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THE MANUFACTURE OF SPECIES: KEW GARDENS, THE EMPIRE, AND THE STANDARDISATION OF TAXONOMIC PRACTICES IN LATE 19TH CENTURY BOTANY

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This paper is about the creation of universals and the maintenance of order in the field of systematic botany during the age of empire. More precisely, it explores how the practice of broadly circumscribing species, or in other words, the broad and variable species concept, became dominant in the practice of taxonomy in the second half of the nineteenth century, and how such broad species were established and given authority.

By the mid-nineteenth century, it seemed that no consensus could ever be reached between botanists concerning the delimitation of species and how this should be done, not to mention more ontological issues opposing evolutionists and creationists. A tremendous controversy arose between those who adopted a broad species concept — “splitters” — and those who preferred narrowly delimited species — “lumpers”. At the methodological level moreover, the right criterion to distinguish a “true species” from a mere variety was hotly debated between those who valued the study of living plants, and those who valued the comparison of dried forms. By the 1880’s and 1890’s, professional botanists working in huge herbaria (especially at Kew Royal Botanic Gardens near London) had largely impose their views:

- a) the broadly-circumscribed species (and genera) became the standard for the delimitation of species (and genera);
- b) the herbarium was recognised as being the essential tool of the taxonomist (rather than field observations or garden cultivation) and the comparison of dried specimens became the major criterion for deciding the circumscription of species;
- c) a particular nomenclatural practice known as the ‘Kew-rule’, where the original specific epithet is not necessarily conserved when the plant is transferred to another genus, was widely followed.

This chapter examines how these three norms for species naming and delimitation came to rule taxonomic practices in the second half of the nineteenth century, and why they appeared, to such leading professional systematic botanists as Joseph Dalton Hooker (1817-1911), George Bentham (1800-1884), Alphonse de Candolle (1806-1893) and Asa Gray (1810-1888), as the only way to maintain order in the field of botanical knowledge, to ensure its progress and

epistemic steadiness, and restore its declining status in the hierarchy of disciplines. The first two sections sketch the situation of taxonomic botany in the middle of the nineteenth century, and the debates on species delimitation. The third section underlines the role of Joseph Dalton Hooker in leading a crusade against the narrow delimitation of species. The fourth and fifth sections examine how professional botanists at the head of huge public herbaria enriched by expanding empires turned their herbaria into metrological institutions that imposed the broad species concept, by controlling the production of new names and setting standards in the practices of classification. They edited colonial floras, monographs and other unprecedented compilatory works. These huge enterprises prepared the grounds for a division of labour amongst botanists, and were (reasons for and) tools to stabilise names and to standardise practices. The final section reflects on Botany's and the British Empire's need for standards.

The proliferation of practitioners and species: a problem of order and authority in 19th century systematics

In the 18th century, systematic botany, the activity of naming and describing plants and classifying them into groups according to degrees of difference and similitude, was deeply related to the encyclopaedic project. It appeared as one of the most successful branches among the sciences, the nearest to its final goal.¹ It had set principles which were adopted not only in the other branches of natural history (zoology, mineralogy), but also in other domains in science, especially chemistry and medicine. Botany was considered a most highly philosophical pursuit. Linnaeus' (as well as Adanson's and Jussieu's) insistence on explicit rules, predictivity, abstraction, numeration, clarity and neutrality of language resonated very strongly with the geometrical, quantifying and rationalising spirit of the enlightenment.² Systematics could still by 1750 believe in completeness, a goal which appeared unachievable in the following decades, due to the rapid increase of specimens brought to herbaria by European expansion in the 18th and 19th centuries. Linnaeus' *Species Plantarum* of 1753 described 5,890 species in 1,097 genera.¹³ One century later, the Candolles' *Prodromus* described 58,975 species in 5,134 genera (dicotyledons only). In 1883, Bentham and Hooker's *Genera Plantarum* estimated that there were 93,605 species (phanerogams only).⁴ This led, in the early 19th century, to a descriptionist shift that made systematic botanists appear as quibblers.⁵ In 1833, a phrenological study from Hewett Cottrell Watson (1804-1881) — who was also a botanist — illustrated the declining status of botany. It stated that, relative to other scientists, the heads of leading botanists were smaller in areas where the higher intellectual activities were carried out.⁶ Though it remained appealing for colonial actors and helped the professionalisation of Botany, the creed of a general inventory of natural productions of the world had, by the mid-nineteenth-century, lost its philosophical prestige.

More deeply, this massive specimen influx also constituted a dramatic epistemic challenge to 18th century classification systems. Most new specimens came from extra-European areas, whereas systems like Linnaeus' and Jussieu's were largely the product and the rationalisation of European folk classifications. There was a relatively limited number of tropical species known in Europe before the end of the eighteenth century. Bringing extra-European and extra-temperate

forms into the eurocentric frame of an existing classification represented a huge challenge. This tension is today revealed by statistical data on the distribution of species into genera. First, a tendency to create more genera (revealed by lower numbers of species per genus) is evident in families important in Classic and European folk economy and culture (such as Gramineae), as compared to tropical families or to temperate families with little economical and cultural relevance (such as Cyperaceae). Also evident is the typical ‘hollow curve’ distribution of species into genera in large cosmopolitan families :a few genera (crafted in the time of Tournefort, Linnaeus and Jussieu) are overcrowded with species, whereas numerous genera (crafted in the 19th century) contain no more than one or two species.⁷ This clearly hints at the conservatism of leading nineteenth-century botanists (with access to the resources of huge collections at the centre of expanding empires), as they tried to fit new exotic forms into the old genera inherited from the great 17th and 18th century botanists, which supposed, as we shall see to impede local botanists from the periphery (sometimes better placed to avoid this eurocentric bias) from creating “too many” new species and new genera.⁸ The enormous number of exotic specimens arriving in Europe was therefore not only a quantitative, but also a qualitative challenge to an established eurocentric taxonomic order.

Not only new species and specimens were proliferating, but also botany practitioners. In the time of Linnaeus and the Jussieus, botanizing in European countries was done mainly by gentlemen of science or by students herborizing with their professor. The botanical exploration of remote regions of the world was done mostly by *protégés* indebted to their scientific patrons.⁹ The old regime of botany was threatened in the nineteenth century when natural history became very popular, not only in the upper and middleclass, but also in the upper working class. Local societies flourished. Botany was now practised by people of diverse social and educational backgrounds, motivations, and interests and practices, etc.¹⁰ European expansion brought overseas thousands of people that practised botany in remote settings. These agents of empire (Scottish doctors, adventurers, missionaries, soldiers, settlers...) had their own agenda. Few of them were ready to use the Latin and were easy to bend to the discipline of a division of labour between collectors and armchair professional naturalists.¹¹

This endless accumulation of newly discovered living forms due to European expansion and to the multiplication of practitioners made the 18th century dream of a completion, bit by bit, of the inventory of nature a problematic enterprise.¹² The anarchic increase of (‘good’ or ‘bad’) species challenged the way in which taxonomic statements had been until then validated and communicated. New actors and new specimens were not readily disciplined into botany’s Ancien Regime. The linnaean canon, for instance, by which a twelve words diagnosis could characterise a species and distinguish it from all others, was now “becoming quite inadequate to the requirements of the science”, because it would constantly have to be refined and reframed so as to take into account all the new species discovered since Linnaeus and Willdenow.¹³ Furthermore, in the middle third of the century, botanical journals became so numerous that it was impossible, even in the richest libraries of Kew or the Paris Museum to gather all the information necessary to identify quickly and correctly name a specimen or to write a monograph of a genus or a family.¹⁴ The cumulative nature of botany was at stake. Bringing order in the field of botanical statements and publications had become a central problem. In the 18th century naturalists viewed themselves as revealing *the* order of nature. By contrast, mid-nineteenth-century monographers seemed concerned rather with bringing *some* order in the chaos of previously published literature. Throughout the latter half of the 19th century, flora-workers and monographers introduced their work in similar ways : “(the botany of India)

presents a perfect chaos of new names for well-known plants, and inaccurate and incomplete descriptions of new ones” or “Es schien mir (...) eine lohnende Aufgabe zu sein, die bis jetzt bekannten Arten dieser für die Technik so überaus wichtig gewordenen Pflanzengattung möglichst vollständig zu vereinigen und mit Hilfe dieses Materials in das noch bestehende Chaos Ordnung und Licht zu bringen.”¹⁵

The case of the genus *Landolphia* illustrates this tendency towards species inflation and the difficulty to make commensurable a crowd of heterogeneous statements from various actors. The *Landolphia* are Apocynaceae growing in Africa and Madagascar. The first specimen that reached Europe was collected by 1787 in the kingdom of Oware (South West Nigeria) by Palisot de Beauvois, a gentleman naturalist who accompanied a French military expedition headed by Captain Landolphe. After examination in the herbarium of the Muséum National d'Histoire Naturelle, Palisot de Beauvois described it in 1806 as *Landolphiaowariensis*.¹⁶ In 1844, only three more species were described, but under two different genera (*Landolphia* and *Vahea*) that were only later united (under *Landolphia*) in Bentham and Hooker's *Genera plantarum*.¹⁷ In East Africa, Dr. John Kirk had observed some *Landolphia* and their elastic gum during the Zambezi expedition with Livingstone (1858-64). Appointed British Consul at Zanzibar a few years later, he studied these plants further and provided Kew with specimens from the coast near Dar-es-Salaam. As a good agent of the new British moral imperialism in Africa, he worked hard to make trade in rubber replace that in slaves in the East coast.¹⁸ The scramble for Africa, and more specifically, the search for African rubber yielding plants, suddenly focused attention on *Landolphia*. Several species produced good rubber and provided a great deal of the African rubber, which represented about one third of the world trade in the last two decades of the century.¹⁹ *Landolphia* therefore became an object of intense interest on the part of travellers, traders, civil servants in African outposts, etc. During the African rubber boom (1870-1914) when natural rubber resources were wildly depleted, several expeditions were organised in Western and Central Africa to find sources of rubber.²⁰ This brought hundreds of new specimens in European herbaria, and saw many diverse actors — explorers, military men, military physicians, missionaries, traders, colonial officers, etc. — claim to have discovered a new species. *Landolphia* also became a hot topic for closet naturalists at home: parallel to the economic boom of rubber in Africa, one can observe a boom in the botanical literature.²¹ But when studying African rubber plants, even those happy few professional botanists who had access to large libraries and herbaria in Kew, Paris and Berlin (the metropolis of ruling colonial powers in Africa) faced great difficulties. They had to “navigate” in a poorly ordered field of statements—sometimes contradicting each other—about *landolphias* (concerning their appearance, distribution, specific identity, economic value, etc.). These statements were published in many different places and genre such as travel narrative, administrative reports or economic correspondence, local publications, etc., rather than in the major and readily accessible botanical periodicals.

How to circumscribe species ?

As the number of claimed species dramatically increased, botanists had conflicting views on the criteria on which to decide whether two different forms belong to the same species or whether their difference should be awarded a specific value. Some would look for evidence in field observation on the living, some would stress experiment in the garden and some would insist on the comparison of numerous dried specimens in the herbarium.

The herbarium, the garden or the field?

Jussieu and Ventenat had hoped that the subordination of characters would provide general rules and principles to weight characters and establish affinities through careful morphological observation (made by the eye, sometimes aided by a lens). But it was clear in the early nineteenth century that no one hierarchy of characters could be applied to all plant groups. Subordination of characters had to be done “locally” because characters had a different taxonomical value depending on the group being considered.²² The selection of characters providing evidence of relationships, and their weighting, obeyed no general method. John S. Henslow (1796-1861), professor of botany in Cambridge University noted in 1837 that

“there is in short, no law whatever hitherto established, by which the limits of variation to a given species can be satisfactorily assigned, and until such a law be discovered, we cannot expect precision in the details of systematic botany. In this respect, the science is pretty much in the same position which mineralogy occupied before the discovery of the laws of crystallography.”

He urged experimental researches, which seemed to be the only scientific approach that could lead to such a law “for the discrimination of species” which would improve “the mere empirical rules at present practised.”²³ In the footsteps of Linnaeus and Koelreuter, some botanists (William Herbert (1778-1847), Alexis Jordan (1814-1897)²⁴, Charles C. Babington (1808-1895), Joseph Decaisne (1807-1882), Charles Naudin (1815-1899), etc.) developed, in the 1840s and 1850s, research program toward an “experimental taxonomy” (a phrase that came into use only in the early 20th century).²⁵ “L’histoire naturelle en général, après n’avoir été longtemps qu’une science d’observation, doit tendre à se faire science d’expérimentation” claimed Decaisne, professor of Culture at the Paris Museum of Natural History.²⁶ Growing large numbers of varieties and species of the same genus, these experimental taxonomists claimed that only experiment (not herbarium or field work) could decide the species question in a truly scientific way. In short, they claimed they could provide systematic botany with the absolute proof it was lacking. For some of these experimentalists like Alexis Jordan and Charles C. Babington, the persistence of differences—even if they were tenuous—between two forms when cultivated through several generations in a garden could evince the existence of two different species.²⁷ But many wondered how many years should one grow these plants so as to document the persistence of the differences. Furthermore, Decaisne mentioned the cases of varieties which can breed true (like the whites and the blacks who belong to the same human species). To Herbert and Decaisne, a more strict criteria, was to unite in one species the two forms, whenever their crossing generated healthy and fertile offspring. In this way, Decaisne’s student Charles Naudin could collate 28 alleged species of honeydew melon into one single species.²⁸ But even this criterium remained inconclusive because there existed fertile interspecific hybrids and because of an indecisive continuum between “fertility” and “sterility”. “The criterium provided by the crossing to discriminate species is not as absolute as I previously believed”, admitted Naudin in 1863.²⁹

Other botanists (like Carl W. von Nägeli, 1817-1891), C. C. Babington or Richard Spruce advocated the observation in situ of the living plant as the best way to detect the minute differences among species. This method was seen as more natural than experimental studies in a garden, and more accurate than the herbarium observation of dried specimens. Herbarium specimens, indeed, showed only a few of the characters that could be used to discriminate plants.

Babington claimed in his *Manual of British Botany*, that “species exist, and that they may often be easily distinguished amongst living plants, even when separated with difficulty from their allies when dried specimens only are examined”. [ADD HERE A NOTE FOR THIS REF : Charles C. Babington, *Manual of British Botany*, 5th ed., London, J. van Doorst, 1862, p. iv] Robert Wight and G. A. Walker Arnott claimed in a study on the Indian Flora, that “we have had advantage over the European botanists who have described Indian plants, they having only seen one or two isolated specimen” whereas Wight and Arnott had observed many exemplars of the same species in “different localities” and “in their natural situation.” Contrarily to Babington who invoked the field to advocate the existence of more species than currently acknowledged, Wight and Arnott claimed that field observations allowed botanists to “cut down species” because they allowed botanists to relativise variable characters like the shape of the leaves and the quantity of pubescence.³⁰ Promoters of field observation, as well as promoters of experiment (Herbert and Decaisne being lumpers, whereas Jordan was a harsh splitter) hence disagreed on the breadth of the species delimitation.

Finally, neither the comparison of series of dried forms, nor field observations, nor experiment in gardens seemed to provide the ultimate test that would allow botanists to reach agreement on the discrimination of species. As a Gray sadly observed that there were “no fixed and philosophical principles for the subordination of characters and the study of affinities in plants.”³¹ As H. C. Watson wrote to Darwin,

“The short truth is, that we have no real proof or test of a species in botany. We may occasionally disprove an alleged species by seeing its descendants become another such species, – or we may unite two by finding a full series of intermediate links. Many botanist assume all describable forms, if not (or until) so disproved or united, to be distinct species, ab initio ad finem.”³²

An epistemic crisis

This lack of accepted and conclusive criteria threatened the status of systematics as a science. Systematics seemed unable to cope with observer-dependant knowledge and to achieve communicability and accumulation. Suppressing individual idiosyncrasy was a prominent feature of nineteenth-century science’s moral economy and proof-making practices. Aperspectival objectivity (as Daston put it) was asserted through many ways such as statistical treatment of data, averaging of observers’ individual features, self-discipline, and the use of self-recording instruments.³³ In systematics, no such material or literary technology was in sight to produce conclusive and accepted proofs in species’ delimitation controversies.

More generally, as compared to the rising Laplacian sciences, systematic botanical knowledge seemed unable to discover or demonstrate regular uniform laws in nature. Some botanists complained about the lack of law in Botany and saw the natural system as being unable to draw a clear distinction between taxa, using terms such as “often”, “sometimes...at other times”, “rarely”, “almost always”, etc.³⁴ Systematics seemed foreign to causal thinking, it “explained nothing.” Those passionately concerned to discover the general laws of the vegetable world had shifted to plant geography, or to plant anatomy and physiology. Classifying plants had lost academic interest. In Germany, the “wissenschaftliche Botanik” emerged in the 1830s and 1840s,

and physiological, geographical, microscopical and experimental approaches took the lead in botany.³⁵ Between 1840 and 1880, systematic botany as a domain owed its survival largely to a single project, i.e. the undertaking of the *Flora brasiliensis*.³⁶ In France, the Paris Museum of Natural History itself, which had been prominent in the institutionalisation of natural history around 1800, experienced a shift toward experimental approaches and disciplines in the decades after 1838.³⁷ The Jussieus' chair of systematic botany was suppressed in 1853 and French naturalists complained about natural history being abandoned in the school curriculae.³⁸ In Great Britain, Richard Drayton has shown how, after the break-up of Banks' patronage network, career opportunities in the empire were vital for the survival of systematics as a science in England.

As no experimental equipment and no conclusive species criterium existed that would mark the boundary between skilled systematists and amateurs, it seemed that systematic botany, a noble and pleasurable science in the 18th century, had become a chaos of incommensurable statements because the cost of entrance for a beginner was very low and anybody could claim to have discovered a species. While other sciences experienced an increased professionalisation, botany appeared progressively as a poorly specialised and amateur science connected with horticulture or women's leisure.³⁹ To many commentators, systematics was a battlefield, where different—and ever opposing—views could never produce any collective and steady knowledge. This was nowhere more dramatically exemplified than in the mid-nineteenth-century debates opposing “splitters”⁴⁰ and “lumpers”⁴¹ on the circumscription of species.

“Splitters” and “lumpers”

The splitters (named in French “l'école analytique”) claimed that within Linnaean species, it was possible to find several stable and distinct types which they claimed to be species. Path-breaking works here were those of Carl Wilhelm von Nägeli (1817-1891) in 1841⁴² and Alexis Jordan (1814-1897) in 1847.⁴³ Though united in their search for smaller and more stable units in nature, the splitters strongly diverged on their ontological views. Some like Jordan were creationists, others like Nägeli were transformists. They also differed over the criteria they advocated to circumscribe species: some (like Babington) stressed local field experience, others (like Jordan) experimental gardening, others (like Nägeli) microscopical studies. However heterogeneous this movement may have been, it was between 1840 and 1870, this splitting trend in systematics was very powerful and was reinforced by the tendency of local botanists in the peripheries of European empires to create new species. By 1850, a ‘splitty’ approach informed the writing of many European and extra-European Floras and strongly challenged the Linnaean species concept.

The “lumpers” were not ready to abandon the broad species concept and invoked the authority of Linnaeus. They considered that species were not made of individuals strictly moulded after one single fixed type, but were rather a spectra of slightly variable forms clustered around the type. Some, like Joseph Decaisne (1807-1882), used experimental cultivation as the criterion to delimit species broadly. Others, like Hooker, Bentham and A. De Candolle, valued the comparison of series of dried specimens as the major criterion for species delimitation.⁴⁴ Whether supporters of the morphological criterium or of the experimental criterium, all “lumpers” worried about a “wholesale manufacture of species” threatening the whole order of classification.⁴⁵

The controversy on the right delimitation of species developed into numerous skirmishes relating to particular groups and places. The Brambles (*Rubus*, Rosaceae) controversy was one of the hottest of them. It involved protagonists like A. Jordan, D. Godron, P. Mueller, O. Kuntze, C. C. Babington, G. A. Walker Arnott and G. Bentham. In 1829 Lindley had described 24 species of *Rubus*. In 1847, the second edition of Babington's *Manual of British botany* discriminated 36 species. Professor of Botany in Cambridge, Babington created the most extensive British herbarium collection of Brambles and grew 40 forms that bred true in the botanical garden. On the continent, Dominique Godron described 49 *Rubus* species, whereas the German P. J. Müller (1859) proposed 236 species in France and Germany. This last work seemed much too splitty to Babington who described 45 British species in 1869.⁴⁶ On the other side, lumpers like G. A. Walker Arnott and Bentham acknowledged no more than half a dozen species, disqualifying other forms as varieties of hybrids.⁴⁷

Three British Floras published nearly simultaneously around 1860 made the debate on the delimitation of species very visible in the UK. In their works, C. C. Babington described 1708 species, W. J. Hooker and G. A. Walker Arnott no more than 1571, and G. Bentham only 1285. How could botanists working on the same country and having in principle access to the same material disagree so much?⁴⁸ Between 5 and 236 *Rubus* species, between 1285 and 1708 plant species in Britain: where was the truth, and what about the scientificity and certainty of systematic botany?

J. D. Hooker's crusade for the broadly circumscribed species

The impossibility of regulating species claims and reaching consensus within the systematic community challenged Botany as a science: objectivity (in its new aperspectival sense of observer-independant knowledge), order and cumulativity were at stake. How did leading professional taxonomists working on the biggest herbaria in the world reacted to these challenges?

Imperial expansion and the development of public herbaria

The nineteenth century saw the rise of the big public natural history collection in general, and of herbaria in particular, as they progressively absorbed and largely superseded private cabinets, and directly acquired holdings as European expansion advanced.⁴⁹ The Museum National d'Histoire Naturelle's herbarium, though instituted as a national collection in 1793, superseded private French collections only in 1857 with one million specimens after Adrien de Jussieu left his herbarium to the Museum. After absorbing some more private collections and benefiting from French colonial expansion, it contained 3 millions specimens in 1907.⁵⁰ The Kew Herbarium was established as a national collection in 1854 thanks to Bentham's gift of his cabinet (200,000 specimens), and extended in 1867 with W. J. Hooker's herbarium (already housed at Kew since 1853). By 1860, with 1.2 million specimens perfectly ordered and arranged in a convenient way, Kew already surpassed all other public and private herbaria in the world.⁵¹ Geneva's herbarium was smaller, though its value was increased by the presence of the specimens used for the writing of the De Candolles' *Prodromus*.⁵² By 1898 Kew contained 3.3 million specimens and maintained its first position in the world, although Berlin's herbarium had

dramatically increased in size after this city became the capital of the Reich in 1871 (it had 4 million specimens by 1913).⁵³

As these institutions were establishing themselves as centres of a 'world botany', the few men who were in charge of them, or who had a daily access to their resources, such as Joseph Dalton Hooker and George Bentham at Kew, Alphonse de Candolle in Geneva, Asa Gray in Boston or Adolf Engler in Berlin, enjoyed increasing power and influence in the field of systematic botany. Though not agreeing on every matter, they had enough in common to impose their idea that species were variable entities and should be broadly circumscribed on the rest of the botanical community. Among these men, Joseph Dalton Hooker certainly played the leading role.⁵⁴ After two decades dominated by splitting trends, in the 1850s he took the lead of a counter-offensive that promoted and imposed the broad species concept.

Hooker's crusade against "species-mongers"⁵⁵

The son of Sir William J. Hooker, the powerful director of Kew Royal Botanic Gardens and Herbarium, Joseph D. Hooker had from his early years access to the huge resources provided by his father's private herbarium and to his extensive social relations. The latter allowed him to be Assistant Surgeon and naturalist on the Antarctic expedition in 1839-1843 and to make intensive explorations in India and the Himalayas in 1848-1851. Aged only 34 when he came back from India, he was one of the most "travelled" botanists in the world and one of those who had experienced the greatest diversity of plants of the globe, both on the field and in the herbarium.⁵⁶ His conception of species, as being more variable and more broadly delimited than most of his contemporaries thought, had already emerged in the 1840s and solidified around 1851-52 while he was working on his Floras of New Zealand and of India. In 1853 he estimated that the total number of known species of plant was no more than 50 000, instead of 70-100 000 currently alleged by others.⁵⁷ In his view, broad species were necessary to make classification more sound and stable. As a brilliant plant geographer, a broad delimitation of species was also necessary to draw meaningful comparisons between floras of different regions and explain the distribution of plants (how to study biogeographic relationships between Arctic regions or alpine areas from tropical or temperate regions if similar forms in these different regions are given different names?).

The promising botanist soon felt himself a crusader against "species-monger".⁵⁸ "What with De Vries, Klotzsch, and Steudel we shall have Phanerogamic Botany messed like *Algae*, except we show a bold front", he wrote to Harvey in 1852.⁵⁹ Alluding to the *Flora indica*, he wrote in 1853 to Bentham :

"It has (...) been impossible to avoid doing battle with all our predecessors' species, whose utter disregard of one another and of any other part of the world has produced inextricable confusion in many cases (...) I admire your great caution and desire to curb my rabid radicalism: but the tide will turn one day and the reducing of species will go on apace (...) I am a *rara avis*, a man who makes his bread with specific botany (...) What is all very pretty play to amateur Botanists is death to me."⁶⁰

In what J. D. Hooker himself viewed as a fight to the death, the *Florae novae-zelandicae* (1853) and the *Flora indica* (1855) were his first weapons directed against splitters. Their aim was to “establish the genera and species (...) on a sound and philosophical basis and to unravel their synonymy.”⁶¹

Within a few years (1853-1860), Hooker had convinced most of the leading botanists in the world that it was time to “show a bold front” against splitters.⁶² In France, Joseph Decaisne led the crusade against Jordan’s follower. After the *Flora indica* had appeared, Decaisne had first reacted against Hooker’s ‘lumping’ views.⁶³ A few years later, he revised his opinion :

“As many of my colleagues, I had more or less shared this narrow vision of species, but time and experience have modified my opinion, and if I had to write again now the monograph of Plantaginaceae [a family he had treated for the Candolle's *Prodromus*...] I would not hesitate to cut down the number of species more than I did.”⁶⁴

Hooker may well have influenced in a similar way Alphonse De Candolle. In the early 1850’s, although opposed to Jordanian species, De Candolle had not hesitated to publish in his *Prodromus* rather ‘splitty’ monographs (for instance Dunal’s one on Solanaceae in 1852). But he had partly changed his mind by 1860. His 1862 monograph on the *Quercus* genus reestablished the specific unity of the European oak tree (*Quercus robur*), established by Linnaeus but split into several species by recent authors.⁶⁵

Installed at Kew with his herbarium in 1854, Bentham also seems to have changed his views after contact with Joseph D. Hooker. Following the publication of his *Handbook of the British Flora* in 1858, which accepted 25% fewer “good species” than Babington’s *Manual of British botany*, Bentham attacked Babington and strongly objected “to the elevation to specific rank of forms which traced over a sufficiently wide area are found to be but local or transitional modifications of a species.”⁶⁶ J. D. Hooker commented in 1858:

“Bentham's late researches into the British Flora have so greatly modified his views of the limits of species [...] He has completed the MS. of his British Flora having studied every species from all parts of the world, and most of them alive in Britain, France and other parts of Europe. Well—he has turned out as great a lumpner as I am! and worse.”⁶⁷

These crusaders of the broad species concept charged the splitters with killing botany as a science. First they were charged with burdening it quantitatively with new names (Jordan saw in *Draba verna* no less than 200 species!). As Decaisne wrote,

“it would be a great acquisition if the describers of plants would condense their species by reducing them to really stable and natural types instead of dividing and multiplying them *ad infinitum*, as has been the custom for the last 30 years. This opinion is not exclusively my own; it is also that of my excellent friend Dr. J. D. Hooker (*Flora Indica*, Introductory Essay, etc.), and even that of most serious monographers, who feel instinctively that this way (...) will sooner or later lead to chaos, which would be the death of science.”⁶⁸

The narrower delimitation of species was not only criticised as a source of disorder. It was dismissed as “of no use to the botanist, general or special” and of no philosophical meaning.⁶⁹ It was just not science. Splitters were therefore seen as responsible for lowering the status of systematic botany. Their “puerilities”, as Hooker and Thomson put it, repelled the ablest and brightest students, and “being abandoned by many of those who are best qualified to do it justice, [systematics] fall into the hand of a class of naturalists, whose ideas seldom rise above species, and who, by what has well been called *hairsplitting*, tend to bring the study of these into disrepute.”⁷⁰

The metrological solution : Kew, the Empire, the Colonial Floras, the *Genera plantarum*, and the *Index kewensis*

How did Hooker and his allies impose their view on the field of systematics ? Bentham and J. D. Hooker started in 1858 to work together on a *Genera plantarum*. Bentham had always been reluctant to any joint authorship. Furthermore, he and J. D. Hooker had then different views on species origins (Hooker being converted to evolution by his friend Darwin whereas Bentham was still fixist). It is only because they shared the same vision on the practical delimitation of species and on the necessity to reorder systematics, that Bentham agreed to get involved in such a co-authorship.⁷¹ Bentham furthermore agreed to write two Floras (Hongkong and Australia) in Hooker’s Colonial floras project. This alliance with Bentham allowed Kew to produce decisive enterprises in the crusade against “species-mongers”: the colonial Floras, the *Genera plantarum* and, later, the *Index Kewensis*. To stabilise taxonomic knowledge and impose their new order on systematics, Hooker and Bentham lacked most of the tools of aperspectival objectivity (in Daston’s sense) that transformed other branches of science in the century. But they had the empire and they instituted Kew as an imperial metrological centre of a world-botany.

William J. Hooker took over the direction of Kew garden in 1841. Within a few decades he and his son transformed Kew from a princely garden and aristocratic park into Britain’s leading botanical institution and a key “tool of empire.”⁷² Sir William J. Hooker thought of instituting Kew as the botanical advisory centre for Victorian imperial expansion. He worked to reactivate the Banksian colonial network and created in 1849 a Museum of Economic Botany at Kew. He also spearheaded plant-hunting overseas explorations and plant transfer projects. The successful transfer of *Cinchona* from South America to India in 1859-61 was one of these global enterprises. These successful efforts to integrate Kew in the imperial machinery established Kew as the botanical clearing house for overseas economic enterprises. Kew was at the centre of an active correspondence between London and overseas’ colonial officers, travellers, planters and missionaries. It served as the head of the network of colonial botanical gardens and a training centre for plant hunters and gardeners. This also led to the centralisation at Kew of botanical collections resulting from a new wave of exploration and surveying accompanying mid-Victorian imperial and commercial expansion.⁷³ Initiated with the installation of Bentham’s and Hooker’s herbaria, Kew’s herbarium contained by 1860 more than 1 million well- arranged specimens supplemented by an extensive library, and was the premier of such institutions in the world.

This allowed the Hookers to launch a wide project to publish colonial Floras. "The want of them, claimed Sir William, is a great obstacle to the development of the productive resources of the colonies."⁷⁴ A first step in this direction came in 1851 when W. Hooker obtained from the Prime Minister a grant for his son to classify his Indian collections and write a Flora.⁷⁵ But

Hooker and Thomson's *Flora indica* stopped after the first volume, partly for lack of support. In 1857, Sir William obtained support from the Colonial Office for a *Flora of the West Indies*. One year later the green light was given for a Flora of Australia. After he became assistant-director to his father at Kew in 1855, J. D. Hooker worked hard on a general plan to publish a Flora for each British possession. Through his extensive relations in metropolitan and imperial political circles, W. Hooker obtained in 1860 funding for this general project. These Floras were published very actively in the following decades: *Flora of the British West Indian Islands* (3 vols. [1859]-1864), *Florae hongkongensis* (1861), *Flora capensis* (3 vols. in 1859-1865), *Florae australiensis* (7 vols., 1863-1878), *Flora of tropical Africa* (3 vols., 1868-1877), and *Flora of British India* (7 vols., 1872-1897).⁷⁶

As well as the Cinchona project, the colonial Floras project might be thought of as “big science.” More than 12,000 pages were published in less than three decades. To secure quick results and wide diffusion, the Hookers broke with the tradition of prestigious, expansive, richly illustrated—and seldom completed—volumes in quarto. They wanted “good, but inexpensive, scientific works on the Vegetable productions of the British Colonies” that could be finished in a reasonable time. They had to be “thoroughly trustworthy in a scientific point of view, and yet not so exclusively scientific in method and language as to be useful to the professed man of science only.”⁷⁷ The florae were concise, standard in their presentation, and published in octavo, without illustration. This choice distinguished the Colonial Floras from the two other contemporaries big enterprises in systematic botany: the Candolles' *Prodromus* (1824-1873) — designed to replace Linnaeus' *Species plantarum* — and the *Flora brasiliensis* (1840-1906) edited successively by Martius, Eichler and Urban.⁷⁸ Both took half a century to complete, were written in Latin and were too expensive to reach a wide audience outside professional botanists.

“To secure uniformity of plan”, Bentham's *Flora hongkongensis* served as the model for all the following Floras.⁷⁹ They were all preceded by the same “outlines of botany” written by G. Bentham to educate local botanists. These outlines were a revision of those given in 1858 by Bentham in his *Handbook of British Flora*. Stating that “species vary within limits which is (sic) often very difficult to express in word”, it documented different aspects and causes of variation (such as the influence of dryness on pubescence, and the tendency of the ratio size of flower/size of leaves to increase under light, bright and open conditions, etc.) and presented different cases of accidental aberrations “which the botanist must always be on his guard against mistaking for specific distinctions.”⁸⁰ Such a ‘lumpist’ manifesto was to be found at the beginning of all colonial Floras and helped to shape the views of generations of local amateur and professional botanists.

The *Genera plantarum* was a second mammoth enterprise to reorder plant taxonomy, which Bentham and Hooker undertook from 1858 to 1882. The general format was decided after consulting “botanical friends in whose judgement we had great confidence” (such as Gray, A. De Candolle, etc.).⁸¹ Although its focus was the groupings at the genus level and above, it had an effect on discussions at the specific level, since the number of species given for each genus tended to be low, in accordance with the broad species concept.

The *Index Kewensis* was the third tool that helped both to establish Kew's position as the world centre for systematic botany and to standardise taxonomic practices at the generic and specific level. Started because of a bequest by Charles Darwin, it was undertaken under Sir Joseph's direction in 1885 to provide an index of all (“good”) species names. This huge work was

completed ten years later, and required the collaboration of no less than twelve librarians and botanists. It has been regularly revised since and remains an essential working tool for botanists.⁸² More than a mere index, it was in its initial volumes (unlike Steudel's earlier index) a guide to correct names stating clearly which names were to be accepted, and which names ("synonyms" or "bad species" being only a variety of the considered species) were to be discarded.⁸³ As we shall see later, the *Index Kewensis* supported nomenclatural practices which reinforced the "broad species" standard.

Initiated in the wake of J. D. Hooker's crusade against narrowly delimited species, the Colonial Floras, the *Genera plantarum*, and the *Index kewensis*, establishing species and generic limits on a world-wide basis, turned out to be very successful and powerful weapons. These huge publications provided compelling standards that imposed the broad species concept in practice, and disciplined beginners', local botanists' and travellers' taxonomic practices. They helped in the last third of the nineteenth century to repel narrow species delimitation outside the boundary of dominant professional Botany and to reinvent the linnaean species that remains at the basis of systematics today.⁸⁴ "I have no doubt of the full and entire correctness of the principles you work on and the Kew Floras and the Gen. Plantarum will more than anything else determine the public botanical opinion and mode of working for the next generations" rightly wrote Asa Gray to Bentham.⁸⁵ The Candolles' *Prodromus* also helped to introduce some standard practices. But J. D. Hooker's estimate of the number of species was even lower than those of the Candolles. Furthermore, the *Prodromus* lacked the unity of purpose that informed J. D. Hooker's enterprises: families were treated by a diversity of contributors, some of them having a rather splitty approach. Finally, the *Prodromus'* audience outside the small circles of full-time botanists was much smaller. On the contrary, the colonial floras were more readily accessible to a greater number of amateur practitioners and contributed to discipline their practices. Many colonial actors (colonial officers, missionaries, military men, etc.) learned the basics of botany while herborizing in their outpost and using a Kew Colonial Flora, hence assimilating through 'hands on' experience, rather than through explicit statements, the practice of delimiting species broadly.

Regulating species' birth and names

Monographs (like those comprised in the *Prodromus*), great Floras, and other major publications (*Genera plantarum*, *Index kewensis*) did not only promote the principle of delimiting species (and genera) broadly. They also very concretely contributed to the elimination from botanical literature of "bad species" (seen as mere varieties of broadly-circumscribed species) and of "bad names" (i. e. synonyms :names given to a plant which represented a species already described by an earlier author).

The Candolle's *Prodromus* (1824-1873) described 58,975 species in 5,134 genera of dicotyledons. In 1862-1883, Bentham and Hooker's *Genera Plantarum* estimated 95,600 species (monocotyledons and dicotyledons) in around 7,600 genera.⁸⁶ Within a quarter of the century in which many new specimens reached European herbaria in the wake of European expansion, botanists could therefore consider with satisfaction that the number of genera was more or less stabilised (which helped the stability of the classification system), but had to accept that the number of known species was still rapidly increasing. 'Birth control' was called for by leading

botanists. The leading professional botanists, who had access to large libraries and herbaria of an imperial metropolis, shared similar views on species delimitation and a similar taste for order. In their monographs and their contributions to colonial Floras or the *Prodromus* or *Die natürlichen Pflanzenfamilien*, they severely “cut down” species proposed by their predecessors, by travellers or by local botanists. In the *Index kewensis* which compiled all species names, decisions about which species were ‘good’ and which not were largely based on these monographs (hence legitimating their taxonomic stance) rather than on the minor publications in which travellers and local botanists published. This ‘demographic control’ exerted by professional botanists in mainstream publications is illustrated below for some genus (*Erophila*, *Rubus* and *Cirsium*) that had been battle ground between lumpers and splitters and for genus of overseas plants (*Cinchona*, *Landolphia*) where monographers repressed travellers tendency to multiply species:

(insert Table 1 here)

One guesses it easily from this table: the controversy between lumpers and splitters on the right circumscription of the species did not reach a closure through any decisive observation or experiment. It was rather decided in practice by the domination of such huge and authoritative publications that influenced most monographers and Flora writers in the late nineteenth century. In practice, “good species” were therefore what “competent” botanists said they were, and mostly they could create or validate a new species. Closure in general was underdetermined by empirical properties and was secured by the authority of persons, texts and institutions whose power was built on the opportunities provided by travel and empire.

Leading systematists also came to impose names and nomenclatural practices which reinforced—and were reinforced by—the standard of broadly delimited species. The clearest and most famous example is the nomenclatural practice that came to be referred to as the ‘Kew rule’. It consisted in considering as valid a binomial name currently in use, even if it had been formed in contradiction with the traditional principle of priority, for instance when a monographer changed the specific epithet, when moving a species from one genus to another.⁸⁷ Most late nineteenth herbarium botanists, especially in Berlin, Kew and Harvard, followed the Kew rule.⁸⁸ The *Index kewensis* was in the late 19th century an extremely powerful tool to impose the Kew rule *in practice*. “Our practice is to take the name under which any given plant is placed in its true genus as the name to be kept up, even though the author of it may have ignored the proper rule of retaining the specific name [i.e. epithet], when transferring it from the old genus to the new” declared B. Daydon Jackson who compiled the *Index kewensis*.⁸⁹ The Kew rule remained in use in the *Index kewensis* until the third supplement (1901-1905) published in 1908, and represented a way by which the *Index kewensis* policed the field of statements in systematics.

The Kew rule, applied in the colonial Floras and the *Index Kewensis*, tended to favour monographers’ work over that of the first describers (often local or colonial botanists, or “splitters”). For species that were removed to another genus, the original epithet could be changed and the name of the original author would cease to be associated with it as authority. For instance an Apocynaceae described by the French Botanist Louis-Pierre as “*Ancyclobotrys pyriformis* Pierre” in 1899 became “*Landolphia pyriformis* Stapf” when Stapf revised the family for the Flora of Africa.⁹⁰ The Kew rule was hence to conform to the kind of taxonomic order Hooker and Bentham wanted to institute. Meanwhile, it had the advantage of reducing bibliographical work to find the correct name of a plant.⁹¹ “It is only second rate botanists who pride themselves of the number of names, good or bad, to which their initials can be attached” said Bentham.⁹² A leading German monographer, Hans Hallier, arguing for the Kew rule, made these points even more explicitly :

"I consider the principle of priority only valid so far as it gives rise to a stable and uniform nomenclature. Therefore I follow the conservative, factual, not-depending-on-the-person, and conditional principle formulated by Celakovsky and the Kew botanists [i.e. the Kew rule], rather than the proliferating, depending-on-the-person, and unconditional principle, which was in germ in De Candolle's nomenclatural rules, and which, in its recent inconsiderate mode of application by O. Kuntze and the Americans [i.e. those advocating an integral and retroactive rule of priority], became the progenitor of an overwhelming proletariat of synonyms."⁹³

In the mind of Hallier and many of the leading herbarium botanists, the Kew rule was therefore seen as a "violence légitime" against old customs of priority, necessary to save the taxonomic order from a "proletariat" of "bad species" proposed by lower botanists naming too many supposedly new species that were prompted by the seeking of glory.⁹⁴ The steadiness of systematic knowledge, they thought, depended on discarding such impure desires.

Standards: ordering botany and the empire

What was at stake in this way to manufacture—"good", i.e. broad—species was no less than the imposition of an order in the field of botanical knowledge. More precisely, a kind of order in which "competent" botanists would be able to work, in which their statements would have immediately more visibility and more authority than other statements from various other actors. Only this, claimed the leading professional botanists, would prevent Botany from chaos. Joseph D. Hooker, well aware that the involvement in botany by very diverse social groups with differentiated practices and motivation was threatening the "Ancien Régime" cognitive order of Botany, complained about "beginners refusing to accept the conclusion arrived at by abler botanists", who "may pause before venturing to institute a genus, [but] it rarely enters into [their] head to hesitate before proposing a new species." "A knowledge of the relative importance of characters can only be acquired by long study; and without a due appreciation of their value, no natural group can be defined" he went on.⁹⁵ Contesting both travellers and pharmacists' legitimacy to produce "good" systematic knowledge, he claimed that the knowledge, however intimate, of one region or of one group of plants were insufficient "to enable an observer to pronounce upon what characters are of specific importance in that group."⁹⁶ William T. Thiselton-Dyer, J. D. Hooker's son-in-law and successor as director of Kew gardens, went even further in this boundary work. Giving up the ideals of the Republic of letters for that of the domination of a few herbarium botanists, he considered that a "all that can be hoped is a general agreement amongst the staffs of the principal botanical institutions in different countries where systematic botany is worked at; the free-lances must be left to do as they like."⁹⁷

Local botanists—i.e. botanists with a 'local' outlook, whether at home or in the colonies—and "species mongers" could well "discover" hundreds of new species, leading closet naturalists undertook to control the validation of these species and deny them any contribution to systematics. That was precisely what the broad species concept did. It required wide comparisons in large collections. It contributed to the invention of the "local botanist", the

“amateur botanist” and of the boundaries that separated them from “competent” professional botanists. J. D. Hooker revealed this motivation to Asa Gray in 1854 : “You say that we are not to pronounce species the same because they are united apparently by certain forms of each—I grant this fully, but how are we to act upon it & deny local botanists specific value to their small fish?”⁹⁸

Some professional herbarium botanists dreamed of going further and called for a greater centralisation of botanical publications and a greater control on descriptions of new species and genera more controlled.⁹⁹ At the International Congress of Botany in 1900, Henri Hua, a botanist at the herbarium of the Paris Museum, even proposed the creation of a single journal where all new species should be described so as to be accepted by the community.¹⁰⁰

Kew gardens and a few others large institutions relegated the splitters and the local (domestic or colonial) botanists to subaltern positions. They imposed the way that legitimate taxonomic evidence had to be administered, favouring the comparison of dry forms over experimental or field criteria. They turned their herbaria into the centres of the order they imposed on the field of taxonomy. They constituted themselves as the metrological centre of the systematic community and attempted to regulate both nomenclature and the species concept. The order of Botany needed standards. The prosperity of the British empire too. The Colonial Floras, claimed Joseph Hooker in 1861, “are indispensable for supplying that fixed nomenclature for their [the colonies’] plants, without which it is impossible for [Kew botanists] or the colonists to carry on a correspondence on these and kindred subjects.” In Sir Joseph’s view, the economic expansion of the British Empire and the orderly progress of systematic botany went hand in hand and both depended on standard names and standard (broad) species delimitation practices.¹⁰¹ For such economic plants as Cinchona, rubber, Gutta-percha or timber, to link in a reliable way a botanical name, a description of the plant, and an estimate of the commercial value of the rubber, was essential for the development and stabilisation of imperial trade. Such knowledge was also crucial in determining which of the wild plants could be better cultivated in plantations. For instance, the question whether Assam and Chinese Tea belonged to the same species or not was crucial for the development of the Indian tea industry. In Africa many—mostly Germans—settlers and capitalists wasted a lot of time and money in trying to grow in plantation African rubber plants instead of the Amazonian *Hevea brasiliensis*. Similarly, Dutch cinchona plantations in Java in the 1850’s and 60s failed because they had (contrary to the British!) introduced a worthless species from South-America (but they later took the lead with *Cinchona ledgeriana*!). These famous examples were called for by Kew botanists as illustrations for the need of taxonomic accuracy and a “central standard of reference”, which only a large botanical metrological institution could assure.¹⁰²

Many scholars have depicted Kew as the botanical centre of power within the British empire, controlling access to career opportunities (especially important in a context where botany was not highly professionalised) and giving leading botanists like the Hookers, Bentham and Thiselton-Dyer the power to impose upon local botanists in the periphery a strict division of work.¹⁰³ As we have seen, much more was at stake than the mere institutional hegemony of Kew in the British empire. It would be an error to interpret the denial to local botanists of the right to institute new species and genera as a mere domination exerted on the field by gate-keepers (herbarium botanists) who monopolised in this way symbolical capital (as in the case of G. Bentham’s authorship for the *Florae australiensis* which overshadowed the merits of the local botanist Ferdinand von Mueller who did much work for the Flora). For Kew botanists, ordering

the “chaos” of botanical knowledge was, for sure, a sincere concern, if not a mission they assigned to themselves. Their ideal was a particular ideal of order, communicability and cumulativeness. The taxonomic order they established was in their view necessary to allow accumulation of data and to increase systematic botany’s philosophical value (and a greater use for phytogeographical studies), as well as its role within the empire.

Interestingly the standards (broad species, taxonomic proof based mainly on observation of dry specimens, Kew rule) which ruled taxonomic practices between 1860 and 1900 became highly contested in the early 20th century. First there was, in the wake of genetics, a revival of interest in the “microspecies” or “jordanons.” Second, ecologists’ and experimental taxonomists’ field- and experimentally-oriented studies came to be seen as of greater general and theoretical interest than herbarium studies.¹⁰⁴ Finally, the principle of priority of the original specific epithet was progressively re-established after 1905 in successive international nomenclatural codes.¹⁰⁵ These early 20th century challenges found their basis in the changing institutional structure in systematics: the metrological power exerted by botanists at large herbaria such as those of Kew was challenged by those at other usually smaller and younger herbaria or laboratories whose scientific agenda focused on the studies of local patterns of variation and field characters.

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¹ Broberg (Gunnar), “The broken circle”, in T. Frängsmyr, J.L. Heilbron et R.E. Rider(eds), *The Quantifying Spirit of the Eighteenth Century*, Berkeley, Univ.of California Press, 1990, 45-71., p. 57.

² Lesch (John E.), “Systematics and the geometrical spirit”, in T. Frängsmyr, J.L. Heilbron et R.E. Rider (eds), *op. cit.*, 1990, 73-111.

³ C.Linné, *Species Plantarum...*, Stockholm, Slavus, 1754. This number this allowed leading botanists to know and memorise nearly all the genera.

⁴ A.-P. and A. de Candolle (ed.), *Prodromus systematis naturalishistoria...* Paris, 1824-1873, 17 vol., vol. 17, 1873, p. 313; Bentham et J.D. Hooker, *Genera Plantarum*, 3 vol., London, 1862-83; **Peter F. Stevens**, *The Development of Biological Systematics: Antoine-Laurent de Jussieu, Nature and the Natural System*, New-York, Columbia Univ. Press, 1994, p. 208 and 477.

⁵ Broberg, *op. cit.* (1990), p. 66

⁶ Hewett C. Watson, “letter to the editor on the relation between cerebral development and the tendency to particular pursuits—and on the heads of botanists”, *The Phrenological Journal*, vol VIII (1833), n° XXXV, p. 97-108. The article also introduces a hierarchy between mere collectors and descriptors, and more philosophically oriented botanists whose “reflective organs” are more developed.

⁷ Walters (S. M.), “The name of the rose: a review of ideas on the european bias in angio sperm classification”, *The New Phytologist*, **104** (1986), 527-46, p. 535-37; Raven (P.), Berlin (B.) & Breedlove (D.E.), “The origin of taxonomy”, *Science*, **174** (1971), 1210-13.

⁸ While refraining Darwin to overinterpret in a realist way the distribution of varieties into species, J. D. Hooker hinted at this bias and stressed the role of ‘psychological factors’ in delimitating species and genera: “botanists (...) do not treat large & small genera equally and similarly, & the sum of inequalities thus produced tends to make the species of small genera look more invariable than that of big” (Hooker to Darwin, 14 March 1858, in F. Burkhard and S. Smith, ed., *The correspondance of Charles Darwin*, Cambridge Univ. Press, vol. 7, 1991, p. 49). He stated that G. Bentham “will make rather hastily a new species in a large genus, of which a vast number of good species have recently turned up” rather than in small genus (Hooker to Darwin, 13-15 July 1858, in F. Burkhard and S. Smith, ed., *The correspondance of Charles Darwin*, Cambridge Univ. Press, vol. 7, 1991, p. 131.)

⁹ Emma Spary, *Utopia’s garden: French Natural History from Old regime to Revolution* (Univ. of Chicago Press, 2000), chap. 2.

¹⁰ See for instances of this diversity, Anne Secord, “Science in the Pub: artisan botanists in early nineteenth century Lancashire”, *History of Science*, **32** (1994), 269-315 (on artisan Botany); Anne Secord, “Corresponding interests: artisans and gentlemen innatural history exchange networks”, *B.J.H.S.*, **27** (1994), 383-408; Ann B. Shteir, *Cultivating Women, Cultivating Science*, John Hopkins UNiv. Press, 1997 (on women Botany); Harriet Ritvo, *The platypus and the mermaid and other figments of the classifying imagination*, Cambridge MA., Harvard Univ. Press, 1997 (on popular zoologies); see also D.E. Allen’s path-opening work, *The naturalist in Britain. A social history*, Harmondsworth, Penguin Books, 1976.

¹¹ Harriet Ritvo, “Zoological nomenclature and the Empire of Victorian Science”, in B. Lightman (ed.), *Victorian science in context*, Univ. of Chicago Press, 1997, 335-353.

¹²An example of 18th century optimism is James Edward Smith, "Introductory discourse...", *Linn. Soc. of London. Transactions*, I, 1788, 1-55 : "He who determines with certainty a single species of the minutest moss or meanest insect, adds so far to the general stock of knowledge, which is more than can be said of many a celebrated name"; Cf. Broberg *op. cit.* (1990).

¹³ Joseph D. Hooker and T. Thomson, *Flora indica*, London, W. Pamplin, 1855, p. 11; see also a similar statement by Bory de Saint-Vincent in 1832 in *Expédition de Morée. Section des Sciences Physiques. t. III-2, Botanique*, par MM. Fauché, Brongniart et Bory de Saint-Vincent, Paris, Levrault, 1832, p. 7.

¹⁴ To write a monograph, one has to find all the original descriptions for all species. On the "difficulty of obtaining access to the necessary periodicals [that will soon] render the effectual study of botany impossible", see Hooker and Thomson, *op. cit.* 1855, p. vi.; see Peter F. Stevens, "J. D. Hooker, Georges Bentham, Asa Gray and Ferdinand Mueller on Species Limits in Theory and Practice: A Mid-Nineteenth-Century Debate and its Repercussions", *Historical Records of Australian Science*, **11**, n°3 (June 1997), 345-370, p. 354-55.

¹⁵ Hooker and Thomson, *op. cit.* 1855, p. 12; Hans Hallier, "Über Kautschuklianeen und andere Apocynaceen", *Jahrbücher der Hamburgischen wissenschaftlichen Anstalten*; **XVII** (1900), 3. Beiheft (Arbeiten des botanischen Museums), 19-216, p. 19.

¹⁶ A. M. F. J. Palisot de Beauvois, *Flore d'Oware et de Benin*, 2 vol. (t. I 1804, t. II 1807), t. I, 1804, p. 54-55, tab. XXXIV (description in reality published in 1806). The type specimen is in Delessert's herbarium, now in Geneva.

¹⁷ A. De Candolle, "Apocynaceae", in *Prodromus systematis naturalis regni vegetabilis*, 1824-1873, vol. 8, 1844, p. 320 for *Landolphia*, p. 327-28 for *Vahea*; Bentham and Hooker, *Genera Plantarum*, London, 1862-83, 3 vol., "Apocynaceae" in vol. II, London 1876, 681-728, see p. 692-93.

¹⁸ Anon., "Sir John Kirk", *Bull. of Miscellaneous Information Kew*, (1922), 49-63; *David Livingstone and the Victorian Encounter with Africa*, London, National Portrait Gallery Publications, 1996.

¹⁹ C. Barlow, S. Jarasuriya et C. Suan Tan, *The World Rubber Industry*, London, Routledge, 1994, table A. 3.

²⁰ To mention only West Africa: Chevalier to Soudan (1898-99), Dewèvre to Congo where he died in 1895, and the German "Westafrikanische Kautschuk-Expedition", to Kamerun and Togo at the initiative of the *Kolonial-Wirtschaftliches Komitee* in 1899-1900. See E. De Wildeman, *Les plantes tropicales de grande*

culture, t IV Café, cacao, cola, vanille, caoutchouc, Bruxelles, 1902, p. 7-8; Rudolf Schlechter, *Westafrikanische Kautschuk-Expedition, 1899-1900*, Berlin, 1900.

²¹ There are many mentions of it in travel accounts from the 1860's, then many particular studies (local, or focused on a few species, or of mainly economic orientation) often from colonial surgeons and pharmacists, and then a peak of taxinomical monographs between 1895 and 1904, followed by a nearly complete lack of interest. See Bonneuil, *Mettre en ordre et discipliner les tropiques: les sciences du végétal dans l'empire français, 1870-1940*, Ph. D. thesis, Univ. of Paris 7, 1997, p. 118-120.

The rubber boom led to the overexploitation of african forests and depletion of the rubber plants, as well as—mainly in equatorial Africa—overexploitation and murder of African people.

²² See for instance the central importance of the characters related to the pod in the classification of leguminosae whereas fruit characters are less important in other families.

²³ J. S. Henslow, “On the requisites necessary for the advance of Botany”, *Mag. of Zool. and Bot.*, **I** (1837), 113-125, quotations resp. p. 116, 120 and 120.

²⁴ A wealthy amateur, cultivating more than 60 000 (Jordanian) species in his garden in Lyons.

²⁵ See Christian Bange, “La culture et l’hybridation peuvent seules décider la question de l’espèce : les travaux de Jordan, Decaisne et Naudin assignent une nouvelle fonction aux jardins botaniques”, in J. L. Fischer (ed.), *Le jardin entre science et représentation*, Paris, CTHS, 1999, 317-329.

²⁶ Joseph Decaisne, “Note sur l’organogénie florale du Poirier, précédée de quelques considérations sur la valeur des caractères spécifiques”, *Bull. Soc. Bota. Fr.*, **IV** (1857), 338-342, p. 339.

²⁷ Charles C. Babington, *The British Rubi; an attempt to discriminate the species of Rubus found in the British Islands*, London, J. van Joost, 1869; A. Jordan “notices sur diverses espèces négligées du genre *Asphodelus*, comprises dans le type de l’*Asphodelus ramosus* de Linné”, *Bull. Soc. Bot. France*, **7** (1860), p. 723.

²⁸ W. Herbert, “On hybridization amongst vegetables”, *J. Hort. Soc. London*, **2** (1847), p. 7; C. Naudin, “Essai d’une monographie des espèces et variétés du genre *Cucumis*”, *Ann. Sci. Nat., Bot.*, 4e série, t. **9** (1856), 5-87.; J. Decaisne, “Lettre de M. Decaisne à M. l’abbé Chaboisseau (avril 1860)”, *Bull. Soc. Bot. France*, **7** (1860), 261-265, p. 262. See Decaisne’s works on the “polymorphism” of the pear tree (*Pyrus*) from 1852 to 1863, synthesised in J. Decaisne, *Le Poirier*, Paris, 1871.

²⁹ Quoted by Bange *op. cit.*, 1999, p. 328.

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- ³⁰ R. Wight and G. A. Walker Arnott, *Prodromus florum peninsulae indiae orientalis*, vol I(1), London, 1834, p. xxi
- ³¹ Asa Gray (1858) quoted by Peter F. Stevens, *The Development of Biological Systematics: Antoine-Laurent de Jussieu, Nature and the Natural System*, New-York, Columbia Univ. Press, 1994, p. 123.
- ³² H. C. Watson to C. Darwin, 19 November 1856, in F. Burkhard and S. Smith, ed., *The correspondence of Charles Darwin*, Cambridge Univ. Press, vol. 6, 1990, p. 278.
- ³³ Lorraine Daston, "Objectivity and the escape from perspective", *Social Studies of Science*, **22** (1992), 597-618; Lorraine Daston, "The Moral Economy of Science", *Osiris*, **10**, 3-4 (1995), 3-24, p. 19-20; Simon Schaffer, "'Astronomers Mark Time': Discipline and the Personal Equation", *Science in Context*, **2**, 1 (1988), 115-145.
- ³⁴ Lefébure (1835) quoted by Stevens *op. cit.*, 1994, p. 212.
- ³⁵ Eugene Cittadino, *Nature as the laboratory. Darwinian plant ecology in the German empire. 1880-1900*, Cambridge, Cambridge Univ. Press, 1990, p. 9-25.
- ³⁶ Carl F. P. von Martius et al., eds, *Flora Brasiliensis*, München, Wien, Leipzig, 1840-1906, 15 vol.. The 55 contributors of this huge Flora (20,733 pages) were paid.
- ³⁷ Camille Limoges, "The development of the Muséum d'Histoire Naturelle of Paris, c. 1800-1914", in R. Fox & G. Weisz (eds), *The organization of Science and Technology in France, 1808-1914*, Cambridge University Press et Maison des Sciences de l'Homme, Paris, 1980, 211-240; Claude Schnitter, "Le développement du Muséum national d'histoire naturelle de Paris au cours de la deuxième moitié du XIXe siècle; «se transformer ou périr»", *Revue d'Histoire des Sciences*, **49**, n°1 (janv.-mars 1996), 53-97.
- ³⁸ Bonneuil, *op. cit.*, 1997, p. 30-31. Decaisne "Etat de l'enseignement des sciences naturelles en France", Feb. 2, 1879, Archives Nationales F 17 3881.
- ³⁹ See Richard H. Drayton, *Imperial science and a scientific empire : Kew gardens and the uses of nature, 1772-1903*, Ph. D, Yale Univ., 1993, p. 190-211 for a detailed study of the British situation (see also Richard H. Drayton, *Nature's Government: Science, Imperial Britain, and the "Improvement" of the World*, Yale Univ. Press, 2000); see also Stevens, *op. cit.*, 1994, chap. 7; Shteir *op. cit.*, 1997.
- ⁴⁰ like C.C. Babington (1808-1895, professor of Botany in Cambridge in 1861) and many local botanists in England, Alexis Jordan (1814-1897) and Alexandre Boreau (1803-75) and many local botanists in France, Carl Wilhelm von Nägeli (1817-1891) in Switzerland and Munich, Johann F. Klotzsch (1805-1860) keeper

of Berlin's herbarium (he had studied Himalayan plants before Hooker), Ernst G. von Steudel (1783-1856) physician in Württemberg.

⁴¹ such as J. D. Hooker and G. Bentham in England and Joseph Decaisne (1807-1882) in France

⁴² Nägeli's first attack on the Linnean broadly circumscribed species is his Ph.D. thesis dissertation from 1841 ("Die Cirsien der Schweiz", *Neue Denkschriften allgemeinen Schweizerische Gesellschaft für die gesammten Naturwissenschaften*, **5** (1841), viii+170 p.) and was followed by studies of algae.

⁴³ A. Jordan, *Observation sur plusieurs plantes nouvelles ou critiques de la France. Premier fragment*, Paris, J.-B. Baillière, 1847. See also A. Jordan, "Remarques sur le fait de l'existence en société, à l'état sauvage, des espèces végétales affines, et sur d'autres faits relatifs à la question de l'espèce", in *Compte-rendu du Congrès de l'Association Française pour l'Avancement des Sciences*, 2e session, Lyon, 1873, 488-505. On Jordan and l'école analytique, see Bange, *op. cit.*, 1999 and Christian Bange, "Alexis Jordan et les partisans de l'École analytique devant les hybrides végétaux spécifiques", unpublished paper kindly communicated by the Author.

⁴⁴ On Hooker's views on variation of species and the effects of hybridisation, see J. D. Hooker, *Flora indica*, 1855, p. v and 19-36.

⁴⁵ anon. [Bentham, G.], "*The British Flora*, 8th ed. 1860 by W. J. Hooker and G.A. Walker Arnott, *Manual of british botany*, 5th ed. 1862 by C. C. Babington, *Handbook of the British Flora*, 1858 by G. Bentham", *The Natural History Review*, **10** (1863), 34-40, p. 38.

⁴⁶ C. C. Babington, *The British Rubi; an attempt to discriminate the species of Rubus found in the British Islands*, London, J. van Joost, 1869; D. Godron, *Le genre Rubus considéré du point de vue de l'espèce*, Nancy, Mémoires de la Soc. Royale de Nancy, 1849.

⁴⁷ William J. Hooker and G. A. Walker Arnott, *The British Flora*, 8th ed., London, Lovell Reeve, 1860; G. Bentham *Handbook of the British Flora*, London, Taylor, 1858, p. 188-191.

⁴⁸ anonymous [G. Bentham], "*The British Flora*, 8th ed. 1860 by W. J. Hooker and G.A. Walker Arnott, *Manual of british botany*, 5th ed. 1862 by C. C. Babington, *Handbook of the British Flora*, 1858 by G. Bentham", *The Natural History Review*, **10** (1863), 34-40.

⁴⁹ This development was made possible by state support to botanical gardens and museums which also had to answer to a growing demand for education from the bourgeoisie and the middle classes. See Farber (P. L.), "The transformation of natural history in the nineteenth century", *J. Hist. Biol.*, **15**, 1982, 145-152;

Kolhstedt (Sally G.), “Essay Review: Museums: Revisiting Sites in the History of the Natural Sciences”, *J. Hist. Biol.*, **28**, 1995, 151-66; Sheet-Pyenson (Susan), *Cathedrals of Science. The Development of Colonial Natural History Museums during the Late Nineteenth Century*, Mc Gill-Queen’s Univ. Press, Kingston & Montreal, 1988.

⁵⁰ Statistics on the Paris Herbarium can be found in Bonneuil, *op.cit.*, 1997, p. 42 bis.

⁵¹ Archives of the RBGKew Pr 96-007 R. Desmond research material 37 and Archives of the RBGKewPRO 21. Paris herbarium could compare in richness, but not in care, organisation, and facility of work.

⁵² Probably a little more than 500 000 specimens in 1850 (A.-P. de Candolle and Delessert’s herbaria taken together).

⁵³ Asa Gray’s collection at Harvard was small by comparison, although of considerable importance.

⁵⁴ Alphonse de Candolle deserves more attention than I could pay him in this paper.

55 This section is much indebted to Stevens, *op. cit.*, 1997.

⁵⁶ On Hooker, see W.B. Turill, Joseph Dalton Hooker, Botanist, Explorer and Administrator, The Hague, 1963; M.Allan, The Hookers of Kew, 1785-1911, London, 1975; W.B. Turill, Joseph Dalton Hooker, Botanist, Explorer and Administrator, The Hague, 1963; anon., “Sir Joseph Dalton Hooker. 1817-1911”, Bull. of Miscellaneous Information Kew, (1912), 1-14; Drayton, *op. cit.*, 1993, 267-368. On J. D. Hooker on **[OR ‘IN’? AS YOU LIKE]** the field, see, Camerini, Jane, “Remains of the Day: Early Victorians on the Field”, in B. Lightman (ed.), Victorian science in context, Univ. of Chicago Press, 1997, 354-377.

⁵⁷ Leonard Huxley, *Life and letters of Sir Joseph Dalton Hooker*, London, 1918, vol. 1, p. 473.

⁵⁸ J. D. Hooker to A. Gray, January 26, 1854, in Huxley, *Life and letters ...*, *op. cit.*, 1918, vol. 1, p. 474.

⁵⁹ Letter to Harvey, 28 march 1852, in Leonard Huxley, *Life and letters ...*, *op. cit.*, 1918, vol. 1 p. 458. Hooker expressed here both his opposition to splitting and to taking too much into account microscopical characters in classification.

⁶⁰ Hooker to Bentham (s.d. 1853), in Leonard Huxley, *Life and letters ...*, *op. cit.*, 1918, vol. 1 p. 471 and 473.

⁶¹ Hooker (Joseph D.), *The Botany of the Antarctic Voyage...II Florae novae-zelandicae*, London, Lovell Reeve, 1853-1855; Hooker and Thomson (1855), p. v.

⁶² Of course these botanists also arrived at positions similar to Hookers' partly independantly, in the context of specific debates (in the families they studied, or in issues debated in their natinal contexts) they were engaged in. Decaisne was much concerned to fight against Jordan's narrow delimitation of species. A. Gray adopted similar positions which were conform to his position at the direction of Harvard University Herbarium having to disciplin local botanists from the West, etc.

⁶³ See Hooker's comments on this in a letter to Darwin (6 Dec.1857), in F. Burkhard and S. Smith, ed., *The correspondance of Charles Darwin*, Cambridge Univ. Press, vol. 6, 1990, p. 499.

⁶⁴ Joseph Decaisne, "Note sur l'organogéniefiorale du Poirier, précédée de quelques considérations sur la valeur des caractères spécifiques", *Bull. Soc. Bota. Fr.*, IV (1857), 338-342,p. 339.

⁶⁵ Alphonse-L. de Candolle , "Étude sur l'espèce à l'occasion d'une révision de la famille de Cupulifères", *Bibliothèque Universelle Archives de Sciences Physiques et Naturelles*, **15** (1862), 211-37.

⁶⁶ anon. [Bentham, G.], "*The British Flora*, 8th ed. 1860 by W. J. Hooker and G.A.Walker Arnott, *Manual of british botany*, 5th ed. 1862 by C.C. Babington, *Handbook of the British Flora*, 1858 by G. Bentham", *The Natural History Review*, **10** (1863), 34-40, p. 38.

⁶⁷ J. D. Hooker to Darwin, 6 Dec. 1857, in F. Burkhard and S. Smith, ed.,*The correspondance of Charles Darwin*, Cambridge Univ.Press, vol. 6, 1990, p. 499. (Hooker's emphasis); see G. Bentham, *Handbook of the British Flora*, 1858.

⁶⁸ Decaisne (Joseph), "Note sur l'organogénie florale du Poirier,précédée de quelques considérations sur la valeur des caractères spécifiques", *Bull. Soc. Bot. de Fr.*, IV (1857), 338-342, p. 339 (translated as "On the development of thefloral organ in the Pear" in the *Gardeners' Chronicle and Agricultural Gazette* of November the 14th 1857, p. 773). Hooker refers to this remark in a letter to Darwin , 6 Dec. 1857, in F. Burkhard and S. Smith, ed., *The correspondance of Charles Darwin*, Cambridge Univ. Press, vol. 6, 1990, p. 500. On Decaisne's criticisms on the splitters, see also Decaisne (Joseph), "Lettre de M. Decaisne à M.l'abbé Chaboisseau (avril 1860)", *Bull. Soc. Bot. Fr.*, 7 (1860), 261-265. On the french debates on species delimitation and variability (Gérard, Naudin, Decaisne, Jordan, Godron, Boreau, etc.),see C. Bange, *op. cit.*, 1999 and Bange, *op.cit.*, unpublished communication.

⁶⁹ George Bentham, "Adress to the Anniversary meeting, May 24, 1866", *Proceedings of the Linnean Society of London*, 1865-66, x-li, p. xxxi.

⁷⁰ Hooker and Thomson, *op. cit.*, 1855, p. 12-13

⁷¹ G. Bentham, “On the Joint and separate Work of Bentham and Hooker's Genera Plantarum”, *J. of the Linnean Soc.*, **20** (1884), 304-308. Bentham writes (p. 305-06) that he accepted the collaboration “not withstanding my normal aversion for partnership botany” because “I had always found that I could perfectly coincide with Hooker in his views in scientific botany.”

⁷² Daniel R. Headrick, *The tools of Empire. Technology and european imperialism in the nineteenth century*. Oxford University Press, 1981; Drayton, op.cit., 1993, p. 322-46; Ray Desmond, *Kew, the history of the Royal Botanic Gardens*, London, Harvill Press, 1995, p. 205-17; Lucille H. Brockway, *Science and colonial expansion. The role of the British Royal Botanic Garden, London*, Academic Press, 1979.

⁷³ Drayton, op. cit., 1993, p. 324-25.

⁷⁴ Quoted by Drayton, op. cit., 1993, p. 334. See p. 332-35 on the Colonial Flora project.

⁷⁵ On the Hookers and Patronage, see Richard Bellon, “Joseph Dalton Hooker’s Ideals for a professional Man of Science”, *J. Hist. Biol.*, **34** (2001), 51-82.

⁷⁶ George Bentham, *Florae hongkongensis*, London, Lovell Reeve, 1861; A. H. R. Grisebach, *Flora of the British West Indian Islands*, 3 vols. [1859]-1864; George Bentham *Florae australiensis*, 7 vol., London, Lovell Reeve, 1863-1878; D. Oliver, *Flora of Tropical Africa*, London, L. Reeve and Co., 1868-1877, 3vols. (the 4-10 were published later in 1896-1937 by William Turner Thiselton-Dyer, David Prain and Arthur William Hill); Hooker (Joseph D.), *Flora of British India*, London, 1872-1897, 7 vol; William H. Harvey et Otto W. Sonder, *Flora Capensis : being a systematic description of the plants of the Cape Colony*, Caffraria, & Port Natal, 1859-1933, 7 vol.(3 vols. were published quickly, the vols. 4-7 published at the turn of the century under the direction of Thiselton-Dyer).

⁷⁷ [J.D. Hooker], “Colonial floras”, *Natural History Review*, newser. **1** (1861), 255-66, p. 255 and 256

⁷⁸ Carl F. P. von Martius et al. (1840-1906). This Flora had more than 20 000 in 4° pages, and nearly 3800 plates. A.-P. and A. de Candolle’s *Prodromus* (1824-1873), had more than 13 000 in 8° pages and was not illustrated.

⁷⁹ [J. D. Hooker], “Colonial floras”, *Natural History Review*, new ser. **1** (1861), 255-66, p. 264; George Bentham, *Florae hongkongensis*, London, Lovell Reeve, 1861; George Bentham, *Handbook of British Flora*, London, 1858.

⁸⁰ George Bentham, *Florae hongkongensis*, London, Lovell Reeve, 1861, quotes resp. p. xxxvi and p. xxxviii.

⁸¹ G. Bentham et J. D. Hooker, *Genera plantarum ad exemplaria imprimis in herbariis kewensibus servata definita*, London, Lovell Reeve, 1862-83, 3 vol; Bentham, George, "On the Joint and separate Work of Bentham and Hooker's Genera Plantarum", *J. of the Linnean Soc.*, **20** (1884), 304-308, p. 306 for the quotation. On this enterprise see Peter F. Stevens, "How to interpret botanical classification—suggestions from history", *Bio Science*, **47**-4 (1997), 243-50. p. 246-48, and Stevens, *op. cit.*, 1994.

⁸² *Index kewensis*..., Oxford, Clarendon, 1895-to date.; see Benjamin D. Jackson, "A new 'index of Plants Names'", *Journal of Botany*, **25** (1887), 66-71 and 150-151 and "The history of the compilation of the *Index kewensis*", *J. of the Roy. Hortic. Soc.*, **49** (1924), 224-229; and Frans A. Stafleu, "Bentham and Hooker", *Taxon*, **15** (1966), n° 1, 37-39.

⁸³ See for instance Otto Kuntze protestations against Kew's nomenclatural hegemonism in "Notes on the Index Kewensis", *J. of Bot.*, **34** (1896), 298-307.

⁸⁴ Peter F. Stevens, "J. D. Hooker, Georges Bentham, Asa Gray and Ferdinand Mueller on Species Limits in Theory and Practice: A Mid-Nineteenth-Century Debate and its Repercussions", *Historical Records of Australian Science*, **11**, n°3 (june 1997), 345-370, p. 360.

⁸⁵ Gray to Bentham, 21 Jan. 1867. RBG Kew Archives, Asa Gray Corr., fol. 430. I am indebted to P. Stevens for bringing it to my knowledge.

⁸⁶ C. Linné, *Species Plantarum*..., Stockholm, Slavius, 1754; A.-P., A. et C. de Candolle (dir.), *Prodromus systematis naturalis historia*... Paris, 1824-1873, 17 vol.; G. Bentham et J. D. Hooker, *Genera plantarum*, 3 vol., London, 1862-83.

⁸⁷ Which was usually only allowed in very particular cases such as the existence in the same genera of the same specific epithet. See Alphonse L. de Candolle, *Lois de la nomenclature botanique*, Genève, Georg, 1867, 29-30. On the Kew Rule see Peter F. Stevens, "George Bentham and the Kew Rule", in D. L. Hackworth, *Improving the stability of names: needs and options*, Königstein, Koeltz Scientific Books, 1991, 157-168.

⁸⁸ Many others opposed it and advocated a consistent application of the principle of priority. Some went as far as asking retroactivity for all names, even at the price of eliminating very widely used names). Successive international congresses in the 20th century laboriously arrived at the conclusion that the "Kew

rule” should be discarded and the rule of priority ought to be followed (though not retrospectively). On these nomenclatural debates see Antonello La Vergata, “Au nom de l'espèce. Classification et nomenclature au XIXe siècle”, in S. Atran et al. (eds), *Histoire du concept d'espèce dans les sciences de la vie*, Paris, Fondation Singer-Polignac, 1987, 193-225 and D. H. Nicholson, “A History of botanical nomenclature”, *Annals of the Missouri Botanical Garden*, **78** (1991), 32-56. See also Gordon McOuat, "Species, Rules and Meaning: The Politics of Language and the Ends of Definitions in 19th Century Natural History", *Stud. Hist. Phil. Sci.*, **27** (1996), 473-519.

⁸⁹ Jackson (Benjamin Daydon), “A new ‘index of Plants’ Names”, *Journal of Botany*, **25** (1887), 66-71 and 150-151, p. 69.

⁹⁰ Otto Stapf, “Apocynaceae”, in W. T. Thiselton-Dyer, *Flora of Tropical Africa*, London, L. Reeve and Co., vol. **IV** (1902), section 1, 24-231.

⁹¹ Stevens, *op.cit.*, 1997, p. 355.

⁹² George Bentham, “Notes on Euphorbiaceae”, *Journal of the Linnean Society, Botany*, **17** (1878), 185-267, p. 190

⁹³ Hans Hallier, “Über Kautschuklianen und andere Apocyneen”, *Jahrbücher der Hamburgischen wissenschaftlichen Anstalten*, **XVII** (1900), 3. Beiheft (Arbeiten des botanischen Museums), 19-216, p. 39. Note how scientific values of objectivity (“sachlich”, “unpersönlich”) are linked to social judgement, being opposed to vulgarity (“Synonymenproletariat”). See also Hans Hallier, *Das proliferierende persönliche und das sachliche, konservative Prioritätsprinzip in der botanischen Nomenklatur*, Hamburg, Lütke & Wulff, 1900.

⁹⁴ Naming a new species provides a double social advantage. First, your name is quoted at the end of the binomial name (as the authority who described the species first) and your name can earn a kind of immortality. Second, you can choose a specific epithet which can be a tribute to somebody else you want to please (for instance, your master, or the colonial governor, etc.). For the disciplining of naming practices in Zoology and its limits, see Ritvo, *op. cit.*, 1997.

⁹⁵ Hooker and Thomson, *op. cit.*, 1855, resp. p. 21, p. 11, p. 10. See also their emphasis on the necessary knowledge of “the amount of variation to which organized beings are subject, which alone will render him a sound botanist” (p. 21).

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- ⁹⁶ J. D. Hooker, "On some species of *Amomum*, collected in Western Tropical Africa by Dr. Daniell, Staff Surgeon", *Hooker's Journal of Botany*, **VI** (1854), 289-299, p. 292.
- ⁹⁷ William T. Thiselton-Dyer, presidential address to the Bot. section of the BAAS quoted par O. Kuntze, "Notes on the Index kewensis", *Journal of Botany*, 34 (1896), 298-307, p. 307
- ⁹⁸ J. D. Hooker to A. Gray, Jan. 26, 1854, in Leonard Huxley, *Life and letters ...*, *op. cit.*, 1918, vol. 1 p. 473-76, cit. p. 476. The argument is also made by Stevens, *op. cit.*, 1997, p. 353 to which I am indebted.
- ⁹⁹ See for instance Hooker and Thomson, *op. cit.*, 1855, p. vi; Stevens, *op. cit.*, 1997, p. 354-55.
- ¹⁰⁰ Henri Hua, "Établissement d'un organe périodique international destiné à la publication des noms nouveaux pour la science botanique", in *Actes du congrès international de botanique (Paris, 1900)*, Lons-le-Saunier, Declume, 1900, 475-483. But the success of such an enterprise required authority to guarantee that species published elsewhere would not be taken into consideration by anyone, authority that no institution possessed.
- ¹⁰¹ [J. D. Hooker], "Colonial floras", *Natural History Review*, new ser. **1** (1861), 255-66, p. 257.
- ¹⁰² William T. Thiselton-Dyer, *The botanical enterprise of the empire*, London, Eyre and Spottiswoode, 1880, p. 8; On victorian culture's and imperial economy's need for standards, see Simon Schaffer Schaffer, "Empires of Physics", in R. Staley, ed., *The Physics of Empire*, Cambridge, Whipple Museum History of Science, 1994, 97-111; Simon Schaffer, "Metrology, metrification and Victorian Values", in B. Lightman (ed.), *Victorian science in context*, Univ. of Chicago Press, 1997, 439-474.
- ¹⁰³ Lucille H. Brockway, *Science and colonial expansion. The role of the British Royal Botanic Garden*, London, Academic Press, 1979; Satpal Sangwan, *Science Technology and Colonisation: An Indian Experience 1757-1857*, New Dehli, Ananika Pratashan, 1991, Deepak Kumar, ed., *Science and Empire: Essays in Indian Context, 1700-1947*, Delhi, 1991, Drayton, *op. cit.*, 2000. See also Marie-Noëlle Bourguet et Christophe Bonneuil, "De l'inventaire du globe à la 'mise en valeur' du monde : botanique colonisation (fin XVIIIe siècle - début XXe siècle). Présentation", *Revue Française d'Histoire d'Outre-Mer*, n° 322-323 (1st semester 1999), 9-38.
- ¹⁰⁴ Stevens, *op. cit.*, 1994, 476-77, n. 61; Joel B. Hagen, "The development of experimental methods in plant taxonomy, 1920-1950", *Taxon*, 32 (1983), 406-416; Joel B. Hagen, "Experimentalists and naturalists in 20th-century botany: Experimental taxonomy, 1920-1950", *Journal of the History of Biology*, 17 (1984), 249-270.

¹⁰⁵ Stevens, *op. cit.*, 1991; La Vergata, *op. cit.*, 1987.