Distribution of monographic data-sets of *Calliandra*, *Inga*, *Leucaena*, *Parkinsonia*, and *Pinus* in electronic format – a model for future dissemination of botanical data.

Reporting on R7276E (extension period 1 March 2004 to 31 August 2004) to develop and enhance BRAHMS online and to publish sample datasets.

Report to the Forestry Research Programme, DFID
Presented 6 October 2004

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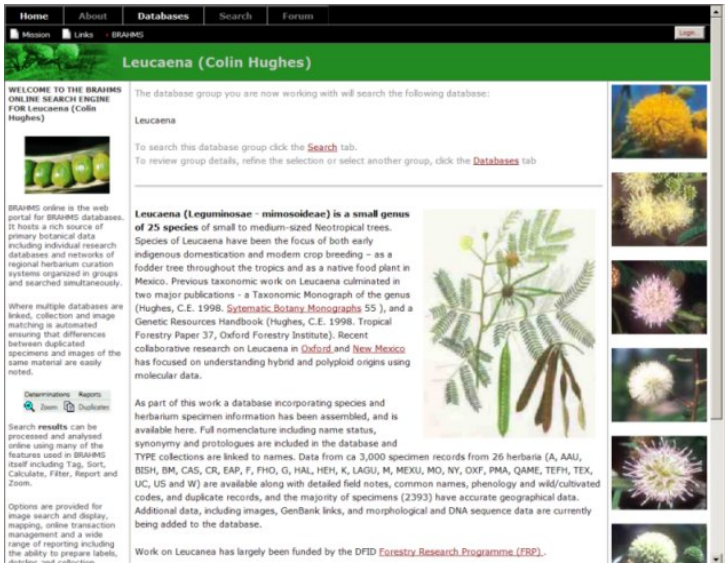


The genus *Leucaena* published using BRAHMS online. Search options lead to detailed information about all of the species in this economically important plant group together with details of the collections used to monograph the genus.

The National Herbarium of the Netherlands (NHN) published in BRAHMS online, linking herbaria in Leiden, Utrecht and Wageningen, illustrates how multiple herbaria can be linked into a single searchable group, opening up access to more complete data on any selected search parameter as well as providing an entirely new method to auto cross-reference and improve data held in regional herbaria.

The larger European herbaria hold many collections from countries targeted by DFID.

Contents

Acknowledgement

I would like to thank FRP for supporting this research project. Wherever possible, FRP has been acknowledged for this support and where relevant, hyperlinks are included to the FRP website. Examples are on the main BRAHMS online website home page, all Home Pages of databases and database groups where FRP has contributed to the generation of the data and in all related documentation.

This publication is an output from a research project funded by the United Kingdom Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID. R7276E - Forestry Research Programme.

Denis Filer, 6 October 2004

List of acronyms

Asia IT&C The European Commission programme for Information Technology and Communication exchange between Europe and Asia.

BOL BRAHMS online

BRAHMS Botanical Research And Herbarium Management System

DFID UK Department for International Development

FRP Forestry Research Programme

Kew MSB Kew Millennium Seed Bank

NHN National Herbarium of the Netherlands

SEABCIN South East Asian Botanical Collections Information Network

URL Uniform Resource Locator (web site address)

VFH Virtual Field Herbarium

1 Executive Summary

This FRP funded extension to R7276 has developed key aspects of BRAHMS online, a web based information interrogation system focusing on botanical research systems and herbaria. It has also promoted the preparation and publication of a number of live databases.

The function of BRAHMS online is several-fold. Firstly, it is to disseminate information on plant species and on the individual botanical collections that ultimately define what a species is and where it occurs. Secondly, by providing functionality to link regional herbaria into a simultaneously searchable entity, it brings together otherwise disparate data into a single 'view' for subsequent processing, analysis and reporting. Thirdly, it makes a significant contribution to herbarium curation by enabling users to verify the identification status of individual herbarium specimens through a process of automated comparison against specimens of the same collection held and identified elsewhere.

Countless studies on biodiversity and conservation assessment carried out each year depend on the accurate naming of plant specimens. Preliminary studies in a sampling exercise in Brazil, based on data held in regional BRAHMS databases, indicate that up to 40% of collections in the Amazon regional herbaria require revision of their identifications. This problem is also evident in the South East Asian Botanical Collections Information Network (SEABCIN) which has been published using BRAHMS online. An example illustrating this difficulty is provided in this report indicating how the outputs of this project provide a mechanism to tackle this problem and thus make a significant impact on the quality of data used in such studies.

The overall purpose of the project then has been to strengthen the foundations for all work that subsequently must use species and herbarium derived data, for example in conservation planning and the analysis and interpretation of regional biodiversity.

During the project, technical work was completed on the development of the BRAHMS online system, the most notable achievements being the addition of the auto-matching of distributed specimens of the same collections and remote updating of online databases, the latter function enabling online users to add or update a database contribution remotely. Both of these and all completed technical work are outlined in this report.

Several online databases have been published as a result of this project (web addresses provided), and processes to published further databases have been streamlined. A number of initiatives are now underway to a) further extend the functionality of these online databases, including potentially linking BRAHMS online to the *Virtual Field Herbarium* online image handling system developed under FRP project R7367 b) develop further regional herbarium database groups, commencing in East and West Tropical Africa and Amazonian Brazil and c) extend the system to work with regional seed banks including those supported through RBG Kews' plant conservation Millennium Seed Bank Project. In this latter context, a draft system linking Australian seed banks is now being evaluated for further funding support.

This report is presented with two annexes: a) a summary of BRAHMS Projects to date and b) BRAHMS online introduced.

2 Background

2.1 Understanding and measuring diversity

Most under-developed, DFID target countries are seriously under-resourced in the various tiers of research institute that provide information about their biological resources, including plant species. It is the case that a) such countries often have a complex kaleidoscope richness of biodiversity; b) remarkably little is properly understood about this diversity – and this includes 'messy groups of plants' where the boundaries of current scientific knowledge would be stretched even in the best scientific establishments; and c) much of this diversity is often seriously threatened by accelerated 'development'.

Development and conservation of natural resources go hand in hand. To provide meaningful conservation support, improvement is needed in two principal areas: reliability of species identification and knowledge of species' distributions. This must be combined with greater dissemination and use of the relevant data. The ultimate source of these data resides with decades of botanical collections held in the regional herbaria. However, the inaccuracy of the identifications, and the lack of quality control of the data-set they represent, can hinder rather than assist with biodiversity assessment and conservation judgements.

There is thus a real need to build capacity in this area, empowering local communities and government research institutes, through training and the provision of information, to have greater understanding of and control over their natural biological resources.

The modern herbarium of Embrapa Amazonia Oriental, Brazil. The herbarium holds *c.*180,000 specimens, all databased in BRAHMS, many with digital fotos.

Specimens such as the one being examined here are commonly 'duplicated' across various herbaria. In other words, different sheets of exactly the same collection are stored in more than one herbarium, often many. Very often, a sheet is sent to a large international herbarium.

Herbaria worldwide are full of wrongly identified specimens – and this has negative consequences across the board for biodiversity research and prioritizing conservation areas. Yet the same specimens have often been correctly identified in a centre of excellence or in a herbarium fortunate enough to have had a specialist visiting botanist.

2.2 Project inception

This project was conceived after a) recognizing key current limitations with the distribution of information about plants, locally, regionally and globally b) understanding the key role that herbaria must increasingly make towards the study and preservation of plant diversity and c) being aware that there is potential to upgrade the accuracy of herbarium information including specimen identifications by encouraging and facilitating data distribution and exchange.

Although many herbaria have computerized their collections, preliminary studies show inconsistencies in species and geographical names, and that many collections are recorded as unidentified although cited in taxonomic revisions or having been identified in other herbaria. A

pilot project in Brazil based on BRAHMS database work indicated that despite recent publication, up to 40% of collections in the Amazon regional herbaria require revision of their identifications.

The concept to publish these databases online in part has been a function of the shift in available technology in that direction. Many herbaria and researchers have been pressing to be able to make their data available as widely as possible. BRAHMS online enables users to consult large research and herbarium databanks without needing to install special software and acquire the data locally.

The most pressing request from those working in this field has been to find a way to improve the flow of data and valuable information not solely to the end user – but also to and between herbaria themselves. BRAHMS online was initially conceived as a mechanism to bring together data from multiple herbaria to a) maximise the information provided on a given search (e.g. where is this species known to have been collected from?) and b) where possible, to allow herbaria to automatically match their specimens with duplicated specimens held at other herbaria and this detect differences in identification and/or other useful facts. This latter function paves the way for herbaria to 'club together' and mutually benefit from each others strengths, all of this increasing the value of their data for applied research – and increasing the meaningfulness of the outputs generated.

2.3 Previous relevant work

The development of *BRAHMS online* builds on a decade of earlier work working with herbaria building up information databanks on their holdings, creating standard lists of taxonomic and geographic names and other data relevant to the overall 'botanical infrastructure'. Much of this work has in turn been linked to the on-going development of the BRAHMS (Botanical Research And Herbarium Management System).

BRAHMS was initially developed with FRP support through a series of strategic FRP support between 1985 and 1995. Work on BRAHMS continues, funded through a mix of project support agreements and small research grants. The system is regularly updated as can be seen from the **Software Revision** notes on the www.brahms.co.uk software page.

3 Project Purpose

The purpose of this project has been to increase access to useful data on a number of key groups of species with special importance to forestry, agriculture and land use. This was initially achieved by the assembly of ‘monographic data disks’ for a number of the key forestry genera in an easy to transfer format. These disks were made available on the internet for download together with software to integrate the data into local databases in herbaria and other research institutions, mostly but not exclusively in Latin America.

This project extension, based on earlier results, has taken advantage of advances in internet technology and the rapid spread of internet access to further improve the flow of useful plant and plant diversity information to and between researchers, research institutions and all others who can potentially make use of descriptive data on plant species for any purpose ranging from pure research to applied work in forestry, agriculture, biodiversity assessment and conservation science. In particular, the project has provided a mechanism for herbaria (the key institutions involved in fundamental botanical work) to upgrade the quality of the data they hold through comparison with similar data held in other herbaria.

This project has aimed to increase the efficiency of the management and exchange of botanical data which has broad development implications for forestry, agriculture and conservation science, highlighting the immediate practical value of developing and using well organized databases in herbaria. By upgrading fundamental botanical data, the project contributes to all pure research activities that depend of accurate botanical data including all forms of biodiversity assessment and conservation analysis.

4 Research Activities

4.1 Introduction

Initial work on BRAHMS online was carried out with support form the European Asia IT&C Programme under the South East Asian Botanical Collections Information Network (SEABCIN) project. This FRP project has enhanced the BRAHMS online system and modified it to be suitable for storing more detailed datasets on individual plant groups. It has also brought together and published data for a number of economically important plant groups – as well as establishing the methodology to enable others to publish their data more easily. The main activities can thus be grouped as follows:

a) Technical development work on the BRAHMS online system
b) Assembly and publication of a series of databases
c) Documentation, dissemination and feedback

4.2 Technical software developments

Programming work was undertaken on the BRAHMS online system as listed here. Examples are given in the Outputs section of this report.

- Text display options added, enabling users to read data directly from variable length memo fields. Associated with this, improvements to all screen data grids.
- Integration of bibliographic search functions.
- Collection category option added to differential associated collection categories.
- Collection matching added.
- Image matching added and image display options improved. Links between BRAHMS online and William Hawthornes' Virtual Field Herbarium developed under **R7367** (Comparison and Development of Tropical Forest Field Guide Formats) are currently being investigated.
- Auto-publish function for remote databases completed. This enables any BRAHMS user to publish a new BRAHMS database online or to update an existing database.

4.3 Assembly and publication of a series of databases

Data for *Inga*, *Leucaena*, and *Pinus* databases were processed for online publication. Various further 'monographic' databases have been processed although were not explicitly mentioned in the project proposal. These include *Agathis*, *Strobilanthes* and *Kalanchoe*. Data on *Calliandra* and *Parkinsonia* are as yet incomplete but expect to be online during November (further information to be provided to FRP about this).

Summary home pages describing these Web sites were prepared and are online.

4.4 Documentation, dissemination and feedback

BRAHMS online was fully documented. This documentation is available online and is included as an Annex to this report. The site is now fully cross-referenced in BRAHMS itself and from the www.brahms.co.uk Web site.

Feedback has been continuous since the first online systems were published. Most of this has been technical feedback linked to adding further functionality.

During 18 – 22 October 2004, a BRAHMS online workshop is to be held in Leiden. Invited are all members of the SEABCIN project. In particular, this workshop will be used to discuss how the current pilot version of SEABCIN database group can a) be expanded to include all available collections b) the production of a SEABCIN leaflet and other relevant promotional materials.

Numerous further herbarium projects have been published using BRAHMS online but until copyright access in cleared, these may not be made public. There has been a large volume of discussion on mechanisms to simplify updating already published systems, copyright issues and the issue of server storage location for published databases.

5 Outputs

5.1 Published databases and database groups

The output of this project extension 'Fully searchable online systems' has been achieved. BRAHMS online is operational and has a growing number of datasets including *Inga*, *Leucaena* and *Pinus*. Additional datasets, not specified in the project specification have been published (*Agathis*, *Kalanchoe* and *Strobilanthes* together with several larger regional database groups). The number of published datasets is expected to grow rapidly.

Examples of individual databases:

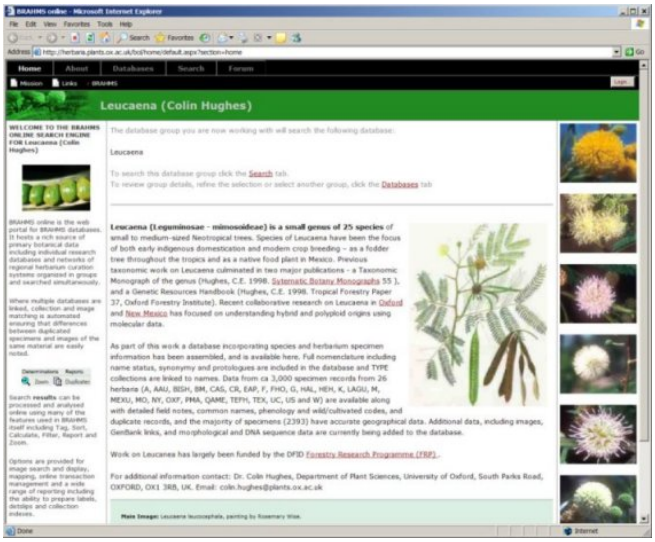
http://herbaria.plants.ox.ac.uk/bol/?inga
http://herbaria.plants.ox.ac.uk/bol/?leucaena
http://herbaria.plants.ox.ac.uk/bol/?pinus
http://herbaria.plants.ox.ac.uk/bol/?strobilanthes
http://herbaria.plants.ox.ac.uk/bol/?agathis

Other groups with multiple databases have also been published are actively being extended. These include the National Herbarium of the Netherlands (Leiden, Utrecht and Wageningen) and the South East Asian herbarium group SEABCIN.

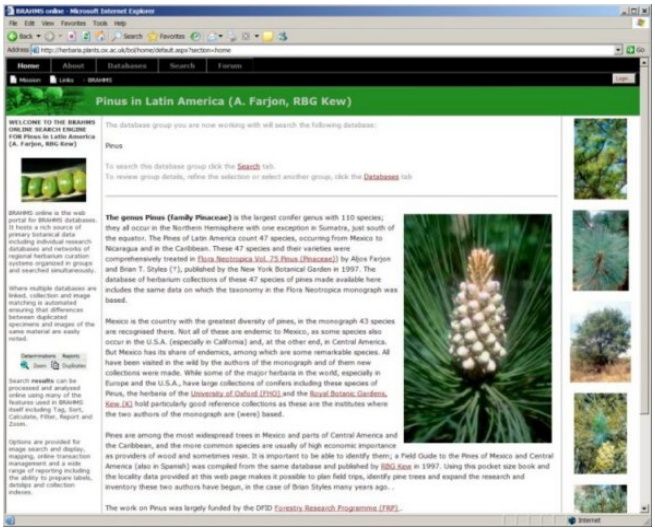
Example web addresses are:

http://herbaria.plants.ox.ac.uk/bol/?nhn
http://herbaria.plants.ox.ac.uk/bol/?seabcin
http://herbaria.plants.ox.ac.uk/bol/?australiaseednet

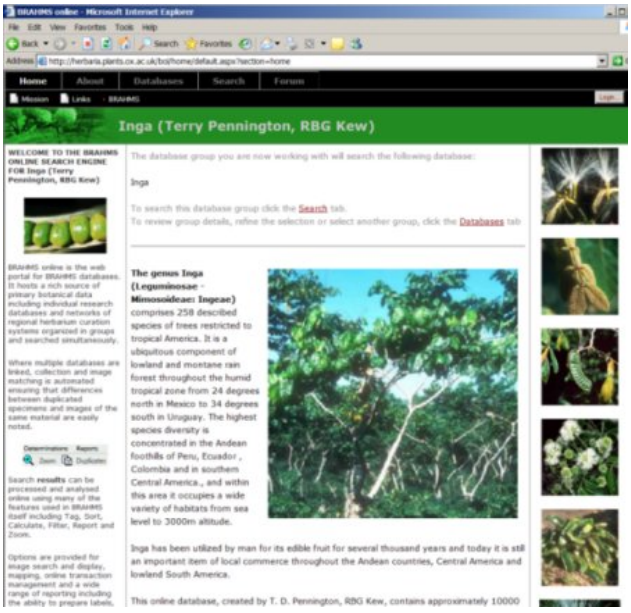
Three examples of BRAHMS online home pages



Leucaena online home page. The Leucaena database was developed and made available by Colin Hughes. An example of a detailed monographic database published online with a comprehensive data on the original botanical collections, taxonomic data including full nomenclature, images (samples only at the moment – awaiting digitization of remainder) and bibliography.



Pinus online home page. The Pinus database was developed and made available by Aljos Farjon. Comments as above.



Inga online home page. The Inga database was developed and made available by Terry Pennington. Comments as above.

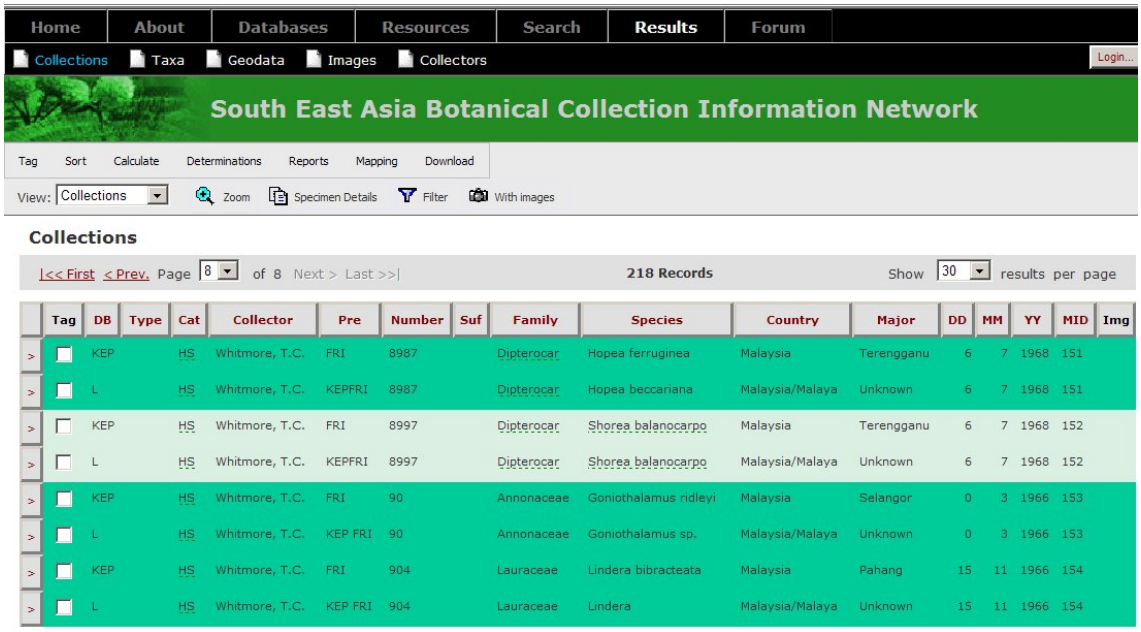
5.2 Example applications

Note that a more detailed treatment of BRAHMS online functionality is provided in Annex 1.

5.2.1 Collection matching

One of the key achievements of this project has been to complete the process of collection matching. Matching works when two or more databases are linked to a group. If a collection is located on a search at more than one herbarium, the records are auto-matched and displayed together in the results page. An example and an explanation of the significance of this follows:

SEABCIN online database group linking together herbaria in South East Asia together with the Leiden herbarium in the Netherlands, the key European herbarium with holding from S.E. Asia.



Tag	DB	Type	Cat	Collector	Pre	Number	Suf	Family	Species	Country	Major	DD	MM	YY	MID	Img
>	KEP		HS	Whitmore, T.C.	FRI	8987		Dipterocar	Hopea ferruginea	Malaysia	Terengganu	6	7	1968	151	
>	L		HS	Whitmore, T.C.	KEPFRI	8987		Dipterocar	Hopea beccariana	Malaysia/Malaya	Unknown	6	7	1968	151	
>	KEP		HS	Whitmore, T.C.	FRI	8997		Dipterocar	Shorea balanocarpo	Malaysia	Terengganu	6	7	1968	152	
>	L		HS	Whitmore, T.C.	KEPFRI	8997		Dipterocar	Shorea balanocarpo	Malaysia/Malaya	Unknown	6	7	1968	152	
>	KEP		HS	Whitmore, T.C.	FRI	90		Annonaceae	Goniothalamus ridleyi	Malaysia	Selangor	0	3	1966	153	
>	L		HS	Whitmore, T.C.	KEP FRI	90		Annonaceae	Goniothalamus sp.	Malaysia/Malaya	Unknown	0	3	1966	153	
>	KEP		HS	Whitmore, T.C.	FRI	904		Lauraceae	Lindera bibracteata	Malaysia	Pahang	15	11	1966	154	
>	L		HS	Whitmore, T.C.	KEP FRI	904		Lauraceae	Lindera	Malaysia/Malaya	Unknown	15	11	1966	154	

This screen picture illustrates both the nature of the problem and how this project contributes to solving it. In this live example, the BRAHMS online SEABCIN database group (see image above this one) has searched for all collection made by T.C. Whitmore. Collection data are gathered from all herbaria that are members of the SEABCIN group. Where the same collection is found at more than one herbarium, these collected are auto-matched (assigned the same Match Identity number in the MID field). Where the species names are different on these matched collections, the records are highlighted in dark green. For example, the botanical collection Whitmore 8987 has been found in the KEP database Kepong herbarium FRIM, Malaysia) identified as *Hopea ferrunginea*. The same collection is stored at L (Leiden, Netherlands) but identified as *Hopea beccariana*. It is also noticeable that the geographic data entered at KEP and L are different.

5.2.2 Flexible data display

Data are displayed in a flexible data grid structure providing the user with menu and toolbar controls to process search results tables.

	Tag	DB	Stat	Syn	Year	Family	Genus	Sp1	Author1	Rank1	Sp2	Author2	Citation
>	☑	leucaena	acc		0	Leguminosae	Leucaena	collinsii	Britton & Rose	ssp.	collinsii		
>	☑	leucaena	acc		1991	Leguminosae	Leucaena	collinsii	Britton & Rose	ssp.	zacapana	C.E.Hughes	Kew Bull. 46

The BRAHMS online data grid allows row, column and cell selection. These selection features are used in Tag, Filter and Calculate options. In the above example, columns SP" is selected as is the cell in that column with the value 'zacapana'.

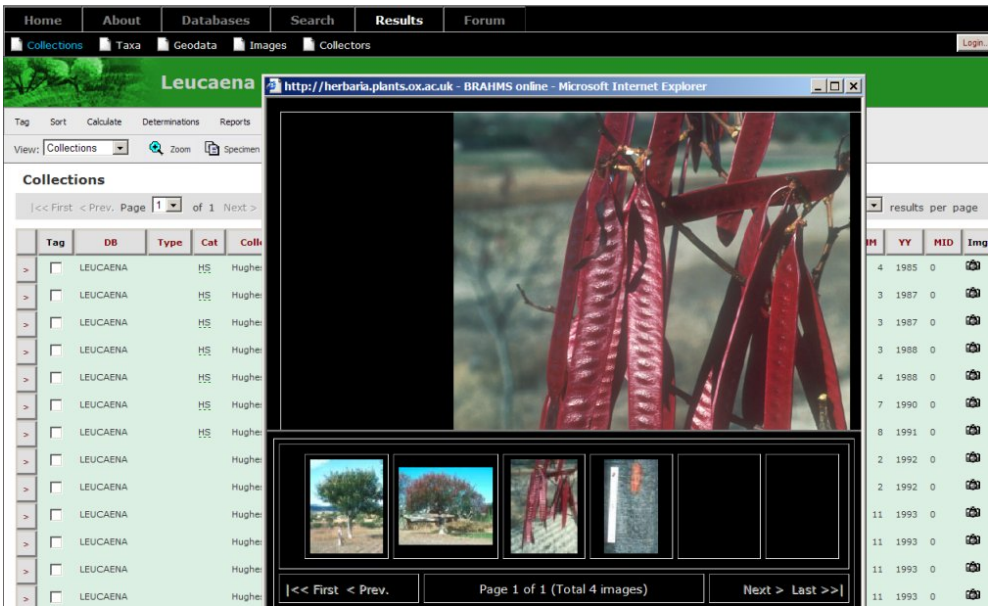
5.2.3 Tagging online

Records can be tagged online (individually selected) and these tagged records subsequently used for generate reports such as specimen summaries and mini-checklists.

In the above example, the COUNTRY column has been selected and used to apply a filter to restrict the view to collections from Honduras. The results table has been sorted by collector name and collection number. The Tag menu has been opened.

5.2.4 Improved image display

Increasing flexibility with image searching was completed. For example, options to search directly on images based on an earlier taxon or collection search were added. Thus a) Search on all collections of Leucaena made above 1000m then b) Create a file listing all images of these collections.



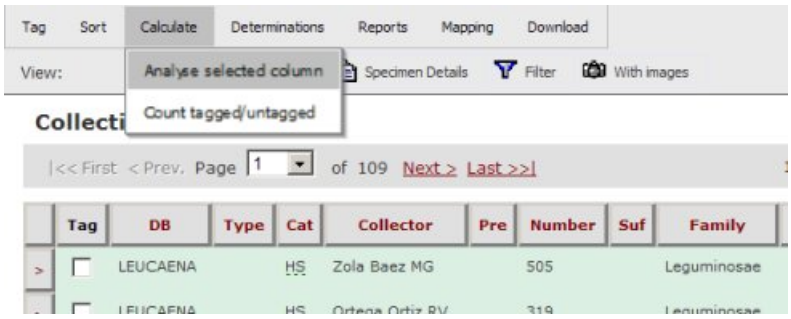
Multiple images are displayed as available and linked to the current record.

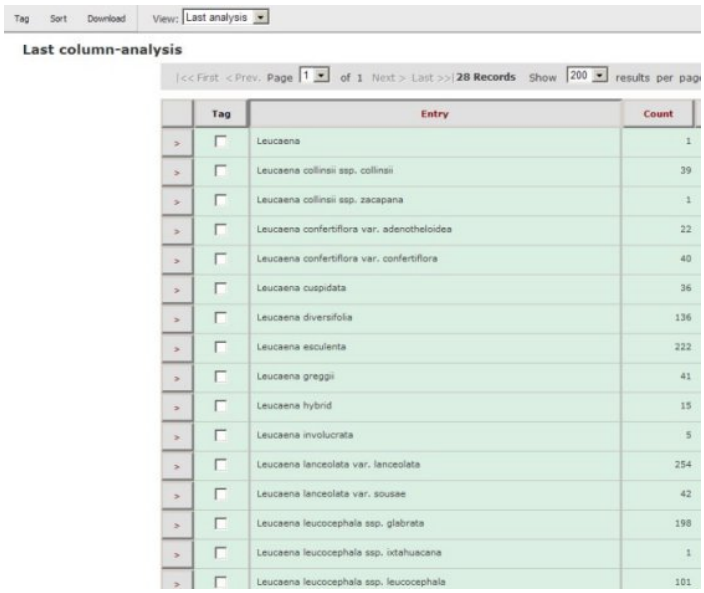
The availability of digitized images for linking to BRAHMS online depends on individual projects. Some herbarium projects are actively building image libraries of their specimens (or Type specimens) and in some cases, specimen labels. Where available, these images can be linked to collections and/or species in BRAHMS and published using BRAHMS online.

The online display of images has been dealt with comprehensively under William Hawthornes' FRP Project R7367 (development of Virtual Field Herbarium). We are currently discussing how BRAHMS online and VFH may be linked.

5.2.5 Calculate and report options.

Calculate options can be used online to analyse data in a number of ways. For example, the total number of collections for each different entry in the selected column can be summarized into an analysis table using the 'Analyse select column option'





Tag Sort Download View: Last analysis

Last column-analysis

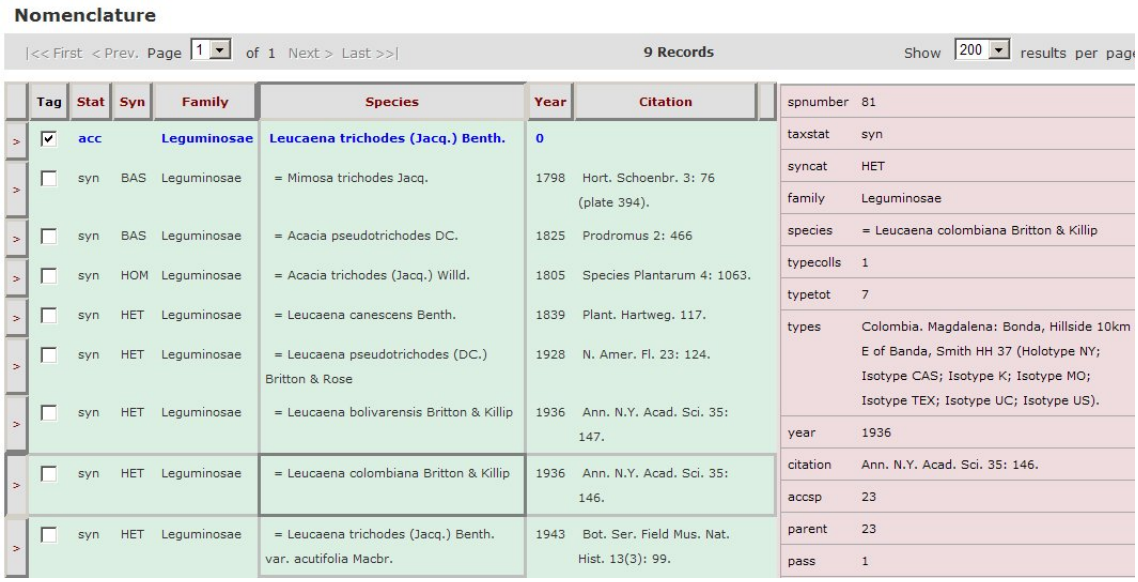
|<< First < Prev. Page 1 of 1 Next > Last >>| **28 Records** Show 200 results per pag

	Tag	Entry	Count
>		Leucaena	1
>		Leucaena collinsii ssp. collinsii	39
>		Leucaena collinsii ssp. zacapana	1
>		Leucaena confertiflora var. adenotheloidea	22
>		Leucaena confertiflora var. confertiflora	40
>		Leucaena cuspidata	36
>		Leucaena diversifolia	136
>		Leucaena esculenta	222
>		Leucaena greggii	41
>		Leucaena hybrid	15
>		Leucaena involucrata	5
>		Leucaena lanceolata var. lanceolata	254
>		Leucaena lanceolata var. sousae	42
>		Leucaena leucocephala ssp. glabrata	198
>		Leucaena leucocephala ssp. ixtahuacana	1
>		Leucaena leucocephala ssp. leucocephala	101

In this table, the user has queried online for all collections made in Mexico and then used the result to create and display a list with the total number of collections for each different species.

5.2.6 Viewing nomenclature

Functionality to store and view detailed species nomenclature (date and place of species publication, synonyms, type details and related text) has been added.



Nomenclature

|<< First < Prev. Page 1 of 1 Next > Last >>| **9 Records** Show 200 results per pag

	Tag	Stat	Syn	Family	Species	Year	Citation
>	☑	acc		Leguminosae	Leucaena trichodes (Jacq.) Benth.	0	
>	☐	syn	BAS	Leguminosae	= Mimosa trichodes Jacq.	1798	Hort. Schoenbr. 3: 76 (plate 394).
>	☐	syn	BAS	Leguminosae	= Acacia pseudotrichodes DC.	1825	Prodromus 2: 466
>	☐	syn	HOM	Leguminosae	= Acacia trichodes (Jacq.) Willd.	1805	Species Plantarum 4: 1063.
>	☐	syn	HET	Leguminosae	= Leucaena canescens Benth.	1839	Plant. Hartweg. 117.
>	☐	syn	HET	Leguminosae	= Leucaena pseudotrichodes (DC.) Britton & Rose	1928	N. Amer. Fl. 23: 124.
>	☐	syn	HET	Leguminosae	= Leucaena bolivarensis Britton & Killip	1936	Ann. N.Y. Acad. Sci. 35: 147.
>	☐	syn	HET	Leguminosae	= Leucaena colombiana Britton & Killip	1936	Ann. N.Y. Acad. Sci. 35: 146.
>	☐	syn	HET	Leguminosae	= Leucaena trichodes (Jacq.) Benth. var. acutifolia Macbr.	1943	Bot. Ser. Field Mus. Nat. Hist. 13(3): 99.

spnumber	81
taxstat	syn
syncat	HET
family	Leguminosae
species	= Leucaena colombiana Britton & Killip
typecolls	1
typetot	7
types	Colombia. Magdalena: Bonda, Hillside 10km E of Banda, Smith HH 37 (Holotype NY; Isotype CAS; Isotype K; Isotype MO; Isotype TEX; Isotype UC; Isotype US).
year	1936
citation	Ann. N.Y. Acad. Sci. 35: 146.
accsp	23
parent	23
pass	1

An example of a detailed nomenclature screen listing all synonyms of Leucaena trichodes together with all the main nomenclatural data. Nomenclatural details such as these are essential to researchers when publishing information on species, unravelling old and muddled names and cleaning up herbarium determinations.

5.2.7 Ability to publish and/or update a database remotely.

To encourage and simplify online publication, one of the outputs of the project has been the development of client-side software enabling users to update their online systems remotely. This process is tightly password controlled.

Data (only those BRAHMS files that are needed) are compressed locally, streamed to the BRAHMS online server where they are decompressed, upgraded, re-indexed and finally published online, replacing the existing database.

The location of BRAHMS online databases is currently being reviewed. Project feedback indicates that for many projects, it would be preferable to publish their data on their own server. In some cases, for perceived data security reasons, this may be required functionality. Technically, this can be achieved using ‘Web Services’ technology and this is currently being assessed.

6 Contribution of Outputs

6.1 How the outputs will contribute towards DFID's developmental goals

Primary botanical data, as found in herbaria, are the starting point for identifying and building up knowledge about species. Many species have links to forestry, agroforesty, agriculture and host of further economic disciplines.

In species rich regions, many of these targeted by the BRAHMS Project, there is still a vast amount to learn and understand about many local species and their economic potential as well as their conservation status and overall importance ecologically.

New genetic sources are continually being sought for food and crop development, pharmacology and drug development, natural pesticides, herbicides, fibres and dyes, timber and related wood products, weed control, horticulture, animal fodder and more.

Herbaria work at the lowest level of botanical knowledge, helping to know the differences between one species and other and be able to gather together species knowledge and information and put this into the correct 'box'. Without good species naming, which in turn has to be linked to physical plant specimens as stored in herbaria, confusion arises and it is very difficult to make reliable statements about individual plants and species. This in turn confuses ecological statements and all categories of biodiversity and conservation study.

This project has created an online information system that aims to a) disseminate valuable information about key plant groups to a wide range of researcher and any others who can use this level of information b) to improve data sets, particularly in herbaria, by enabling herbarium workers to consult data on similar or the same collections in other herbaria in their region and c) by searching multiple databases simultaneously, to bring together more information about the data being consulted (*e.g.* a particular species) than would otherwise be possible.

This project assists the development process by improving the botanical data infrastructure and distributing these data as widely as possible.

6.2 Pathways to target institutions and beneficiaries

The beneficiaries of this project lie mostly within the research communities and it is through this path that the results of this project will be further used, developed and distributed to client institutions (mostly herbaria), and thus contribute to the development process.

The client institutions themselves, with access to the outputs of this project, can in turn be expected to provide improved data and information to a broad range of applied activities including those that directly impinge on the livelihoods of targeted FRP focus groups.

Information about BRAHMS online is principally available via internet search engines and our own promotion. A number of BRAHMS online related workshops are planned for 2004/2005 starting in Leiden 18-22 October 2004.

Two presentations were given on BRAHMS online at the Flora Malesiana Symposium held in the Philippines Mid September 2004. These presentations focused on the results of the SEABCIN Project. An article has been published in the widely distributed Singapore Botanic Garden Magazine on the use of BRAHMS online with their Type Collection digitization project.

6.3 Future promotion of benefits

It is critical close track is kept of the effectiveness of BRAHMS online, responding to feedback for system improvement and in particular, extending and expanding the number of online databases.

Articles and presentations have and will continue be published about this system in local and international journals and meetings.

6.4 Future support

There is considerable potential to further develop BRAHMS online, for example extending its use in distributing information about seeds. Discussions are currently underway with the Kew Millennium Seed Bank Project concerning the use of BRAHMS online to link and publish online regional seed bank databases. This potential project will discussed at RBG Kew on Thursday 7th October 2004.

The project will seek modest funding support to undertake the following activities:

- Add a Seed Bank search module. This would enable seed banks to publicize their 'in stock' seed collections together with a wide range of data concerning seed pre-treatment, germination, testing, all related species information. Images of seeds and seedlings could also be included.
- Expand the range of processing tools for search results, notably to add online mapping and more reporting options.
- Filter options are being extended.
- Ability to store online databases on any secure, reliable server using Web Services technology.
- Automated database updating using Web Services technology.
- Ability to call functions in BRAHMS online using Web Services technology from BRAHMS itself. For example, to search for a specific collection in SEABCIN and download this to an RDE file, while using RDE.
- Enable automated downloading of appropriate results, for example updated specimen identifications, to a local database.
- Links to **R7367** Virtual Field Herbarium.
- Links to GBIF online search system (prototype has been developed but this needs further development).
- Extending of data storage and reporting options.