

# Appendix 10

(N.B. the internet version can be accessed at  
<http://icrafnt2/cfdocs/examples/treesd/LeuCat/main.HTM>)

## The World *Leucaena* Catalogue

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**List of Acronyms**

**ACIAR:** Australian Centre for International Agricultural Research

**ATFGRC:** Australian Tropical Forages Genetic Resource Centre (a unit of CSIRO Tropical Agriculture)

**CIAT:** Centro Internacional de Agricultura Tropical

**CSIRO:** Commonwealth Scientific and Industrial Research Organization

**IPGRI:** International Plant Genetic Resources Institute

**ILRI:** International Livestock Resources Institute

**OFI:** The Oxford Forestry Institute

**UH:** The University of Hawaii

## The World *Leucaena* Catalogue

### Introduction

The genus *Leucaena* (largely native to Mexico and central America), has attracted widespread attention for its usefulness as a multipurpose plant throughout the tropics and subtropics. The most widely grown species (*L. leucocephala*) has spread throughout the tropical world, being a valuable source of fodder and fuel. In the past two decades, there has been increasing interest in the other species in the genus.

The compilation of a World *Leucaena* Catalogue was agreed to be a high priority at an International Workshop held in Bogor, Indonesia, in January 1994. The proceedings of this workshop have been published as ACIAR Proceedings No. 57 (Shelton *et al.* 1995). Financial support for the compilation, production and distribution of the catalogue were provided through ACIAR Project No. 9433 and the UK Department for International Development. Much of the text/discussion in Sections 2 and 3 below is based on the paper by Hughes *et al.* (1995).

### 1. Background/Objectives

Three major germplasm collections of *Leucaena* species have been assembled by CSIRO (Australia), the University of Hawaii (USA) and the Oxford Forestry Institute (UK). As well as these three major collections there are a number of national *Leucaena* germplasm collections, which have often been largely derived from the three major collections. The two most significant of these are held at CIAT (Colombia), and at ILRI (Ethiopia). Each of these collections has been assembled with distinct objectives, philosophies, and procedures and are considered in more detail in Section 2 below. All five collections maintain computerised databases, with their own individual numbering systems, but up until now there has been no single integrated cross-referenced database of these major collections. Because *Leucaena* germplasm has been widely and freely exchanged throughout the world, and also because of the non-standard recording of passport data, it has not been possible before now to compare the holdings in different collections, and thus to assess accurately the extent to which duplication between collections might have occurred (see Section 8), nor to determine readily the full range of collection sites that have been sampled.

The objectives in compiling this catalogue have been:

1. To provide an easy to use database of the main *ex situ* collections of *Leucaena* seed.
2. To collate, and standardise as far as possible, passport data from the various collections, and thus allow detailed study and/or comparison of the various accessions.
3. To standardise the species nomenclature across the various collections.

### 2. The collections

### *University of Hawaii*

In 1962, the University of Hawaii (UH) started assembling their first germplasm collection of leucaena, initially based on miscellaneous seed lots acquired world-wide from the various non-native sources where leucaena was cultivated. Early collections were dominated by the one species of greatest interest at that time, *L. leucocephala*, and by seed from non-native sources. Organised efforts to explore and collect seed from the natural populations of leucaena began in 1967 when Dr J. Brewbaker led a UH team to Mexico and other countries in Latin America. For the first time this collection gathered a range of *Leucaena* species other than *L. leucocephala*. Germplasm collections by UH researchers, led by Dr. Brewbaker, continued intermittently over the next 20 years. Major expeditions in 1977, 1978, 1985 and 1988 sampled natural populations throughout Mexico and Central America (Brewbaker and Sorensson 1994). By 1988 a large collection - almost 1000 accessions, representing most taxa - had been assembled and grown in Hawaii. It was still dominated by *L. leucocephala* which accounted for 541 out of 967 accessions. Seedlots are documented with basic data held on a spreadsheet database using the 'K' number series. There are 964 entries from this collection listed in the catalogue.

### *CSIRO*

Between the mid 1950s and the mid 1970s CSIRO assembled a largely opportunistic collection of 200 accessions, mainly *L. leucocephala*, from non-native sources. In the late 1970s and early 1980s, extensive targeted collections were made, principally in Mexico, by R. Reid (working with S. Zárate). These collections were mainly of species other than *L. leucocephala*. Passport data for the collections are documented mainly under the 'CPI' (Commonwealth Plant Introduction) numbering system, although other prefixes such as CQ and, lately, ATF also occur. The data are stored as part of the overall tropical forages database maintained by the Australian Tropical Forages Genetic Resource Centre in a UNIX-based data management system. The catalogue contains 558 entries from the ATFGRC collection.

### *Oxford Forestry Institute*

In the mid 1980s, OFI started to assemble a new *Leucaena* seed collection, for two reasons. Firstly, several little known and potentially valuable species had been discovered in Guatemala and Honduras, having been overlooked by previous collecting expeditions. Secondly, OFI realised that several of these species were already severely degraded and under threat of substantial genetic erosion or even extinction. The main objective of the OFI collection program was to assemble all *Leucaena* species, but to concentrate on the lesser-known species. From 1984 to 1992, a series of annual expeditions to Mexico and Central America made collections in collaboration with the Forest Authorities and tree seed banks in the regions. Identities were verified from voucher specimens deposited in major herbaria in Mexico, USA and Europe. Passport data are stored in a dedicated database system SISTEM+. OFI has contributed 248 entries to the catalogue. These correspond mainly to bulk 'provenance' seed collections. Associated data on the more than 1000 individual tree half-sib seedlots (see Section 3 below) are available in the OFI database.

### *Centro Internacional de Agricultura Tropical*

Although some of the CIAT collection is derived from accessions obtained from the UH and ATFGRC collections, a significant contribution has also been made through field collection, mainly by R. Schultze-Kraft, in Mexico and Colombia. There are 216 entries from CIAT in the catalogue.

### *International Livestock Research Institute*

Most of the ILRI collection has been obtained from the three main collections. However, collections of *L. leucocephala* by J. Lazier and J. Keoghan (mainly from Belize) also feature prominently. The ILRI collection has 174 entries in the catalogue.

### **3. Seed collection strategies**

The international *Leucaena* germplasm collections have used different sampling (i.e. collecting) strategies because the collectors have had radically different objectives. Methods of collecting agricultural crop germplasm are not the same as methods of collecting germplasm for forest tree improvement.

The UH and CSIRO collections were made essentially as for any crop germplasm. The collection expeditions were relatively short, they sampled widely across localities, and included small but variable numbers of parent trees. The resulting seedlots were termed 'accessions'. An accession can thus be progeny from a single parent tree or from several trees, but rarely includes more than 10 parents. Seed from individual trees generally cannot be identified. This approach makes little attempt to select particular trees within natural populations, and does not assemble representative population samples, but it allows cost-effective sampling of as many sites as possible by sampling in relation to soil changes and microclimate. Arboretum-style trials (sometimes unreplicated) were used for initial screening of the many accessions collected. Further evaluation and breeding then relies on seed increase from superior accessions.

In contrast, forest tree improvement programs (on which the OFI collections are based) are largely directed to out-crossing species. They follow highly-structured sampling strategies and collect seed from natural populations. During the longer seed collection expeditions, often extending over a number of years, large numbers of parent trees are sampled across large populations, avoiding neighbouring trees. These collections, termed 'provenances', usually include a minimum of 25 parent trees, and often up to 50-60, and are expected to be genetically diverse and amenable to subsequent selection and breeding. The seed source can be identified and provenance variation can be used as a starting point in any improvement program. In many cases, individual tree seedlots are also collected at the same time. Such an approach, with maintenance of family identity, allows family-based half-sib progeny trials (out-crossing species) to be established. It aims to maintain a much stricter level of control over pedigree and a much broader genetic base within provenances.

### **4. The genetic resource**

The entries in this catalogue have been entered according to the latest taxonomic revision of the genus, proposed by Dr Colin Hughes of OFI (Hughes 1997a, 1998). These publications provide full nomenclature, descriptions and synonymy, but a "layman's guide" also provides a simpler treatment and species descriptions (Hughes 1997b).

All the species of *Leucaena* are listed below in alphabetical order, together with some of their commoner, most-recently used synonyms, and some of their characteristics. These

descriptions have been based on the references above, and also on Hughes (1993), which includes much information on attributes, natural distribution and tree characteristics. Maps (provided by Dr Colin Hughes) showing the natural distribution of these species, based on the collecting locations of 2393 herbarium specimens, are included in Appendix 1.

**4.1** *L. collinsii*: An important species of the seasonally dry tropical inland valleys of southern Mexico (Chiapas) and Guatemala; superior wood quality; has been subdivided into subsp. *collinsii* (restricted to Chiapas) and subsp. *zacapana* (restricted to Rio Motagua valley, Guatemala).

**4.2** *L. confertiflora*: occurs at highest elevation of any *Leucaena* species (2500m in Central Mexico); has been subdivided into var. *confertiflora* and var. *adenotheleidea*.

**4.3** *L. cuspidata*: a poorly known species, from cold and dry areas of the Sierra Madre Oriental in Mexico.

**4.4** *L. diversifolia*: (syn. *L. diversifolia* 4x, *L. diversifolia* subsp. *diversifolia* i.e the so-called tetraploid diversifolias); distributed along a narrow belt at mid elevations from Hidalgo in Mexico south to northern Guatemala; potential both for direct use and hybridisation (growth, tree form, acid tolerance, psyllid resistance).

**4.5** *L. esculenta*: widely cultivated throughout the highlands of Mexico for its edible pods; moderate cold tolerance and high psyllid resistance.

**4.6** *L. greggii*: one of the most northerly and cold tolerant species; small size, slow growing.

**4.7** *L. involucrata*: rare species restricted to the mountains of the north-west Mexican states of Sonora and northern Sinaloa.

**4.8** *L. lanceolata*: large leaflets; wide distribution throughout the dry deciduous tropical forest formation in Mexico; has been subdivided into var. *lanceolata* and var. *sousae* on the basis of leaflet size and pubescence of pods and leaves.

**4.9** *L. lempirana*: a newly-described species, restricted to two areas in the Department of Yoro in Honduras.

**4.10** *L. leucocephala*: (syn. *L. glauca*, *L. latisiliqua*); the best known and most widely cultivated species of *Leucaena*; has been subdivided into three subspecies: subsp. *leucocephala* represents the common shrubby type; subsp. *glabrata* is more arborescent, and has been the focus of much recent work; subsp. *ixtahuacana* is a new, poorly known subspecies restricted to a small area near the Mexico-Guatemala border.

**4.11** *L. macrophylla*: a large-leaflet species, extending from sea-level to the mid-elevations of central Mexico; has been subdivided into subsp. *macrophylla*, with a distribution as described above, and subsp. *istmensis*, which is a lowland subspecies, essentially restricted to Oaxaca and southern Veracruz.

**4.12** *L. magnifica*: previously recognised as a subspecies of *L. shannonii*; distribution restricted to the Department of Chiquimula in south-east Guatemala.

**4.13** *L. matudae*: previously *L. esculenta* subsp. *matudae*; distribution restricted to part of the Rio Balsas depression in Guerrero, Mexico.

**4.14** *L. multicapitula*: large-leaflet species that grows in wet tropical lowland forest; occurs in Nicaragua, Costa Rica, and Panama.

**4.15** *L. pallida*: (syn. *L. oaxacana*, *L. paniculata*); combines moderate to high psyllid resistance and cold tolerance; distributed mainly in the mid interior highlands of south-central Mexico.

**4.16** *L. pueblana*: little known small tree from the arid Tehuacan Valley of southern Puebla and northern Oaxaca in Mexico.

**4.17** *L. pulverulenta*: common in parts of north-east Mexico, and also extending north into Texas; a source of high quality firewood and small timber.

**4.18** *L. retusa*: most northerly species of *Leucaena*; small, slow-growing with yellow flowers.

**4.19** *L. salvadorensis*: a little-known species from El Salvador, Honduras, and Nicaragua; wood is highly valued for house construction.

**4.20** *L. shannonii*: occurs widely in dry deciduous tropical forest, in disjunct distribution from southern Mexico to south-central Nicaragua; generally small and slow growing.

**4.21** *L. trichandra*: (syn. *L. diversifolia* subsp. *trichandra*, *L. diversifolia* 2x, *L. revoluta*, *L. standleyi*, *L. stenocarpa*: i.e. all the “diploid” *diversifolia*s); the most widely distributed species of *Leucaena* (after *L. leucocephala*), occurring from northern Nicaragua to as far north as Durango in Mexico.

**4.22** *L. trichodes*: (syn. *L. pseudotrichodes*); large leaflet species, occurring in South America, as far south as 15°S in Peru.

**4.23** *L. xmixtec*: the sterile triploid hybrid between *L. leucocephala* subsp. *glabrata* and *L. esculenta*; occurs frequently but sporadically in six states in south-central Mexico. (Note that there are no entries for this species in this catalogue. It is included in this list only for completeness).

**4.24** *L. xspontanea*: the hybrid between *L. leucocephala* subsp. *glabrata* and *L. diversifolia*; found in six widely scattered countries, reflecting its spontaneous origin following wide introduction and cultivation of the parent species.

## 5. Structure of the catalogue

The catalogue has been assembled from data files provided by institutions holding the five major collections listed above. Because each collection has a different system of recording passport data, and some collections maintain more comprehensive records than others, it has been necessary to make extensive compromises on which data are included in the catalogue.

Data in 24 fields (see Section 6 below) have been combined for a total of 2160 entries in an Excel Spreadsheet (Microsoft Excel 5.0, running under Windows 3.11). This file (LEUCCAT1.XLS) is on the accompanying disk this publication. Some suggestions for using the catalogue are given in Section 7. The version of the catalogue on the disk has been sorted alphabetically by species, subspecies and home collection.

## 6. Database fields

This section details the fields contained in the database, and what is included in them. The fields chosen were necessarily a compromise, but are intended to provide the maximum amount of information commensurate with the chosen file structure. With few exceptions, they include exactly what was provided in the files from the five collections, put into standardised formats. Because not all collections treat similar information in identical ways, it may be necessary to search a number of fields to find what you are looking for. It was not practicable to include all the detail contained in the original databases, and if the information you are looking for is not in this spreadsheet, you should consult the appropriate institution for the original files. Although there may appear to be significant gaps in many of the fields listed below, it must be stressed that this catalogue can only present the data that was supplied, and at the same degree of accuracy.

**Field A. Entry.** This number (from 1 to 2160) identifies the “primary” position of any entry in the catalogue, sorted by species. This field may be used for returning the catalogue to its original state (order) should you have sorted it on any other field, or for identifying any particular entry. The number of entries from each of the five collections is: CIAT 216, CSIRO 558, ILRI 174, OFI 248 and UH 964.

**Fields B and C. Species and subspecies/variety.** The taxonomy adopted in this catalogue is that proposed by Hughes (1997a, 1998). The complete list of species and subspecies, together with some synonyms, is given above in Section 4. Entries were assigned to species based on the species name under which they were currently listed (see Fields E and F), details on collection location, and any available morphological data. There are a number of cases where information was insufficient to reach a decision (e.g. species held as *L. diversifolia*, but with no indication as to whether they might reasonably be *L. trichandra* (2n) or *L. diversifolia* (4n)), or where the species is unidentified. These entries have been listed as “?”. Where appropriate, the subspecies or variety (in the strict botanical sense) is given in Field C.

**Field D. Home.** This field identifies which of the five collections holds the entry. The abbreviations for the home collections are self-evident. Contact names and addresses for inquiries regarding the five collections are given in Section 11.

**Field E and F. Held as and subspecies/variety.** These are the species designations under which entries were held in the five collections in early 1997. To maintain the integrity of the records from the original collections, any spelling mistakes have not been corrected. Some entries have “?” appended.

**Field G. ID.** This is the identifier under which an entry is held in its “home” collection.

**Field H. *Other Number*.** This field contains *all* the other identifying numbers contained in the original databases. Of the 2160 entries, 1679 have at least one “Other number” listed. These numbers can include identifying numbers from other collections, collecting numbers, or any one of a large variety of other types of numbers! The same number may occur in different format in different collections (e.g. 78-77 and 7877) and no attempt has been made to standardise these. There may also be relevant data in the “Comments” field.

**Field I. *Duplicate*.** An entry in this field indicates that this accession is also held in another collection(s). The collections in which it is held are given, although there is no indication of which is the “primary donor” collection.

**Field J. *Source Country*.** Because of the common practice of obtaining seed from other collections, it is useful to have a record of where an entry came from, even if nothing is known of its real origin. The *Source* field usually records the country from which an entry was supplied to a particular collection, as opposed to where it was actually collected. However, in some cases it contains the country in which the accession was collected, which is usually given in Field 11. The country codes have all been standardised where possible to the IPGRI list of country abbreviations (Anon 1982). (There are data available for 1025 of the 2160 entries).

**Field K. *Country Collected*.** This field lists the country, again in standardised abbreviated form, where an entry was collected. In some cases it is the same as the source country (Field J). Data are available for 1807 of 2160 entries. The most common country is Mexico (1115 entries) followed by Guatemala (119), Colombia (81), USA (68), Honduras (59), and El Salvador (53).

**Fields L and M. *Province* and *Site*.** These fields give more detail for the collecting location. For Mexican locations, the names of States have been reduced to acronyms of two or three letters, which are self-evident (e.g. OAX = Oaxaca). No attempt has been made to correct what might appear to be inconsistencies in spelling. (Data available for 1539 and 806 of 2160 entries). There is some inconsistency in how different collections treat the Country-Province-Site hierarchy, with “Site” in some being equivalent to “Province” in others.

**Fields N and O. *Latitude* and *Longitude*** (recorded in degrees and minutes). These fields provide standardised data for the collecting locations. (Data available for 1224 and 1175 respectively of 2160 entries).

**Field P. *Altitude*.** Recorded in metres. (Data available for 1243 of 2160 entries).

**Field Q. *Rainfall*.** Recorded in millimetres. (Data available for 252 of 2160 entries).

**Field R. *Stand type*.** Records details of the nature of stand where seed collection was made. The six categories are: controlled cross, cultivated indigenous (guajal), natural population, plantation (exotic or native range) and seed orchard. There may be further detail in the “Comments” field. It is worth remembering that most collections other than those made by OFI were mainly from single trees, or at best a small number. (Data available for 248 of 2160 entries).

**Field S. Date.** This is the year of collection or acquisition. (Data available for 1463 of 2160 entries).

**Field T. Collector.** This lists the person(s) or institution making the original collection. While names are generally given, sometimes only initials or acronyms were provided in the original data files. (Data available for 1497 of 2160 entries).

**Field U. Supplier.** Where an entry has been obtained from another collection (as opposed to collected) the supplier (person or institution) is given, where available. (Data available for 897 of 2160 entries).

**Fields V and W. Voucher and Herbarium.** Some entries are referenced by voucher botanical specimens. The herbaria holding the specimens are listed by their standard Index Herbariorum abbreviations, except in the case of the less formal herbaria at CSIRO Townsville (DAVIES) and ILRI (ILRI). (Data available for 154 and 347 of 2160 entries). OFI maintains a database of the herbarium specimen *Leucaena* holdings of 22 major world herbaria.

**Field X. Comments.** Includes Notes and Comments as supplied. (Data available for 367 of 2160 entries).

## 7. How to use the catalogue

The catalogue has been supplied as an Excel (V5.0) spreadsheet, as this software is widely used, and provides good search facilities. However, should you wish to search and/or manipulate the data using other software packages you are of course at liberty to do so. There should be no problems in importing the Excel spreadsheet into other modern database or spreadsheet packages. The comments below refer specifically to Excel version 5.0, and may differ from what is available on other software, or from what is appropriate for other versions of Excel. It is assumed that any user has a basic knowledge of Excel. **Before you perform any searching or sorting operation on the catalogue, it would be wise to make a copy from which to work, in case something goes wrong!**

There is no attempt in this text to make a detailed study of the catalogue, with the exception of an assessment of the extent of duplication that exists. Each user of the catalogue will probably have different requirements; the usefulness of the data is limited only by the imagination of the user!

The *Field widths* in the catalogue have been set to various sizes which are a compromise between displaying the full name and/or content of the field and displaying a reasonable number of fields on any one screen. In Excel, an entry that is too large for the cell it is in will spill over into the cell to the right, if that cell is unoccupied. Should you want to see the complete contents of any cell, double click the left mouse button. If you want to change the field widths, do so! A field may of course be hidden using Format/Column/Hide if you don't want to see it.

*Searching:* Excel has a powerful search facility, accessible as Data/Filter/AutoFilter. This enables, for any particular field, the selection of any particular category as displayed, or the

opportunity for a more flexible customised search. It is possible to combine search criteria over any number of fields. An example of this is given below. Those familiar with search techniques should skip this example!

**Example 1:** Suppose you want to **display all entries in the database that are held by OFI, that were collected in Honduras after 1990**. This is one way of doing it, starting from the spreadsheet as supplied.

1. Using the mouse, select *Data/Filter/Autofilter*. You should now see arrows at the top of every column.
2. Move to the “Home” field (column F). Click on the arrow to display the available alternatives. Click on OFI. All the entries held by OFI will be displayed. There should be 248.
3. Move to the “Country Collected” field (column L). If you click on the arrow here, you get a large number of choices. You can either scroll down the list until you come to “HND” and click on that, or it is probably quicker to click on “Custom”. You can then select “=”, enter HND in the box, and click OK, to produce the same result. The 15 entries held by OFI that were collected in Honduras should now be displayed.
4. Move to the “Date” field (column T). Click on the arrow, and select “Custom”. Enter “>” (meaning “greater than “ or “after”) and enter 1990 in the Box. Click OK. You should now have 5 entries displayed that meet the search criteria above.
5. To get the full data set back in view, select *Data/Filter/Show All*.

There may be other ways of doing the search, and if you have a version of Excel other than 5.0 you may need to do it differently.

It is also possible to use the Edit/Find facility to locate a particular character string, but this will not display all the “hits” at once. You can select a particular field (column) to search, or select the whole sheet to access **all** fields (such as “Comments”) to locate information contained therein.

If you are searching for a particular character string, it may be wise to include “wildcard” characters in your search criteria, both for Data/Filter and for Edit/Find. Thus if you wanted to know where K636 was held, one way would be to search the “Other number” field for “\*K636\*”. (The asterisks indicate any character/s before or after K636). It is necessary to use these wildcards as this would then detect any occurrences of K636 that might have quotation marks, or other prefixes or suffixes. The same principles also apply to searching other fields.

*Sorting:* Excel also provides a fast sorting facility to enable you to display the catalogue in any way you choose. Entries can be sorted on up to three fields sequentially. As supplied on the disk, the entries have been sorted by *Species*, *Subspecies*, and *Home*. A simple example of sorting is given below. Skip it if you don’t need it.

**Example 2.** Suppose you want information on **which entries in the database have come from high latitudes (i.e. further away from the equator)**. You could of course use the Filter facility, setting some lower limit, but you can also sort the entries so you can see all the entries that have Latitude recorded.

1. Using the mouse select *Data/Sort*.
2. Click on the arrow in the top panel to select “Latitude”. Select “Descending” if you want to see highest ones first.

3. Select “None” in the lower two panels. (You can of course do more complex sorts using these as additional sort categories).

4. Select OK.

Your data should now be sorted, with those entries from highest latitudes at the top of the list. Again, if you have a version of Excel other than 5.0 you may need to do it differently.

## 8. Duplication

Although the collection has 2160 entries, these are not all unique; i.e. the total resource is less than these 2160. This occurs because of duplication. Duplication can be of four types: internal, direct, indirect, and genetic. (The distinction between these types was first pointed out by Dr Colin Hughes). The four types of duplication are considered below.

**8.1 Internal duplication** occurs when the same genetic material appears more than once in any one collection. As an example, the Malaysian cultivar ML1 (*L. leucocephala*) occurs three times in the CSIRO collection (CPIs 105060, 107766, and 115076). There are many examples of this type of duplication, but it is relatively insignificant, probably only about 1%.

**8.2 Direct duplication** occurs when the same genetic material is held in more than one collection. This duplication can result from the sharing of material from joint collecting expeditions, or by acquisition of material from an existing collection. Information on this can be found from two sources in the catalogue: by looking at entries that were “supplied” rather than “collected” (i.e. with entries in the “Source Country” and/or “Supplier” fields, or by comparisons within the “Other numbers” field. As an example, in the UH collection, *L. trichandra* K480 was collected in Honduras by J. Brewbaker and A. Molina as *L. diversifolia* (2x). It has “Other numbers” of PI443500, and 78-77c. This same accession is held by CIAT (CIAT17497, other numbers 7877 and ILCA11669, Donor Country USA) and by ILRI (11669, other number CIAT17497, Donor Country Colombia).

The best approach to assessing direct duplication is to examine the “Other numbers” field. This field can record numbers such as collecting numbers (in the “original” collection) or the number from a donor collection. The occurrence of an “Other number” is not necessarily an indication of duplication, and many entries have more than one “Other number”. There are about 75 “Other numbers” occurring twice (suggesting two or three occurrences in the catalogue) and 21 instances of “Other numbers” occurring three or more times, with some (K156, K636, KX3) occurring more than 6 times. As before, there is a considerable degree of uncertainty in this type of estimate, since “Other numbers” are not always recorded, or may be recorded differently in different collections.

**8.3 Indirect duplication** occurs when collections have the same geographic origin or provenance. This type of duplication is more difficult to assess, because of differing collecting methods, and because of the relative imprecision of recording collecting sites, one minute being roughly 1.5 km; up to 15 collections have been made at sites with the identical recorded latitude and longitude. Another complication is that many collecting sites are in mountainous areas, and sites with the same recorded latitude and longitude could vary considerably in altitude. There are 1224 entries with some record of collecting location. At face value, these represent only about 860 unique sites, but because of the difficulties

mentioned above, this figure is not reliable. In addition to these, there may of course be many other sites where precise details were not recorded. Users of the catalogue interested in this sort of duplication are invited to make their own assessments!

**8.4 Genetic duplication** can occur with species such as *L. leucocephala* which are self-pollinating. Many accessions may be genetically identical, and therefore a source of redundancy. There is no way to assess this from the current catalogue, except to make the observation that most of the *L. leucocephala* subsp. *leucocephala* are virtually morphologically indistinguishable, and therefore possibly genetically identical. Brewbaker and Sun (1996) showed that all non-native *L. leucocephala* subsp. *leucocephala* outside Mexico was of a single genotype only .

### **8.5 Overall assessment of duplication**

Table 1 lists the species in this catalogue, and the number of entries which are held for each in the catalogue, both before and after making an assessment of duplication. There is necessarily some degree of uncertainty in many cases. In the Table, all hybrids have been considered to be unique. Thus the degree of duplication in the overall collection is about 13%. However, since most recent collections have dealt with species other than *L. leucocephala*, and the overall resource is heavily weighted towards *L. leucocephala*, it is of interest to examine the entries of “non-*leucocephala*” species. If the hybrids are excluded (many being controlled crosses), and also the undetermined entries (designated “?”) the total number of accessions is reduced to 807, of which about 642 are probably unique. This suggests duplication of about 21%.

## **9. Obtaining seed**

Seed stocks of the various entries have not been included in the database because seed supplies are generally very limited, and only very small quantities can be supplied in most cases. Another reason for not listing seed stocks is that these stocks frequently change. For availability of seed, it is necessary to consult the individual institutions. Contact names and addresses are given in Section 11. Seed provided by international institutions often has restrictions on its transfer under the Convention on Biological Diversity, and these restrictions may include requirements relating to Intellectual Property Rights.

## **10. Updating the catalogue**

As more collections of leucaena are made, the catalogue will need to be updated. It is anticipated that this will be achieved through the international *Leucaena* research and development network LEUCNET, possibly on an annual basis, and making use of internet capabilities.

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## 12. Disclaimer

While the information in the catalogue, disk, and the accompanying text is accurate to the best knowledge and ability of the authors, no responsibility for the accuracy or otherwise of the information or instructions can be accepted by the authors, publishers or distributors of this catalogue or by the curators of the individual collections.

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**Table 1.** The number of entries of various *Leucaena* species in the catalogue, both originally and after assessing direct duplication.

Species	Subspecies/variety	No. of entries in catalogue	No. of entries after adjusting for duplication
<i>collinsii</i>	<i>collinsii</i>	24	17
	<i>zacapana</i>	31	29
<i>confertiflora</i>	<i>adenotheloidea</i>	7	7
	<i>confertiflora</i>	10	7
<i>cuspidata</i>		7	6
<i>diversifolia</i>		101	68
<i>esculenta</i>		67	61
<i>greggii</i>		42	39
<i>involucrata</i>		2	2
<i>lanceolata</i>	(unassigned)	8	8
	<i>lanceolata</i>	55	44
	<i>sousae</i>	22	15
<i>lempirana</i>		2	2
<i>leucocephala</i>	(unassigned)	435	414
	<i>glabrata</i>	201	150
	<i>ixtahuacana</i>	2	2
	<i>leucocephala</i>	523	473
<i>macrophylla</i>	(unassigned)	11	8
	<i>macrophylla</i>	34	24
	<i>istmensis</i>	11	8
<i>magnifica</i>		7	5
<i>matudae</i>		3	2
<i>multicapitula</i>		5	4
<i>pallida</i>		57	41
<i>pueblana</i>		3	3
<i>pulverulenta</i>		53	43
<i>retusa</i>		28	22
<i>salvadorensis</i>		15	10
<i>shannonii</i>		55	43
<i>trichandra</i>		112	97
<i>trichodes</i>		35	27
<i>xmixtec</i>		0	0
<i>xspontanea</i>		16	16?
“hybrid”		142	142?
?		34	32
<b>Total</b>		2160	1871

## Appendix 1.

This Appendix contains maps showing the natural distribution of *Leucaena* species, based on the collecting locations of 2393 herbarium specimens.

List of Figures:

Figure 1. Map of southern Mexico and Guatemala showing the distribution of the two subspecies of *L. collinsii*.

Figure 2. Map of southern and central Mexico showing the distributions of the two varieties of *L. confertifolia*.

Figure 3. Map of southern and central Mexico showing the distribution of *L. cuspidata*.

Figure 4. Map of southern and eastern Mexico and Guatemala showing the distribution of *L. diversifolia*.

Figure 5. Map of central Mexico showing the distribution of *L. esculenta*.

Figure 6. Map of northern Texas, U.S.A. showing the distribution of *L. greggii*.

Figure 7. Map of north-west Mexico showing the distribution of *L. involucrata*.

Figure 8. Map of Mexico showing the distributions of the two varieties of *L. lanceolata*.

Figure 9. Map of Honduras showing the distribution of *L. lempirana*.

Figure 10. Map of Mexico and northern Central America showing the distributions of the three subspecies of *L. leucocephala*.

Figure 11. Map of central Mexico showing the distributions of the two subspecies of *L. macrophylla*.

Figure 12. Map of Guatemala showing the distribution of *L. magnifica*.

Figure 13. Map of south-central Mexico showing the distribution of *L. matudae*.

Figure 14. Map of Nicaragua, Costa Rica and Panama showing the distribution of *L. multicapitula*.

Figure 15. Map of central Mexico showing the distribution of *L. pallida*.

Figure 16. Map of central Mexico showing the distribution of *L. pueblana*.

Figure 17. Map of eastern Mexico and the southern U.S.A. showing the distribution of *L. pulverulenta*.

Figure 18. Map of northern Mexico and Texas, U.S.A. showing the distribution of *L. retusa*.

Figure 19. Map of Honduras showing the distribution of *L. salvadorensis*.

Figure 20. Map of south-eastern Mexico and north Central Mexico (Belize, Guatemala, Honduras, El Salvador and Nicaragua) showing the distribution of *L. shannonii*.

Figure 21. Map of Mexico and north Central Mexico (Belize, Guatemala, Honduras, El Salvador and northern Nicaragua) showing the distribution of *L. trichandra*.

Figure 22. Map of north-west South America showing the distribution of *L. trichodes*.