



University of
Reading

Lacistemataceae: e-monography and revision

Fiona Elizabeth Young

Submitted in partial fulfilment
of the requirements for the degree of
MSc. Plant Diversity: taxonomy and evolution

21 September 2009

Contents

Preamble	i
Abstract.....	ii
Acknowledgements.....	iii
List of figures	iv
List of tables.....	iv
Introduction	1
Methodology	8
Results.....	14
Discussion	34
Conclusion.....	42
Cited references.....	44
Website references.....	47
Appendices	56

Preamble

I chose this dissertation topic because:

1. as a lifelong sufferer of depression, I am unemployable as a professional scientist as my research has to play “second fiddle” to the management of my disability. So as an independent scientist this research was devised so I could be a research leader of an extendable project to fit around my disability;
2. of my passion for trees, their preservation and South American tropical forests; and
3. as a basis for a doctorate entitled *Lacistemataceae: systematics and ecology*.

So let us not waste any more time and metaphorically dive straight in to see what I have achieved during this research.

Abstract

Introduced here to the scientific community is the electronic or e-monograph. The e-monograph is the newest member of the online biodiversity repositories working towards the 2010 deadline set by the Convention of Biological Diversity.

The Blackboard academic course module tool was used as a storage facility for working document, deadlines and expenditure. Both project supervisors could be kept apprised of the latest developments by sending announcements.

Lacistemataceae was selected from the 490 flowering plant families using the elimination criteria of project time constraint, existing online database, economic usage, completed molecular phylogeny, restricted distribution range, non-woody, non-Neotropical distribution.

The family revision formed the foundation for designing the Lacistemataceae Holistic Database (LHD) and construction of the e-monograph Lacistemataceae Holistic Database @ www.lacistemataceae.org.

At the first phase of development, this revision includes an analysis of monographic content and TDWG standards for species page construction on the e-monograph, a literature review on the nomenclature and types for all 69 species names. However, time constraint prevented the species delimitation morphological statistic analysis from being reported here.

The nomenclatural part of this revision has become part of the Global Species Databases (GSD) contributing towards the Species 2000 & ITIS Catalogue of Life Annual Checklist 2009.

The project budget was set at £500 due to limited finance. Expenditure totalled £357.87.

The website is now international recognized as links to www.lacistemataceae.org are found on the Angiosperm Phylogeny Website, the Catalogue of Life, the Encyclopedia of Life and is number one search result on Google.

Keywords

electronic (e-)monograph, website, Blackboard, Lacistemataceae, Lacistemataceae Holistic Database, www.lacistemataceae.org, revision, typification, Catalogue of Life Annual Checklist 2009

Acknowledgements

Lacistemataceae name derivation: Christopher Davis (BM);

Granting usage of logos for the website: Yuri Roskov (Species 2000), Shaun Horan (UoR);

Copyright advice: Ian Sainsbury (UoR);

Specimens loans: Peter Stafford (BM), Stephen Blackmore (E), David Mabberley, Sue Zmarzty (K);

Digitising specimens and placing them online for this project: Raoul Palese;

Granting permission to use copyrighted material on the website: Harold Voris, Modesto Zarate, Paul Berry, Heather Huggins, Vary Coates, Beth Parada, Billie Turner, Alex Popovkin, Brian McCarthy;

Digitising specimens, posted me the images and giving permission to display on the website: Stephanie Zabel, Arne Anderberg, Mia Ehn, Maria Backlund;

Constructive comments on the website: Hans-Joachim Esser, Peter Stevens, Yuri Roskov;

Granting access to JSTOR Global Plants Initiative database for BM specimen images: Deirdre Ryan

Confirmation that Berlin type specimens had been destroyed: Robert Vogt;

Tracking down location of a voucher specimen: Nadja Korotkova;

Librarians at the University of Reading, Natural History Museum, London and Kew Library, Royal Botanic Gardens for their assistance to locate protologues;

Librarians and curatorial assistants across the world for digitising books and herbaria specimens;

Andrew W Mellon Foundation for funding the *Latin American Plants Initiative* without which type specimen images would be unavailable;

Herman Sleumer (d. 1993) for over 40 years dedicated research to complete the Flacourtiaceae monograph on which part this dissertation is based;

Stephen Jury, Ronald Rutherford, RNG Herbarium, UoR for introductory/specimen loan permission letters and specimen loan curation respectively;

Robert Smith and Alicia Peña-Bizama, UoR for additional support;

Rafaa Shkwa, Ph.D student, UoR for personal mentoring;

and finally, many thanks go to my UoR MSc. dissertation supervisors Alastair Culham & Yuri Roskov for their endless patience, advice and guidance throughout.

List of figures

Figure 1.	Information flow between the e-monograph and the global biodiversity repositories as part of the CBD and GSPC 16 targets	2
Figure 2.	CoL MS Excel tables and their relationships	9
Figure 3.	Blackboard: Introduction page.....	14
Figure 4.	Blackboard: deadlines page	15
Figure 5.	Blackboard: problem solved page	15
Figure 6.	<i>Lacistema aggregatum</i> leaves and inflorescence	16
Figure 7.	<i>Lacistema lucidum</i> inflorescence	16
Figure 8.	<i>Lacistema aggregatum</i> fruit and seed	16
Figure 9.	LHD brainstorming flipchart.....	20
Figure 10.	Lacistemataceae Holistic Database on CoL AC09.....	21
Figure 11.	Lacistemataceae tree on CoL	21
Figure 12.	<i>Lacistema nena</i> species page on CoL	22
Figure 13.	LHD tables and relationships	22
Figure 14.	MS Publisher 2007 version of www.lacistemataceae.org. Website screenshots of the four major internet browsers	32
Figure 15.	Website screenshot (all web browsers): MS Notepad and html version	33
Figure 16.	Website disc space used as of 2 September 2009	35
Figure 17.	The common names book reference problem.....	36

List of tables

Table 1.	Resultant heading from monographic contents analysis	17
Table 2.	Nomenclature and typification of Lacistemataceae	19
Table 3.	Top five website host providers.....	30
Table 4.	Project expenditure	33

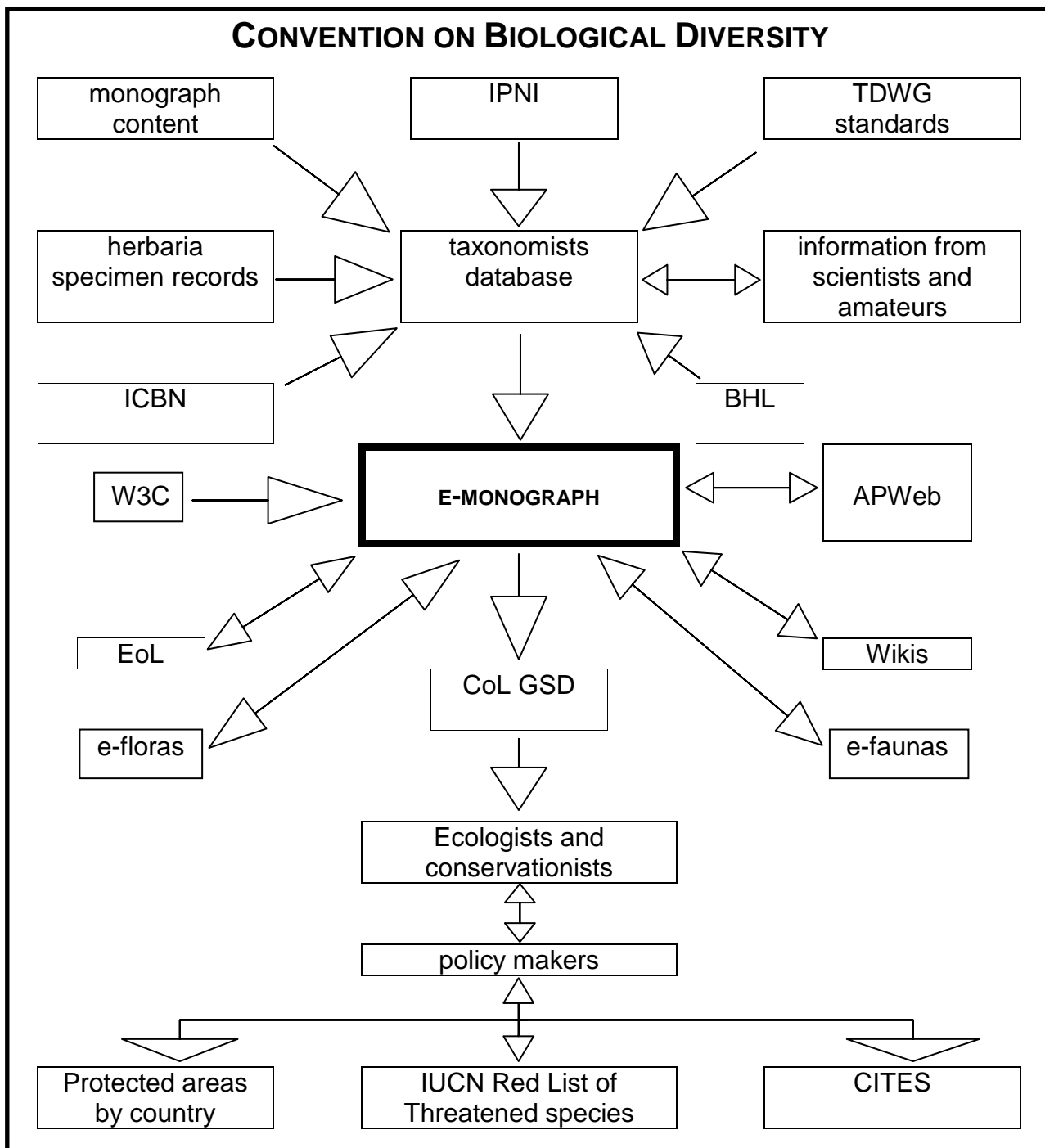
Introduction

Monographs in the past were written only for the taxonomic specialist or the enthusiastic citizen scientist. On 19 April 2002 the Convention on Biological Diversity (CBD 2002) passed Decision VI/9: Global Strategy for Plant Conservation (GSPC). GSPC has 16 targets to be completed by the end of 2010 (<http://www.cbd.int/gspc/targets.shtml>) so calls for monographic authors to collaborate with other members of the scientific community to quantify (and if required) to assist with conservation of their specialist plant group (figure 1).

Relevant to this work are GSPC Targets: Target 1 states “a widely accessible working list of known plant species, as a step towards a complete world flora”. Species 2000 & ITIS Catalogue of Life (CoL) at www.sp2000.org (2009) is the working list not just for plants but all living organisms on Earth. The world’s flora is encompassed within the Encyclopedia of Life (EoL) at www.eol.org (2008 & Wilson 2003) a project to produce a page for every species on Earth. EoL incorporates target 14 that states “the importance of plant diversity and the need or its conservation incorporated into communication, educational and public awareness programmes”. Target 14 mentions conservation that is addressed in Target 2 stated as “a preliminary assessment of the conservation status of all known plant species, at national, regional and international levels”. A taxon revision transferred from a hard copy into an electronic format makes this information readily available to field ecologists with mobile internet to access the relevant identification key. Ecologists working in collaboration with conservationists can write reports on the vulnerability of a particular species or habitat and this information is used to guide policy makers resulting in the Convention on International Trade in Endangered Species of Wild

Fauna and Flora (CITES 1975) into protecting species and CBD member countries protecting habitats.

Figure 1. Information flow between the e-monograph and the global biodiversity repositories as part of the CBD and GSPC 16 targets



The world wide web has brought information accessibility to the public the lack of collaboration in the biodiversity informatics world has continued the piecemeal approach where information is stored across global repositories and their electronic databases. Nicholas (2009) suggests that internet users are frustrated by thousands of results generated by search engines on a specific topic. Users would prefer a “one stop shop”, but the amount of data held by aggregator databases, for instance, the Global Biodiversity Information Facility (GBIF date unknown) is equally frustrating as the system is too slow making the user go elsewhere. The solution is this: global repositories have their own open access online databases: for books (Biodiversity Heritage Library), herbaria specimen virtual catalogues, the International Nucleotide Sequence Database Collaboration, and International Plant Names Index (to name a few) so the e-monograph can harvest this information to provide a “one stop specialist shop”. The e-monograph with a smaller subset of biodiversity will be faster to access than GBIF.

Taxonomists, taxonomic research organisations, biodiversity informatists are collaborating to design novel tools. A few examples: interactive mapping using ESRI ArcGIS software (ESRI 1995), Xper²: taxonomic database manager that can be used to write publications, websites and species keys (Vignes-Leebe 2004 onwards), online taxonomic content management tool: EDIT Scratchpads (Roberts & Smith 2007), LUCID (Centre for Biological Information Technology 2009) and DELTA software (Dallwitz 1980 and Dallwitz 2009) to produce online identification and diagnostic keys.

The basis of any monograph or revision, electronic or hard copy format is to review all taxon names their validity and typification. Names and type specimen assignment are governed by rules defined by the International Code of Botanical Nomenclature (ICBN) that are updated approximately every five years and available online by the International Association for Plant Taxonomy (IAPT). Taxon names are held by The International Plant Names Index (IPNI 2004). IPNI itself states “Over one million records have come from Index Kewensis. This is global in coverage and lists names from the first edition of Linnaeus’s *Species Plantarum*” in 1753 “to those being published now.” Three other reference works have been incorporated the Gray Herbarium Card Index (350,000 plus records of New World taxa published on or after January 1886) and the Australian Plant Names Index (63,000 plus names compiled since 1973) of Australian vascular plants and Index Filicum (fern and fern allies).

The revision moves on to species delimitation using the morphological species concept. Morphological statistical analysis also provides information towards detailed species descriptions and interactive species identification key. DNA sequencing and phytochemical analysis maybe the norm today for species delimitation analysis that continues to throw up cryptic species and unrelated species that look morphologically the same. These expensive techniques are not available to workers in developing countries with limited finance but are required to identify species in the field.

The Biodiversity Information Standards was formerly known as Taxonomic Database Working Group (TDWG). TDWG governs and develops the international electronic

contents and data standards for exchange between data providers and users. These standards cover floristic regions of the world, world geographical scheme for recording plant distributions, herbaria information and protocols for data interchange, correct citation of species names and their authors and many more. Ultimately, these standards are to ensure that all online biodiversity data providers can exchange data in the same format by automated software programmes known as wrappers.

The World Wide Web Consortium (W3C 2004) develop new web technologies, web writing standards, website language learning and website validation tools for any website developer to use the web to its full potential to disseminate their subject across the global electronic highways.

With all the foundational components in place (figure 1) e-floras, e-faunas and introducing here the e-monograph can be used to facilitate the CBD's GSPC 16 targets. ILDIS, the International Legume Database and Information Service were one of the first attempts towards the "one-stop shop" in this case for the bean and pea family (ILDIS 1996). FloraBase (Western Australian Herbarium 1998) covering one of the world's plant biodiversity hotspots currently covers all vascular plants and in time hopes to extend to include fungi, lichen, bryophytes and algae. This site offers photographs, static maps, DELTA Intkey species identification keys and closed access to herbaria specimen records. The only other e-monograph the author could locate is Cordyceps and related fungi. This website went live around the 1 January 2009 (pers. comm. Joey Spatafora (CD appendix/introduction/2009_spatafora document) and includes systematic

information on 500 species and includes a BLAST molecular sequence search engine. CRIA SpeciesLink (CRIA 2005a) incorporates biological material from natural history museums, herbaria and cultural collections to form the basis of the new online version of Flora Brasiliensis. The previous Flora Brasiliensis was authored by C F P von Martius, A W Eichler and I Urban between 1840 and 1906. It contained 22,767 species in 15 volumes totalling 10,367 pages (CRIA 2005b). The SpeciesLink website is at an early stage of development it will become the authoritative dynamic, interactive site for all Brazilian biodiversity.

An e-monograph including woody species can be linked to The Inside Wood online database (Inside Wood 2004) which provides descriptions and images on living and fossil wood and for vascular plants there is a specialist database on pollen incorporating images (Global Pollen Database 2001).

E-fauna although may seem irrelevant are essential part of online biodiversity databases as they provide links to produce an online global biodiversity food web for plant species do not evolve in isolation.

Finally an e-monograph can be used by the taxonomic author to add and correct information on the generalist wikis: Wikipedia, Wikispecies, and incorporate hyperlinks back to their own e-monograph.

The aim is to demonstrate the practicality and scientific effectiveness of conducting an open access internet accessible e-monograph.

To accomplish the aim, the objectives are:

- design a project logistics Blackboard site;
- select a small family that has not been worked on for a few decades;
- analyse monographic content to design a database;
- design a database to accumulate data from herbaria specimens via online catalogues and herbaria visits;
- revise the nomenclature and typification in light of the changing rules of the ICBN;
- design a website to publish the results;
- to write an international recognized website on a consumables expenditure of £500.

Methodology

Project logistics: Blackboard site

Blackboard is a course module tool for academics to place background material, assignments, results and hyperlinks to related online material. For this dissertation, the author requested a Blackboard module to be allocated as the research & development site. The University does daily backups of Blackboard so this facility was an additional storage for important research documents.

Free to design the site, a menu was designed to incorporate dissertation project material, author background information, research materials, conference attendance, expenditure, deadlines and used to keep project supervisors apprised of latest results. Two areas were constantly amended as research progressed: problems and problems solved.

Family selection

This was accomplished by analysing the 490 families listed in *Flowering Plant Families of the World* (Heywood *et al.* 2007) and eliminating families using the following criteria: project time constraint – greater than 25 species, existing online family database, economic usage, completed molecular phylogeny, restricted distribution range (thus the family had been monographed in a flora), non-woody, non-Neotropical distributed family. Brief research was done on the family to produce a working basis for e-monograph development.

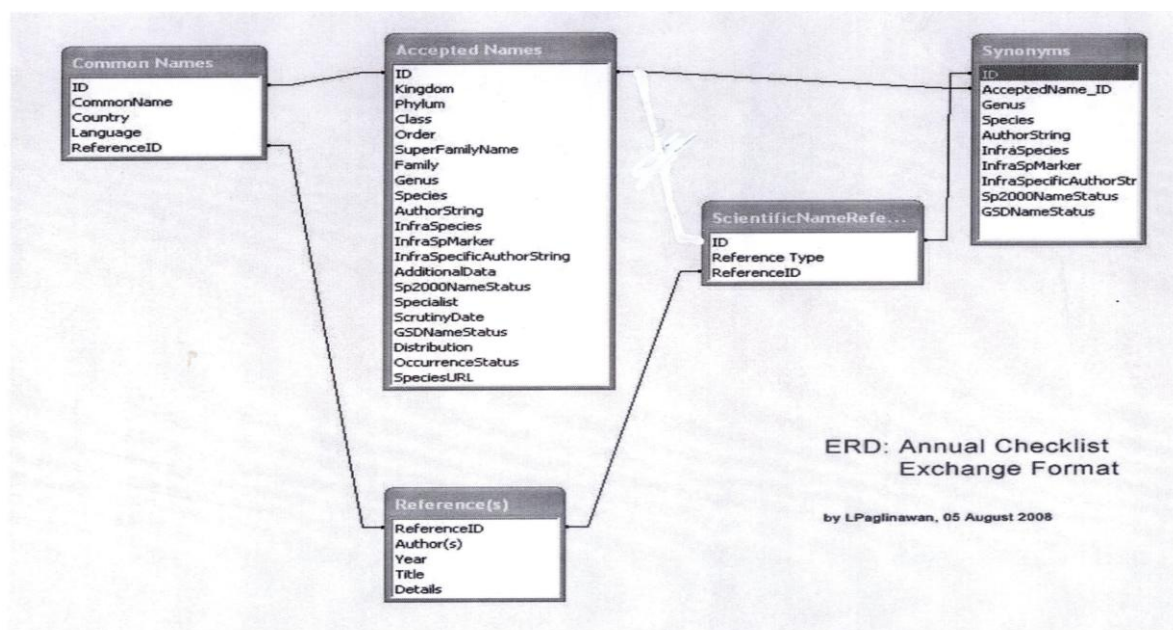
Monograph content analysis

To assess content for the e-monograph, 27 hard copy monographs and associated works dating between 1893 and 2007 were thumbed through. The headings and contents were noted and were used to construct a spreadsheet of all the categories located.

Database design

Separate databases were required for this project. The first was to submit information to the Species 2000 Catalogue of Life (CoL) Annual Checklist 2009 (AC09). For inclusion into AC09 a standard dataset had to be submitted to the CoL Secretariat before December for the data to be verified before it goes “live” on 1 April the following year. The *Annual Checklist Dataset* requirements are located at http://www.sp2000.org/index.php?option=com_content&task=iew&id=41&Itemid=49. Detailed information on the 11 fields and standard database files are downloaded online from the Species 2000 documents page. For AC09 the Microsoft Excel version was used (figure 2).

Figure 2. CoL MS Excel tables and their relationships



To conclude the CoL submission a logo needed to be designed (described below), the database given a name and an abstract written. The logo used the Google Earth map of the Americas as the basis. The map was printed out (CD appendices: LHD_logos/print_of_logo.doc), the outline transferred onto A4 transparency film and scanned into the computer (CD appendices: LHD_logos/laci_scanned_logo.pdf). This image was coloured using MS Paint and brochidodromus leaf venation drawn onto South America (CD appendices: LHD_logos/CoL_LHD_logo.pdf).

The second database is the workhorse behind the website. The initial brainstorming for LHD design was done using a flipchart. This brainstorming continued from the monograph content analysis. Further investigation of TDWG standards (<http://www.tdwg.org/standards/>) and morphological character measurements gave birth to specific relational tables within LHD.

Revision of nomenclature and typification

Lacistemataceae names were searched on the International Plant Names Index (IPNI) that retrieved 96 records (IPNI 2004) and (CD appendix: IPNI plant names.doc). Removal of duplicate names generated by the three reference sources on IPNI (Grays Card Index, Australian Plant Names Index, Kew Bulletin) reduced the number to 69. The protologues working list (CD appendix: protologues_jun2008.doc) in conjunction with the Flacourtiaceae monograph (Sleumer 1980) were used to track down the original protologue documents for verification and herbaria holding the type specimens. Online herbaria catalogues were checked to verify they were still holding the types and records checked as to whether images were available. Imaged types were hyperlinked from the e-monograph. Digitized images and

permission was requested from offline herbaria in order to display images directly on the website. For protologues still subject to copyright regulations (CD appendices: copyright) an email request was sent to the publication editor requesting permission to display a scan of the original document on the website. Compton *et al.* (1998) typification list layout was used to write the dissertation results and adapted for the website species name page. The basis for nomenclature and typification in Sleumer (1980) was the 1978 Leningrad Code (ICBN 1978). This revision required consultation of the latest code, 2006 Vienna “Red” Code (ICBN 2006) to ensure changes over the last two decades had been incorporated correctly.

Website logistics and design

The following selection criteria were used to pick a web host: domain name fees, annual webhost fee and website capacity allocation. A list of potential site hosts was gained via a Google search.

A website requires a domain name plus a specific ending, for example, .org, .com, .co.uk. It is advisable to choose a name that relates to the content and the type of organisation promoted, for example, .com is used by commercial websites, .org is used by non-profit organisations.

Website design took into consideration the World Wide Web Consortium code of practice (W3C 1994). Background and font coloration for users with colour blindness (Okabe & Ito 2008), poor eyesight (text to speech software), dyslexia (Krouse & Irvine 2003) and the rest of us who suffer from eyestrain (pers. comm. Dr Judy

Turner) generated from using visual display units without taking recommended breaks (HSE 1992).

The first version of the website was written on MS Publisher 2007. Page templates are automatically generated by the software. The pages just required colour adjustment and adding the information for the pages. The website was later completed/redeveloped using MS notepad and html web language (Lehnert 2002) to write each page due to problems with Publisher and uploading of files to the web host provider.

Metatags are an essential part of any website, without them internet search engines will not be able to locate your hard work. The MetaTags Generator at <http://www.addme.com/meta.htm> was used to generate code to place between the <head> </head> html commands at the top of every web page.

A free counter (<http://www.free-counter.com/>) was added to the website after choosing the leaf design to compliment the website from the hundreds of designs available. The generated code was placed at the bottom of the introduction.html page.

Internationally recognized website on a consumables budget of £500

As a self-funded student living on Disability and Housing benefit funding for this project was extremely limited. The maximum budget was set to £500.

For international recognition of the website the author contacted Peter Stevens the author of the Angiosperm Phylogeny website for a hyperlink to be displayed on the Lacistemataceae page, the Encyclopedia of Life to curate the Lacistemataceae pages, and Mac Alford the author of the Lacistemataceae page on the Tree of Life Web Project. It was hoped that the metatags would place the website on the first page of Lacistemataceae results on the Google search engine.

Results

Project logistics: Blackboard site

Three screenshots of the Blackboard research & development site are shown in figures 3-5. Remaining screenshots can be viewed in the document: LHD_blackboard-site.doc (CD appendix). The design of the Blackboard programme means only authorized users can view the entire site or export the zipped Blackboard folder (CD appendix) to exactly the same version (8.0.375.9) as currently used by UoR.

Figure 3. Blackboard: Introduction page

University of Reading

Home Help Logout

My Notices My Courses/Orgs My Files Help

MSC PROJECT FY (BI MSCPROJ FY) > ANNOUNCEMENTS

Announcements

LACISTEMATACEAE

LACISTEMATACEAE HOLISTIC DATABASE

WWW.LACISTEMATACEAE.ORG

VIEW TODAY VIEW LAST 7 DAYS VIEW LAST 30 DAYS VIEW ALL

August 31, 2009 - September 07, 2009

Tue, Aug 18, 2009 -- *Encyclopedia of Life (EoL) and LHD* Posted by: Fiona Young

Dear all

Today I have been made joint curator (with Mac Alford) of Lacistemataceae on EoL.

But what I did not expect to see is a link to my website on each of the EoL Lacistemataceae species pages. Follow this link: <http://eol.org/pages/8349333> to *Lacistema aggregatum* (P.J. Bergius) Rusby and explore from there.

How awesome is that! International recognition of my MSc. dissertation on a budget of £500. Now I definitely need to find funding for my Ph.D to continue my research.

Fee

Figure 4. Blackboard: deadlines page

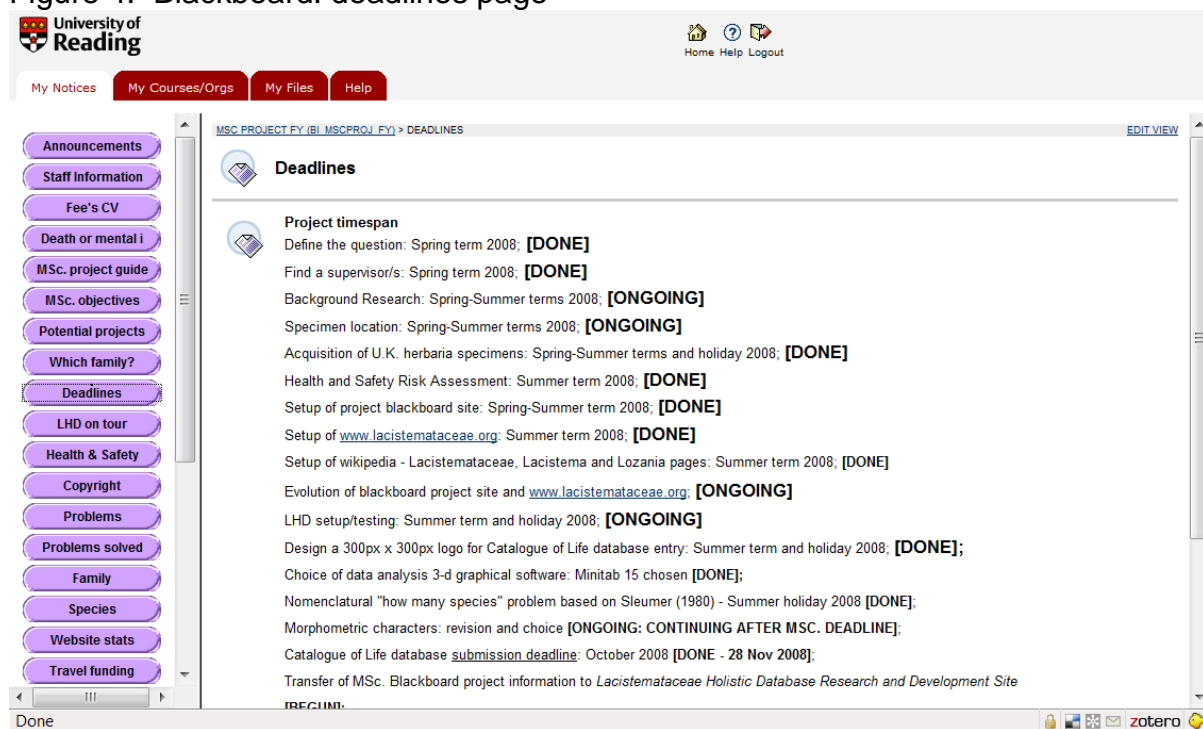
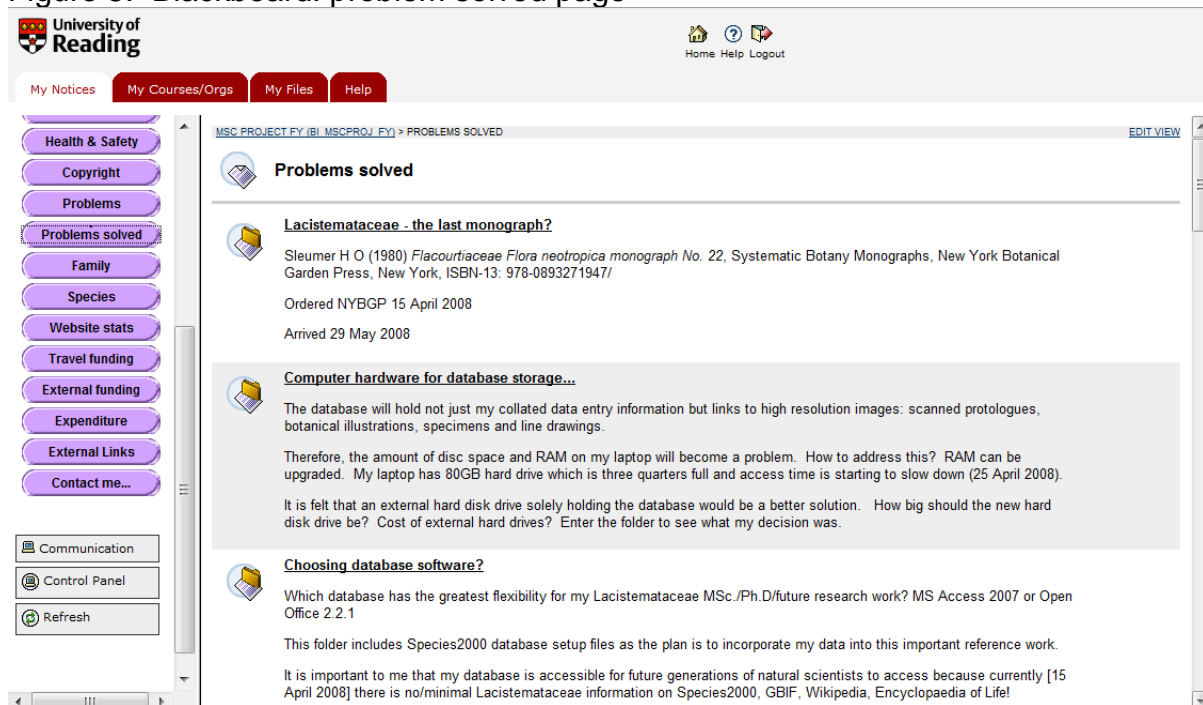


Figure 5. Blackboard: problem solved page



Family selection

After analysis two families remained of the initial 490: Lacistemataceae and Schlegiaceae. Lacistemataceae was chosen over Schlegiaceae due to its larger distribution range.

Lacistemataceae consist of two genera *Lacistema* and *Lozania* comprising of 11 and 4 species respectively (Mabberley 2008). They are small trees and shrubs, with simple, alternate, entire, brochidodromous leaves (figure 6). Inflorescence: one or more axillary catkin-like (figure 7) or spiciform racemes. Each flower is c. 1 mm in length, mainly bisexual with one bifurcated stamen (figure 7: circled). The fruit is c. 10 mm in length, fleshy, red, brown, or maroon in colour containing 1-3 seeds. The seeds are <10 mm in length and white in colour (figure 8). Habitat: primary and secondary forests (montane, moist and lowland regions) and cerrado.



Figure 6. *Lacistema aggregatum* leaves and inflorescence
© T B Croat, www.tropicos.org



Figure 8. *Lacistema aggregatum* fruit and seed
© T B Croat, www.tropicos.org



Figure 7. *Lacistema lucidum* inflorescence
© F E Young

Lacistemataceae (previously tribe Lacistemeae) had been previously monographed by Sleumer (1980) as part of Flacourtiaceae. Sleumer (1980) states “the delimitation of several species is still arbitrary”. APG (2003), and Chase *et al.*, (2002) suggested that Flacourtiaceae is polyphyletic, has been lumped into superorder Malpighiales (pers. comm. Kinman 2008) and that research is still ongoing as to the family’s placement and whether it should be incorporated into Salicaceae.

Monograph content analysis

The headings found within the 27 monographs and associated works are shown in table 1. The raw dataset is available on the CD appendices/methodology folder/analysis_of_monographs.xls document. These were used as a guide to design the website.

Table 1. Resultant heading from monographic contents analysis

general headings:	classification hierarchy conservation cultivation information DNA phylogeny medicinal uses morphological phylogeny overall introduction paleobotany information species identification key taxon description taxon distribution taxon distribution map taxon introduction taxon latitude and longitude distribution co-ordinates toxicity information typical morphology
species headings:	accepted name aestivation diagram altitude authority chromosomal number common names dispersal mechanism

	distribution map DNA/RNA sequences Examined herbaria specimen list floral formula flowering period habitat Images: herbaria specimens, line drawings, botanical illustrations, photographs IUCN Red List information Latin protologue latitude and longitude distribution co-ordinates other uses phytochemistry information pollinators polyploidy number Protologue reference species confusion information Species description synonym authority synonyms timber uses type specimen location
Appendices:	general index references/bibliography taxon index terminology glossary world checklist

Database design

The flipchart initial design is shown in figure 9. The database name chosen is *Lacistemataceae Holistic Database*. The CoL version of LHD can be viewed on the CD appendix/results folder/ COL/CoL_FEYoung_LHD_AC09 and online at http://www.catalogueoflife.org/show_database_details.php?database_name=LHD.

The CoL LHD database and logo screenshots are shown in figures 10-12. It was initially planned to be written using Open Office version 2 free software, but at the time of there was no Access-like database, therefore, MS Access 2007 was used. The relationships of LHD tables can be seen in figure 13. LHD is located on the CD appendix: LHD/LHD_20Jul2009.accdb (note this document cannot be converted to MS Office 2003 file version as it uses new features not present on the 2003 version).

For conservation reasons all location information contained in the herbarium specimens table have been removed although the headings remain in situ.

Revision of nomenclature and typification

The revisions of the validly published names are listed in table 2. The online version can be viewed at <http://www.lacistemataceae.org/species.html>.

Table 2. Nomenclature and typification of Lacistemataceae

Lacistema aggregatum (P.J. Bergius) Rusby, Bull. New York Bot. Gard.: 447, 1906
 ≡ *Piper aggregatum* P.J. Bergius, Acta Helv. Phys.-Math.: 131-132, table X, 1772 ≡
Lacistema myricoides Sw., Prodr. (Swartz): 12, 1788 ≡ *Lacistema aggregatum* Fawc.
 & Rendle, Fl. Jamaica [Fawcett & Rendle]: 29-30, 1914 – Holotypus: Rolander s.n.
 (SBT!)

= *Nematospermum laevigatum* Rich., Acta Soc. Hist. Nat. Paris: 105, 1792 –
 Holotypus: Leblond 244 (P)

= *Synzyganthera purpurea* Ruiz & Pav., Syst. Veg. Fl. Peruv. Chil. 1: 273, 1798 ≡
Didyandra purpurea (Ruiz & Pav.) Willd., Sp. Pl. 4(2): 971, 1805 ≡ *Lacistema*
purpureum (Ruiz & Pav.) A.DC., Prodr. XVI(2): 593-4 – Holotypus: Ruiz & Pavon
 s.n. (MA, fragments: F!, F!)

= *Piper fasciculatum* Rudge, Pl. Guian. 1: 9, table 4, 1805 – Holotypus: Martin s.n.
 (BM)

Figure 9. LHD brainstorming flipchart

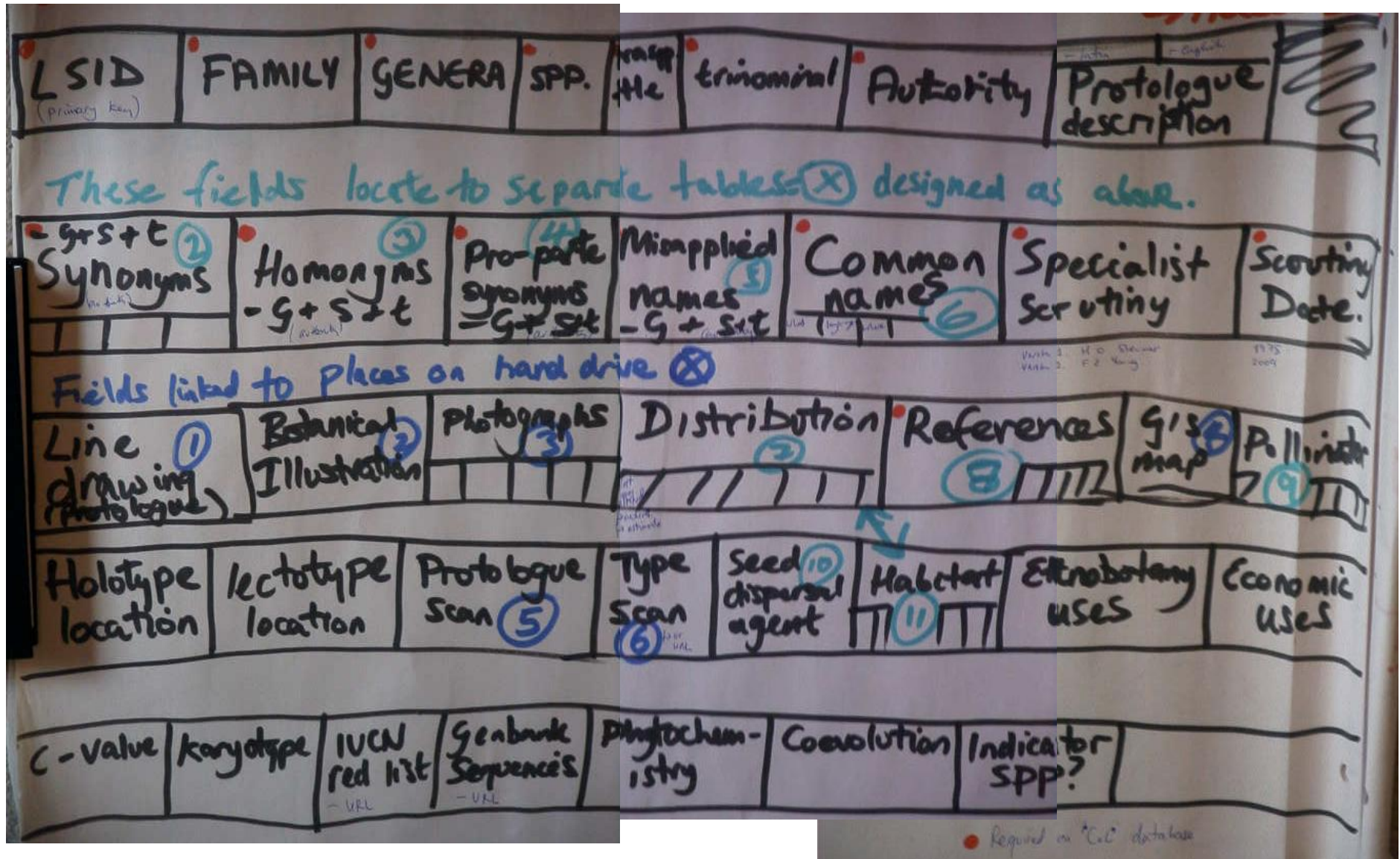


Figure 10. Lacistemataceae Holistic Database on CoL AC09

Species 2000
ITIS

Catalogue of Life: 2009 Annual Checklist
indexing the world's known species

LHD

Database details	
Full name:	Lacistemataceae Holistic Database
Short name:	LHD
Version:	Oct 2008
Release date:	October 19th, 2008
Authors/editors:	FE Young
Taxonomic coverage:	Plantae – Magnoliophyta – Magnoliopsida – Malpighiales – Lacistemataceae
Number of species names:	16 accepted names; 50 synonyms
Number of infraspecies names:	0 accepted names; 3 synonyms
Number of common names:	2
Total number of names:	71
Abstract:	Lacistemataceae is a small family of trees and shrubs located mainly in wet lowland, montane, dry and moist forests in the West Indies, Mexico, Mesoamerica, South America excluding Chile. The objective of the Lacistemataceae Holistic Database is to continue the 40 years dedicated research of Dr. Herman Sleumer (d. 1993). LHD will update knowledge encompassing systematic and environmental sciences.
Organization:	Centre for Plant Diversity and Systematics, School of Biological Sciences, The University of Reading, Reading, UK
Web site:	http://www.lacistemataceae.org

Back to last page | New search

Figure 11. Lacistemataceae tree on CoL

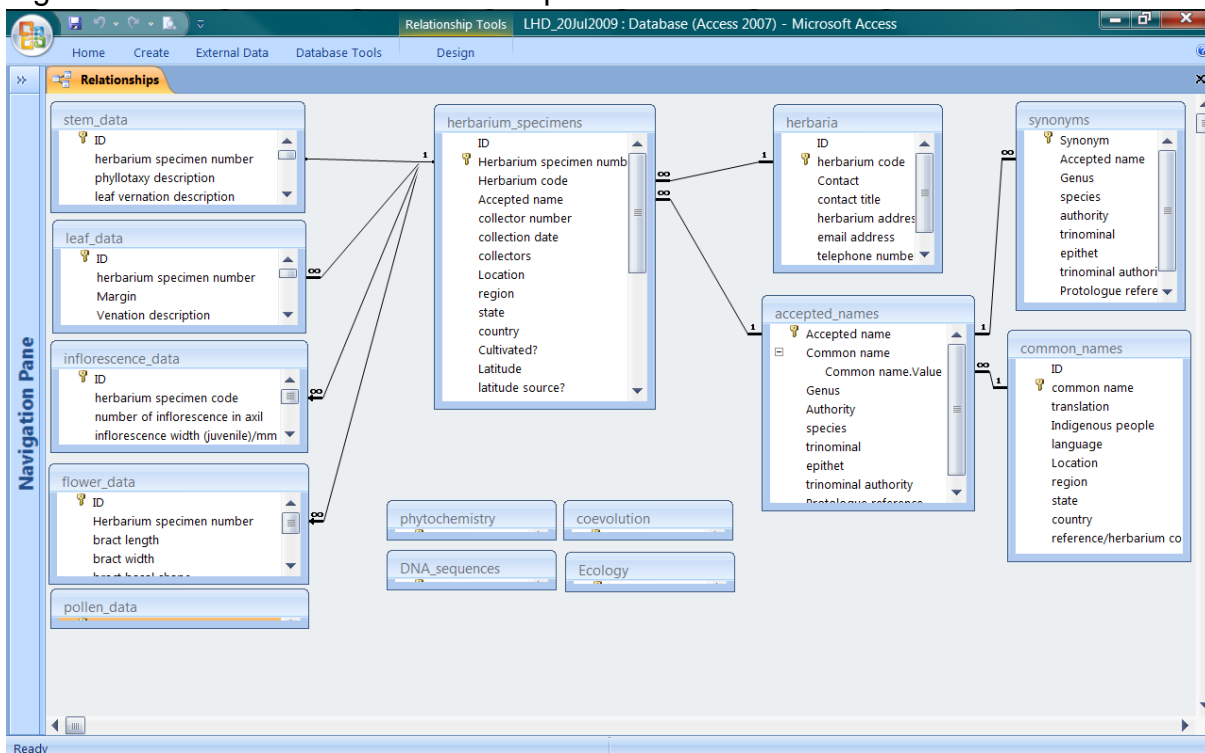
Species 2000
ITIS

Catalogue of Life: 2009 Annual Checklist
indexing the world's known species

- Family Lacistemataceae LSID
 - Genus **Lacistema** LSID
 - Lacistema aggregatum* LSID
 - Lacistema grandifolium* LSID
 - Lacistema hasslerianum* LSID
 - Lacistema krukovii* LSID
 - Lacistema lucidum* LSID
 - Lacistema macbridei* LSID
 - Lacistema nena* LSID
 - Lacistema polystachyum* LSID
 - Lacistema pubescens* LSID
 - Lacistema robustum* LSID
 - Lacistema serrulatum* LSID
 - Genus **Lozania** LSID
 - Lozania glabrata* LSID
 - Lozania grandiflora* LSID
 - Lozania klugii* LSID
 - Lozania mutisiana* LSID
 - Lozania pittieri* LSID

Figure 12. *Lacistema nena* species page on CoL

Figure 13. LHD tables and relationships



- = *Lacistema floribundum* Miq., *Linnaea* 18: 24, 1844 – Holotypus: Focke 660 (GH!)
- = *Lacistema elongatum* Schnizl., *Fl. Bras. (Martius)* 4(1): column 282, 1857 – Holotypus: Martius anno 1919 (M)
- = *Lacistema angustum* Schnizl., *Fl. Bras. (Martius)* 4(1), column 283-4, 1857 – Lectotypus: R. Schomburgk 1092 (BR!)
- = *Lacistema myricoides* Sw. var. *stipitatum* A.DC., *Prodr.*, XVI(2): 592, 1868 – Holotypus: Wulschlaegel s.n. (M)
- = *Lacistema recurvum* A.DC., *Prodr.* XVI(2): 593, 1868 – Lectotypus: Splitgerber s.n. (W, K, L)
- = *Lacistema coriaceum* A.DC., *Prodr.* XVI(2): 593, 1868 – Holotypus: Spruce 3082 (G-DC!)
- = *Lacistema poeppigii* A.DC., *Prodr.* XVI(2): 593, 1868 – Holotypus: Peoppig 2735 (G-DC!)
- = *Lacistema bolivianum* Gand., *Bull. Soc. Bot. France*: 288, 1919 – Holotypus: Bang 2400 (LY)
- = *Lacistema guyanense* Gand., *Bull. Soc. Bot. France*: 288, 1919 – Holotypus: Jelski s.n. (LY)
- = *Lacistema rosidiscum* J.F. Macbr., *Candollea* 5: 392, 1934 – Holotypus: Williams 7216 (F!, fragments: G!, L!)
- = *Lacistema curtum* J.F. Macbr., *Candollea* 5: 392, 1934 – Holotypus: Killips & Smith 24617 (F!, fragment G!)

- = *Lacistema orinocense* Baehni, Candollea 8: 43-44, 1940 – Holotypus: Rusby & Squires 180 (G)
- = *Lacistema weberbaueri* Baehni, Candollea 8: 46, 1940 – Holotypus: Weberbauer 4497 (G!)
- = *Lacistema aggregatum* (P.J. Bergius) Rusby var. *elongatum* Maguire, Bull. Torrey Bot. Club 75(3): 293 – Holotypus: Fanshawe 2200 (NY!)
- = *Lacistema occidentale* Cuatrec., Fieldiana, Bot., 27(1): 93, 1950 – Holotypus: Cuatrecasas 19595 (F!)
- = *Lacistema pacificum* Cuatrec., Fieldiana, Bot., 27(1): 93-94, 1950 – Holotypus: Cuatrecasas 15875 (F)
- *Lacistema macrophylla* Klotzsch, protologue unknown – Holotypus: Schomburgk 1451 (B!) nom. inval. (ICBN Art. 43.1)
- *Lacistema paladofum* Poepp., protologue unknown – Syntypus: Poeppig 1428 (F ex G!) nom. inval. (ICBN Art. 43.1)

Distribution: Argentina (Misiones), Belize, Bolivia, Brasil (Distrito Federal, Goias, Mato Grosso do Sul, Mato Grosso, Bahia, Maranhao, Pernambuco, Sao Paulo, Acre, Amazonas, Amapa, Para, Roraima, Tocantins, Parana), Colombia, Costa Rica, Ecuador, French Guiana, Guyana, Honduras, Jamaica, Mexico (Veracruz, Guerrero, Oaxaca, Chiapas, Tabasco), Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad & Tobago, Venezuela.

Lacistema grandifolium Schnizl., Fl. Bras. 4(1): column 284-5, table 81, figure 1 – Lectotypus (designated here): Poiteau anno 1814 (G!)

= *Lacistema ellipticum* Glaz., Bull. Soc. Bot. France, Mem. 3g: 648, 1912 –
Holotypus: Glaziou 14279 (?)

- *Lacistema tomentosum* Miq. ex Pulle, Enum. Vasc. Pl. Surinam: 146, 1906 –
Holotypus: Focke 935 (?) nom. inval. (ICBN Art. 43.1)

Distribution: Brasil (Mato Grosso, Bahia, Acre, Amazonas, Para, Rondonia, Parana),
French Guiana, Guyana, Suriname, Venezuela

Lacistema hasslerianum Chodat, Bull. Herb. Boissier, Tome III (2me serie): 394,
1903 – Holotypus: Hassler 5031 (G!)

= *Lacistema serrulatum* auct. non Mart. A.DC., Prodr., XVI(2): 591, 1868 – Holotypus:
Sello s.n. (BR!)

= *Lacistema fagifolium* Chodat & Chirtoiu, Bull. Soc. Bot. Genève, Vol X(7): 342-343,
1918 – Holotypus: Lund anno 1834 (G-DC!)

- *Lacistema aggregatum* non (P.J. Bergius) Sw. sensu stricto, Lilloa 26: 26-28, 1953
– Syntypus: Rodrigues 405 (LIL) nom. inval. (ICBN Art. 43.1)

Distribution: Argentina (Misiones), Bolivia, Brazil (Districto Federal, Goias, Mato
Grosso do Sul, Mato Grosso, Minas Gerais, Sao Paulo, Para, Parana), Paraguay

Lacistema krukovii Sleumer, Fl. Neotrop. Monogr. 22: 184-185, 1980 – Holotypus:
Krukoff 6807 (U!)

Distribution: Brasil (Amazonas)

Lacistema lucidum Schnizl., Fl. Bras., 4(1): column 282-3, tables 79 & 81, figure V,
1857 – Holotypus: destroyed (B), lectotypus assignment required

- *Lacistema pubescens* Mart. subsp. *longistipulatum* G. Agostini, protologue unknown – Syntypus: Dusen 15362 (NY!), Dusen 15322 (NY!) nom. inval. (ICBN Art. 43.1)

Distribution: Brasil (Sao Paulo, Parana)

Lacistema macbridei Baehni, *Candollea* 8: 42, 1940 – Holotypus: Tessman 5282 (G!)

≡ *Lacistema macbridii* Baehni, *Candollea* 8: 42, 1940 – Holotypus: Tessman 5282 (G!) (ICBN Art. 32.5)

Distribution: Ecuador, Peru

Lacistema nena J.F. Macbr., *Candollea* 5: 392, 1934 – Holotypus: Williams 1876 (F, fragment G!)

Distribution: Bolivia, Brasil (Acre, Amazonas), Colombia, Ecuador, Peru

Lacistema polystachyum Schnizl., *Fl. Bras.* 4(1): column 284, table 78, figure 1, 1857 – Holotypus: Spruce 220 (W?)

= *Lacistema intermedium* Schnizl., *Fl. Bras.* 4(1): column 281, table 81, figure 2, 1857 – Lectotypus: Martius s.n. (M)

= *Lacistema lucidum* auct. non Schnizl. A.DC., *Prodr.* XVI(2): 593, 1868 – Holotypus: Spruce 1844 (G-DC!)

= *Lacistema pubescens* Mart. var. *glabrescens* Huber, *Bol. Mus. Paraense Hist. Nat. Ethnogr.* 5(2): 332, 1909 – Holotypus: Ducke s.n. (MG)

Distribution: Bolivia, Brasil (Mato Grosso, Amazonas, Amapa, Para, Rondonia, Parana), French Guiana, Guyana, Suriname

Lacistema pubescens Mart., Nov. Gen. Sp. Pl. (Martius) 1: 155, plate 94, 1826 – Holotypus: Martius obs. 2603 (M)

= *Lacistema ellipticum* Schnizl., Fl. Bras. 4(1): column 285, 1857 – Lectotypus: Pohl 4401 (F ex B! (fragment))

- *Lacistema pubescens* Mart. subsp. *serrulatum* Mart., protologue unknown – Syntypus: Saint-Hilaire s.n. (NY!)

Distribution: Bolivia, Brasil (Distrito Federal, Mato Grosso do Sul, Mato Grosso, Bahia, Maranhao, Minas Gerais, Rio de Janeiro, Sao Paulo, Amazonas, Amapa, Para, Rondonia, Parana), French Guiana, Venezuela

Lacistema robustum Schnizl. Fl. Bras. 4(1): column 271, table 77, 1857 – Lectotypus (designated here): Lhotsky anno 1831 (G-DC!)

= *Lacistema recurvum* Schnizl. Fl. Bras. 4(1): column 283, table 81, figure 4, 1857 – Holotypus: Sello 776 cited as 786 (F ex B!)

= *Lacistema intermedium* A.DC., Prodr. XVI(2): 592, 1868 – Holotypus: Blanchet 2191 (G-DC!)

= *Lacistema blanchetii* A.DC., Prodr. XVI(2): 592, 1868 – Holotypus: Blanchet 3522 (G-DC!)

- *Lacistema rostratum* Schnizl., protologue unknown – Syntypus: Sello s.n. (K!)

Distribution: Brasil (Mato Grosso, Bahia, Pernambuco, Espirito Santo)

Lacistema serrulatum Mart., Nov. Gen. Sp. Pl. (Martius) 1: 156m plate 95, 1826 –
Holotypus: Martius anno 1817 (M)

= *Lacistema leptostachyum* Chodat & Chirtoiu, Bull. Soc. Genève X(7): 343-4, 1918
– Holotypus: Lhotsk anno 1832 (G-DC!)

Distribution: Bolivia, Brasil (Distrito Federal, Goais, Minas Gerais, Rio de Janeiro, Sao Paulo)

Lozania glabrata A.H. Gentry, Ann. Missouri Bot. Gard., 75(4): 1431-1433, 1989 –
Holotypus: Gentry & Fallen 17425 (COL!)

Distribution: Colombia

Lozania grandiflora Schult., Mant. 3 (Schultes & Schultes f.): 109, 1827 –
Holotypus: unknown (?)

Lozania klugii (Mansf.) Mansf., Notizbl. Königl. Bot. Gart. Berlin: Br. 11(107): 596-7,
1932 – Lectotypus (designated here): Klug 1430 (F!) ≡ *Monandrodendron klugii*
Mansf., Repert. Spec. Nov. Regni Veg. Beih., Berlin: 30, Nr. 799/806: 178 –
Holotypus: Klug 1430 (B - destroyed)

= *Lacistemopsis poculifera* Kuhlm., Anais Reuniao Sul-Amer. Bot., Rio de Janeiro: 3:
85-86, plate 14, 1940 – Holotypus: Ducke 386 (US!)

Distribution: Brasil (Sao Paulo, Amazonas), Colombia, Ecuador, Peru

Lozania mutisiana Schult., Mant. 3 (Schultes & Schultes f.), Stuttgart: 109, 1827 –
Holotypus: Mutis 2186 (MA)

- = *Monandrodendron schultzei* Mansf., Notizbl. Königl. Bot. Gart. Berlin, Br. 10(98): 860-862, 1929 – Holotypus: Schultze 1462 (unknown)
- = *Monandrodendron peruvianum* Mansf., Repert. Spec. Nov. Regni Veg. Beih., 29(781/790): 11, 1931 – Holotypus: Killip & Smith 25968 (US!)
- = *Lozania bipinnata* L.B. Sm., Phytologia 1(3): 138-9, 1935 – Holotypus: Lawrance 524 (US)
- = *Lozania montana* Standl., Publ. Field Mus. Nat. Hist., Bot. Ser., 18(2): 722, 1937 – Holotypus: Brenes 4365 (F)
- = *Perrottetia costaricensis* Lundell, Phytologia 1(14): 451, 1937 ≡ *Perrottetia racemosa* Standl., Publ. Field Mus. Nat. Hist., Bot. Ser., 18(2): 633, 1937 – Holotypus: Standley & Valerio 49894 (F)
- *Lozania nemoralis* DC., Prodr., 3: 30, 1828 – Holotypus: unknown (?)

Distribution: Colombia, Costa Rica, Ecuador, Nicaragua, Panama, Peru, Venezuela

Lozania pittieri (S.F. Blake) L.B. Sm., Phytologia 1(3): 138, 1935 ≡ *Lacistema pittieri* S.F. Blake, Contr. U.S. Natl. Herb., 20(13): 520, 1924 ≡ *Lacistema trichoneurum* Blake ex Knuth, Repert. Spec. Nov. Regni Veg. Beih., 42: 292, 1928 – Holotypus: Pittier 8974 (US!)

= *Lacistema pedicellatum* Standl., J. Wash. Acad. Sci., 17(1): 8, 1927 ≡ *Lozania pedicellata* (Standl.) L.B. Sm., Phytologia 1(3): 138, 1935 - Holotypus: Pittier 4152 (US!)

Distribution: Colombia, Costa Rica, Nicaragua, Panama, Venezuela

Website logistics and design

The web host provider chosen was <http://www.uk-cheapest.co.uk> after assessing the results from Google search. The best five providers, their costs and website capacity allocation are shown in table 3. The domain name chosen for the website was www.lacistemataceae.org and went live 10 May 2008. The web hosting and domain name registration fees cost £76.50 for two years.

Table 3. Top five website host providers

Web host internet address	Commonest domain names and fee per year*				Web host annual fee*	Website capacity
	.co.uk	.org.uk	.org	.com		
www.1and1.co.uk	£2.99	£2.99	£8.99	£8.99	£70.32	4 GB
www.ukhost4u.com	£9.99	£9.99	£9.99	£9.99	£39.99	2 GB
www.123-reg.co.uk	£2.79	£2.79	£8.99	£8.99	£47.88	500 MB
www.uk-cheapest.co.uk	£3.47	£3.47	£7.97	£7.97	£29.99	500 MB
www.freewebs.com	Not applicable**				Free***	40 MB

* Price as of 04 September 2008

** does not use a usual domain name but [http://www.freewebs.com/\[your website name\]/](http://www.freewebs.com/[your website name]/)

*** Free web hosting comes at a price of an advertising banner at the top of every web page

The MS Publisher 2007 website introductory page is shown in figure 14a. However, when viewed on other web browsers: Firefox (figure 14b) and Netscape (figure 14c) background coloration and the title banner are absent. In Safari (figure 14d) the introductory page is correct, but pages 2 and 3 have lost the title banner. This problem of incompatibility of Microsoft software on all non-Microsoft web browsers was solved by rewriting the website using MS notepad and the web language html (figure 15).

The resultant website was archived in September 2009 and can be viewed by inserting the www.lacistemataceae.org CD-ROM located inside the back cover of this

dissertation into a computer. The website will autorun if this feature is set up on your computer. If the CD does not autorun select <start><run><browse>, select <contents.html> from your DVD-ROM drive and finally select <open><ok>. The free counter has been removed as it is only functional on the online version.

Internationally recognized website on a consumables budget of £500

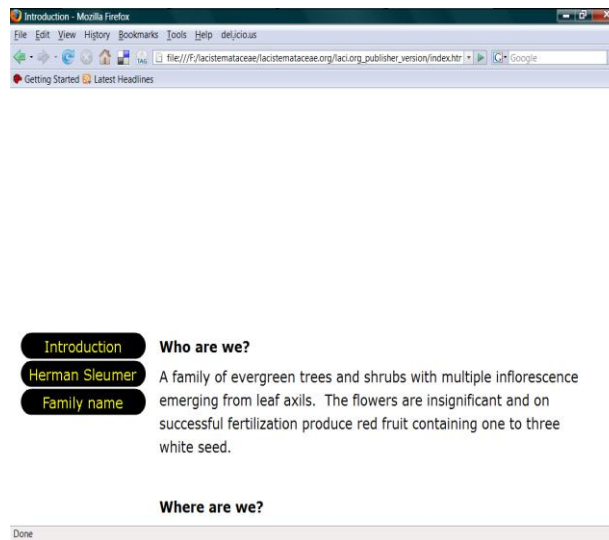
Project expenditure totalled £375.87 (table 4). Expenditure was constrained to purchase laptop equipment for file storage (an external hard drive and case, buy a second-hand LCD screen for dual screen working and upgrade of laptop RAM to increase processing speed. To buy books on writing a website in html and the Flacourtiaceae monograph. The monograph was unavailable at the University of Reading libraries or herbarium library. Trips via train were required to the Botanical libraries of the Natural History Museum and the Kew Herbarium to photocopy (a charge is made by the library) protologues and other research documentation unobtainable through the University of Reading Interlibrary loan scheme. Finally a Geology Map was purchased as a basis to produce a Google Earth map overlay for family and genera distribution maps.

An online family database is all very well but without recognition by the international scientific community it is little more than the work of a citizen scientist. www.lacistemataceae.org is now hyperlinked from the Lacistemataceae page on Angiosperm Phylogeny Website (Stevens 2001) and the Lacistemataceae species pages on the Encyclopedia of Life. Is the number one result in a Google search for Lacistemataceae and is the only search result from www.biologybrowser.com (Thomson Reuters 2005).

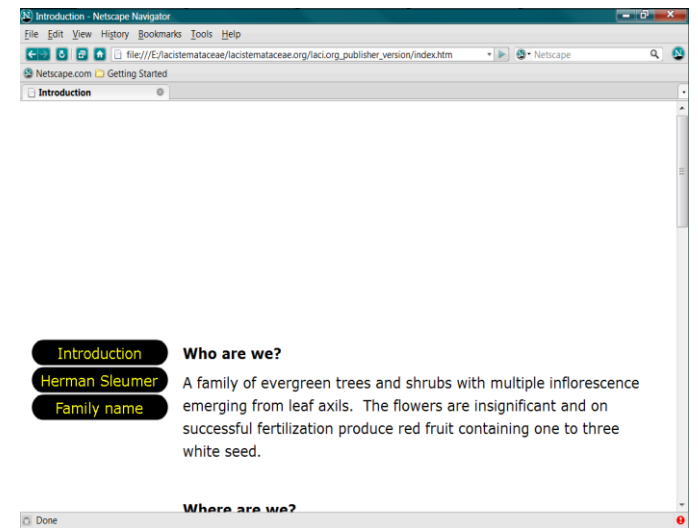
Figure 14. MS Publisher 2007 version of www.lacistemataceae.org. Website screenshots of the four major internet browsers.



a) MS Internet Explorer ver. 7



b) Mozilla Firefox ver. 2



c) AOL Netscape Navigator ver. 9.0.0.6



d-f) Apple Mac Safari ver. 3.1.2

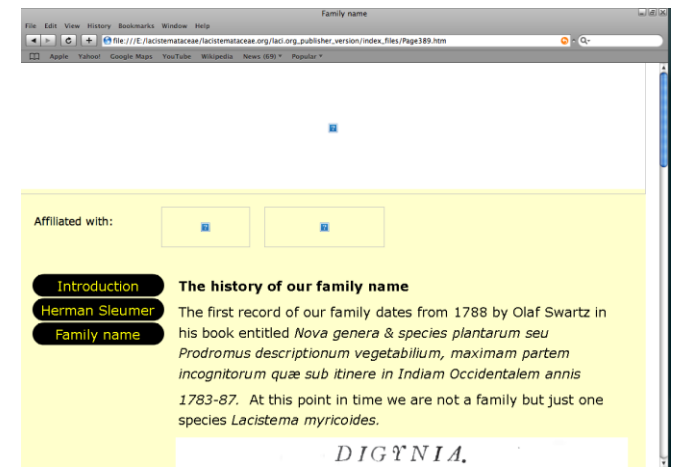
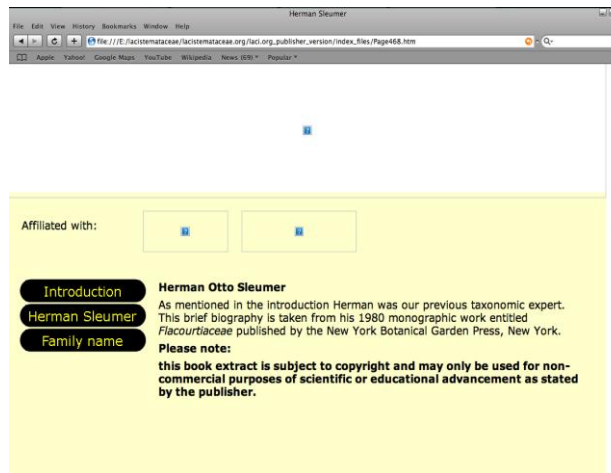


Figure 15. Website screenshot (all web browsers): MS Notepad and html version



Table 4. Project expenditure

Cost in £	When	What (if applicable where)
22.21	15 April 2008	Flacourtiaceae monograph
64.89	25 April 2008	500GB External Hard Drive
18.45	05 May 2008	Protective case for external hard drive and cables
43.52	14 April 2008	www.lacistemataceae.org web hosting and domain name fees
18.20	14 May 2008	Train fare to visit NHM General Herbarium – Lacistemataceae specimens
18.20	19 May 2008	Train fare to visit NHM General Herbarium – Lacistemataceae specimens
7.74	30 June 2008	Book – The Web Wizards Guide to HTML
13.90	02 July 2008	Train fare to visit Kew Library, RBG
0.71	02 July 2008	Photocopy charge for 2 protologue pages
27.95	17 July 2008	2GB RAM upgrade for laptop (for faster internet downloading)
18.30	24 July 2008	Train fare to visit NHM Botany Library
5.20	24 July 2008	Photocopy charge for 26 protologues
10.00	24 July 2008	Purchase of Global Geological Maps from British Geological Society shop at NHM (for Google Earth overlay)
36.60	25 July 2008	15" LCD additional screen for laptop (for website species page production)
18.30	30 July 2008	Train fare to visit NHM Botany and General Libraries
32.98	16 April 2009	Website hosting 1 year renewal fee
10.10	13 May 2009	Train fare to visit Kew Library, RBG
8.62	13 May 2009	Photocopy charges
375.87		TOTAL EXPENDITURE

Discussion

The Blackboard project site was indispensable for deadline tracking and document storage while locating type specimens and their protologues. Initially only both supervisors and myself were enrolled but as the project progressed the network of UoR contacts expanded as their assistance was required. Not all problems have been solved and more have become known during this revision. For instance, the morphological statistical analysis could not be completed as it was taking half an hour to measure the stem and leaves. The inflorescence and minuscule flowers could not be measured as microscope eyepieces were underpowered. Higher powered eyepieces (x25) could not be purchased within the budget limit.

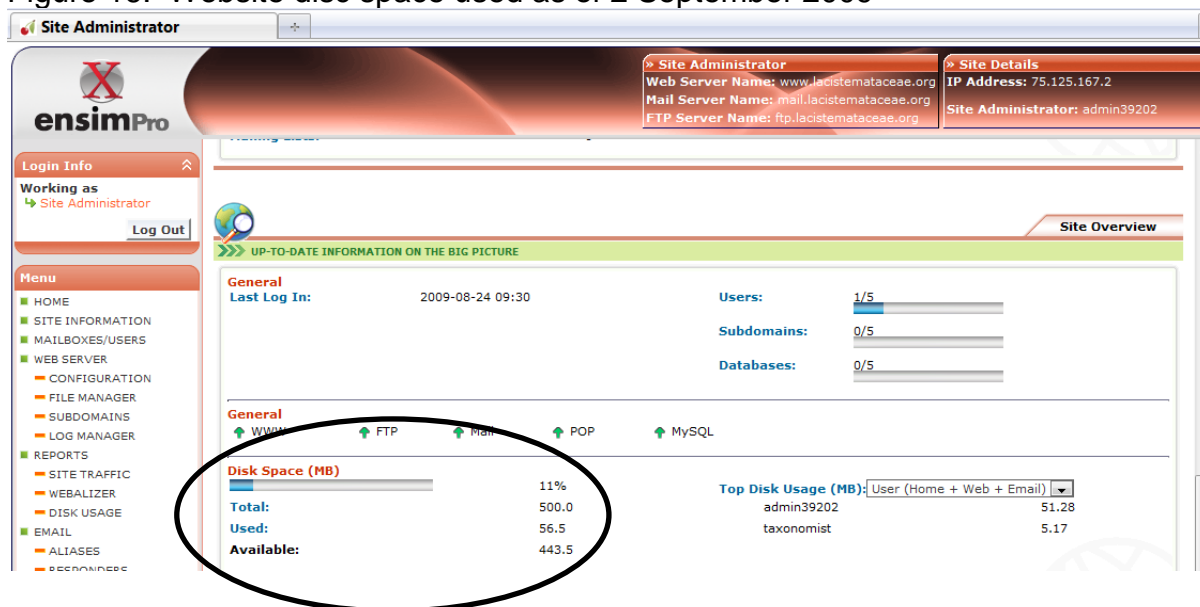
The first design of the website using MS Publisher 2007 caused display problems on 3 out of 4 web browsers (figure 14). Publisher was a nightmare to work with as any website rewrite meant that using the “publish to go” command renamed all the files for upload. As each file required uploading one at a time to the web host provider, removal of all previous files and the file upload become tediously slow when the website grew to more than 15 files. This is why the website was rewritten using html web language and MS notepad. This continuing unwillingness of Microsoft to write software that works correctly on all other manufacturers software will eventually cause their collapse if they do not learn to “collaborate rather than compete” for the great good of humanity and all biodiversity.

The design of the website is currently flawed as it uses three frames (top, menu and content) and text-to-speech software will only read the top frame (figure 15). Black text on a yellow background is not optimal for dyslexics, better is blue text on a

yellow background. With over 300 pages and images it was impractical to do a complete rewrite before the dissertation deadline, however a rewrite is planned for 2010. Before the rewrite an investigation into transferring LHD into open source MySQL database for online queries using html language needs to be completed first. Brief looks through web language manuals suggest the use of MySQL and php language maybe the way forward.

Choosing www.uk-cheapest.co.uk on the grounds of web allocation capacity and low price has paid off financially. Many of the cheap host providers allocated 50 MB and running out of space means buying more can be expensive. As of 2 September 2009, the e-monograph uses 56.5 MB, 29.2 MB are the 300+ uploaded files. The remaining 27 MB are the website and email functional files (figure 16).

Figure 16. Website disc space used as of 2 September 2009



The nomenclatural information submitted to the CoL AC09 contains an erroneous common names link for *Lacistema nena*. Rather than the reference, stating Bennett et al. (2002) what is shown is the protologue reference (figure 17). This problem is

due to the bad design of the relational tables. This problem will be eliminated for the AC10 by submitting a cut down version using the tables: accepted names, synonyms and common names of LHD Access file.

Figure 17. The common names book reference problem

The image shows two screenshots of the 'Catalogue of Life: 2009 Annual Checklist' website. The top screenshot displays the 'Common name details' for *Lacistema nena*. A callout box highlights a small red book icon in the top right corner of the details panel. The bottom screenshot shows the 'Literature reference' section, which lists a single reference by Macbride J F (1934) titled 'New or renamed spermatophytes mostly Peruvian' from the journal *Candollea*.

Common name details

Common name:	Waits Numi
Language:	Shuar
Country:	Ecuador
Accepted scientific name:	<i>Lacistema nena</i>
Source database:	Lacistemataceae Holistic Database [LHD]

[Back to last page](#) | [New search](#)

Literature reference

1 literature reference found:

Author	Macbride J F
Year	1934
Title	New or renamed spermatophytes mostly Peruvian
Source	in <i>Candollea</i> : 5:392

[Back to last page](#) | [New search](#)

LHD is extendible in its design (figure 13). These tables: pollen data, phytochemistry, coevolution, DNA sequences, Ecology are present but not currently in use until future funding can be found to continue this research. Unlike a standard database, LHD contains tables that include all herbaria specimen records that are linked to the morphological measurement tables for stem, leaf, inflorescence and flower. On examination of a herbaria specimen this data is available for transference to any statistical package for analysis, for example, the ongoing species delimitation using Minitab.

Using LHD to produce the Lacistemataceae, *Lacistema* and *Lozania* distribution maps has been problematic. Herbaria have been pressurized into using automatic georeferencing software for their online catalogues and/or data submissions to GBIF. To remove this “dirty” data not retrieved directly from specimen labels from LHD three columns: latitude source, longitude source and altitude source were added. In addition, a fourth cultivated column is needed to remove material grown outside the normal species range so these records will be ignored.

Taking the GBIF Lacistemataceae dataset produced duplication of data located online tropicos catalogue from the Missouri Botanic Garden Herbaria and misalignment of data resulting in two plots for one specimen record. There was no time to dig deeper into the problem or produce a map as evidence. Yesson *et al.* (2007) analysed 630,871 GBIF legume data points for accuracy and sampling consistency. The results suggest 84% accuracy but GBIF lacks global data, for example data from Brazilian herbaria is not included. Accurate georeferencing of data is essential in light of OpenModeller (de Souza Munoz 2009) and the impact of

climate change on species distribution and extinction threat. All three maps required reconstruction (Yesson & Culham 2006).

Copyright legislation and the “publish or perish” scientific mentality are strangling the production of online e-monographs and other scientific databases. Books, journals and herbaria specimen records and images are rapidly shifting towards online catalogues not all of them are open access. Out of copyright does not happen until 75 years after the death of the author for published material and 31 December 2039 for unpublished material. BioMed Central: the open access publisher, leads the way towards the removal of commercial publishers owning the copyright to scientific written and peer reviewed material. Photocopying of “out of copyright” material at specialist scientific libraries requires the signing of a form that states the photocopied information cannot be passed onto another person. An email exchange with Ian Sainsbury, a copyright specialist at UoR suggests that this action is legal. Finally, the scientific community need to count online databases towards a scientist’s publication record. If the scientific community do not deal with these problems the wikis will continue to dominate the online database world.

This revision is based partially on the Sleumer (1980) but its usage was minimal to ensure that any earlier mistakes were not carried into the e-monograph and future publications. One major typification error that has been rectified is for *Lacistema myricoides*. Sleumer (1980) had designated the holotype as Swartz s.n., but in fact the earlier name *Piper aggregatum* already had a holotype of Rolander s.n. and this holotype has been assigned to *Lacistema myricoides*. A possible morphological error is that Sleumer (1980) states, “Inflorescences...numerous sessile flowers spirally arranged” in 900 herbaria specimens examined (but not measured) so far

only one specimen exhibits spirally arranged flowers. Further investigation of specimen morphology is required to confirm spirally inflorescence throughout the family.

The basis for nomenclature and typification in Sleumer (1980) was the 1978 Leningrad Code (ICBN 1978). This revision required consultation of the latest code, 2006 Vienna “Red” Code (ICBN 2006) to ensure changes over the last two decades had been incorporated correctly. Sleumer regularly uses the words: hololecotype and isolecotype on type specimen examined for the Flacourtiaceae monograph. These terms are no longer used and have been substituted by holotype or lectotype and isotype respectively on each of the species pages. The holotypes of *Lacistema grandifolium* Schnizl. (Poiteau anno 1814), *L. lucidum* Schnizl. (Sello numbers: “1”, “5”, “136”, “138”), *L. robustum* Schnizl. (Lhotzky anno 1831), *Monandrodendron klugii* Mansf. (Klug 1430), and *M. schultzei* Mansf. (Schultze 1462) were destroyed in the bombing of the Berlin herbarium. Lectotypes located at G and G-DC herbaria have been assigned to *L. grandifolium* and *L. robustum* respectively. It is unknown which of the Sello “1” and “228” isotype specimens should correctly be assigned to *L. lucidum* as these specimens have not been examined. An isotype held at F herbarium has been temporarily assigned as the lectotype of *M. klugii* although not on the website. This will not occur until the author feels competent to identify which of the four isotypes ought to be official declared the lectotype when compared to the protologue description. It is currently unknown if any isotypes exist for *M. schultzei*, therefore, no lectotype can be assigned.

Not all the types have been tracked to specific herbaria and research is ongoing for *Lacistema ellipticum* Glaz. (Glaziou 14279), *Lacistema polystachyum* Schnizl.

(Spruce 220) believed held at W, *Lozania grandiflora* Schult., *Monandrodendron schultzei* Mansf., and *Lozania nemoralis* DC.

Lozania grandiflora Schult., is of concern as no specimens from 4200 herbaria records have been located to date. Further investigation is required as to why this is the case but cannot be completed within the time span of this dissertation.

Only one herbarium was unwilling to speed up the LAPI digitization of their type specimens for the deadline of this dissertation. These types will be available online sometime in 2010. Not all types supposedly held by herbaria are stated in their online herbaria catalogues. These herbaria will be contacted by email after the dissertation deadline. For herbaria without online catalogues, emails were sent to curators in July and replies are awaited. The types believed held at IAN herbarium have not been located by the IAN curator. A CD-ROM of all herbaria specimen images to check this is indeed the case is currently in preparation. The data from these images will be added to LHD on their arrival.

As for the future, there are many gaps to fill on the e-monograph species pages. The species delimitation analysis is to be completed. Images of leaves, inflorescence and flowers for species comparison will be added as will an interactive multi-access species identification key. A visit to the Missouri Botanic Garden Herbarium, St. Louis, U.S.A. in January 2010 to examine the largest collection of *Lacistemataceae* specimens outside of the distribution range. It is hoped that leaf material can be taken for DNA sequencing and phytochemical analysis to create a phylogenetic tree. A fieldtrip to South America is in the initial planning stages to

discover the mechanisms of pollination, seed dispersal and other ecological information.

Lacistemataceae Holistic Database @ www.lacistemataceae.org is now linked to all the important players in the online community. You will find hyperlinks to the e-monograph on the Lacistemataceae page on Angiosperm Phylogeny Website, the species pages on the Encyclopedia of Life, the species names on the Species 2000 & ITIS Catalogue of Life Annual Checklist 2009 onwards. The website is number one on a Lacistemataceae Google search and the only reference on the Biology Browser database at www.Biologybrowser.com (Thomson Reuters 2005).

Considering the meagre budget of £500 this basal work towards expanding the knowledge on the systematics and ecology of Lacistemataceae as part of the much larger plans by the Convention on Biological Diversity Global Strategy for Plant Conservation is quite an achievement.

Conclusion

Introduced here to the scientific community is the electronic or e-monograph. The e-monograph is the newest member of the online biodiversity repositories working towards the 2010 deadline set by the Convention of Biological Diversity.

The Blackboard academic course module tool was used as a storage facility for working document, deadlines and expenditure. Both project supervisors could be kept apprised of the latest developments by sending announcements.

Lacistemataceae was selected from the 490 flowering plant families using the elimination criteria of project time constraint, existing online database, economic usage, completed molecular phylogeny, restricted distribution range, non-woody, non-Neotropical distribution.

The family revision formed the foundation for designing the Lacistemataceae Holistic Database (LHD) and construction of the e-monograph Lacistemataceae Holistic Database @ www.lacistemataceae.org.

At the first phase of development, this revision includes an analysis of monographic content and TDWG standards for species page construction on the e-monograph, a literature review on the nomenclature and types for all 69 species names. However, time constraint prevented the species delimitation morphological statistic analysis from being reported here.

The nomenclatural part of this revision has become part of the Global Species Databases (GSD) contributing towards the Species 2000 & ITIS Catalogue of Life Annual Checklist 2009.

The project budget was set at £500 due to limited finance. The expenditure totalled £375.87.

The website is now international recognized as links to www.lacistemataceae.org can be seen on the Angiosperm Phylogeny Website, the Catalogue of Life, the Encyclopedia of Life and is number one search result on Google.

Cited references

Angiosperm Phylogeny Group (2003) *An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II*, Botanical Journal of the Linnean Society, London, Vol. 141(4): 407, 419, 424, 431

Biodiversity Heritage Library Project (2005) *Biodiversity Heritage Library* available online at <http://www.biodiversitylibrary.org/>

Bisby F A, Roskov Y R, Orrell T M, Nicolson D, Paglinawan L E, Bailly N, Kirk P M, Bourgoin T, baillargeon G (eds.) (2009) *Species 2000 & ITIS Catalogue of Life: 2009 Annual Checklist*, Reading, U.K. available online at www.catalogueoflife.org/annual-check-list/2009/

Centre for Biological Information Technology (2009) *Lucid identification and diagnostic keys*, University of Queensland, Australia available online at www.lucidcentral.com

Chase M W, Zmarty S, Lledo M D, Wurdack K J, Swenson S M, Fay M F (2002) *When in doubt, put it in Flacourtiaceae: A molecular phylogenetic analysis based on plastid rbcL DNA sequences*, Kew Bulletin, Royal Botanic Gardens, Kew, Vol. 57(1): 141, 143, 150, 155-6, 162-3, 181

CITES Secretariat (1975) *Convention on International Trade in Endangered Species of Wild Fauna and Flora*, Geneva, Switzerland available online at <http://www.cites.org/>

Compton J A, Culham A, Jury S L (1998) *Reclassification of Actaea to include Cimicifuga and Souliea (Ranunculaceae): Phylogeny inferred from morphology, nrDNA ITS, and cpDNA trnL-F sequence variation*, Taxon, International Association for Plant Taxonomy, Vienna: 47(3): 593-634 (see CD appendices)

Convention on Biological Diversity (2002) *Global Strategy for Plant Conservation*, The Secretariat of the Convention on Biological Diversity, Montreal [accessed 23 July 2009 at <http://www.cbd.int/gspc/intro.shtml>]

CRIA (2005a onwards) *SpeciesLink*, Centro de Referencia em Informacao Ambiental, Fundacao de Amparo a Pesquisa do Estado de Sao Paulo, Brasil available online at <http://splink.cria.org.br/index?criaLANG=en>

CRIA (2005b) *Flora Brasiliensis*, Centro de Referencia em Informacao Ambiental, Fundacao de Amparo a Pesquisa do Estado de Sao Paulo, Brasil available online at <http://florabrasiliensis.cria.org.br/index>

Dallwitz M J (1980) *A general system for coding taxonomic descriptions*, Taxon, Vol. 29(1): 41-46

Dallwitz M J (2009) *DELTA – Description Language for Taxonomy* available online at <http://delta-intkey.com/>

de Souza Munoz M E, De Giovanni R, de Siqueira M F, Sutton T, Brewer P, Pereira R S, Lange Canhos D A, Canhos V P (2009) *openModeller: a generic approach to species' potential distribution modelling*, Geoinformatica, Springer Netherlands available online at

<http://d.yimg.com/kq/groups/21884461/1305611140/name/openModeller.pdf>

Encyclopedia of Life (2009) available online at www.eol.org

ESRI: Environmental Systems Research Institute, Inc. (1995) ARCGis software, Redlands, CA, USA available online at www.esri.com

GBIF (date unknown) Global Biodiversity Information Facility available online at <http://www.gbif.org/>

Global Pollen Database (2001 onwards) *Global Pollen Database*, WDC for Paleoclimatology, National Climatic Data Center, NC, USA available online at <http://www.ncdc.noaa.gov/paleo/pollen.html>

Health and Safety Executive (1992) The Health and Safety (Display Screen Equipment) Regulations 1992, Crown Copyright [accessed online 22:12 on 12 September 2009 at http://www.opsi.gov.uk/si/si1992/Uksi_19922792_en_1.htm#end]

Heywood V H, Brummitt R K, Culham A, Seberg O (2007) *Flowering plant families of the world*, Royal Botanic Gardens, Kew

ILDIS (1996 onwards) *International Legume Database and Information Service*, School of Biological Sciences, University of Southampton available online at www.ildis.org

Inside Wood (2004 onwards) available online at <http://bio.kuleuven.be/sys/iawa/>

International Code of Botanical Nomenclature (1978) *Leningrad "Red" Code*, Regnum Vegetabile 97, Bohn Scheltema & Holkema, Utrecht

International Code of Botanical Nomenclature (2006) *Vienna "Red" Code*, Regnum Vegetabile 146, A.R.G. Gantner Verlag KG., also available online at <http://ibot.sav.sk/icbn/main.htm>

International Plant Names Index (2004 onwards) available online at <http://www.ipni.org> [accessed 01:31 on 13 March 2008]

Kinman K (2008) *Family Lacistemataceae*, Taxacom email dated Jan 10, 2009 at 07:28:11 pm (see CD appendices)

Krouse S L, Irvine J H (2003) *Perceptual dyslexia: its effect on the militar cadre, and benefits of treatment* presentation available online at <http://www.internationalmta.org/2003/2003PowerPointFiles/A11-Krouse-Irlen%20Syndrome.ppt>

Lehnert W (2002) *The web wizard's guide to html*, Addison Wesley, Boston

Mabberley D J (2008) *Mabberley's Plant Book*, 3rd Edition, Cambridge University Press, Cambridge: 462, 504

Malhi Y, Phillips O L (2005) *Tropical forests and global atmospheric change*, Oxford University Press, Oxford

Nicholas D (2009) *Information seeking in cyberspace presentation*, CIBER research group, University College, London (see appendices for the presentation)

Okabe M, Ito K (2008) *Color Universal Design (CUD) – How to make figures and presentations that are friendly to Colorblind people* [accessed online at 17:53 on 6 December 2008 from <http://jfly.iam.u-tokyo.ac.jp/color/#pallet>] (also available on CD appendices)

Phillips O L and 65 others (2009) Drought sensitivity of the Amazon rainforest, *Science* Vol. 323: 1344-1347

Roberts D, Smith V S (2007) The EU project EDIT and building to community web servers, Zoology departmental presentation, Zoology Department, Natural History Museum, London (available online at <http://vsmith.info/files/2007.SmithScratchpadsZoo.ppt>)

Sleumer H O (1980) *Flora neotropica monograph number 22: Flacourtiaceae*, The New York Botanical Garden Press, New York: 182-206 (see CD appendices)

Thomson Reuters (2005) *Biology Browser: Life sciences information community* available online at www.biologybrowser.org

UKC (2008) *Web host provider for www.lacistemataceae.org*, online at <http://www.uk-cheapest.co.uk>

Vignes-Leebe R (2004 onwards) *Xper2*, Laboratoire d'Informatique et Systematique, Université Pierre et Marie Curie, Paris (available online at <http://lis-upmc.snv.jussieu.fr/lis/?q=en/resources/softwares/cai/xper2/downloads/last>)

W3C (1994 onwards) *World Wide Web Consortium*, Massachusetts Institute of Technology, European Research Consortium for Informatics and Mathematics, Keio University available online at www.w3c.org

Western Australian Herbarium (1998 onwards). *FloraBase: The Western Australian Flora*, Department of Environment and Conservation, available online at <http://florabase.dec.wa.gov.au/>

Wilson E O (2003) *The encyclopedia of life*, Trends in Ecology and Evolution, Elsevier B.V., Vol. 18(2): 77-80

Yesson C, Brewer P W, Sutton T, Caithness N, Pahwa J S, Burgess M, Gray W A, White R J, Jones A C, Bisby F A, Culham A (2007) *How global is the Global Biodiversity Information Facility?*, PLoS ONE available online at <http://www.plosone.org/article/info:doi/10.1371/journal.pone.0001124>

Yesson C, Culham A (2006) *A Phyloclimatic study of Cyclamen*, BMC Evolutionary Biology, Vol 6: 72 available online at <http://www.biomedcentral.com/1471-2148/6/72>

Website references

- Abbott B J, Hartwell J L, Leiter J, Spetzman L A, Schepartz S A (1967) *Screening data from the Cancer Chemotherapy National Service Centre Screening Laboratories, XLI, Plant Extracts*, Cancer Research, American Association for Cancer Research Inc., Philadelphia, Vol. 27(2): 508
- Agostini G (1972) Revaluacion de *Lozania pittieri* (Lacistemaceae), Pittieria, Herbario de la Facultad de Ciencias Forestales de la Universidad de Los Andes, Merida, Venezuela, No. 4: 43-47
- Agostini G (1973) *El genero Lozania Mutis (Lacistemaceae)* in Acta Botanica Venezuelica, Graficas Continente S.A., Caracas, Vol. 8(1-4): 167-175
- Andel T van (2001) *Floristic composition and diversity of mixed primary and secondary forests in northwest Guyana*, Biodiversity and Conservation, Springer, Netherlands, Vol. 10(10): 1673
- Angiosperm Phylogeny Group (2003) *An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II*, Botanical Journal of the Linnean Society, London, Vol. 141(4): 407, 419, 424, 431
- ASU International Institute for species exploration & Media Alchemy (date unknown) *Planet Bob*, Arizona State University available online at <http://planetbob.asu.edu/index.html>
- Baehni C (1940) *Les Lacistemacees des Andes et des regions avoisinantes* in Candollea: Organe du Conservatoire et du Jardin botaniques de la Ville de Geneve redige par B P G Hochreutiner, Directeur du Conservatoire et du Jardin, Edition, abonnement et vente conservatoire botanique, Geneve, Vol 8: 42-44, 46
- Baehni C (1941) *Lacistemaceae* in Flora of Peru, Field Museum of Natural History - Botanical Series, Field Museum Press, Chicago, Vol. 8, Part IV (1): 52-56
- Bennett B C, Baker M A, Andrade P G (2002) *Ethnobotany of the Shuar of Eastern Ecuador* in Advances in Economic Botany Vol. 14, The New York Botanical Garden Press, New York: 185
- Bentham G, Hooker J D (1880-83) *Genera plantarum ad exemplaria imprimis in herbariis kewensisbus servata definita*, Facsimile reprint 1965, Verlag von J. Cramer, Weinheim, Vol. 3(1): 412-413
- Bergio P J (1772) *Ternio graminum ex America novorum descripta & inconibus illustrata* in Acta Helvetica, Physico-Mathematico-Anatomico-Botanico-Medica figuris aeneis illustrata, et in Usus Publicos exarata, Typis & Sumptibus Joh. Rodolphi Im-Hof et Filii, Volumen 7: 131-132, table X
- Bessey C E (1915) *The phylogenetic taxonomy of flowering plants*, Annals of the Missouri Botanical Garden, Missouri Botanical Garden Press, Missouri, Vol. 2(1/2): 129

- Blake S F (1924) *New plants from Venezuela*, Contributions from the United States National Herbarium, Smithsonian Institution: United States National Museum, Vol. 20(13): 520
- Brummitt R K (1992) *Vascular plant families and genera*, The Board of Trustees of the Royal Botanic Gardens, Kew: 592-593
- Candolle A L P P de (1868) *Prodromus systematis naturalis regni vegetabilis sive enumeratio contracta ordinum, generum specierumque plantarum huc usque cognitarum, juxta methodi naturalis normas digesta*, Sumptibus Sociorum Treuttel et Wulrtz, Parisii, Vol. XVI, part 2: 590-595
- Chalk L (1937) *The phylogenetic value of certain anatomical features of dicotyledonous woods*, Annals of Botany, Oxford University Press, Vol. 1(3): 425
- Chase M W, Zmarty S, Lledo M D, Wurdack K J, Swenson S M, Fay M F (2002) *When in doubt, put it in Flacourtiaceae: A molecular phylogenetic analysis based on plastid rbcL DNA sequences*, Kew Bulletin, Royal Botanic Gardens, Kew, Vol. 57(1): 141, 143, 150, 155-6, 162-3, 181
- Chirtoiu M (1918) *Observations sur les Lacistema et la situation systematique de ce genre* in Bulletin de la Societe Botanique de Geneve, H. Georg & Co., Bale & Lyon, 2me serie, Volume X(7): 317-349
- Chodat R, Hassler E (1903) *Plantae Hasslerianae soit enumeration des plantes recoltees au Paraguay par le Dr. Emile Hassler, D'Aarau (Suisse) de 1885 a 1902* in Bulletin de L'Herbier Boissier sous la direction de G. Beauverd, Conservateur de l'Herbier, Imprimerie Romet, Geneve, Tome III (2me serie): 394
- Commission for the Geological Map of the World (2000) *Geological Map of the World 2nd edition*, Scale 1:25000000, CGMW & UNESCO, Paris
- Cronquist A (1968) *The evolution and classification of flowering plants*, Thomas Nelson and Sons Ltd., London: 367
- Cuatrecasas J (1950) *Contributions to the Flora of South America, Studies in South American Plants - II* in Fieldiana: Botany, Chicago Natural History Museum Press, Chicago, Vol. 27(1): 93-94
- Dahlgren R M T (1975) *A system of classification of angiosperms to be used to demonstrate the distribution of characters*, Botaniska Notiser, The Swedish Natural Science Research Council, Stockholm, Vol. 128(1): 129
- Daly D C (2004) *Lacistemataceae* in Smith N, Mori S A, Henderson A, Stevenson D W, Heald S V (Eds.), *Flowering plants of the Neotropics*, The New York Botanic Garden & Princeton University Press, New Jersey: 200-201
- Develey P F, Peres C A (2000) *Resource seasonality and the structure of mixed species bird flocks in a coastal Atlantic forest of southeastern Brazil*, Journal of Tropical Ecology, Cambridge University Press, Vol. 16(1): 50

- Dorr L J (1995) *Plant collecting along the Lower Orinoco, Venezuela: H. H. Rusby and R. W. Squires (1896)*, Brittonia, New York Botanical Garden Press, Vol. 47(1): 14
- Duchelle A E (2007) *Observations on Natural Resource use and Conservation by the Shuar in Ecuador's Cordillera del Condor*, Ethnobotany Research & Applications, Vol. 5: 12
- Duque A, Sanchez M, Cavelier J, Duivenvoorden J F (2002) *Different floristic patterns of woody understorey and canopy plants in Colombian Amazonia*, Journal of Tropical Ecology, Cambridge University Press, Cambridge, Vol. 18(4): 519
- Encyclopedia of Life (2007) *www.eol.org video trailer* available online at <http://www.youtube.com/watch?v=6NwfGA4cxJQ&feature=related>
- Endlicher S (1837) *Genera plantarum secundum ordines naturales disposita*, Fr. Beck Universitatis Bibliopolam, Vindobonae: 291
- Engler A (1964) *Syllabus der Pflanzenfamilien mit besonderer Berücksichtigung der Nutzpflanzen nebst einer Übersicht über die Florenreiche und Florengebiete der Erde*, Gebrüder Borntraeger, Berlin, Vol. II. Band Angiospermen: 325
- Engler A, Prantl K (1982) *Die natürlichen Pflanzenfamilien nebst ihren Gattungen und wichtigeren Arten insbesondere den Nutzpflanzen, bearbeitet unter Mitwirkung zahlreicher hervorragender Fachgelehrten*, Verlag von Wilhelm Engelmann, Leipzig, Vol. 7, III Teil, 1 Hälfte: 14-15
- Erdtman G (1952) *Pollen morphology and plant taxonomy: Angiosperms (an introduction to palynology. I)*, Almqvist & Wiksell, Uppsala: 112, 178-9
- Fawcett W, Rendle A B (1914) *Flora of Jamaica containing descriptions of the flowering plants known from the island*, The Trustees of the British Museum, Vol. III Dicotyledons, families Piperaceae to Connaraceae: 29-30
- Ferreira L V, Prance G T (1998) *Species richness and floristic composition in four hectares in the Jau National Park in upland forests in Central Amazonia*, Biodiversity and Conservation, Springer, Netherlands, Vol. 7(10): 1353
- Forest F, Chase M W (2009) *Eurosoid I*, in Hedges S B, Kumar S (Eds.) *The Timetree of Life*, Oxford University Press, New York: 189
- Gandoger M (1919) *Sertum plantarum novarum pars secunda*, Seance du 10 October 1919, Bulletin de la Societe Botanique de France, La Societe, Paris, Vol. 66: 288
- Gentry A H (1989) *New Species and a New Combination for Plants from Trans-Andean South America*, Annals of the Missouri Botanical Garden, Missouri Botanical Garden Press, Vol. 75(4): 1431-1433
- Glaziou A F M (1912) *Plantae Brasiliae centralis a Glaziou lectae, Liste des plantes du Bresil Central Recueillies en 1861-1895* in Memoires publies par La Societe Botanique de France, Tome Premier, Memoires Nos. I-VII (3g), Au Siege de la Societe, Paris: 648

Glick T F (1991) Science and Independence in Latin America (with special reference to New Granada) *The Hispanic American Historical Review*, Vol. 71(2): 307-334

Good R (1933) *A geographical survey of the flora of temperate South America*, *Annals of Botany*, Oxford University Press, Vol. 47(4): 699, 717

Grant B (2009) A Fading Field, *TheScientist.com* available online at <http://www.the-scientist.com/2009/06/1/32/1/>

Gunderson A (1950) *Family of dicotyledons*, *Chronica Botanica Company*, Waltham: 79-80

Heywood V H, Brummitt R K, Culham A, Seberg O (2007) *Flowering plant families of the world*, Royal Botanic Gardens, Kew: 178

Hohnwalk S, Rischkowsky B, Camarao A P, Schultze-Kraft R, Rodrigues Filho J A, King J M (2006) *Integrating cattle into the slash-and-burn cycle on smallholdings in the Eastern Amazon, using grass-capoeira or grass-legume pastures*, *Agriculture, Ecosystems and Environment*, Elsevier B.V., Amsterdam, Vol. 117 (4): 272

Holgate P (1966) *Bivariate generalizations of Neyman's Type A Distribution*, *Biometrika*, Biometrika Trust, London, Vol. 53(1/2): 243

Huber J (1909) *Materiaes para a Flora amazonica VII. Plantae Duckeanae austro-guyanenses, Enumeracao das plantas siphonogamas colleccionadas de 1902 a 1907 na Guyana brasileira pelo Sr. Adolpho Ducke e determinadas in Boletim do Museu Paraense de Historia Natural E Ethnographia, Estabelemento Graphico de C. Wiegandt, Brazil, Tomo 5, Fasciculos 2: 332*

Hutchinson J (1926) *The families of flowering plants 1. Dicotyledons arranged according to new system based on their probable phylogeny*, Macmillan and Co., Limited, London: 11, 108

International Plant Names Index (2008) available online at <http://www.ipni.org>

Ivanauskas N M, Monteiro R, Rodrigues R R (2003) *Alterations following a fire in a forest community of Alto Rio Xingu*, *Forest Ecology and Management*, Elsevier B.V., Amsterdam, Vol. 184(1-3): 246

Jang M, Pezzuto J M (1996) *Assessment of cyclooxygenase inhibitors using in vitro assay systems*, *Methods in Cell Science*, Springer, Netherlands, Vol. 19(1): 28

Jansen S, Broadley M R, Robbrecht E, Smets E (2002) *Aluminium Hyperaccumulation in Angiosperms: A Review of Its Phylogenetic Significance*, *Botanical Review*, Springer & New York Botanical Garden Press, Vol. 68(2): 245, 252-4

Kallersjo M, Farris J S, Chase M W, Bremer B, Fay M F, Humphries C J, Petersen G, Seberg O, Bremer K (1998) *Simultaneous parsimony jackknife analysis of 2538 rbcL DNA sequences reveals support for major clades of green plants, land plants, seed plants and flowering plants*, *Plant Systematics and Evolution*, Springer-Verlag, Austria, Vol. 213(3-4): 275, 282

Kuhlmann, J G (1940) *Especies Novas Equatoriais e Tropicais-Orientais Brasileiras* in Anais da Primeira Reuniao Sul-Americana de Botanica, Ministerio da Agricultura: Instituto de Biologia Vegetal Jardim Botânico, Rio de Janeiro, Vol. 3: 85-86, plate 14

Ledru M-P, Braga P I S, Soubies F, Fournier M, Martin L, Suguio K, Turcq B (1996) *The last 50,000 years in the Neotropics (Southern Brazil): evolution of vegetation and climate*, Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier B.V., Amsterdam, Vol. 123: 255

Lundell C L (1940) *Noteworthy spermatophytes from Mexico and Central America* in Phytologia, H A Gleason and H N Moldenke, The New York Botanical Garden, New York, Vol. 1(14): 451

Macbride J F (1934) *New or renamed spermatophytes mostly Peruvian* in Candollea: Organe du Conservatoire et du Jardin botaniques de la Ville de Geneve redige par B P G Hochreutiner, Directeur du Conservatoire et du Jardin, Edition, abonnement et vente conservatoire botanique, Geneve, Vol 5: 392-393

Maddison, D. R. and K.-S. Schulz (eds.) (2007) *Lacistemataceae*, The Tree of Life Web Project available online at <http://tolweb.org/Lacistemataceae>

Maguire B (1948) *Plant Explorations in Guiana in 1944, chiefly to the Tafelberg and the Kaieteur Plateau-III*, Bulletin of the Torrey Botanical Club, Torrey Botanical Society, Vol 75(3): 292-3

Mansfeld R (1929) *Monandrodendron nov. gen. Flacourt.*, in Notizblatt des Konigl. Botanischen Gartens und Museums zu Berlin-Dahlem, Botanischer Garten und Botanisches Museum, Berlin-Dahlem: Vol. 10, Nr. 98: 860-862

Mansfeld R (1931) *Die Gattung Monandrodendron* in Repertorium specierum novarum regni vegetabilis, Selbstverlag des Herausgebers, Dahlem bei Berlin: Vol. 30, Nr. 799/806: 178-9

Mansfeld R (1931) *Eine zweite Art der Gattung Monandrodendron* in Repertorium specierum novarum regni vegetabilis, Selbstverlag des Herausgebers, Dahlem bei Berlin: Vol. 29, Nr. 781/790: 177

Mansfeld R (1932) *Die Gattung Lozania Mutis*, Notizblatt des Konigl. botanischen Gartens und Museums zu Berlin, Botanischer Garten und Botanisches Museum, Berlin-Dahlem, Br. 11, Nr. 107: 592-7

Marquete R (2001) *Reserva ecologica do IBGE (Brasilia - DF): Flacourtiaceae*, Rodriguesia, Revista do Jardim Botânico, Rio de Janeiro, Vol. 52(80): 5-6, 12, 14

Martius K F P de (1826) *Nova genera et species plantarum quas in itinere per Brasiliam annis 1818-1820 jussu et auspiciis Maximiliani Josephi I. Bavariae regis augustissimi suscepto collegit et descripsit*, Monachii, Munchen, Vol. 1: 155, 156, plates 94, 95

Martius K F P von (1857) *Flora Brasiliensis, Enumeratio plantarum in Brasilia hactenus detectarum quas suis aliorumque botanicis studiis descriptas et methodo naturali digestas partim icone illustratas*, Monachii et Lipsiae (Munich & Leipzig), Vol. 4(1): columns 276-288, tables 77-81

Melo C, Oliveira P E (2009) *Frugivory in Lacistema hasslerianum Chodat (Lacistemaceae), a gallery forest understory treelet in Central Brazil*, Brazilian Journal of Biology, Instituto Internacional de Ecologica, Sao Carlos, Vol. 69(1): 201-207

Miquel F A G (1844) *Plantae Surinamenses Novae* in Schlechtendal D F L von, *Linnaea ein Journal fur die Botanik in ihrem ganzen Umfange, Oder Beitrage zur Pflanzenkunde*, C.A. Schwetschke und Sohn, Halle: Vol. 18: 24

Morales F, Fonseca R M (2002) *No. 11 Lacistemataceae* in Diego-Perez N, Fonseca R M (eds.) *Flora de Guerrero*, Facultad de Ciencias de la UNAM, Mexico City

Mutis S (1810) *Semanario del nuevo Reyno de Granada*, Santa De de Bogota

NASA: Earth Observatory (2008) *Deforestation in Mato Grosso, Brazil*, available online at <http://earthobservatory.nasa.gov/IOTD/view.php?id=35891>

Nebel G, Kvist L P, Vanclay J K, Christensen H, Freitas L, Ruiz J (2001) *Structure and floristic composition of flood plain forests in the Peruvian Amazon*, *Forest Ecology and Management*, Elsevier B.V., Amsterdam, Vol. 150(1-2): 39, 49

Paton A J, Brummitt N, Govaerts R, Harman K, Hinchcliffe S, Allkin B, Lughadha E N (2008) *Towards Target 1 of the Global Strategy for Plant Conservation: a working list of all known plant species - progress and prospects*, *Taxon*, International Association for Plant Taxonomy, Vienna, Vol. 57(2): E6

Persoon C H (1805) *Synopsis plantarum, seu enchiridium botanicum, complectens enumerationem systematicam specierum hucusque cognitarum*, Bibliopolas Treuttel et Wurtz et Tubingae/J.G. Cottam, Parisiis Lutetiorum, Pars Prima: 5

Persoon C H (1807) *Synopsis plantarum, seu enchiridium botanicum, complectens enumerationem systematicam specierum hucusque cognitarum*, Bibliopolas Treuttel et Wurtz et Tubingae/J.G. Cottam, Parisiis Lutetiorum, Pars Secunda: 577

Pulle A (1906) *An enumeration of the vascular plants known from Surinam, together with their distribution and synonymy*, E J Brill Ltd, Leiden: 146

Richard L C M (1792) *Catalogus plantarum ad societatem, ineunte Anno 1792, e Cayenna Missarum a Domino le Blond*, Actes de la Societe D'Historie Naturelle de Paris, Tome Premier, Premiere Partie, De l'Imprimerie de la Societe, Paris: 105

Riley L A M (1925) *Critical notes on Trinidad plants ("St. George" Pacific Expedition, 1924)*, *Bulletin of Miscellaneous Information (Royal Gardens, Kew)*, Vol. 1925(3): 142

Roosmalen, M G M van (1985) *Fruits of the Guianan flora*, Institute of Systematic Botany, Utrecht University and Silvicultural Department of Wageningen Agricultural University, Netherlands: 146-8

- Rudge E (1805) *Plantarum Guianae rariorum icones et descriptiones Hactenus Ineditae*, Sumptibus Auctoris, Typis Richardi Taylor et Soc., Londini, Volumen 1: 9 and table 4
- Ruiz H, Pavon J (1798) *Systema vegetabilium Florae Peruvianaee et Chilensis, characteres prodromi genericos differentiales, specierum omnium differentias, durationem, loca natalia, tempus florendi, nomina vernacula, vires et usus nonnullis illustrationibus interspersis complectens*, Typis Gabrielis de Sancha, Madrid, Vol. 1: 273
- Rusby H H (1906) *An enumeration of the plants collected in Bolivia by Miguel Bang, Part 4 with descriptions of new genera and species*, Bulletin of The New York Botanical Garden, New York Botanical Garden Press, New York: Vol. 4(14): 447
- Santos E (1969) *Lacistemaceae* in Flora Ecologica de Restingas do Sudeste do Brasil, Universidade Federal do Rio de Janeiro Museu Nacional, Rio de Janeiro, Vol. 13
- Savolinen V, Fay M F, Albach D C, Backlund A, Bank M van der, Cameron K M, Johnson S A, Lledo M D, Pintaud J-C, Powell M, Sheahan M C, Soltis D E, Soltis P S, Weston P, Whitten W M, Wurdack K J, Chase M W (2000) *Phylogeny of the Eudicots: a nearly complete familial analysis based on rbcL gene sequences*, Kew Bulletin, Royal Botanic Gardens, Kew, Vol. 55(2): 266-7, 301
- Schultes J A (1822) *Mantissa in volumen primum systematis vegetabilium Caroli a Linne ex editione* Joan. Jac. Roemer M.D. etc. et Jos. Aug. Schultes M.D. etc. curante I.A. Schultes, M.D. et Prop.p.o., Stuttgartiae: sumtibus J.G. Cottae: 3, 66, 369
- Schultes J A (1827) *Mantissa in volumen tertium systematis vegetabilium caroli a Linne ex editione Additamentum II, ad Manissam I Classis*, Jos. Aug. Schultes M.D. et Prof. et Jul... Herm. Schultes M. et Ch. D., Stuttgartiae, sumtibus J.G. Cottae: 109
- Secretariat of the Convention on Biological Diversity (1993) *Text of the Convention on Biological Diversity*, United Nations- Treaty Series, New York: Vol. 1760, A-30619 available online at <http://www.cbd.int/convention/convention.shtml>
- Secretariat of the Convention on Biological Diversity (2002) *Global Strategy for Plant Conservation* available online at <http://www.cbd.int/gspc/>
- Sherman P M (2002) *Effects of land crabs on seedling densities and distributions in a mainland neotropical rain forest*, Journal of Tropical Ecology, Cambridge University Press, Cambridge, Vol. 18(1): 72
- Sleumer H O (1953) *Las Flacourtiaceas Argentinas* in Lilloa revista de Botanica, Universidad Nacional de Tucuman, Tucuman, Republica Argentina, Vol. 26: 26-28
- Sleumer H O (1980) Flora Neotropica: Monograph Number 22 - Flacourtiaceae, The New York Botanical Garden, New York: 182-206

Smith L B (1935) *Taxonomic notes on American phanerogams - II*, H.A. Gleason and Harold N. Moldenke, The New York Botanical Garden, New York, Vol. 1(3): 138-9

Sommer R, Abreu Sa T D de, Vielhauer K, Araujo A C de, Holster H, Vlek P L G (2002) *Transpiration and canopy conductance of secondary vegetation in the eastern Amazon*, Agricultural and Forest Meteorology, Elsevier B.V., Amsterdam, Vol. 112(2): 106

Sprengel C P J (1822) *Species plantarum minus cognitae, I. Eigene Abhandlungen und Auszuge, Fam. 6 (Anleit. zur Kenntn. der Gew. 2te Aufl.), XXXIII Amentaceae* in Neue Entdeckungen im ganzen Umfang der Pflanzenkunde, Friedrich Fleischer, Leipzig, Dritter Band: 20-21

Sprengel K P J (1824) *Caroli Linnaei Systema Vegetabilium editio decima sexta*, Sumtibus Librariae Dieterichianae, Gottingae, Volumen 1, Classis 2: 94, 124

Standley P C (1927) *New plants from Central America - VI*, Journal of the Washington Academy of Sciences, Washington Academy of Sciences, Vol. 17(1): 8

Standley P C (1937) *Flora of Costa Rica part II*, Field Museum of Natural History, Botanical Series, Field Museum Press, Chicago, Vol 18(2): 633, 722

Stearn W T, Williams L H J (1957) *Martin's French Guiana plants and Rudge's "Plantarum Guianae rariorum Icones"*, Bulletin du Jardin botanique de l'Etat a Bruxelles, National Botanic Garden of Belgium, Vol. 27(2): 250, 265

Stevens P F (2001 onwards) *Malpighiales phylogeny*, Angiosperm Phylogeny Website available online at <http://www.mobot.org/MOBOT/research/APweb/trees/malpighialesnotl.gif>

Svenning J-C, Engelbrecht B M J, Kinner D A, Kursar T A, Stallard R F, Wright S J (2006) *The relative roles of environment, history and local dispersal in controlling the distributions of common tree and shrub species in a tropical forest landscape, Panama*, Journal of Tropical Ecology, Cambridge University Press, Cambridge, Vol. 22(5): 580-582

Swartz O (1788) *Nova Genera & Species Plantarum seu Prodromus descriptionum vegetabilium, maximam partem incognitorum quae sub itinere in Indiam Occidentalem annis 1783-87*, Holmiae, Upsaliae and Aboae, Bibliopoliis Acad. M. Swederi: 1, 12

Takhtajan A (1959) *Die Evolution der Angiospermen*, Veb Gustav Fischer Verlag, Jena: 202

The Stationery Office Limited (2008) *Systematics and Taxonomy: Follow Up*, House of Lords Science and Technology Committee, HL Paper 162 available online at <http://www.publications.parliament.uk/pa/ld200708/ldselect/ldsctech/162/162.pdf>

Toriola D, Chareyre P, Buttler A (1998) *Distribution of primary forest plant species in a 19-year old secondary forest in French Guiana*, Journal of Tropical Ecology, Cambridge University Press, Vol. 14(3): 339

Torres R B (1997) *Lacistemaceae* in Melo, M M R Fuiza de *et al.* (eds.), *Flora Fanerogamica de Ilha do Cardoso* (Sao Paulo, Brasil), Instituto de Botanica, Sao Paulo: 105-107

Tyree M T, Yang S, Cruiziat P, Sinclair B (1994) *Novel methods of measuring hydraulic conductivity of tree root systems and interpretation using AMAIZED*, *Plant Physiology*, Dartmouth Journal Services, Waterbury, Vol. 104(1): 189-190

Valio I F M (2003) *Seedling growth of understorey species of the Southeast Brazilian tropical forest*, *Brazilian Archives of Biology and Technology*, Brazil: Vol. 46(4): 698-700

Vasconcelos S S, Zarin D J, Araujo M M, Rangel-Vasconcelos L G T, Carvalho C J R de, Staudhammer C L, Assis Oliveira F de (2008) *Effects of seasonality, litter removal and dry-season irrigation on litterfall quantity and quality in eastern Amazonian forest regrowth, Brazil*, *Journal of Tropical Ecology*, Cambridge University Press, Cambridge, Vol. 24(1): 28

Willdenow C L von (1805) *Caroli a Linne Species plantarum exhibente plantas rite cognitatas ad genera relatas cum differentiis specificis, nominibus trivialibus synonymis selectis, locis natalibus secundum systema sexuale digestas*, editio quarta, Berolini, Berlin: Vol. 4, part 2: 971

Appendices

The appendices are located on the DVD-ROM inside the back cover of this dissertation.

Each of the appendices has been named to co-inside with the content headings, making it easier to locate each specific appendix reference. Not all material within each appendix has been quoted within this report but for completeness it was decided to keep all relevant material together.

In addition, other research material has been added as a backup for future research and they are:

- *images from external sources*: Alex Popovkin “a Russian in Brasil” these have been downloaded from Alex’s flickr page after he contacted me directly. Modesto Zarate is currently tree surveying for Faculty Escuela Ciencias Forestales, University of San Simon, Bolivia. Modesto sent me these images of *Lacistema nena* located within the survey area;
- *IUCN Red List Preliminary assessment*: This research was carried out for the Biodiversity assessment and sustainable plant use MSc. 2009 module (PSMB5B) taught by Emeritus Profs. V Heywood and G Prance and Prof. F Bisby;
- *MSc. seminars*: includes both Lacistemataceae presentations;
- *Research papers*: There are 37 additional papers to be added to the website literature list but the deadline prevented this work from being completed.