllidaceae)		
Amaryllis nervosa Kunth	Valles de Aragua	Convallibus Araguensibus, juxta Cura, villam Comitis de Tovar

[1] Modern families correspond to APG III (2009);
[2] Humboldt & al. (1816-1825) was published in quarto and folio editions, but the text and localities cited are thesame irrespective of format;
[3] Page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Coll. n°	Vol n°: page n° (species n°)[3]	Observations
s.n.	1: 223(9)	
s.n.	1: 223(10)	
s.n.	1: 226(5)	Species also cited for Peru
755	1: 227(1)	
s.n.	1: 229(1)	
s.n.	1: 230(3)	
s.n.	1: 231(1)	
s.n.	1: 232(2)	
s.n.	1: 232(4)	
s.n.	1: 248(2)	
s.n.	1: 255(2)	
s.n.	1: 260(7)	
550	1: 263(7)	
551	1: 264(1)	Species also cited for Colombia
651	1: 270(1)	
897	1: 270(2)	Duplicate found at P
635	1: 270(3)	Duplicate found at P
1147	1: 271(6)	Duplicate found at P
634	1: 271(8)	Duplicate found at P
285	1: 272(9)	Duplicate found at P
s.n.	1: 273(1)	
865	1: 273(3)	
953	1: 273(4)	
s.n.	1: 274(6)	
626	1: 275(9)	
s.n.	1: 276(1)	
s.n.	1: 278(2)	

Table 1. – Cont.

Taxon[1]	Locality on label	Locality in Humboldt & al. (1816-1825)[2]
Hypoxydeae (Hypoxidaceae)		
Hypoxis breviscapa Kunth	Orinoco, Angostura	Inter urbem Santo Tomas del Angostura et El Trapiche de Don Felix Farreras
Bromeliaceae (Bromeliaceae)		
Tillandsia trichoides Kunth	Caripe	Cuchilla de Guanaguana et prope Caripe Cumanensium
Tillandsia usneoides (L.) L.	Cumaná	Prope La Victoria et Caracas
Pitcairnia pruinosa Kunth	sine loc.	In saxosis insulae Pararuma et ad ripam Orinoci prope Atures
Palmae (Arecaceae)		
Mauritia flexuosa L. f.	Angostura (Orinoco)	Prov. Cumanensis et Caracasanae, ad ostia Orinoci, et prope montem Duida
Haemodoraceae (Haemodoraceae)		
Wachendorfia orinocensis Kunth	Orinoco, Isla de Pararuma	Fluminis Orinoci propter confluentem Sinaruci et in insula Pararumo
Irideae (Iridaceae)		
Cipura graminea Kunth	Orinoco, Angostura	In ripa Orinoci propter urbem Santo Thomas del Angostura
Cipura martinicensis (Jacq.) Kunth	Cumanacoa, Cocollar, Caripe	Prope coenobium Caripense, in montis Cocollar et juxta Cumanacoam
Moraea linearis Kunth	Orinoco, Angostura	Guayanae prope El Trapiche de Farreras
Sisyrinchium tinctorium Kunth	Orinoco	In ripa Orinoci prope Esmeraldam et confluentem Sodomonis
Sisyrinchium iridifolium Kunth	Caracas, La Venta	Prope Caracas et La Victoria
Musaceae (Heliconiaceae)		
Heliconia psittacorum L. f.	Caripe	Convallis Caripensis
Orchideae (Orchidaceae)		
Habenaria angustifolia Kunth	Guyana, Trapiche de D. Farreras	Guayanae inter El Trapiche de Fereras [sic] et urbem Santo Thomas del Angostura
Isochilus linearis (Jacq.) R. Br.	Cumaná	Prope Cumanacoa
Cymbidium glandulosum Kunth	Silla de Caracas	Montis Avila vel Silla de Caracas
Cymbidium cordigerum Kunth	Valles de Aragua, Puerto Cabello	Inter Santa Barbara et Porto Cabello
Cymbidium violaceum Kunth	Orinoco, Atures, Maypures, San Fernando	Prope cataractas Aturensium et San Fernando de Atabapo
Ionopsis pulchella Kunth	Valles de Aragua, prope Porto Cabello	No locality indicated for Venezuela
Vanilla aromatica Sw.	Bordones	Several localities in northern and southern Venezuela
Dendrobium longifolium Kunth	Angostura, Trapiche D. F. Farreras	No locality indicated for Venezuela
Fluviales (Potamogetonaceae)		
Potamogeton tenuifolius Kunth, nom. illeg. hom.	Laguna de Valencia, Valles de Aragua	In lacu Tacariguae prope urbem Novae Valenciae
Fluviales (Ruppiaceae)		
Ruppia maritima L.	Nova Barcelona	Prope urbem Novae Barcellonae (Laguna del otro lado) inter Cumaná et Caracas

[1] Modern families correspond to APG III (2009);
[2] Humboldt & al. (1816-1825) was published in quarto and folio editions, but the text and localities cited are thesame irrespective of format;
[3] Page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Coll. n°	Vol n°: page n° (species n°)[3]	Observations
1073	1: 286(1)	
347	1: 290(1)	
161	1: 290(2)	
s.n.	1: 295(2)	
1068	1: 310(1)	
843	1: 319(1)	
1111	1: 320(2)	
181	1: 321(3)	
1069	1: 321(1)	
s.n.	1: 324(3)	
683	1: 324(5)	Duplicate found at P
282	1: 326(2)	
s.n.	1: 330(2)	
301	1: 340(1)	
1194	1: 340(1)	
1192	1: 341(2)	Duplicate found at P
919	1: 341(3)	
s.n.	1: 348(1)	Species also cited for Colombia
155	1: 355(1)	
1067	1: 360(7)	Species also cited for Colombia
1104	1: 370(2)	
1088	1: 371(1)	

The specimens now in P-Bonpl. must be considered the nomenclatural types (holotypes, isotypes, and syntypes) of names of species described in HUMBOLDT & al. (1816-1825) as this is the collection that formed the basis for this publication. However, taxonomic problems arise when type material is not found in P-Bonpl. as there are only a few indications by Kunth that the material he studied corresponded to specimens deposited in Bonpland's "private" collection. We determined that 235 species of monocotyledon described in HUMBOLDT & al. (1816-1825) are not represented now by specimens in P-Bonpl. Of these 235 species, no material whatsoever could be found for 203 species (Table 2). Thirty-two species, however, were represented by pen and ink line drawings with wash (grisailles), which in most cases were rendered by Pierre Jean François Turpin (1775-1840) (Table 3). Some of the grisailles contain slight corrections in pencil suggesting that they were preliminary versions of plates that were later engraved and included in HUMBOLDT & al. (1816-1825). Approximately half (106) of the species for which type specimens are not found now in P-Bonpl. are *Poaceae*. This suggests that Humboldt allowed Kunth to remove grass specimens for the latter's treatment of the family in volume one of KUNTH (1833) and its supplement (KUNTH, 1835).

The whereabouts of material thought to be deposited in P-Bonpl. but not found there has always puzzled botanists interested in this historical collection. HIND & JEFFREY (2001) encountered a similar problem in their study of the *Asteraceae* that were described in HUMBOLDT & al. (1816-1825). They analyzed the microfiche edition of P-Bonpl. (IDC, 1972), and were perplexed that many taxa had not been imaged and they had no explanation for this except that perhaps specimens were unavailable to be filmed, or alarmingly, that specimens had disappeared from this collection. We believe that there is strong evidence that the missing specimens did not disappear, but in fact were deposited in the general collections in Paris (P) or in B-W or B. Alternatively, it is possible that original collections, and not just duplicates or fragments, were acquired by the herbaria we listed above as minor depositories of Bonpland and Humboldt specimens. Yet another possibility, suggested by LACK (2004a), is that Bonpland did not number all of the herbarium specimens and that a complete set corresponding to the entries in the "Journal Botanique" never existed. Also, as noted by LACK (2004a), it seems reasonable to expect that herbarium specimens of succulent or bulky plants might not have been prepared as these plants present unusual challenges to the collector. Palms *(Arecaceae),* a family that incited great interest in the two explorers, typically require special handling and yield bulky specimens. Interestingly, 14 of the 24 palm species described by Kunth in 1816 in HUMBOLDT & al. (1816-1825) are not found now in P-Bonpl.

We also know from an 1801 letter (MOHEIT, 1993: 126 [letter nr. 41]) from Humboldt to Willdenow that many specimens collected in Venezuela were destroyed by a combination of extremely high humidity and temperature. Of particular note is Humboldt's comment regarding the conservation of plant specimens: "Aber ach! mit Thränen eröffnen wir fast unsere Pflanzenkisten. Unsere Herbarien haben dasselbe Schicksal, über das bereits Sparman, Banks, Swartz und Jacquin geklagt. Die unermessliche Nässe des amerikan[ischen] Klimas, die Geilheit der Vegetation, in der es so schwer ist, alte, ausgewachsene Blätter zu finden, haben über 1/3 unserer Sammlung verdorben ... Ist man 3-4 Monate abwesend, so kennt man sein Herbar[ium] kaum wieder, von den 8 Exemplaren muss man 5 wegwerfen ...." [With tears in our eyes we are opening the boxes with plants. Our herbarium has suffered the same fate to which already Sparman [sic], Banks, Swartz and Jacquin complained. The immeasurable humidity of the American weather, responsible for the accelerated growth of the vegetation that makes impossible to find fully developed leaves have destroyed more than one third of our collection … one scarcely recognizes his herbarium after 3-4 months of absence, from 8 specimens 5 should be thrown away …]. Interestingly, almost four decades later Bonpland informed the director of the Muséum in Paris that some of his herbarium specimens were destroyed by similar environmental problems during the time he spent in Argentina and Paraguay (HAMY, 1906: 5 January 1837): " … le temps m'a à peine permis de la parcourir et d'en séparer le papier en partie détruit par l'humidité et les plantes réduites en poussière" [… time hardly allowed me to go through it (referring to the collection sent to Paris) and remove the paper partially destroyed by the humidity and the plants (that were) reduced to dust].

The P and P-JU herbaria

Toward the end of December 1805 Humboldt wrote Bonpland (HOSSARD, 2004: 22): "I will send your plants as soon as we have finished sorting them out". This seems a clear indication that not long after their arrival in Europe the two explorers had divided the specimens into two main sets, one permanently kept by Humboldt in Paris and the other consisting of an unknown number of specimens kept by Bonpland (referred to here as Bonpland's "private" set of collections). As can be inferred from correspondence between the two explorers (HOSSARD, 2004), soon after Humboldt sent the plants to Bonpland he realized the importance of this material for the preparation of HUMBOLDT & al. (1816-1825) and he asked Bonpland to return it to Paris. Thus, in at least three letters sent to Bonpland in 1806 (HOSSARD, 2004: 26, 46, 52), Humboldt firmly pointed out the critical importance of receiving without delay Bonpland's private set, as well as an unknown number of specimens belonging to Humboldt's set of collections but still kept by Bonpland in Paris. Much later, when Bonpland left Europe in November 1816 with the intention of settling in Argentina (SARTON, 1943; LOURTEIG, 1977; HOSSARD, 2001)

Table 2. – Monocotyledon species cited in Humboldt & al. (1816-1825) for which corresponding specimens were not found in P-Bonpl.

Taxon[1]	Vol n°: page n° (species n°)[2]	Present-day country (ex Humboldt & al., 1816-1825)	Observations
Aroideae (Araceae)			
Pothos microstachyus Kunth	1: 75(2)	Colombia	
Pothos macrophyllus Sw.	1: 77(8)	Colombia	
Pothos angustatus Kunth	1: 77(9)	Venezuela	
Pothos subsagittatus Kunth	1: 77(10)	Venezuela	
Dracontium pertusum L.	1: 78(1)	Venezuela, Colombia	
Pothos panduriformis Kunth	1: 78(12)	Venezuela	One specimen with this name in B-W
Caladium arboreum Kunth	1: 80(1)	Venezuela	
Caladium lacerum (Jacq.) Willd.	1: 80(2)	Venezuela	
Aroideae (Cyclanthaceae)			
Carludovica palmata Ruiz & Pav.	1: 79(1)	Colombia	
Typhinae (Typhaceae)			
Typha tenuifolia Kunth	1: 82(2)	Venezuela	
Gramineae (Poaceae)			
Paspalum carinatum Flüggé	1: 85(1)	Ecuador	
Paspalum stellatum Flüggé	1: 85(2)	Colombia	A fragment ex B-W is at US
Paspalum distichophyllum Kunth	1: 86(3)	Colombia	A fragment ex B-W is at US
Paspalum repens P. J. Bergius	1: 88(9)	Venezuela	
Paspalum scoparium Flüggé	1: 89(13)	Venezuela	One specimen with this name in B-W
Paspalum leptostachyum Flüggé	1: 90(14)	Venezuela	A fragment ex B-W is at US
Paspalum lenticulare Kunth	1: 92(21)	Venezuela	Fragments ex B-W and P-Bonpl. are at US
Panicum monostachyum Kunth	1: 96(2)	Venezuela	A fragment ex P-Bonpl. is at US
Panicum adscendens Kunth	1: 97(3)	Ecuador	
Panicum leucophaeum Kunth	1: 97(4)	Venezuela, Colombia	
Panicum myuros Lam.	1: 98(5)	Colombia	
Panicum fasciculatum Sw.	1: 98(6)	Venezuela, Ecuador, Mexico	
Panicum obtusum Kunth	1: 98(7)	Mexico	Fragments ex P and B are at US
Panicum bulbosum Kunth	1: 99(8)	Mexico	A fragment ex P-Bonpl. is at US
Panicum avenaceum Kunth	1: 99(9)	Ecuador	A fragment ex P-Bonpl. is at US
Panicum decolorans Kunth	1: 100(10)	Mexico	A fragment ex P-Bonpl. is at US
Panicum zizanioides Kunth	1: 100(11)	Colombia	
Panicum glutinosum Lam., nom. illeg. hom.	1: 100(12)	Venezuela	
Panicum divaricatum L.	1: 101(13)	Venezuela, Cuba	
Panicum ruscifolium Kunth	1: 101(14)	Mexico	
Panicum divergens Kunth, nom. utique rejic.	1: 102(15)	Ecuador	
Panicum olyroides Kunth	1: 102(16)	Venezuela	Duplicate found at P; fragment ex P-Bonpl. at US
Panicum cayennense Lam.	1: 103(18)	Venezuela	
Panicum xalapense Kunth	1: 103(19)	Mexico	A fragment ex P-Bonpl. is at US
Panicum jumentorum Pers.	1: 104(20)	Venezuela, Cuba	
Panicum glaucescens Kunth	1: 104(21)	Venezuela, Colombia	A fragment ex P-Bonpl. is at US
Panicum rigens Sw.	1: 104(22)	Venezuela	
Panicum granuliferum Kunth	1: 105(23)	Venezuela	A fragment ex P-Bonpl. is at US

[1] Modern families correspond to APG III (2009);

[2] The page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Table 2. – Cont

Taxon[1]	**Vol n°: page n° (species n°)**[2]	**Present-day country (ex Humboldt & al., 1816-1825)**	**Observations**
Panicum micranthum Kunth	1: 105(24)	Venezuela	A fragment ex P-Bonpl. is at US
Panicum trichoides Sw.	1: 105(25)	Venezuela, Colombia	
Oplismenus crus-pavonis Kunth	1: 108(5)	Venezuela	
Oplismenus zelayensis Kunth	1: 108(6)	Mexico	
Oplismenus colonus (L.) Kunth	1: 108(7)	Mexico	
Setaria gracilis Kunth	1: 109(1)	Colombia	
Pennisetum purpurascens Kunth	1: 113(1)	Mexico	
Aristida humilis Kunth	1: 121(1)	Venezuela	A fragment ex P-Bonpl. is at US
Aristida setifolia Kunth	1: 122(2)	Venezuela	Duplicate found at P; and a fragment ex P-Bonpl. is at US
Aristida recurvata Kunth	1: 123(7)	Venezuela	Duplicate found at P; a fragment ex P is at US
Streptachne tenuis Kunth	1: 124(3)	Venezuela	
Stipa ibarrensis Kunth	1: 125(1)	Ecuador	A fragment ex P is at US
Podosemum implicatum Kunth	1:127(1)	Mexico	
Podosemum tenellum Kunth	1: 128(3)	Mexico	A fragment ex P is at US
Agrostis lanata Kunth	1: 136(4)	Mexico	
Vilfa humifusa Kunth	1: 137(2)	Venezuela	
Vilfa tenacissima (L. f.) Kunth	1: 138(4)	Venezuela	
Vilfa trichodes Kunth	1: 139(7)	Peru	
Crypsis phleoides Kunth	1: 140(1)	Venezuela	A fragment ex P-Bonpl. is at US
Crypsis stricta Kunth	1: 140(2)	Colombia	A fragment ex B-W is at US
Deyeuxia rigida Kunth	1: 144(4)	Ecuador	A fragment ex P is at US
Deyeuxia planifolia Kunth	1: 145(6)	Peru	
Deyeuxia eriantha Kunth	1: 145(7)	Mexico	
Deyeuxia ligulata Kunth	1: 145(8)	Ecuador	A fragment ex P is at US
Avena elongata Kunth	1: 148(4)	Mexico	A fragment ex B is at US
Bromus rotundatus Kunth	1: 152(8)	Mexico	A fragment ex P is at US
Poa patula Kunth	1: 158(6)	Ecuador	A fragment ex P is at US
Poa olmedi Kunth	1: 159(9)	Peru	
Poa aturensis Kunth	1: 161(12)	Venezuela	A fragment ex B is at US
Poa acutiflora Kunth	1: 161(13)	Colombia	
Poa mulalensis Kunth	1: 162(17)	Ecuador	
Poa remota Kunth, nom. illeg. hom.	1: 163(18)	Ecuador	A fragment via P ex Bonpland's "Herbier de l'Amérique équatoriale" is at US
Poa dactyloides Kunth, nom. illeg. hom.	1: 163(19)	Ecuador	A fragment via P ex Bonpland's "Herbier de l'Amérique équatoriale" is at US
Chloris virgata Sw.	1: 166(3)	Mexico	
Chloris polydactyla (L.) Sw., comb. illeg.	1: 167(5)	Mexico	
Chloris gracilis Kunth, nom. illeg. hom.	1: 168(7)	Peru	
Saccharum violaceum Tussac	1: 182(2)		Colitur frequentissime inter tropicos
Eriochrysis cayanensis P. Beauv.	1: 183(1)	Venezuela	
Andropogon angustifolius Kunth, nom. illeg. hom.	1: 184(1)	Mexico	A fragment via P ex Bonpland's "Herbier de l'Amérique équatoriale" is at US
Andropogon montufari Kunth	1: 184(2)	Ecuador	A fragment via P ex Bonpland's "Herbier de l'Amérique équatoriale" is at US
Andropogon plumosus Willd.	1: 185(3)	Venezuela	One specimen under this name in B-W; fragment ex P at US

[1] Modern families correspond to APG III (2009);

[2] The page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Table 2. – Cont

Taxon[1]	Vol n°: page n° (species n°)[2]	Present-day country (ex Humboldt & al., 1816-1825)	Observations
Andropogon allionii DC.	1: 185(4)	Mexico	
Andropogon leucostachyus Kunth	1: 187(7)	Venezuela	
Andropogon tristachyus Kunth	1: 187(8)	Venezuela	A fragment ex P is at US
Andropogon lanuginosus Kunth	1: 187(9)	Ecuador	A fragment ex P is at US
Andropogon condensatus Kunth	1: 188(10)	Colombia	There are fragments ex B and P at US; and a sheet via P from Bonpland's "Herbier de l'Amérique équatoriale" at US
Andropogon decolorans (Willd.) Kunth	1: 190(14)	Venezuela	
Anthistiria reflexa Kunth, nom. illeg. superfl.	1: 191(1)	Venezuela	
Ischaemum hispidum (Willd.) Kunth	1: 194(1)	Venezuela, Ecuador	Duplicate under *Andropogon hispidus* in B-W
Oryza latifolia Desv.	1: 195(1)	Colombia	
Pharus glaber Kunth	1: 196(1)	Venezuela	
Pharus scaber Kunth	1: 196(2)	Colombia	
Olyra longifolia Kunth	1: 198(3)	Venezuela	A fragment ex B-W is at US
Olyra cordifolia Kunth	1: 198(4)	Colombia	A fragment ex P is at US
Olyra micrantha Kunth	1: 199(5)	Venezuela	Duplicate found at P; fragment ex P at US.
Luziola mexicana Kunth, nom. nud.	1: 199(1)	Mexico	
Nastus chusque Kunth	1: 201(1)	Colombia, Ecuador	Isotype at US, the material from P via herb. Trinius
Cyperaceae (Cyperaceae)			
Cyperus articulatus L.	1: 202(1)	Venezuela, Ecuador, Peru	One specimen under this name in B-W
Cyperus nudus Kunth	1: 203(2)	Mexico	
Cyperus mucronatus L.	1: 203(4)	Mexico	
Cyperus oligostachyus Kunth	1: 204(5)	Venezuela	One specimen under this name in B-W
Cyperus cuspidatus Kunth	1: 204(6)	Venezuela	Duplicate found at P
Cyperus aurantiacus Kunth	1: 205(7)	Venezuela	
Cyperus aureus Kunth, nom. illeg. hom.	1: 205(8)	Ecuador	
Cyperus hydra Kunth, nom. illeg. hom.	1: 205(9)	Mexico	
Cyperus prolixus Kunth	1: 206(10)	Colombia	
Cyperus tolucensis Kunth	1: 206(11)	Mexico	
Cyperus simplex Kunth	1: 207(12)	Colombia	
Cyperus compressus L.	1: 207(13)	Mexico	
Cyperus melanostachyus Kunth	1: 207(14)	Colombia	
Cyperus variegatus Kunth	1: 208(15)	Mexico	
Cyperus divergens Kunth	1: 208(16)	Mexico	
Cyperus seslerioides Kunth	1: 209(17)	Venezuela	
Cyperus manimae Kunth	1: 209(18)	Venezuela	Duplicate found at P
Cyperus luzulae (L.) Retz.	1: 209(19)	Venezuela	
Cyperus surinamensis Rottb.	1: 210(20)	Venezuela	One specimen under this name in B-W
Cyperus rufus Kunth	1: 210(21)	Colombia	
Mariscus filiformis (Sw.) Kunth	1: 213(2)	Venezuela	
Mariscus flabelliformis Kunth	1: 215(7)	Venezuela	
Mariscus polyphyllus Kunth	1: 217(12)	Ecuador	
Papyrus odorata (L.) Kunth	1: 217(1)	Venezuela	
Isolepis squarrosa (L.) Kunth	1: 221(4)	Venezuela	
Isolepis bufonia Kunth	1: 222(7)	Venezuela	Duplicate under *Scirpus bufonius* (Kunth) Spreng. in B-W

[1] Modern families correspond to APG III (2009);

[2] The page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Table 2. – Cont

Taxon[1]	**Vol n°: page n° (species n°)**[2]	**Present-day country (ex Humboldt & al., 1816-1825)**	**Observations**
Isolepis exilis Kunth	1: 224(11)	Venezuela	
Isolepis hirta Kunth	1: 224(12)	Venezuela	Duplicate under *Scirpus hirtus* (Kunth) Poir. in B-W
Scirpus exiguus Kunth	1: 225(1)	Colombia	
Scirpus trichoides Kunth	1: 225(2)	Colombia	
Scirpus capitatus L.	1: 225(3)	Venezuela	One specimen with this name in B-W
Schoenus tenuifolius Kunth	1: 228(2)	Venezuela	
Schoenus pubescens Kunth, nom. illeg. superfl.	1: 228(3)	Venezuela	
Schoenus globosus Kunth, nom. illeg. hom.	1: 229(4)	Colombia	
Chaetospora globosa Kunth	1: 230(2)	Venezuela	
Chaetospora aurea (Vahl) Kunth	1: 231(5)	Venezuela	
Scleria scabra Willd.	1: 232(3)	Venezuela	One specimen under this name in B-W
Scleria floribunda Kunth	1: 233(5)	Colombia	
Junceae (Juncaceae)			
Juncus bogotensis Kunth	1: 235(1)	Colombia	
Juncus compressus Kunth, nom. illeg. hom.	1: 235(2)	Mexico	
Juncus platycaulos Kunth	1: 236(3)	Venezuela, Colombia	
Juncus prolifer Kunth	1: 236(4)	Colombia	
Juncus microcephalus Kunth	1: 237(5)	Colombia	
Juncus floribundus Kunth	1: 237(6)	Venezuela	
Juncus densiflorus Kunth	1: 238(7)	Venezuela	Duplicate found at P; a fragment ex P is at MO
Juncagineae (Juncaginaceae)			
Triglochin mexicanum Kunth	1: 244(1)	Mexico	
Podostemeae (Podostemaceae)			
Podostemum ruppioides Kunth	1: 246(1)	Venezuela	
Marathrum foeniculaceum Bonpl.	1: 246(1)	Colombia	
Alismaceae (Alismataceae)			
Sagittaria guayanensis Kunth	1: 250(1)	Venezuela	
Restiaceae (Eriocaulaceae)			
Eriocaulon pilosum Kunth	1: 251(1)	Colombia	
Eriocaulon dendroides Kunth	1: 252(2)	Colombia	
Eriocaulon congestum Kunth	1: 252(3)	Venezuela	One specimen under this name in B-W
Eriocaulon umbellatum Lam.	1: 252(4)	Venezuela	One specimen under this name in B-W
Eriocaulon microcephalum Kunth	1: 253(5)	Ecuador	
Eriocaulon tenue Kunth	1: 253(6)	Venezuela	
Eriocaulon decemangulare L.	1: 254(7)	Venezuela	
Abolboda pulchella Bonpl.	1: 256(1)	Venezuela	One specimen under this name in B-W
Abolboda imberbis Kunth	1: 256(2)	Venezuela	
Restiaceae (Hydrocharitaceae)			
Elodea orinocensis Rich.	*7*: 161(2)	Venezuela	

[1] Modern families correspond to APG III (2009);

[2] The page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Table 2. – Cont

Taxon[1]	Vol n°: page n° (species n°)[2]	Present-day country (ex Humboldt & al., 1816-1825)	Observations
Commelineae (Commelinaceae)			
Commelina elliptica Kunth	1: 259(5)	Venezuela	
Commelina floribunda Kunth	1: 260(8)	Venezuela	
Colchiceae (Tofieldiaceae)			
Tofieldia frigida Kunth	1: 267(1)	Ecuador	
Colchiceae (Melanthiaceae)			
Helonias virescens Kunth	1: 267(1)	Mexico	
Asparegeae (Smilacaceae)			
Smilax cordifolia Willd.	1: 271(4)	Mexico	
Smilax triplinervia Willd.	1: 272(10)	Venezuela	One specimen under this name in B-W
Smilax mollis Willd.	1: 272(11)	Mexico	Duplicate found at P
Dioscorinae (Dioscoreaceae)			
Dioscorea scabra Willd.	1: 273(2)	Venezuela	One specimen under this name in B-W
Dioscorea coriacea Willd.	1: 274(5)	Ecuador	
Dioscorea trachycarpa Kunth	1: 274(8)	Venezuela	
Amaryllideae (Amaryllidaceae)			
Pancratium littorale Jacq.	1: 279(1)	Colombia	
Pancratium undulatum Kunth	1: 280(2)	Venezuela	
Pancratium incarnatum Kunth	1: 280(3)	Ecuador	
Pancratium aurantiacum Kunth	1: 280(4)	Ecuador	
Haemanthus dubius Kunth	1: 281(1)	Ecuador	
Amaryllideae (Alstroemeriaceae)			
Alstroemeria salsilla L.	1: 284(6)	Colombia	
Hypoxideae (Hypoxidaceae)			
Hypoxis humilis Kunth	1: 286(2)	Venezuela	
Hypoxis elongata Kunth	1: 287(4)	Colombia	
Tulipaceae (Asparagaceae)			
Yucca spinosa Kunth	1: 289(1)	Mexico	
Yucca acaulis Kunth	1: 289(2)	Venezuela	
Bromeliaceae (Bromeliaceae)			
Pourretia lanuginosa Ruiz & Pav.	1: 295(1)	Peru	
Bromelia karatas L.	1: 297(1)	Venezuela	
Bromelia ananas L.	1: 297(2)	America Aequinoctialis	
Bromeliaceae (Asparagaceae)			
Agave americana L.	1: 297(1)	America Aequinoctialis	

[1] Modern families correspond to APG III (2009);

[2] The page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Table 2. – Cont

Taxon[1]	Vol n°: page n° (species n°)[2]	Present-day country (ex Humboldt & al., 1816-1825)	Observations
Palmae (Arecaceae)			
Corypha maritima Kunth	1: 298(2)	Cuba	
Corypha pumos Kunth	1: 298(3)	Mexico	
Corypha nana Kunth	1: 299(4)	Mexico	
Corypha tectorum Kunth	1: 299(5)	Venezuela	
Chamaerops mocini Kunth	1: 301(1)	Mexico	
Cocos nucifera L.	1: 301(1)	Locis maritimus	
Cocos butyracea L. f.	1: 301(2)	Colombia	
Cocos crispa Kunth	1: 302(3)	Cuba	
Aiphanes praga Kunth	1: 303(1)	Venezuela	
Oreodoxa sancona Kunth	1: 304(1)	Colombia	
Oreodoxa frigida Kunth	1: 304(2)	Colombia	
Mauritia aculeata Kunth	1: 311(2)	Venezuela	
Irideae (Iridaceae)			
Cipura humilis Kunth	1: 320(1)	Colombia	
Moraea acorifolia Kunth	1: 322(5)	Venezuela	
Sisyrinchium tenuifolium Willd.	1: 324(4)	Mexico	
Musaceae (Musaceae)			
Musa paradisiaca L.	1: 326(1)	Am. Aequinoctalis	
Musaceae (Heliconiaceae)			
Heliconia bihai (L.) L.	1: 326(1)	Am. Aequinoctales	
Amomeae (Cannaceae)			
Canna glauca L.	1: 328(1)	Venezuela	One specimen under this name in B-W
Amomeae (Zingiberaceae)			
Alpinia occidentalis Sw.	1: 329(1)	Colombia	One specimen under this name in B-W
Zingiber officinale Roscoe	1: 329(1)	Venezuela	
Orchideae (Orchidaceae)			
Ophrys paleacea Kunth	1: 334(2)	Ecuador	
Trichoceros antennifer Kunth	1: 338(2)	Ecuador	
Anguloa grandiflora (Bonpl.) Kunth	1: 343(2)	Ecuador	
Orchideae (Hydrocharitaceae)			
Najas arguta Kunth	1: 371(1)	Colombia	
Fluviales (Araceae)			
Lemna minuta Kunth	1: 372(1)	Colombia	

[1] Modern families correspond to APG III (2009);

[2] The page numbers cited here are for the quarto edition of Humboldt & al. (1816-1825) (see Harriman (1992) for corresponding page numbers in the folio edition).

Table 3. – Monocotyledon species cited in HUMBOLDT & al. (1816-1825) but only represented by grisailles in P-Bonpl.

Taxon[1]	Vol n°: page n° (species n°)[2]	Locality in HUMBOLDT & al. (1816-1825)[3]
Aroideae (Araceae)		
Pothos pedatus Kunth	1: 78(11)	Colombia
Gramineae (Poaceae)		
Paspalum ciliatum Kunth, nom. illeg. hom.	1: 87(5)	Colombia
Paspalum aureum (P. Beauv.) Kunth	1: 93(24)	Colombia
Paspalum fimbriatum Kunth	1: 93(25)	Colombia
Paspalum lanatum Kunth	1: 94(26)	Mexico
Eriochloa polystachya Kunth	1: 95(2)	Ecuador
Panicum rottboellioides Kunth	1: 96(1)	Venezuela
Panicum aturense Kunth	1: 103(17)	Venezuela
Pennisetum uniflorum Kunth	1: 114(2)	Venezuela
Thrasya paspaloides Kunth	1: 121(1)	Venezuela
Streptachne scabra Kunth	1: 124(1)	Mexico
Aegopogon cenchroides Willd.	1: 132(1)	Venezuela, Ecuador
Aegopogon geminiflorus Kunth	1: 133(2)	Venezuela
Polypogon interruptus Kunth	1: 134(1)	Venezuela
Arundo nitida Kunth	1: 149(1)	Colombia
Dinebra repens Kunth	1: 172(4)	Mexico
Polyodon distichus Kunth	1: 175(1)	Ecuador
Chondrosum gracile Kunth	1: 176(3)	Mexico
Pentarrhaphis scabra Kunth	1: 178(1)	Mexico
Triaena racemosa Kunth	1: 179(1)	Mexico
Elionurus tripsacoides Willd.	1: 192(1)	Venezuela, Colombia
Diectomis fastigiata (Sw.) Kunth	1: 193(1)	Venezuela
Cyperaceae (Cyperaceae)		
Mariscus mutisii Kunth	1: 216(10)	Colombia
Isolepis lanata Kunth	1: 220(2)	Venezuela
Restiaceae (Eriocaulaceae)		
Eriocaulon ensifolium Kunth	1: 254(8)	Colombia
Palmae (Arecaceae)		
Martinezia caryotaefolia Kunth	1: 305(1)	Venezuela, Colombia
Attalea amygdalina Kunth	1: 310(1)	Colombia
Orchideae (Orchidaceae)		
Ophrys ciliata Kunth	1: 334(1)	Venezuela
Catasetum maculatum Kunth	7: 157(1)	Colombia
Catasetum macrocarpum Kunth	7: 158(2)	French Guiana
Anguloa superba Kunth	1: 343(1)	Peru
Masdevallia uniflora Ruiz & Pav.	1: 361(1)	Ecuador

[1] Modern families correspond to APG III (2009);

[2] The page numbers cited here are for the quarto edition of HUMBOLDT & al. (1816-1825) (see HARRIMAN, 1992 for corresponding page numbers in the folio edition);

[3] The localities cited here are resolved to the present-day country of the place name(s) cited in HUMBOLDT & al. (1816-1825).

(Fig. 7) he took with him these collections (i.e., the "private" set) and attempted also to take the "Journal Botanique" (Hiepko, 2006) (Fig. 5A, 5B, 6). The field notes fortunately were reclaimed at the last moment by Kunth (Lack, 2004a), but the specimens went with Bonpland back to South America and were not returned to Europe until 1832 (Fig. 7). In 1837 Bonpland described the return of these specimens to Paris in a letter to the director of the Muséum (Hamy, 1906: 5 January 1837): "Ces plantes peuvent être divisées en deux parties. Dans la première je placerai les plantes doubles du voyage que j'ai fait avec M. de Humboldt et qui me sont tombées en partage; et dans la seconde, des plantes de tous les pays qui fesaient partie de mon herbier général" [These plants can be divided into two parts. In the first I will place the duplicates from the voyage I undertook with M. Humboldt and which were my share; and in the second, plants from all countries that constitute part of my general herbarium].

Bonpland specimens arrived again in Paris in 1833 and on 21 July 1837 the Muséum agreed to incorporate all of them in P (Lack, 2003). These specimens and their duplicates in other herbaria can be recognized by a printed notation on their labels (viz., "Herbier donné par M. Bonpland en 1833" or "Herbier de l'Amérique équatoriale, donné par M. A. Bonpland") (Fig. 10). Bonpland's set is important not only because some of the unicates contained in it were used by Kunth while editing Humboldt & al. (1816-1825), but also because this private set undoubtedly contains a large number of duplicates of P-Bonpl. as well as types associated with Humboldt & Bonpland (1808-1809) and Humboldt & Bonpland (1806-1823). Bonpland was deeply invested in these two publications and one would expect that many of the specimens he cited in these monographs were always kept in his private herbarium. It is possible, too, that types associated with those in Bonpland (1813), none of which have yet been located (Stafleu & Cowan, 1976), also once were contained in his private collection or, as will be explained below, are present in other historical herbaria such as that of P-JU.

The exact number of specimens and taxa once contained in Bonpland's private set of Bonpland and Humboldt collections, now fully integrated in P, remains unknown and physically locating these specimens is a monumental task. This is not only attributable to the large number of specimens involved, but also because relevant specimens might have had several name changes over the years as they were studied and curated. However, targeted efforts focused on specific families such as *Asteraceae* (Hind & Jeffrey, 2001) and *Solanaceae* (Granados Tochoy & al., 2007; S. Knapp, *pers. comm.*) have often shown promising results. Moreover, preliminary studies carried out in the palm *(Arecaceae)* family clearly demonstrated that some of the specimens used for the publication of Humboldt & Bonpland (1816-1825) are to be found in the general collection in Paris.

An electronic search of P-JU yielded 32 collections of different pteridophyte and angiosperm families linked to Bonpland. Among these collections, the specimens labeled with New World localities can definitely be associated with Aimé Bonpland, but for specimens labeled with European localities it is not clear whether they were gathered by Aimé or his brother Michel-Simon, who also was in close contact with Antoine-Laurent de Jussieu. In this historic herbarium there is a particularly good representation of specimens of the genus *Tacsonia* Juss. *(Passifloraceae),* which is not surprising as de Jussieu based several species (e.g., *T. glaberrima* Juss., *T. manicata* Juss., and *T. tripartita* Juss.) on specimens collected by Aimé Bonpland in present-day Colombia, Ecuador, Peru, and Venezuela.

We also are aware that Humboldt and Bonpland had sent by the end of January 1805 not only dried herbarium specimens to the Muséum National d'Histoire Naturelle, Paris, but also abundant seed (*MS 617,* Médiathèque Michel Crépeau, La Rochelle) (Fig. 11) that undoubtedly was given to the Jardin des Plantes for cultivation. There is always the possibility that specimens prepared from this cultivated material found their way into P.

The B-W herbarium

The retrieval, examination, and evaluation of monocotyledon specimens collected by Bonpland and Humboldt and now deposited in B-W (Fig. 3A, 3B, 7) is challenging and has inherent practical difficulties (see e.g. Hind & Jeffrey, 2001). The complicated methodology we adopted for our project, however, proved to be quite satisfactory for retrieving and analyzing Venezuelan monocotyledon specimens. We discovered 126 specimens of Venezuelan monocotyledon in this herbarium (Fig. 3B, 12) and they correspond to the same number of species arranged in 64 genera and 26 families (Table 4).

In addition to herbarium specimens, Humboldt and Bonpland sent seed to Willdenow and while we do not know the exact number of propagules, we do know from a letter Humboldt sent to Bonpland on 21 December 1805 (Hossard, 2004: 22) that as many as 75 "species" conveyed to Willdenow were successfully cultivated in Berlin and that Willdenow expected many more seeds to germinate.

Willdenow's set of Bonpland and Humboldt specimens contained not only duplicates of most of the collections deposited in P-Bonpl., but also some unique specimens not represented in the principal set. After Willdenow's death in 1812, his herbarium passed to the custody of his friend D. F. K. von Schlechtendal (1767-1842) (McVaugh, 1955) and eventually Schlechtendal's son, Diederich Franz Leonhard von Schlechtendal. The herbarium was purchased by the Botanischer Garten und Botanisches Museum Berlin-Dahlem and came into its possession in 1818. The younger Schlechtendal



Fig. 10. – Representative specimen collected by Bonpland and Humboldt deposited in P. The example is *Smilax cumanensis* Willd. *(Smilacaceae)*. Note Bonpland's handwriting on the original label (bottom left-hand corner of the specimen).

[© Herbarium, Muséum National d'Histoire Naturelle, Paris]

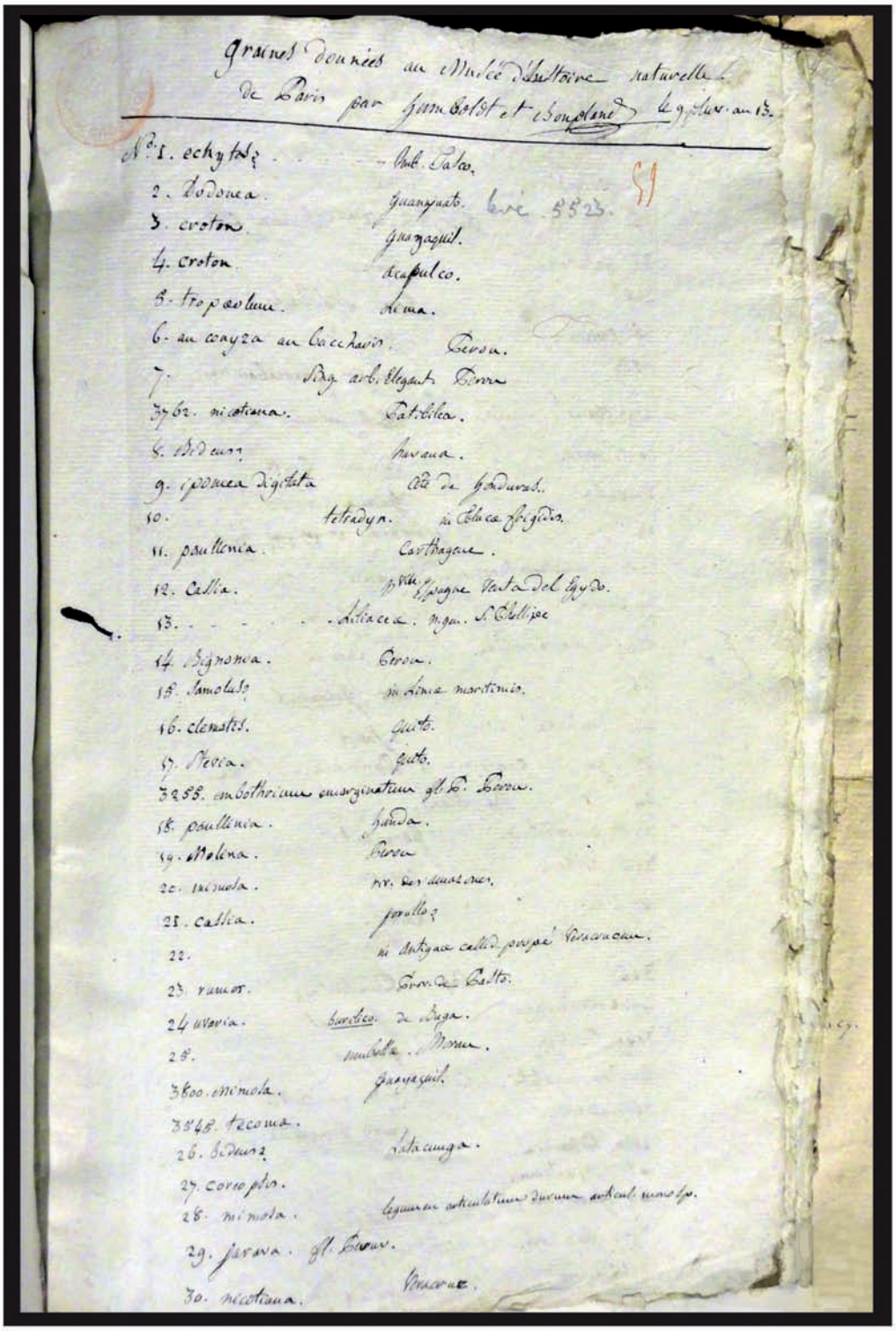


Fig. 11. – Partial text of a list of seed sent by Humboldt and Bonpland to the Muséum National d'Histoire Naturelle, Paris. The page shown is dated "9 pluv an 13" (i.e., 29 January 1805). [© Médiathèque Michel Crépeau, La Rochelle]



Fig. 12. – Representative specimen collected by Bonpland and Humboldt deposited in B-W. The example is *Epidendrum atropurpureum* Willd. *(Orchidaceae)*. Note Bonpland's handwriting on the original label. Arrows point to D. F. L. von Schlechtendal's annotations at the top right-hand corner of the sheet with the species name and at the bottom right-hand corner with the word "Humboldt" and letter "W" (for Willdenow).

[© Botanischer Garten und Botanisches Museum Berlin-Dahlem]

Table 4. – Venezuelan specimens of monocotyledon deposited in B-W.

Taxon[1]	Locality in folder or on label [loc. in "Journal Botanique"]	Coll. n°
Cannaceae		
Canna glauca L.	Villa del Pao, cultus	1086
Costaceae		
Costus ciliatus Miq.	Bordones (sw von Cumaná)	136
Zingiberaceae		
Alpinia latifolia Link	sine loc.	s.n.
Alpinia occidentalis Sw.	Cumaná, Caripe	194
Marantaceae		
Thalia racemosa Link	Caripe	218
Thalia pubescens Link	Caripe	303
Thalia nemorosa Link	Orinoco, Casiquiare	s.n.
Iridaceae		
Marica graminea (Kunth) Roem. & Schult.	Angostura [Hac. D. F. Farreras]	s.n.
Marica martinicensis (Jacq.) Ker Gawl.	Caripe [Cocollar et Cumaná]	181
Haemodoraceae		
Xiphidium laevigatum ined.	Orinoco, in umbris Javita	950
Xiphidium angustifolium Link	Orinoco, Isla de Pararuma	843
Pontederiaceae		
Heteranthera alismoides Link	Caracas [Quebrada Cotecita]	584
Xyridaceae		
Abolboda pulchella Bonpl.	Maypure	1114
Chloerum pusillum ined.	Atabapo	1099
Cyperaceae (part I)		
Schoenus flavus Link	Orinoco, Maypure	s.n.
Rhynchospora filiformis Vahl	Caracas [Turimiquire]	538
Rhynchospora lanceolata Kunth	Orinoco	s.n.
Dichromena ciliata Vahl, nom. illeg. hom.	Orinoco	s.n.
Dichromena squarrosa Link	Orinoco	s.n.
Scirpus leucostachyus (Kunth) Poir.	Orinoco	s.n.
Scirpus capitatus L.	Cumaná, Cocollar	545
Scirpus capitatus L.	sine loc. [Mariara et Barbula, in Aguas Calientes]	754
Scirpus capitatus L.	sine loc. [Setaria de Barbula]	755
Scirpus sphacelatus (R. Br.) Poir.	Via Tucuremo prope la [Villa] de Cura, V. de Aragua	764
Scirpus sesquipollicaris Kunth, nom. nud., pro syn.	Orinoco	s.n.
Scirpus bufonius (Kunth) Spreng.	Am. Merid. [Caripe]	536
Scirpus hirtus (Kunth) Poir.	Orinoco [Setaria de Barbula]	755

[1] Taxa are arranged according to the number assigned in D. F. L. Schlechtendal's catalogue; families here indicated correspond to the classification of APG III (2009).

N° Schl. Cat.	Observations
5	Duplicate, which we expected to be deposited in P-Bonpl., not found
16	
20	Link did not cite a locality in his protologue, but modern databases (e.g., TROPICOS) assign the collection number 203, which may correspond to a Venezuelan locality. *Humboldt & Bonpland 203* (B-W), however, is placed at the end of this herbarium, without a catalogue number and stored as *Calathea* sp.
21	Duplicate, which we expected to be deposited in P-Bonpl., not found
31	
32	
33	
1026	Possible duplicate in P labeled *Cipura graminea* Kunth, the basionym of this combination and name used in HUMBOLDT & al. (1816-1825).
1028	Duplicate in P-Bonpl. labeled *Cipura martinicensis* (Jacq.) Kunth, the name used in HUMBOLDT & al. (1816-1825)
1031	This name probably first proposed by Willdenow as LINK (1820) indicated that it was already on the specimen, but Link could not differentiate this taxon from *X. floribundum* Sw.
1032	
1036	
1067	
1068	Locality absent from the label on the specimen, but written by Willdenow on the main label of the folder
1094	Duplicate at B photographed by J. Francis Macbride, but specimen no longer extant
1134	
1145	Duplicate at B photographed by J. Francis Macbride, but specimen no longer extant
1151	
1153	Kunth note states: "*Rapatea* [fr.] cf. with number 1094"
1166	Possible duplicate deposited in P as *Isolepis leucostachya* Kunth, the name used in HUMBOLDT & al. (1816-1825)
1183	
1183	
1183	Number also assigned to collections with catalogue numbers 1224, 2361; duplicate in P-Bonpl. as *Schoenus spadiceus* (Lam.) Vahl, the name used in HUMBOLDT & al. (1816-1825)
1193	
1200	
1219	
1224	Number also assigned to collections with catalogue numbers1183-3, 2361; duplicate in P-Bonpl. as *Schoenus spadiceus* (Lam.) Vahl, the name used in HUMBOLDT & al. (1816-1825)

Table 4. – Cont.

Taxon[1]	**Locality in folder or on label [loc. in "Journal Botanique"]**	**Coll. n°**
Scirpus vahlii Lam.	Am. Merid. [Orinoco]	845
Scirpus spadiceus L.	Am. Merid. [Bordones in humid.]	541
Scirpus junciformis (Kunth) Poir., comb. illeg.	Am. Merid. [Caripe Cocollar]	537
Scirpus fuscescens Link	Orinoco	s.n.
Abildgaardia laevigata ined.	sine loc. [Turimiquire, Cocollar]	549
Cyperus articulatus L.	sine loc. [Bordones]	548
Cyperus filifolius Kunth	Orinoco	s.n.
Cyperus oligostachyus Kunth	sine loc. [Bordones]	546
Cyperus surinamensis Rottb.	sine loc. [sine loc.]	542
Cyperus junceus Link	Orinoco [Isla de Pararuma]	867
Cyperus rhaphiostachys Kunth	Orinoco	847
Cyperus conglobatus Link	Orinoco, Cariche	845
Cyperus globuliferus J. Presl & C. Presl, nom. illeg. hom.	Orinoco [Maypure]	885
Poaceae (part I)		
Kyllinga odorata Vahl	Am. Merid. [Bordones, Cumaná, Cocollar, Caripe]	544
Zoysia rigida Kunth	Orinoco	s.n.
Paspalum scoparium Flüggé	Nova Barcellona	s.n.
Reimaria elegans Flüggé	Cumaná	s.n.
Ceresia aristata Steud., nom. nud., pro syn.	Cumaná	s.n.
Elionurus ciliaris Kunth	Esmeraldas	s.n.
Aegopogon cenchroides Willd.	Caracas	s.n.
Digitaria monostachya Steud., nom. nud., pro syn.	Orinoco	s.n.
Aglycia distachya Steud., nom. nud.	Orinoco	s.n.
Milium confertum L.	Aranjuez, Spain	199
Stipa alpestris Steud., nom. nud., pro syn.	Silla de Caracas	s.n.
Cynosurus sp. nov. ined.	Aranjuez, Spain	200
Eriocaulaceae		
Eriocaulon sphacelatum Kunth	Caracas	755
Eriocaulon decangulare L.	sine loc.	s.n.
Eriocaulon congestum Kunth	Cumaná	s.n.
Eriocaulon umbellatum Lam.	Cumaná	s.n.
Araceae (part I)		
Pothos canniformis Kunth, nom. illeg.	sine loc. [habit Sta. Cruz]	396
Pothos venosus Schult. & Schult. f.	Cumaná [prope Caripe]	295
Pothos panduriformis Kunth	Orinoco	1198
Pothos digitata Jacq.	Valles de Aragua [Cocollar]	789

[1] Taxa are arranged according to the number assigned in D. F. L. Schlechtendal's catalogue ; families here indicated correspond to the classification of APG III (2009).

N° Schl. Cat.	Observations
1228	Collection number also asigned to *Cyperus conglobatus* Link; duplicate in P-Bonpl. as *Isolepis vahlii* (Lam.) Kunth, the name used in Humboldt & al. (1816-1825)
1257	
1268	No description of the collection in the "Journal Botanique"; duplicate in P-Bonpl. under *Isolepis junciformis* Kunth, the name used in Humboldt & al. (1816-1825)
1270	
1277	
1280	
1293	
1300	Species described in Humboldt & al. (1816-1825), but material not found at P-Bonpl.; duplicate at B photographed by J. Francis Macbride, but specimen no longer extant
1324	
1340	
1386	
1389	Collection number also assigned to *Schoenus vahlii* Lam.
1411	
1442	Duplicate at P-Bonpl.
1516	
1588	
1617	
1618	Line drawing at P under *Thrasya paspaloides* Kunth
1633	Duplicate at P-Bonpl.
1637	Only represented at P-Bonpl. as a line drawing
1657	
1664	Duplicate at P-Bonpl. under *Eriochloa distachya* Kunth, the name used in Humboldt & al. (1816-1825)
1671	The date indicated in the label (flor. an 7 = 20.04. – 19.05.1799) corresponds to the visit by Humboldt and Bonpland to Aranjuez, Spain (March-May 1799, Biermann & al., 1968)
1783	Duplicate at P-Bonpl. under *Podosemum alpestre* Kunth, the name used in Humboldt & al. (1816-1825)
2023	The date indicated on the label (flor. an 7 = 20.04. – 19.05.1799) corresponds to the visit by Humboldt & al. (1816-1825) to Aranjuez, Spain (March-May 1799, Biermann & al., 1968)
2361	Number also assigned to collections with catalogue numbers 1183-3, 1224; duplicate at P-Bonpl. under *Schoenus spadiceus* (Lam.) Vahl, the name used in Humboldt & al. (1816-1825)
2368	This collection (sheet 2) corresponds to the *Eriocaulon decemangulare* (L.) Kunth, nom. illeg. (found at P-Bonpl.) and later decribed as *E. humboldtii* Kunth
2374	The locality on the folder does not corrrespond to the locality proposed in Humboldt & al. (1816-1825), viz. "In sylvis Orinocensibus prope ostia fluminis Yao"
2375	Duplicate, which we expected to be deposited in P-Bonpl., not found; the locality on the folder does not corrrespond to the locality proposed in Humboldt & al. (1816-1825), *viz. "Ripa Orinocensi prope Maypures et rupem Aricagua"*
3096	
3097	
3103	Species described in Humboldt & al. (1816-1825), but not found at P-Bonpl.; Kunth did not indicate that the type material was seen elsewhere
3105	

Table 4. – Cont.

Taxon[1]	Locality in folder or on label [loc. in "Journal Botanique"]	Coll. n°
Potamogetonaceae		
Potamogeton caricifolius Schult. & Schult. f., nom. nud., pro syn.	Laguna de Valencia, Valle de Aragua	1104
Heliconiaceae		
Heliconia humilis (Aubl.) Jacq.	Cumaná	184
Bromeliaceae		
Bromelia lasiantha Schult. f., nom. nud., pro syn.	Cumaná	563
Pitcairnia pruinosa Kunth	Isla de Pararuma	870
Tillandsia utriculata L.	Cumaná	112
Tillandsia patens Schult.	Caripe	556
Tillandsia recurvata (L.) L.	Cumaná	59
Tillandsia usneoides (L.) L.	Cumaná	161
Tillandsia trichoides Kunth	Caripe	347
Burmanniaceae		
Burmannia brachyphylla Schult. & Schult. f.	Orinoco, Atures	871
Commelinaceae		
Tradescantia divaricata Vahl	Cumaná, San Fernando	198
Tradescantia zanonia (L.) Sw.	Cumaná, Caripe	551
Amaryllidaceae		
Amaryllis nervosa Kunth	Prope Cura, Valles de Aragua	742
Allium candidissimum Cav.	Madrid [Cumaná]	268
Hypoxidaceae		
Hypoxis breviscapa Kunth, nom. illeg. hom.	Orinoco	1073
Asparagaceae		
Codonocrinum agavoides Schult. f., nom. nud., pro syn.	Prope Caracas, Cumaná	663
Xanthorrhoeaceae		
Aloe mitriformis Willd., nom. illeg. hom.	Caracas, La Venta	1133
Poaceae (part II)		
Bambusa latifolia Bonpl.	Casiquiare, Orinoco	1090
Alstroemeriaceae		
Drymophila nudicaulis ined.	Cumaná, Caripe	202
Orchidaceae		
Orchis pentadactyla ined.	Orinoco, Esmeraldas	1005
Oncidium carthaginense Sw.	Valles de Aragua, Portocabelo	1193
Epidendrum atropurpureum Willd.	Valles de Aragua, [Porto Cabelo]	1192
Epidendrum elongatum Jacq.	Montaña del Avila, Caracas	616

[1] Taxa are arranged according to the number assigned in D. F. L. Schlechtendal's catalogue ; families here indicated correspond to the classification of APG III (2009).

N° Schl. Cat.	Observations
3207	Duplicate at P-Bonpl. under *Potamogeton tenuifolius* Kunth, nom. illeg. hom., the name used in HUMBOLDT & al. (1816-1825)
4986	
6312	
6320	Possible duplicate at P-Bonpl.
6325	
6333	
6335	
6337	There is no description of the collection in the "Journal Botanique", where it is identified as "Barba de Palos"; duplicate at P-Bonpl.
6338	Duplicate at P-Bonpl.
6341	
6351	With description of the collection in the "Journal Botanique" and identified as "*Tillandsia*"
6353	In the "Journal Botanique" this species corresponds to number 550 and number 551 was asigned to *Peperomia peltoidea* Kunth *(Piperaceae);* duplicate at P-Bonpl. under *Campelia zanonia* (L.) Kunth, the name used in HUMBOLDT & al. (1816-1825)
6427	Duplicate at P-Bonpl.
6495	The label indicates Madrid and the date indicated in the label (germ. an 7= = 21.03. – 19.04.1799) corresponds to their visit to this city
6582	Duplicate at P-Bonpl.
6766	This name was published as a synonymy of *Yucca acaulis* Kunth *(Asparagaceae)*
6784	
7010	Duplicate at P-Bonpl., fragment ex P at US
11231	
16857	
16866	
16872	Duplicate at P-Bonpl. under *Cymbidium cordigerum* Kunth, the name used in HUMBOLDT & al. (1816-1825)
16879	With fine line drawing by Humboldt in the "Journal Botanique"

Table 4. – Cont.

Taxon[1]	**Locality in folder or on label [loc. in "Journal Botanique"]**	**Coll. n°**
Vanilla aromatica Sw.	sine loc. [Bordones]	155
Schwaegrichenia caripensis ined.	Cumaná, Caripe, [Sta. Maria]	242
Pteroceras formosum ined.	Cueva del Guacharo prope Caripe, Cumaná	219
Cranichis viscosa ined.	Caracas [Montaña de Avila]	618
Cymbidium distichum ined.	Caripe	571
Cymbidium longifolium D. Don, nom. utique rejic.	Orinoco, Angostura trapiche de D. F. Farreras	1067
Typhaceae		
Typha angustifolia L.	Laguna de Valencia	736
***Cyperaceae* (part II)**		
Scleria capitata Willd.	Atabapo	s.n.
Scleria nutans Kunth	Cumaná	s.n.
Scleria cyperina Kunth	Cumaná	s.n.
Scleria scabra Willd.	Cumaná	s.n.
***Arecaceae* (part I)**		
Bactris minor Jacq.	Caripe	343
Alismataceae		
Sagittaria bracteata Seub.	Angostura [Hac. D. F. Farreras]	1079
***Araceae* (part II)**		
Caladium grandifolium (Jacq.) Willd.	Caracas	s.n.
***Poaceae* (part III)**		
Critha infracta Willd., nom. nud.	Orinoco	s.n.
Smilacaceae		
Smilax maypurensis Willd.	Maypure	897
Smilax lappacea Willd.	Caracas, Rio Anauco	635
Smilax siphilitica Willd.	Casiquiare	1147
Smilax scabriuscula Willd.	Caracas, Rio Anauco	634
Smilax cumanensis Willd.	Bordones, Cumaná	285
Smilax triplinervia Willd.	Rio Atabapo	s.n.
Dioscoreaceae		
Dioscorea alata L.	Orinoco [prope Angostura]	1062
Dioscorea scabra Willd.	Orinoco, Isla de Pararuma	864
Dioscorea aspera Willd.	Insel Pararuma, Orinoco	865
Dioscorea cuspidata Willd.	Orinoco	953
Dioscorea polygonoides Willd.	Orinoco	s.n.
***Arecaceae* (part II)**		
Mauritia flexuosa L. f.	Orinoco	s.n.

[1] Taxa are arranged according to the number assigned in D. F. L. Schlechtendal's catalogue ; families here indicated correspond to the classification of APG III (2009).

N° Schl. Cat.	Observations
16882	This collection number was completely scratched out in the "Journal Botanique" and has no description; duplicate at P-Bonpl.
16916	Specimen placed among the *Orchidaceae* in B-W although it belongs to the *Amaryllidaceae*
16919	
16953	With description of the collection and fine line drawing by Humboldt in the "Journal Botanique"
16988	
16998	With description of the collection and fine line drawings by Humboldt in the "Journal Botanique"; duplicate at P-Bonpl. under *Dendrobium longifolium* Kunth, the name used in HUMBOLDT & al. (1816-1825)
17087	
17335	Duplicate at P-Bonpl.
17336	
17337	
17338	Duplicate, which we expected to be deposited in P-Bonpl., not found
17539	
17559	
17742	
18266	
18382	Duplicates found at P-Bonpl. and P
18383	Duplicates found at P-Bonpl. and P
18387	Duplicates found at P-Bonpl. and P
18395	Duplicates found at P-Bonpl. and P
18396	Duplicates found at P-Bonpl. and P
18399	No duplicates found at P-Bonpl. and P
18414	Possible duplicate at P-Bonpl. under *Dioscorea alata* L.
18417	
18418	Duplicate at P-Bonpl.
18419	Duplicate at P-Bonpl.
18421	Possible duplicate at P-Bonpl.
18433	Possible duplicate at P-Bonpl. under *Mauritia flexuosa* L. f.

Table 4. – Cont.

Taxon[1]	Locality in folder or on label [loc. in "Journal Botanique"]	Coll. n°
Hydrocharitaceae		
Stratiotes nymphoides Willd.	Laguna de la Quebrada de Tacagua	662
***Poaceae* (part IV)**		
Andropogon bracteatus Willd.	Cumaná	s.n.
Andropogon hispidus Willd.	Cumaná	s.n.
Andropogon plumosus Willd.	Cumaná	s.n.
Andropogon fastigiatus Sw.	Cocollar	s.n.
Panicum glaucum L.	Cumaná	s.n.
Panicum nigricans Spreng., nom. nud., pro syn.	Cocollar	s.n.
Panicum gracile Spreng., nom. nud., pro syn.	Rio Atabapo près del l'Equateur	s.n.
Panicum pedunculare Steud.	Cumaná	s.n.
Panicum orinocense Spreng., nom. nud., pro syn.	Orinoco	s.n.
Panicum acutifolium Spreng., nom. nud., pro syn.	Cumanacoa	s.n.
Panicum macrospermum Spreng., nom. nud., pro syn.	Orinoco	s.n.
Panicum triticeum Spreng., nom. nud., pro syn.	Rio Atabapo	s.n.
Panicum lagopus Spreng., nom. nud., pro syn.	Cumaná, Caripe	s.n.
***Marantaceae* (part II)**		
Calathea sp.	sine loc. [sine loc.]	203
***Araceae* (part III)**		
Araceae sp.	San Carlos, Rio Negro	984

[1] Taxa are arranged according to the number assigned in D. F. L. Schlechtendal's catalogue; families here indicated correspond to the classification of APG III (2009).

was appointed curator of this collection the following year and he initiated a complete rearrangement of B-W according to the Linnaean system (Schlechtendal, 1832). He produced a detailed catalogue of the Willdenow Herbarium, which L. Krug copied much later introducing mistakes (Hiepko, 1972) (Fig. 4A, 4B). In Schlechtendal's catalogue all species represented in the collection are assigned a reference number. With respect to the groups of monocotyledon studied, most specimens of the same family are physically united in only one place in the collection, but in some cases specimens of a family are found in two (e.g., *Arecaceae, Cyperaceae,* and *Marantaceae*), three (e.g., *Araceae*) or even four different places (e.g., *Poaceae*) (Table 4).

Bonpland and Humboldt specimens are in general well preserved and often retain the original label in Bonpland's hand (Fig. 12, 13A, 13B), although in some cases Humboldt added spelling corrections to the localities proposed by Bonpland. In many cases these labels contain the collection number, locality, and date of collection (following the French Republican calendar), and occasionally they include a common name. Willdenow was in the habit of noting on labels, which he subsequently affixed to folders, the geographical origin of the specimens within. He did this also with specimens from the Humboldt and Bonpland expedition. However, in some cases the locality written on the label affixed to the folder does not correspond to the locality cited in either Humboldt & al. (1816-1825) or the "Journal Botanique". Two examples illustrate this situation. First, the label on the folder for *Eriocaulon congestum* Kunth *(Eriocaulaceae)* indicates "Cumaná", but the label on the Bonpland and Humboldt specimen lacks a collection number and locality. Nevertheless, Kunth indicated "Amazonas" as the type locality when he described the species in Humboldt & al. (1816-1825). The genus *Eriocaulon* L. is not present in Cumaná or northern Venezuela. We believe therefore that the specimen was collected in the Venezuelan Guayana, but for whatever reasons Willdenow failed to copy the locality information correctly on the folder's label. A second example is *Scirpus hirtus* Poir. *(Cyperaceae)* where the label on the specimen clearly indicates the collection number ("755") and locality ("Orinoco"). However, we believe that this collection number is incorrect since collection numbers for specimens gathered in this region of Venezuela (i.e., present-day Amazonas state) begin with number 821. Moreover,

N° Schl. Cat.	Observations
18477	With description of the collection and identified as "*Limnocharis humboldtii*" (ined.) in the "Journal Botanique"
18655	
18656	
18657	Duplicate, which we expected to be deposited in P-Bonpl., not found
18659	
18704	
18733	
18737	
18758	
18766	
18772	
18774	
18792	
18827	
s.n.	
s.n.	With description of the collection and identified as "*Arum*" in the "Journal Botanique"

the same collection number (755) was given to a specimen of *Schoenus spadiceus* (Lam.) Vahl *(Cyperaceae)* collected in the mountains near Caracas and deposited in P-Bonpl.

The Bonpland and Humboldt specimens in B-W were studied almost exclusively by Willdenow, but after his death in 1812 and especially after D. F. L. von Schlechtendal was appointed director of the herbarium in 1819, they were made accessible to many other botanists including Johann Jakob Römer (1763-1819) and Josef August Schultes (1773-1831), who apparently also had access to the botanical notes left by Willdenow (McVaugh, 1955). Schultes's son, Julius Hermann Schultes (1804-1840), Curt Polycarp Joachim Sprengel (1766-1833), Johann Heinrich Friedrich Link (1767-1851), and many others also were able to study these Bonpland and Humboldt collections. After Link was appointed director of the Berlin garden in 1815, he had access to B-W and he published (Link, 1820) at least seven new species of monocotyledon based on specimens collected by Bonpland and Humboldt. As will be described below, it was only much later that Kunth was able to study the Bonpland and Humboldt collections in B-W.

Several authors (e.g., Stafleu & Cowan, 1983; Rankin Rodríguez & Greuter, 2001; Lack, 2003) have suggested that it was D. F. L. von Schlechtendal who enabled Römer and Schultes, and others, to use and publish Willdenow's manuscript names and brief descriptions. However, more recently Hiepko (2006) has demonstrated convincingly that the publication of most of Willdenow's manuscript names was arranged instead by the elder Schlechtendal. In any case, this arrangement led to the multiplication of synonyms because of the independent but nearly simultaneous publication of taxa based on these collections (and manuscripts); Kunth in Humboldt & al. (1816-1825) and Römer & Schultes in the third volume of their *Systema Vegetabilium* (McVaugh, 1955). The nomenclatural consequences for over 250 names have been discussed elsewhere (McVaugh, 1955; Hiepko, 2006). Hence, while preparing the manuscript of Humboldt & al. (1816-1825), Kunth was unable to study Willdenow's set of the Bonpland and Humboldt collections, which contained not only duplicates, but also some unicates (Hiepko, 2006). Kunth only gained access to Willdenow's set when he was appointed assistant-director of the Botanischer Garten in 1829. Apart from

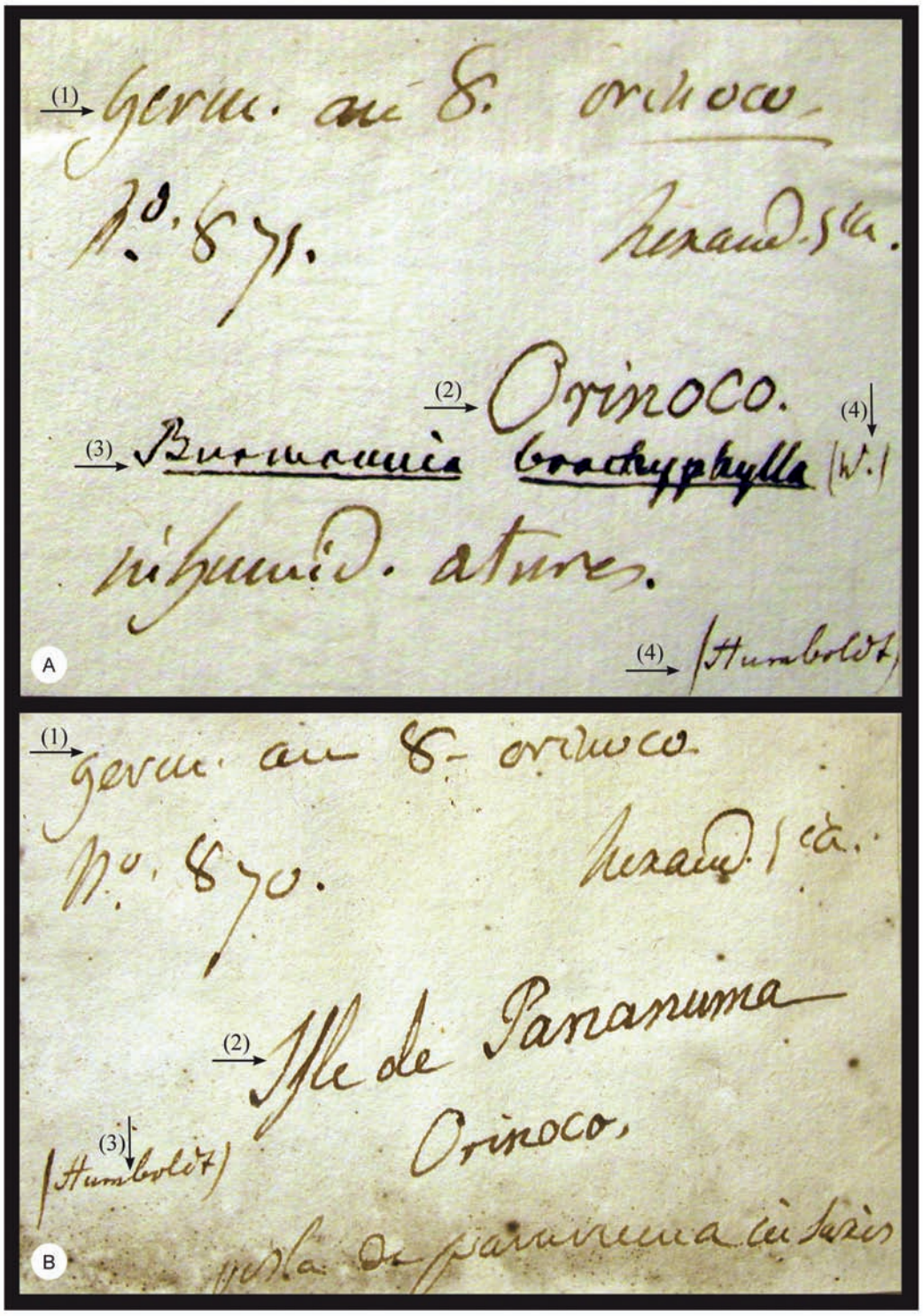


Fig. 13. – Example of labels associated with the Bonpland and Humboldt monocotyledon specimens at B-W. **A.** Bonpland label showing different handwritings (1) Bonpland, (2) Humboldt, (3) Willdenow, (4) D. F. L. von Schlechtendal; **B.** Bonpland label showing different handwritings (1) Bonpland, (2) Humboldt, (3) D. F. L. von Schlechtendal.

[© Botanischer Garten und Botanisches Museum Berlin-Dahlem]

Römer and Schultes, other taxonomists also studied the Bonpland and Humboldt collections and in some cases they too contributed to the multiplication of synonymous names. Just to cite one example, Kunth described *Yucca acaulis* Kunth *(Asparagaceae)* based on Bonpland and Humboldt collection number 633, which presumably was deposited in P-Bonpl., but the same collection was later described as *Codonocrinum agavoides* Schult. & Schult. f. *(Asparagaceae)* and based on a duplicate specimen deposited in B-W.

Three specimens in B-W have numbers, localities (i.e., Madrid, Aranjuez), and dates that correspond to the Spanish segment of the Humboldt and Bonpland expedition, the portion of the voyage before the two explorers left Europe. The specimens are determined as *Allium candidissimum* Cav. *(nom. illeg.) (Amaryllidaceae), Milium confertum* L. *(Poaceae),* and *Cynosurus sp. nov.* (ined.) *(Poaceae)* (Table 3), all taxa considered to be European. While it is tempting to interpret this as a case of mistaken numbering (the numbers otherwise correspond to plants gathered near Cumaná), we suspect that these specimens were numbered independently of the American ones. The analysis of Lack (2004a) of the "Journal Botanique" noted that the first of the seven volumes *(MS 221)* has "several short runs" of collection numbers, and this volume covers Humboldt and Bonpland's itinerary in France and Spain.

Finally, the active exchange program maintained by Willdenow with other contemporary botanists seems to be the principal reason why some of the specimens used by Willdenow as types of names that he published are not found now in B-W. Yet this might not be the case with respect to Bonpland and Humboldt specimens since we assume that Willdenow appreciated the novelty and value of these botanical collections made in what had been largely unexplored areas of the Americas and he would have been reluctant to part with them.

The B herbarium

The private herbarium of Kunth contained ca. 70,000 specimens, comprising about 54,500 species and including almost 3000 types of names of taxa described in Humboldt & al. (1816-1825) (Fig. 1), as well as many duplicates from the herbarium in Paris (Hiepko, 1987). There is little doubt that it was Humboldt himself who donated to Kunth the set of almost 3000 specimens from the American expedition shortly before Humboldt left Paris for Berlin. After Kunth's death in 1850 his herbarium was purchased by the Prussian state and added to B (Fig. 3A, 7, 14). Unfortunately most of these specimens were destroyed during the Allied bombing of Berlin in 1943, along with the greater part of B (Merrill, 1943; Grimé & Plowman, 1986; Hiepko, 1987).

As noted earlier, it is only through the photographs of J. Francis Macbride of the Field Museum of Natural History, Chicago that we have any visual record of many specimens that once were deposited in B. Studying these photographs we were able to identify nine specimens that could be attributed unequivocally to the set of collections that Humboldt gave to Kunth. To this group belong not only specimens collected by Bonpland and Humboldt that Kunth described almost 30 years after finishing Humboldt & al. (1816-1825) (e.g., *Tradescantia cumanensis* Kunth, *Commelinaceae*), but also Bonpland and Humboldt specimens (e.g., *Cyperus oligostachyus* Kunth, *Cyperaceae, Eriocaulon tenue* Kunth, and *Juncus densiflorus* Kunth, *Juncaceae*) not found in P-Bonpl. (Table 2). A well documented case of a Bonpland and Humboldt specimen described by Kunth long after he left Paris is that of *Phaedranassa multiflora* Kunth *(Amaryllidaceae)* (Leuenberger & Arroyo-Leuenberger, 2006). We believe that this confirms that Humboldt permitted Kunth to take with him to Berlin not only an important group of type specimens of taxa described in Humboldt & al. (1816-1825), but also undetermined specimens that required further study (Fig. 14).

The HAL herbarium

HAL proved to be a more important repository of Bonpland and Humboldt specimens than previously appreciated. There was no direct contact between the explorers and the curators of this herbarium. Instead, the specimens were acquired through D. F. L. von Schlechtendal, who held positions in both Berlin and Halle. From 1819 to 1833, Schlechtendal was in charge of the Berlin herbarium, including the large Willdenow collection (B and B-W). He left Berlin when he was appointed professor of botany and director of the botanical garden of the university in Halle where he served until his death in 1866. Presumably he brought these Bonpland and Humboldt collections with him to Halle (Fig. 7).

In an electronic search (http://herbarium.univie.ac.at/database/index.php) of HAL we identified more than 50 Bonpland and Humboldt specimens that clearly represent duplicates of specimens deposited in B-W (Fig. 15). We do not know why Schlechtendal removed these duplicate collections from B-W, but suspect that as director of the Berlin herbarium he probably believed that their removal would not impact the value of the Willdenow collection, especially in those cases where enough material was clearly available.

Two collections in HAL associated with the species *Scleria cyperina* Kunth (Fig. 15) and *S. nutans* Kunth, respectively, clearly can be regarded as duplicates (i.e., isotypes) of corresponding specimens in B-W as the specimen pairs contain identical information on their labels (viz., "America Merid., Cumaná, Humboldt"). All specimens studied have original labels on which Schlechtendal wrote that the specimen was a duplicate from B-W and he copied the scanty information contained on the Willdenow specimens (Fig. 15). Hence, in most cases only the locality "America Meridionalis" and the



Fig. 14. – Monocotyledon specimen collected by Bonpland and Humboldt deposited in B. The specimen corresponds to *Amaryllis nervosa* Kunth, hom. illeg. *(Amaryllidaceae)* collected in present-day Aragua state of Venezuela. Note Kunth's handwriting on the label (bottom left-hand corner of the specimen).

[© Botanischer Garten und Botanisches Museum Berlin-Dahlem]



Fig. 15. – Monocotyledon specimen collected by Bonpland and Humboldt deposited in HAL. The specimen is an isotype of *Scleria cyperina* Kunth *(Cyperaceae)* collected in present-day Sucre state of Venezuela. Note D. F. C. von Schlechtendal's handwriting on the label (bottom left-hand corner of the specimen).

[© Herbarium, Martin-Luther Universität, Halle-Wittenberg]

additional note "Humboldt" was written by Schlechtendal; very rarely more detailed information on the locality (e.g., Cumaná) was provided. Numbers and dates of collections are completely lacking, which complicates the recognition of isotypes or designation of lectotypes. In any case, it is expected that eventually the number of Bonpland and Humboldt specimens discovered in the general herbarium of the Martin-Luther Universität will elevate this herbarium to fourth (in terms of specimen number) among the important depositories of Bonpland and Humboldt specimens. Inasmuch as Schlechtendal was interested in genera of *Cyperaceae* (e.g., *Carex* L.) and *Poaceae* (e.g., *Panicum* L., *Paspalum* L.) we suspect that eventually a large amount of Bonpland and Humboldt material will be located in these families in HAL.

The Cavanilles Herbarium (MA-CAV)

The first page of the "Journal Botanique" *(MS 1332)* includes a list of 39 collections that Humboldt and Bonpland sent from Havana to Antonio José Cavanilles in Madrid (Fig. 6A) and correspondence between Humboldt and Willdenow (Moheit, 1993: 129 [letter nr. 41]), indicates that seed was sent in 1800 to Casimiro Gómez Ortega, director of the Real Jardín Botánico, Madrid, and probably also to Cavanilles, the clergyman and botanist who eventually succeeded Ortega as director (Fig. 7). Our research demonstrates that Cavanilles cultivated and later described new species from seed collected near Cumaná by Bonpland and Humboldt. We expected that we would find type collections vouchering the names of these new species in MA-CAV and following an examination of the microfiche of this herbarium (IDC, 1994) we were able to locate the types of two *Asteraceae* names: *Tagetes peduncularis* Cav. (Fig. 5A) and *T. verticillata* Lag. & Rodr. Labels on both specimens indicate that these plants originated in Cumaná and that they had flowered in the Real Jardín Botánico, Madrid in 1801. These label data agree with information published in the relevant protologues.

When Humboldt wrote Cavanilles from Mexico on 22 April 1803 (Moheit, 1993: 227 [letter nr. 103]), he indicated that an unspecified number of herbarium specimens gathered by the expedition were ready to be sent to Madrid. A search of the microfiche of the MA-CAV failed to yield any specimen that could be tied to such a shipment. Perhaps Humboldt learned that Cavanilles was in poor health and this prompted him to send the promised specimens elsewhere. In any case, no monocotyledon specimens, cultivated or otherwise, that could be linked to the Humboldt and Bonpland expedition were located in the Cavanilles Herbarium.

The LR herbarium

The specimens associated with the so called "Herbier Bonpland" (LR) in La Rochelle traditionally have been attributed to Michel-Simon Goujaud Bonpland, older brother of Aimé Bonpland. This herbarium was described by Rallet (1970) and Stauffer & Stauffer (2010). A letter dated 18 brumaire an X (i.e., 9 November 1800) (Hamy, 1906) that Aimé sent to his brother from Cumaná indicates that three boxes with plants collected by the expedition were to be sent to the Muséum in La Rochelle. If these specimens arrived safely we would expect them to be in the "Herbier Bonpland". We studied a majority of the specimens (all of the monocotyledons and ca. 90 per cent of the dicotyledons) in this herbarium with the hope of finding collections that could be attributed to this shipment from Venezuela to France. The "Herbier Bonpland", which is kept separate from other collections in the Muséum in La Rochelle, consists of 36 bundles each with 60-70 specimens for a total of 2000-2500 specimens. Few of the specimens are mounted, which means that we were obliged to handle them with extreme care to avoid creating confusion. The 36 bundles are arranged according to the Linnaean system and consist of seven bundles of monocotyledons, 28 bundles of dicotyledons, and one bundle of cryptogamic plants (*algae,* lichens, and mosses) and fungi. The monocotyledon portion of the collection appears to be better preserved than the dicotyledon one, as the latter shows evidence of what appears to be insect damage in *Asteraceae* and *Brassicaceae*, especially. In contrast, the *Poaceae* are very well preserved and surprisingly diverse taxonomically.

Few of the labels for specimens in LR have locality data. Those that do indicate that collections were made in France (e.g., Barèges, bois de Boulogne), French gardens (e.g., H.F., or "Hortus Fontainebleau"), Spain (e.g., Aranjuez, Barcelone, Madrid, Tenerife, "Hispania"), or other countries (St.-Thomas, Portugal, Suisse (Vaud), Tunisie). Michel-Simon actively corresponded with many contemporary botanists, whose names can be found on specimen labels, including Bellanger, Bonafosse, Cavanilles, de Candolle, Desfontaines, Delisle, Lorenti, Née, Pourret, Richard, Thibault, Thouin, Violet, Verdier, and Zimmermann. There are very few dates on the labels. In fact, only two were found: 1792 associated with the locality "Cévennes" and 1843 with "Barèges".

It should be pointed out that doubts were raised by Jolinon & Pignal (1998) with respect to whether or not LR was distinct from the "Herbier Dessalines d'Orbigny", even though Rallet (1970) did not express any doubt about their distinctiveness. The formation of the "Herbier Dessalines d'Orbigny", also deposited in the Muséum in La Rochelle, has been attributed to Charles-Marie Dessalines d'Orbigny (1770-1856), father of the famous explorer Alcide Charles Victor Marie Dessalines d'Orbigny (1802-1857). It consists of 13 bundles

stored adjacent to the "Herbier Bonpland". We found no internal evidence that would allow one to unequivocally distinguish or separate the two herbaria. In many respects (e.g., the format of the specimens, the type of information recorded on labels, etc.) the two collections resemble each other and more critical study is needed to establish whether or not they were formed independently of each other.

Nor were we able to clearly establish a difference between the specimens collected by Michel-Simon and the ones that might have been collected by his brother Aimé. Moreover, a comparison of the handwriting of the two brothers does not allow us to distinguish specimens that either one labeled or annotated. Many of the collections from Spain match localities visited by Aimé shortly before he and Humboldt left Europe (e.g., Aranjuez, Madrid) and at least one locality (i.e., Tenerife) was visited by the explorers en route to the Spanish colonies in America. In fact, Michel-Simon wrote to André Thouin on 15 January 1799 (folder 68/11, archives, Bibliothèque, Muséum d'Histoire Naturelle, La Rochelle) and told the Parisian horticulturist that he had received some plants collected in Spain by his brother. This alone suggests that an important number of plants from Spain were indeed collected by Aimé shortly before he and Humboldt departed Europe.

Despite many complications and much confusion we were able to locate in LR two specimens that can be attributed unequivocally to the Humboldt and Bonpland expedition. The first is a lichenized fungus bearing the name *Gymnoderma,* but recently identified as *Dictyonema glabratum* (Spreng.) D. Hawksw. by P. Roberts *(pers. comm.),* and its label indicates that it was sent from Caracas by Aimé Bonpland. Curiously, among the Humboldt fungi deposited in K there are none from Venezuela (Roberts, 2011). The second specimen is a *Mutisia* L. f. *(Asteraceae)* labeled "hab. in Monte Quindio". Monte Quinidio is a locality Humboldt and Bonpland visited during the Colombian portion of their journey. We discovered no monocotyledon specimens in the herbarium of the Muséum in La Rochelle that could be connected unequivocally to the Humboldt and Bonpland expedition.

The Médiathèque Michel Crépeau, La Rochelle preserves 53 documents associated with Aimé Bonpland (all arranged in their folder cote 'MS 617'). The documents are a mixture of lists of seed that Bonpland distributed to European botanical gardens including Berlin, Montpellier, and Paris (Fig. 11), and correspondence he received from Humboldt, José Antonio Pavón (1754-1840), Augustin Pyramus de Candolle (1778-1841), and others. Also present in the Médiathèque are copies of letters that Aimé sent to the Empress Josephine (1763-1814) and several documents associated with his administrative duties in the Jardin de Malmaison. It is also worth mentioning an interesting group of botanical notes, most of them related to *Arecaceae, Melastomataceae,* and the genus *Cinchona* L. *(Rubiaceae).* Although none of these documents provided critical information for our research on Venezuelan monocotyledons they certainly represent an important source of data relating to the botanical work of Aimé Bonpland.

Venezuelan monocotyledons and the "Journal Botanique" of Bonpland and Humboldt

The field notes of Bonpland and Humboldt, also known as the "Journal Botanique", are deposited in the Bibliothèque Centrale, Muséum National d'Histoire Naturelle, Paris. The format and contents of these manuscripts were analyzed by Lack (2004a, 2004b). The "Journal Botanique" consists of seven bound volumes that include descriptions of 4528 collections made by Bonpland and Humboldt during their American journey (Fig. 5A, 5B, 6). Bonpland was clearly in charge of compiling all the information, but complete descriptions or comments on specific taxa (e.g., *Arecaceae, Bromeliaceae, Orchidaceae*) were occasionally added by Humboldt (Fig. 6). Entries were made in black ink. Although descriptions are in Latin and French, notes in Spanish are scattered throughout the text and mostly concern local uses, common names, etc.

Detailed information on the locality, often later complemented by Humboldt himself, and date of collection always precedes a group of entries. The entries are numbered sequentially throughout the work, although occasionally plants that were collected in one region received numbers corresponding to a later stage of the journey. Provisional scientific names were proposed and used, first by Bonpland and later added by Willdenow and Kunth to whom the "Journal Botanique" passed. As stated by Hiepko (2006), Kunth's use of many names proposed by Willdenow in the "Journal Botanique", for which Kunth failed to give Willdenow credit, was a source of conflict with other German botanists who were aware of this situation.

The descriptions in the "Journal Botanique" are typically extensive (Fig. 6) but in a relatively few cases (e.g., numbers 423-475, which correspond to pteridophytes collected in eastern Venezuela), only a collection number and a provisional name (no description) were entered. Given the detailed nature of collection localities published in Humboldt & al. (1816-1825), it seems clear that Kunth made full use of the information contained in the "Journal Botanique", perhaps amended or even edited by Humboldt himself. Very few drawings are included in the "Journal Botanique", but the few present were mostly done by Humboldt, who was deeply impressed by the morphology of orchid flowers and who chose to make very detailed sketches of some of them. As indicated by Humboldt in his diary of the journey (Faak, 2000), specimens were not always described in the "Journal Botanique" when they were first encountered in the field, but sometimes descriptions were added much later (e.g., 200 plants collected in the regions of Cocollar, Caripe, and Catuaro were described out of chronological sequence).

Three of the seven volumes comprising the "Journal Botanique" (*MS 1332, 1333,* and *1334*) include notes pertaining to Venezuelan plants. One volume *(MS 1332)* contains descriptions of 690 plants; numbers 1-16 describe plants collected in the Canary Islands, some of them from cultivation in the botanical garden of Orotava (Fig. 5A), 17-572 plants collected from "Province Nouvelle Andalousie au Cumaná", 573 a plant collected in "Province Caracas au Venezuela", and 574-690 plants mostly collected in localities in eastern Venezuela (e.g., Bordones, Cumaná, and Caripe) (Fig. 5B) except for a handful collected during the journey from Cumaná to Caracas. This is the only volume of the "Journal Botanique" that terminates with a synoptic classification of all the plants cited in the volume. This classification (following Tournefort's system) includes also the number of collection (from page 184), and an alphabetic index to all taxa cited (from page 192). We assume that Bonpland did not continue producing this type of synoptic classification for the rest of the volumes as it entailed an extremely large amount of work. Those interested in more details on the plants collected by Bonpland and Humboldt in Cumaná can get additional information on 78 species that Humboldt described for this region in his field diaries (Tagebuch I, Bl. 37V-41R, cited by Faak, 2000).

A second volume *(MS 1333)* includes numbers 691-1215 that concern collections made in north-central Venezuela (e.g., Caracas, Aragua, and Lago Valencia), the llanos (e.g., La Villa), present-day Amazonas state (e.g., Atures, Yavita, Rio Negro, Casiquiare, and La Esmeralda), and the lower Orinoco (e.g., Angostura, now Bolívar state). On the inner side of the front cover of the manuscript, Humboldt included a detailed list of all the palms observed to date in their travels, proposing scientific and recording common names.

A third volume *(MS 1334)* covers numbers 1216-1591 and includes the last collections made in Venezuela (i.e., Cumaná, Bordones) and the first collections made during Humboldt and Bonpland's initial visit to Cuba. The lack of specific localities associated with these collections makes it difficult to clearly determine which collections were the last ones made in Venezuela and which were the first made in Cuba. The last collection unequivocally referring to a Venezuelan locality (i.e., Bordones) is number 1235 and the first collection clearly indicating a Cuban locality (i.e., Havana) is number 1254. Numbers 1236-1253 apparently were assigned to a series of plants that were collected in several central and southern Venezuelan localities, but for reasons unknown only described in a very late stage of the journey. This is the case for number 1244, which was assigned to a specimen of *Lecythis ollaria* L. *(Lecythidaceae)* collected in the Venezuelan llanos (i.e., Villa de Cura, Calabozo), a locality that Humboldt and Bonpland had visited long before their arrival in Cuba. As stated by Humboldt in his field diaries, the two explorers had to wait for two months for the ship that would carry them to Cuba and they used this time to arrange the large number of specimens they had collected in Venezuela (Faak, 2000).

Humboldt wrote Willdenow from Havana on 21 February 1801 (Moheit, 1993: 122 [letter nr. 41]) and pointed out that a copy of the manuscripts associated with the Venezuelan plants, specifically two volumes containing descriptions of 1400 species, had been made and was being shipped via the French vice-consul in Havana to Michel-Simon Goujaud Bonpland in La Rochelle. The survival of these manuscript notes was a major preoccupation of Humboldt and Bonpland, who not only copied "in triplo", at least, the notes gathered in the early stages of their travels (Faak, 2000), but also preserved them in a "waterproof" chest during the stormy passage from Barcelona (Venezuela) to Havana. We were unable to find any copies of these manuscripts and the one ostensibly deposited in La Rochelle could not be found in the archives of the Muséum where most botanical documents owned by the Bonpland brothers are thought to have been deposited. Nor were copies found in the Médiathèque Michel Crépeau, La Rochelle and their absence in the catalogue of historical documents of this institution (Musset, 1889) suggests that they may never have been deposited there. The fate of these copies of the "Journal Botanique" remains a mystery; however, one cannot completely exclude the possibility that a copy survives in one of the private collections consulted by Hamy (1906), all of which contained ample amounts of correspondence by Aimé Bonpland.

Curious, we also began to explore the extent to which Kunth made use of the descriptions produced by Bonpland. Thus for a few species of Venezuelan monocotyledon we compared the description proposed by Bonpland in the "Journal Botanique" to the one published by Kunth in Humboldt & al. (1816-1825). In the cases of *Tillandsia trichoides* Kunth *(Bromeliaceae) (Bonpland 347)* and *Schoenus tenuifolius* Kunth *(Cyperaceae) (Bonpland 542)* the descriptions proposed by Bonpland in the "Journal Botanique" consisted of only one line whereas the descriptions published by Kunth in Humboldt & al. (1816-1825) were much more detailed. In contrast, the description of *Smilax cumanensis* Willd. *(Smilacaceae) (Bonpland 285)* (Fig. 10) prepared in the field by Bonpland is much more complete than the one provided by Kunth in Humboldt & al. (1816-1825). However, as this species had already been described by Willdenow in 1806 Kunth probably felt no need to elaborate on its description and chose to concentrate on describing unnamed taxa. In the case of *Aiphanes praga* Kunth *(Arecaceae) (Bonpland 341)* the amount of information presented by Bonpland and Kunth is more or less equal. These preliminary comparisons reveal no obvious pattern as to how the field note information was utilized and we are left to conclude that ascription of authorship for plant species described from collections made during the expedition probably should be assigned on a case by case basis.

Conclusions

Duplicates of specimens deposited in P-Bonpl. were found in the general collection at P and in B-W. We identified at least eight duplicates of specimens held in the Bonpland Herbarium in the general collection (P). Unicates have been previously identified by other botanists (e.g., GRANADOS TOCHOY & al., 2007) and others likely will be spotted in the future. With respect to B-W, our investigation demonstrated that about 30 specimens concentrated in a relatively small number of monocotyledon families (e.g., *Bromeliaceae, Cyperaceae, Dioscoreaceae, Orchidaceae, Poaceae,* and *Smilacaceae*) share the same collection number as specimens in the Bonpland Herbarium and can therefore be regarded as duplicates.

The 1801 letter (MOHEIT, 1993: 126 [letter nr. 41]) from Humboldt to Willdenow, which implied that approximately one-third of the specimens collected in Venezuela had been destroyed due to poor conservation conditions, offers an explanation as to why so many specimens expected to be in P-Bonpl. cannot be found there today. The comments in the letter lend credibility to our assumption that a relatively large number of species described by Kunth in HUMBOLDT & al. (1816-1825) were based exclusively on descriptions prepared by Bonpland and written in the "Journal Botanique". Some of the specimens expected to be preserved in the Bonpland Herbarium but not located there were found in the general collection in P or in B-W. Eight species that we expected to find in the Bonpland Herbarium, many of them species of *Smilax* L., were located in P. Similarly, 18 species not found in the Bonpland Herbarium were found in the B-W. This is a remarkably high number of collections when one considers that our investigation was restricted to Venezuelan monocotyledons. We expect that a more thorough search of the Willdenow Herbarium will yield even more such specimens. In addition, many authors other than Kunth (e.g., Bonpland, Flüggé, Lamarck, Linnaeus, Poiret, Rottbøl, and Willdenow) are linked to species for which no material could be found in the Willdenow Herbarium, which suggests that Kunth gave priority to conserving specimens of taxa he described and regarded of secondary importance specimens associated with taxa described by others.

With respect to the species that are only represented by grisailles (and not herbarium specimens) in P-Bonpl., a specimen of one such species (i.e., *Aegopogon cenchroides* Humb. & Bonpl. ex Willd., *Poaceae*) was discovered in B-W and specimens of two other species (i.e., *Panicum rottboellioides* Kunth and *Thrasya paspaloides* Kunth, both *Poaceae*) were located in P. The discovery of original material of *T. paspaloides* suggests that the lectotypification of this name by BURMAN (1981) should be reexamined. We cannot explain why so many species represented only by grisailles in P-Bonpl. do not have corresponding specimens and suspect no explanation will be forthcoming until all the relevant herbaria have complete databases that can be compared and analyzed for patterns.

It is clear that the two brothers Goujaud Bonpland shared a passion for botany, which probably started long before their formal studies in Paris and Montpellier. Their botanical talents, however, were expressed in remarkably different ways. The younger Aimé, keen to explore remote areas of the world, successfully collected and described what had been a virtually unknown Neotropical flora. His expedition with Humboldt is widely acknowledged to be one of the most successful scientific journeys of the early 19th century and its botanical results are regarded nowadays as milestones in the domains of taxonomy and floristics. In contrast, the older Michel-Simon appears to have interpreted botany as an applied science strongly linked to agronomy. The older Bonpland's rich herbarium and the large amount of archival data relating to his botanical activities clearly show his deep interest in botany. Michel-Simon focused his studies on regional flora, promotion of local botanical courses, and development of more applied aspects of the science such as agronomy and plant uses. Undoubtedly Aimé was, at least in his early years, deeply influenced by his brother's botanical interests. The added influence of prominent botanists such as de Jussieu, Desfontaines, Lamarck, and Thouin, and field experience gained in the Neotropics made Aimé one of the most important botanists of his time.

We tried to establish a relationship between our studies of the main sets of monocotyledon specimens collected by Bonpland and Humboldt in Venezuela, manuscript descriptions of the same in the "Journal Botanique", and published descriptions in HUMBOLDT & al. (1816-1825) in order to explore the still controversial subject of author ascription. The idea that Kunth is the sole author of the species published in HUMBOLDT & al. (1816-1825) seems to have originated with BARNHART (1902) who attributed the editorial work leading to the publication of HUMBOLDT & al. (1816-1825) solely to Kunth, and who stated that Humboldt's only contribution was the introduction. More recently STAFLEU & COWAN (1979) wrote that Kunth is "the main author to whom new taxa are to be attributed" and further pointed out that the authorship should be cited as "Kunth in Humboldt Bonpland and Kunth". HIND & JEFFREY (2001) found ample evidence to confirm that Kunth was the author of new taxa of *Asteraceae* in HUMBOLDT & al. (1816-1825) (*Asteraceae* in vol. 4, 1820), but they advanced no arguments regarding author ascription. M. NEE (cited in MORI & al., 2002) suggested that a strict interpretation of GREUTER & al. (2000) (art. 46.6), now MCNEILL & al. (2006) (art. 46.7) would strongly support recognizing Humboldt, Bonpland, and Kunth as the authors of taxa described in HUMBOLDT & al. (1816-1825) since only internal evidence in this publication is to be used to determine correct author citation, and the evidence in the work points to collective authorship.

The authorship of the new species described in HUMBOLDT & al. (1816-1825) was apparently negotiated at a very early stage of the editing of the work as evidenced by a letter from

Bonpland to Humboldt dated 7 October 1814 (Hamy, 1906). This letter, apparently overlooked by many concerned with how to ascribe authorship to taxa described in this publication, offers important insights into Bonpland's thoughts about the matter: "il est de toute justice que cet ouvrage [Humboldt & al. (1816-1825)] soit publié sous le nom de M. Künth, puisqu'il le rédige … il est évident qu'il [Kunth] prise toutes nos descriptions, tous les noms que nous avons pu mettre dans le voyage, qu'il les arrange à sa manière et qu'il les publie comme il l'entend" [it is only right that this work should be published under Kunth's name, because he edits it … it is also apparent that he [Kunth] takes all of our descriptions, all of the provisional names that we proposed during the voyage, that he arranges them in his way and that he publishes them as he understands them]. From our perspective and despite Bonpland's own words, Bonpland clearly played a much more important role in the description of the new species than the one that has generally been attributed to him in botanical literature. Our study of the "Journal Botanique" proves that Bonpland was not only responsible for collecting most of the plant specimens during the expedition but as stated in a letter from Humboldt to the authorities of the Muséum in Paris (Hamy, 1906; 18 December 1804), Bonpland was in charge of describing almost 80 per cent of the specimens collected. Our study of the entries in the "Journal Botanique" also makes clear that many of the specimens were already identified in a preliminary manner in the field. Moreover, in a letter dated 8 March 1806 (Hossard, 2004: 29) that Humboldt sent to Bonpland, Humboldt reported how astonished Willdenow had been with Bonpland's botanical skills, especially with respect to the preliminary identifications in the field of many of the plants that were collected during the expedition.

There may be different interpretations with respect to authorship of species described in Humboldt & al. (1816-1825) and they should be discussed on a case by case basis making use of the now fully available original sources of information, especially the field notes of the "Journal Botanique". Bonpland and Humboldt not only collected the plants in the field but also thoroughly described them in their field notes, which then were made available to Kunth. Based on these arguments we believe that a collective authorship such as "Kunth, Bonpland & Humboldt" would better reflect the enormous botanical effort each botanist made in bringing to fruition Humboldt & al. (1816-1825). A collective authorship seems especially appropriate for all those taxa not located now in P-Bonpl. as they most probably were described by Kunth solely on the basis of Bonpland's original field notes, given that the associated specimens already had been destroyed by 1801 or were no longer available to Kunth due to the removal of Bonpland's "private" herbarium to Argentina.

Acknowledgments

We express our gratitude to Marc Pignal, Jean-Noël Labat (†), Cécile Aupic, and Gérard Aymonin (all herbarium, Muséum National d'Histoire Naturelle, Paris) for facilitating our studies of P-Bonpl., and to Pascale Heurtel (Bibliothèque Centrale, Muséum National d'Histoire Naturelle, Paris) for granting us access to the "Journal Botanique". We greatly thank Robert Vogt and Hans Walter Lack (both Botanischer Garten und Botanisches Museum Berlin-Dahlem) for allowing us to study the B-W herbarium. We are obligated to Catherine Menant, Guillaume Baron, and Chantal de Gaye (all Muséum d'Histoire Naturelle, La Rochelle) for kindly providing valuable information on the "Bonpland Herbarium" and the original manuscripts of Michel-Simon Goujaud Bonpland. Muriel Hoareau (Médiathèque Michel Crépeau, La Rochelle) is thanked for providing us access to original and microfilmed documents pertaining to Aimé Bonpland. Natalia Tkach and Martin Röser (both Martin-Luther Universität, Halle-Wittenberg) are acknowledged for providing critical information on Bonpland and Humboldt specimens deposited in the Schlechtendal herbarium in HAL. Ledis Regalado Gabancho and Pedro Herrera kindly confirmed the absence of Bonpland and Humboldt specimens in HAC. Likewise, N. Imchanitzkaja (LE) kindly confirmed the absence of expedition specimens in St. Petersburg. Peter Roberts (K) graciously shared his knowledge of the fungal collections made by Humboldt. The libraries of the Conservatoire et Jardin botaniques, Geneva (Patrick Perret, Patrick Bungener), the Royal Botanic Gardens, Kew, the Muséum d'Histoire Naturelle, La Rochelle, and of the universities of Basel, Bern, and Zurich are acknowledged for granting generous access to their historical bibliographic collections. Finally, we are indebted to André Charpin and Nicolas Fumeaux (both Conservatoire et Jardin botaniques, Geneva), Olivier Durbin (Muséum National d'Histoire Naturelle, Paris) and Hans Walter Lack for kindly reviewing earlier versions of the manuscript.

References

APG III (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Bot. J. Linn. Soc.* 161: 105-121.

Arroyo-Leuenberger, S. & B. E. Leuenberger (1996). Type specimens of names in American Amaryllidaceae at the Berlin-Dahlem herbarium (B and B-W). *Willdenowia* 25: 693-702.

Barnhart, J. H. (1902). Dates of the "Nova Genera" of Humboldt, Bonpland and Kunth. *Bull. Torrey Bot. Club* 29: 585-598.

Biermann, K.-R., I. Jahn & F. G. Lange (1968). *Alexander von Humboldt Chronologische Übersicht über wichtige Daten seines Lebens.* Beiträge zur Alexander-von-Humboldt-Forschung 1. Akademie Verlag.

Bonpland, A. J. (1813). *Description des plantes rares cultivées à Malmaison et à Navarre*. Paris.

Burdet, H. (2008). *Collections de Candolle: catalogue des collecteurs botaniques, une documentation*. Editions HMB, Genève.

Burman, A. G. (1981). The status and typification of *Thrasya paspaloides* Humb., Bonpl. & Kunth (Gramineae). *Bot. J. Linn. Soc.* 82: 331-342.

Delprete, P. G. (2001). The Neotropical Rubiaceae collected by Humboldt and Bonpland and described by Bonpland, Kunth, and Roemer and Schultes. *In:* Aymard, G. (ed.), Alexander von Humboldt: homenaje al bicentenario de su llegada a tierras venezolanas. *BioLlania* 7: 22-51.

Dorr, L. J. & J. H. Wiersema (2010). Names of American vascular plants published in Loefling's Iter Hispanicum (1758) and its German translation (1766). *Taxon* 59: 1245-1262.

Faak, M. (2000). *Alexander von Humboldt. Reise durch Venezuela. Auswahl aus den amerikanischen Reisetagebüchern.* Akademie Verlag.

Granados Tochoy, J. C., S. Knapp & C. I. Orozco (2007). Solanum humboldtianum (Solanaceae): an endangered new species from Colombia rediscovered 200 years after its first collection. *Syst. Bot.* 32: 200-207.

Greuter, W., J. McNeill, F. R. Barrie, H. M. Burdet, V. Demoulin, T. S. Filgueiras, D. H. Nicolson, P. C. Silva, J. E. Skog, P. Trehane, N. J. Turland & D. L. Hawksworth (2000). International Code of Botanical Nomenclature (Saint Louis Code). *Regnum Veg.* 138.

Grimé, W. E. & T. Plowman (1986). Type photographs at Field Museum of Natural History. *Taxon* 35: 932-934.

Hamy, E. T. (1906). *Aimé Bonpland, médecin et naturaliste, explorateur de l'Amérique du Sud; sa vie, son œuvre, sa correspondance, avec un choix de pièces relatives à sa biographie, un portrait et une carte.* E. Guilmoto, Paris.

Harriman, N. A. (1992). *A combined index to the binomials and plates in volumes 1-7 of the folio and quarto editions of the Nova Genera et Species Plantarum of Humboldt, Bonpland, and Kunth, 1816-1825.* Privately published, Oshkosh, Wisconsin.

Hiepko, P. (1972). *Herbarium Willdenow. Alphabetical index*. Inter Documentary Company AG, Zug.

Hiepko, P. (1987). The collections of the Botanical Museum Berlin-Dahlem (B) and their history. *Englera* 7: 219-252.

Hiepko, P. (2006). Humboldt, his botanical mentor Willdenow, and the fate of the collections of Humboldt & Bonpland. *Bot. Jahrb. Syst.* 126: 509-516.

Hind, D. J. N. & C. Jeffrey (2001). A checklist of the Compositae of vol. IV of Humboldt, Bonpland & Kunth's Nova Genera et Species Plantarum. *Compositae Newslett.* 37.

Holmgren, P. K., N. H. Holmgren & L. C. Barnett (1990). Index Herbariorum, part I: the herbaria of the world, ed. 8. *Regnum Veg.* 120.

Hossard, N. (2001). *Aimé Bonpland, 1773-1858: médecin, naturaliste, explorateur en Amérique du Sud: à l'ombre des arbres*. Editions L'Harmattan.

Hossard, N. (2004). *Correspondance: 1805-1858. Alexander von Humboldt & Aimé Bonpland.* Editions L'Harmattan.

Humboldt, F. W. H. A. von & A. J. Bonpland (1806-1823). *Monographia melastomatacearum*. 2 vol. Paris.

Humboldt, F. W. H. A. von & A. J. Bonpland (1808-1809). *Plantæ æquinoctiales*. 2 vol. Tübingen.

Humboldt, F. W. H. A. von, A. J. Bonpland & C. S. Kunth (1816-1825). *Nova genera et species plantarum*. 7 vol. Paris.

IDC [Inter Documentation Company AG] (1971). *Microfiche of the Herbarium C. L. Willdenow (1765-1812)*. IDC Microform Publishers, Leiden.

IDC [Inter Documentation Company AG] (1972). *Microfiche of the Herbarium Humboldt, Bonpland and Kunth*. IDC Microform Publishers, Leiden.

IDC [Inter Documentation Company AG] (1994). *Microfiche of the herbarium A. J. Cavanilles (1745-1804).* IDC Microform Publishers, Leiden.

Jolinon, J.-C. & M. Pignal (1998). *Les herbiers de La Rochelle. Compte-rendu d'expertise*. Muséum National d'Histoire Naturelle, Laboratoire de Phanérogamie.

Knapp, S. (2007). The description of Solanum and other Solanaceae collected by Humboldt and Bonpland: a case study of collaboration versus competition in 19th century taxonomy. *Bot. Jahrb. Syst.* 127: 117-132.

Knuth, R. (1928). Initia Florae venezuelensis. *Repert. Spec. Nov. Regni Veg. Beih.* 43.

Kunth, C. S. (1833). *Enumeratio plantarum*. Vol. 1. G. Collae, Stuttgart and Tübingen.

Kunth, C. S. (1835). *Enumeratio plantarum*. *Supplementa tomi primi*. G. Collae, Stuttgart and Tübingen.

Lack, H. W. (2001). The plant self impressions prepared by Humboldt and Bonpland in tropical America. *Bot. Mag.* ser. 6, 18: 218-229.

Lack, H. W. (2003). Alexander von Humboldt und die botanischen Sammlungen in Berlin. *Algorismus* 41: 107-132.

Lack, H. W. (2004a). The botanical field notes prepared by Humboldt and Bonpland in tropical America. *Taxon* 53: 501-510.

Lack, H. W. (2004b). Botanische Feldarbeit: Humboldt und Bonpland im tropischen Amerika (1799-1804). *Ann. Naturhist. Mus. Wien, B* 105: 493-514.

Lack, H. W. (2009). *Alexander von Humboldt und die botanische Erforschung Amerikas*. Prestel Verlag.

Lanjouw, J. & F. A. Stafleu (1954). Index herbariorum. Part II (1). Collectors A-D. *Regnum Veg.* 2: 1-174.

Lanjouw, J. & F. A. Stafleu (1957). Index herbariorum. Part II (2). Collectors E-H. *Regnum Veg.* 9: 175-295.

Leuenberger, B. E. & S. Arroyo-Leuenberger (2006). Humboldt, Bonpland, Kunth and the type specimen of Rauhia multiflora (Amaryllidaceae) from Peru. *Willdenowia* 36: 601-609.

Lindorf, H. (2004). Notices on the Austrian expedition in a Venezuelan document dated 1787 and comments on botanical names linked to the collectors. *Acta Bot. Venez.* 27: 57-64.

Link, H. F. (1820). Der Botanische Garten bei Berlin und die Willdenow'sche Kräutersammlung. *Jahrb. Gewächsk*. 3: 13-184.

Lourteig, A. (1977). Aimé Bonpland. *Bonplandia (Corrientes)* 3: 269-317.

McNeill, J., F. R. Barrie, H. M. Burdet, V. Demoulin, D. L. Hawksworth, K. Marhold, D. H. Nicolson, J. Prado, P. C. Silva, J. E. Skog, J. H. Wiersema & N. J. Turland (2006). International Code of Botanical Nomenclature (Vienna Code). *Regnum Veg.* 146.

McVaugh, R. (1955). The American collections of Humboldt and Bonpland, as described in the Systema Vegetabilium of Roemer and Schultes. *Taxon* 4: 78-86.

Mears, J. A. (1981). Guide to plant collectors represented in the herbarium of the Academy of Natural Sciences of Philadelphia. *Proc. Acad. Nat. Sci. Philadelphia* 133: 141-165.

Merrill, E. D. (1943). Destruction of the Berlin Herbarium. *Science* ser. 2, 98: 490-491.

Miller, H. S. (1970). The herbarium of Aylmer Bourke Lambert: notes on its acquisition, dispersal, and present whereabouts. *Taxon* 19: 489-553.

Minguet, Ch. (1989). *Alejandro de Humboldt, cartas americanas*. Biblioteca Ayacucho, Caracas.

Moheit, U. (ed.) (1993). *Briefe aus Amerika 1799-1804. Alexander von Humboldt*. Beiträge zur Alexander-von-Humboldt-Forschung 16. Akademie-Verlag.

Mori, S. A., C. Gracie, M. Hoff & T. Kirchgessner (2002). *Checklist of the gymnosperms and flowering plants of central French Guiana*. New York Botanical Garden.

Musset, G. (1889). *Catalogue général des manuscrits des bibliothèques publiques de France*. Tome VIII. Paris.

Rallet, L. (1970). La collection d'herbiers conservés au Muséum de La Rochelle. *Ann. Soc. Sci. Nat. Charente-Maritime* 5: 45-52.

Rankin Rodríguez, R. & W. Greuter (2001). Humboldt, Willdenow, and Polygala (Polygalaceae). *Taxon* 50: 1231-1247.

Roberts, P. (2011). Alexander von Humboldt's fungal collection at Kew. *Kew Bull.* 66: 191-194.

Röpert, D. (2009). *Digital specimen images at the herbarium Berolinense* [http://ww2.bgbm.org/herbarium/default.cfm].

Sandwith, N. Y. (1925). Humboldt and Bonpland's itinerary in Venezuela. *Bull. Misc. Inform.* 1925: 295-319.

Sarton, G. (1943). Aimé Bonpland (1773-1858). *Isis* 34: 385-399.

Schlechtendal, D. F. L. (1832). Einige Worte über das Willdenow'sche Herbarium so wie über die Königl. Pflanzensammlung zu Berlin. *Flora* 15: 561-567.

Smith, C. E., Jr. (1962). Henry Muhlenberg - botanical pioneer. *Proc. Amer. Philos. Soc.* 106: 443-460.

Solomon, J. C. (1982). The systematics and evolution of Epilobium (Onagraceae) in South America. *Ann. Missouri Bot. Gard*. 69: 239-335.

Stafleu, F. A. & R. S. Cowan (1976-1988). Taxonomic literature (2nd ed.). 7 vols. *Regnum Veg.* 94.

Stauffer, F. W. & J. Stauffer (2010). Les frères Goujaud-Bonpland, deux destins, une passion commune pour la botanique. *In:* Martinière, G. & T. Lalande (ed.), *Aimé Bonpland un naturaliste rochelais aux Amériques (1773-1858):* 67-87. Rivages des Xantons - Les Indes Savantes, Paris.

Stearn, W. T. (1968). *Humboldt, Bonpland, Kunth and tropical American botany. A miscellany on the Nova Genera et Species Plantarum.* Verlag von J. Cramer.

Tkach, N., B. Heuchert, U. Braun & M. Röser (2009). *Collection of D. F. L. von Schlechtendal in the herbarium of Halle, Germany (HAL)*. Poster presented in the 3rd Meeting of the Global Plant Initiative, Medellín, Colombia. November 2009.

Urban, I. (1916). *Geschichte des Königlichen Botanischen Museums zu Berlin-Dahlem (1815-1913): nebst Aufzählung seiner Sammlungen*. C. Heinrich, Dresden.

Wurdack, J. J. (1971). Geographic errors in Bonpland collections of Melastomataceae. *Taxon* 20: 591-593.