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REVIEW PAPER

Bibliometric Analysis of a Decade Orchidaceae Research: A Comprehensive Study in the Agriculture Field

Siti Agus Tina, Ni Made Armini Wiendi*, Krisantini

Department of Agronomy and Horticulture, Faculty of Agriculture, IPB University
IPB Dramaga Campus, Bogor 16680, Indonesia

*Corresponding author; email: nmarmini@gmail.com

Abstract

Orchidaceae is a family of flowering plants esteemed in numerous countries globally, so they are a promising subject for further exploration. The evolution of Orchidaceae research over the past decade is a foundation for identifying areas warranting deeper investigation. bibliographic analysis based on the Scopus database was used to elucidate the advancements in research over a decade. We brought data on an increasing number of publications between 1943 to 2023. About 7139 documents were found about orchid research, and 59% were in agriculture filtered by subject area, from around 2013 until 2023. America and Asia have the most significant number of Orchidaceae species, approximately 12000. However, China stands out with many publications with a high citation rate. Regarding the organization that publishes the journal, from 16204 organizations, the University of Chinese Academy is a prominent contributor characterized by substantial collaboration in advancing orchid research. Furthermore, the co-occurrence and all keywords indicating genetics, biodiversity, and taxonomy have been used as basis research topics in the last ten years. With additional analyses and reviews, this bibliometric analysis demonstrates that the research on Orchidaceae, specifically in agriculture, thrives every decade. Hence, we recommend future orchid conservation and research that should focus on the current gaps in knowledge and practice, including species distributions, management of species, and threats of extinction for developing or creating new cultivars to intensify a high potential commercial value.

Keywords: conservation, species, breeding, orchid, biotechnology

Introduction

The Orchidaceae family exhibits a broad geographical range spanning all continents except Antarctica. It stands out as one of the most extensive and varied flowering plants, encompassing 10% of all systematically confirmed angiosperms and 40% of monocotyledon species (Anghelescu et al., 2023). There are approximately 25000-35000 species worldwide (Silva, 2012). Orchids are the highest number of species in all angiosperm families (Wati et al., 2022). This underscores the importance of mapping the distribution of these flowers to enhance the identification of additional species. With the advancement of technology, there is a growing public interest in cultivating the Orchidaceae family due to its aesthetically pleasing flower shapes. Orchids are significant among key species, prompting extensive research to develop new varieties in countries like Holland, Germany, Italy, Spain, and Kenya. This effort has created over 30000 orchid varieties that are extensively utilized in floriculture. These nations invest heavily in research to cultivate novel orchid species, producing approximately 500 new varieties yearly (Misirova, 2023).

Additionally, in historical times, the Chinese mainland population uncovered evidence that specific components of this flower possess medicinal properties, notably those belonging to the genus *Dendrobium* (Bulpitt et al., 2007). Numerous scientific and practical endeavours are underway worldwide to advance floriculture and landscape design, enhancing the aesthetics of roads, communities, parks, and gardens.

Nevertheless, despite the swift progress of scientific advancement, numerous unidentified wild species persist. Scientists have conducted expeditions across the globe, as exemplified by Suetsugu et al.

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(2023), who unveiled the orchid species *Spiranthes hachijoensis* in Japan, and Farminhao et al. (2024), who revealed the species *Solenangis impraedicta* in Madagascar. Nonetheless, discovering newly evolved species remains incomplete over successive years. In addition, orchid conservation also poses a challenge due to the difficulty of growing orchids from seeds and their relatively slow growth. This is because germinating orchid seeds are tiny in size and do not have endosperm. Based on Edward et al. (2018), the lack of a functional endosperm following fertilization is probably determined during ovule development. Ovule development is intricate, and precise specifications of different embryo sac components are crucial for their function during fertilization and the initial phases of embryo development. Then, farmers start using tissue culture (Silva, 2013).

Research conducted at universities and government institutions has created numerous novel orchid varieties via artificial mutations, including chemical and physical mutagenesis techniques. Various non-targeted mutagenesis techniques are accessible, from chemical treatments involving alkylating agents to irradiation using X-rays, gamma rays, neutrons, or heavy ion beams at different dosages. These methods are generally cost-effective and have demonstrated efficacy as mutagens across various species (Hakeem et al., 2021). However, genetic engineering still requires to be more feasible for many ornamental breeding endeavors due to its high cost and the requisite expertise for successfully transforming and regenerating ornamental crops. The initial investigation into ethyl methane sulfonate (EMS) in breeding ornamental plants dates to its discovery in 1946 (Melsen and Wouw, 2021).

Mutagenesis serves as a crucial breeding technique in ornamental plants. It introduces novel colors and forms, enhances plant structure, prolongs shelf life, confers resistance to pests and diseases, generates novelties and peculiarities, or induces variations to facilitate subsequent breeding programs (Sheela and Sheena, 2014).

The agriculture sector in flower cultivation is evolving alongside significant technological advancements. Colombia and Indonesia boast a higher number of orchid species compared to other countries. However, when it comes to the production of ornamental orchids, Japan leads the way with a production value of USD 3.7 billion, followed closely by the Netherlands with USD 3.6 billion and the US with approximately USD 3.3 billion (Xia et al., 2010). The orchid industry plays a significant role in the global floriculture market, valued at USD 9 billion (Hassan et al., 2016). Therefore, a promising outlook for developing orchids in agriculture is supported by ample research to facilitate increased production.

Research that has evolved leaves its mark on researchers in the form of scientific articles. These publications serve as foundational texts to be analyzed and expanded upon. Notably, platforms like Scopus provide access to such resources. Presently, tracking the annual volume of publications serves as a metric to gauge the extent of research in orchid studies and the advancements made therein. This tracking aids in identifying which research areas are in urgent need of further development. This scientific article aims to chart the trajectory of orchid research, particularly within agricultural contexts, and comprehensively discuss the potential avenues for future development, along with the necessary aspects that must be cultivated to realize them.

Materials and Methods

Database Selection and Search Query

This investigation obtained data from the 'Scopus dataset' for several publication documents. For the literature review, article sources were not restricted for a more complete and comprehensive explanation. Data was obtained from 1943 to 2023 and visualized by dividing by decade. Furthermore, we elucidate the topic of research that thrives every decade.

Document Exclusion and Inclusion

The title of the observation key was 'Orchid' AND publication year from <2012 AND publication year >2024 AND excluding the document type 'Book chapter' and 'Note' AND limit to subject area 'Agriculture' or 'limit to subject area "Biotechnology". In addition to observing in-depth, we selected the key to 'orchid' AND each genus.

Data Extraction and Analysis

Data were extracted in CSV format using MS Excel software for further research analysis. VOSviewer software and RStudio visualized the data. Data on orchids' distribution were collected and visualized using MS Excel.

Result and Discussion

Progress of Scientific Publication and Research in Orchidaceae Worldwide

Bibliometric indicators offer reliable evidence and

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an overview of scientific activity. The quantity of publications is regarded as an indicator of scientific production. (Vinkler, 1988). Citations-based indicators are valuable and revealing measures of the impact and internationalization of scientific work (Martin and Irvine, 1983). This article proves that there has been a sharp increase in publications from 1943 to the present. This was seen in the first decade of 2003 and continued to develop continuously until this year, written in 2023 (Figure 2).

Over the last decade, 7139 orchid documents were identified, with 59% focusing specifically on agricultural aspects (Figure 3). As the demand for orchids as ornamental plants rises, the presented data illustrates a growing annual interest among researchers in generating novel findings to enhance the value of orchid plants, both commercially and

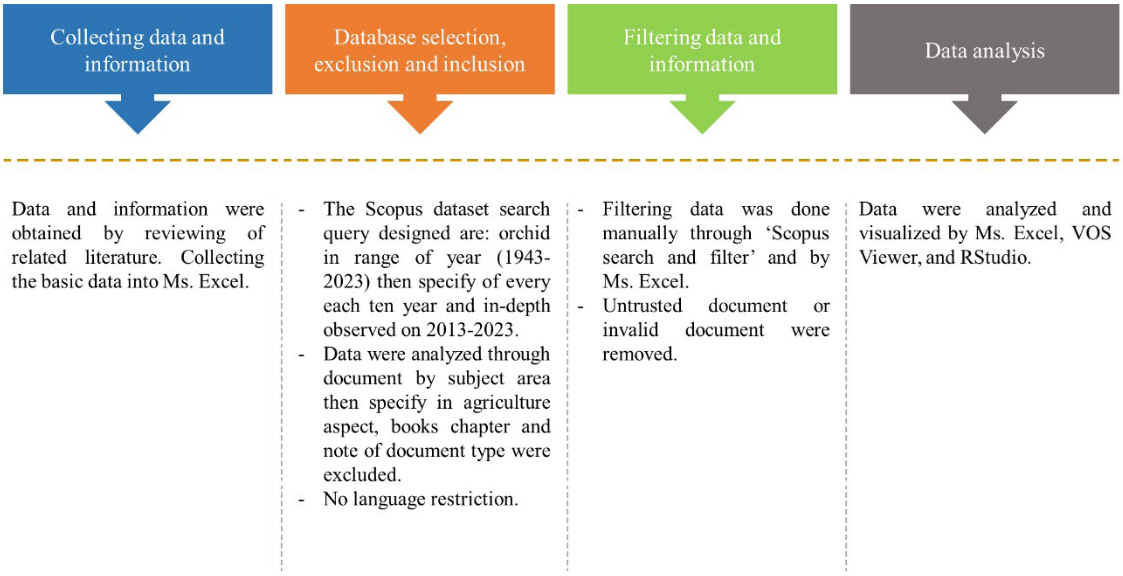

Figure 1. Flow chart of the orchid bibliometric analysis

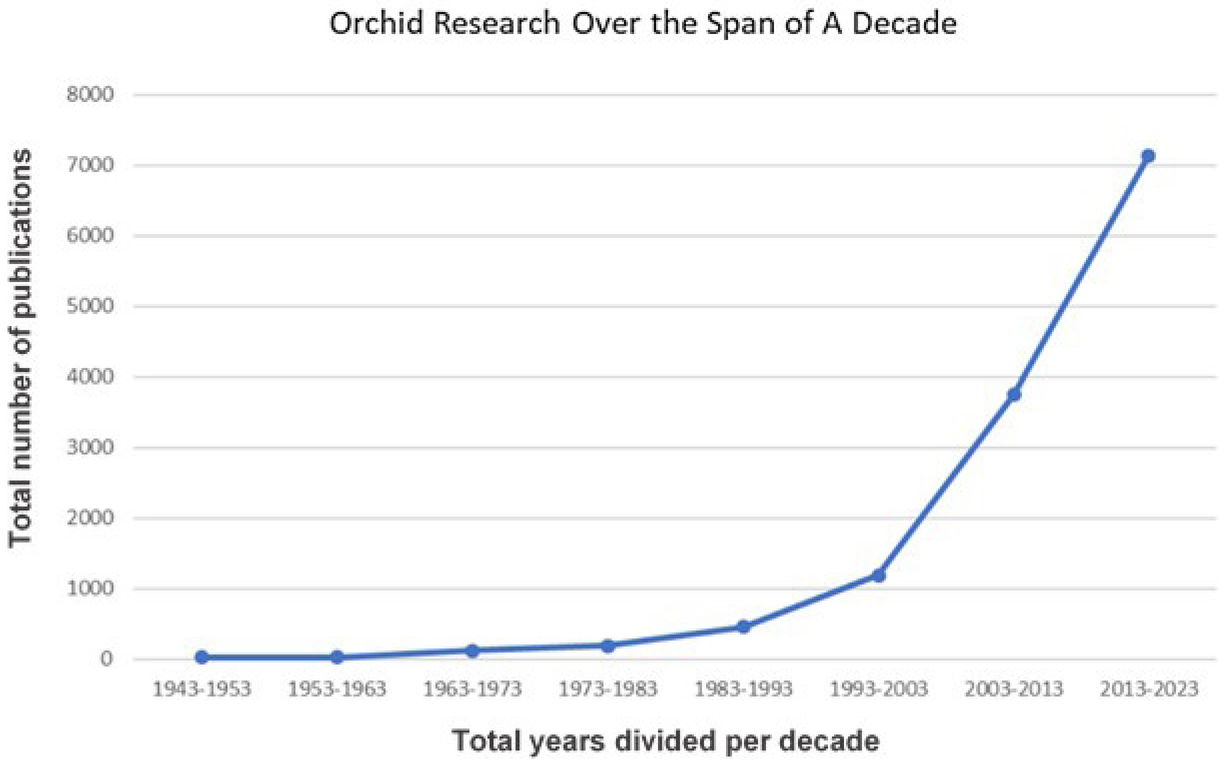

Figure 2. The evolution of publication quantity of Orchidaceae research across all scientific disciplines over each decade from 1943 to 2023.

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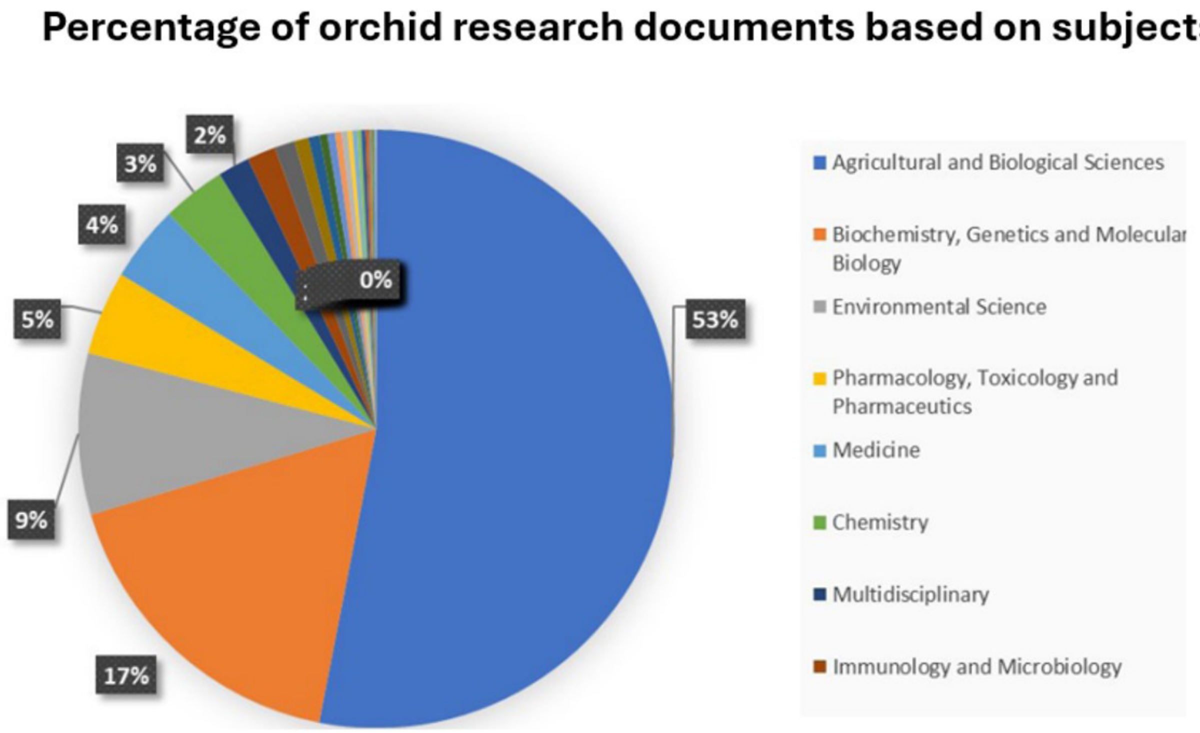

Figure 3. Percentage of orchid research based on subject area from 1973-2023

otherwise. However, it does not mean we have never faced obstacles with these things.

This shows that awareness of scientific observations increases over time every year. There are only 3 documents found of Orchidaceae research in 1943-1953 and this topic about pathogen and pharmaceutical in *Vanda* sp., In the next decade, 1953-1963, 8 publications mostly discussed karyotype and genome in Orchidaceae then other topics followed. In 1963-1973, physiology and biosynthesis aspects were observed for the first time in Orchidaceae; the documents discussed alkaloids and anthocyanin. The tissue culture methods using the leaf tip explants were published very early on.

An increasing number of publications and diverse topics ensued between 1973 and 1983. There are 138 documents on discovering new species, pollination, breeding, and chromosome observation in Orchidaceae. In this decade, 9,10 dihydrophenanthrene was isolated for the first time in the Orchidaceae family. Cytologically chromosome observation was the main topic hyped at this time, such as in the West Himalayan Orchids tribe *Neottieae* by Mehra et al., *Listera ovata* Vosa, and 35 species more by Sau and Sharma in 1983. In 1983-1993 about 418 documents were found, two stilbenoids from *Arundina bambusifolia* were observed and published by Majumder and Ghosal in *Phytochemistry* also followed by stilbenoids and phenanthrene glucoside observation from *Bletilla striata* by Yamaki et al., and new phenolic derivatives from *Galeola faberi* was isolated, bibenzyl derivatives from *Dendrobium* and *Bulbophyllum triste* was analyzed by Majumder and Pal in 1993. Orchid distribution and discovering new species were the main topic that researchers interested in, such as terrestrial orchid *Apostasia elliptica* found in Borneo by Poulsen, two species of *Bulbophyllum* from Papua New Guinea was discovered by Vermuelen and O'Byrne, new species of *Epipogium* from Arunachal Pradesh was discovered by Chowdhery et al., *Mesadenella meei* in 1993. Majumder published research about the Coelogyne genus in a *Phytochemistry* journal with the topic of steroidal ester from *Coelogyne uniflora* in 1990 and the next year 1991 isoflaccidinin and isooxoflaccidin, stilbenoids from *Coelogyne flaccida*.

In 1993-2003, a total of 1227 documents were published, and molecular experiment in Orchidaceae was conducted and published such as tropical epiphytic CAM orchid Mokara Yellow by Li et al., rare Gorae Leek Orchid, *Prasophyllum diversiflorum* Nicholls by Garrick et al., Victorian and Tasmanian populations of *Prasophyllum correctum* D.L. Jones by Orthia et al., *Anacamptis palustris* by Salvatore et al. 2023. Besides that, in this decade, a pathogen in Orchidaceae was observed such as Cymbidium mosaic virus (CymMV) by Sherpa et al. and polyphagous pest of orchids by Uechi et al., Cyanobacteria on the roots of epiphytic orchids by

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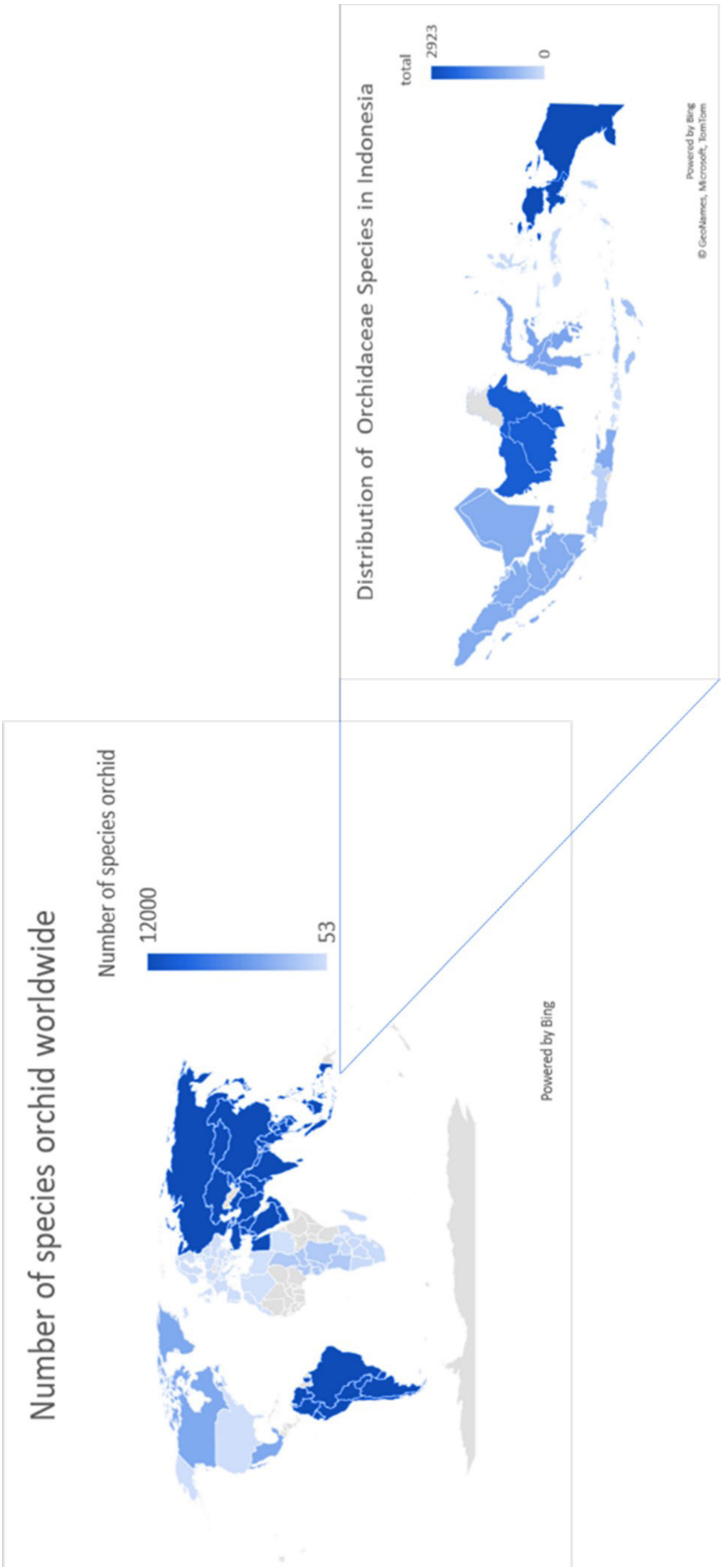

Figure 4. Comparison of the orchid distribution of all continents versus Indonesia. The data explained the number of species in the recent five years from 2019-2023

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Tsavkelova in 2003. *Phalaenopsis*, *Dendrobium*, and *Cattleya* genus were most observed in this era.

Several publications rocketed increase in the recent decade, 2003-2023; in this decade, the publication about Orchidaceae reached 10414 documents. The research topics in this decade are very diverse, ranging from discovering new species, studying evolution and mechanisms, transcriptome analysis, and secondary metabolite to developing new orchid cultivars through artificial mutations. The publication not only on research progress but also reviews specific topics, for example, mutation there is discussed about orchid protocorm-like bodies by Cardoso et al. 2020, polyploidization in orchids by Vilcherrez-Atoche in 2022, etc. For the research progress in mutation such as mutation using ionization radiation in *Paphiopedilum* by Luan et al. 2012, mutation in the SEPALLATA-like MADS-Box gene HrSEP-1 in *Habenaria radiata* (Orchidaceae) by Mitoma and Kanno in 2018, a mutational hotspots Plastomes in *Debregeasia* (Urticaceae) by Wang et al. in 2020, Mutation in focus: first record of a wild chimeric individual for the subtribe *Laeliinae (*Orchidaceae) by Barberena in 2021.

We collected and obtained data about the number of species of orchids worldwide in all continents, then visualized using a worldwide map following Indonesia (Figure 4). The American and Asian continents have the most significant number of orchid species, thus, more than 12000 species, respectively. This number makes these two continents compete in finding new species that can be developed further. Specifically, Colombia and Indonesia are the countries with the most significant number of orchid species, with approximately 4270 (Alba- Patiño, 2021) and 5000 species (Haryanto et al., 2020; Trimanto et al., 2023), respectively. Columbia is a megadiverse country in the American continent and Indonesia in Asia. Megadiverse countries are those that host the highest biodiversity index on Earth, measured by the total number of species in a country, the degree of endemism of those species, and their high taxonomic levels (Mittermeier et al., 1999).

From the data we obtained from 2013 to 2023, which is a decade, we see that China has the most significant scientific publications and research on Orchidaceae. This sharply contrasts Indonesia, which is not even in the top 10 countries with scientific publications on Orchidaceae research based on Scopus data (Figure 5). We do not place restrictions on language when downloading scientific manuscripts, so this is not a factor. However, according to Roubik (2024), the Orchidaceae family are victims of an extensive illegal trade. It threatens Southeast Asia with hundreds of tropical plant species (Phelps and Webb, 2015), and almost all Southeast Asian countries are developing countries except Singapore. Orchidaceae are heavily traded for ornamental reasons, with over 85 % traded from all ornamental plants (Mozer and Prost, 2023).

Most research documents on orchids in this decade were produced by China, which can be seen in Figure 5. China has produced more than 1000 scientific publications totally in a decade recently. This is supported by the research of Nguyen and Choung (2020). Chinese scientific and technological capability was reflected through numerous inventions that required sophisticated knowledge and techniques, including the compass of papermaking or article publication. Furthermore, despite not having a significant number of orchid species, China generates

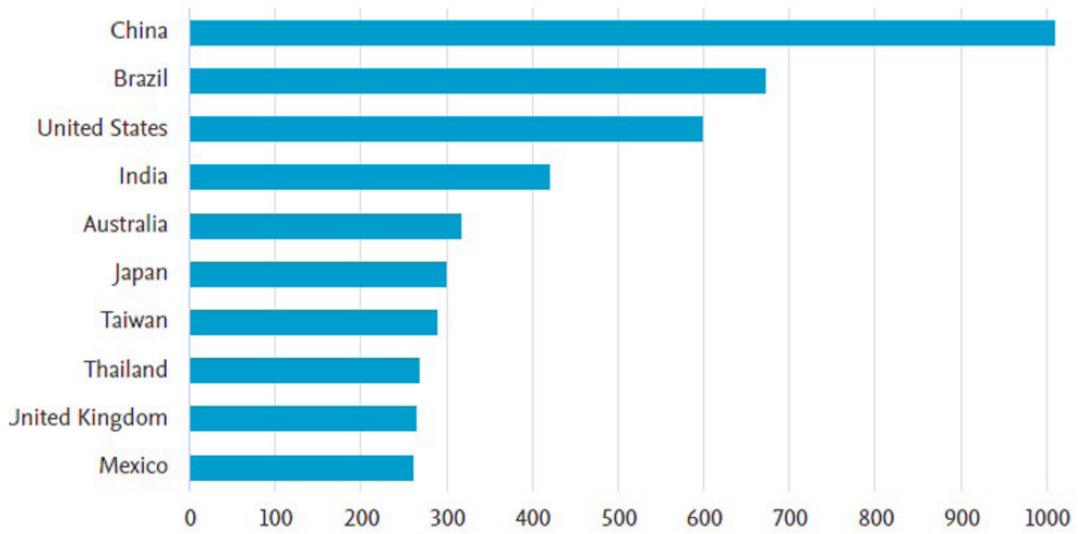

Figure 5. Total number of orchid documents by country from 2013 until 2023.

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the highest quantity of research articles for scientific journals compared to countries with greater orchid diversity. China has generated substantial research output to compensate for the abundance of published manuscripts (Fu et al., 2011).

China has the highest number of citations, which is in line with the highest number of publications, followed by India, Japan, the United States, and Brazil (Figure 6), which is also in line with the data in Figure 5. The citation shows that this country has more advanced scientific development. This has also been reviewed in one of the articles, 'The Scientific Impact of Nations: Journal Placement and Citation Performance' by Smith et al. (2014).

Data that was analyzed using VOSviewer provides a list of documents that produced most articles

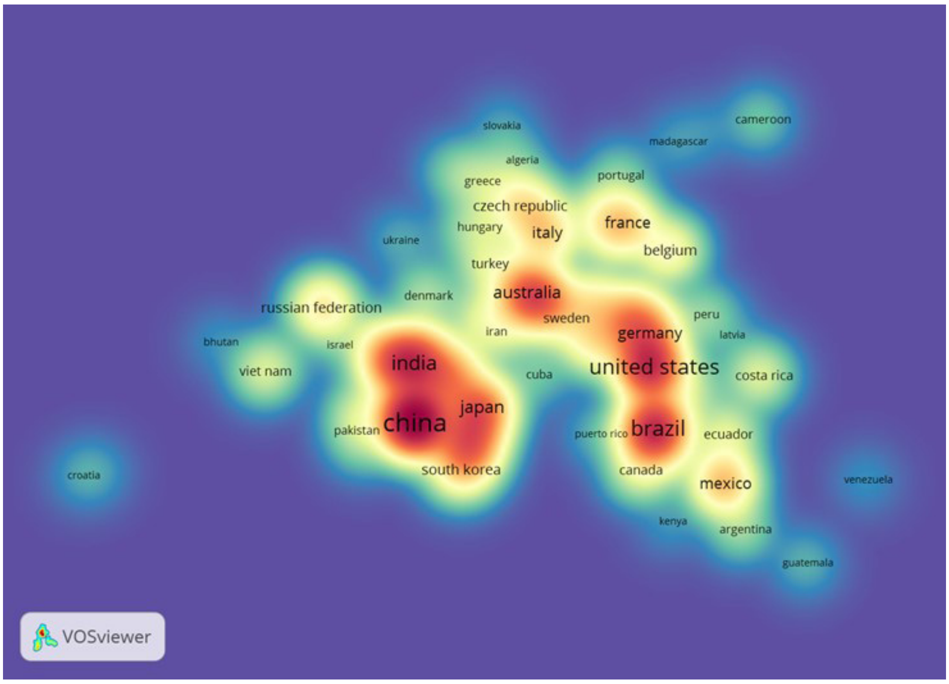

Figure 6. Network visualization map for citations and countries that produced articles on orchids

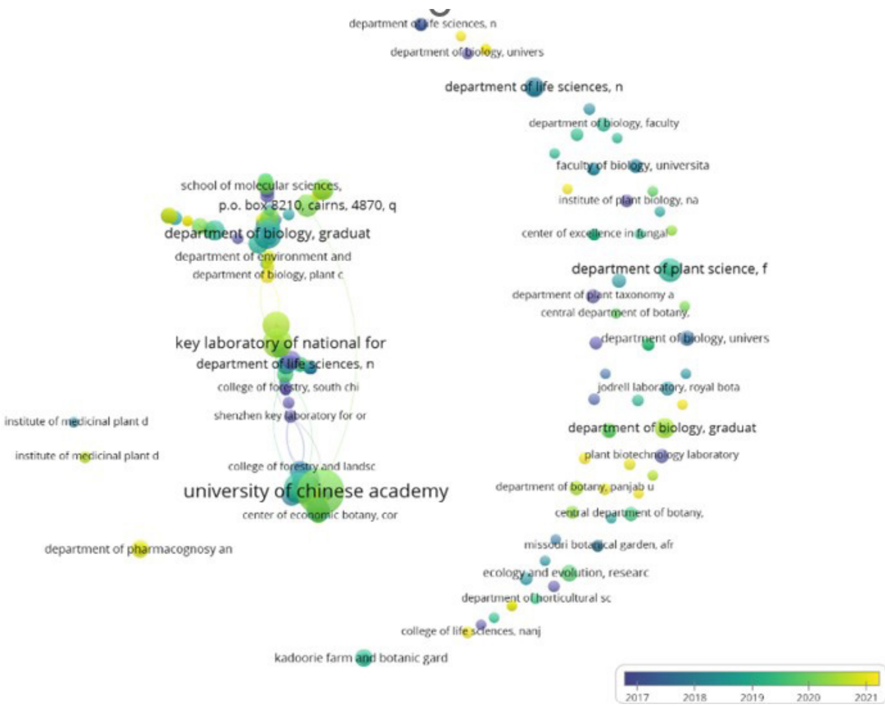

Figure 7. Network visualization map for co-authors and organizations that publish studies on orchids

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throughout the study period. The VOSviewer analysis yielded 16,200 institutions researching orchids, but approximately 222 met the threshold. Figure 7 shows the various organizations that published Orchidaceae research. The University of Chinese Academy of Sciences has a considerable role compared to other institutions. This result is similar to another field, 'The Chinese Academy of Sciences', which has a higher publication than other universities in China (Nguyen and Choung, 2020).

Research and Development to Improve the Commercial Values of Orchidaceae

The network shows 1000 items (keywords) that connect each other; the links indicate the relationships between a pair of nodes; moreover, the strength of this connection is observed in the width of the link, where a greater number implies a greater relationship. The data of Figure 8 shows Orchidaceae has a width and width link to genetics, biodiversity, taxonomy, conservation, article, metabolism, flower, pollination, and evolution. This indicates that research on this topic was strongly related to 1000 keywords building 6 clusters. The first cluster was filled with items about adaptation, anatomy and histology, evolution, organic compounds, genetics, pollination, biodiversity, conservation, etc. There are 205 items in the second cluster, some of them are anthocyanin, abiotic stress, bioinformatics, biosynthesis, biosynthetic pathway, gene, genetics, genome, transcriptome, transgenic plant, etc. In the third cluster, there are 178 items available; some of the items are anti-inflammatory, antibacterial, metabolomics, secondary metabolites, and pharmacology. Moreover, there are 172 items in the fourth cluster, they are agriculture, amino acid, biochemistry, biotechnology, cytology, gene, histology, horticulture, in vitro, plant cell, protocorm-like bodies, tissue, and tissue culture, etc. In five clusters, there are 96 items, they are cell nucleus, chloroplast, chromosome, classification, cluster analysis, DNA, gene conservation, genome, molecular evolution, phylogenomics, plant breeding, and species. The sixth cluster has 46 items, comparative studies, pathophysiology and treatment outcome, etc.

Network visualization keywords can indicate the relation between Orchidaceae research and other fields. In the data in Figure 8, we can discuss that the development of Orchidaceae in the genetic aspect has quite a significant role; apart from that, 'unclassified drugs' in discovering new drugs are also seen to have been developed. Conservation and taxonomy in identifying new species is essential in developing countries with few publications. However, it has a potential for wild species to grow up; this is because there is a possibility that new species have yet to be observed by researchers.

Most Orchidaceae are traded for horticultural values and medicinal products and play a significant role in cosmetic production. Nevertheless, orchids exhibit a low tolerance to harvesting, potentially leading to declines in species population if excessive individuals are collected. (Hinsley, 2018). Gathering wild orchids contributes to the decrease of approximately one-third of endangered Orchidaceae species (IUCN Red List, 2024). Consequently, the bulk of legal trade involves propagated specimens.

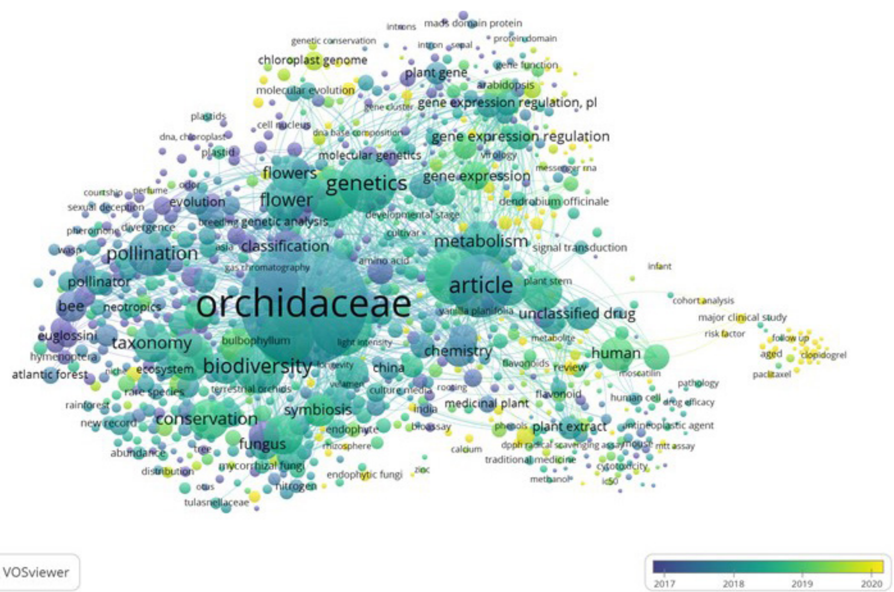

Figure 8. Network visualization map for co-occurrence and all keywords that indicate the relation between Orchidaceae research and other fields.

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Approximately 500 new species are identified in all plant families annually. Currently, there have been cataloged 736 genera within the Orchidaceae family. The discovery of new orchid genera occurs at a rate of roughly 13 species per year, as per data spanning the ten years before 2004 (Schuiteman, 2004). However, some newly identified genera are subdivisions of species already known within other genera rather than purely novel discoveries (Chase et al., 2015). Even though the data shows that Orchidaceae have many genera, only a few have been improved and have global markets. They are *Phalaenopsis*, *Dendrobium*, *Cymbidium*, *Vanda*, and *Cattleya* (De et al., 2015) (Figure 9).

Several species were mixed between species and hybrids. The type of cut orchid exported depends on the producer's location and preferences. The Netherlands and New Zealand are well known for their *Cymbidium*; the Netherlands and Taiwan for *Phalaenopsis*; Malaysia, Singapore, and Thailand for *Dendrobium* and *Mokara*; and Taiwan and Thailand for *Oncidium* and *Vanda* (Yuan et al., 2021).

Phalaenopsis is one of the most popular cultivated orchids worldwide; around 92 native species and 34112 hybrids have been registered with the Royal Horticulture Society; however, only 18 native species are frequently used for breeding (Hsu et al., 2018). The breeding purpose of *Phalaenopsis* is commonly to improve several aspects, such as flower morphology, flower color, and scent.

Dendrobium dramatically impacts the economic value of several Asian countries because flower production is better in tropical conditions (Ketsa and Warrington, 2023). *Dendrobium* species and hybrids exhibit excellent growth traits, low maintenance requirements, easy propagation, abundant flowering, and high productivity. They are popular due to their floriferousness, wide range of flower colors, sizes, and shapes, year-round availability, and long vase life (De et al., 2014).

The *Cattleya* genus is considered the 'Queen of the Orchids' (AOS, 2013). It differs from other orchids commonly by its large flowers arranged in inflorescences and has well-established markets (Cardoso et al., 2016). Despite its significant market potential, *Cattleya* remains less favoured than *Phalaenopsis* and *Dendrobium*. For market purposes, farmers usually produce hybrids. On the other hand, the challenge of creating a *Cattleya* hybrid was found because of the cultivation, including a long juvenile period, the low durability of flowers in planta and as cut flowers, and season-dependent flowering (Cardoso et al., 2016).

The genus *Vanda* was a little bit different from other genera. The species has both horticultural and medicinal importance, but its commercial value is usually for medicinal purposes. It is used to prepare various traditional medicines, owing to the presence of various phytochemicals such as alkaloids, flavonoids, phenols, etc. It is also supported by historical distribution; Vanda is commonly found in India (Manipur, Meghalaya, Nagaland, Arunachal Pradesh, Sikkim, West Bengal, Himachal Pradesh, Uttarakhand), Bangladesh, Bhutan, Nepal, China, Myanmar, and Indochina, which these countries are the place traditional medicine were made (Pathak et al., 2022).

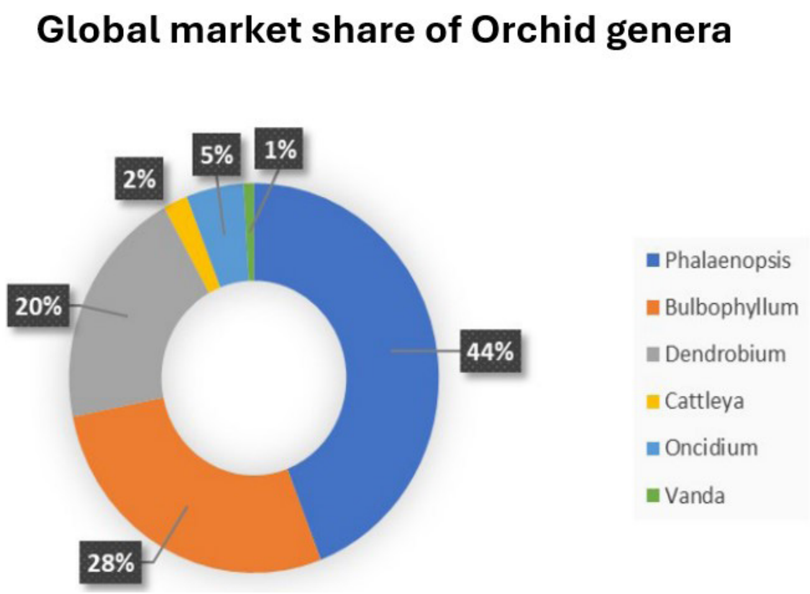

Figure 9. Percentage of global market share of Orchidaceae genera

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In the last decade (2013 to 2023), documents regarding orchid genera in the Scopus database show that the *Dendrobium* genus is the most widely observed, followed by *Phalaenopsis* and *Cymbidium*, with the rest being *Vanda*, *Oncidium*, *Cattleya*, *Bulbophyllum*, and *Coelogyne* (Figure 10).

The number of documents in the Scopus database on orchid research is not in line with the number of species in a particular genus (Figure 11). The number of research documents on *Phalaenopsis* is higher than on *Dendrobium*, while the species in *Dendrobium* are more numerous than *Phalaenopsis*.

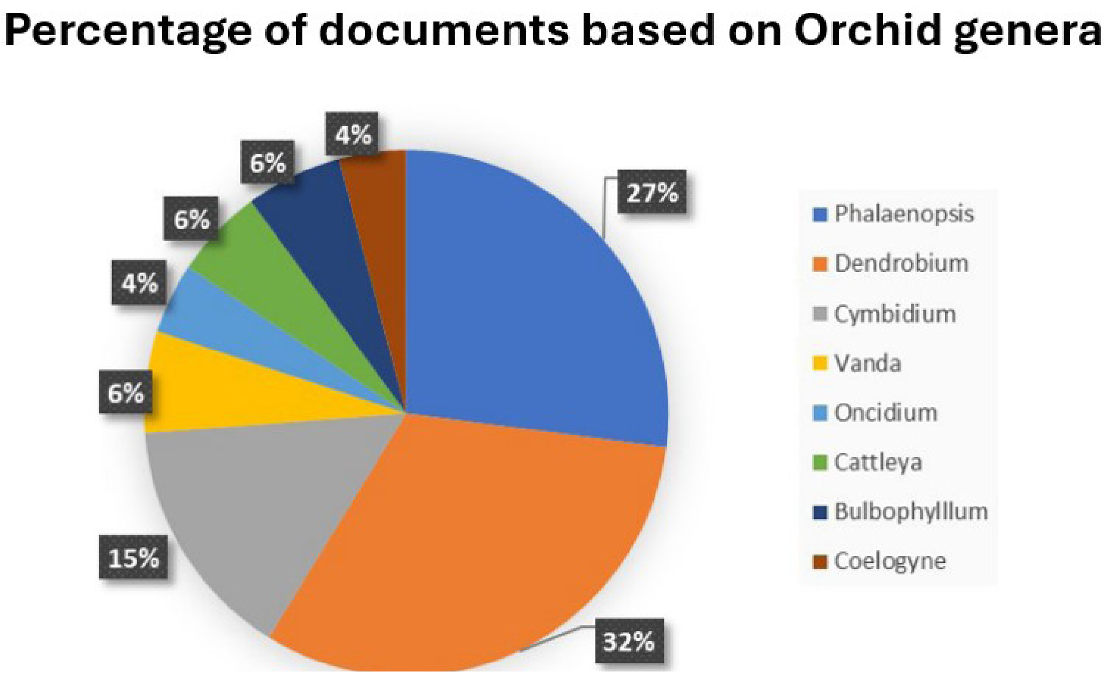

Figure 10. Percentage of Scopus-indexed documents of several genera of orchids within 10 years (2013-2023)

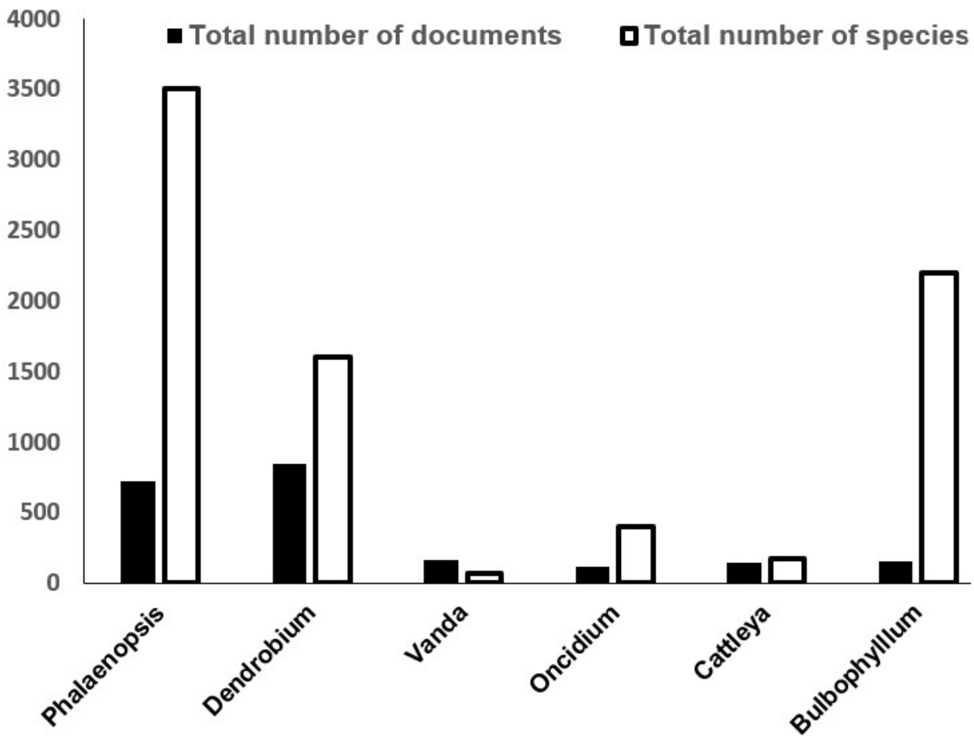

Figure 11. Comparison of total document and total species of several genera of Orchidaceae within 10 years (2013-2023)

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Breeding Technique for Improving the Trait of New Cultivars for Commercial Purposes

The history started 4000 years ago in China; the Chinese were the first to fully write and utilize orchids as medicinal plants (Yang L., 2008; Teoh, 2016). The beautiful appearance of orchid flowers attracts people to collect orchids.

The floral structure of orchids is highly specialized, with a lip, or labellum, a landing platform for pollinators, and a column that houses both the male and female reproductive organs (Bhattacharyya et al., 2023). However, there were many obstacles and challenges to producing massive amounts for commercial purposes. About 160 years ago, the first method for orchid seed germination in horticulture was born, marking a significant departure from how other seeds germinated (Moore, 1849). This approach was an innovative, significant horticultural and biological advance. Half a century after Moore's discovery, Noel Bernard (1874–1911) made another quantum jump when he formulated a method for symbiotic germination of orchid seeds in vitro. This is probably the first method for in vitro propagation of any plant (Yam and Arditti, 2009). Nowadays, farmers can use tissue culture to propagate orchids from the vegetative organ; despite that, as research progresses, many breeders want to produce new cultivars to improve the quality of the trait.

Hence, technology has helped to develop more as time has gone by. In the early years, breeders used pollination, whether self-pollination or cross-pollination. This process involves placing or inserting pollinia into the stigmatic cavity of flowers. Pollinia contain numerous pollen tubes that carry nuclei responsible for fertilizing ovules, leading to seed formation in significant quantities. The development of embryos, termed embryogenesis, varies from 3 to 18 months, depending on species and cross-type. Significant variations in seed development duration can occur even within the same genus (Cardoso et al., 2023). Hybridization, whether occurring naturally or through artificial means, integrates the excellent characteristics of the two parents within the hybrid offspring. *Phalaenopsis* intermedia, originating from a cross between *P. aphrodite* and *P. rosea*, initially documented in 1853, is one of the earliest natural hybrids. Conversely, Calanthe, the inaugural artificial orchid hybrid noted by Dominy in 1856, emerged from a cross of *Calanthe masuca* and *Calanthe furcate* (De Chandra et al., 2019; Li et al., 2021).

Orchid breeding requires a long time to get the specific expected traits. Chemical and physical mutations in orchid plants were first discovered at the beginning of the development of plant genetics in the 20th century. At that time, researchers began identifying and studying genetic changes that occurred naturally or were caused by environmental factors in orchids and other plants. Then, mutation breeding was used in many orchid species, mainly to produce distinctive physical characteristics (Li et al., 2021), increase levels of medicinal compounds, and enhance resistance to biotic and abiotic stresses.

This century can be said to be the dawn of biotechnology-driven by the economy; the merging of conventional breeding methods with transgenic technology became a solution for assisting researchers in creating desired phenotypes in flowers, stress resilience, and postharvest longevity in ornamental plants that are not seen in nature (Partap et al., 2023). Examples are *Phalaenopsis amabilis* (Perdana et al., 2021) and *Dendrobium lineale* (Febriyanti et al., 2020).

Another new technology is gene editing, a technique for creating a new cultivar without inserting a new gene. CRISPR/Cas is a technology in genetics that is currently being hyped for manipulating recombination (Jin et al., 2023; Ovcharenko and Rudas, 2023). The genus edited in one of their species is *Phalaenopsis*; the example is *Phalaenopsis amabilis* (L.). Blume (Suputri et al., 2024), *Phalaenopsis* sp. (Tong et al., 2020).

Potentials of The Indonesian Orchidaceae

About 5000 Orchidaceae species exist in Indonesia. As a megadiverse country with a variety of plant resources, Indonesia should have comprehensive data on flora distribution, which is published in document article journals, to become a source of knowledge for the Indonesian and international community. This resource richness is also reflected in many species of Orchidaceae that have been found in Indonesia, some of the largest genera found in Indonesia include *Phalaenopsis*, *Dendrobium*, *Bulbophyllum*, *Vanda*, *Cattleya*, and *Coelogyne*.

Phalaenopsis, *Dendrobium*, *Bulbophyllum*, *Vanda*, and *Cattleya*, already improved, whether by conventional way or mutation breeding; however, different from them, *Coelogyne* has a lack of improvement although it has economic potential. *Coelogyne* can be found across Indonesia, from Sumatra to Papua Island. *Coelogyne* has a different look and consists of approximately 200 species worldwide (Gravendeel, 2000). Still, most are in Southeast Asia, and about a hundred species are in Indonesia (Puspitaningtyas and Handini, 2014). *Coelogyne* is distributed in Southeast Asia and is mainly found in Borneo, Sumatra, the Himalayas

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Island (Gravendeel 2000), Papua and Papua New Guinea (Ramadanil,2010). Several well-known *Coleogyne* species are *Coelogyne pandurata*, *Coelogyne asperata* and *Coelogyne dayana*, *Coelogyne fragrans*.

Coelogyne fragrans have a high market potential due to their black lip, attractive color, and unique shape (Sut et al., 2017), resulting in many collectors are interested. Moreover, the flowers of *Coelogyne fragrans* could produce a sweet fragrant aroma. *Coelogyne fragrans* is usually known as the 'Papuan black orchid', but it has not been widely propagated or even genetically confirmed. Some of the drawbacks of this orchid are petals only bloom in 1-2 weeks, requiring more intensive maintenance because the flowers fall off quickly, the stems are small and easily crumple up when the flowers bloom. Research on *Coelogyne* could be expanded to improve their agronomic traits, even though Kushardian (2022) has conducted a mutation breeding study using colchicine on *Coelogyne fragrans*. The highest content of compound composition in the *Coelogyne* mutants was demonstrated to be a phenolic, with the stilbene group as the potential compound (Tina, 2024).

Conclusion

From 1943 to 2023 there has been a sharp increase in the number of publications in the Scopus database. This indicates the increasing modernization of research on Orchidaceae. Research topics are very diverse, from simple pharmacology in the early decade to developing secondary metabolites in biosynthesis using genetic approaches in the latest decade. There has been an increase in scientific publications on the Orchidaceae family. More than half of them discussed agricultural aspects, which would be helpful for the commercial orchid industry. Of the 736 genera of all species, *Phalaenopsis*, *Dendrobium*, *Cymbidium*, *Vanda*, and *Cattleya* have a high potential for ornamental value in the future. These genera also have many publications documents based on the Scopus database. Several Indonesian genera including *Phalaenopsis*, *Dendrobium*, *Bulbophyllum*, *Vanda*, and *Cattleya*. had their agronomic traits improved. In addition, the *Coelogyne* genus has many native species with great potential to be developed on the market.

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