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Short communication

Twenty years of Chinese vascular plant novelties, 2000 through 2019

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ABSTRACT

From 2000 to 2019, 11,895 new names or new additions to the Chinese vascular flora were proposed by 4226 individuals (4086 articles and 140 books), as documented in the Chinese Plant Names Index (CPNI). During those 20 years, 4407 new taxa of vascular plants were described from China, including 7 new families, 132 new genera, 3543 new species, 68 new subspecies, 497 new varieties and 160 new forms. Additionally, 3562 new combinations and names at new rank and 306 new replacement names were also proposed. Among these various new names were 150 invalid names and 108 illegitimate names, including some that have not been resolved. Six hundred and forty three vascular plants were reported as new to China, while 2349 names were reduced to synonyms of 1406 taxa. The data show that the Chinese flora increased in size at the rate of about 200 taxa annually during those years. Despite the increased attention given to biodiversity in recent years, the evidence indicates that a large number of species in China have yet to be discovered. Further basic investigation of the Chinese flora is needed. Additionally, in the past two decades only 8.5% of the newly published species have been based on molecular evidence, but in the past five years such data have increased significantly, reaching about 20%. Molecular data will undoubtedly become increasingly significant in the discovery of new species in the coming years. Yunnan, Guangxi, Sichuan, Xizang and Taiwan were important sources of new discoveries, with more than 3300 new taxa and records from these five provinces. By area, Taiwan and Hainan, two islands in southern China, have the highest density of newly discovered species. Regional plant surveys are still needed, especially in areas in the southwest and on the southern islands.

1. Introduction

China has the richest and most diverse flora of any country in the northern hemisphere, with more than 32,500 species of vascular plants documented from throughout its vast territory (Hong and Blackmore, 2015). In a recent report from Kew (Willis and Bachman, 2016), China was among the top three countries in the discovery and naming of new species of vascular plants published between 2006 and 2015. According to data from the International Plant Names Index (IPNI), the number of vascular plants reported as new to science from China has regularly exceeded 100 per year during that decade, with the total number being 1537 (Willis, 2017). Those numbers, however, do not account for all new names published in China during that period. Some publications dealing with Chinese vascular plants have not been included in international databases for various reasons. Some journals and books published locally in China are not readily available outside the country. The actual number of newly describe Chinese vascular plants is significantly greater than the number reported in IPNI. To supplement the international databases of plant names a regional database was needed. The Chinese Plant Names Index (CPNI) is a database of names of Chinese vascular plants that attempts to fill that gap by indexing new names and name changes that have been proposed for the Chinese flora.

The first account of new names of Chinese vascular plants was released via the worldwide web (http://cpni.ibiodiversity.net) and simultaneously printed in hard copy (Du and Ma, 2019a; 2019b). The hard copy index, covering the years 2000 through 2017, contains 10,850 entries. The online version covering all data from 2000 to 2019, contains 11,895 entries.

The 11,895 names accounted for were authored by 3276 scholars. A unique entry accounts for the name of each newly

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described taxon and its place of publication. The entries deal with all novelties at the rank of family, genus, species, subspecies, variety, form and named hybrids. Name changes (new combinations, new names at new rank and new replacement names), new records and new synonyms, and lectotypifications and neotypifications for vascular plants reported or recorded from China are also included. Invalid and illegitimate names of Chinese vascular plants that were used during the 2000–2019 period are given in Appendix I.

The following is a summary of the CPNI for the 20 years, 2000 through 2019.

2. New taxa published each year

From 2000 through 2019, 4407 new taxa were described based on Chinese vascular plants, including 7 new families, 132 new genera (details on newly published families and genera is in Appendix II), 3543 new species, 68 new subspecies, 497 new varieties and 160 new forms. Among the 132 newly established genera, 26 were based on new species. The remaining new genera were based on previously published species in existing genera. The number of new species have regularly exceeded 177 per year for the past 20 years. The number of names below the level of species has averaged 36 per year, but fell below 20 per year in the most recent three years of the period covered. The data show that despite increased attention paid to biodiversity hotspots, a large number of undescribed species in China await discovery. Further investigation is certainly necessary.

The publication of new species supported by molecular evidence has only gradually increased since 2010 in China; only 1/5 of the species published between 2014 and 2019 were accompanied by molecular data (See more details in the supplementary file). The publication of new taxa based on molecular evidence is increasingly recognized as important supporting evidence for names published in international journals (Fig. 1).

3. Families and genera in which new taxa were described

New species published in the 20 years from 2000 through 2019 were in 172 families (according to the current molecular systematics[1]) and 859 genera, covering about 55% of the families and 26% of the genera recognized in China. Statistics on the number of newly described vascular plants indicate that a large number of them were published in the well-known large families, such as Orchidaceae (89 gen., 376 sp.), Asteraceae (35 gen., 200 sp.), Poaceae (51 gen., 197 sp.), Fabaceae (28 gen., 180 sp.), Rosaceae (17 gen., 151 sp.), Ranunculaceae (12 gen., 135 sp.). The limestone areas of China, which harbor many local endemics, have been the source of many of them, especially in such families as Gesneriaceae (29 gen., 226 sp.), Urticaceae (11 gen., 193 sp.), Begoniaceae (1 gen., 80 sp.) and Balsaminaceae (1 gen., 69 sp.). The 25 families and genera with the most new species of vascular plants in China are shown in Table 1.

During those 20 years, 376 new species of Orchidaceae were published by 208 scholars, but only 12 scholars published more than 10 species. In fact, those 12 scholars published 247 new species of orchids, accounting for more than 66% of all orchids described during that period.

The use of molecular data accompanying the publication of new species of orchids was also relatively higher than in other families. Fifty three species, about 14 percent of new orchids, were published with molecular evidence compared to the 8.5 percent of all species with molecular data. Gesneriaceae also showed a greater use of molecular data.

Two hundred twenty six new species of Gesneriaceae were published by 142 scholars, but only 8 scholars published more than 10 species. Those 8 scholars published 155 new species, accounting for more than 68% of the total. Thirty seven species, about 16.3%, were published with molecular evidence, which was greater than in Orchidaceae. In difficult taxa such as Orchidaceae and Gesneriaceae, the knowledge and experience of experts is indispensable for the identification of taxa. The application of new technologies to supplement that knowledge is a welcome development.

4. The source of new taxa

More than 1164 new taxa and 230 newly recorded species were reported from Yunnan in southwest China. They represent about one third of the total and are far more than for any other province. Guangxi, Sichuan and Xizang were also important sources of new discoveries, with more than 1600 new taxa and records from these three provinces. By area, Taiwan and Hainan, two islands in southern China, have the highest density of newly discovered species. Yunnan and Guangxi also have a high density of newly described species, even though they occupy vast areas, perhaps due to the long-term attention of taxonomists to these areas; Guangxi because of its extensive limestone and Yunnan because its great diversity of habitats, which range from tropical to alpine. The number of new discoveries from Guizhou, however, was far fewer than from the neighboring provinces of Guangxi, Sichuan and Yunnan, even though Guizhou has a similar topography and climatic and also extensive karst areas. The difference may be due to fewer field studies within the province (Fig. 2).

5. Authors of new taxa

The 4382 new names and 3838 newly transferred names of Chinese vascular plants were authored by 1892 (86.7%) Chinese authors and 289 (13.3%) foreign authors. At the species level, 2633 new species, about 74.3% of all new names, were published solely by Chinese scholars; 539 new species, about 15.2%, were published solely by foreign authors; 371 new species, about 10.5%, were published by cooperation between Chinese and foreign authors. The number of botanists who published new names based on transfers was significantly less than the number who published new taxa. Eight hundred and fourteen scholars published new combinations, new names at new rank, and new replacement names. The top 25 Chinese and foreign botanists who published new taxa (with the standard abbreviation of their name and full name) are in Table 2. Chinese and foreign authors who published new combinations for Chinese vascular plants are shown in Table 3.

6. Taxonomic studies leading to name changes

Besides new taxa of vascular plants, 643 plants were discovered for the first time in China during this period. Newly published taxa and newly discovered taxa have resulted in a net increase of 252 additions per year to the flora of China. At the same time, 3562 new combinations and names at new rank, and 306 new replacement names were published. Additionally, 2349 names were reduced to synonymy under 1406 names. Synonymizing resulted in a net reduction of 50 taxa per year in the Chinese flora. The data still show an overall increase of about 200 taxa per year in the Chinese flora. Based on figures for the most recent years, there appears to be no tendency to deviate from this pattern. The findings indicate that China still has a large number of undescribed species awaiting

[1] Lycopodiophyta & Pteridophyta according to PPG I (Pteridophyte Phylogeny Group, 2016), Gymnosperm according to Christenhusz et al. (2011), Angiosperms according to APG IV (Angiosperm Phylogeny Group, 2016).

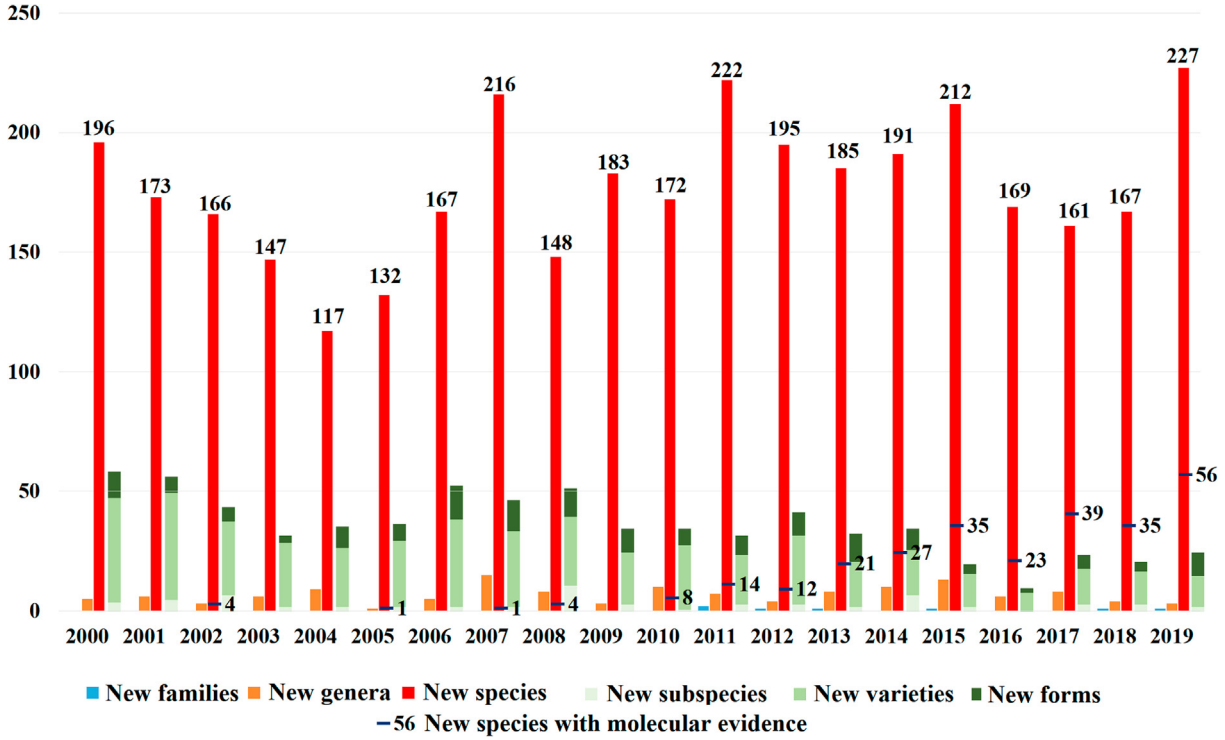

Fig. 1. Number of Chinese vascular plants described as new to science from 2000 through 2019.

Table 1
Top 25 families and genera in which new species of vascular plants from China were described from 2000 through 2019.

Family	Number of Genera	Number of Species	Genus	Family	Number of Species
Orchidaceae	89	376	*Elatostema*	Urticaceae	156
Gesneriaceae	29	226	*Astragalus*	Fabaceae	98
Asteraceae	35	200	*Begonia*	Begoniaceae	80
Poaceae	51	197	*Primulina*	Gesneriaceae	74
Urticaceae	11	193	*Polystichum*	Dryopteridaceae	70
Fabaceae	28	180	*Impatiens*	Balsaminaceae	69
Rosaceae	17	151	*Corydalis*	Papaveraceae	62
Ranunculaceae	12	135	*Cotoneaster*	Rosaceae	61
Papaveraceae	4	94	*Carex*	Cyperaceae	59
Dryopteridaceae	7	86	*Aspidistra*	Asparagaceae	58
Asparagaceae	13	85	*Saussurea*	Asteraceae	53
Begoniaceae	1	80	*Taraxacum*	Asteraceae	46
Rubiaceae	19	77	*Poa*	Poaceae	42
Balsaminaceae	1	69	*Sorbus*	Rosaceae	38
Cyperaceae	5	65	*Bulbophyllum*	Orchidaceae	37
Brassicaceae	1	58	*Rhododendron*	Ericaceae	37
Acanthaceae	12	47	*Delphinium*	Ranunculaceae	34
Ericaceae	5	47	*Clematis*	Ranunculaceae	33
Primulaceae	6	47	*Paphiopedilum*	Orchidaceae	33
Araceae	8	45	*Pedicularis*	Orobanchaceae	30
Magnoliaceae	5	44	*Meconopsis*	Papaveraceae	29
Orobanchaceae	9	41	*Strobilanthes*	Acanthaceae	29
Berberidaceae	5	36	*Arisaema*	Araceae	28
Zingiberaceae	9	36	*Primula*	Primulaceae	28
Aristolochiaceae	3	31	*Cymbidium*	Orchidaceae	26

discovery. The number of new vascular plants described worldwide has been stable at around 2000 per year for each year since 2015 (Christenhusz and Byng, 2016). New taxa based on Chinese plants therefore account for about one tenth of the worldwide total.

7. Place of publication for new names

New taxa and nomenclatural changes in China were published in 188 journals and 140 books. Among the 11,895 entries, 9652 names, about 81.1%, were published in 4086 articles in 188 journals. The remaining 2243 entries, about 18.9%, were published in books. Among those, 1714 were published in floras and checklists, 421 in monographs and 73 in proceedings. Articles with the Chinese authors as the lead author accounted for the majority, even though most of the articles were published in English. Although 188 journals published articles on new names and name changes of Chinese vascular plants, 85% of the articles were published in 26 journals, such as *Phytotaxa*, *Journal of Systematics and Evolution* (formerly

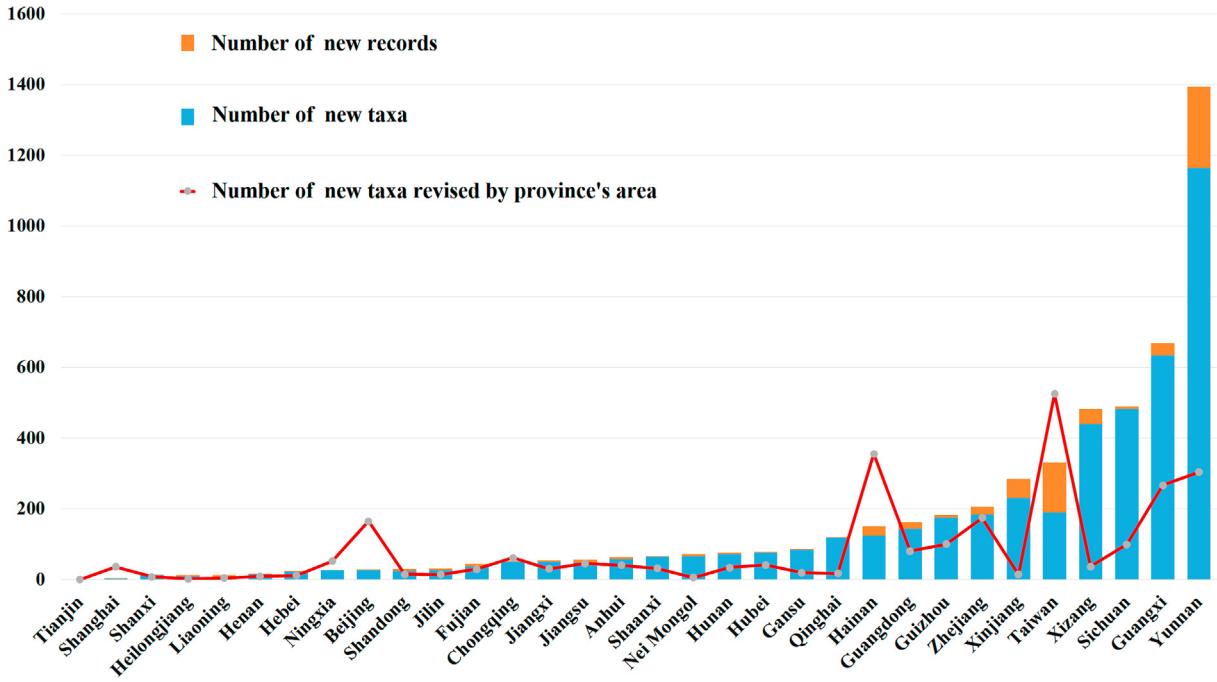

Fig. 2. Number of plant species described and recorded by province in China from 2000 through 2019.

Table 2
Top 25 Chinese and foreign authors of new species of Chinese plants from 2000 through 2019.

Standard Form	Full Name	Number of New Species	Standard Form	Full Name	Number of New Species
W. T. Wang	Wang, Wen Tsai	293	Podlech	Podlech, Dietrich	80
Y. M. Shui	Shui, Yu Min	105	Li Bing Zhang	Zhang, Li Bing	70
Yan Liu	Liu, Yan	93	B. Hylmö	Hylmö, Bertil	59
Z. J. Liu	Liu, Zhong Jian	90	J. Fryer	Fryer, Jeanette	59
W. H. Chen	Chen, Wen Hong	78	Lidén	Lidén, Magnus	55
Y. G. Wei	Wei, Yi Gang	77	Al-Shehbaz	Al-Shehbaz, Ihsan Ali	50
L. R. Xu	Xu, Lang Ran	74	Kirschner	Kirschner, Jan	44
F. Wen	Wen, Fang	67	Štěpánek	Štěpánek, Jan	44
Y. S. Chen	Chen, You Sheng	61	Ormerod	Ormerod, Paul Abel	26
S. C. Chen	Chen, Sing Chi	51	McAll.	McAllister, Hugh A.	25
Z. Y. Zhu	Zhu, Zheng Yin	49	J. R. I. Wood	Wood, John Richard Ironside	21
L. Liu	Liu, Liang	47	H. Ohba	Ohba, Hideaki	19
X. H. Jin	Jin, Xiao Hua	46	Sarn. Singh	Singh, Sarnam	16
T. P. Yi	Yi, Tong Pei	45	A. K. Monro	Monro, Alexandre Kenneth	15
X. F. Jin	Jin, Xiao Feng	45	Panigrahi	Panigrahi, Gopinath	15
C. I Peng	Peng, Ching I	42	Boufford	Boufford, David Edward	14
H. Sun	Sun, Hang	40	O. Gruss	Gruss, Olaf	14
T. P. Lin	Lin, Tsan Piao	40	T. Yamaz.	Yamazaki, Takasi	14
W. B. Xu	Xu, Wei Bin	38	Tzvelev	Tzvelev, Nikolai Nikolaievich	12
H. Li	Li, Heng	36	Rushforth	Rushforth, Keith D.	11
F. W. Xing	Xing, Fu Wu	34	S. Akiyama	Akiyama, Shinobu	11
L. J. Chen	Chen, Li Jun	34	Businský	Businský, Roman	9
Q. E. Yang	Yang, Qin Er	33	Grey-Wilson	Grey-Wilson, Christopher	9
Y. H. Wu	Wu, Yu Hu	33	H. Ohashi	Ohashi, Hiroyoshi	9
Y. Z. Zhao	Zhao, Yi Zhi	28	S. M. Phillips	Phillips, Sylvia Mabel	9

Acta Phytotaxonomica Sinica), *Novon*, *Nordic Journal of Botany*, *Annales Botanici Fennici*, *Bulletin of Botanical Research* and *Journal of Tropical and Subtropical Botany* (Fig. 3). Since 2008, most of the articles were published in journals monitored by the *Scientific Citation Index* (SCI; Anonymous, 2020) (Fig. 4).

Chinese journals represented the majority of journals in which new names were published before 2008, which was related to China's research evaluation system. The quality of journals with strict international peer review are significantly better than domestic journals. Articles in English are more convenient for an international audience. Among the journals, *Phytotaxa* has played a major role in accelerating the publication of new discoveries, with 507 new species from China published since its founding in 2009. *Phytotaxa* has published more than a quarter of the approximately 2000 species described each year worldwide and has become a major player in the dissemination of knowledge on newly described plants.

Table 3
Top 25 Chinese and foreign authors of new combinations of Chinese plants from 2000 through 2019.

Standard Form	Full Name	Number of New Combinations	Standard Form	Full Name	Number of New Combinations
N. H. Xia	Xia, Nian He	91	Mich. Möller	Möller, Michael	181
C. Y. Wu	Wu, Cheng Yih	78	A. Weber	Weber, Anton	149
X. C. Zhang	Zhang, Xian Chun	71	H. Ohashi	Ohashi, Hiroyoshi	95
S. C. Chen	Chen, Sing Chi	70	Al-Shehbaz	Al-Shehbaz, Ihsan Ali	87
Y. F. Deng	Deng, Yun Fei	59	Rabeler	Rabeler, Richard Kevin	80
H. Peng	Peng, Hua	57	W. L. Wagner	Wagner, Warren Lambert	80
S. Liao	Liao, Shuai	56	Pimenov	Pimenov, Michael Georgievich	69
C. C. Hu	Hu, Chia Chi	55	Razafim.	Razafimandimbison, Sylvain G.	63
X. X. Zhu	Zhu, Xin Xin	55	Li Bing Zhang	Zhang, Li Bing	62
S. L. Chen	Chen, Shou Liang	54	Fraser-Jenk.	Fraser–Jenkins, Christopher Roy	60
X. H. Jin	Jin, Xiao Hua	50	Kljuykov	Kljuykov, Evgeniy Vasilyevich	57
S. G. Lu	Lu, Shu Gang	48	J. S. Ma	Ma, Jin Shuang	55
Y. Tang	Tang, Ya	48	Schuit.	Schuiteman, André	54
X. Y. Zhu	Zhu, Xiang Yun	47	G. H. Zhu	Zhu, Guang Hua	51
S. R. Zhang	Zhang, Shu Ren	44	M. G. Gilbert	Gilbert, Michael George	48
Yin Z. Wang	Wang, Yin Zheng	41	N. Kilian	Kilian, Norbert	47
Z. R. He	He, Zhao Rong	39	Rydin	Rydin, Catarina	46
D. Y. Hong	Hong, De Yuan	37	Figlar	Figlar, Richard B.	35
Y. H. Tong	Tong, Yi Hua	37	Turland	Turland, Nicholas J.	35
W. T. Wang	Wang, Wen Tsai	35	Hovenkamp	Hovenkamp, Peter Hans	32
Z. R. Wang	Wang, Zhong Ren	35	Soják	Soják, Jiří	32
L. T. Lu	Lu, Ling Ti	32	M. B. Crespo	Crespo, Manuel Benito	31
W. T. Jin	Jin, Wei Tao	32	Mart.-Azorín	Martínez-Azorín, Mario	31
H. Sun	Sun, Hang	30	Mavrodiev	Mavrodiev, Evgenij Vladimirovich	31
Z. J. Liu	Liu, Zhong Jian	30	J. J. Wood	Wood, Jeffrey James	30

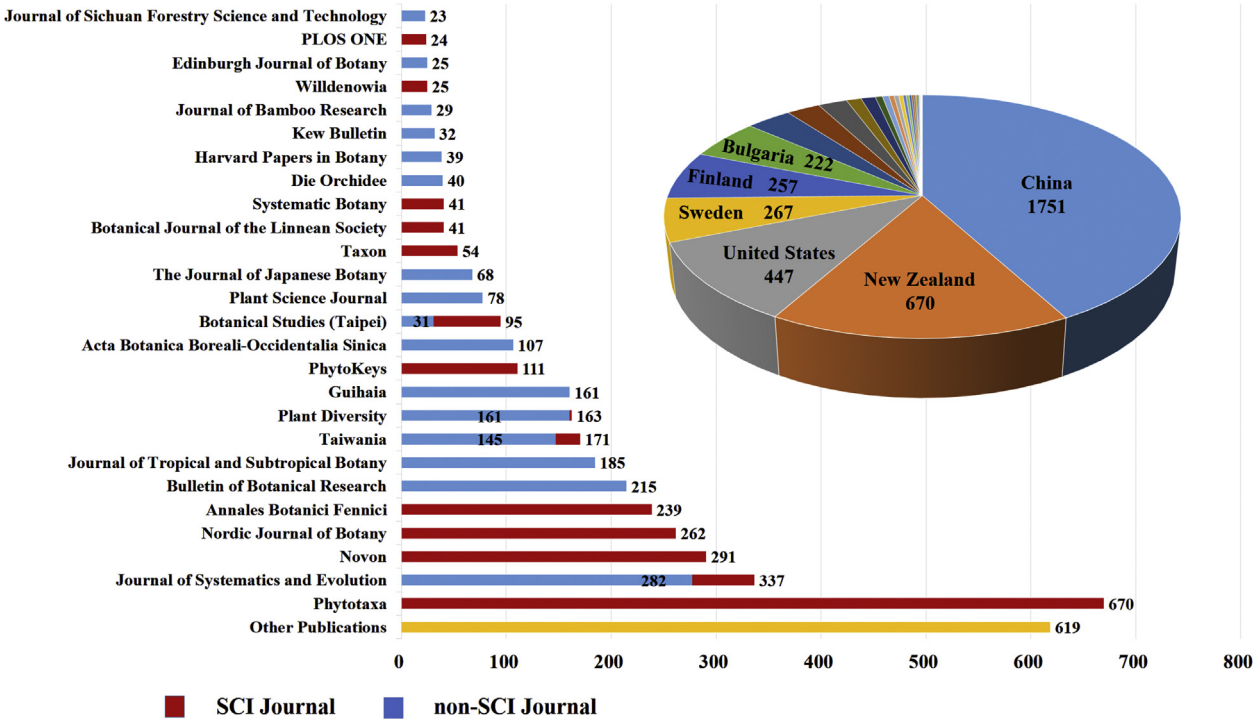

Fig. 3. Top 26 journals in which new names and name changes of Chinese vascular plants were published from 2000 through 2019; pie chart showing number of articles published by country.

8. Invalid and illegitimate names

We examined the original literature for 7555 newly described or transferred Chinese vascular plants and discovered more than 150 names that were not validly published. Failure to designate a type specimen, lack of a Latin (or English) description or diagnosis and new transferred names unaccompanied by a reference to the basionym or replaced synonyms were the main reasons. One hundred and eight names were illegitimate because they were published as later homonyms or isonyms. The names of the 258 invalid or illegitimate names and reasons for their rejection are given in Appendix I.

The availability of two national floras published within the past 60 years (Editorial Committee of FRPS, 2004; Wu et al., 2013), and

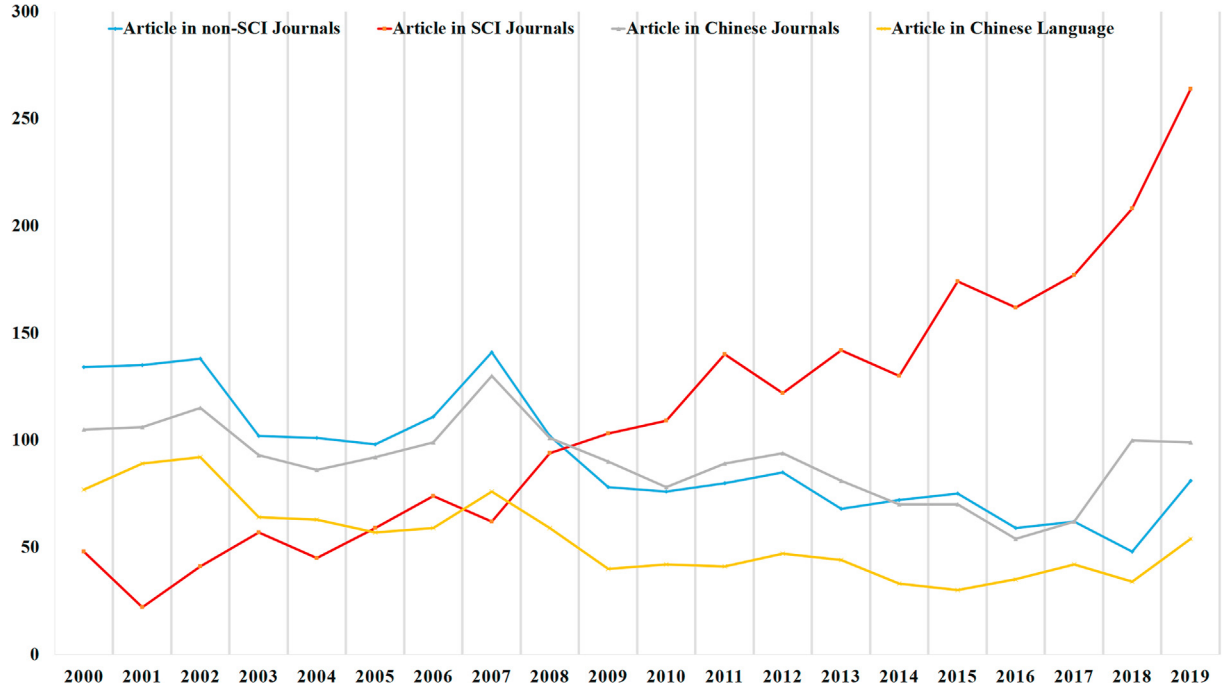

Fig. 4. Number of articles published annually in SCI journals, non-SCI journals, Chinese journals and articles written in Chinese by Chinese authors from 2000 through 2019.

more than 40 local floras at the province level or above (Du et al., 2020), make it easier than in the past to recognize undescribed species. It is especially critical that these new taxa are discovered. Since urbanization and the resulting sprawl threaten natural habitats in China. As in the rest of the world, expanded field studies should be encouraged and supported so that the remaining undescribed plants can be found before they and their habitats are lost.

Author contributions

C. Du and J. S. Ma planned and designed the research. C. Du and S. Liao collected the original data and standardized the data, C. Du analysed the data and wrote the manuscript, J. S. Ma and Boufford revised the manuscript.

Declaration of competing interest

This article does not involve conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pld.2020.08.004.

References

Angiosperm Phylogeny Group, 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Bot. J. Linn. Soc. 181, 1–20. https://doi.org/10.1111/boj.12385.

Anonymous, 2020. History of citation indexing. Clarivate Analytics. https://clarivate.com/webofsciencegroup/essays/history-of-citation-indexing/, 2020-08-13.

Christenhusz, M.J.M., Chase, M.W., Fay, M.F., 2011. A new classification and linear sequence of extant gymnosperms. Phytotaxa 19, 55–70.

Christenhusz, M.J.M., Byng, J.W., 2016. The number of known plants species in the world and its annual increase. Phytotaxa 261, 201–217.

Du, C., Ma, J.S., 2019a. Chinese Plant Names Index 2000-2009. Science Press, Beijing, pp. 1–606.

Du, C., Ma, J.S., 2019b. Chinese Plant Names Index 2010-2017. Science Press, Beijing, pp. 1–601.

Du, C., Liu, Q.R., Ma, J.S., et al., 2020. Introduction of the local floras of China. J. Jpn. Bot. 95, 179–193.

Editorial Committee of FRPS, 2004. In: Introduction. Flora Reipublicae Popularis Sinicae, vol. 1. Science Press, Beijing, pp. 1–1044.

Hong, D.Y., Blackmore, S., 2015. Plants of China: A Companion to the Flora of China. Cambridge University Press, Cambridge and New York, pp. 1–472.

Willis, K.J., Bachman, S., 2016. The State of the World's Plants Report-2016. Royal Botanic Gardens, Kew, Richmond, pp. 1–84.

Pteridophyte Phylogeny Group, 2016. A community-derived classification for extant lycophytes and ferns. J. Systemat. Evol. 54, 563–603. https://doi.org/10.1111/jse.12229.

Willis, K.J., 2017. The State of the World's Plants Report-2017. Royal Botanic Gardens, Kew, Richmond, pp. 1–100.

Wu, C.Y., Raven, P.H., Hong, D.Y. (Eds.), 2013. Flora of China, vol. 1. Introduction. Science Press, Beijing, and Missouri Botanical Garden, St. Louis, pp. 1–254.