A 2013 linear sequence of legume genera set in a phylogenetic context – A tool for collections management and taxon sampling

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A R T I C L E   I N F O

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A B S T R A C T

The Leguminosae (or Fabaceae) currently comprises 751 genera. In most of the world’s herbaria the genera are arranged by old, non-phylogenetic, classification systems which, while offering insights into morphological similarity, make no explicit statement as to evolutionary relationships. While classifications based on morphology are useful tools for plant identification, they do not offer the predictive value that phylogenetically based linear sequences provide. The legume collection of c.750,000 specimens in the Herbarium of the Royal Botanic Gardens, Kew was moved to a new building between 2010 and 2011, which presented the opportunity to reorganise the collection by a linear sequence based on a number of relatively comprehensive published legume phylogenies. The numbered linear sequence adopted at Kew has been updated and emended to include generic changes that have been published up to March 2013. The linear sequence, together with an alphabetical list of genera, is presented here to serve as a management tool for future taxon sampling and herbarium curation. The process used to develop the linear sequence and to rearrange the legume collection at Kew is discussed together with plans for future dissemination of changes to the sequence as new phylogenies are published and incorporated.

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1. Introduction

The Leguminosae (alternative name Fabaceae), commonly called the bean or pea family, is currently divided into three subfamilies (Caesalpinioideae, Mimosoideae and Papilionoideae), further subdivided into 35 tribes which together comprise 751 genera containing a total of c.19,500 species (LPWG, 2013a). The Leguminosae is second only to the grass family in economic value, but has significantly greater habit, flower and fruit diversity. Legumes are ubiquitous throughout the main biomes and occur in nearly all vegetation types globally. Published phylogenies of legumes at the supra-generic level have been accumulating at an ever increasing rate since the beginning of the millennium. An international legume systematics community is now working towards producing a comprehensive phylogenetic estimate and revised classification for all Leguminosae (LPWG, 2013a,b; Wojciechowski, 2013—this issue).

Many of the world’s herbaria are using out-of-date classification systems to arrange plant families and genera. Some have their herbarium specimens ordered alphabetically at all levels of the nomenclatural hierarchy and, whilst convenient for specimen filing and easy consultation, such arrangements are inefficient when used as an identification tool since they carry no predictive value about taxon relationships. Where resources permit, a number of herbaria are now arranging their plant families by the APG system (e.g., the Edinburgh Botanic Garden (E); the Natural History Museum, London (BM), the Museum National d’Histoire Naturelle, Paris (P), the University of Western Australia (UWA), Duke University, U.S.A. (DUKE), and North Carolina State University, U.S.A. (NCSC)). Many other herbaria are using the APG family delimitation, but order the families alphabetically (E. Haston, pers. comm., and Haston et al., 2007). In the Herbarium of the Royal Botanic Gardens, Kew, Leguminosae (approximately 750,000 specimens) were recently moved (2010–2011) to the newly built fifth wing of the Herbarium building. This presented the opportunity to update the arrangement of the genera from the old Bentham and Hooker (1865) classification to a system that better reflects the modern understanding of inter-generic relationships within legumes. The new arrangement of genera for herbarium specimens was completed in May 2011, and the supplementary legume seed and reprint collections subsequently were rearranged by the same linear sequence. Other large supplementary collections (fruits, illustrations) are in the process of being reorganised according to the new linear arrangement.

Bentham in Bentham and Hooker’s (1865) Genera Plantarum recognised 399 genera in the Leguminosae which together comprised c.6500 species. When part 1 of Advances in Legume Systematics (Polhill and Raven, 1981) was published, somewhat before the era of molecular phylogenetics, those numbers had increased to 650 genera and 18,000 species. Thirteen years later (Polhill, 1994), the number of genera recognised had increased to 671, but the estimated number of species had decreased to c.17,000. Legumes of the World (Lewis et al., 2005), an encyclopaedic compendium of legume genera, recognised...
727 genera and provided a more accurate estimate of 19,325 accepted species in the family. At the time of writing this paper the number of genera stands at 751 and the species at c.19,500 (LPWG, 2013). It is clear from this brief overview that the number of accepted genera and species of legumes has increased significantly in the past 150 years and that the number of accepted genera, even today, is far from static.

Since Legumes of the World (Lewis et al., 2005) a number of genera have been placed in synonymy, e.g., the two monospecific genera Ophicioporus (Bunge) Ilk. and Barnebyella Podlech have been informally returned to Astragalus (M.F. Wojciechowski, pers. comm.), Vaughania S. Moore has been subsumed back into Indigofera (Schrire, 2008), Spartidium Pomel becomes a synonym of the reinstated genus Calobota Eклл. & Zeyh. (Boatwright et al., 2009); Pellegrinirodendron (Harms) J. Léonard is now part of Gilbertiodendron J. Léonard (Esteira et al., 2012), and Bergeronia Micheli and Margaritolobium Harms have been reduced to synonyms of Muelleria Lf. (Silva et al., 2012). The synonymisation of other genera have been proposed (e.g., Paloveopsis and Elisabetha into Paloe, Redden et al., in press; Guiniea into Calliandra, Souza et al., in press). All native New World species formerly placed in Lotus are segregated into four genera: Hosackia Douglas ex Lindl., Acmispon Raf., Syrratum Vogel and Orteleya D.D. Solokoff (Solokoff, 1999, 2000, 2003; Solokoff et al., 2007), segregates which we recognise in the linear sequence presented here, although Brouillet (2008) only accepts two: Acmispon (including Syrratum and Orteleya) and Hosackia. Degtjareva et al. (2006, 2008) placed Dorycynium Mill. and Tetragonolobus Scop. back in synonymy under Lotus, and Degtjareva et al. (2012) show that Anthyllis is paraphyletic with respect to Hymenocarpus Sav., and thus place the latter into synonymy under Anthyllis, although these suggested changes are not yet adopted in our list. It is probable that Securigera DC. will be placed back into synonymy under Coronilla L. (Solokoff, pers. comm.).

In contrast, since 2005, more than 30 genera have been added to the list of 727 presented in Legumes of the World. A number of generic names have been resurrected from synonymy and are now considered to be accepted genera based on recent phylogenetic analyses: Phyllobium Fisch. (Zhang and Podlech, 2006); Acaicilla Britton & Rice (Rico Arce and Bachman, 2006); Senegalia (Seigler et al., 2006a); Pityrocarpa Britton Rose (Jobson and Luckow, 2007); Vachellia Wight & Arn. (Brown et al., 2008); Bionia Mart. ex Benth. (Queiroz, 2008); Isomacrolobium Aubrèv. & Pellegr. (Breterel, 2008); Leptolobium (Rodrigues and Tozzi, 2008); Fairchildia Britton & Rose (Torke and Schaal, 2008); Calobota Eклл. & Zeyh. (Boatwright et al., 2009); Schnella Raddi (Wunderlin, 2010); Cochliasanthus Trew and Condylolythys Piper (Delgado-Salinas et al., 2011); Euchthora Eckl. & Zeyh., Listia M. Mey. and Leobordea Del. (Boatwright et al., 2011); Ottotropis Nees (Ohashi and Ohashi, 2012a); Steinbachiai Harms (Lewis et al., 2012). Other taxa have been raised to generic rank from a previously described infrageneric taxon: Leptosporon (Benth.) A. Delgado, and Sigmidotropis (Piper) A. Delgado (Delgado-Salinas et al., 2011). Some recently recognised segregates have required new generic names: Guianodendron Sch. Rodr. & A.M.G.Azevedo (Rodrigues and Tozzi, 2006); Mariossoua Seigler & Ehinger (Seigler et al., 2006b); Wiliboriella Boatwr. & B.-E. Van Wyk (Boatwright et al., 2009); Ladeania A. N. Egan and Reveal (2009); Ancistrotropsis A. Delgado (Delgado-Salinas et al., 2011); Ezolobo B.-E. Van Wyk & Boatwr. (Boatwright et al., 2011); Helicotropis A. Delgado (Delgado-Salinas et al., 2011); Paragiodia I. Thompsons. (Thompson, 2011); and Verdesmum Ohashi and Ohashi (2012b). In addition, Heteroformus M. Sousa (2005) and Tabaraoa L.P. Queiroz, G.P. Lewis & M.F. Wojc. (Queiroz et al., 2010) are newly discovered genera described from relatively recent field-collected specimens. The current estimate of 751 genera and ca. 19,500 species will change soon because more new genera are anticipated (D. Cardoso, A.N. Egan, S.L. Gomez-Acevedo, M. Luckow, J.E. Meireles, H. Ohashi, E.R. Souza, and J.J. Wieringa, pers. comm., and Cardoso et al., 2012b, in which a new genus is flagged, but not formally published), including one described by Mackinder and Wieringa (in press).

The aim of this paper is to provide a generic backbone for the legume family arranged within a phylogenetic context, essentially as a working list of all the legume genera widely accepted in March 2013 by the international legume community. It is hoped that this will serve as a practical guide to taxonomic sampling in future legume research, as well as a linear sequence by which herbarium curators might choose to arrange their legume genera.

2. Materials and methods

2.1. Collections management

The Leguminosae, together with the Compositae (Asteraceae), were chosen as the two families to be moved to the new building of the Kew Herbarium, officially opened in November 2010. One reason for selecting these two families for the move was to reduce the risk of specimen damage by a number of beetle species, including the biscuit or herbarium beetle (Stegobium panicum) which preferentially seeks out parts of dried specimens (mostly the flowers and fruits) of a number of Compositae and legume genera (particularly the anthers of some taxa, e.g., members of the Cassiaceae) as a food source. The new herbarium building is temperature and humidity controlled and specimens are stored in closed boxes housed on open-shelved compactors in custom-built vaults, all designed to reduce the risk of pest infestation. To minimise the risk of transferring any beetles from the old accommodation to the new building, all specimens were frozen for 72 h at −40 °C prior to their relocation.

To ensure that all legume specimens were moved efficiently, more than 30,000 genus folders were given the appropriate new linear sequence number prior to the material being boxed, frozen and relocated. A detailed spreadsheet was also prepared to cross-map the location of each genus in the old herbarium cupboards with the number of boxes that the genus would occupy in its new location, allowing space for future expansion as newly accessioned material is added to the collection. Between June 2010 and May 2011 an estimated 750,000 legume specimens (including c.30,000 types) were relocated.

To facilitate access to specimens in the new arrangement, each box (holding between c. 25 and c. 100 specimens, depending on individual specimen woodiness) is labelled with genus name and number, species content and geographical region. Coloured stickers indicate the main geographical areas (e.g., Europe, Africa, the Americas) with additional geographical data added as a number that cross references to a standard Kew world list of continental and subcontinental regions. A red stripe was added to the label of a box that contains an index to species, and a blue star indicates the inclusion of cultivated material.

2.2. Enumeration of genera

Due to the increased storage space available in the new building, the move provided an impetus to reinvent a major collection material that, for a number of years, had been stored elsewhere due to lack of space. The move also provided the impetus to rearrange all legume genera by the new linear sequence based on the latest published phylogenies, most of which had already been consulted when preparing genus accounts for Legumes of the World (Lewis et al., 2005). Thus, the linear sequence largely follows the phylogenetic content of Legumes of the World. More specifically, the sequence was adapted from Lewis et al. (2005: 5, Fig. 1: a phylogeny of Leguminosae compiled as a supertree, based on a number of analyses cited therein), and fine-tuned using a series of trees representing the latest view of phylogenetic relationships among genera within each legume tribe.
Table 1
Numbered linear sequence of legume genera.

| Number | Genus          |
|--------|----------------|
| 1      | Cercis         |
| 2      | Adenanthera    |
| 3      | Griffonia      |
| 4      | Bremia         |
| 5      | Balsamia       |
| 6      | Glochidion     |
| 7      | Tylosema       |
| 8      | Barylea        |
| 9      | Lysiphus       |
| 10     | Phylotesia     |
| 10.01  | Schnella       |
| 11     | Lasiosperma    |
| 12     | Pilocereus     |
| 13     | Neoapaloxylon  |
| 14     | Schotia        |
| 15     | Barnesyndron   |
| 16     | Gononoeoxylon  |
| 17     | Brandeza (=Bathiaea) |
| 18     | Oxystigma      |
| 19     | Kingiodendron  |
| 20     | Grossteddyoxylon |
| 21     | Prioria        |
| 22     | Colophosperma  |
| 23     | Hardwickia     |
| 24     | Dalila         |
| 25     | Eurypetalum    |
| 26     | Eperua         |
| 27     | Augugardia     |
| 28     | Stenobalanaxis |
| 29     | Pelogyne       |
| 30     | Hymenaea       |
| 31     | Gubritoria     |
| 32     | Hylodendron    |
| 33     | Gillettodendron|
| 34     | Baikaea        |
| 35     | Tessmannia     |
| 36     | Sindorrhus     |
| 37     | Sindorpis      |
| 38     | Copafera       |
| 39     | Detarrum       |
| 40     | Enderita       |
| 41     | Lyndice        |
| 42     | Saraca         |
| 43     | Letcostegane   |
| 44     | Taiboterea     |
| 45     | Scoropoloueae  |
| 45.01  | Annea          |
| 45.02  | Gabonius       |
| 46     | Crotalaria     |
| 47     | Lebruniodendron|
| 48     | Plagiospermis  |
| 49     | Mickeelia      |
| 50     | Mahloa        |
| 51     | Cymotria       |
| 52     | Tamarindus     |
| 53     | Infredia       |
| 54     | Afzelia        |
| 55     | Brodriquesia   |
| 56     | Loesenera      |
| 57     | Neochevaleroxylon |
| 58     | Normandiodendron|
| 59     | Zenkerella     |
| 60     | Humboldtia     |
| 61     | Hypocostisia   |
| 62     | Leonardoa     |
| 63     | Amherstia      |
| 64     | Ecuadendron   |
| 65     | Tamarindus     |
| 66     | Brachychytris  |
| 67     | Heterostenon  |
| 68     | Elsholtzia     |
| 69     | Brownea       |
| 70     | Browneopisi    |
| 71     | Macrolobium    |
| 72     | Palvobalanaxis |
| 73     | Cryptosperma  |
| 74     | Dicymbe        |
| 75     | Polyostemonanthus |
| 76     | Pseudocorylophium |
| 77     | Gilbertiodendron|
| 78     | Pellegriniodendron G.B. Gilbert  |

Table 1 (continued)

| Number | Genus          |
|--------|----------------|
| 79     | Didierlea      |
| 80     | Libreuillia    |
| 81     | Michelosia     |
| 82     | Brachystegia   |
| 83     | Fullebardia    |
| 84     | Anthocalyx    |
| 85     | Bikinia        |
| 86     | Tetrabelina    |
| 87     | Microbelina    |
| 88     | Oddoniodendron |
| 89     | Engleriodendron|
| 90     | Lindenbergiell|
| 91     | Anthonotha     |
| 92     | Isobelina      |
| 93     | Berlinia       |
| 94     | Duparquetia    |
| 95     | Poepigea       |
| 96     | Baucloria      |
| 97     | Elymocarpus    |
| 98     | Mendravia      |
| 99     | Fistemonanthus |
| 100    | Aptelea        |
| 101    | Storkciella    |
| 102    | LahНА        |
| 103    | Peltoitesi     |
| 104    | Koompassia     |
| 105    | Martoidendron  |
| 106    | Androttendron  |
| 107    | Calippa        |
| 108    | Zenia          |
| 109    | Dittienia      |
| 110    | Dictiulla      |
| 111    | Dicorynus      |
| 112    | Gymnodendron   |
| 113    | Gleditschia    |
| 114    | Uroselena      |
| 115    | Tetrapeltoxan  |
| 117    | Arcoa          |
| 118    | Acrocarpus     |
| 119    | Ceratonia      |
| 120    | Pterogyne      |
| 121    | Vosacopula     |
| 122    | Melanoxylon    |
| 123    | Corindesmya    |
| 124    | Batesia        |
| 125    | Chamaertricta  |
| 126    | Seina          |
| 127    | Corsa          |
| 128    | Cordeauxa      |
| 129    | Stuhlmannia    |
| 130    | Haematoxylon   |
| 131    | Tiarla         |
| 132    | Coulterrea     |
| 133    | Moullavia      |
| 134    | Sineliana      |
| 135    | Pterolobium    |
| 136    | Mezuroner      |
| 137    | Caralsalina    |
| 138    | Catalognostia  |
| 139    | Pomaria        |
| 140    | Erythrostemon  |
| 141    | Poincianella   |
| 142    | Lihshiba       |
| 143    | Hoffmanseggia  |
| 144    | Shahlia        |
| 145    | Stenodrepanum  |
| 146    | Javoria        |
| 147    | Lophocarpina   |
| 148    | Balacamaspon  |
| 149    | Dipyrrhychia   |
| 150    | Dinebavhera    |
| 151    | Tachigali      |
| 152    | Arapatellia    |
| 153    | Jachisubiubera |
| 154    | Schlothubium   |
| 155    | Bussea         |
| 156    | Peltohorum     |
| 157    | Parkinonia     |
| 158    | Ectolyneus     |
| 159    | Heteroforum    |
| 160    | Delonix        |
| 161    | Colvillera     |
| 162    | G.P. Lewis et al. / South African Journal of Botany 89 (2013) 76–84
| Genus | Number |
|-------|--------|
| Plagiocarpus | 325 |
| Templetonia | 326 |
| Hornea | 327 |
| Cristona | 328 |
| Thincola | 329 |
| Lamprolobium | 330 |
| Anoppianthus | 331 |
| Azalia | 332 |
| Pipanthus | 333 |
| Thermopsis | 334 |
| Bapaia | 335 |
| Cadia | 336 |
| Cyclopsia | 337 |
| Xipholetha | 338 |
| Amphiphala | 339 |
| Stirtanopus | 340 |
| Podalyria | 341 |
| Liparia | 342 |
| Virilia | 343 |
| Calpurnia | 344 |
| Spartodium = Caloba | 347.02 |
| Lebeckia | 346 |
| Eudora | 346.01 |
| Wiborgia | 347 |
| Wiborgiella | 347.01 |
| Caloba | 347.02 |
| Raphia | 348 |
| Aspalathus | 349 |
| Lotionis | 350 |
| Listia | 350.01 |
| Lebordea | 350.02 |
| Bolusia | 351 |
| Euchla | 351.01 |
| Crotalaria | 352 |
| Pearsonia | 353 |
| Rothia | 354 |
| Robynsiophyton | 355 |
| Melolobium | 356 |
| Dichias | 357 |
| Polybia | 358 |
| Argyrolobium | 359 |
| Lupinus | 360 |
| Antaristophyllum | 361 |
| Sellocharis | 362 |
| Adenocardus | 363 |
| Cytisophyllum | 364 |
| Argyrocytisus | 365 |
| Petilwia | 366 |
| Laburnum | 367 |
| Podocytisus | 368 |
| Hesperolobarium | 369 |
| Cytisus | 370 |
| Lembobiti | 371 |
| Calicote | 372 |
| Echinocarptum | 373 |
| Erysia | 374 |
| Retama | 375 |
| Gonystyctus | 376 |
| Genista | 377 |
| Spartium | 378 |
| Stauranthus | 379 |
| Ulex | 380 |
| Hymenolobium | 381 |
| Andira | 382 |
| Adesma | 383 |
| Amica | 384 |
| Zorna | 385 |
| Purpurea | 386 |
| Nissolia | 387 |
| Chaetocalyx | 388 |
| Riedeliea | 389 |
| Dicrolobium | 390 |
| Cranocarpus | 391 |
| Briya | 392 |
| Platynymicus | 393 |
| Platynymus | 394 |
| Inocarpus | 395 |
| Maraniona | 396 |
| Tipiana | 397 |
| Ramoniana | 398 |
| Centrobolium | 399 |
| Paramachaerium | 400 |
Table 1 (continued)

| Genus          | Number |
|----------------|--------|
| Desmodium      | 637    |
| Ototropis      | 637.01 |
| Codariocalyx   | 638    |
| Hydrolepis     | 639    |
| Heguera        | 640    |
| Pseudarthria   | 641    |
| Pycnospora     | 642    |
| Mecopus        | 643    |
| Uraia          | 644    |
| Chamaea        | 645    |
| Alysicarpus    | 646    |
| Desmodiastrum  | 647    |
| Melliniella    | 648    |
| Leptodesma     | 649    |
| Elnotes        | 650    |
| Sesbania       | 651    |
| Hippocrages    | 652    |
| Scorpusus      | 653    |
| Securigera     | 654    |
| Coronilla      | 655    |
| Podolotus      | 656    |
| Anthyllis      | 657    |
| Hymenocardis   | 658    |
| Pseudololus    | 659    |
| Antopetisella  | 660    |
| Hiosella       | 661    |
| Orispodolus    | 662    |
| Dorycnopsis    | 663    |
| Kebriza        | 664    |
| Otleyea        | 665    |
| Acnopteryx     | 666    |
| Syrmatum       | 667    |
| Lotus          | 668    |
| Derycynus      | 669    |
| Tetragonolobus | 670    |
| Triopodion     | 671    |
| Hammatolobium  | 672    |
| Cytisnus       | 673    |
| Hebestigma     | 674    |
| Lennia         | 675    |
| Gliricidia     | 676    |
| Pitea          | 677    |
| Olimora        | 678    |
| Robina         | 679    |
| Poissonia      | 680    |
| Coursetia      | 681    |
| Peteria        | 682    |
| Genistodium    | 683    |
| Sphinctospermum| 684    |
| Galerrya       | 685    |
| Endragama      | 686    |
| Sarcodum       | 687    |

Condylostylis, Euchlora, Lebordeea, Leptosprorn, Listia, Ototropis, Phyllolobium, Schnella, Sigmoiodotrups, and Steinbachielda) and six
synomisations (Barneyella, Bergeronia, Margaritolobium, Ophiocarpus, Pellegrinoendotherm, and Spartidium are no longer accepted genera).  
Table 1 presents the linear sequence by which legume genera in the Kew herbarium are arranged. It is a generic backbone of the
Leguminosae arranged within a phylogenetic context and thus implicitly includes predictive value based on relationships among genera. It
includes the 751 legume genera widely accepted by the international legume community in March 2013. Each genus is given a unique number.
737 genera (those accepted during the 2010–2011 relocation of legumes at Kew) have an integer, although a small number of these are now
recognised as synonyms of other accepted genera and these synonyms are annotated in the table. Twenty genera added to the overall list of
accepted genera since 2009 are allotted new decimal numbers that place them next to the genus to which they are most closely related
(e.g., Schnella is given the unique decimal number 10.01 placing it next to its close generic relative Phanera, genus 10; Verdesmum, genus 629.01 is placed next to its sister genus Hansia, genus 629). A small number of
genera already in press are included in the linear sequence and given a decimal number in anticipation of imminent publication (Annea, Gabonius, and Staminodiathmus), but these genera are not counted in the
current total of 751. The linear sequence that we present is a March 2013 snap-shot of accepted legume genera, but the numbering
used is based on our original list drawn up for the specimen move in 2010–2011, with new synonyms annotated and additional genera added, based on the 2009 literature onwards. We also know that a number of new synonyms and newly reinstated or described genera are to be published in the near future and we can therefore safely predict that the list of genera will constantly be changing for the foreseeable future.

Table 2 is an alphabetical list of the legume genera presented in Table 1.

4. Discussion

4.1. Limitations of the linear sequence and dealing with dynamic change

The single greatest limitation of the implementation of a linear sequence to represent phylogenetic relationships is that it flattens out a 3-D model of relationships into a straight line and, inevitably, some information is lost as a consequence. The challenge is to construct a linear sequence that best represents known inter-
genere relationships (see Haston et al., 2007 and Wearn et al., 2013 for the challenges, and linear sequences adopted, at the family level using the Angiosperm Phylogeny Group II and with APG III classifications, respectively).

Large collections of herbarium specimens cannot be reorganised frequently because of lack of resources (staff time and money) and
lack of available space. In addition, it is not desirable to continually reorganise systems that serve perfectly well for information retrieval.
Nevertheless, exceptionally an opportunity to rearrange a whole herbarium, or one large family, presents itself and offers the chance to re-
order material by the latest systematic or phylogenetic information. In the Herbarium at Kew this opportunity arose in 2010 for the le-
gume family. Drawing up a linear sequence for the re-arrangement of legume genera was relatively straightforward because such a list
already existed implicitly in Legumes of the World (Lewis et al., 2005). Adding in new synonyms, reinstated genera and newly de-
scribed ones published between 2005 and 2009 was likewise not problematic. Nevertheless, the 2010 linear sequence adopted for le-
gumes at Kew was a snap-shot at that point in time. From 2010 to
now an additional c.20 genera have been reinstated or described as
new and these have been added to the linear sequence presented here. It is evident that having relocated 750, 000 legume specimens in accordance with a new linear sequence it is not desirable then to

(e.g., Lewis et al., 2005: 58, for tribe Cercideae). Legume genera reinstated
based on new data, or described as new between 2005 and 2009 were
inter-collated into the linear sequence to give a total of 737 genera, an
increase of 10 on the number of genera presented in Legumes of the
World.

Since 2009, a number of legume genera have either been
synomised, reinstated or described as new, taking the current
total of accepted genera to 751 (the number reported by the LPWG, 2013). These changes are included in the linear sequence presented here.

3. Results

We recognise 751 legume genera. This is an increase of 14 over
the 737 genera recognised in 2009 when the linear sequence
was prepared prior to the legume move in 2010–2011. The difference
of 14 is made up of seven recently published segregates
(Ancistrortopsis, Ezoalba, Helicotropis, Ladaenia, Parugooodia, Verdesmum,
and Wiborgiello), 13 genus reinstatements or up-rankings from
previous infrageneric taxa (Amphiodon, Calobota, Cochliasanthus,
### Table 2 (continued)

| Genus | Number |
|-------|--------|
| Cobotria | 757 |
| Code 463 |
| Codonopsis | 703 |
| Conopodium | 706 |
| Corallodendron | 707 |
| Corethrodendron | 709 |
| Coremilla | 712 |

(continued on next page)
| Table 2 (continued) |
|---------------------|
| **Genus** | **Number** |
| Hypocalyxus | 443 |
| Isoria | 88 |
| Indostigma | 489 |
| Indigofere | 492 |
| Indopsidium | 186 |
| Ingia | 237 |
| Inocarpus | 395 |
| Intisia | 53 |
| Isochrysis | 94 |
| Isomicrobium | 92 |
| Isotropis | 449 |
| Jacksonia | 450 |
| Jacobshornia | 134 |
| Jullarnberia | 84 |
| Kalagpia | 109 |
| Kamalacarpus | 200 |
| Kebirita | 694 |
| Kennedia | 618 |
| Kingiogossos | 79 |
| Koenigiana | 106 |
| Kotschya | 417 |
| Kummerowia | 622 |
| Kuesana | 492 |
| Labichea | 104 |
| Lablab | 599 |
| Labiolum | 367 |
| Laecania | 536 |
| Lambagropsis | 330 |
| Lambdinaea | 11 |
| Lathyrus | 735 |
| Latrobea | 452 |
| Leghia | 346 |
| Lebruniadendron | 47 |
| Lectinea | 288 |
| Lenobroprios | 371 |
| Lenorodendron | 187 |
| Lenoporum | 163 |
| Lennea | 675 |
| Les | 734 |
| Lob Lorbeora | 350.02 |
| Leonardsonia | 62 |
| Leptocarpus | 406 |
| Leptodendron | 649 |
| Leptolobus | 302 |
| Leptopena | 451 |
| Leumannia | 606.06 |
| Lepedezia | 623 |
| Leserita | 706 |
| Leucopus | 197 |
| Leucocleora | 248 |
| Leucophasalos | 438 |
| Leucoplastege | 413 |
| Libidusa | 143 |
| Librevilla | 81 |
| Liparia | 342 |
| Lister | 350.01 |
| Loeoera | 56 |
| Lonchocarpus | 522 |
| Lonchocarpus | 418 |
| Lotois | 350 |
| Lotus | 668 |
| Luzetia | 294 |
| Luminos | 380 |
| Luzonia | 526 |
| Lysulce | 224 |
| Lysiphylum | 99 |
| Maackia | 316 |
| Machaerium | 412 |
| Macrocarpus | 72 |
| Macropachysanthus | 527 |
| Macropilum | 609 |
| Markhamia | 276 |
| Macrotyloma | 597 |
| Mantinea | 50 |
| Marko | 50 |
| Margaritolumbus | 527 |
| Marina | 434 |
| Maritiantha | 217 |
| Maritornaxos | 232 |
| Martiodendron | 107 |
| Masteria | 651 |
| Mateus | 643 |
| Medicago | 731 |
| Melzotropis | 546 |
| Menispermum | 123 |
| Mellilotus | 729 |

| Table 2 (continued) |
|---------------------|
| **Genus** | **Number** |
| Melliniella | 648 |
| Melotobium | 356 |
| Mendontria | 100 |
| Menoneeuria | 137 |
| Michxiosoria | 82 |
| Micreobactria | 40 |
| Microberlinia | 89 |
| Microcarbus | 90 |
| Microlobus | 210 |
| Milbraeiiodendron | 271 |
| Milletia | 508 |
| Mimosia | 217 |
| Missionguizantia | 156 |
| Mireba | 463 |
| Midenhavera | 151 |
| Mithracarpus | 635 |
| Monoperyx | 279 |
| Montigena | 709 |
| Mora | 160 |
| Morpha | 517 |
| Mucina | 517 |
| Mueilla | 519 |
| Mucilaginosus | 472 |
| Mundula | 512 |
| Myrciopsis | 276 |
| Myrciunus | 278 |
| Myrsyn | 277 |
| Mynanthus | 610 |
| Neopatagonyron | 13 |
| Neolitiospermum | 57 |
| Neolitiosis | 581 |
| Neolitiosphaera | 310 |
| Neorayna | 568 |
| Neourantia | 667 |
| Nephrolepis | 651 |
| Nepiura | 196 |
| Nephostylis | 593 |
| Newrotia | 188 |
| Nisia | 387 |
| Nogra | 572 |
| Normandiodendron | 38 |
| Olenia | 628 |
| Olenyia | 678 |
| Olostrochocarpus | 722 |
| Olona | 728 |
| Opiocarpus | 698 |
| Ophryostelia | 542 |
| Orbea | 586 |
| Oryzopsis | 702 |
| Ormocarpus | 425 |
| Ormocarpus | 424 |
| Ormocarpus | 297 |
| Ornithopus | 162 |
| Orphandendron | 263 |
| Orzya | 61 |
| Ostroycarpus | 483 |
| Ostiobolus | 582 |
| Otis | 455 |
| Otopera | 560 |
| Otofrois | 677.01 |
| Ottleya | 665 |
| Otunia | 626 |
| Oxysobium | 465 |
| Oxysobium | 604 |
| Oxystegia | 18 |
| Oxystep | 702 |
| Oryzopsis | 696 |
| Pachyelasme | 164 |
| Pachyelasme | 565 |
| Painteria | 253 |
| Palou | 65 |
| Palvobolus | 66 |
| Panarchenia | 368 |
| Paracalyx | 548 |
| Paracarpus | 506 |
| Parechona | 406.01 |
| Paramachaerus | 400 |
| Paramacrolomus | 73 |
| Parapappas | 209 |
| Parapappas | 240 |
| Parasenianthes | 243 |
| Parastephoia | 515 |
| Paraxana | 205 |
| Parkinsonia | 158 |
| Parkochetus | 725 |
| Parryella | 420 |
| Pezonia | 353 |
| Pelegrinodendron | 78 |
| Peteliera | 426 |
| Petogyne | 29 |
| Petragyna | 157 |
| Pentaclethra | 174 |
| Periplas | 478 |
| Peperoma | 299 |
| Pecinellodendron | 338 |
| Peetalosyce | 105 |
| Peeteria | 682 |
| Peetria | 369 |
| Phanera | 10 |
| Phaeosolus | 605 |
| Philephoros | 695 |
| Phylacium | 580 |
| Phyllodium | 625 |
| Phyllobium | 698.01 |
| Phyllosyce | 487 |
| Physostigma | 602 |
| Picketia | 285 |
| Picketia | 421 |
| Pilostigma | 12 |
| Pilliptiostigma | 313 |
| Pilophyllum | 151 |
| Pseudobismium | 606.03 |
| Pseudophyllum | 36 |
| Sporocarpus | 65 |
| Sporophyllum | 65 |
| Staphyliosperma | 684 |
| Sphingia | 250 |
| Sporiotropis | 307 |
| Sporogicyclaera | 695 |
| Stachyothyrsus | 171 |
| Stahila | 145 |
| Stauracanthus | 304.01 |
| Stauracanthus | 379 |
| Steinbacchella | 412.01 |
| Stemnocoileus | 28 |
| Stenodromos | 146 |
| Stirtonanthus | 340 |
| Stonesiella | 458 |
| Stockelia | 702 |
| Streborhiza | 712 |
| Strongylocos | 562 |
| Strongylocos | 607 |
| Styrhophodendron | 211 |
| Stuhlmannia | 130 |
| Stylomartes | 408 |
| Stypophloleus | 276 |
| Sulcia | 720 |
| Sutherlandia | 707 |
| Swainsonia | 708 |
| Swartzia | 257 |
| Sweetia | 293 |
| Syringchnia | 500 |
| Symmetricalia | 172 |
| Syrtamia | 967 |
| Tabaora | 322 |
| Tachigali | 152 |
| Tadahagi | 632 |
| Tallabrotia | 64 |
| Tammarinthus | 172 |
| Tara | 132 |
| Taralea | 280 |
| Tavernsia | 721 |
| Temelopina | 326 |
| Tephrosia | 511 |
| Teranensa | 578 |
| Tessarina | 35 |
| Tetralberia | 87 |
| Tetragonobus | 670 |
| Tetrapleurus | 177 |
| Tetrapetalopan | 117 |
Table 2 (continued)

| Genus           | Number | Genus       | Number |
|-----------------|--------|-------------|--------|
| Teyleria        | 569    | Vicia       | 733    |
| Thailentadopisss | 236    | Vigna       | 603    |
| Theurnia        | 334    | Vignocenthanthus | 220 |
| Thincolia       | 329    | Viminaria   | 448    |
| Tibetia         | 694    | Virgilia    | 343    |
| Tipuna          | 397    | Vouacapoua  | 122    |
| Trilacanthus    | 636    | Wajira      | 591    |
| Trilodium       | 732    | Wallaceoeoendron | 241 |
| Trigonella      | 730    | Weberhauenella | 427 |
| Tripodium       | 671    | Wiborgia    | 347    |
| Trischadium     | 260    | Wiborgiella | 347.01 |
| Tyloserna       | 7      | Wisteria    | 689    |
| Ulnisia         | 111    | Wouthuercsis | 269   |
| Uleanthus       | 265    | Xerocladia  | 192    |
| Ulex            | 380    | Xeroderris  | 485    |
| Umitza          | 116    | Xiphotheca  | 338    |
| Urita           | 644    | Xylia       | 181    |
| Uribea          | 290    | Zapoteca    | 220    |
| Urodon          | 457    | Zena        | 110    |
| Vachelia        | 215    | Zenkorella  | 59     |
| Vandassina      | 620    | Zollernia   | 286    |
| Vatairea        | 285    | Zornia      | 385    |
| Vataireopsis    | 296    | Zuccagnia   | 147    |
| Variouea        | 501    | Zygia       | 231    |
| Vavilovia       | 737    | Zygoarpurarum | 423  |
| Verdesseium     | 629.01 |             |        |

change the overall number of genera every time a new genus is added to the sequence or one on the list is synonymised. In consequence, a limitation of the list presented here is that we have had to introduce decimal numbers for new (post-2009) additions to the sequence so as to incorporate those genera in the most appropriate phylogenetic position (e.g. Schnella, reinstated based on Wunderlin, 2010 and Sinou et al., 2009, has been allotted number 10.01 to place it next to its closest relative Phanera, genus 10; the new genus Lodeania A.N.Egan & Revel is given the decimal number 589.01 placing it next to its relative Prosartidium, genus 589). Users of the list are, of course, at liberty to arrange and number their legume genera by any system they choose when re-curating their herbarium collections.

Whilst repositioning collections of newly reinstated or segregate genera next to, or near, the genus in which they were previously included is relatively straightforward, responding to the more complex results of other systematic research can be curatorialy challenging. Thus, papers published post-2009, which include data on newly discovered genus alignments, or present novel phylogenetic topologies or clade structure, have not had, to date, all of their published results assimilated into our linear sequence. An example of this is the recent paper by Cardoso et al. (2012a) that realigns Aicosmium s.s. (now reduced to three species) with the Dalbergioid clade, some distance from the two genera Leptolobium and Guianadendron (segregated from Aicosmium s.l.) both included in the Bowdichia clade of the Genistoid s.l. clade. While our linear sequence includes Guianadendron (as genus 303) and Leptolobium (genus 302) it does not renumber Aicosmium (genus 301 in our sequence) so as to place it within the Pterocarpus clade of Dalbergioid legumes. Such dynamic change, when incorporated into our list will require a new decimal number for Aicosmium s.s., close to Pterocarpus (genus 402), and will leave number 301 unoccupied. The realignment of Aicosmium s.s. is just one example out of a number of genera that have been repositioned within the legume phylogeny since 2009. Such changes to the linear sequence will be physically disruptive to herbarium collections and will thus require more staff time and management. If space permits then planning ahead to leave adequate expansion room within a collection will greatly facilitate such genus re-positionings.

Furthermore, the advent of lower cost next generation sequencing has given new impetus to the construction of supra-generic legume phylogenies. In particular, the recently formed Legume Phylogeny Working Group is exploring these technologies with a view to producing a comprehensive phylogenetic estimate and revised classification for all Leguminosae. Consequently, we think it wise to wait for the outcome of the bulk of that research before realigning some genera which might have to be moved again in the light of new evidence.

4.2. Managing and communicating future modifications to the linear sequence

The legume team at Kew continually updates the arrangement of our legume collections based on new publications in accredited botanical journals. In the future, reinstated or newly described genera will receive a new decimal number to place them appropriately in the linear sequence. Herbarium specimens will be re-curated in accordance with the publication in which the new genera were proposed. Revisions and monographs that result in genera being segregated will likewise lead to the addition of new genus numbers. At Kew we are always pleased to receive direct from an author notification of their new legume papers so that we can keep our collections up-to-date. We hold a comprehensive legume reprint collection which acts as a valuable supplement to our herbarium specimens and we encourage legume researchers to use this as a safe repository for their research in hard-copy.

We anticipate publishing regular updates to our linear sequence so that others who wish to adopt the same system will have access to the changes. One possible way to do this will be annually in the legume newsletter Bean Bag which is compiled, edited and distributed by Kew. We are also close to going live with our Legumes of the World Online (LOWO) project, which builds on the hard copy publication Legumes of the World. The genus-level backbone that LOWO provides will be linked to other electronic legume resources and our ultimate aim is to provide a one-stop-shop for legume information. LOWO will also provide an ideal hub through which to communicate changes to the linear sequence presented here.

5. Recommendations

We recommend the following:

That the sequence presented here replaces all previously published linear systems of legumes which do not take account of the huge advances in our knowledge of legume supra-generic relationships elucidated by phylogenetic studies published during the last 15 years. To maximise the utility of legume collections as identification tools, those collections must be managed in a systematic order.

Constant review of newly published taxonomic literature is needed to monitor and evaluate which proposed changes in supra-generic relationships should be implemented in the collections.

Minor recurrences can be carried out more or less continuously whilst information concerning major rearrangements is compiled for less frequent implementation.

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