



## The number of known plants species in the world and its annual increase

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### Abstract

We have counted the currently known, described and accepted number of plant species as ca 374,000, of which approximately 308,312 are vascular plants, with 295,383 flowering plants (angiosperms; monocots: 74,273; eudicots: 210,008). Global numbers of smaller plant groups are as follows: algae ca 44,000, liverworts ca 9,000, hornworts ca 225, mosses 12,700, lycophytes 1,290, ferns 10,560 and gymnosperms 1,079. *Phytotaxa* is currently contributing more than a quarter of the ca 2000 species that are described every year, showing that it has become a major contributor to the dissemination of new species discovery. However, the rate of discovery is slowing down, due to reduction in financial and scientific support for fundamental natural history studies.

When working on the classification of vascular plants at a global scale, we often receive questions about the numbers of currently described and accepted species in a particular lineage. Additionally, in *Phytotaxa* and other taxonomical journals, it is general practice to cite numbers of genera and species in a family or genus, when the organism of study is introduced (e.g. Chen *et al.* 2015, Christenhusz 2015, Fernandez-Júnior & Esteves 2016, Ortiz *et al.* 2016, Otto & Verloove 2016, Sofiyanti *et al.* 2016, and many more). The numbers of species of given families fluctuates though, because systematic research is not static with new species and genera continually being described, whilst others are being synonymised. As soon as a number is published, the number is outdated. There are also disagreements in taxonomy with differing opinions on species circumscriptions in some groups, whilst reliable accounts are difficult to find or are only rough estimates in others rather than actual counts. This is particularly the case in large species rich groups. Nevertheless, there is a demand for a reliable estimate of species numbers, and in light of the recently published APG IV (2016), we thought it useful to compile a list of genera and species and calculate the annual increase.

Below we provide a list of all vascular plant families (Table 1; lycophytes and ferns based on Christenhusz & Chase 2014; gymnosperms based on Christenhusz *et al.* 2011; angiosperms based on APG IV 2016), with estimated numbers of described and accepted genera and species. This should not be confused with the total hypothesised number of species (i.e. described and undescribed) which is subject to increases (new discovery) and declines (new synonyms) as new evidence comes available. Species numbers for families that have been treated in the *Kew Checklist of Selected Plant Families* (WCSP 2016) are generally followed here and adapted where new evidence has emerged but was not yet absorbed into this checklist or proven contradictory by the taxonomic community. If families were not treated then the most recent monographs, revisions and flora treatments were consulted. These numbers were originally compiled for our comprehensive plant family books (Byng 2014, 2015, in press, Christenhusz, Fay & Chase, in press) and rather than cite per family an exhaustive list of sources, substantial references can be found therein. Admittedly, this list is also already out of date, as several new species will have been published in the period it took for this paper to come to press, but it at least gives an informed estimate of there currently being **308,312** described, accepted, vascular plant species of which **295,383** are angiosperms (monocots: 74,273, eudicots: 210,008), gymnosperms: 1,079, ferns: 10,560, lycophytes 1,290 (Table 1). We have not estimated numbers of mosses and algae, as our expertise does not lie in these plant groups, but existing estimates of 9,000 species of liverworts (Marchantiophyta; Crandall-Stotler & Stotler 2000), 200–250 hornworts (Anthocerotophyta; Villarreal *et al.* 2010), 12,700 mosses (Bryophyta; Crosby *et al.* 1999; Cox *et al.* 2014), ca 44,000 algae (Guiry 2012; although number is likely to be much higher), amounts to a total of **ca 374,000** (~374,262) **plant species worldwide**. These numbers differ from earlier estimates by Chapman (2009), which has substantially lower estimates, with 310,129 as the total number of plants species of which 281,621 are vascular plants.

A higher estimate is by Pimm & Joppa (2015) which states that there are an estimated 450,000 species. We stress that our counts are more accurate and reliable as they are actual counts of accepted, published species in each linear, based on counts taken from monographic studies (removing synonymy bias), rather than informed estimates from group specialists (which includes taxonomical bias for groups not covered by such specialists) or hypothetical numbers of possible species (described and yet not discovered) calculated by using statistical models (e.g. Joppa *et al.* 2011a, Pimm & Joppa 2015). Useful as these calculated estimates may be, it does not tell us the numbers of known species at this present day, and predictions for the future are often unreliable.

**TABLE 1.** Estimated numbers of genera and species in a linear sequence of vascular plants (based on Christenhusz *et al.* 2011, Christenhusz & Chase 2014 and APG IV 2016), with numbers of taxa taken or adapted from Byng (2014, 2015, in press), Christenhusz, Fay & Chase (in press) and WCSP (2016). For sources see references cited in Byng (2015).

| Order                 | Family           | Approximate no of genera | Approximate no of species |
|-----------------------|------------------|--------------------------|---------------------------|
| Lycopodiales          | Lycopodiaceae    | 3                        | 400                       |
| Isoëtiales            | Isoëtaceae       | 1                        | 140                       |
| Selaginellales        | Selaginellaceae  | 1                        | 750                       |
| <b>Total lycopods</b> | <b>3</b>         | <b>5</b>                 | <b>1,290</b>              |
| Equisetales           | Equisetaceae     | 1                        | 20                        |
| Ophioglossales        | Ophioglossaceae  | 4                        | 80                        |
| Psilotales            | Psilotaceae      | 2                        | 12                        |
| Marattiales           | Marattiaceae     | 6                        | 135                       |
| Osmundales            | Osmundaceae      | 4                        | 25                        |
| Hymenophyllales       | Hymenophyllaceae | 2                        | 650                       |
| Gleicheniales         | Gleicheniaceae   | 6                        | 165                       |
| Gleicheniales         | Dipteridaceae    | 2                        | 9                         |
| Gleicheniales         | Matoniaceae      | 2                        | 4                         |
| Schizaeales           | Schizaeaceae     | 4                        | 190                       |
| Salviniales           | Marsileaceae     | 3                        | 65                        |
| Salviniales           | Salviniaceae     | 2                        | 20                        |
| Cyatheaales           | Cyatheaceae      | 12                       | 700                       |
| Polypodiales          | Lonchitidaceae   | 1                        | 2                         |
| Polypodiales          | Saccolomataceae  | 2                        | 12                        |
| Polypodiales          | Cystodiaceae     | 1                        | 1                         |
| Polypodiales          | Lindsaeaceae     | 6                        | 220                       |
| Polypodiales          | Dennstaedtiaceae | 10                       | 240                       |
| Polypodiales          | Pteridaceae      | 45                       | 1,150                     |
| Polypodiales          | Aspleniaceae     | 24                       | 2,780                     |
| Polypodiales          | Polypodiaceae    | 76                       | 4,080                     |
| <b>Total ferns</b>    | <b>21</b>        | <b>215</b>               | <b>10,560</b>             |
| Cycadales             | Cycadaceae       | 1                        | 107                       |
| Cycadales             | Zamiaceae        | 9                        | 230                       |
| Ginkgoales            | Ginkgoaceae      | 1                        | 1                         |
| Welwitschiales        | Welwitschiaceae  | 1                        | 1                         |

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TABLE 1. (Continued)

| Order                    | Family             | Approximate no of genera | Approximate no of species |
|--------------------------|--------------------|--------------------------|---------------------------|
| Gnetales                 | Gnetaceae          | 1                        | 43                        |
| Ephedrales               | Ephedraceae        | 1                        | 68                        |
| Pinales                  | Pinaceae           | 11                       | 228                       |
| Araucariales             | Araucariaceae      | 3                        | 37                        |
| Araucariales             | Podocarpaceae      | 19                       | 187                       |
| Cupressales              | Sciadopityaceae    | 1                        | 1                         |
| Cupressales              | Cupressaceae       | 29                       | 149                       |
| Cupressales              | Taxaceae           | 6                        | 27                        |
| <b>Total gymnosperms</b> | <b>12</b>          | <b>83</b>                | <b>1,079</b>              |
| Amborellales             | Amborellaceae      | 1                        | 1                         |
| Nymphaeales              | Hydatellaceae      | 1                        | 12                        |
| Nymphaeales              | Cabombaceae        | 2                        | 6                         |
| Nymphaeales              | Nymphaeaceae       | 5                        | 70                        |
| Austrobaileyales         | Austrobaileyaceae  | 1                        | 1                         |
| Austrobaileyales         | Trimeniaceae       | 1                        | 8                         |
| Austrobaileyales         | Schisandraceae     | 3                        | 85                        |
| Canellales               | Canellaceae        | 5                        | 23                        |
| Canellales               | Winteraceae        | 5                        | 65                        |
| Piperales                | Saururaceae        | 4                        | 6                         |
| Piperales                | Piperaceae         | 5                        | 3,700                     |
| Piperales                | Aristolochiaceae   | 7                        | 500                       |
| Magnoliales              | Myristicaceae      | 21                       | 520                       |
| Magnoliales              | Magnoliaceae       | 2                        | 294                       |
| Magnoliales              | Degeneriaceae      | 1                        | 2                         |
| Magnoliales              | Himantandraceae    | 1                        | 2                         |
| Magnoliales              | Eupomatiaceae      | 1                        | 3                         |
| Magnoliales              | Annonaceae         | 105                      | 2,500                     |
| Lurales                  | Calycanthaceae     | 3                        | 10                        |
| Lurales                  | Siparunaceae       | 2                        | 75                        |
| Lurales                  | Gomortegaceae      | 1                        | 1                         |
| Lurales                  | Atherospermataceae | 6                        | 16                        |
| Lurales                  | Hernandiaceae      | 5                        | 58                        |
| Lurales                  | Monimiaceae        | 24                       | 217                       |
| Lurales                  | Lauraceae          | 45                       | 2,850                     |
| Chloranthales            | Chloranthaceae     | 4                        | 77                        |
| Acorales                 | Acoraceae          | 1                        | 2                         |
| Alismatales              | Araceae            | 114                      | 3,750                     |
| Alismatales              | Tofieldiaceae      | 4                        | 28                        |

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TABLE 1. (Continued)

| Order         | Family           | Approximate no of genera | Approximate no of species |
|---------------|------------------|--------------------------|---------------------------|
| Alismatales   | Alismataceae     | 17                       | 115                       |
| Alismatales   | Butomaceae       | 1                        | 1                         |
| Alismatales   | Hydrocharitaceae | 16                       | 135                       |
| Alismatales   | Scheuchzeriaceae | 1                        | 1                         |
| Alismatales   | Aponogetonaceae  | 1                        | 56                        |
| Alismatales   | Juncaginaceae    | 3                        | 34                        |
| Alismatales   | Maundiaceae      | 1                        | 1                         |
| Alismatales   | Zosteraceae      | 2                        | 22                        |
| Alismatales   | Potamogetonaceae | 6                        | 110                       |
| Alismatales   | Posidoniaceae    | 1                        | 9                         |
| Alismatales   | Ruppiceae        | 1                        | 8                         |
| Alismatales   | Cymodoceaceae    | 5                        | 17                        |
| Petrosaviales | Petrosaviaceae   | 2                        | 4                         |
| Dioscoreales  | Nartheciaceae    | 5                        | 35                        |
| Dioscoreales  | Burmanniaceae    | 8                        | 99                        |
| Dioscoreales  | Dioscoreaceae    | 9                        | 715                       |
| Pandanales    | Triuridaceae     | 9                        | 55                        |
| Pandanales    | Velloziaceae     | 5                        | 306                       |
| Pandanales    | Stemonaceae      | 4                        | 37                        |
| Pandanales    | Cyclanthaceae    | 12                       | 230                       |
| Pandanales    | Pandanaceae      | 5                        | 982                       |
| Liliales      | Campynemataceae  | 2                        | 4                         |
| Liliales      | Corsiaceae       | 3                        | 27                        |
| Liliales      | Melanthiaceae    | 17                       | 173                       |
| Liliales      | Petermanniaceae  | 1                        | 1                         |
| Liliales      | Alstroemeriaceae | 4                        | 254                       |
| Liliales      | Colchicaceae     | 15                       | 285                       |
| Liliales      | Philesiaceae     | 2                        | 2                         |
| Liliales      | Ripogonaceae     | 1                        | 6                         |
| Liliales      | Smilacaceae      | 1                        | 255                       |
| Liliales      | Liliaceae        | 15                       | 705                       |
| Asparagales   | Orchidaceae      | 736                      | 28,000                    |
| Asparagales   | Boryaceae        | 2                        | 12                        |
| Asparagales   | Blandfordiaceae  | 1                        | 4                         |
| Asparagales   | Asteliaceae      | 3                        | 37                        |
| Asparagales   | Lanariaceae      | 1                        | 1                         |
| Asparagales   | Hypoxidaceae     | 4                        | 159                       |
| Asparagales   | Doryanthaceae    | 1                        | 2                         |

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TABLE 1. (Continued)

| Order           | Family           | Approximate no of genera | Approximate no of species |
|-----------------|------------------|--------------------------|---------------------------|
| Asparagales     | Ixioliriaceae    | 1                        | 4                         |
| Asparagales     | Tecophilaeaceae  | 9                        | 27                        |
| Asparagales     | Iridaceae        | 66                       | 2,244                     |
| Asparagales     | Xeronemataceae   | 1                        | 2                         |
| Asparagales     | Asphodelaceae    | 39                       | 900                       |
| Asparagales     | Amaryllidaceae   | 75                       | 1600                      |
| Asparagales     | Asparagaceae     | 114                      | 2900                      |
| Arecales        | Dasypogonaceae   | 4                        | 16                        |
| Arecales        | Arecaceae        | 181                      | 2,600                     |
| Commelinales    | Hanguanaceae     | 1                        | 12                        |
| Commelinales    | Commelinaceae    | 41                       | 731                       |
| Commelinales    | Philydraceae     | 3                        | 6                         |
| Commelinales    | Pontederiaceae   | 6                        | 34                        |
| Commelinales    | Haemodoraceae    | 14                       | 102                       |
| Zingiberales    | Strelitziaceae   | 3                        | 7                         |
| Zingiberales    | Lowiaceae        | 1                        | 18                        |
| Zingiberales    | Heliconiaceae    | 1                        | 194                       |
| Zingiberales    | Musaceae         | 3                        | 91                        |
| Zingiberales    | Cannaceae        | 1                        | 10                        |
| Zingiberales    | Marantaceae      | 29                       | 570                       |
| Zingiberales    | Costaceae        | 7                        | 143                       |
| Zingiberales    | Zingiberaceae    | 50                       | 1,600                     |
| Poales          | Typhaceae        | 2                        | 51                        |
| Poales          | Bromeliaceae     | 51                       | 3,475                     |
| Poales          | Rapateaceae      | 16                       | 94                        |
| Poales          | Xyridaceae       | 5                        | 399                       |
| Poales          | Eriocaulaceae    | 7                        | 1,207                     |
| Poales          | Mayacaceae       | 1                        | 6                         |
| Poales          | Thurniaceae      | 2                        | 4                         |
| Poales          | Juncaceae        | 8                        | 464                       |
| Poales          | Cyperaceae       | 90                       | 5,500                     |
| Poales          | Restionaceae     | 51                       | 572                       |
| Poales          | Flagellariaceae  | 1                        | 4                         |
| Poales          | Joinvilleaceae   | 1                        | 4                         |
| Poales          | Ecdeiocoleaceae  | 2                        | 3                         |
| Poales          | Poaceae          | 780                      | 12,000                    |
| Ceratophyllales | Ceratophyllaceae | 1                        | 4                         |
| Ranunculales    | Eupteleaceae     | 1                        | 2                         |

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TABLE 1. (Continued)

| Order                   | Family            | Approximate no of genera | Approximate no of species |
|-------------------------|-------------------|--------------------------|---------------------------|
| Ranunculales            | Papaveraceae      | 42                       | 775                       |
| Ranunculales            | Circaeasteraceae  | 2                        | 2                         |
| Ranunculales            | Lardizabalaceae   | 7                        | 40                        |
| Ranunculales            | Menispermaceae    | 68                       | 440                       |
| Ranunculales            | Berberidaceae     | 14                       | 700                       |
| Ranunculales            | Ranunculaceae     | 43                       | 2,346                     |
| Proteales               | Sabiaceae         | 3                        | 66                        |
| Proteales               | Nelumbonaceae     | 1                        | 3                         |
| Proteales               | Platanaceae       | 1                        | 8                         |
| Proteales               | Proteaceae        | 83                       | 1660                      |
| Trochodendrales         | Trochodendraceae  | 2                        | 2                         |
| Buxales                 | Buxaceae          | 6                        | 123                       |
| Gunnerales              | Myrothamnaceae    | 1                        | 2                         |
| Gunnerales              | Gunneraceae       | 1                        | 63                        |
| Dilleniales             | Dilleniaceae      | 11                       | 430                       |
| Saxifragales            | Peridiscaceae     | 4                        | 12                        |
| Saxifragales            | Paeoniaceae       | 1                        | 33                        |
| Saxifragales            | Altingiaceae      | 1                        | 15                        |
| Saxifragales            | Hamamelidaceae    | 26                       | 86                        |
| Saxifragales            | Cercidiphyllaceae | 1                        | 2                         |
| Saxifragales            | Daphniphyllaceae  | 1                        | 30                        |
| Saxifragales            | Iteaceae          | 2                        | 18                        |
| Saxifragales            | Grossulariaceae   | 1                        | 150                       |
| Saxifragales            | Saxifragaceae     | 33                       | 640                       |
| Saxifragales            | Crassulaceae      | 35                       | 1,400                     |
| Saxifragales            | Aphanopetalaceae  | 1                        | 2                         |
| Saxifragales            | Tetracarpaeaceae  | 1                        | 1                         |
| Saxifragales            | Penthoraceae      | 1                        | 2                         |
| Saxifragales            | Haloragaceae      | 9                        | 145                       |
| Saxifragales or Rosales | Cynomoriaceae     | 1                        | 2                         |
| Vitales                 | Vitaceae          | 14                       | 910                       |
| Zygophyllales           | Krameriaceae      | 1                        | 18                        |
| Zygophyllales           | Zygophyllaceae    | 22                       | 285                       |
| Fabales                 | Quillajaceae      | 1                        | 3                         |
| Fabales                 | Fabaceae          | 751                      | 19,500                    |
| Fabales                 | Surianaceae       | 5                        | 8                         |
| Fabales                 | Polygalaceae      | 21                       | 900                       |
| Rosales                 | Rosaceae          | 91                       | 2,950                     |

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TABLE 1. (Continued)

| Order        | Family           | Approximate no of genera | Approximate no of species |
|--------------|------------------|--------------------------|---------------------------|
| Rosales      | Barbeyaceae      | 1                        | 1                         |
| Rosales      | Dirachmaceae     | 1                        | 2                         |
| Rosales      | Elaeagnaceae     | 3                        | 60                        |
| Rosales      | Rhamnaceae       | 55                       | 950                       |
| Rosales      | Ulmaceae         | 7                        | 45                        |
| Rosales      | Cannabaceae      | 8                        | 100                       |
| Rosales      | Moraceae         | 38                       | 1,180                     |
| Rosales      | Urticaceae       | 53                       | 2625                      |
| Fagales      | Nothofagaceae    | 1                        | 43                        |
| Fagales      | Fagaceae         | 8                        | 927                       |
| Fagales      | Myricaceae       | 3                        | 57                        |
| Fagales      | Juglandaceae     | 9                        | 50                        |
| Fagales      | Casuarinaceae    | 4                        | 91                        |
| Fagales      | Ticodendraceae   | 1                        | 1                         |
| Fagales      | Betulaceae       | 6                        | 167                       |
| Cucurbitales | Apodanthaceae    | 2                        | 10                        |
| Cucurbitales | Anisophylleaceae | 4                        | 71                        |
| Cucurbitales | Corynocarpaceae  | 1                        | 5                         |
| Cucurbitales | Coriariaceae     | 1                        | 14                        |
| Cucurbitales | Cucurbitaceae    | 95                       | 965                       |
| Cucurbitales | Tetramelaceae    | 2                        | 2                         |
| Cucurbitales | Daticaceae       | 1                        | 3                         |
| Cucurbitales | Begoniaceae      | 2                        | 1,825                     |
| Celastrales  | Lepidobotryaceae | 2                        | 2                         |
| Celastrales  | Celastraceae     | 96                       | 1,350                     |
| Oxalidales   | Huaceae          | 2                        | 4                         |
| Oxalidales   | Connaraceae      | 12                       | 180                       |
| Oxalidales   | Oxalidaceae      | 5                        | 570                       |
| Oxalidales   | Cunoniaceae      | 27                       | 330                       |
| Oxalidales   | Elaeocarpaceae   | 12                       | 615                       |
| Oxalidales   | Cephalotaceae    | 1                        | 1                         |
| Oxalidales   | Brunelliaceae    | 1                        | 60                        |
| Malpighiales | Pandaceae        | 3                        | 17                        |
| Malpighiales | Irvingiaceae     | 3                        | 13                        |
| Malpighiales | Ctenolophonaceae | 1                        | 2                         |
| Malpighiales | Rhizophoraceae   | 15                       | 147                       |
| Malpighiales | Erythroxylaceae  | 4                        | 242                       |
| Malpighiales | Ochnaceae        | 32                       | 550                       |

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TABLE 1. (Continued)

| Order        | Family           | Approximate no of genera | Approximate no of species |
|--------------|------------------|--------------------------|---------------------------|
| Malpighiales | Bonnetiaceae     | 3                        | 35                        |
| Malpighiales | Clusiaceae       | 13                       | 750                       |
| Malpighiales | Calophyllaceae   | 14                       | 475                       |
| Malpighiales | Podostemaceae    | 46                       | 300                       |
| Malpighiales | Hypericaceae     | 6                        | 590                       |
| Malpighiales | Caryocaraceae    | 2                        | 26                        |
| Malpighiales | Lophopyxidaceae  | 1                        | 1                         |
| Malpighiales | Putranjivaceae   | 2                        | 216                       |
| Malpighiales | Centroplacaceae  | 2                        | 6                         |
| Malpighiales | Elatinaceae      | 2                        | 35                        |
| Malpighiales | Malpighiaceae    | 73                       | 1,315                     |
| Malpighiales | Balanopaceae     | 1                        | 9                         |
| Malpighiales | Trigoniaceae     | 5                        | 28                        |
| Malpighiales | Dichapetalaceae  | 3                        | 170                       |
| Malpighiales | Euphroniaceae    | 1                        | 3                         |
| Malpighiales | Chrysobalanaceae | 18                       | 533                       |
| Malpighiales | Humiriaceae      | 8                        | 56                        |
| Malpighiales | Achariaceae      | 32                       | 155                       |
| Malpighiales | Violaceae        | 31                       | 980                       |
| Malpighiales | Goupiaceae       | 1                        | 2                         |
| Malpighiales | Passifloraceae   | 29                       | 980                       |
| Malpighiales | Lacistemataceae  | 2                        | 14                        |
| Malpighiales | Salicaceae       | 56                       | 1,220                     |
| Malpighiales | Peraceae         | 5                        | 127                       |
| Malpighiales | Rafflesiaceae    | 3                        | 25                        |
| Malpighiales | Euphorbiaceae    | 209                      | 6,252                     |
| Malpighiales | Linaceae         | 10                       | 255                       |
| Malpighiales | Ixonanthaceae    | 3                        | 17                        |
| Malpighiales | Picrodendraceae  | 25                       | 96                        |
| Malpighiales | Phyllanthaceae   | 57                       | 2,050                     |
| Geraniales   | Geraniaceae      | 5                        | 830                       |
| Geraniales   | Francoaceae      | 8                        | 37                        |
| Myrtales     | Combretaceae     | 10                       | 530                       |
| Myrtales     | Lythraceae       | 27                       | 620                       |
| Myrtales     | Onagraceae       | 22                       | 656                       |
| Myrtales     | Vochysiaceae     | 7                        | 217                       |
| Myrtales     | Myrtaceae        | 132                      | 5,950                     |
| Myrtales     | Melastomataceae  | 165                      | 5,115                     |

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TABLE 1. (Continued)

| Order           | Family            | Approximate no of genera | Approximate no of species |
|-----------------|-------------------|--------------------------|---------------------------|
| Myrtales        | Crypteroniaceae   | 3                        | 13                        |
| Myrtales        | Alzateaceae       | 1                        | 1                         |
| Myrtales        | Penaeaceae        | 9                        | 32                        |
| Crossosomatales | Aphloiaceae       | 1                        | 1                         |
| Crossosomatales | Geissolomataceae  | 1                        | 1                         |
| Crossosomatales | Strasburgeriaceae | 2                        | 2                         |
| Crossosomatales | Staphyleaceae     | 2                        | 45                        |
| Crossosomatales | Guamatelaceae     | 1                        | 1                         |
| Crossosomatales | Stachyuraceae     | 1                        | 8                         |
| Crossosomatales | Crossosomataceae  | 4                        | 10                        |
| Picramniales    | Picramniaceae     | 3                        | 49                        |
| Sapindales      | Biebersteiniaceae | 1                        | 4                         |
| Sapindales      | Nitrariaceae      | 3                        | 19                        |
| Sapindales      | Kirkiaceae        | 1                        | 6                         |
| Sapindales      | Burseraceae       | 19                       | 615                       |
| Sapindales      | Anacardiaceae     | 83                       | 860                       |
| Sapindales      | Sapindaceae       | 142                      | 1,860                     |
| Sapindales      | Rutaceae          | 148                      | 2,070                     |
| Sapindales      | Simaroubaceae     | 22                       | 108                       |
| Sapindales      | Meliaceae         | 53                       | 600                       |
| Huerteales      | Gerrardinaceae    | 1                        | 2                         |
| Huerteales      | Petenaeeae        | 1                        | 1                         |
| Huerteales      | Tapisciaceae      | 2                        | 6                         |
| Huerteales      | Dipentodontaceae  | 2                        | 20                        |
| Malvales        | Cytinaceae        | 2                        | 10                        |
| Malvales        | Muntingiaceae     | 3                        | 3                         |
| Malvales        | Neuradaceae       | 3                        | 10                        |
| Malvales        | Malvaceae         | 244                      | 4,225                     |
| Malvales        | Sphaerosepalaceae | 2                        | 18                        |
| Malvales        | Thymelaeaceae     | 46                       | 913                       |
| Malvales        | Bixaceae          | 4                        | 23                        |
| Malvales        | Cistaceae         | 9                        | 170                       |
| Malvales        | Sarcolaenaceae    | 10                       | 71                        |
| Malvales        | Dipterocarpaceae  | 16                       | 695                       |
| Brassicales     | Akaniaceae        | 2                        | 2                         |
| Brassicales     | Tropaeolaceae     | 1                        | 94                        |
| Brassicales     | Moringaceae       | 1                        | 13                        |
| Brassicales     | Caricaceae        | 6                        | 35                        |

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TABLE 1. (Continued)

| Order             | Family             | Approximate no of genera | Approximate no of species |
|-------------------|--------------------|--------------------------|---------------------------|
| Brassicales       | Limnanthaceae      | 2                        | 8                         |
| Brassicales       | Setchellanthaceae  | 1                        | 1                         |
| Brassicales       | Koerberliniaceae   | 1                        | 2                         |
| Brassicales       | Bataceae           | 1                        | 2                         |
| Brassicales       | Salvadoraceae      | 3                        | 11                        |
| Brassicales       | Emblingiaceae      | 1                        | 1                         |
| Brassicales       | Tovariaceae        | 1                        | 2                         |
| Brassicales       | Pentadiplandraceae | 1                        | 1                         |
| Brassicales       | Gyrostemonaceae    | 4                        | 20                        |
| Brassicales       | Resedaceae         | 12                       | 107                       |
| Brassicales       | Capparaceae        | 30                       | 324                       |
| Brassicales       | Cleomaceae         | 1                        | 346                       |
| Brassicales       | Brassicaceae       | 328                      | 3,628                     |
| Berberidopsidales | Aextoxicaceae      | 1                        | 1                         |
| Berberidopsidales | Berberidopsidaceae | 2                        | 3                         |
| Santalales        | Olacaceae          | 29                       | 180                       |
| Santalales        | Opiliaceae         | 11                       | 33                        |
| Santalales        | Balanophoraceae    | 17                       | 44                        |
| Santalales        | Santalaceae        | 43                       | 1,000                     |
| Santalales        | Misodendraceae     | 1                        | 8                         |
| Santalales        | Schoepfiaceae      | 3                        | 58                        |
| Santalales        | Loranthaceae       | 76                       | 1,050                     |
| Caryophyllales    | Frankeniaceae      | 1                        | 90                        |
| Caryophyllales    | Tamaricaceae       | 4                        | 78                        |
| Caryophyllales    | Plumbaginaceae     | 30                       | 725                       |
| Caryophyllales    | Polygonaceae       | 48                       | 1,200                     |
| Caryophyllales    | Droseraceae        | 3                        | 180                       |
| Caryophyllales    | Nepenthaceae       | 1                        | 150                       |
| Caryophyllales    | Drosophyllaceae    | 1                        | 1                         |
| Caryophyllales    | Dioncophyllaceae   | 3                        | 3                         |
| Caryophyllales    | Ancistrocladaceae  | 1                        | 21                        |
| Caryophyllales    | Rhabdodendraceae   | 1                        | 3                         |
| Caryophyllales    | Simmondsiaceae     | 1                        | 1                         |
| Caryophyllales    | Physenaceae        | 1                        | 2                         |
| Caryophyllales    | Asteropeiaceae     | 1                        | 8                         |
| Caryophyllales    | Macarthuriaceae    | 1                        | 10                        |
| Caryophyllales    | Microteaceae       | 1                        | 9                         |
| Caryophyllales    | Caryophyllaceae    | 81                       | 2,625                     |

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TABLE 1. (Continued)

| Order          | Family             | Approximate no of genera | Approximate no of species |
|----------------|--------------------|--------------------------|---------------------------|
| Caryophyllales | Achatocarpaceae    | 2                        | 11                        |
| Caryophyllales | Amaranthaceae      | 165                      | 2,040                     |
| Caryophyllales | Stegnospermataceae | 1                        | 4                         |
| Caryophyllales | Limeaceae          | 1                        | 21                        |
| Caryophyllales | Lophiocarpaceae    | 2                        | 6                         |
| Caryophyllales | Kewaceae           | 1                        | 8                         |
| Caryophyllales | Barbeuiaceae       | 1                        | 1                         |
| Caryophyllales | Gisekiaceae        | 1                        | 8                         |
| Caryophyllales | Aizoaceae          | 121                      | 1,900                     |
| Caryophyllales | Phytolaccaceae     | 5                        | 33                        |
| Caryophyllales | Petiveriaceae      | 9                        | 20                        |
| Caryophyllales | Sarcobataceae      | 1                        | 2                         |
| Caryophyllales | Nyctaginaceae      | 31                       | 400                       |
| Caryophyllales | Molluginaceae      | 9                        | 80                        |
| Caryophyllales | Montiaceae         | 14                       | 230                       |
| Caryophyllales | Didiereaceae       | 7                        | 22                        |
| Caryophyllales | Basellaceae        | 4                        | 19                        |
| Caryophyllales | Halophytaceae      | 1                        | 1                         |
| Caryophyllales | Talinaceae         | 2                        | 28                        |
| Caryophyllales | Portulacaceae      | 1                        | 115                       |
| Caryophyllales | Anacampserotaceae  | 3                        | 36                        |
| Caryophyllales | Cactaceae          | 127                      | 1750                      |
| Cornales       | Nyssaceae          | 5                        | 37                        |
| Cornales       | Hydrostachyaceae   | 1                        | 22                        |
| Cornales       | Hydrangeaceae      | 9                        | 223                       |
| Cornales       | Loasaceae          | 20                       | 308                       |
| Cornales       | Curtisiaceae       | 1                        | 1                         |
| Cornales       | Grubbiaceae        | 1                        | 3                         |
| Cornales       | Cornaceae          | 2                        | 85                        |
| Ericales       | Balsaminaceae      | 2                        | 1,000                     |
| Ericales       | Marcgraviaceae     | 7                        | 120                       |
| Ericales       | Tetrameristaceae   | 3                        | 5                         |
| Ericales       | Fouquieriaceae     | 1                        | 11                        |
| Ericales       | Polemoniaceae      | 26                       | 350                       |
| Ericales       | Lecythidaceae      | 25                       | 355                       |
| Ericales       | Sladeniaceae       | 2                        | 3                         |
| Ericales       | Pentaphragmaceae   | 12                       | 330                       |
| Ericales       | Sapotaceae         | 54                       | 1,273                     |

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TABLE 1. (Continued)

| Order         | Family            | Approximate no of genera | Approximate no of species |
|---------------|-------------------|--------------------------|---------------------------|
| Ericales      | Ebenaceae         | 4                        | 800                       |
| Ericales      | Primulaceae       | 53                       | 2,790                     |
| Ericales      | Theaceae          | 9                        | 240                       |
| Ericales      | Symplocaceae      | 2                        | 260                       |
| Ericales      | Diapensiaceae     | 5                        | 12                        |
| Ericales      | Styracaceae       | 11                       | 160                       |
| Ericales      | Sarraceniaceae    | 3                        | 34                        |
| Ericales      | Roridulaceae      | 1                        | 2                         |
| Ericales      | Actinidiaceae     | 3                        | 360                       |
| Ericales      | Clethraceae       | 2                        | 75                        |
| Ericales      | Cyrillaceae       | 2                        | 2                         |
| Ericales      | Ericaceae         | 124                      | 4,250                     |
| Ericales      | Mitrastemonaceae  | 1                        | 2                         |
| Icacinales    | Oncothecaceae     | 1                        | 2                         |
| Icacinales    | Icacinaceae       | 25                       | 165                       |
| Metteniusales | Metteniusaceae    | 11                       | 50                        |
| Garryales     | Eucommiaceae      | 1                        | 1                         |
| Garryales     | Garryaceae        | 2                        | 25                        |
| Gentianales   | Rubiaceae         | 590                      | 13,620                    |
| Gentianales   | Gentianaceae      | 102                      | 1735                      |
| Gentianales   | Loganiaceae       | 15                       | 390                       |
| Gentianales   | Gelsemiaceae      | 3                        | 11                        |
| Gentianales   | Apocynaceae       | 366                      | 5,100                     |
| Gentianales   | Boraginaceae      | 135                      | 2,535                     |
| Vahliales     | Vahliaceae        | 1                        | 8                         |
| Solanales     | Convolvulaceae    | 53                       | 1,660                     |
| Solanales     | Solanaceae        | 100                      | 2,600                     |
| Solanales     | Montiniaceae      | 3                        | 5                         |
| Solanales     | Sphenocleaceae    | 1                        | 2                         |
| Solanales     | Hydroleaceae      | 1                        | 12                        |
| Lamiales      | Plocospermataceae | 1                        | 1                         |
| Lamiales      | Carlemanniaceae   | 2                        | 5                         |
| Lamiales      | Oleaceae          | 26                       | 790                       |
| Lamiales      | Tetrachondraceae  | 2                        | 3                         |
| Lamiales      | Calceolariaceae   | 2                        | 271                       |
| Lamiales      | Gesneriaceae      | 152                      | 3,540                     |
| Lamiales      | Plantaginaceae    | 94                       | 1,900                     |
| Lamiales      | Scrophulariaceae  | 62                       | 1,830                     |

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TABLE 1. (Continued)

| Order          | Family             | Approximate no of genera | Approximate no of species |
|----------------|--------------------|--------------------------|---------------------------|
| Lamiales       | Stilbaceae         | 8                        | 40                        |
| Lamiales       | Linderniaceae      | 23                       | 220                       |
| Lamiales       | Byblidaceae        | 1                        | 7                         |
| Lamiales       | Martyniaceae       | 5                        | 16                        |
| Lamiales       | Pedaliaceae        | 13                       | 75                        |
| Lamiales       | Acanthaceae        | 210                      | 4,000                     |
| Lamiales       | Bignoniaceae       | 82                       | 870                       |
| Lamiales       | Lentibulariaceae   | 3                        | 316                       |
| Lamiales       | Schlegeliaceae     | 4                        | 37                        |
| Lamiales       | Thomandersiaceae   | 1                        | 6                         |
| Lamiales       | Verbenaceae        | 32                       | 1,000                     |
| Lamiales       | Lamiaceae          | 241                      | 7530                      |
| Lamiales       | Mazaceae           | 3                        | 33                        |
| Lamiales       | Phrymaceae         | 13                       | 186                       |
| Lamiales       | Paulowniaceae      | 3                        | 8                         |
| Lamiales       | Orobanchaceae      | 98                       | 1,960                     |
| Aquifoliales   | Stemonuraceae      | 12                       | 90                        |
| Aquifoliales   | Cardiopteridaceae  | 5                        | 43                        |
| Aquifoliales   | Phyllonomaceae     | 1                        | 4                         |
| Aquifoliales   | Helwingiaceae      | 1                        | 4                         |
| Aquifoliales   | Aquifoliaceae      | 1                        | 500                       |
| Asterales      | Rousseaceae        | 4                        | 6                         |
| Asterales      | Campanulaceae      | 81                       | 2,300                     |
| Asterales      | Pentaphragmataceae | 1                        | 30                        |
| Asterales      | Stylidiaceae       | 6                        | 245                       |
| Asterales      | Alseuosmiaceae     | 5                        | 13                        |
| Asterales      | Phellinaceae       | 1                        | 12                        |
| Asterales      | Argophyllaceae     | 2                        | 21                        |
| Asterales      | Menyanthaceae      | 6                        | 60                        |
| Asterales      | Goodeniaceae       | 12                       | 440                       |
| Asterales      | Calyceraceae       | 4                        | 60                        |
| Asterales      | Asteraceae         | 1,623                    | 24,700                    |
| Escalloniales  | Escalloniaceae     | 7                        | 103                       |
| Bruniales      | Columelliaceae     | 2                        | 8                         |
| Bruniales      | Bruniaceae         | 6                        | 81                        |
| Paracryphiales | Paracryphiaceae    | 3                        | 36                        |
| Dipsacales     | Adoxaceae          | 5                        | 225                       |
| Dipsacales     | Caprifoliaceae     | 28                       | 825                       |

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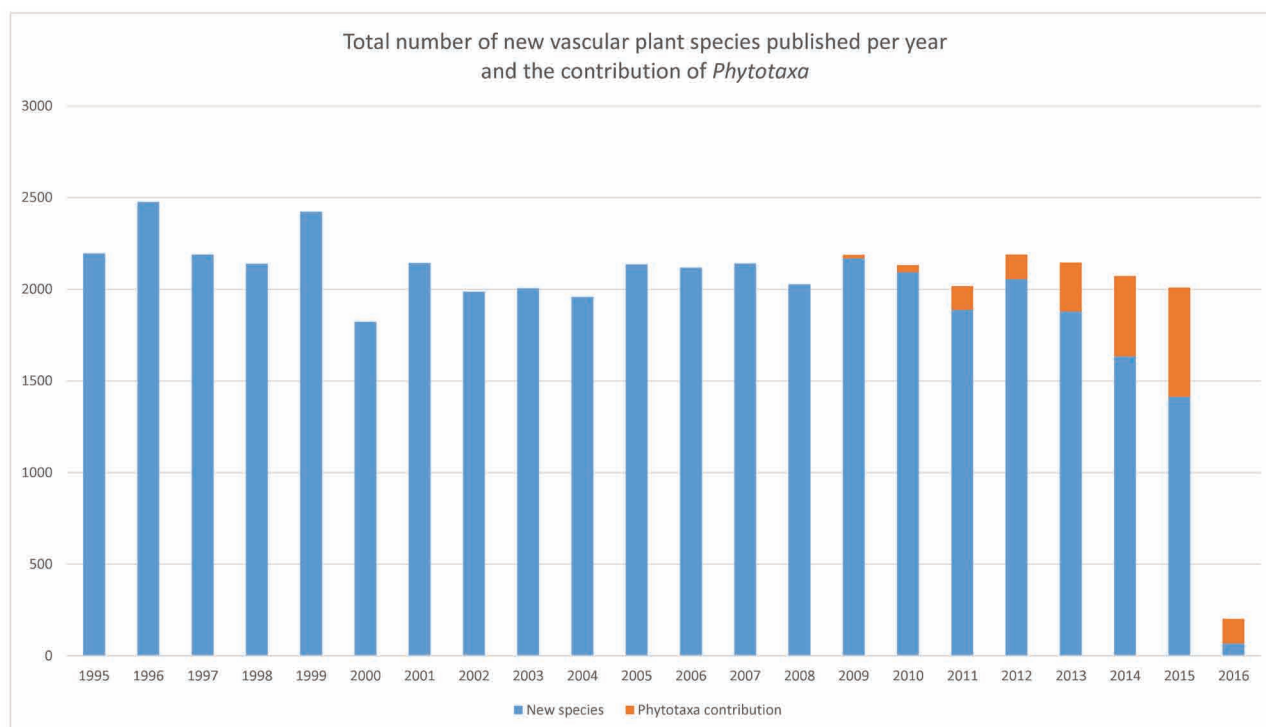
TABLE 1. (Continued)

| Order                        | Family         | Approximate no of genera | Approximate no of species |
|------------------------------|----------------|--------------------------|---------------------------|
| Apiales                      | Pennantiaceae  | 1                        | 4                         |
| Apiales                      | Toricelliaceae | 3                        | 10                        |
| Apiales                      | Griselinaceae  | 1                        | 7                         |
| Apiales                      | Pittosporaceae | 7                        | 245                       |
| Apiales                      | Araliaceae     | 43                       | 1,650                     |
| Apiales                      | Myodocarpaceae | 2                        | 15                        |
| Apiales                      | Apiaceae       | 442                      | 3,575                     |
| <b>Total angiosperms</b>     | <b>416</b>     | <b>13,164</b>            | <b>295,383</b>            |
| <b>Total vascular plants</b> | <b>452</b>     | <b>13,467</b>            | <b>308,312</b>            |

The largest vascular plant families are Orchidaceae (ca 736 genera, ca 28,000 species; Chase *et al.* 2015) and Asteraceae (ca 1,623 genera, ca 24,700 species; e.g. Funk *et al.* 2009), the difference showing that the generic taxonomy of Asteraceae appears to need further revision as the rate of species per genus is higher in Orchidaceae than in Asteraceae, which has fewer species but more than twice the number of genera, which seems highly inflated.

Since Linnaeus (1753) over 250,000 plant species have been described (Payne 2016) and the number of species is increasing every day, particularly in large families like Orchidaceae, Asteraceae and Fabaceae. However, the rate of new species discovery and publication has not always been the same. During ages of exploration in the 18<sup>th</sup> and 19<sup>th</sup> Centuries, spikes in numbers of published new species names can be observed. Peaks in species description are particularly noticeable in the periods between 1830–1850 and 1890–1920, when per decade over 35,000 species names were proposed (Lindon *et al.* 2015; note that this data includes new species, new names and new combinations). These corresponded with major taxonomic works (e.g. Candolle 1824–1873, Steudel 1840–1841, Bentham & Hooker 1862–1883, Kuntze 1891–1898) or major regional floristic studies of newly explored areas (e.g. Siebold & Zuccarini 1837–1870, Martius 1840–1906, Boissier 1843–1859, Miquel 1855–1859), when species delimitation became more closely scrutinised. Currently the numbers of new species published per decade (excluding new combinations) has stabilised around 20,000 per decade (Lindon *et al.* 2015). An average of ca 2,000 new species are now published annually, although the last years there seems to be a slight decline and we can only hope that this is not a continuing trend (Fig. 1). It should be noted that *Phytotaxa* contributed over a quarter of the total number of species published in 2015 (Fig 1), a major increase in the input of this journal to plant taxonomy, making it currently the largest journal in systematic botany in the world (Zhang *et al.* 2014). The main countries that yield the greatest numbers of new species are Australia, Brazil, China and New Guinea, although many smaller African, American, Pacific and Central and tropical Asian countries also contribute substantial numbers, which is reflected in the increase in new species published by scientists from biodiverse BRIC countries, which have invested in their taxonomic capacity, shifting away from European and North American taxonomists as main descriptors of taxonomic novelties (Zhang *et al.* 2014). A recent study has shown that most new species are probably to be found in the world's biodiversity hotspots (Joppa *et al.* 2011b). Large parts of the world are still in need of further biological exploration, particularly these designated biodiversity hotspots, but large areas not designated as such, particularly in the tropics and subtropics are still greatly in need of field study as well. The specific dynamics of species exploration, description, extinction rates (estimated to be 1000 to 10,000 times the background rate) and numbers of scientists involved in this work is detailed by the exploratory analyses of Pimm & Joppa (2015).

The age of large general botanical explorations appears to be over, even though many new species are still to be discovered. It seems that most new species are now discovered among existing collections in herbaria (Bebber *et al.* 2010), but as taxonomy is increasingly under financial pressure, resulting in a reduced number of taxonomists in big natural history institutions being paid by core funding to carry out descriptive, fundamental sciences. Fundamental research, needed to build upon applied studies which are generally well-funded, are not receiving the recognition among funding bodies that is required to complete the task of documenting and describing the natural diversity of our planet, plants in particular. It seems that discovery of extinct animals (particularly dinosaurs) receive more attention by the media and leading scientific journals than a new species of plant or animal that is still living among us. Do we really need species to become extinct before we value their fundamental description and associated traits?



**FIGURE 1.** Increase in numbers of new vascular plant species published during the last two decades, based on data from the International Plant Name Index (IPNI 2016; [www.ipni.org](http://www.ipni.org), accessed 6 March 2016). The actual numbers may possibly be somewhat higher as these numbers exclude hybrid taxa (which may be considered species in some cases) and taxa known at subspecific ranks that were elevated to species. On the other hand it includes species that were published but are now no longer accepted, which may even the numbers out. The years 2015 and 2016 were not yet completely indexed at this time and hence their final numbers will be higher.

It is important to estimate the numbers of known species, as we are dealing with an unprecedented rate of extinction. Since Linnaeus aimed to document all species of plants in 1753, the starting date of nomenclatural taxonomy of vascular plants, 139 described plant species are now known to have become extinct or only occur in cultivation (categories EX and EW of IUCN 2015), although many may have disappeared without ever having been discovered or further categorised as such (see Pimm & Joppa 2015 for further information on the current extinction rate of plant species). Taxonomy still has a massive task to undertake to describe and classify new species and *Phytotaxa* has played a major role in accelerating the publication of this species discovery, with the publication of 1750 new species since its foundation in 2009 (Christenhusz *et al.* 2009, Christenhusz *et al.* 2011, Zhang *et al.* 2014).

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