# Richard Spruce
## A botanist on the Amazon and the Andes

Annual Report
for the
**Richard Spruce Project**
1st of June to 31st December 2002

Submitted jointly by:
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## Summary/Initial stages

Work began on the Richard Spruce project in June at the Royal Botanic Gardens Kew and in July at The Natural History Museum. In keeping with the collaborative nature of this project, we advertised the posts at both institutions jointly, and Daniela Zappi and Sandra Knapp sat on both recruitment boards in order to ensure compatibility of the project team. Methods of recruitment at the two institutions differed somewhat, but the experience of co-recruitment was an extremely positive one, and in harmonizing our practice we have established best practice for future projects to be carried out jointly by the two institutions. We had strong fields of candidates for both positions, and both staff members hired for the project have made positive contributions to life at both institutions. Training and induction (learning about the institutions) courses, were attended by Tania Durt and Sharon Grant at both RBG Kew and the NHM, fostering inter-institutional understanding. Weekly meetings are held between Sharon Grant and Tania Durt, alternating between the institutions. Monthly meetings of the entire project team similarly alternate between NHM and Kew.

In this first six monthly report we have divided the work undertaken into its main tasks: specimen location, construction of the database, specimen scanning and imaging, work with the archival Spruce notebooks and the construction of the project website. We have begun work on all these fronts, but some are necessarily more advanced than others (i.e. database versus website). We have also appended a work schedule for the rest of calendar year 2003. This does not include the proposed visit by Blanca León, which will be for some three months during the year, as these dates have not yet been confirmed.

## Methods

### Locating and databasing specimens

Location of all of Spruce's specimens presented the first challenge of this project. Spruce's collections are spread throughout both herbaria, separated taxonomically and by geographic area. In order to database and scan all the specimens, we first needed to find them in the collections. We are using two methods to do this. First, we used the lists of Peruvian and Ecuadorian families and genera from the *Catalogue of the Flowering Plants and Gymnosperms of Peru* (Brako & Zarucchi 1993) and the *Catalogue of the Vascular Plants of Ecuador* (Jørgensen & León-Yanez 1999). In addition we compiled a preliminary list of Spruce's collections from the notebooks held at RBG Kew (see Table I)

for a count of families noted in Spruce's notebooks). This provided us with a preliminary impression of the families and genera we needed to account for in our search. In order to prepare the initial list of families and specimens used to facilitate finding the specimens in the herbarium (see above), only the collecting numbers and provisional identifications used by Spruce were transcribed; complete transcription of the notebooks began soon after. We are using this initial list to make sure we do not miss any of the Spruce collections meant to be in the herbaria – often these are out on loan to other institutions or researchers, if this is the case we are writing to those individuals to ask for return of the material in a timely fashion.

*Kew*

At Kew, we started by searching throughout the Rubiaceae (the coffee family, highly diverse in Spruce's collections, see Table I) pulling out all Spruce specimens found within genera mentioned in the above catalogues found in geographical Area 17 (includes Peru, Ecuador, Venezuela, Colombia and Bolivia). Specimens from Peru and Ecuador were extracted from the herbarium, but also from Venezuela and Colombia, where Richard Spruce collected before travelling to Peru.

Once located, specimens were barcoded and immediately databased. An Access relational database was used, taking into consideration Kew's specimen database core fields: collector, collector number, species name, collection locality, etc. (see detailed description of database design below). Once the specimens are barcoded and databased, they are scanned. A special project label is added to indicate that the specimen has been imaged; thus preventing future duplication of effort. Before they are replaced into the herbarium cabinets, every specimen will be put within a white cover in order to protect these valuable historical specimens and to enhance the usability and long-term maintenance of the collection.

1302 Kew Spruce specimens from Peru and Ecuador from different families (see Table I) were recorded on the database. In addition, 154 Spruce specimens from Colombia and Venezuela have been recorded on the database.

*NHM*

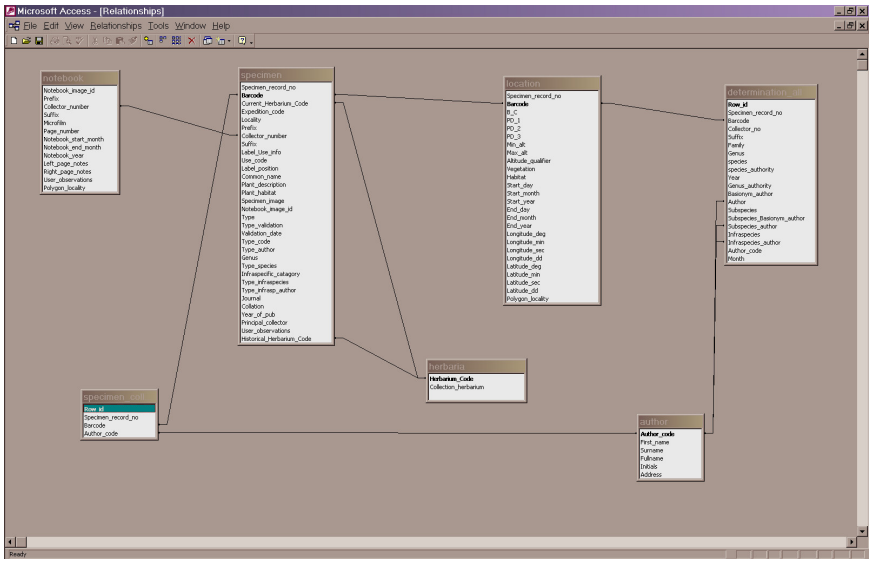
The first set of specimens to be dealt with at the Museum were the pteridophytes (ferns and fern allies). Blanca León extracted approximately one half of these from the collections during her preliminary visit in June 2002. During July and August the rest of the specimens were located. To date, all of Spruce's pteridophytes that are in the main collection at the NHM have been located and databased, some 600 specimens in total. A large number have been checked and identified by Blanca León. Several nomenclatural problems with Spruce collections were encountered during this process, these will be researched and highlighted on the project website. There is also a set of Spruce specimens located in the "backlog" of the fern section; these are held in special boxed sets made up by NHM staff members in the early part of the 20$^{th}$ century. We think that the Spruce collections in these boxes are duplicates of those held in the main collection, but if time permits these will also be entered into the database.

The Natural History Museum holds one of the main sets of Spruces' moss and lichen collections; these present a special challenge as several specimens are mounted on a single sheet. To date, 13 families have been searched and 100 specimens have been databased.

**The database**

Because of the short length of the project and the large amounts of data to be dealt with it was necessary to be able to begin data entry as soon as possible. As a result database development has had to be carried out alongside data entry. In order to do this a temporary-ACCESS database was constructed.

This initial database contained a single, simple flat file that was a combination of the RBG Kew data structure and the principal botanical database used at the museum. It had 71 fields (see Table II) and contained a large amount of replication. The resulting database soon became too large. A more efficient database structure was required which would retain all the original information and still be flexible enough to incorporate additional fields.




Using a simple relational model the original table was divided into four major tables and some supporting tables that retained the information content of the initial table but reduced some of the repetition. It has been designed to be able to link to some of the bigger reference databases that are being constructed at the museum for example the people database, and to allow expansion to include other projects. The development of the database is an ongoing process, and the resulting well-thought out and rigorously tested structure will become a model for future historical databasing projects at both institutions.

## Scanning and imaging

*Kew*

The scanner used at Kew has a framework especially developed by Andrew McRobb (Information Services Department) which turns the scanner upside-down in order to scan the herbarium specimens without turning them over, thus minimizing the risk of physical damage to the collections.

The specimen scanning process uses the software Adobe Photoshop, two-tone bars, one colour and one black and white, and a Kew scale ruler. Additionally a label will be stuck on each sheet indicating that the specimen has been imaged. The quality of the images is 600 ppi. The images are stored as TIFF files (lossless archival quality). So far 113 specimens have been scanned.

*NHM*

Digital imaging at the Museum is being carried out using a manually focussed, mounted Nikkon 150mm lens. A Phase 1 FC70 Mk 2 scanner replaces the usual camera back on the system and is attached to a PC. Digital Studio Camera System software v3.0.3 is used to capture images at a resolution of 300 pixels per inch (ppi), in Tag Image File Format (TIFF). Adobe Photoshop software is then used to reduce the size of the images for use on the web. This is achieved by reducing the resolution to 72 ppi, cropping the image to remove the greyscale and then lastly, it is converted to Joint Photographic Experts Group (JPEG) format. All images have a grey scale, scale bar and a project label.

The original 300 ppi images are stored on the Museum's network server and backed up on to CD-Rom. These images will be archived by the Botany Department curation team so that they can be used after completion of the project. The 72 ppi JPEG images will be linked to the database and will be the ones that will be viewed on the web site.

Computer specification:

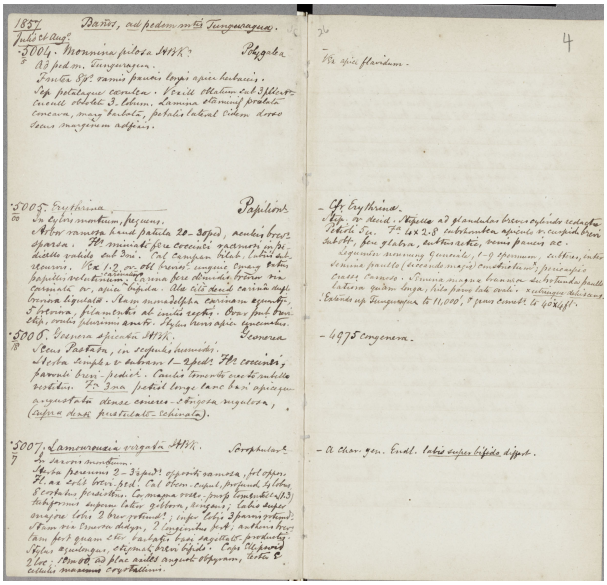
Pentium Pro(r) 128Mb
Hard drive 6GB + 2GB
Video card – 3D RAGE PRO AGP 2X (English)
Monitor resolution: 800x600

Colour depth: 24bpp V-Freq: 75 Hz / H-Freq: 46 KHz

**Transcribing notebooks**

The two collecting notebooks maintained by Spruce (1855-1864), usually held in the Archives section of the Library are now available at the Kew main library where Tania Durt can have access in order to transcribe them.

All data written down in the notebooks is being transcribed and the information stored using the same ACCESS database used for the specimens in order to facilitate cross-referencing and ultimate access using the web site. In total, there are 2662 individual "collecting" numbers in the 2 notebooks, of which 1763 have already been totally transcribed and databased.



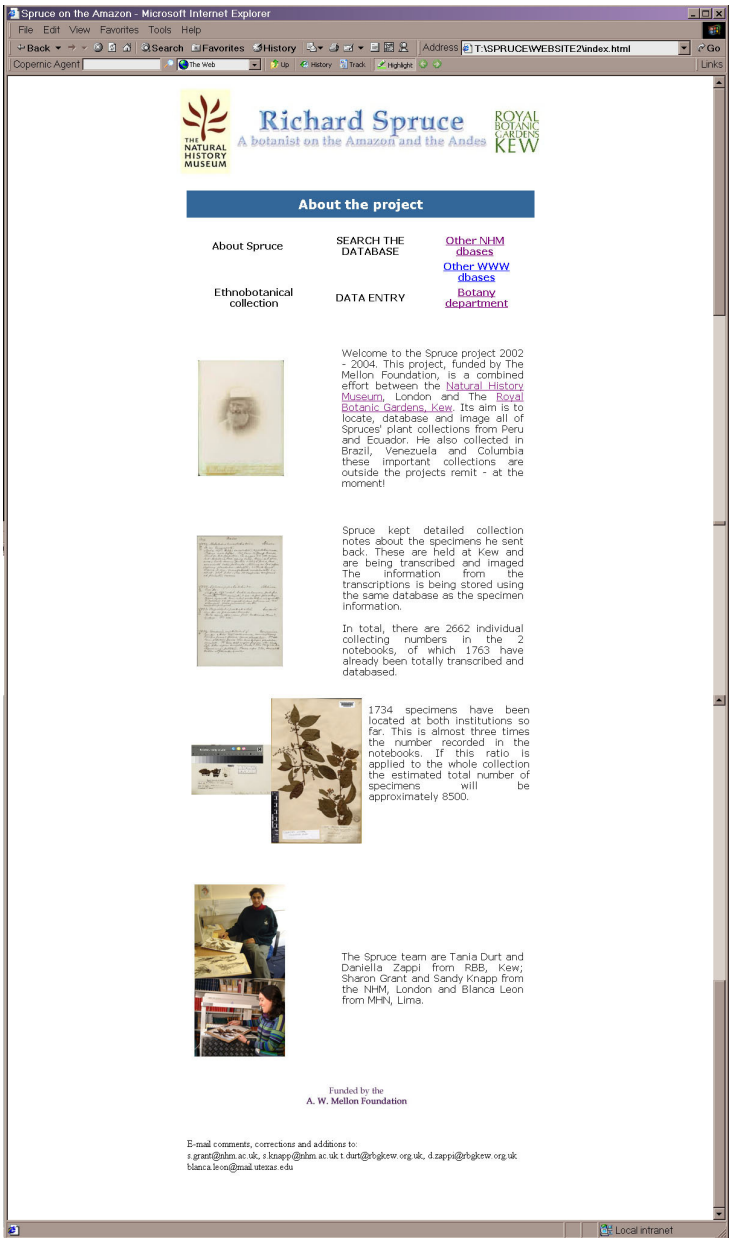
One interesting outcome of the examination of the notebooks is elucidation of Spruce's working methods. Botanists have long assumed that he numbered his collections in the field, much as botanists today do, but the notebooks clearly show he assigned numbers to collections later, often grouping plants from the same family together. From example, all the pteridophytes are consecutively numbered apart from the angiosperms and gymnosperms. By working with all the elements of Spruce's work in the region, we are gaining a new view on his time in the Andes.

**Imaging notebooks**

After the notebooks are transcribed they will be photographed at Kew by Andrew McRobb (image creation specialist) using the equipment that has recently been acquired by RBG Kew for the Oak Spring Library Rare Books Digitisation and Preservation Project (see project report for specifications).

## Website

A preliminary website has been designed by the team and launched from the Museum webserver (http://www.nhm.ac.uk/botany/databases/). It contains a brief description of the project, the aims and contact information. This will form the basic design of the final web site that will allow the user to interactively search the specimen database and access jpeg images of the specimens. The site will reside on the NHM web server and once fully functional should require little maintenance beyond updating of identification of specimens as our knowledge increases.




By presenting a preliminary website at this stage in the project we hope to solicit comments and feedback from the botanical community so that we can improve our presentation of information and ensure utility of the final product for especially for taxonomic botanists. In addition to the taxonomic information presented, we will prepare during the coming year a short sketch of Spruce's travels in the region aimed at a popular audience, with photographs and maps, in order to place the project in context for those not interested in the complexities of the taxonomic data.

## Discussion

Work during this first six month period `has focused upon finalization of the database design and on the transcription of the notebooks. Our current knowledge of the approximate numbers of species and specimens will allow efficient time management for the rest of the project (see Tables III-V).

### Types

We knew before the project began that Spruce's collections from Peru and Ecuador were rich in types – specimens used for the description of new species or genera. While databasing specimens, it was noticed that many specimens only have a Spruce determination – they have only ever been identified by Spruce himself, never by subsequent generations of botanists. Many of Spruce's collections are presently in type covers. There will not be sufficient time to revise all the specimens, so we have decided to put our priority on the assessing, checking and validating of type material, those specimens tied to the publication of new names in science. In order to do this, the protologues (original descriptions) will be located in the libraries of the participating institutions and ideally scanned (or photographed if the publication is fragile or very old) to have a complete set of information on the website about the specimens critical for the application of names.

We have begun to address potential problems of copyright with this protologue information, provision of this sort of basic taxonomic information will go some way to demonstrating the utility of a "biodiversity commons" (see Moritz, 2001). Careful researching of type specimens will make the website and database useful to the widest possible community of botanists, particularly those in Peru and Ecuador, who do not have easy access to any of this information. Nomenclatural problems encountered while working with pteridophytes include, among others; 1) mixed collections – where Spruce apparently assigned the same collection number to different species and two specimens have been used to describe two different species, 2) cases where several Spruce collections have been used to describe a new species, one of these must be selected as what is know as the lectotype to stabilize usage of the name, and 3) many un-numbered collections have been found, quite a few of which have been used as type material in this group. By carefully investigating the typification status of these specimens we will help to stabilize the application of names through scholarly research.

### Overlap of specimens between institutions

Because the complete set of pteridophyte specimens has been located at both institutions it has been possible to compare the degree of overlap between the two collections.
We have found that at least four families are held at only one or the other of the two institutions. Specimens of the Vittariaceae and Azollaceae are only to be found at the NHM, while specimens of the Selaginellaceae and Marsileaceae are only to be found at Kew. It is also important to note that although there are representatives of all other families at both institutions, they may not be the same collections. Our collections are in no way complete duplicates of one another, doing

this project together has greatly increased the effectiveness of our information capture and ultimately presentation of this important set of collections to the botanical community at large.

**Estimate of number of specimens**

We estimated the number of Spruce specimens from Peru and Ecuador to be approximately 7500, including duplicates, using the numbers presented in Spruce's notebooks. To date, 1734 specimens have been located at both institutions. This is almost three times the number recorded in the notebooks for those families. If this ratio is applied to the Spruce collection as a whole, the estimated total number of specimens at both institutions will be approximately 8500.

1734 / 596 = 2.91

Estimated total no of specimens = 8500

Many specimens of pteridophytes were un-numbered (55 of 1734 in total), thus not recorded in the notebooks. We estimate that the proportion of un-numbered collcections for angiosperms and gymnosperms will be lower, as Spruce was particularly interested in ferns and fern allies. He certainly worked with these specimens, perhaps separating out things he considered different post-numbering – but in the absence of any documentation of his working methods, we cannot be sure of this. Experience with a few angiosperms families (Rubiaceae and Solanaceae) tends to support his view.

## Conclusion

The work is advancing both in scope and speed in a satisfactory manner, despite a somewhat slow start due to delays in hiring project personnel. Figures showing overlap between K and NHM in terms of both taxonomic and physical specimen coverage are proving to be very interesting. It is now possible to see clearly the complementarity of the institutions as the project it is undertaken by both, in terms of providing a much awaited global idea of Spruce's plant collections. We will soon be looking forward to putting together the different elements (specimen and notebook databases and images) in order to provide a useful Internet tool, both for plant taxonomists and the general public.

## References

Brako, L. & J.L. Zarucchi 1993. *Catalogue of the Flowering Plants and Gymnosperms of Peru*. Monographs in Systematic Botany from the Missouri Botanical Garden, v. 45. St.Louis, Missouri. 1286 p.

Jørgensen, P.M. & S. León-Yanez 1999. *Catalogue of the Vascular Plants of Ecuador*. Monographs in Systematic Botany from the Missouri Botanical Garden, v. 75. St.Louis, Missouri. 1181 p.

Moritz, T. 2001. Building the biodiversity commons.


# Richard Spruce

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ROYAL BOTANIC GARDENS KEW

| Family | No of specimens located | No of specimens from notebook |
|---|---|---|
| Zygophyllaceae | 4 | |
| Vochysiaceae | 16 | 2 |
| Violaceae | | 13 |
| Verbenaceae | | 22 |
| Valerianaceae | | 12 |
| Urticaceae? | | 1 |
| Urticaceae | 5 | 18 |
| Umbelliferae | 1 | |
| Typhaceae | | 1 |
| Turneraceae | | 1 |
| Tropaeolaceae | | 3 |
| Trigoniaceae | | 2 |
| Tovariaceae | | 1 |
| Tiliaceae | | 6 |
| Thymeleaceae | | 2 |
| Theophrastaceae | | 2 |
| Theaceae | | 14 |
| Tectariaceae | 16 | |
| Symplocaceae | | 2 |
| Styracaceae | | 2 |
| Sterculiaceae | | 11 |
| Staphyleaceae | | 2 |
| Solanaceae | 2 | 92 |
| Smilacaceae | | 1 |
| Sinopteridaceae | 2 | |
| Simaroubaceae | | 1 |
| Scrophulariaceae? | | 1 |
| Scrophulariaceae | | 48 |
| Sapotaceae | | 5 |
| Sapindaceae | | 26 |
| Salicaceae | | 1 |
| Rutaceae | | 4 |
| Rubiaceae | 372 | 149 |
| Rosaceae | 40 | 23 |
| Rhizophoraceae | | 2 |
| Rhamnaceae | | 6 |
| Ranunculaceae | | 12 |
| Pteridophyta | 1728 | 596 |
| Psilotaceae | 3 | |
| Proteaceae | | 5 |
| Primulaceae | | 4 |
| Pottiaceae | 254 | |
| Potamogetonaceae | | 2 |
| Portulacaceae | | 6 |
| Pontederiaceae | | 2 |
| Polygonaceae | | 6 |
| Polygonacae | | 1 |
| Polygalaceae | | 19 |
| Polemoniaceae | | 1 |
| Podocarpaceae | | 1 |
| Poaceae? | | 1 |
| Poaceae | | 106 |
| Plumbaginaceae | | 1 |
| Plantaginaceae | | 5 |
| Piperaceae | 4 | 32 |
| Phytolaccaceae | | 5 |
| Passifloraceae | | 13 |
| Papilionaceae | 1 | |
| Papaveraceae | | 1 |
| Oxalidaceae | | 14 |
| Orchidaceae | | 93 |
| Onagraceae | 30 | 18 |
| Olacaceae | | 5 |
| Ochnaceae | | 3 |
| Nympheaceae | | 1 |
| Nyctaginaceae? | | 1 |
| Nyctaginaceae | | 12 |
| no data | | 1 |
| Najadaceae | | 1 |
| Myrtaceae | 17 | 11 |
| Myrsinaceae | | 11 |
| Myristicaceae | | 1 |
| Myricaceae | | 4 |
| Moraceae | | 11 |
| Monimiaceae | | 8 |
| Molluginaceae | | 2 |
| Menispermaceae | | 5 |
| Meliaceae | | 4 |
| Melastomataceae | 162 | 64 |
| Martyniaceae | | 1 |
| Marcgraviaceae | | 2 |
| Marantaceae | 2 | 4 |
| Malvaceae | | 11 |
| Malpighiaceae | | 15 |
| Lythraceae | 17 | 7 |
| Loranthaceae | | 5 |
| Lophosoriaceae | 3 | |
| Lomariopsidaceae | 60 | |
| Loganiaceae | 5 | 7 |
| Lobeliaceae | | 24 |
| Loasaceae | 9 | 11 |
| Linaceae | | 1 |
| Limnocharitaceae | | 1 |
| Lentibulariaceae | | 1 |
| Lemnaceae | | 1 |
| Lecythidaceae | | 2 |
| Lauraceae | | 10 |
| Lamiaceae | 1 | 38 |
| Labiatae | 2 | |
| Juncaceae | | 8 |
| Iridaceae | | 5 |
| Icacinaceae | | 1 |
| Hydrophyllaceae | | 1 |
| Hydrocharitaceae | | 1 |
| Hydrangeaceae | 11 | 5 |
| Humiriaceae | | 1 |
| Hippocreteaceae | | 1 |
| Hippocrateaceae | | 1 |
| Haloragidaceae | | 1 |
| Gunneraceae | | 2 |
| Grossulariaceae | | 5 |
| Gleicheniaceae | 6 | |
| Gesneriaceae | | 29 |
| Geraniaceae | | 7 |
| Gentianaceae | | 16 |

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| | | |
|---|---|---|
| **Flacourtiaceae** | | 13 |
| **Fabaceae** | | 148 |
| **Fabacaee** | | 1 |
| **Euphorbiaceae?** | | 1 |
| **Euphorbiaceae** | | 54 |
| **Ericaceae** | 6 | 33 |
| **Elatinaceae** | 2 | 1 |
| **Elaeocarpaceae?** | | 1 |
| **Elaeocarpaceae** | | 1 |
| **Ebenaceae** | | 1 |
| **Dioscroeaceae** | | 1 |
| **Dioscoreaceae** | | 3 |
| **Dilleniaceae** | | 1 |
| **Dicksoniaceae** | 23 | |
| **Dichapetalaceae** | | 1 |
| **Cyperaceae** | 2 | 42 |
| **Cyatheaceae** | 34 | |
| **Curcurbitaceae** | | 5 |
| **Cunoniaceae** | 6 | 4 |
| **Cucurbitaceae** | 25 | 11 |
| **Crassulaceae** | 5 | 2 |
| **Coriariaceae** | | 1 |
| **Convolvulaceae** | | 21 |
| **Convolvulacaee** | | 1 |
| **Connaraceae** | | 1 |
| **Commelinaceae** | | 12 |
| **Combretaceae** | | 6 |
| **Columelliaceae** | | 1 |
| **Clusiaceae** | | 15 |
| **Clusiacaee** | | 1 |
| **Clethraceae** | 6 | 2 |
| **Chrysobalanaceae** | 8 | 3 |
| **Chloranthaceae** | | 1 |
| **Chloranthacceae** | | 1 |
| **Chenopodiaceae** | | 1 |
| **Celastraceae** | | 4 |
| **Caryophyllaceae** | | 15 |
| **Caricaceae** | | 8 |
| **Caprifoliaceae** | | 2 |

| | | |
|---|---|---|
| **Capparidaceae** | | 11 |
| **Campanulaceae** | | 2 |
| **Callitrichaceae** | | 2 |
| **Burseraceae** | | 3 |
| **Burmanniaceae** | | 1 |
| **Buddleiaceae** | 3 | 3 |
| **Bromeliaceae** | | 4 |
| **Brassicaceae** | | 18 |
| **Boraginaceae?** | | 2 |
| **Boraginaceae** | | 27 |
| **Bombacaceae** | | 2 |
| **Bignoniaceae** | | 21 |
| **Betulaceae** | | 1 |
| **Berberidaceae** | | 6 |
| **Begoniaceae** | 26 | 14 |
| **Balanophoraceae** | | 1 |
| **Athyriaceae** | 91 | |
| **Asteraceae** | 2 | 186 |
| **Asclepiadaceae** | | 24 |
| **Aristolochiaceae** | | 3 |
| **Araliaceae** | | 5 |
| **Araceae** | | 1 |
| **Aquifoliaceae** | | 3 |
| **Apocynaceae** | | 20 |
| **Apiaceae** | 1 | 24 |
| **Annonaceae** | | 7 |
| **Anacardiaceae** | | 5 |
| **Amaryllidaceae** | | 1 |
| **Amaranthaceae** | | 9 |
| **Alstroemeriaceae** | | 5 |
| **Alismataceae** | | 1 |
| **Algae** | | 2 |
| **Adiantaceae** | 1 | |
| **Actinidiniaceae** | | 1 |
| **Actinidiaceae** | | 2 |
| **Acanthaceae** | | 35 |
| **?Lacistemea** | 1 | |

| | |
|---|---|
| **59** | Families from database |
| **182** | **Families from notebooks** |

Total located = 2922
Total from notebook = 2662

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## Number of types by family

| Family | No of types |
|---|---|
| Thelypteridaceae | 10 |
| Tectariaceae | 5 |
| Selaginellaceae | 11 |
| Rubiaceae | 2 |
| Pteridophyta | 25 |
| Pteridaceae | 19 |
| Pottiaceae | 74 |
| Polypodiaceae | 22 |
| Lycopodiaceae | 1 |
| Lomariopsidaceae | 6 |
| Isoetaceae | 2 |
| Dryopteridaceae | 33 |
| Athyriaceae | 19 |
| Aspleniaceae | 8 |

Total number of types = 237

## Pteridophyte sub-table

| Family | No of specimens located | No of specimens from notebook |
|---|---|---|
| **Vittariaceae (P)** | 1 | |
| **Thelypteridaceae (P)** | 99 | |
| **Selaginellaceae (P)** | 56 | 9 |
| **Schizaeaceae (P)** | 8 | |
| **Pteridophyta** | 539 | 584 |
| **Pteridaceae (P)** | 135 | |
| **Polypodiaceae (P)** | 451 | |
| **Ophioglossaceae (P)** | 3 | |
| **Marsileaceae (P)** | 2 | |
| **Lycopodiaceae (P)** | 63 | 3 |
| **Grammitidaceae (P)** | 5 | |
| **Equisetaceae (P)** | 8 | |
| **Dryopteridaceae (P)** | 140 | |
| **Azollaceae (P)** | 1 | |
| **Aspleniaceae (P)** | 223 | |

Pteridophyte specimens located from Kew and NHM = 1734
Number of Pteridophyte specimens from notebook = 596

1734 / 596 = 2.91

Estimated total no of specimens = 8500

Specimens databased from KEW = 1416
Specimens databased from NHM = 588

## Pteridophyte comparison table

| Family | Kew Count | NHM Count |
|---|---|---|
| *Vittariaceae* | | 1 |
| **Thelypteridaceae** | 76 | 23 |
| **Selaginellaceae** | 56 | |
| **Schizaeaceae** | 2 | 6 |
| **Pteridophyta** | 192 | 347 |
| **Pteridaceae** | 92 | 43 |
| **Polypodiaceae** | 335 | 116 |
| **Ophioglossaceae** | 2 | 1 |
| **Marsileaceae** | 2 | |
| **Lycopodiaceae** | 46 | 17 |
| **Grammitidaceae** | 2 | 3 |
| **Equisetaceae** | 7 | 1 |
| **Dryopteridaceae** | 117 | 23 |
| **Azollaceae** | | 1 |
| **Aspleniaceae** | 180 | 43 |