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Review Article

An analysis on Indian Flowering Plants described between 2000 and 2020

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Abstract

From 2000 to 2020, approximately 1306 newly discovered taxa and 14 new genera have been added to the Indian angiosperm flora by 111 journals, among these 233 newly described taxa synonymized to already existing 209 taxa. Where about 24 states and three union territories are the type locations for these newly described taxa and were not clear the distribution about five new taxa. The present analysis shows that an average of one new taxon is described in every 5.5 days. Highest number of 132 taxa published in the year of 2017 and least number of 17 published in the year of 2005. Last 10 years data obviously indicates that the new plant species discoveries drastically increased, more than 100 taxa discovered in 2016, 2017 and 2020 with 105, 132 and 114 respectively. From 2000 to 2009 only 389 taxa discovered and from 2010 to 2020 total of 917 taxa described from different states of India. It shows the Indian flora increased the size at the rate of an average of 62.19 taxa annually. Despite the attention given to biodiversity in recent years increased, the evidence indicates that a large number of species in India have yet to be discovered. However, more than 850 new taxa have been discovered in Kerala, Tamil Nadu, Arunachal Pradesh, Maharashtra, and Andaman Nicobar (UT) over the course of the previous 21 years, making these five provinces significant sources of new discoveries. Particularly Kerala and Tamil Nadu have the highest density of newly discovered species in last two decades. Regional plant surveys are still needed, especially in areas such as Western Ghats, Eastern Ghats, Andaman Nicobar (UT) and Himalayas. In this study we attempted to provide insights into the present status of botanical discoveries of flowering plants in last 21 years.

Keywords: *Indian flowering plants, new discoveries, India.*

Introduction

India is biologically rich and forms of four major biodiversity hotspots of the Himalayas, the Western Ghats, the Indo-Burma and the Sunderland including Andaman–Nicobar Islands, which are recognized for their high value for biodiversity conservation and the high levels of threat (Reddy, *et al*., 2021). Species description is continuing processes which is increasing the number of species steadily in the global area parallelly with unprecedented rate of extinction. Periodical estimation of species diversity is much important for making conservation priorities of the species rich areas and potential resourceful species. The World Checklist of Vascular Plants which shows the total of 347,298 accepted species (WCVP, 2020) and currently accounted 351,030 accepted species of vascular plants in the world (POWO, 2023) whereas in the World Flora Online represented 381,959 accepted species as on date (WFO, 2023). New discoveries in the plant kingdom have been published at rates of ca. 2,100 to 2,600 species per year for the past 15 years (IPNI, 2022, Willis 2017).

Since eons, the Indian subcontinent has been rich in natural, biological, ethnic, cultural, and

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religious diversity. The history of plant literature is quite available in India from ancient Vedic period. Plants were researched and categorized during the time based on their values and utility of humans, such as medicinal, food, fiber, and so on in Rigveda and whole usefulness of plants have provided in Vrikshayurveda. Botanical knowledge in India began in the 16th and 17th centuries, the first invaders and plant explorers were Dutch, followed by Portuguese and Europeans, mainly Britishers, who thoroughly investigated the great vegetation richness of the Indian subcontinent until 1950s. The Indian history of plant explorations divided in two periods *viz*. Pre-Linnaean and Post-Linnaean (Sikarwar, 2020). Altogether a total of 21,558 taxa of angiosperms occurs under 268 families and 2,744 genera in India, the present database also provides 1404 cultivated taxa, and a total of 1907 infraspecific taxa including 1518 varieties, 337 subspecies and 52 forma, which constitutes some 7–8 percent of the total plant species in the world (BSI, 2023).

In this study, we attempt to address some of these complex challenges, such as how many species have been described in last 21 years in India, where they do exist, and, thus, where collection efforts must be improved to permit the discovery of previously undiscovered species. To assess the state of taxonomic knowledge in India, we examined the current status of taxonomic collections as well as data from Indian angiosperm species published between 2000 and 2020.

Literature Survey

In this study, we compiled a list of new and newly described Angiosperms plant taxa in India from 2000 to 2020 based on an exclusive survey of literature through online and offline. The major source of the data synthesizes from the search engines of International Plant Name Index and Plants of World Online (IPNI, 2023; POWO, 2023), journals which are preferred by the Indian authors searched by the journal archives and Plant Discoveries reports accounted by Botanical Survey of India, the distribution and type information of the specimens gathered from the original protologue or from major herbaria. Family circumscription follows Angiosperm Phylogeny Group–IV (2016). The taxonomic ranks of species, varieties and subspecies considered for the account and new genera accounted separately, whereas erected new combinations, hybrids, forma and strains and other infra–specific ranks are ignored. We collected data on the distribution of each taxon at the state or regional level from the type specimens or other specimen localities cited in the original published literature. Type information was adopted from the original protologues

New Taxa Published Each Year

Since from 2000 through 2020, total of 1306 new taxa and 14 genera were described by several authors, including 1115 species, 164 varieties and 27 subspecies in that 233 newly described taxa synonymized to 209 existing taxa, the most of the new genera were proposed in India based on previously existing genera or species. Data showed that the Indian plant species description increased the size at the rate an average of 62.19 taxaannually during those years. Highest number of 132 taxa has been published in the year 2017 and least number of 17 taxa were published in the year of 2005. Last 10 years data clearly indicates that the new taxa discoveries drastically increased, more than 100 taxa discovered in 2016, 2017 and 2020 with 105, 132 and 114 respectively. From 2000 to 2009 only 389 taxa discovered and from 2010 to 2020 total of 917 taxa described from different states of India (**Fig. 1**). It clearly indicates that the last decade paid the considerable attention towards plant exploration by taxonomists in India, hence large number of undescribed species still awaits discovery, further exploration is certainly necessary.

Only 16 species of new plants discovered in Bhutan Himalayas in 9 years period from 2009 to 2017 (Gyeltshen, *et al*., 2018). From 2000 to 2019 total of 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 among these 2349 names were reduced to synonyms of 1406 taxa (Du, *et al*., 2020).From 1990 to 2006 total of 2875 new angiosperm species were described from Brazil, approximately one new species is described every two days (Sobral and Stehmann, 2009). In Myanmar, about 13 genera, 193 species, 7 subspecies, 19 varieties, and 2 forms have been newly described from 2000 to 2019 (Yang, *et al*., 2020). The recent biological description is a result of modern methodological developments (phylogenetics) and technological improvement (molecular biology and modern computing capabilities), coupled with an increasing awareness of the current biodiversity crisis across the world (Brummitt, *et al*., 2021).

Family and Genera Contributed New Taxa

A total of 1306 taxa has been discovered belonging to 439 genera and 117 families (arranged according to POWO 2023, APG-IV 2016). Statistics on the number of newly described angiosperm taxa indicate that a large number of them were belonging in the well-known prominent families, such as Poaceae (112), Orchidaceae (87), Balsaminaceae (71), Acanthaceae (56), Fabaceae and Zingiberaceae (54), Apocynaceae and Lauraceae (53), Cyperaceae (52.) and Melastomataceae (43) (**Fig.2).** Genera like *Impatiens* alone produced highest number of 71 taxa, followed by *Ceropegia* (including Brachystelma-23) 42, *Eriocaulon* 34, *Strobilanthes* 23, *Fimbristylis, Memecylon* and *Musa* 19, *Sonerila* 18, *Tripogon* 17, *Crotalaria* 16, *Amomum,* and *Cinnamomum* 15 and *Syzygium* 14 respectively. It is clearly showing that theses genera are not settled, probably some more new discoveries in such genera are expected in India for forthcoming years too. During the last 21 years of period highest number new grass taxa (about 112 species) that has been contributed about 8.5% of total taxa described, 87 orchid species (6.66%) and 71 balsams species (5.4%) described by different authors and from various locations of Indian region. These findings support the credibility of the new taxa on the list. We are aware of the challenges that would arise in evaluating the number of new species provided here, because species conceptions differ amongst authors, and among them are lumpers and splitters. Allowing for this is a difficult endeavor that requires knowledge beyond the scope of this study. It is probable that numerous species reported within the last 21 years may be lost to synonymy in the near future as variants of older and more variable species. Most of newly recorded taxa are from herbaceous families, which probably reflect the difficulty of collecting tree and liana species, particularly at remote sites without canopy access, many woody taxa flower infrequently and it is not easy to find flowering material, as well as good fruiting specimens where these are important (Middleton, *et al*., 2019).

State-wise analysis

A total of 24 Indian states and three Union Territories have been contributed a minimum of single taxa to a maximum of 329 taxa. From Kerala state approximately 329 new taxa described, almost 25.2% of new taxa in past 21 years, followed by Tamil Nadu with 174 taxa (13.4%), Arunachal Pradesh with 158 taxa (12.1%), Maharashtra 114 taxa (8.8%), Andaman and Nicobar 75 taxa (5.8%), Karnataka 59 taxa (4.5%), Assam 55 taxa (4.2%), Sikkim 41 taxa (3.1%), Meghalaya 40 taxa (3.1%) and Andhra Pradesh and Uttarakhand 35 taxa (2.6%) and remaining all states and UTs together contributed 191 taxa (14.7%). Above data is clearly indicating that the Indian States which are having on Western Ghats *i.e.* Tamil Nadu and Kerala alone contributed 38.8% of new taxa in last 21 years. More than 8 states and one UT contributed 10 or less than 10 species only, as of our collected and available data Lakshadweep contributed only one species, Punjab, Tripura, Bihar and Haryana not even proposed single species in last 21 years (**Fig.3; Map.1)**. A few new taxa (about 5) could not able to trace their original type locality in protologue.

Journals Published New Taxa

New taxa have been published in 111 journals and books which are belonging to different countries, several authors preferred the Phytotaxa for describing new taxa, which

shows predominantly 218 taxa, followed by Nordic Journal of Botany 126 taxa, Rheedea 102 taxa, Journal of Economic and Taxonomic Botany 95 taxa, Kew Bulletin 71 taxa, Indian Journal of Forestry and Nelumbo (incl. The Bulletin of the Botanical Survey of India) 63 taxa, Taiwania 60 taxa, Webbia 45 taxa (41 spp., 2 var.), and Edinburgh Journal of Botany 39 taxa. A total of 10 different journals published three taxa each, whereas in 18 journals published two taxa each, but approximately 41 journals have published only single species. Nearly 16.7% of new taxa published in Phytotaxa and other top 15 journals published around 61.8% of new taxa, remaining 95 journals and books altogether only for 21.5% new taxa published (**Fig. 4**) It shows that the journal which are preferred by the Indian Taxonomists to publish their new discoveries.

Type Information of Taxa

A total of 96 different herbaria are home for these 1306 newly described taxa, majorly of 525 taxa and their type sheets deposited in the Central National Herbarium, Howrah–BSI unit (CAL) followed by The Madras Herbarium at Coimbatore (MH) 124 taxa, Tropical Botanical Garden and Research Institute (TBGT) 85 taxa, Calicut University Herbarium (CALI) 71 taxa, Botanical Survey of India, Eastern Regional Centre (ASSAM) 66 taxa, and Royal Botanical Garden Kew (K) 31 taxa, approximately 37 herbaria are each holding single type specimen. Nearly 40% of type sheets deposited in CAL, remaining 60% type sheets are in various herbaria in India, information gathered from the original protologue.

Regional, State and local Floras

With a wide range of climatic variations from the torrid to the arctic, India has vastand varied vegetation. India can be categorized into eight distinct floristic regions or vegetation zones, namely the western Himalayas, the eastern Himalayas, Assam, the Indus plain, the Ganga plain, the Deccan, Malabar and the Andamans which comprises enormous number of flowering species. The lists of flowering species have been compiled throughout the country since from the British explorers. Though the Hooker's Flora of British India, Indian plants are not accounted in the single head by the Flora of Independent India even after 75 years of post-independent period except some fragmented publications of BSI, especially for selected genera and families in India. Last 20 years, almost all the Indian States have accounted their state Floras or through Regional Floras and 17 States have revised its State Floras. Some recent Regional Floras Like Flora of the Himalayas (Ruttley, 2019), Database of Himalayan flowering plants (Rana and Rawat, 2017), Flora of Eastern Ghats (Pullaiah, *et al*., 2002 – 2020) and Flora of Western Ghats (Nayar, *et al*., 2014) covers the majority of the Indian States. In additions, the fragmentary monographs, revisions and localized district Floras also enumerated the list of plant sources in small scale throughout the country.

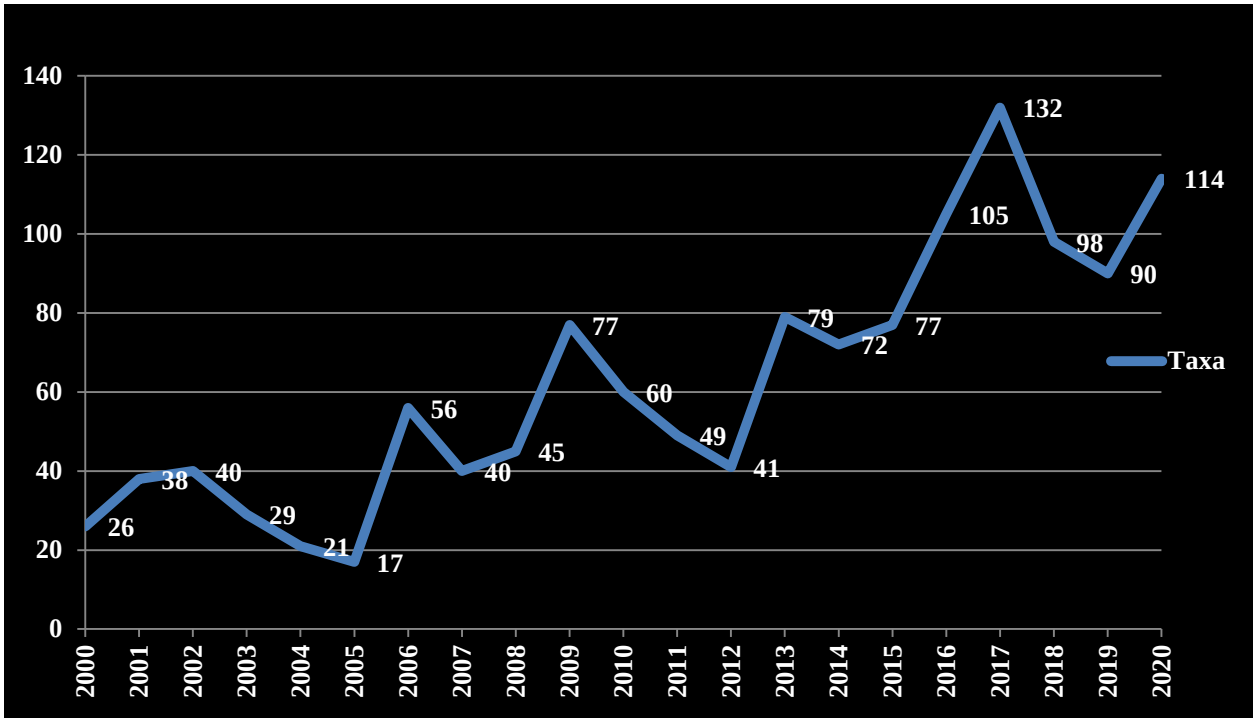


Figure 1: Number of taxa described as new to science from 2000 to 2020

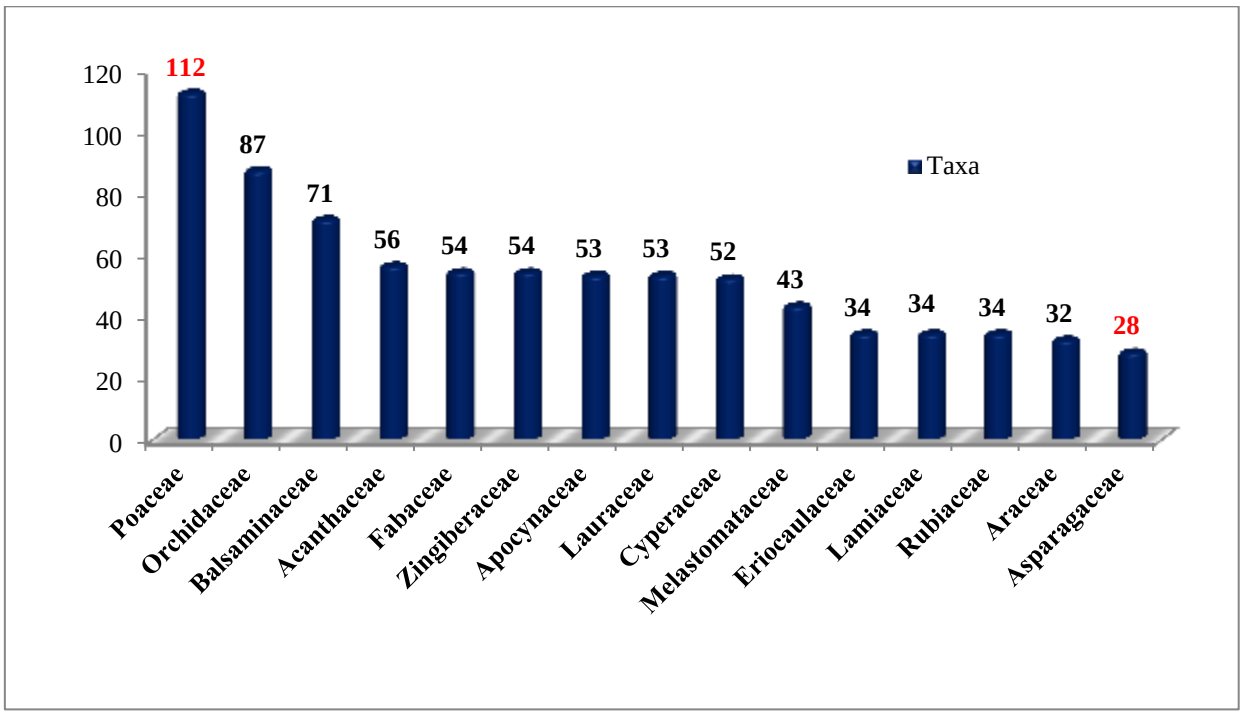


Figure 2: Top 15 families contributed new taxa

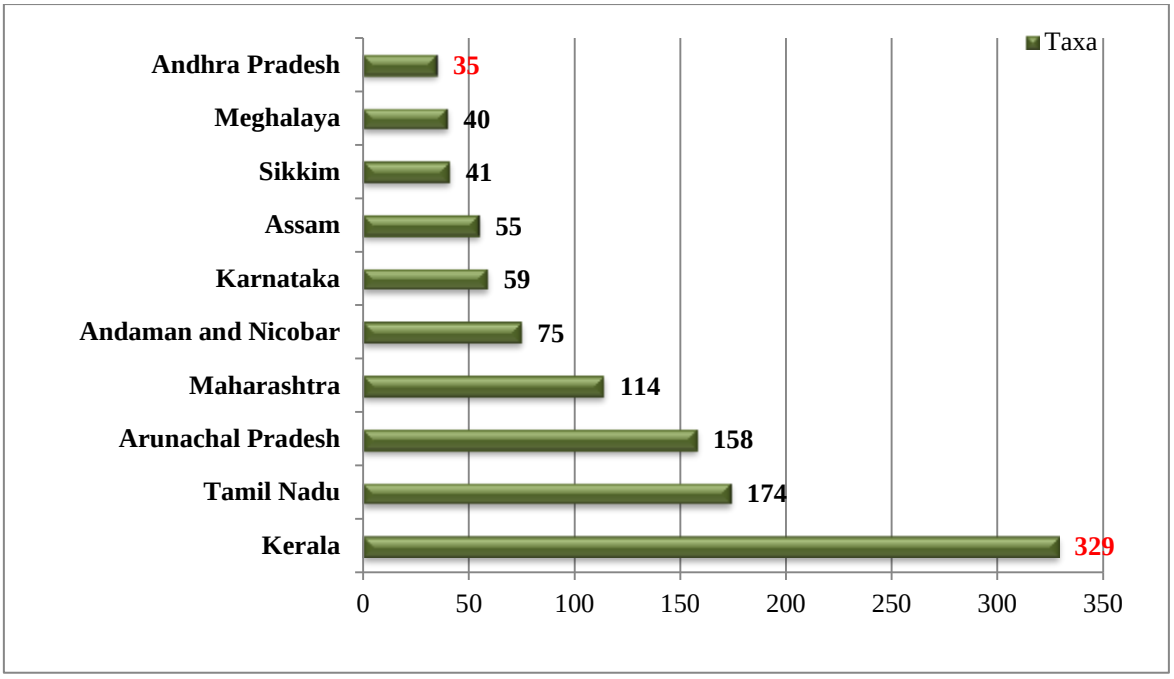


Figure 3: Top 10 states contributed new taxa

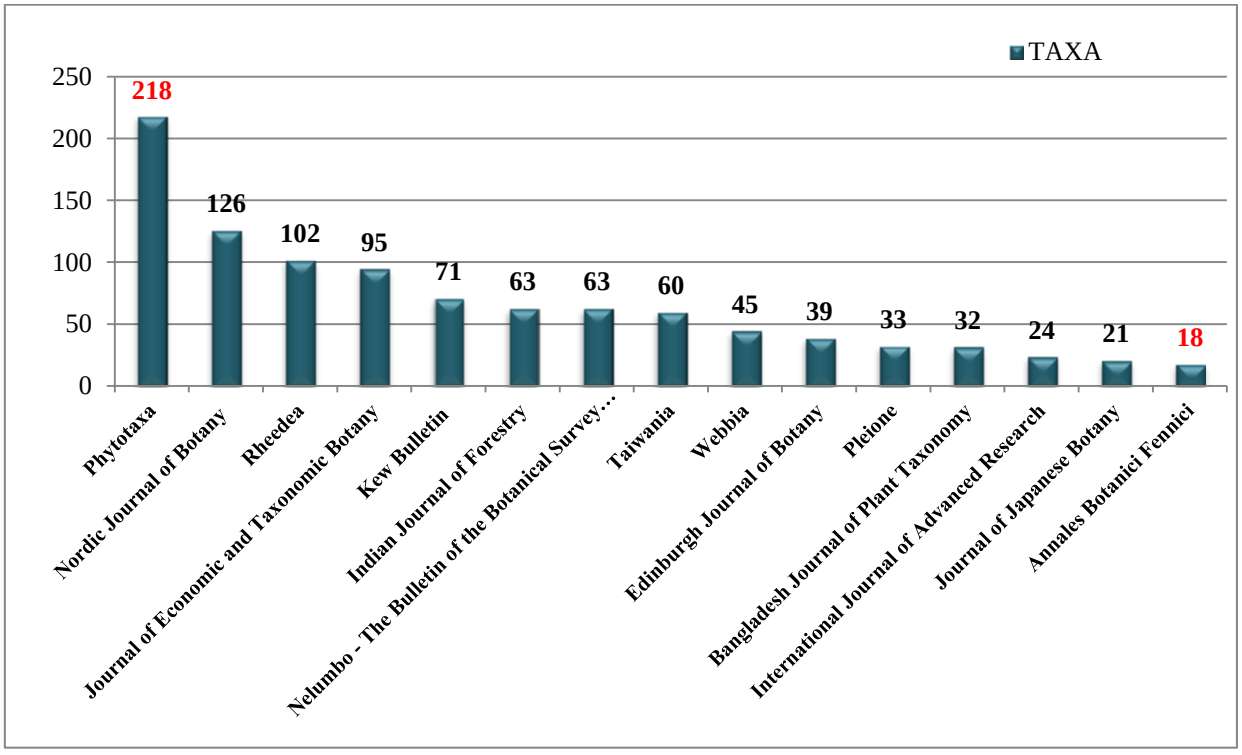
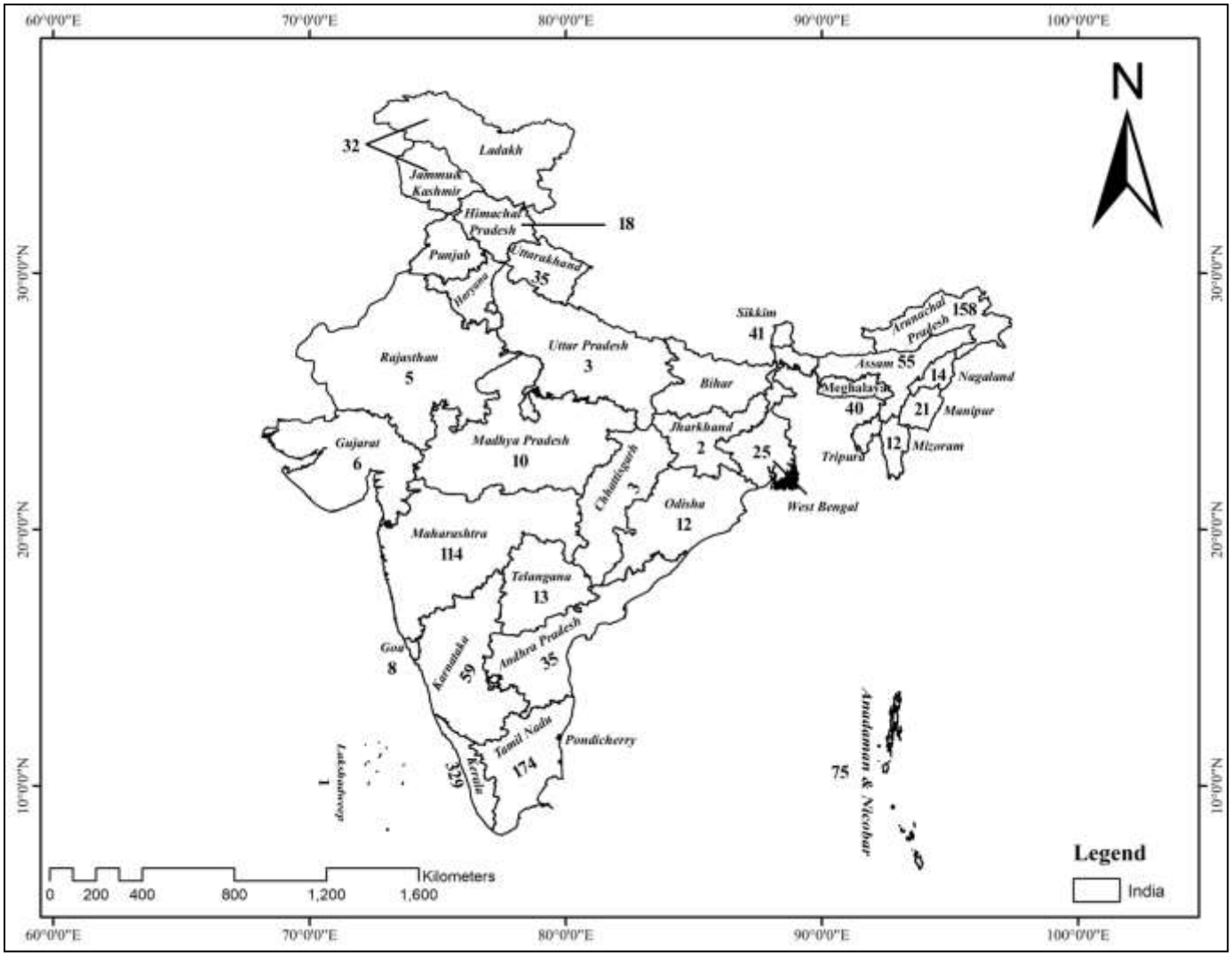


Figure 4: Top 15 journals which new taxa published from 2000 through 2020



Map 1: Showing the State-wise distribution of described taxa from 2000 to 2020

Conclusion

Research and discovery of new species is essential for searching alternate diversity resources and making conservation planning. If species remain unknown to science, they cannot be forced into conservation planning and so the possibility to protect them from extinction is questionable. Furthermore, until species are scientifically documented they cannot be fully evaluated for their resource potential as new foods, medicines, and other products for the benefit of humanity. We recommend that more plant resources are invented through scientific discovery and description of new plant taxa, before their extinction. Priorities to be included more investment in on hand training for taxonomists, and creating employment through building and equipping plant-based research centers for them, especially in species-rich countries like India. Scientific discovery and naming of plant taxa are increasingly important for making conservation efforts because of the species which remains to be discovered often those most likely to be risk of extinction. This will be of interest to botanical professionals, conservationists and policy makers seeking to identify the conservation priorities including those of international importance. Large subcontinent like India has compiled its floristic wealth before the British period through *Flora of British India* (Hooker, 1872-1897). After the independence of 75 years, Indian botanists unable to compile the Flora of Independent India and have only fragmented publications like Regional, State and Local Floras. The completion of Flora of India requires more field work from

Himalayas to Kanyakumari, taxonomic studies on new and existing collections, and national and international initiatives and encouragement continued international cooperation. In addition, Indian Flora needs modern taxonomic treatments and participation of experts for the preparation of modern Flora. There is also urgent need to attract young taxonomists for work on inventories, taxonomic exploration, identification, nomenclature, herbarium work and comparative taxonomic studies.

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