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Research Article

Evolutionary System of Magnoliaceae Based on Chloroplast Genomic and Morphological Evolutionomy

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Abstract

Magnoliaceae Juss. are the most primitive taxa of Fructophyta D.L. Fu & H.Fu and have extremely important scientific values for the research of evolutionomy of fruit plants. Based on the evolutionary analysis of the complete chloroplast genomes of representative plants of Magnoliaceae in the NCBI (National Center for Biotechnology Information, USA) database, this paper firstly established the evolutionary systems of subgenera and sections of *Magnolia* L. and that of sections of *Michelia* L. and firstly proposed the evolutionary boundary of subgenera of Magnoliaceae Juss.. Magnoliaceae Juss. include 4 natural genera: *Yulania* Spach, *Magnolia* L., *Michelia* L. and *Liriodendron* L., which all have the same boundary: PHS (17bp) ≥ 0.9234 (intragenus) or PHS (17bp) ≤ 0.9232 (inter genera). The most primitive genus of Magnoliaceae Juss. is *Yulania* Spach not *Magnolia* L.. The genus *Magnolia* L. includes 7 natural subgenera and the evolutionary boundary is PHS (17bp) ≥ 0.938 (intrasubgenus) or PHS (17bp) ≤ 0.937 (inter subgenera). *Magnolia* subgen. *Talauma* (Juss.) Pierre includes 3 natural sections, *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu includes 4 natural sections and *Michelia* L. includes 3 natural sections, which all have the same evolutionary boundary: PHS (17bp) ≥ 0.961 (intrasection) or PHS (17bp) ≤ 0.960 (inter sections). Moreover, 4 new subgeneric combinations, 1 new section and 3 new sectional combinations, 14 new specific names and 95 new specific combinations have been scientifically and validly published. This paper scientifically solves the confusion between the traditional classification system and the modern phylogenic system of Magnoliaceae, and lays a solid theoretical and practical foundation for the research of fruit plant evolution.

Keywords

Evolutionary System, Evolutionomy, Magnoliaceae, New Taxa, Chloroplast Complete Genome, Typical Algorithm

1. Introduction

The plants of Magnoliaceae Juss. [1-12] have many primitive characters such as branchlets with annular stipular scars, flower (mixed) bud with spathaceous perules and bracts, and androecia and gynoecia spirally arranged on the elongated tori [13-44], are the most primitive taxa of Fructophyta [45-46] and will play an important role in the evolutionomy

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of fruit plants. But they are also difficult taxa of traditional classification because different taxonomists have different even controversial opinions, such as two systems of Nooteboom and Xia in Flora of China [39]. Among many traditional classification systems of Magnoliaceae, Xia's 17 genera systems [40] is the most authoritative, but most of the genera are not supported by modern phylogenic theories.

The main basis of phylogenic theories is the "tree of life" of Darwin's theory of evolution [47], based on the theories of "common ancestor" and "germogenesis" [48]. Because of the theory's subjectivity and partiality, the system cannot scientifically show the evolutionary relationships among different beings [45, 48-49], which can lead to new confusions of classification of fruit plants. For example, the plastid tree of subfamily Magnolioideae Y.W.Law of Magnoliaceae based on phylogenic theories [37] has some obvious deficiencies. First, the two biggest Clade system (Clade I and Clade II) is very different from the system of three subgenera established before [9], and the three bigger Clades of Clade II (Clade A, Clade B and Clade C) and the four bigger Clades of Clade C, may be called Clade C1, Clade C2, Clade C3 and Clade C4 here, should be what rank of the classification of the system? No answer in the paper, actually the theoretical limitation of Phylogeny. Next, the Clade C3 is genus *Yulania* Spach and the Clade C4 is genus *Michelia* L., which had the closest phylogenic relationship in the paper, but in fact *Michelia* L. and *Yulania* Spach have the closest phylogenetic and evolutionary relationships with genus *Magnolia* L. respectively [51], also the theoretical limitation of phylogeny. Finally, the Clade C, a mishmash, includes the plants of Genera of *Yulania* Spach, *Magnolia* L. and *Michelia* L., which will consequentially lead to new confusions of taxonomy of Magnoliaceae Juss., and the Clade C4 (*Michelia* L.) had two sections (Clades): Sect. *Michelia* and Sect. *Maingola*, which should be appearing next in the taxonomic key, but Sect. *Michelia* was first and Sect. *Maingola* was eleventh, logical confusion of hierarchy.

The publications of the evolutionary continuity principle [45], the evolutionary particularity principle [46] and the first systematic theoretical monograph of new science of Evolutionomy "The Theory and Practice of Evolutionomy" [49] marked the formation of the basic theoretical system of evolutionary, which can overcome the shortcomings of traditional plant taxonomy and modern phylogenic theory, and can establish a scientific evolutionary system based on the evolutionary relationships between organisms, and scientifically solve the mystery of biological evolution. For example, based on the chloroplast complete genomes of 28 species of Magnoliaceae, the evolutionary system of Magnoliaceae includes 4 natural genera: *Yulania* Spach, *Magnolia* L., *Michelia* L. and *Liriodendron* L., which have the same evolutionary boundary: PHS(17bp) ≥ 0.93 (intragenus) (or PHS ≤ 0.92 inter genera) [51], and the evolutionary system of genus *Yulania* Spach includes 4 natural sections: *Yulania* sect. *Yulania*, *Yulania* sect. *Buergeria* (Sieb. & Zucc.) D.L.Fu, *Yulania* sect. *Rosula* D.L.Fu and *Yulania* sect. *Tulipastrum* (Spach) D.L.Fu, which have the same evolutionary boundary: PHS(17bp) ≤ 0.960 (inter sections) (or PHS(17bp) ≥0.961 intrasection) [50]. Based on the analyses of chloroplast complete genomic sequences, it is discovered that fruit plants originated from Ginkgoopsida, not from Cycadopsida thought by the euanthium-theory or Chlamydopsermopsida thought by the pseudoanthium-theory, and the relatively most primitive species of fruit plants is the new species *Yulania puberula* D.L.Fu [51], not the plants of Amborellaceae Pinch. in APG system [47], which scientifically solve the mystery of the origin and evolution of fruit plants.

Since 1978 [21], many new combinations or new names of Magnoliaceae Juss. have been published by many taxonomists [2, 3, 5, 6, 8, 10, 11, 22, 27-32, 34-36, 40, 52-53], but most of them are not validly published, according to the Article 37.1 "A name published on or after 1 January 1953 without a clear indication of the rank of the taxon concerned is not validly published" and other relevant articles of International Code of Botanical Nomenclature (Melbourne Code, 2011). So, relevant taxa urgently need to be scientifically and validly published or established.

In order to do this, the authors downloaded 78 representative chloroplast complete genomic sequences of Magnoliaceae from the NCBI (National Center for Biotechnology Information, USA) database, carried out evolutionomic analysis, established the evolutionary systems of genus, subgenus and section ranks, and developed the taxonomic keys to the genera, subgenera and sections of the family. The results are as follows.

2. Materials and Methods

2.1. Chloroplast Complete Genomes of Magnoliaceae Juss

Total 78 chloroplast complete genomes of representative species of Magnoliaceae were selected from NCBI (National Center for Biotechnology Information, USA) database. Their correct names and cpDNA numbers of NCBI are listed in Table 1, Table 2, Table 3 or Table 4.

2.2. Evolutionary Analyses of Chloroplast Genomes

The typical algorithm [51] is mainly adopted in the evolutionary analyses of chloroplast genomes, by comparing the phylogenetic similarity (PHS) and the evolutionary similarity (EVS) between the designated type and objective taxon which can determine the relatively evolutionary relationships among different taxa. The formulae are as follows:

$$PHS = \frac{\text{SPHL}}{\text{APHL}}$$

PHS = phylogenetic similarity between the type and objective taxon; SPHL = the number of same phylogenetic loci between the type and objective taxon; APHL = the number of all phylogenetic loci of the type; statistics of phylogenetic loci using Nucleotide Barcodes (17bp).

$$EVS = \frac{\text{SEVL}}{\text{AEVL}}$$

EVS = evolutionary similarity; SEVL = same evolutionary loci between the type and taxon; AEVL = all evolutionary loci of the type (evolutionary loci statistics just including SNB (17bp) of transitions and transversions in the middle of barcode; SNB = Single Nucleotide Barcodes).

3. The Evolutionary System of Genera of Magnoliaceae Juss

3.1. Confirmation of 4 Genera of Magnoliaceae

The phylogenetic similarities (PHS) are analyzed based on the chloroplast complete genome of 78 species of Magnoliaceae using the types of 4 species: *Yulania denudata* (Desr.) D.L.Fu, *Magnolia wilsonii* Rehd., *Michelia tsiampacca* L. and *Liriodendron tulipifera* L. respectively, and the results are shown in Tables 1 to 4.

Table 1. *PHS of chloroplast genomes between Yulania denudata and different species of Magnoliaceae Juss.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Yulania denudata*_JN867577.1	133206	1	*Michelia baillonii*_NC048453.1	121457	0.9118
*Yulania cylindrica*_MN990617.1	131801	0.9895	*Magnolia delavayi*_MN780910.1	121410	0.9114
*Yulania liliiflora*_NC023238.1	129270	0.9705	*Magnolia championii*_MN990574.1	121372	0.9112
*Yulania salicifolia*_NC023240.1	127070	0.9539	*Michelia maudiae*_NC047409.1	121370	0.9111
*Yulania zenii*_NC040954.1	126573	0.9502	*Magnolia ovata*_NC048993.1	121339	0.9109
*Yulania campbellii*_MN457685.1	126571	0.9502	*Michelia champaca*_MT269873.1	121335	0.9109
*Yulania dawsonia*_MN990622.1	126568	0.9502	*Magnolia grandiflora*_NC020318.1	121332	0.9109
*Yulania viridula*_MN990590.1	126505	0.9497	*Magnolia gilbertoi*_NC048958.1	121328	0.9108
*Yulania biondii*_KY085894.1	126313	0.9483	*Magnolia shangsiensis*_MN990575.1	121297	0.9106
*Yulania pseudokobus*_LC530277.1	126170	0.9472	*Magnolia fraseri*_MN990599.1	121295	0.9106
*Yulania cordata*_MW415416.1	123745	0.9290	*Magnolia tamaulipana*_NC057299.1	121275	0.9104
*Yulania acuminata*_JX280391.1	123659	0.9283	*Magnolia pyramidata*_NC023236.1	121260	0.9103
*Magnolia nitida*_MN990640.1	122799	0.9219	*Michelia chapensis*_NC053737.1	121257	0.9103
*Magnolia omeiensis*_NC048460.1	122554	0.9200	*Magnolia virginiana*_MN990608.1	121245	0.9102
*Magnolia mexicana*_MN700657.1	122478	0.9195	*Michelia compressa*_MN604380.1	121231	0.9101
*Magnolia sinica*_NC023241.1	122465	0.9194	*Magnolia bidoupensis*_MN990624.1	121224	0.9100
*Magnolia ofeliae*_NC051512.1	122459	0.9193	*Magnolia siamensis*_MN990592.1	121171	0.9097
*Magnolia duperreana*_NC057297.1	122432	0.9191	*Magnolia chimantensis*_MN990632.1	121157	0.9095
*Magnolia macrophylla*_MN990609.1	122117	0.9168	*Michelia cathcartii*_NC023234.1	121126	0.9093
*Magnolia dodecapetala*_NC048992.1	122039	0.9162	*Michelia figo*_NC053861.1	121123	0.9093
*Magnolia polita*_MN990605.1	122032	0.9161	*Magnolia officinalis*_NC020316.1	121121	0.9093
*Magnolia portoricensis*_MN990604.1	122008	0.9159	*Michelia martini*_NC054188.1	121111	0.9092
*Magnolia kachirachirai*_MN990641.1	121875	0.9149	*Magnolia coco*_NC050980.1	121091	0.9091
*Magnolia dealbata*_NC023235.1	121824	0.9146	*Magnolia decidua*_MN990591.1	121079	0.9090
*Magnolia amazonica*_NC048959.1	121815	0.9145	*Michelia shiluensis*_NC047417.1	121054	0.9088
*Magnolia hookeri*_NC053862.1	121748	0.9140	*Magnolia yalana*_MT560391.1	121034	0.9086

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Michelia malayca*_MN990630.1	121739	0.9139	*Magnolia guatemalensis*_MN990628.1	121025	0.9086
*Magnolia zhengyiana*_NC053863.1	121728	0.9138	*Michelia odora*_NC023239.1	121014	0.9085
*Magnolia obovata*_MN990571.1	121644	0.9132	*Magnolia odoratissima*_NC042680.1	121013	0.9085
*Magnolia wilsonii*_NC046054.1	121643	0.9132	*Magnolia hodgsonii*_MN990587.1	120996	0.9083
*Magnolia dixonii*_NC048960.1	121615	0.9130	*Michelia montana*_MN990614.1	120995	0.9083
*Michelia balansae*_NC053860.1	121612	0.9130	*Magnolia albosericea*_MN990620.1	120907	0.9077
*Magnolia dandyi*_NC037004.1	121609	0.9129	*Magnolia pacifica*_MN990636.1	120901	0.9076
*Magnolia duclouxii*_NC037002.1	121580	0.9127	*Michelia tsiampacca*_MN990607.1	120862	0.9073
*Magnolia tripetala*_NC024027.1	121578	0.9127	*Magnolia sieboldii*_MN990583.1	120762	0.9066
*Michelia laevifolia*_NC035956.1	121575	0.9127	*Magnolia lenticellata*_MN990629.1	120662	0.9058
*Magnolia conifera*_NC037001.1	121558	0.9126	*Michelia ovalis*_MN990602.1	120654	0.9058
*Magnolia kwangsiensis*_HM775382.1	121536	0.9124	*Liriodendron tulipifera*_DQ899947.1	103965	0.7805
*Michelia gioii*_NC057298.1	121521	0.9123	*Liriodendron chinense*_NC030504.1	103689	0.7784

Table 2. *PHS of chloroplast genomes between Magnolia wilsonii and different species of Magnoliaceae Juss.*

Species name and cpDNA number of NCBI	PHL17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia wilsonii*_NC046054.1	133149	1	*Magnolia grandiflora*_NC020318.1	123344	0.9264
*Magnolia obovata*_MN990571.1	126866	0.9528	*Magnolia yalana*_MT560391.1	123188	0.9252
*Magnolia tripetala*_NC024027.1	126856	0.9527	*Magnolia hodgsonii*_MN990587.1	123138	0.9248
*Magnolia sieboldii*_ MN990583.1	125819	0.9449	*Magnolia coco*_NC050980.1	123125	0.9247
*Magnolia hookeri*_NC053862.1	125719	0.9442	*Magnolia albosericea*_MN990620.1	123103	0.9246
*Magnolia zhengyiana*_NC053863.1	125708	0.9441	*Magnolia odoratissima*_NC042680.1	123053	0.9242
*Magnolia duclouxii*_NC037002.1	125580	0.9432	*Magnolia lenticellata*_MN990629.1	122973	0.9236
*Magnolia officinalis*_NC020316.1	125533	0.9428	*Magnolia kachirachirai*_MN990641.1	122944	0.9234
*Magnolia dandyi*_NC037004.1	125517	0.9427	*Yulania cordata*_MW415416.1	122919	0.9232
*Magnolia conifera*_NC037001.1	125435	0.9421	*Yulania acuminata*_JX280391.1	122816	0.9224
*Magnolia decidua*_MN990591.1	125034	0.9391	*Michelia malayca*_MN990630.1	122790	0.9222
*Magnolia mexicana*_MN700657.1	124680	0.9364	*Yulania salicifolia*_NC023240.1	122731	0.9218
*Magnolia ofeliae*_NC051512.1	124634	0.9360	*Michelia laevifolia*_NC035956.1	122659	0.9212
*Magnolia duperreana*_NC057297.1	124606	0.9358	*Michelia balansae*_NC053860.1	122606	0.9208
*Magnolia macrophylla*_MN990609.1	124266	0.9333	*Michelia gioii*_NC057298.1	122545	0.9204
*Magnolia polita*_MN990605.1	124253	0.9332	*Michelia baillonii*_NC048453.1	122491	0.9200
*Magnolia dodecapetala*_NC048992.1	124229	0.933	*Michelia champaca*_MT269873.1	122463	0.9197
*Magnolia portoricensis*_MN990604.1	124210	0.9329	*Michelia maudiae*_NC047409.1	122419	0.9194
*Magnolia amazonica*_NC048959.1	124157	0.9325	*Michelia chapensis*_NC053737.1	122342	0.9188
*Magnolia tamaulipana*_NC057299.1	124067	0.9318	*Michelia compressa*_MN604380.1	122301	0.9185

Species name and cpDNA number of NCBI	PHL17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia nitida*_MN990640.1	124020	0.9314	*Yulania zenii*_NC040954.1	122300	0.9185
*Magnolia dealbata*_NC023235.1	123973	0.9311	*Michelia martini*_NC054188.1	122211	0.9179
*Magnolia virginiana*_MN990608.1	123969	0.9311	*Yulania pseudokobus*_LC530277.1	122166	0.9175
*Magnolia dixonii*_NC048960.1	123830	0.9300	*Yulania campbellii*_MN457685.1	122160	0.9175
*Magnolia guatemalensis*_MN990628.1	123806	0.9298	*Yulania dawsonia*_MN990622.1	122144	0.9173
*Magnolia omeiensis*_NC048460.1	123720	0.9292	*Yulania cylindrica*_MN990617.1	122132	0.9173
*Magnolia pacifica*_MN990636.1	123643	0.9286	*Michelia figo*_NC053861.1	122126	0.9172
*Magnolia gilbertoi*_NC048958.1	123641	0.9286	*Michelia shiluensis*_NC047417.1	122122	0.9172
*Magnolia kwangsiensis*_HM775382.1	123598	0.9283	*Yulania biondii*_KY085894.1	122064	0.9167
*Magnolia championii*_MN990574.1	123596	0.9283	*Yulania viridula*_MN990590.1	122044	0.9166
*Magnolia ovata*_NC048993.1	123561	0.9280	*Michelia odora*_NC023239.1	121972	0.9161
*Magnolia fraseri*_MN990599.1	123516	0.9277	*Michelia montana*_MN990614.1	121971	0.9160
*Magnolia pyramidata*_NC023236.1	123493	0.9275	*Michelia tsiampacca*_MN990607.1	121928	0.9157
*Magnolia delavayi*_MN780910.1	123467	0.9273	*Michelia cathcartii*_NC023234.1	121889	0.9154
*Magnolia chimantensis*_MN990632.1	123451	0.9272	*Michelia ovalis*_MN990602.1	121716	0.9141
*Magnolia bidoupensis*_MN990624.1	123415	0.9269	*Yulania denudata*_JN867577.1	121646	0.9136
*Magnolia sinica*_NC023241.1	123404	0.9268	*Yulania liliiflora*_NC023238.1	121178	0.9101
*Magnolia shangsiensis*_MN990575.1	123378	0.9266	*Liriodendron tulipifera*_DQ899947.1	106020	0.7963
*Magnolia siamensis*_MN990592.1	123355	0.9264	*Liriodendron chinense*_NC030504.1	105677	0.7937

Table 3. *PHS of chloroplast genomes between Michelia tsiampacca and different species of Magnoliaceae Juss.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Michelia tsiampacca*_MN990607.1	133228	1	*Magnolia duclouxii*_NC037002.1	121851	0.9146
*Michelia ovalis*_MN990602.1	131984	0.9907	*Magnolia conifera*_NC037001.1	121809	0.9143
*Michelia balansae*_NC053860.1	128835	0.967	*Magnolia kwangsiensis*_HM775382.1	121789	0.9141
*Michelia laevifolia*_NC035956.1	128742	0.9663	*Yulania salicifolia*_NC023240.1	121776	0.914
*Michelia gioii*_NC057298.1	128719	0.9662	*Magnolia gilbertoi*_NC048958.1	121734	0.9137
*Michelia baillonii*_NC048453.1	128623	0.9654	*Magnolia ovata*_NC048993.1	121717	0.9136
*Michelia champaca*_MT269873.1	128608	0.9653	*Magnolia delavayi*_MN780910.1	121662	0.9132
*Michelia maudiae*_NC047409.1	128576	0.9651	*Magnolia virginiana*_MN990608.1	121626	0.9129
*Michelia chapensis*_NC053737.1	128559	0.965	*Magnolia championii*_MN990574.1	121588	0.9126
*Michelia compressa*_MN604380.1	128553	0.9649	*Magnolia tamaulipana*_NC057299.1	121579	0.9126
*Michelia martini*_NC054188.1	128360	0.9635	*Magnolia fraseri*_MN990599.1	121534	0.9122
*Michelia figo*_NC053861.1	128323	0.9632	*Magnolia pyramidata*_NC023236.1	121481	0.9118
*Michelia shiluensis*_NC047417.1	128242	0.9626	*Magnolia bidoupensis*_MN990624.1	121479	0.9118
*Michelia montana*_MN990614.1	128230	0.9625	*Magnolia chimantensis*_MN990632.1	121443	0.9115

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Michelia odora*_NC023239.1	128203	0.9623	*Yulania dawsonia*_MN990622.1	121428	0.9114
*Michelia malayca*_MN990630.1	126413	0.9488	*Yulania cylindrica*_MN990617.1	121378	0.9111
*Michelia cathcartii*_NC023234.1	125552	0.9424	*Magnolia decidua*_MN990591.1	121377	0.911
*Magnolia nitida*_MN990640.1	122913	0.9226	*Magnolia shangsiensis*_MN990575.1	121328	0.9107
*Magnolia duperreana*_NC057297.1	122857	0.9222	*Magnolia siamensis*_MN990592.1	121311	0.9106
*Magnolia mexicana*_MN700657.1	122796	0.9217	*Yulania zenii*_NC040954.1	121310	0.9105
*Magnolia omeiensis*_NC048460.1	122752	0.9214	*Magnolia sieboldii*_MN990583.1	121300	0.9105
*Magnolia ofeliae*_NC051512.1	122737	0.9213	*Yulania campbellii*_MN457685.1	121285	0.9104
*Magnolia sinica*_NC023241.1	122458	0.9192	*Magnolia guatemalensis*_MN990628.1	121267	0.9102
*Magnolia polita*_MN990605.1	122452	0.9191	*Magnolia odoratissima*_NC042680.1	121197	0.9097
*Magnolia portoricensis*_MN990604.1	122425	0.9189	*Yulania viridula*_MN990590.1	121170	0.9095
*Magnolia dodecapetala*_NC048992.1	122373	0.9185	*Magnolia coco*_NC050980.1	121156	0.9094
*Magnolia macrophylla*_MN990609.1	122323	0.9181	*Yulania biondii*_KY085894.1	121147	0.9093
*Magnolia amazonica*_NC048959.1	122311	0.9181	*Magnolia pacifica*_MN990636.1	121115	0.9091
*Yulania cordata*_MW415416.1	122168	0.917	*Magnolia yalana*_MT560391.1	121087	0.9089
*Yulania acuminata*_JX280391.1	122081	0.9163	*Magnolia hodgsonii*_MN990587.1	121081	0.9088
*Magnolia obovata*_MN990571.1	122038	0.916	*Yulania pseudokobus*_LC530277.1	121063	0.9087
*Magnolia hookeri*_NC053862.1	121976	0.9155	*Magnolia albosericea*_MN990620.1	121048	0.9086
*Magnolia dixonii*_NC048960.1	121971	0.9155	*Magnolia lenticellata*_MN990629.1	120974	0.908
*Magnolia dealbata*_NC023235.1	121969	0.9155	*Magnolia grandiflora*_NC020318.1	120871	0.9072
*Magnolia kachirachirai*_MN990641.1	121923	0.9151	*Yulania denudata*_JN867577.1	120858	0.9072
*Magnolia wilsonii*_NC046054.1	121923	0.9151	*Magnolia officinalis*_NC020316.1	120731	0.9062
*Magnolia zhengyiana*_NC053863.1	121894	0.9149	*Yulania liliiflora*_NC023238.1	120443	0.904
*Magnolia tripetala*_NC024027.1	121888	0.9149	*Liriodendron tulipifera*_DQ899947.1	104176	0.7819
*Magnolia dandyi*_NC037004.1	121886	0.9149	*Liriodendron chinense*_NC030504.1	103957	0.7803

Table 4. *PHS of chloroplast genomes between Liriodendron tulipifera and different species of Magnoliaceae Juss.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Liriodendron tulipifera*_DQ899947.1	133246	1	*Magnolia pyramidata*_NC023236.1	105308	0.7903
*Liriodendron chinense*_NC030504.1	123803	0.9291	*Magnolia tamaulipana*_NC057299.1	105235	0.7898
*Magnolia mexicana*_MN700657.1	106694	0.8007	*Magnolia virginiana*_MN990608.1	105234	0.7898
*Magnolia ofeliae*_NC051512.1	106671	0.8006	*Magnolia decidua*_MN990591.1	105202	0.7895
*Magnolia portoricensis*_MN990604.1	106508	0.7993	*Magnolia kachirachirai*_MN990641.1	105052	0.7884
*Magnolia polita*_MN990605.1	106507	0.7993	*Magnolia officinalis*_NC020316.1	105033	0.7883
*Magnolia dodecapetala*_NC048992.1	106361	0.7982	*Magnolia guatemalensis*_MN990628.1	105024	0.7882
*Magnolia duperreana*_NC057297.1	106297	0.7978	*Yulania cordata*_MW415416.1	105019	0.7882

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia amazonica*_NC048959.1	106150	0.7966	*Michelia malayca*_MN990630.1	104997	0.7880
*Magnolia gilbertoi*_NC048958.1	106028	0.7957	*Magnolia sieboldii*_ MN990583.1	104970	0.7878
*Magnolia wilsonii*_NC046054.1	106018	0.7957	*Yulania acuminata*_JX280391.1	104930	0.7875
*Magnolia dixonii*_NC048960.1	105921	0.7949	*Magnolia pacifica*_MN990636.1	104918	0.7874
*Magnolia macrophylla*_MN990609.1	105872	0.7946	*Magnolia grandiflora*_NC020318.1	104838	0.7868
*Magnolia championii*_MN990574.1	105872	0.7946	*Michelia laevifolia*_NC035956.1	104757	0.7862
*Magnolia chimantensis*_MN990632.1	105834	0.7943	*Yulania salicifolia*_NC023240.1	104741	0.7861
*Magnolia delavayi*_MN780910.1	105830	0.7942	*Michelia gioii*_NC057298.1	104615	0.7851
*Magnolia obovata*_MN990571.1	105827	0.7942	*Michelia balansae*_NC053860.1	104589	0.7849
*Magnolia ovata*_NC048993.1	105763	0.7937	*Michelia chapensis*_NC053737.1	104555	0.7847
*Magnolia bidoupensis*_MN990624.1	105757	0.7937	*Michelia maudiae*_NC047409.1	104521	0.7844
*Magnolia tripetala*_NC024027.1	105693	0.7932	*Michelia baillonii*_NC048453.1	104492	0.7842
*Magnolia shangsiensis*_MN990575.1	105690	0.7932	*Michelia martini*_NC054188.1	104478	0.7841
*Magnolia hookeri*_NC053862.1	105666	0.7930	*Yulania zenii*_NC040954.1	104440	0.7838
*Magnolia nitida*_MN990640.1	105663	0.7930	*Michelia champaca*_MT269873.1	104424	0.7837
*Magnolia duclouxii*_NC037002.1	105656	0.7929	*Michelia compressa*_MN604380.1	104403	0.7835
*Magnolia dealbata*_NC023235.1	105651	0.7929	*Yulania pseudokobus*_LC530277.1	104337	0.7830
*Magnolia siamensis*_MN990592.1	105643	0.7928	*Michelia cathcartii*_NC023234.1	104322	0.7829
*Magnolia zhengyiana*_NC053863.1	105640	0.7928	*Yulania campbellii*_MN457685.1	104319	0.7829
*Magnolia kwangsiensis*_HM775382.1	105629	0.7927	*Yulania dawsonia*_MN990622.1	104315	0.7829
*Magnolia dandyi*_NC037004.1	105550	0.7921	*Yulania viridula*_MN990590.1	104300	0.7828
*Magnolia conifera*_NC037001.1	105506	0.7918	*Yulania biondii*_KY085894.1	104249	0.7824
*Magnolia yalana*_MT560391.1	105500	0.7918	*Michelia shiluensis*_NC047417.1	104216	0.7821
*Magnolia odoratissima*_NC042680.1	105495	0.7917	*Michelia figo*_NC053861.1	104201	0.7820
*Magnolia omeiensis*_NC048460.1	105492	0.7917	*Michelia tsiampacca*_MN990607.1	104177	0.7818
*Magnolia hodgsonii*_MN990587.1	105469	0.7915	*Yulania cylindrica*_MN990617.1	104137	0.7815
*Magnolia lenticellata*_MN990629.1	105461	0.7915	*Michelia odora*_NC023239.1	104130	0.7815
*Magnolia albosericea*_MN990620.1	105456	0.7914	*Michelia montana*_MN990614.1	104102	0.7813
*Magnolia coco*_NC050980.1	105432	0.7913	*Michelia ovalis*_MN990602.1	104022	0.7807
*Magnolia fraseri*_MN990599.1	105367	0.7908	*Yulania denudata*_JN867577.1	103967	0.7803
*Magnolia sinica*_NC023241.1	105336	0.7905	*Yulania liliiflora*_NC023238.1	103412	0.7761

It can be seen from Tables 1 to 4 that using the types of *Yulania denudata* (Desr.) D.L.Fu, *Magnolia wilsonii* Rehd., *Michelia tsiampacca* L. and *Liriodendron tulipifera* L. respectively, Magnoliaceae Juss. obviously include 4 natural genera: *Yulania* Spach, *Magnolia* L., *Michelia* L. and *Liriodendron* L., which all have the same boundary: PHS(17bp) $\geqslant$ 0.9234 (intragenus) or PHS(17bp) $\leqslant$ 0.9232 (inter genera). So, the 4 genera can be confirmed again by the chloroplast complete genomic evolutionomy.

3.2. Confirmation of the Primitivity of Genus *Yulania* Spach

Although it has been concluded that Magnoliaceae are the

relatively most primitive family and *Yulania* Spach is the relatively most primitive genus [51] of fruit plants, Wang & al. [37] were still thought that *Magnolia* L. was the relatively most primitive genus despite having 86 samples of chloroplast complete genomes of Magnoliaceae Juss.

To more scientifically reflect the relatively evolutionary relationships between *Yulania* Spach and *Magnolia* L., 12 representative species of each genus and total 24 samples are selected and calculated the evolutionary similarities with 7 samples of genus *Ginkgo* L., the results are shown in Table 5.

Table 5. *EVS of chloroplast genomes of Genera Ginkgo L. with Yulania Spach and Magnolia L.*

Genera	Representative Chloroplast Genomes	EVL/17bp	EVS
Ginkgo L.	*Ginkgo biloba*_KP099648.1_KX673573.1_AB684440.1 _MG922650.1_JN867585.1_MN443423.1_JN867578.1	1071	1
Yulania Spach	*Yulania cylindrica*_MN990617.1; *Yulania denudata*_JN867577.1; *Yulania liliiflora*_NC023238.1; *Yulania salicifolia*_NC023240.1; *Yulania biondii*_KY085894.1; *Yulania zenii*_NC040954.1; *Yulania pseudokobus*_LC530277.1; *Yulania viridula*_MN990590.1 *Yulania dawsoniana*_MN990622.1; *Yulania campbellii*_MN457685.1; *Yulania acuminata*_JX280391.1; *Yulania cordata*_MW415416.1	59	0.055
Magnolia L.	*Magnolia kachirachirai*_MN990641.1; *Magnolia kwangsiensis*_HM775382.1 *Magnolia mexicana*_MN700657.1; *Magnolia chimantensis*_MN990632.1 *Magnolia yalana*_MT560391.1; *Magnolia virginiana*_MN990608.1 *Magnolia macrophylla*_MN990609.1; *Magnolia pyramidata*_NC023236.1 *Magnolia obovata*_MN990571.1; *Magnolia wilsonii*_NC046054.1 *Magnolia sieboldii*_NC041435.1; *Magnolia conifera*_NC037001.1	12	0.023

It can be seen from Table 5 that EVS between genera *Ginkgo* L. and *Yulania* Spach is 0.055 obviously closer than that 0.023 between genera *Ginkgo* L. and *Magnolia* L. So, it can be concluded that *Yulania* Spach is the most primitive genus of Magnoliaceae Juss.

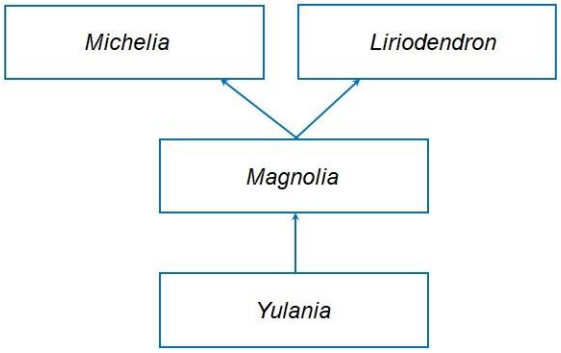

Figure 1. *Evolutionary system of genera of Magnoliaceae Juss. based on the chloroplast genomic and morphological Evolutionomy [51].*

Based on Tables 1 to 5, it can be confirmed that the evolutionary system of genera of Magnoliaceae Juss. (Figure 1) is scientific.

4. The Evolutionary System of Subgenera of *Magnolia* L.

4.1. The Subgenera of *Magnolia* L.

The phylogenetic similarities (PHS) are analyzed based on the chloroplast complete genome of 47 species of *Magnolia* L. using the types of 7 species respectively: *Magnolia sinica* (Y. W. Law) D. L. Fu, *Magnolia kwangsiensis* Figlar & Noot. ex D.L.Fu, *Magnolia dodecapetala* (Lam.) D.L.Fu, *Magnolia virginiana* L., *Magnolia dealbata* Zucc., *Magnolia fraseri* Walter and *Magnolia wilsonii* Rehd., the results are shown in Tables 6 to 11 and Table 2.

Table 6. *PHS of chloroplast genomes between Magnolia sinica and other species of the genus.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia sinica*_NC023241.1	133228	1	*Magnolia tamaulipana*_NC057299.1	123294	0.925
*Magnolia nitida*_MN990640.1	131420	0.986	*Magnolia gilbertoi*_NC048958.1	123283	0.925
*Magnolia omeiensis*_NC048460.1	131101	0.984	*Magnolia fraseri*_MN990599.1	123178	0.925
*Magnolia kachirachirai*_MN990641.1	129815	0.974	*Magnolia pyramidata*_NC023236.1	123170	0.925
*Magnolia duperreana*_NC057297.1	124364	0.934	*Magnolia delavayi*_MN780910.1	123129	0.924
*Magnolia mexicana*_MN700657.1	124304	0.933	*Magnolia ovata*_NC048993.1	123127	0.924
*Magnolia ofeliae*_NC051512.1	124248	0.933	*Magnolia championii*_MN990574.1	123119	0.924
*Magnolia polita*_MN990605.1	123859	0.930	*Magnolia bidoupensis*_MN990624.1	123113	0.924
*Magnolia portoricensis*_MN990604.1	123812	0.929	*Magnolia guatemalensis*_MN990628.1	123003	0.923
*Magnolia dodecapetala*_NC048992.1	123778	0.929	*Magnolia siamensis*_MN990592.1	122984	0.923
*Magnolia macrophylla*_MN990609.1	123698	0.929	*Magnolia chimantensis*_MN990632.1	122983	0.923
*Magnolia amazonica*_NC048959.1	123683	0.928	*Magnolia shangsiensis*_MN990575.1	122962	0.923
*Magnolia hookeri*_NC053862.1	123564	0.928	*Magnolia decidua*_MN990591.1	122940	0.923
*Magnolia zhengyiana*_NC053863.1	123523	0.927	*Magnolia coco*_NC050980.1	122907	0.923
*Magnolia dandyi*_NC037004.1	123493	0.927	*Magnolia pacifica*_MN990636.1	122889	0.922
*Magnolia dealbata*_NC023235.1	123458	0.927	*Magnolia odoratissima*_NC042680.1	122736	0.921
*Magnolia obovata*_MN990571.1	123436	0.927	*Magnolia yalana*_MT560391.1	122716	0.921
*Magnolia tripetala*_NC024027.1	123414	0.926	*Magnolia sieboldii*_MN990583.1	122705	0.921
*Magnolia conifera*_NC037001.1	123408	0.926	*Magnolia hodgsonii*_MN990587.1	122681	0.921
*Magnolia duclouxii*_NC037002.1	123405	0.926	*Magnolia albosericea*_MN990620.1	122654	0.921
*Magnolia wilsonii*_NC046054.1	123404	0.926	*Magnolia grandiflora*_NC020318.1	122497	0.920
*Magnolia dixonii*_NC048960.1	123372	0.926	*Magnolia lenticellata*_MN990629.1	122417	0.919
*Magnolia kwangsiensis*_HM775382.1	123349	0.926	*Magnolia officinalis*_NC020316.1	122206	0.917
*Magnolia virginiana*_MN990608.1	123336	0.926			

Table 7. *PHS of chloroplast genomes between Magnolia kwangsiensis and other species of the genus.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia kwangsiensis*_HM775382.1	132933	1	*Magnolia tamaulipana*_NC057299.1	123219	0.927
*Magnolia duperreana*_NC057297.1	127870	0.962	*Magnolia championii*_MN990574.1	123213	0.927
*Magnolia ofeliae*_NC051512.1	124329	0.935	*Magnolia virginiana*_MN990608.1	123184	0.927
*Magnolia mexicana*_MN700657.1	124325	0.935	*Magnolia chimantensis*_MN990632.1	123129	0.926
*Magnolia portoricensis*_MN990604.1	123981	0.933	*Magnolia delavayi*_MN780910.1	123049	0.926
*Magnolia polita*_MN990605.1	123957	0.933	*Magnolia bidoupensis*_MN990624.1	123028	0.926
*Magnolia dodecapetala*_NC048992.1	123870	0.932	*Magnolia fraseri*_MN990599.1	123009	0.925
*Magnolia amazonica*_NC048959.1	123848	0.932	*Magnolia shangsiensis*_MN990575.1	122992	0.925

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia nitida*_MN990640.1	123830	0.932	*Magnolia siamensis*_MN990592.1	122976	0.925
*Magnolia macrophylla*_MN990609.1	123800	0.931	*Magnolia pyramidata*_NC023236.1	122937	0.925
*Magnolia omeiensis*_NC048460.1	123645	0.93	*Magnolia kachirachirai*_MN990641.1	122882	0.924
*Magnolia wilsonii*_NC046054.1	123596	0.93	*Magnolia coco*_NC050980.1	122867	0.924
*Magnolia dealbata*_NC023235.1	123562	0.93	*Magnolia pacifica*_MN990636.1	122812	0.924
*Magnolia tripetala*_NC024027.1	123521	0.929	*Magnolia yalana*_MT560391.1	122798	0.924
*Magnolia dixonii*_NC048960.1	123521	0.929	*Magnolia guatemalensis*_MN990628.1	122771	0.924
*Magnolia dandyi*_NC037004.1	123436	0.929	*Magnolia decidua*_MN990591.1	122736	0.923
*Magnolia obovata*_MN990571.1	123431	0.929	*Magnolia hodgsonii*_MN990587.1	122734	0.923
*Magnolia hookeri*_NC053862.1	123408	0.928	*Magnolia odoratissima*_NC042680.1	122704	0.923
*Magnolia conifera*_NC037001.1	123364	0.928	*Magnolia lenticellata*_MN990629.1	122664	0.923
*Magnolia zhengyiana*_NC053863.1	123355	0.928	*Magnolia albosericea*_MN990620.1	122604	0.922
*Magnolia sinica*_NC023241.1	123346	0.928	*Magnolia sieboldii*_MN990583.1	122573	0.922
*Magnolia gilbertoi*_NC048958.1	123291	0.928	*Magnolia grandiflora*_NC020318.1	122408	0.921
*Magnolia duclouxii*_NC037002.1	123282	0.927	*Magnolia officinalis*_NC020316.1	122149	0.919
*Magnolia ovata*_NC048993.1	123237	0.927			

Table 8. *PHS of chloroplast genomes between Magnolia dodecapetala and other species of the genus.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia dodecapetala*_NC048992.1	133062	1	*Magnolia wilsonii*_NC046054.1	124226	0.934
*Magnolia dixonii*_NC048960.1	131521	0.988	*Magnolia dealbata*_NC023235.1	124214	0.934
*Magnolia amazonica*_NC048959.1	131451	0.988	*Magnolia tripetala*_NC024027.1	124156	0.933
*Magnolia ovata*_NC048993.1	131220	0.986	*Magnolia omeiensis*_NC048460.1	124126	0.933
*Magnolia gilbertoi*_NC048958.1	130492	0.981	*Magnolia hookeri*_NC053862.1	124086	0.933
*Magnolia mexicana*_MN700657.1	129006	0.970	*Magnolia obovata*_MN990571.1	124077	0.933
*Magnolia ofeliae*_NC051512.1	128981	0.969	*Magnolia zhengyiana*_NC053863.1	124040	0.932
*Magnolia polita*_MN990605.1	126366	0.950	*Magnolia dandyi*_NC037004.1	124031	0.932
*Magnolia portoricensis*_MN990604.1	126320	0.949	*Magnolia tamaulipana*_NC057299.1	123991	0.932
*Magnolia chimantensis*_MN990632.1	125554	0.944	*Magnolia duclouxii*_NC037002.1	123945	0.932
*Magnolia championii*_MN990574.1	125353	0.942	*Magnolia conifera*_NC037001.1	123933	0.931
*Magnolia siamensis*_MN990592.1	125131	0.940	*Magnolia virginiana*_MN990608.1	123875	0.931
*Magnolia delavayi*_MN780910.1	125127	0.940	*Magnolia kwangsiensis*_HM775382.1	123869	0.931
*Magnolia shangsiensis*_MN990575.1	125119	0.940	*Magnolia sinica*_NC023241.1	123775	0.93
*Magnolia duperreana*_NC057297.1	125117	0.940	*Magnolia fraseri*_MN990599.1	123775	0.93
*Magnolia bidoupensis*_MN990624.1	125098	0.940	*Magnolia pyramidata*_NC023236.1	123669	0.929
*Magnolia lenticellata*_MN990629.1	125043	0.940	*Magnolia decidua*_MN990591.1	123627	0.929

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia coco*_NC050980.1	124918	0.939	*Magnolia guatemalensis*_MN990628.1	123615	0.929
*Magnolia yalana*_MT560391.1	124842	0.938	*Magnolia pacifica*_MN990636.1	123413	0.928
*Magnolia hodgsonii*_MN990587.1	124835	0.938	*Magnolia kachirachirai*_MN990641.1	123349	0.927
*Magnolia albosericea*_MN990620.1	124789	0.938	*Magnolia sieboldii*_ MN990583.1	123335	0.927
*Magnolia odoratissima*_NC042680.1	124786	0.938	*Magnolia grandiflora*_NC020318.1	123228	0.926
*Magnolia macrophylla*_MN990609.1	124576	0.936	*Magnolia officinalis*_NC020316.1	122793	0.923
*Magnolia nitida*_MN990640.1	124392	0.935			

Table 9. *PHS of chloroplast genomes between Magnolia virginiana and other species of the genus.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia virginiana*_MN990608.1	132925	1	*Magnolia dixonii*_NC048960.1	123452	0.929
*Magnolia tamaulipana*_NC057299.1	130647	0.983	*Magnolia dealbata*_NC023235.1	123446	0.929
*Magnolia guatemalensis*_MN990628.1	130221	0.980	*Magnolia delavayi*_MN780910.1	123393	0.928
*Magnolia pacifica*_MN990636.1	130047	0.978	*Magnolia sinica*_NC023241.1	123332	0.928
*Magnolia grandiflora*_NC020318.1	129551	0.975	*Magnolia championii*_MN990574.1	123284	0.928
*Magnolia mexicana*_MN700657.1	124454	0.936	*Magnolia gilbertoi*_NC048958.1	123244	0.927
*Magnolia ofeliae*_NC051512.1	124376	0.936	*Magnolia bidoupensis*_MN990624.1	123235	0.927
*Magnolia hookeri*_NC053862.1	124323	0.935	*Magnolia ovata*_NC048993.1	123234	0.927
*Magnolia dandyi*_NC037004.1	124317	0.935	*Magnolia fraseri*_MN990599.1	123193	0.927
*Magnolia zhengyiana*_NC053863.1	124293	0.935	*Magnolia kwangsiensis*_HM775382.1	123183	0.927
*Magnolia duperreana*_NC057297.1	124239	0.935	*Magnolia siamensis*_MN990592.1	123149	0.927
*Magnolia conifera*_NC037001.1	124184	0.934	*Magnolia chimantensis*_MN990632.1	123139	0.926
*Magnolia duclouxii*_NC037002.1	124165	0.934	*Magnolia pyramidata*_NC023236.1	123133	0.926
*Magnolia obovata*_MN990571.1	124104	0.934	*Magnolia sieboldii*_MN990583.1	123078	0.926
*Magnolia tripetala*_NC024027.1	124002	0.933	*Magnolia shangsiensis*_MN990575.1	123040	0.926
*Magnolia wilsonii*_NC046054.1	123964	0.933	*Magnolia coco*_NC050980.1	122957	0.925
*Magnolia polita*_MN990605.1	123890	0.932	*Magnolia kachirachirai*_MN990641.1	122884	0.925
*Magnolia macrophylla*_MN990609.1	123880	0.932	*Magnolia yalana*_MT560391.1	122873	0.924
*Magnolia dodecapetala*_NC048992.1	123875	0.932	*Magnolia hodgsonii*_MN990587.1	122855	0.924
*Magnolia portoricensis*_MN990604.1	123858	0.932	*Magnolia officinalis*_NC020316.1	122842	0.924
*Magnolia nitida*_MN990640.1	123854	0.932	*Magnolia odoratissima*_NC042680.1	122810	0.924
*Magnolia amazonica*_NC048959.1	123792	0.931	*Magnolia albosericea*_MN990620.1	122726	0.923
*Magnolia omeiensis*_NC048460.1	123720	0.931	*Magnolia lenticellata*_MN990629.1	122645	0.923
*Magnolia decidua*_MN990591.1	123571	0.930			

Table 10. *PHS of chloroplast genomes between Magnolia dealbata and other species of the genus.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia dealbata*_NC023235.1	133183	1	*Magnolia ovata*_NC048993.1	123552	0.928
*Magnolia macrophylla*_MN990609.1	131462	0.987	*Magnolia tamaulipana*_NC057299.1	123552	0.928
*Magnolia mexicana*_MN700657.1	124850	0.937	*Magnolia championii*_MN990574.1	123496	0.927
*Magnolia ofeliae*_NC051512.1	124703	0.936	*Magnolia sinica*_NC023241.1	123455	0.927
*Magnolia duperreana*_NC057297.1	124571	0.935	*Magnolia delavayi*_MN780910.1	123449	0.927
*Magnolia polita*_MN990605.1	124297	0.933	*Magnolia virginiana*_MN990608.1	123447	0.927
*Magnolia portoricensis*_MN990604.1	124265	0.933	*Magnolia chimantensis*_MN990632.1	123426	0.927
*Magnolia dodecapetala*_NC048992.1	124215	0.933	*Magnolia bidoupensis*_MN990624.1	123365	0.926
*Magnolia amazonica*_NC048959.1	124109	0.932	*Magnolia shangsiensis*_MN990575.1	123347	0.926
*Magnolia nitida*_MN990640.1	124004	0.931	*Magnolia siamensis*_MN990592.1	123254	0.925
*Magnolia pyramidata*_NC023236.1	123998	0.931	*Magnolia decidua*_MN990591.1	123169	0.925
*Magnolia fraseri*_MN990599.1	123994	0.931	*Magnolia yalana*_MT560391.1	123140	0.925
*Magnolia wilsonii*_NC046054.1	123970	0.931	*Magnolia odoratissima*_NC042680.1	123139	0.925
*Magnolia hookeri*_NC053862.1	123931	0.931	*Magnolia coco*_NC050980.1	123135	0.925
*Magnolia tripetala*_NC024027.1	123915	0.930	*Magnolia guatemalensis*_MN990628.1	123107	0.924
*Magnolia obovata*_MN990571.1	123912	0.930	*Magnolia hodgsonii*_MN990587.1	123103	0.924
*Magnolia dixonii*_NC048960.1	123884	0.930	*Magnolia sieboldii*_MN990583.1	123018	0.924
*Magnolia dandyi*_NC037004.1	123826	0.930	*Magnolia pacifica*_MN990636.1	123007	0.924
*Magnolia duclouxii*_NC037002.1	123820	0.930	*Magnolia albosericea*_MN990620.1	122976	0.923
*Magnolia zhengyiana*_NC053863.1	123820	0.930	*Magnolia kachirachirai*_MN990641.1	122910	0.923
*Magnolia conifera*_NC037001.1	123769	0.929	*Magnolia lenticellata*_MN990629.1	122904	0.923
*Magnolia omeiensis*_NC048460.1	123710	0.929	*Magnolia grandiflora*_NC020318.1	122811	0.922
*Magnolia gilbertoi*_NC048958.1	123592	0.928	*Magnolia officinalis*_NC020316.1	122657	0.921
*Magnolia kwangsiensis*_HM775382.1	123560	0.928			

Table 11. *PHS of chloroplast genomes between Magnolia fraseri and other species of the genus.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia fraseri*_MN990599.1	133107	1	*Magnolia tamaulipana*_NC057299.1	123205	0.926
*Magnolia pyramidata*_NC023236.1	132296	0.994	*Magnolia virginiana*_MN990608.1	123195	0.926
*Magnolia mexicana*_MN700657.1	124381	0.934	*Magnolia sinica*_NC023241.1	123178	0.925
*Magnolia duperreana*_NC057297.1	124301	0.934	*Magnolia championii*_MN990574.1	123155	0.925
*Magnolia ofeliae*_NC051512.1	124230	0.933	*Magnolia ovata*_NC048993.1	123114	0.925
*Magnolia macrophylla*_MN990609.1	124218	0.933	*Magnolia bidoupensis*_MN990624.1	123111	0.925
*Magnolia dealbata*_NC023235.1	123995	0.932	*Magnolia kwangsiensis*_HM775382.1	123011	0.924
*Magnolia polita*_MN990605.1	123862	0.931	*Magnolia chimantensis*_MN990632.1	123000	0.924

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia portoricensis*_MN990604.1	123818	0.93	*Magnolia shangsiensis*_MN990575.1	122981	0.924
*Magnolia dodecapetala*_NC048992.1	123779	0.93	*Magnolia siamensis*_MN990592.1	122937	0.924
*Magnolia nitida*_MN990640.1	123707	0.929	*Magnolia decidua*_MN990591.1	122905	0.923
*Magnolia amazonica*_NC048959.1	123643	0.929	*Magnolia guatemalensis*_MN990628.1	122867	0.923
*Magnolia hookeri*_NC053862.1	123544	0.928	*Magnolia yalana*_MT560391.1	122750	0.922
*Magnolia obovata*_MN990571.1	123517	0.928	*Magnolia coco*_NC050980.1	122749	0.922
*Magnolia wilsonii*_NC046054.1	123516	0.928	*Magnolia sieboldii*_MN990583.1	122735	0.922
*Magnolia tripetala*_NC024027.1	123491	0.928	*Magnolia albosericea*_MN990620.1	122733	0.922
*Magnolia omeiensis*_NC048460.1	123432	0.927	*Magnolia hodgsonii*_MN990587.1	122730	0.922
*Magnolia zhengyiana*_NC053863.1	123427	0.927	*Magnolia odoratissima*_NC042680.1	122675	0.922
*Magnolia dandyi*_NC037004.1	123390	0.927	*Magnolia kachirachirai*_MN990641.1	122671	0.922
*Magnolia duclouxii*_NC037002.1	123379	0.927	*Magnolia pacifica*_MN990636.1	122646	0.921
*Magnolia dixonii*_NC048960.1	123377	0.927	*Magnolia lenticellata*_MN990629.1	122445	0.92
*Magnolia conifera*_NC037001.1	123292	0.926	*Magnolia grandiflora*_NC020318.1	122374	0.919
*Magnolia gilbertoi*_NC048958.1	123271	0.926	*Magnolia officinalis*_NC020316.1	122274	0.919
*Magnolia delavayi*_MN780910.1	123262	0.926			

It can be seen from Tables 6 to 11 and Table 2 that using the types of 7 species *Magnolia sinica* (Y.W.Law) D.L.Fu, *Magnolia kwangsiensis* Figlar & Noot. ex D.L.Fu, *Magnolia dodecapetala* (Lam.) D.L.Fu, *Magnolia virginiana* L., *Magnolia dealbata* Zucc., *Magnolia fraseri* Walter and *Magnolia wilsonii* Rehd., respectively, *Magnolia* L. obviously includes 7 natural subgenera: *Magnolia* subgen. *Pachylarnax* (Dandy) D.L.Fu, *Magnolia* subgen. *Kmeria* Pierre, *Magnolia* subgen. *Talauma* (Juss.) Pierre, *Magnolia* subgen. *Magnolia*, *Magnolia* subgen. *Macrophylla* (Figlar & Noot.) D.L.Fu, *Magnolia* subgen. *Tuliparia* (Spach) D.L.Fu and *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu, which all have the same boundary: PHS(17bp) ≥0.938 (intrasubgenus) or PHS(17bp) ≤ 0.937 (inter subgenera).

However, there is an exception, that is, *Magnolia duperreana*_NC057297.1 simultaneously appears in two subgenera: *Magnolia* subgen. *Kmeria* Pierre and *Magnolia* subgen. *Talauma* (Juss.) Pierre (Table 7 and Table 8). In this regard, we adopt a treatment method that "Drop of ink does not stain the sea", and makes a correct classification based on its evolutionary taxonomic characters and the phylogenetic similarity of the chloroplast genome, that is: *Magnolia duperreana* and *Magnolia kwangsiensis* are both unisexual, obviously different from bisexual *Magnolia dodecapetala*, and the phylogenetic similarity between *Magnolia duperreana* and *Magnolia kwangsiensis* is PHS=0.962, which is significantly closer than that between *Magnolia duperreana* and *Magnolia dodecapetala* PHS=0.940. Therefore, *Magnolia duperreana* belongs to *Magnolia* subgen. *Kmeria* Pierr and not to *Magnolia* subgen. *Talauma* (Juss.) Pierre.

4.2. The Evolutionary System of Subgenera of *Magnolia* L.

Since *Magnolia* subgen. *Pachylarnax* (Dandy) D.L.Fu is closest to the *Yulania* Spach (Table 1), it is the relatively most primitive in the genus *Magnolia* L.. According to Tables 6 to 11 and Table 2, the evolutionary system of 7 subgenera of the genus *Magnolia* can be determined as shown in Figure 2.

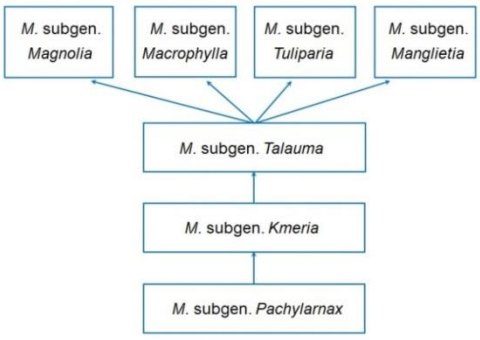

Figure 2. *Evolutionary system of subgenera of Magnolia L. based on the chloroplast genomic and morphological Evolutionomy.*

Table 12. *PHS of chloroplast genomes between Magnolia chimantensis and other species of Magnolia subgen Talauma.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia chimantensis*_MN990632.1	132460	1	*Magnolia championii*_MN990574.1	124354	0.939
*Magnolia lenticellata*_MN990629.1	130406	0.985	*Magnolia bidoupensis*_MN990624.1	124276	0.938
*Magnolia polita*_MN990605.1	128285	0.969	*Magnolia delavayi*_MN780910.1	124237	0.938
*Magnolia portoricensis*_MN990604.1	128258	0.968	*Magnolia siamensis*_MN990592.1	124149	0.937
*Magnolia mexicana*_MN700657.1	126064	0.952	*Magnolia shangsiensis*_MN990575.1	124111	0.937
*Magnolia ofeliae*_NC051512.1	126009	0.951	*Magnolia hodgsonii*_MN990587.1	123947	0.936
*Magnolia dodecapetala*_NC048992.1	125556	0.948	*Magnolia coco*_NC050980.1	123943	0.936
*Magnolia amazonica*_NC048959.1	125495	0.947	*Magnolia yalana*_MT560391.1	123939	0.936
*Magnolia dixonii*_NC048960.1	125171	0.945	*Magnolia odoratissima*_NC042680.1	123854	0.935
*Magnolia gilbertoi*_NC048958.1	125017	0.944	*Magnolia albosericea*_MN990620.1	123811	0.935
*Magnolia ovata*_NC048993.1	124933	0.943			

Table 13. *PHS of chloroplast genomes between Magnolia coco and other species of Magnolia subgen. Talauma.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia coco*_NC050980.1	133017	1	*Magnolia ofeliae*_NC051512.1	125437	0.943
*Magnolia championii*_MN990574.1	130987	0.985	*Magnolia dodecapetala*_NC048992.1	124914	0.939
*Magnolia bidoupensis*_MN990624.1	130560	0.982	*Magnolia amazonica*_NC048959.1	124844	0.939
*Magnolia shangsiensis*_MN990575.1	130453	0.981	*Magnolia polita*_MN990605.1	124828	0.938
*Magnolia odoratissima*_NC042680.1	130213	0.979	*Magnolia portoricensis*_MN990604.1	124785	0.938
*Magnolia albosericea*_MN990620.1	130163	0.979	*Magnolia dixonii*_NC048960.1	124431	0.936
*Magnolia yalana*_MT560391.1	130109	0.978	*Magnolia gilbertoi*_NC048958.1	124341	0.935
*Magnolia hodgsonii*_MN990587.1	130093	0.978	*Magnolia ovata*_NC048993.1	124305	0.935
*Magnolia siamensis*_MN990592.1	129826	0.976	*Magnolia chimantensis*_MN990632.1	123939	0.932
*Magnolia delavayi*_MN780910.1	128553	0.966	*Magnolia lenticellata*_MN990629.1	123374	0.928
*Magnolia mexicana*_MN700657.1	125448	0.943			

5. The Evolutionary System of Sections of Magnoliaceae Juss

5.1. The Evolutionary System of Sections of *Magnolia* subgen. *Talauma* (Juss.) Pierre

The phylogenetic similarities (PHS) are analyzed based on the chloroplast complete genome of 21 species of *Magnolia* subgen. *Talauma* (Juss.) Pierre using the types of 3 species *Magnolia dodecapetala* (Lam.) D.L.Fu, *Magnolia chimantensis* Steyerm. & Maguire and *Magnolia coco* DC. respectively, and the results are shown in Table 8 and Tables 12 to 13.

It can be seen from Table 8 and Tables 12 to 13 that using the types of 3 species *Magnolia dodecapetala* (Lam.) D.L.Fu, *Magnolia chimantensis* Steyerm. & Maguire and *Magnolia coco* DC. respectively, *Magnolia* subgen. *Talauma* (Juss.) Pierre obviously includes 3 natural sections: *Magnolia* sect. *Talauma*, *Magnolia* sect. *Dugandiodendron* (Lozano) D.L.Fu and *Magnolia* sect. *Gwillimia* DC., which all have the same

boundary: PHS(17bp) ≥ 0.961 (intrasection) or PHS(17bp) ≤ 0.960 (inter sections).

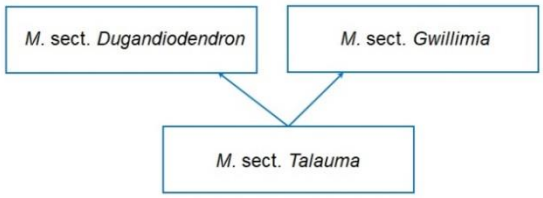

Figure 3. *Evolutionary system of sections of subgenus Magnolia subgen. Talauma (Juss.) Pierre based on the chloroplast genomic and morphological Evolutionomy.*

Since the section *Magnolia* sect. *Talauma* is closest to *Magnolia* subgen. *Kmeria* Pierre (Table 7), it is the relatively most primitive in the subgenus *Magnolia* subgen. *Talauma* (Juss.) Pierre. According to Table 8 and Tables 12 to 13, the evolutionary system of 3 sections of *Magnolia* subgen. *Talauma* (Juss.) Pierre can be determined as shown in Figure 3.

5.2. The Evolutionary System of Sections of *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu

The phylogenetic similarities (PHS) are analyzed based on the chloroplast complete genome of 11 species of *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu using the types of 4 species *Magnolia wilsonii* Rehd., *Magnolia sieboldii* K.Koch, *Magnolia obovata* Thunb. and *Magnolia conifera* (Dandy) D.L.Fu respectively, and the results are shown in Table 2 and Tables 14 to 16.

Table 14. *PHS of chloroplast genomes between Magnolia sieboldii and other species of Magnolia subgen. Manglietia.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia sieboldii*_MN990583.1	133296	1	*Magnolia zhengyiana*_NC053863.1	124777	0.936
*Magnolia wilsonii*_NC046054.1	125817	0.944	*Magnolia duclouxii*_NC037002.1	124693	0.936
*Magnolia obovata*_MN990571.1	125807	0.944	*Magnolia dandyi*_NC037004.1	124673	0.935
*Magnolia tripetala*_NC024027.1	125650	0.943	*Magnolia officinalis*_NC020316.1	124397	0.933
*Magnolia conifera*_NC037001.1	125574	0.942	*Magnolia decidua*_MN990591.1	124178	0.932
*Magnolia hookeri*_NC053862.1	124837	0.937			

Table 15. *PHS of chloroplast genomes between Magnolia obovata and other species of Magnolia subgen. Manglietia.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia obovata*_MN990571.1	133242	1	*Magnolia zhengyiana*_NC053863.1	125744	0.944
*Magnolia officinalis*_NC020316.1	130193	0.977	*Magnolia duclouxii*_NC037002.1	125714	0.944
*Magnolia tripetala*_NC024027.1	129800	0.974	*Magnolia dandyi*_NC037004.1	125654	0.943
*Magnolia wilsonii*_NC046054.1	126866	0.952	*Magnolia conifera*_NC037001.1	125569	0.942
*Magnolia hookeri*_NC053862.1	125812	0.944	*Magnolia decidua*_MN990591.1	124994	0.938
*Magnolia sieboldii*_ MN990583.1	125808	0.944			

Table 16. *PHS of chloroplast genomes between Magnolia conifera and other species of Magnolia subgen. Manglietia.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Magnolia conifera*_NC037001.1	133163	1	*Magnolia obovata*_MN990571.1	125568	0.943
*Magnolia dandyi*_NC037004.1	132371	0.994	*Magnolia tripetala*_NC024027.1	125529	0.943
*Magnolia duclouxii*_NC037002.1	130020	0.976	*Magnolia wilsonii*_NC046054.1	125433	0.942
*Magnolia hookeri*_NC053862.1	129917	0.976	*Magnolia sieboldii*_MN990583.1	124610	0.936
*Magnolia zhengyiana*_NC053863.1	129869	0.975	*Magnolia officinalis*_NC020316.1	124258	0.933
*Magnolia decidua*_MN990591.1	129025	0.969			

It can be seen from Table 2 and Tables 14 to 16 that using the types of 4 species *Magnolia wilsonii* Rehd. *Magnolia obovata* Thunb., *Magnolia sieboldii* K.Koch and *Magnolia conifera* (Dandy) D.L.Fu respectively, *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu obviously includes 4 natural sections: *Magnolia* sect. *Longnuhua* D.L.Fu, sect. nov., *Magnolia* sect. *Oyama* Nakai, *Magnolia* sect. *Rytidospermum* Spach and *Magnolia* sect. *Manglietia*, which all also have the same boundary: PHS(17bp) ≥ 0.961 (intrasection) or PHS(17bp) ≤ 0.960 (inter sections).

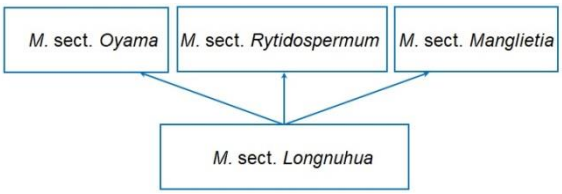

Figure 4. *Evolutionary system of sections of Magnolia subgen. Manglietia (Blume) D.L.Fu based on the chloroplast genomic and morphological Evolutionomy.*

Since *Magnolia* sect. *Longnuhua* D.L.Fu is closest to *Magnolia* subgen. *Talauma* (Juss.) Pierre (Table 8), it is the relatively most primitive in the subgenus *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu. According to Table 2 and Tables 14 to 16, the evolutionary system of 4 sections of *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu can be determined as shown in Figure 4.

5.3. The Evolutionary System of Sections of Genus *Michelia* L.

The phylogenetic similarities (PHS) are analyzed based on the chloroplast complete genome of 17 species of *Michelia* L. using the types of 3 species *Michelia malayca* D.L.Fu, *Michelia cathcartii* Hook.f. & Thomson and *Michelia tsiampacca* L. respectively, and the results are shown in Tables 17 to 18 and Table 3.

Table 17. *PHS of chloroplast genomes between Michelia malayca and other species of genus Michelia.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Michelia malayca*_MN990630.1	133221	1	*Michelia martini*_NC054188.1	126848	0.952
*Michelia laevifolia*_NC035956.1	127265	0.955	*Michelia compressa*_MN604380.1	126821	0.952
*Michelia cathcartii*_NC023234.1	127235	0.955	*Michelia shiluensis*_NC047417.1	126599	0.95
*Michelia balansae*_NC053860.1	127152	0.954	*Michelia figo*_NC053861.1	126573	0.95
*Michelia gioii*_NC057298.1	127092	0.954	*Michelia montana*_MN990614.1	126567	0.95
*Michelia baillonii*_NC048453.1	127058	0.954	*Michelia odora*_NC023239.1	126501	0.95
*Michelia maudiae*_NC047409.1	127019	0.953	*Michelia tsiampacca*_MN990607.1	126407	0.949
*Michelia chapensis*_NC053737.1	126941	0.953	*Michelia ovalis*_MN990602.1	126160	0.947
*Michelia champaca*_MT269873.1	126938	0.953			

Table 18. *PHS of chloroplast genomes between Michelia cathcartii and other species of genus Michelia.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Michelia cathcartii*_NC023234.1	133165	1	*Michelia compressa*_MN604380.1	126026	0.946
*Michelia malayca*_MN990630.1	127241	0.956	*Michelia martini*_NC054188.1	125961	0.946
*Michelia balansae*_NC053860.1	126369	0.949	*Michelia figo*_NC053861.1	125859	0.945
*Michelia laevifolia*_NC035956.1	126300	0.948	*Michelia shiluensis*_NC047417.1	125840	0.945
*Michelia baillonii*_NC048453.1	126295	0.948	*Michelia odora*_NC023239.1	125768	0.945
*Michelia gioii*_NC057298.1	126269	0.948	*Michelia montana*_MN990614.1	125759	0.944
*Michelia maudiae*_NC047409.1	126216	0.948	*Michelia tsiampacca*_MN990607.1	125550	0.943
*Michelia chapensis*_NC053737.1	126123	0.947	*Michelia ovalis*_MN990602.1	125299	0.941
*Michelia champaca*_MT269873.1	126109	0.947			

It can be seen from Tables 17 to 18 and Table 3 that using the types of 3 species: *Michelia malayca* D.L.Fu, *Michelia cathcartii* Hook.f. & Thomson and *Michelia tsiampacca* L. respectively, the genus *Michelia* L. obviously includes 3 natural sections: *Michelia* sect. *Aromadendron* (Blume) D.L.Fu, *Michelia* sect. *Alcimandra* (Dandy) D.L.Fu and *Michelia* sect. *Michelia*, which all also have the same boundary: PHS(17bp) ≥ 0.961 (intrasection) or PHS(17bp) ≤ 0.960 (inter sections).

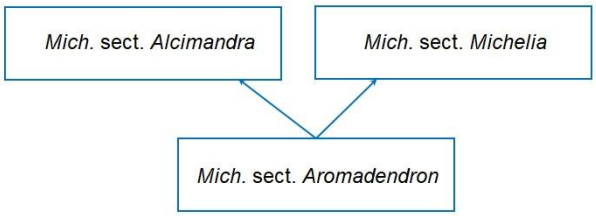

Figure 5. *Evolutionary system of sections of Michelia L. based on the chloroplast genomic and morphological Evolutionomy.*

Since *Michelia* sect. *Aromadendron* (Blume) D.L.Fu is closest to *Magnolia* L. (Table 2), it is the relatively most primitive in the genus *Michelia* L.. According to Table 3 and Tables 15 to 16, the evolutionary system of 3 sections of *Michelia* L. can be determined as shown in Figure 5.

5.4. Confirmation of the Evolutionary System of Sections of Genus Yulania Spach

The phylogenetic similarities (PHS) are analyzed based on the chloroplast complete genome of 12 species of *Yulania* L. using the types of 4 species: *Yulania denudata* (Desr.) D.L.Fu, *Yulania biondii* (Pamp.) D.L.Fu, *Yulania viridula* D.L.Fu et al. and *Yulania acuminata* (L.) D.L.Fu respectively, and the results are shown in Table 1 and Tables 19 to 21.

Table 19. *PHS of chloroplast genomes between Yulania biondii and other species of genus Yulania.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Yulania biondii*_KY085894.1	133127	1	*Yulania viridula*_MN990590.1	127122	0.955
*Yulania zenii*_NC040954.1	131663	0.989	*Yulania cylindrica*_MN990617.1	126809	0.953
*Yulania pseudokobus*_LC530277.1	130189	0.978	*Yulania denudata*_JN867577.1	126315	0.949
*Yulania salicifolia*_NC023240.1	130028	0.977	*Yulania liliiflora*_NC023238.1	125953	0.946
*Yulania dawsonia*_MN990622.1	127153	0.955	*Yulania cordata*_MW415416.1	124186	0.933
*Yulania campbellii*_MN457685.1	127127	0.955	*Yulania acuminata*_JX280391.1	124082	0.932

Table 20. *PHS of chloroplast genomes between Yulania viridula and other species of genus Yulania.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Yulania viridula*_MN990590.1	133230	1	*Yulania cylindrica*_MN990617.1	127024	0.953
*Yulania campbellii*_MN457685.1	130641	0.981	*Yulania pseudokobus*_LC530277.1	126959	0.953
*Yulania dawsonia*_MN990622.1	130581	0.980	*Yulania denudata*_JN867577.1	126505	0.950
*Yulania salicifolia*_NC023240.1	127887	0.960	*Yulania liliiflora*_NC023238.1	126096	0.947
*Yulania zenii*_NC040954.1	127350	0.956	*Yulania cordata*_MW415416.1	124220	0.932
*Yulania biondii*_KY085894.1	127119	0.954	*Yulania acuminata*_JX280391.1	124113	0.932

Table 21. *PHS of chloroplast genomes between Yulania acuminata and other species of genus Yulania.*

Species name and cpDNA number of NCBI	PHL/17bp	PHS	Species name and cpDNA number of NCBI	PHL/17bp	PHS
*Yulania acuminata*_JX280391.1	132907	1	*Yulania viridula*_MN990590.1	124112	0.934
*Yulania cordata*_MW415416.1	132089	0.994	*Yulania cylindrica*_MN990617.1	124105	0.934
*Yulania salicifolia*_NC023240.1	124741	0.939	*Yulania biondii*_KY085894.1	124077	0.934
*Yulania zenii*_NC040954.1	124301	0.935	*Yulania pseudokobus*_LC530277.1	123958	0.933
*Yulania dawsonia*_MN990622.1	124204	0.935	*Yulania denudata*_JN867577.1	123657	0.930
*Yulania campbellii*_MN457685.1	124131	0.934	*Yulania liliiflora*_NC023238.1	123225	0.927

It can be seen from Table 1 and Tables 19 to 21 that using the types of 4 species: *Yulania denudata* (Desr.) D.L.Fu, *Yulania biondii* (Pamp.) D.L.Fu, *Yulania viridula* D.L.Fu et al. and *Yulania acuminata* (L.) D.L.Fu respectively, the genus *Yulania* Spach obviously includes 4 natural sections: *Yulania* sect. *Yulania*, *Yulania* sect. *Buergeria* (Dandy) (Sieb. & Zucc.) D.L.Fu, *Yulania* sect. *Rosula* D.L.Fu and *Yulania* sect. *Tulipastrum* (Spach) D.L.Fu, which all also have the same boundary: PHS(17bp) ≥ 0.961 (intrasection) or PHS (17bp) ≤ 0.960(inter sections) as before [50].

To confirm the evolutionary system of sections of *Yulania* Spach, two representative species of each section are selected and calculated the evolutionary similarities with 7 samples of genus *Ginkgo* L., the results are shown in Tables 22 to 24.

Table 22. *EVS of chloroplast genomes of Ginkgo L. with Yulania sect. Yulania and Y. sect Buergeria.*

Genera & Sections	Representative Chloroplast Genomes	EVL/17bp	EVS
Ginkgo L.	*Ginkgo biloba*_KP099648.1 _KX673573.1_AB684440.1 _MG922650.1_JN867585.1_MN443423.1_JN867578.1	937	1
Yulania sect. *Yulania*	*Yulania puberula* *Yulania cylindrica*	10	0.0107
Yulania sect. *Buergeria*	*Yulania salicifolia*_NC023240.1 *Yulania biondii*_KY085894.1	8	0.0085

Table 23. *EVS of chloroplast genomes of Ginkgo L. with Yulania sect. Yulania and Y. sect Rosula.*

Genera & Sections	Representative Chloroplast Genomes	EVL/17bp	EVS
Ginkgo L.	*Ginkgo biloba*_KP099648.1 _KX673573.1_AB684440.1 _MG922650.1_JN867585.1_MN443423.1_JN867578.1	937	1
Yulania sect. *Yulania*	*Yulania puberula* *Yulania cylindrica*	10	0.0107
Yulania sect. *Rosula*	*Yulania viridula*_MN990590.1 *Yulania campbellii*_MN457685.1	9	0.0096

Table 24. *EVS of chloroplast genomes of Ginkgo L. with Yulania sect. Yulania and Y. sect Tulipastrum.*

Genera & Sections	Representative Chloroplast Genomes	EVL/17bp	EVS
Ginkgo L.	*Ginkgo biloba*_KP099648.1 _KX673573.1_AB684440.1 _MG922650.1_JN867585.1_MN443423.1_JN867578.1	951	1
Yulania sect. *Yulania*	*Yulania puberula* *Yulania cylindrica*	18	0.0189
Yulania sect. *Tulipastrum*	*Yulania acuminata*_JX280391.1 *Yulania cordata*_MW415416.1	14	0.0147

From Tables 22 to 24, it can be concluded again that *Yulania* sect. *Yulania* is the relatively most primitive in genus *Yulania* Spach. According to Table 1 and Tables 17 to 19, the evolutionary system of 4 sections of *Yulania* Spach can be determined again as shown in Figure 6.

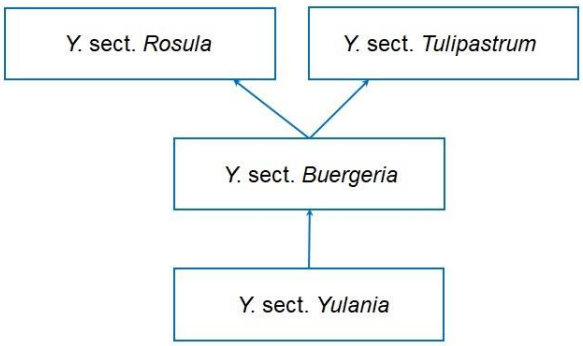

Figure 6. *Evolutionary system of sections of Yulania Spach based on the chloroplast genomic and morphological Evolutionomy [50].*

6. Keys of Magnoliaceae Juss

6.1. Key to the Genera of Magnoliaceae

1a. Fruit aggregates ovoid, cylindric or spicate, mature carpels beaked or not, dehiscent, seeds compressed globose or ellipsoid, 7-15 mm in diameter, exotestae red or yellow, sacrotestae white, fleshy and succulent.

2a. Flowers appearing before leaves or simultaneously, perules and bracts 2-5 per flower, membranous, gynoecia sessile, ovules 2 per carpel; Mature carpels dehiscing into 2 valves along dorsal sutures …… 1. *Yulania* Spach

2b. Flowers appearing after leaves or leaves evergreen, perules absent, bract 1 per flower, papery, leathery or fleshy, gynoecia sessile or stipitate, ovules 2-14 per carpel; Mature carpels dehiscing along dorsal and/or ventral sutures, circumscissile, or irregularly dehiscing.

3a. Flower (Mixed) buds terminal, young leaves open or conduplicate in bud; Leaves evergreen and spiral, or deciduous; Flower bisexual, unisexual or both, usually lotiform, tepals subsimilar; Fruit aggregates usually ovoid, globose or ellipsoid, mature carpels sessile, compressed globose, woody …… 2. *Magnolia* L.

3b. Flower buds axillary or terminal, young leaves conduplicate in bud; Leaves evergreen and biserial, rarely spiral; Flower bisexual, lotiform or cyathiform, tepals subsimilar or dissimilar; Fruit aggregates usually spicate or cylindric, mature carpels shortly stalked or sessile, globose, compressed globose or connate, leathery, woody or fleshy……
……3. *Michelia* L.

1b. Fruit aggregates fusiform, mature carpels samaroid, indehiscent, seeds compressed ellipsoid, about 2 mm in di-

ameter, exotestae palely brown, sacrotestae disappear…… …… 4. *Liriodendron* L.

6.2. Key to the Subgenera of *Magnolia* L.

1a. Young leaf blades open in buds …… …… 1. *Magnolia* subgen. *Pachylarnax* (Dandy) D.L.Fu

1b. Young leaf blades conduplicate in buds.

2a. Flowers unisexual …… …… 2. *Magnolia* subgen. *Kmeria* Pierre

2b. Flowers bisexual.

3a. Plants evergreen, with ovules 2 per carpel or pedicels 3-5-nodulated.

4a. Mature carpels dehiscing circumscissile, some along dorsal and/or ventral sutures but pedicels 3-5-nodulated …… …… 3. *Magnolia* subgen. *Talauma* (Juss.) Pierre

4b. Mature carpels dehiscing along dorsal and/or ventral sutures, and pedicels 1-2-nodulated …… ……4. *Magnolia* subgen. *Magnolia*

3b. Plants deciduous, or evergreen with ovules 4 or more per carpel and pedicels 1-2-nodulated.

5a. Leaves deciduous, with cordate or auriculate base.

6a. Plants hairy; Leaves 25-100 cm long, with cordate or auriculate base …… … 5. *Magnolia* subgen. *Macrophylla* (Figlar & Noot.) D.L.Fu

6b. Plants glabrous; Leaves 15-30 cm long, with auriculate base …… 6. *Magnolia* subgen. *Tuliparia* (Spach) D.L.Fu

5b. Leaves evergreen or deciduous, with cuneate to rounded base ……7. *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu

6.3. Key to the Sections of *Yulania* Spach

1a. Trees with flowers appearing before leaves, or shrubs.

2a. Flowers usually vase-shaped, tepals subsimilar or dissimilar, usually 3 per whorl.

3a. Flowers cyathiform, petals more than 3 cm wide ……00… 1. *Yulania* sect. *Yulania*

3b. Flowers lageniform, petals less than 3 cm wide …… …… 2. *Yulania* sect. *Buergeria* (Sieb. & Zucc.) D.L.Fu

2b. Flowers usually lotiform, tepals subsimilar usually 4 per whorl …… 3. *Yulania* sect. *Rosula* D.L.Fu

1b. Trees with flowers appearing simultaneously as leaves …… 4. *Yulania* sect. *Tulipastrum* (Spach) D.L.Fu

6.4. Key to the Sections of *Magnolia* subgen. *Talauma* (Juss.) Pierre

1a. Pedicels 1-2-nodulated.

2a. Connectives with short appendages …… …… 1. *Magnolia* sect. *Talauma*

2b. Connectives with long and slender appendages …… …… 2. *Magnolia* sect. *Dugandiodendron* (Lozano) D.L.Fu

1b. Pedicels 3-5-nodulated ……... …… 3. *Magnolia* sect. *Gwillimia* DC.

6.5. Key to the Sections of *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu

1a. Leaves deciduous; Ovules 2 per carpel, rarely ovules 4-8 but leaves pseudoverticillate.

2a. Leaves biserial or spiral.

3a. Pedicels obviously 2-nodulated …… ……1. *Magnolia* sect. *Longnuhua* D.L.Fu

3b. Pedicels 1-nodulated or 1-nodulated like …… …… 2. *Magnolia* sect. *Oyama* Nakai

2b. Leaves pseudoverticillate…… …… 3. *Magnolia* sect. *Rytidospermum* Spach

1b. Ovules 4 or more per carpel; Leaves evergreen, rarely deciduous and spiral …… 4. *Magnolia* sect. *Manglietia*

6.6. Key to the Sections of *Michelia* L.

1a. Flower buds terminal.

2a. Stamens about (0.6-)1.3 cm long …… …… 1. *Michelia* sect. *Aromadendron* (Blume) D.L.Fu

2b. Stamens about 4 cm long …… …… 2. *Michelia* sect. *Alcimandra* (Dandy) D.L.Fu

1b. Flower buds axillary…… 3. *Michelia* sect. *Michelia*

7. New Taxa of Magnoliaceae

7.1. Subgeneric Combinations of *Magnolia* L.

Magnolia subgen. *Pachylarnax* (Dandy) D.L.Fu, subgen. st. nov. *Pachylarnax* Dandy, Bull. Misc. Inform. Kew 1927(7): 260. 1927. Typus: *Magnolia praecalva* (Dandy) D.L.Fu. ─ *Parakmeria* Hu & W.C.Cheng, Acta Phytotax. Sin. 1(1): 1. 1951. Typus: *Magnolia omeiensis* (W.C.Cheng) Dandy. ─ *Micheliopsis* H.Keng, Quart. J. Taiwan Mus. viii. 209. 1955. Typus: *Magnolia kachirachirai* (Kaneh. & Yamam.) Dandy. ─ *Manglietiastrum* Y.W.Law, Acta Phytotax. Sin. 17(4): 72. 1979. Typus: *Magnolia sinica* (Y.W.Law) D.L.Fu. ─ *Magnolia* subgen. *Gynopodium* (Dandy) Figlar & Noot., Blumea 49(1): 94. 2004, nom. inval.. Typus: *Magnolia nitida* W.W.Sm. About 9 species, in E & SE Asia.

Magnolia subgen. *Macrophylla* (Figlar & Noot.) D.L.Fu, subgen. grad. nov. *Magnolia* sect. *Macrophylla* Figlar & Noot., Blumea 49(1): 92. 2004. ─ *Metamagnolia* Sima & S.G.Lu, Proc. Second Internat. Symp. Fam. Magnoliac. 66. 2012, nom. inval.. Typus: *Magnolia macrophylla* Michx., Fl. Bor.-Amer. (Michaux) 1: 327. 1803. About 5 species, in N America.

Magnolia subgen. *Tuliparia* (Spach) D.L.Fu, subgen. grad. nov. *Magnolia* sect. *Tuliparia* Spach, Hist. Nat. Vég. 7: 477. 1839. ─ *Magnolia* sect. *Auricula* Figlar & Noot., Blumea 49(1): 92. 2004 (as '*Auriculatae*'). ─ *Paramagnolia* Sima & S.G.Lu, Proc. Second Internat. Symp. Fam. Magnoliac. 65. 2012, nom. inval.. Typus: *Magnolia fraseri* Walter, Fl. Carol. [Walter] 159. 1788. (─ *Magnolia auriculata* Desr., Encycl. [J.

Lamarck & al.] 3(2): 673. 1792.) About 2 species, in N America.

Magnolia subgen. *Manglietia* (Blume) D.L.Fu, subgen. st. nov. *Manglietia* Blume, Verh. Batav. Genootsch. Kunst. 9: 149. 1823. Typus: *Magnolia glaucifera* D.L.Fu (*Manglietia glauca* Blume). ─ *Paramanglietia* Hu & W.C.Cheng, Acta Phytotax. Sin. 1(3): 255. 1951. Typus: *Magnolia aromatica* (Dandy) D.L.Fu (*Paramanglietia aromatica* (Dandy) Hu & W.C.Cheng). ─ *Sinomanglietia* Z.X.Yu, Acta Agric. Univ. Jiangxiensis 16(2): 202. 1994. Typus: *Magnolia decidua* (Q.Y.Zheng) D.L.FU. (*Sinomanglietia glauca* Z.X.Yu & Q.Y.Zheng). ─ *Magnolia* sect. *Rytidospermum* Spach, Hist. Nat. Vég. (Spach) 7: 474. 1839. ─ *Houpoea* N.H.Xia & C.Y.Wu, Fl. China 7: 64. 2008. Typus: *Magnolia tripetala* L. (*Houpoea tripetala* (L.) Sima, nom. inval.). ─ *Magnolia* sect. *Oyama* Nakai, Fl. Sylv. Kor. 20: 117. 1933. ─ *Oyama* (Nakai) N.H.Xia & C.Y.Wu, Fl. China 7: 66. 2008. Typus: *Magnolia sieboldii* K.Koch (*Oyama sieboldii* (K.Koch) N.H.Xia & C.Y.Wu). 4 sections, about 48 species, in Asia and America.

7.2. New Section of *Magnolia* L.

Magnolia sect. *Longnuhua* D.L.Fu, sect. nov.

Magnolia sect. *Oyama* Nakai similis, sed spathacei-bracteis in medio pedicello, pedicellis et pedicelli-fructibus annulati-cicatricatis spathacei-bracteis manifestis in medio, 2-noduliformibus.

Shrubs or trees, deciduous. Branchlets with annular stipular scars. Flower (Mixed) buds solitary, terminal, young leaves conduplicate in bud. Leaves simple, alternate, ovate to obovate, papery, lower surfaces grayish green or glaucous, pubescent, margin entire. Stipules adnate to the petiole. Flowers appearing after leaves, solitary, terminal, bisexual. Pedicles obviously 2-nodulated, usually slender, pendulous or erect at anthesis. Bracts solitary, spathaceous, caducous. Tepals 9–12, 3 per whorl, usually white, subsimilar. Stamens red, caducous; filaments stout; anthers dehiscing introrsely, connective apices obtuse or emarginate. Gynoecia sessile; carpels few to many, distinct; ovules usually 2 per carpel; styles curved outward. Fruit aggregates ellipsoid, pendulous; mature carpels distinct, leathery or woody, dehiscing along dorsal sutures, persistent on torus, apices shortly beaked. Seeds compressed globose or ellipsoid, exotestae red or yellow, sacrotestae white, fleshy and succulent.

Typus: *Magnolia wilsonii* Rehd., Pl. Wilson. (Sargent) 1(3): 395. 1913.

3 species, in E Asia. *Magnolia wilsonii* Rehder, *Magnolia globosa* Hook.f. & Thoms. and *Magnolia sinensis* (Rehd. & Wils.) Stapf.

7.3. New Sectional Combinations of Magnoliaceae Juss.

Magnolia sect. *Dugandiodendron* (Lozano) D.L.Fu, sect. comb. nov., *Dugandiodendron* Lozano, Caldasia 11: 33. 1975. *Magnolia* subsect. *Dugandiodendron* (Lozano) Figlar & Noot., Blumea 49(1): 90. 2004; *Magnolia* sect. *Dugandiodendron* (Lozano) T.B.Zhao, Shijie Yulanshu Zhiwu Ziyuan yu Zaipei Liyong. 19. 2013, nom. inval.. Typus: *Magnolia mahechae* (Lozano) D.L.Fu. ─ *Magnolia* sect. *Splendentes* Dandy ex A.V ázquez, Brittonia 46(1): 4. 1994, nom. inval.. Typus: *Magnolia polita* D.L.Fu (—*Magnolia splendens* Urb., nom. illeg.). ─ *Magnolia* subsect. *Cubenses* Imkhan., Novosti Sist. Vyssh. Rast. 28: 60. 1991. Typus: *Magnolia cubensis* Urb. About 30 species, in S America.

Michelia sect. *Aromadendron* (Blume) D.L.Fu, sect. comb. nov., *Aromadendron* Blume, Bijdr. Fl. Ned. Ind. 1: 10. 1825; *Talauma sect. Aromadendron* (Blume) Miquel, Ann. Mus. Bot. Lugduno -Batavi 4:70. 1868; *Magnolia* sect. *Aromadendron* (Blume) Noot., Blumea 31(1): 89. 1985; Typus: *Michelia malayca* D.L.Fu (— *Aromadendron elegans* Blume). — *Magnolia* sect. *Maingola* Dandy, Bot. Mag. 165: t. 16. 1948; *Magnolia* subsect. *Maingola* (Dandy) Figlar & Noot., Blumea 49(1): 93. 2004. Typus: *Michelia macklottii* (Korth.) D.L.Fu (— *Magnolia maingayi* King). About 9 species, in SE Asia.

Michelia sect. *Alcimandra* (Dandy) D.L.Fu, sect. comb. nov. ─ *Alcimandra* Dandy, Bull. Misc. Inform. Kew 1927(7): 260. 1927. *Magnolia* sect. *Alcimandra* (Dandy) Noot., Blumea 31(1): 88. 1985. Typus: *Michelia cathcartii* Hook.f. & Thoms. 1 species, in E & SE Asia.

7.4. New Names and New Specific Combinations of Magnoliaceae Juss

Magnolia admirabilis (L.Fu et al.) D.L.Fu, sp. transl. nov. *Manglietia admirabilis* Y.W.Law & R.Z.Zhou ex L.Fu, Q.W.Zeng & X.M.Hu, Novon 23(1): 37. 2014; *Magnolia admirabilis* (Y.W.Law & R.Z.Zhou ex L.Fu, Q.W.Zeng & X.M.Hu) C.B.Callaghan & Png, PhytoKeys 146: 5. 2020, nom. inval..

Magnolia amazonica (Ducke) D.L.Fu, sp. transl. nov. *Talauma amazonica* Ducke, Arch. Jard. Bot. Rio de Janeiro 4: 11. 1925; *Magnolia amazonica* (Ducke) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 70. 1996, nom. inval..

Magnolia arcabucoana (Lozano) D.L.Fu, sp. transl. nov. *Talauma arcabucoana* Lozano, Fl. Colombia (1983+) 1: 58. 1983; *Magnolia arcabucoana* (Lozano) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 70. 1996, nom. inval..

Magnolia argyrotricha (Lozano) D.L.Fu, sp. transl. nov. *Dugandiodendron argyrotrichum* Lozano, Caldasia 11(53): 38, figure 1975 (as '*argyrothrichum*'); *Magnolia argyrotricha* (Lozano) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 70. 1996, nom. inval..

Magnolia aromatica (Dandy) D.L.Fu, sp. transl. nov. *Manglietia aromatica* Dandy, J. Bot. 69: 231. 1931; *Magnolia aromatica* (Dandy) V.S.Kumar, Kew Bull. 61(2): 183. 2006, nom. inval..

Magnolia beccarii (Ridl.) D.L.Fu, sp. transl. nov. *Talauma beccarii* Ridl., Bull. Misc. Inform. Kew 1912(9): 381. 1912. *Magnolia liliifera* var. *beccarii* (Ridl.) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 71. 1996.

Magnolia boliviana (M.Nee) D.L.Fu, sp. transl. nov. *Talauma boliviana* M.Nee, Brittonia 46(4): 265, figure 1994. *Magnolia boliviana* (M.Nee) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 26. 1996, nom. inval..

Magnolia calimaensis (Lozano) D.L.Fu, sp. transl. nov. *Dugandiodendron calimaense* Lozano, Dugandiodenron & Talauma Neotrop. 35. 1994; *Magnolia calimaensis* (Lozano) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 70. 1996, nom. inval..

Magnolia calophylla (Lozano) D.L.Fu, sp. transl. nov. *Dugandiodendron calophyllum* Lozano, Caldasia 12: 283 (-286), figure 1978; *Magnolia calophylla* (Lozano) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 70. 1996, nom. inval..

Magnolia calophylloides Figlar & Noot. ex D.L.Fu, sp. nom. nov. *Manglietia calophylla* Dandy, J. Bot. 66: 46. 1928 (non *Magnolia calophylla* (Lozano) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 70. 1996); *Magnolia calophylloides* Figlar & Noot., Blumea 49(1): 95. 2004. nom. inval..

Magnolia cararensis (Lozano) D.L.Fu, sp. transl. nov. *Dugandiodendron cararense* Lozano, Dugandiodenron & Talauma Neotrop. 52. 1994; *Magnolia cararensis* (Lozano) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 70. 1996, nom. inval.

Magnolia caricifragrans (Lozano) D.L.Fu, sp. transl. nov. *Talauma caricifragrans* Lozano, Mutisia 36: 2. 1972; *Magnolia caricifragans* (Lozano) Govaerts, World Checkl. & Bibliogr. Magnoliaceae [D.G. Frodin & R. Govaerts] 70. 1996, nom. inval..

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8. Conclusion

Magnoliaceae Juss. include 4 natural genera: *Yulania* Spach, *Magnolia* L., *Michelia* L. and *Liriodendron* L., whose chloroplast complete genomes all have the same evolutionary boundary: PHS(17bp) ≥ 0.9234 (intragenus) or PHS(17bp) ≤ 0.9232 (inter genera). The most primitive genus of Magnoliaceae Juss. is *Yulania* Spach not *Magnolia* L. because the phylogenetic relationship between *Yulania* Spach and *Ginkgo* L. is 0.055 obviously closer than that 0.023 between *Magnolia* L. and *Ginkgo* L..

Magnolia L. includes 7 natural subgenera: *Magnolia* subgen. *Pachylarnax* (Dandy) D.L.Fu, *Magnolia* subgen. *Kmeria* Pierre, *Magnolia* subgen. *Talauma* (Juss.) Pierre, *Magnolia* subgen. *Magnolia*, *Magnolia* subgen. *Macrophylla* (Figlar & Noot.) D.L.Fu, *Magnolia* subgen. *Tuliparia* (Spach) D.L.Fu and *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu, whose chloroplast complete genomes all have the same boundary: PHS(17bp) ⩾0.938 (intrasubgenus) or PHS(17bp) ⩽0.937 (inter subgenera). *Magnolia* subgen. *Pachylarnax* (Dandy) D.L.Fu is the relatively most primitive in the genus.

Yulania Spach includes 4 natural sections: *Yulania* sect. *Yulania*, *Yulania* sect. *Buergeria* (Dandy) (Sieb. & Zucc.) D.L.Fu, *Yulania* sect. *Rosula* D.L.Fu and *Yulania* sect. *Tulipastrum* (Spach) D.L.Fu, and *Yulania* sect. *Yulania* is the relatively most primitive. *Magnolia* subgen. *Talauma* (Juss.) Pierre includes 3 natural sections: *Magnolia* sect. *Talauma*, *Magnolia* sect. *Dugandiodendron* (Lozano) D.L.Fu and *Magnolia* sect. *Gwillimia* DC., and *Magnolia* sect. *Talauma* is the relatively most primitive in the subgenus. *Magnolia* subgen. *Manglietia* (Blume) D.L.Fu includes 4 natural sections: *Magnolia* sect. *Longnuhua* D.L.Fu, sect. nov., *Magnolia* sect. *Oyama* Nakai, *Magnolia* sect. *Rytidospermum* Spach and *Magnolia* sect. *Manglietia*, and *Magnolia* sect. *Longnuhua* D.L.Fu is the relatively most primitive in the subgenus. *Michelia* L. includes 3 natural sections: *Michelia* sect. *Aromadendron* (Blume) D.L.Fu, *Michelia* sect. *Alcimandra* (Dandy) D.L.Fu and *Michelia* sect. *Michelia*, and *Michelia* sect. *Aromadendron* (Blume) D.L.Fu is the relatively most primitive in the genus. The evolutionary boundary of section rank of chloroplast complete genomes is PHS(17bp) ≥ 0.961 (intrasection) or PHS(17bp) ≤ 0.960 (inter sections).

Each evolutionary taxa of different ranks of Magnoliaceae Juss. have the respectively evolutionary taxonomic characters, and the taxonomic keys to the genera, subgenera and sections have been scientifically developed. At the same time, 4 new subgeneric combinations, 1 new section and 3 new sectional combinations, 14 new specific names and 95 new specific combinations have been scientifically and validly published in the article.

Abbreviations

EVL: evolutionary loci.
EVS: evolutionary similarity.
NCBI: national center for biotechnology information
PHL: phylogenetic loci.
PHS: phylogenetic similarity.

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Conflicts of Interest

The authors declare no conflicts of interest.

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