

A GLOBAL SYSTEMATIC REVIEW ON ORCHID DATA IN PROTECTED AREAS

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A systematic global literature review of studies devoted to Orchidaceae taxa in Protected Areas is presented here. It is aimed to understand research topics of studies on orchids in Protected Areas around the world. Used is the methodology well established in biological and medical science with a focus on two international databases (Scopus, Web of Science Core Collection) and one national (Russian Science Citation Index). Examined are the data on each paper's Protected Area location, habitat studied, topic discussed, and IUCN status of each Protected Area. It is hypothesised that orchids are predominantly investigated in Protected Areas, and therefore, the published results of studies on orchids are properly indexed by databases globally. The question is whether the most threatened plants, orchids, would be investigated in more detail and intensity in areas legally protected by authorities (nature reserves, national parks, natural monuments, wildlife sanctuaries, etc.), and whether the databases Scopus, Web of Science Core Collection, Russian Science Citation Index cover appropriately the majority of papers on orchids in Protected Areas on a global scale. There were found 331 publications on orchids in Protected Areas, including 72 from RSCI, 96 from Scopus, 163 from Web of Science Core Collection. A high percentage of the studies were conducted in the tropics, while vast temperate and subtropical regions (Northern Eurasia, Central and Western Asia, Northern and Central parts of North America, non-tropical Africa, and most parts of Australia) were poorly represented. Most studies were conducted in forests (in descending order of abundance – tropical, temperate, boreal), and were focused predominantly on the diversity and distribution of orchids in Protected Areas, followed by issues of taxonomy, structure and population dynamics, conservation threats of Orchidaceae, and orchid-consort interactions (insects-pollinators, trees-phorophytes, symbiotic fungi). It is concluded that the use of only the databases Scopus, Web of Science Core Collection and Russian Science Citation Index does not provide a sufficient amount of data to generalise comprehensive data about studies of orchids in Protected Areas at a global scale. In future systematic reviews of other, in non-English-language, international and national databases should be carried out.

Key words: bibliographic database, biodiversity, conservation, focus of study, habitat, national park, nature reserve, Orchidaceae, threatened taxa

Introduction

With over 28 000 accepted species within 763 genera (Christenhusz & Byng, 2016), the Orchidaceae is one of the richest plant families in the world. Orchids are distributed over all the continents except Antarctica, with the greatest abundance in tropical and subtropical regions (Chase, 2005). Orchids occupy a wide range of habitats, with epiphytic, terrestrial, and subterranean life forms (Cribb et al., 2003; Givnish et al., 2016). Despite this, many orchids are endemic to small areas, naturally rare and threatened (e.g. Waterman & Bidartondo, 2008; Crain & Tremblay, 2014; Barberena et al., 2018; Fateryga et al., 2020). More than half (56.5%) of the 948 orchid species estimated worldwide using Global IUCN Red List criteria were considered threatened (e.g. Gale et al., 2018). Apart of global IUCN estimation, there are numerous publications concerning regional assessment of orchid species using IUCN Categories and Criteria (e.g. Blinova & Uotila, 2011; Eliáš et al., 2015; Khapugin et al., 2017a,b; Zhou et al., 2018). Such assessments provide up-

dates for orchid species' status in different regions and contribute to gathering and providing newer data for global IUCN estimation of certain taxa. Taxa within the Orchidaceae are still being described annually in the tropics and subtropics (e.g. Forster & Souza, 2007; Averyanov et al., 2016a, 2018; Ječmenica et al., 2016; Pelsler et al., 2016) and less commonly in temperate regions (e.g. Jagiełło, 1988). A high percentage of endemism is noticed within this plant family (Hopper & Gioia, 2004; Swarts & Dixon, 2009). Specifically, orchid richness and abundance depends on habitat size, elevation range (Jacquemyn et al., 2005; Schödelbauerová et al., 2009; Acharya et al., 2011; Crain & Tremblay, 2014), light availability, soil moisture, and canopy height and area (Gravendeel et al., 2004; Huang et al., 2008; McCormick & Jacquemyn, 2014). As the largest and most threatened family (Chase, 2005; Crain & Tremblay, 2014; Christenhusz & Byng, 2016; Barberena et al., 2018; Efimov, 2020), the Orchidaceae is a flagship plant family for conservationists, biologists and ecologists worldwide (Fig. 1).

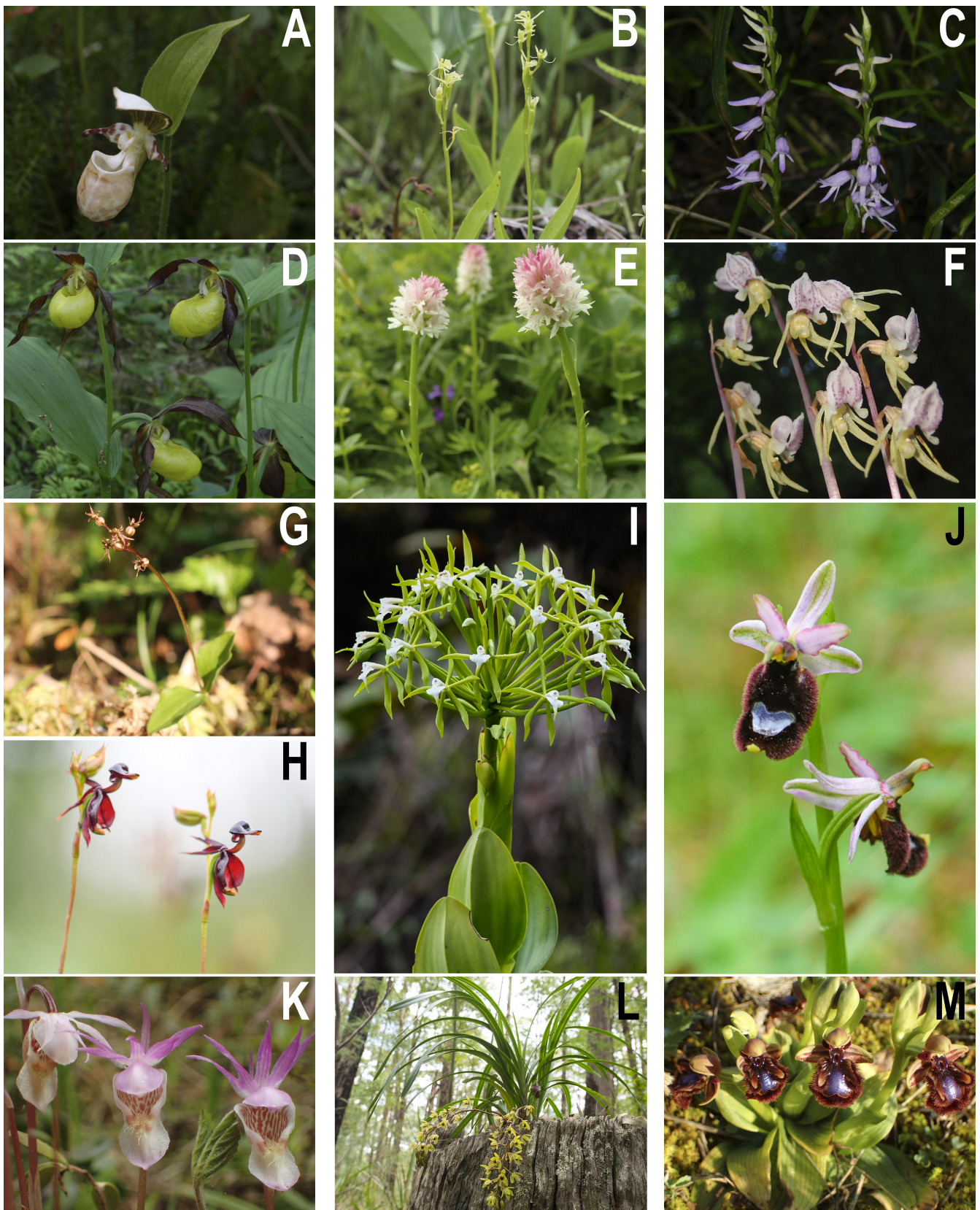


Fig. 1. Orchids in Protected Areas. A – *Cypripedium yatabeanum* in the Nalychevskiy National Park, Russia (P.G. Efimov); B – *Liparis loeselii* in the Sebezhskiy National Park, Russia (P.G. Efimov); C – *Ponerorchis cucullata* in the National Park «Smolny», Russia (A.A. Khapugin); D – *Cypripedium calceolus* in the Mordovia State Nature Reserve, Russia (A.A. Khapugin); E – *Nigritella carpatica* in the Verkhovyna National Nature Park, Ukraine (M. Bobocea); F – *Epipogium aphyllum* in the Bucegi Natural Park, Romania (M. Bobocea); G – *Neottia cordata* in the Vodlozerskiy National Park, Russia) (G.G. Chugunov); H – *Caleana major* in the Grantville Nature Reserve, Australia (W. Chen); I – *Epidendrum lacustre* in the Alto Mayo Protection Forest, Peru (W. Chen); J – *Ophrys flavicans* in the Gargano National Park, Italy (W. Chen); K – *Calypso bulbosa* in the Oulanka National Park, Finland (M. Bobocea); L – *Cymbidium suave* in the Ku-ring-gai Chase National Park, Australia (W. Chen); M – *Ophrys speculum* subsp. *speculum* in the Mount Olympus National Park, Greece (M. Bobocea).

There are now over 100 000 Protected Areas (PAs) worldwide, covering over 12% of the Earth's land surface (Chape et al., 2005; PARF, 2019; UNEP-WCMC & IUCN, 2019). Protected Areas are a key component of the global response to environmental changes and degradation (Gaston et al., 2008; Conroy et al., 2011). They positively contribute to biodiversity conservation (Leverington et al., 2010; Akasaka et al., 2017; Ruchin & Makarkin, 2017; Gebremedihin et al., 2018). The effectiveness of Protected Area Networks in different regions depends on representativeness of endemic and threatened taxa (Jackson et al., 2009; Vellak et al., 2009; Gray et al., 2016), size (Schödelbauerová et al., 2009; Leroux et al., 2015), type (Lemenager et al., 2014; Fitzsimons, 2015; Furlonge et al., 2015), and protection support on behalf of government and non-government authorities (Jackson & Gaston, 2008; Leverington et al., 2010; Tuvi et al., 2011; Bicknell et al., 2017). It is well-known that in several parts of the world, biological diversity generally decreases (Butchart et al., 2010; Le Roux et al., 2019), even within established PAs (Clark et al., 2013; Hill et al., 2015). Protected Areas are considered the most effective effort to protect characteristic or threatened species, habitats and ecosystems and to counteract the biodiversity loss (Geldmann et al., 2013; Coetzee et al., 2014; Gray et al., 2016). Obviously, PAs attract researchers of different scopes as a platform for studying a target object within minimally disturbed ecosystems. Hence, it can be assumed that most threatened plants (orchids) would be investigated in more detail and intensity in areas legally protected by local or federal authorities (nature reserves, national parks, sanctuaries, etc.). It is hypothesised that orchids are likely to be investigated in PAs and publications on the Orchidaceae family are better indexed by databases in the most orchid-rich regions more than in regions poor in orchid species.

Conducted is a systematic review using literature indexing tools in three databases (two international and one national (Russian)) to identify areas that have received less attention in research of orchids for promoting more intense studies in future. The aims are to: (1) qualitatively summarise the literature on studies of orchids including publication information, study area location, ecosystem/habitat investigated, problem/topic discussed, IUCN status of PAs; and (2) summarise the data on PAs distribution where orchids are investigated using data from selected databases.

Material and Methods

Generated is a literature search for orchid species using three databases (Fig. 2): Web of Science Core Collection (WoS CC), an international database; Scopus, an international database; Russian Science Citation Index (RSCI) database, a Russian database.

In WoS CC, were used the following search strings on 23 December 2019 to obtain studies on Orchidaceae in PAs: Topic: [(Orchid*) AND («Protected Area*» OR «Reserve» OR «National Park» OR «Sanctuary» OR «Natural Monument» OR «Natural Park»)]. Subsequently is used the default search engine settings for the Science Citation Index Expanded (1975–2019) but excluded the Social Sciences and Arts & Humanities citation indices. Finally, records were refined by document types: Article OR Review.

As an international alternative is used the search function in the database Scopus. Although the search and exclusion options are not identical between the two databases, the same search terms were used, on 23 December 2019. Like WoS CC, the search was delimited by relevant areas of study by using the «Limit to» function to include studies in the following areas: Agricultural and Biological Sciences OR Environmental Science OR Biochemistry, Genetics and Molecular Biology OR Earth and Planetary Sciences. Subsequently the results were narrowed to a subset of studies published in «Journal» source type. When found the same study in WoS CC and Scopus, it was attributed to WoS CC.

In the RSCI database, literature was searched on 23 December 2019, using the following search strings: Topic: [(orkhid*) AND (orchid*)]. Both Russian and English characters were used for the input of the searching terms in RSCI. Then the search was delimited by relevant areas of study by using the «Thematic» function to include studies in the following areas: «Botany» OR «Ecology» OR «Theory and Methods of Environment Research and Conservation. Environmental Basis of Use of Natural Sources» OR «Plant and Animal World Conservation» OR «Wildness Conservation. Terrestrial and Aquatic Protected Areas» OR «Conservation of Environment and Natural Sources in Separate Regions and Countries».

Non-related publications were excluded by title, abstract and/or a careful reading of full text if necessary. Only included is literature that reported on orchid species in PAs or on non-field-based studies of orchids collected in PAs, including laboratory, genetic and cytological studies, and rarer reviews of generalised data on orchid species in PAs.

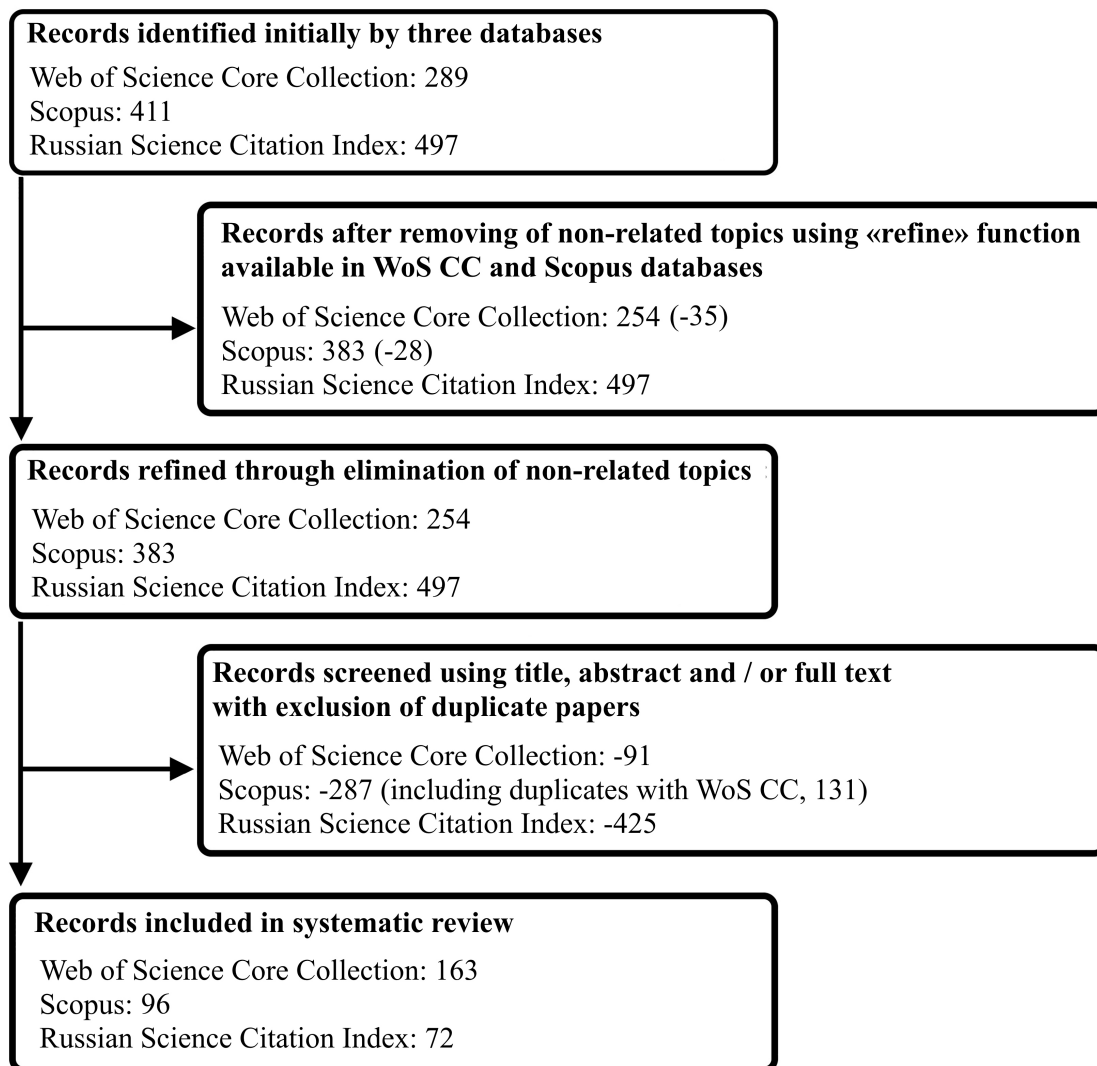


Fig. 2. Diagram documenting search and inclusion process and criteria.

According to these requirements, initially 1197 records were identified across the three databases accessed, of which 497 were from RSCI, 289 – from WoS CC, 411 – from Scopus. After refining (available only in WoS CC and Scopus), the records were reduced to 254 and 383, respectively. Excluded were 865 studies on unrelated topics (of which 425 were from RSCI, 287 – from Scopus, 91 – from WoS CC), or duplicates after reading abstracts or full texts (if needed). Eventually, 331 papers were included according to the criteria, of which 72 were from RSCI, 96 – from Scopus, 163 – from WoS CC (Fig. 2 and see Electronic Supplement 1). There were overlaps (all of which were assigned to WoS CC) of 131 records between Scopus and WoS CC, five records between RSCI and WoS CC.

Then the following information was extracted from all remaining studies: (1) publication journal; (2) year of publication; (3) country in which the study was conducted; (4) list of PAs in each coun-

try; (5) co-ordinates of study location; (6) habitat in which the species of interest were found; (7) focus of the study (see below).

Distinguished are nine types of habitats where orchids have been studied: (1) Tropical forests; (2) Temperate forests; (3) Boreal forests; (4) Shrublands/scrublands; (5) Grasslands; (6) Farmlands; (7) Peatlands; (8) Cliffs and rocks.

The studies included in our review are classified into seven focal categories: (1) Plant-consort interaction; (2) Conservation threats; (3) Orchids as source for laboratory studies; (4) Population structure and dynamics; (5) Distribution and diversity; (6) Taxonomic studies; (7) Economic importance and uses.

Google Maps (<https://www.google.com/maps>) has been used to indicate the location of PAs according to their latitude and longitude. When study sites were identified by more than one location within a PA, each of them has been characterised by their mid-point, using the Geographic

Midpoint Calculator (<http://www.geomidpoint.com>). On the basis of co-ordinates, all PAs have been separated in natural zones: tropics (between 23.5°N and 23.5°S), subtropics (23.5°–35.0°N and 23.5°–35.0°S), temperate zone (35.0°–66.5°N and 35.0°–66.5°S), Arctic (66.5°–90.0°N) and Antarctic (66.5°–90.0°S).

In addition, the 2018 bibliometric data have been compared on the included journals from Scopus and WoS CC. For this purpose, analysed are the 2018 JCR Impact Factor (IF) of journals from WoS CC and the 2018 CiteScore values of journals from Scopus (available at <http://www.scopus.com/>). Finally all journals are ranked by quartiles of both databases to demonstrate the quality of journals dealing with orchid research in PAs.

Results

Journals and years of publication

The 331 involved studies on orchids in PAs were published in 155 different journals. Of these 155 journals, 46 ones were identified by RSCI with 72 articles, 60 – by Scopus with 96 articles, and 80 – by WoS CC with 163 articles (Fig. 3).

The publications on orchids in PAs in the selected databases included in the review were published from 1969 to 2018 (Fig. 4). A remarkable increase in number of published studies occurred in the 2000s with a few peaks (2007, 2011, and 2017) and declines (2006, 2010, and 2012). Noticed is a higher contribution of publications by WoS CC and Scopus databases through the study period. The RSCI database has contributed considerably to the number of published articles since 2000.

The 2018 JCR IF was available for 96 of the 107 journals included in the analysis. The highest number of articles has been published in journals devoted mainly to plant systematics (Phytotaxa, Lankesteriana, etc.) or, less commonly, to plant conservation (Biodiversity and Conservation, Biological Conservation) (Table). Four journals (International Journal of Environmental Studies, Canadian Field Naturalist, Genetics and Molecular Research, and Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis) did not have a 2018 JCR IF due to indexation discontinuing in 1985, 2011, 2015, and 2017 respectively). Five journals (Acta Agrobotanica, Biosystems Diversity, Nature Conservation Research, Revista de Sociedad Gaditana de Historia Natural, Tomsk State University Journal) were excluded from this analysis as the sources are indexed in Emerging

Sources Citation Index database. In general, the 2018 IF JCR of all included journals varied between 0.283 (Acta Biologica Colombiana) and 7.299 (New Phytologist).

Of the 127 Scopus titles, seven journals (Indian Forester, Zoos' Print Journal, Revista Científica UDO Agrícola, Asian Journal of Plant Pathology, Svensk Botanisk Tidskrift, Fragmenta Floristica et Geobotanica Polonica, and Bangladesh Journal of Plant Taxonomy) were excluded from this analysis as discontinued in the database after 2001, 2008, 2012, 2016, 2017, 2018, and 2018, respectively. Among the analysed journals, the 2018 CiteScore values varied between 0.000 (Ecologia Balkanica and Acta Botanica Venezuelica) and 3.787 (New Phytologist). No relationship between number of articles per journal and IF JCR / CiteScore values ($p > 0.05$) could be found. This indicates the significance of different-level journals in highlighting the research of orchids in PAs in worldwide (Fig. 5).

Location of Protected Areas, habitats and study focuses

Based on analysis of records included, the studies of Orchidaceae species in PAs were carried out in eight habitats as reported in 283 papers, while 49 papers did not provide any information on habitat. Habitats investigated included tropical forests, temperate forests, boreal forests, shrublands and scrublands, grasslands, farmlands, peatlands, and cliffs and rocky sites (Fig. 6). The largest number (228) of studies across all databases on orchids in PAs was in forest ecosystems with a predominance in the tropics. Lower numbers of studies were conducted in grasslands (77), followed by peatlands (20), farmlands (16), shrublands & scrublands (14), on cliffs & rocks (12) (Fig. 6).

The most common focus of the studies on Orchidaceae in PAs concerned issues of diversity and distribution of plant species around the world. Taxonomic studies were also abundant in the analysis, followed by studies on structure and dynamics of populations, conservation threats, and interactions of orchids with their consorts (insects-pollinators, trees-photophytes, symbiotic fungi) (Fig. 7). Orchid species used as sources for laboratory studies (morphology, anatomy, genetics, phylogeny, *in vitro* propagation, seed germination, fungal diversity in orchid roots) were found in 29 publications. Many publications were devoted to both diversity and taxonomy of orchids.

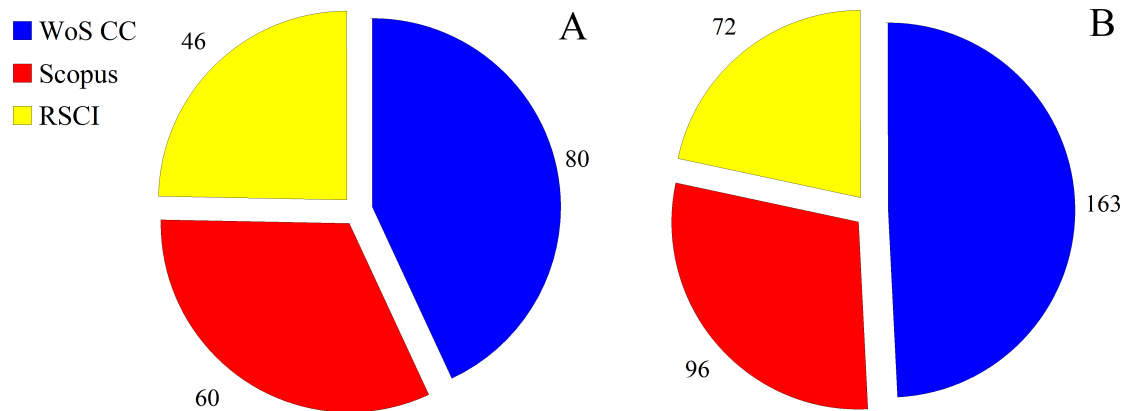


Fig. 3. The number of journals (A) and publications (B) identified through a global literature search from 1975 to December 2019 using RSCI, WoS CC, and Scopus databases for research on orchids in Protected Areas.

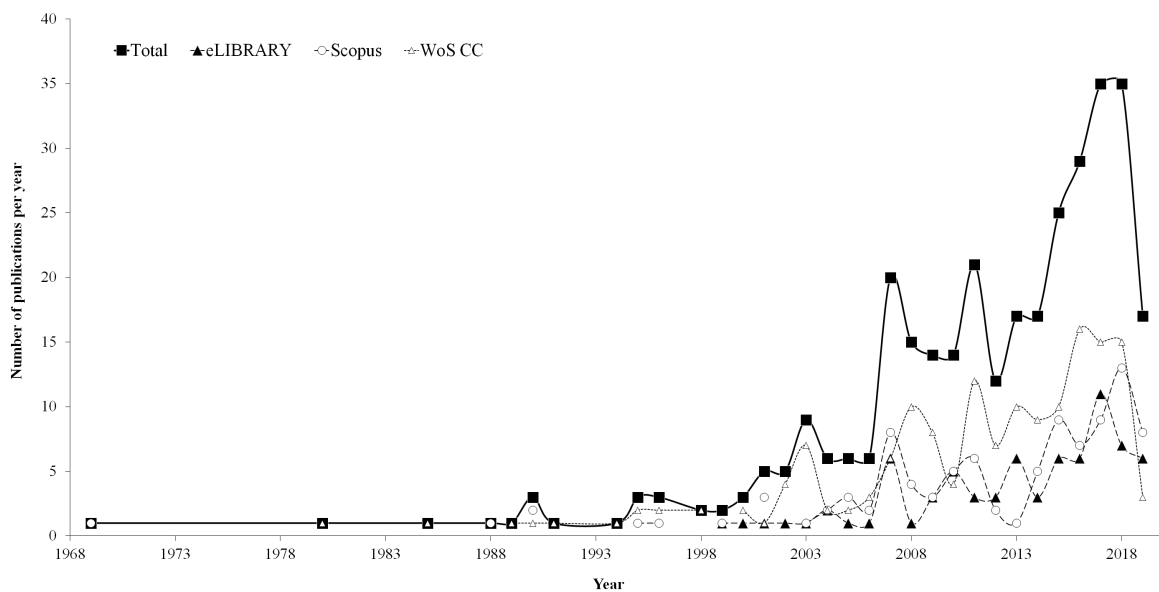


Fig. 4. The number of publications per year. Global literature identified through a search from 1975 to December 2019 using RSCI, WoS CC, and Scopus databases for research on orchids in Protected Areas.

Table. The list of leading journals in terms of number of articles included in the review.

Journal	Quartile CiteScore / JCR	Number of articles	Percent of total number of articles
Phytotaxa	Q3 / Q3	20	6.5
Lankesteriana	Q3 / –	14	4.2
Turczaninowia	Q3 / –	11	3.6
Botanical Journal of the Linnean Society	Q1 / Q1	10	3.2
Biological Conservation	Q1 / Q1	9	2.9
Taiwania	Q3 / Q4	9	2.9
Biodiversity and Conservation	Q1 / Q1	7	2.3
PhytoKeys	Q2 / Q2	7	2.3
Fragmenta Floristica et Geobotanica Polonica	– / –	6	1.9
Biotropica	Q1 / Q2	5	1.6
Botanical Sciences	Q3 / Q3	5	1.6
Herald of Tver State University. Series: Biology and Ecology	– / –	5	1.6
Acta Botanica Brasilica	Q2 / Q3	5	1.3
Australian Journal of Botany	Q2 / Q3	4	1.3
Plant Biology	Q1 / Q2	4	1.3
Plant Ecology and Evolution	Q3 / Q3	4	1.3
Plant Systematics and Evolution	Q2 / Q2	4	1.3
Others		179	57.9

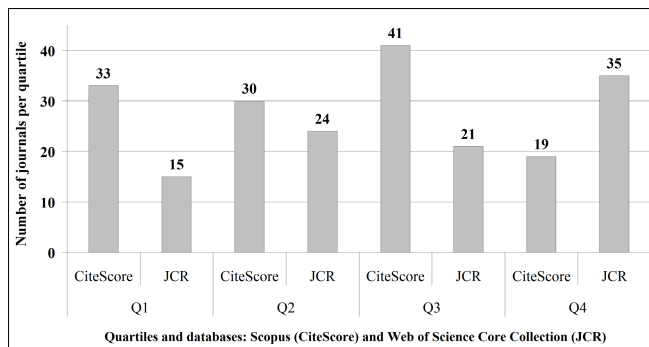


Fig. 5. Number of journals per quartiles (Q1–Q4) of databases Scopus (2018 CiteScore), and Web of Science Core Collection (2018 JCR IF) analysed.

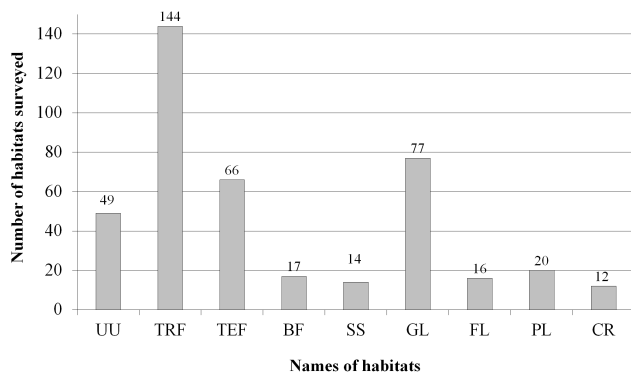


Fig. 6. Habitats investigated (Plots include studies from Web of Science Core Collection, Scopus, and RSCI). Habitat designations: UU – Unknown / Uncertain, TRF – Tropical Forest, TEF – Temperate Forest, BF – Boreal Forest, SS – Shrubland and Scrubland, GL – Grassland, FL – Farmland, PL – Peatland, CR – Cliffs and Rocks.

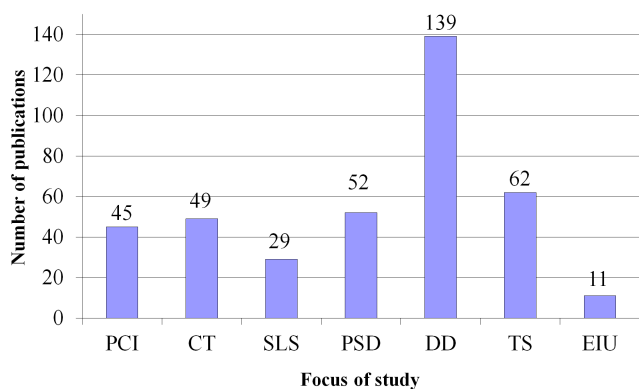


Fig. 7. Focus of study (Plots include studies from Web of Science Core Collection, Scopus, and RSCI). Names of focuses: PCI – Plant-consort(s) interactions, CT – Conservation threats, SLS – Source for laboratory studies, PSD – Population structure and dynamics, DD – Distribution and diversity, TS – Taxonomic studies, EIU – Economic importance and uses.

There are 376 PAs in which Orchidaceae species have been studied, or from where plant material has been extracted for laboratory investigations (Fig. 8, and see Electronic Supplement 2). Geographically, 47 PAs are located in

nine countries of South America (12.7% of all countries and 12.5% of all PAs); 61 PAs – in ten countries of North America (14.1% of all countries and 16.2% of all PAs); 109 PAs – in 19 countries of Asia (26.8% of all countries and 29.0% of all PAs); 131 PAs – in 21 countries of Europe (29.6% of all countries and 34.8% of all PAs); 11 PAs – in two countries of Oceania (2.8% of all countries and 2.9% of all PAs); 17 PAs – in 10 countries of Africa (14.1% of all countries and 4.5% of all PAs) (Fig. 8).

The 376 PAs were classified into six IUCN protected area management categories (Dudley, 2008). Only 54% (categories Ia, Ib, II – Fig. 9) of all PAs have a special protection regime supported by a Guard Department staff of nature reserves and national parks. We believe orchid populations are comprehensively protected only under these conditions. At the same time, PAs of other categories (III, IV, V, VI) are exposed to human influence on a different level. As one of the most vulnerable plant families, the surviving of orchids could be possible only under minimal human pressure or under accurate management of orchid habitats in urbanised and/or populated areas.

On the basis on data on location of PAs, all study sites are assessed to four climate zones, arctic, temperate, tropics, subtropics, to determine, which regions present the highest number of PAs with orchid research. The survey demonstrates that selected bibliographic databases confirm the predominance of tropical and temperate PAs for investigation on Orchidaceae species (Fig. 10, Electronic Supplement 2). A lower number (42) of PAs were located in the subtropics, while only two PAs (Malla Strict Nature Reserve, Finland; Kandalaksha State Nature Reserve, Russia) were identified as Arctic.

Discussion

This systematic review documents the evidence of studies on Orchidaceae within PAs around a world. Undoubtedly, this undercounts areas where the species are presented, because the analysed international (WoS CC, Scopus) and regional (RSCI) databases do not include all studies. Therefore, a systematic review carried out using national and regional literature databases may offer more comprehensive insights into the general literature on studies of orchids in PAs around a world.

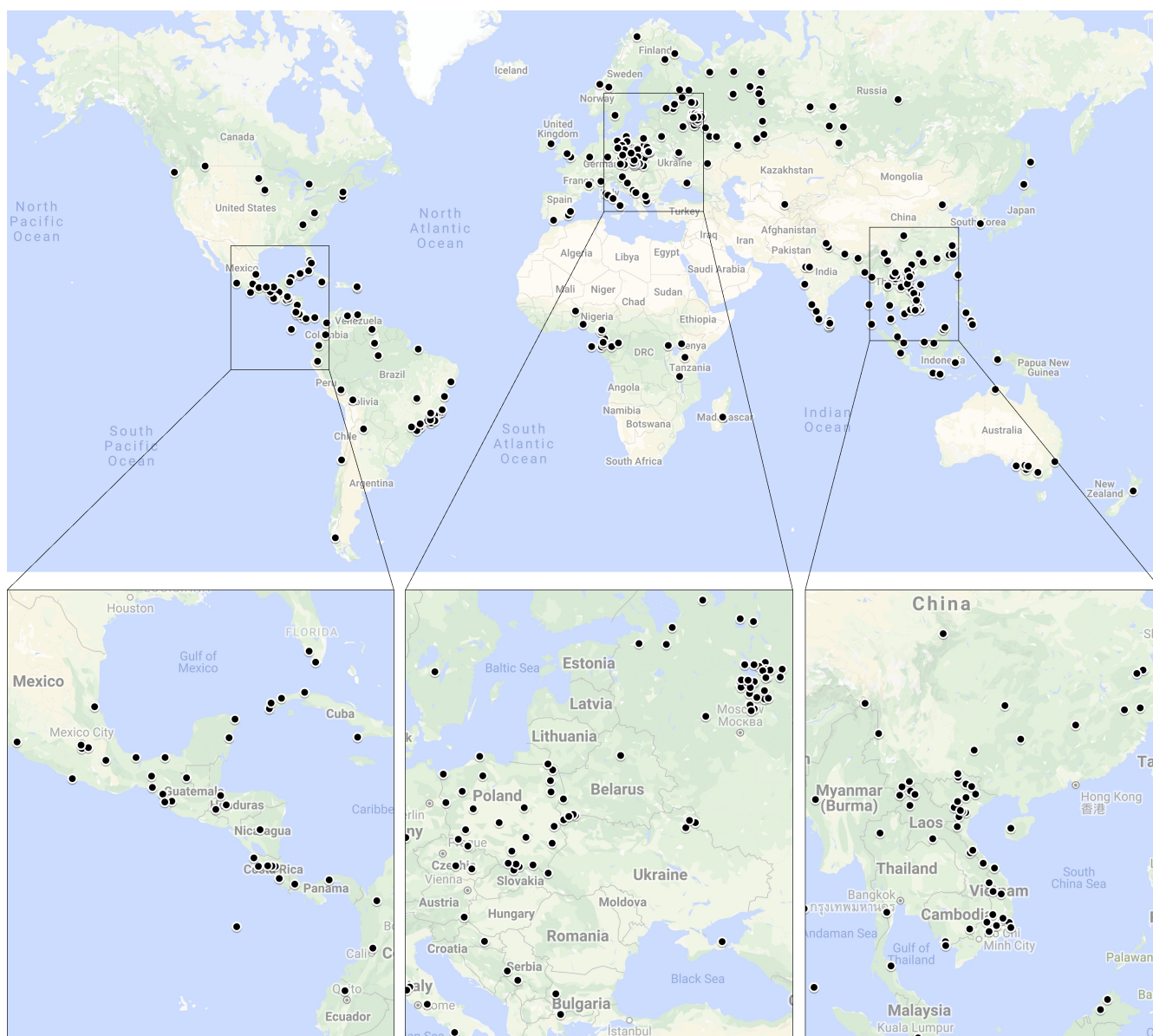


Fig. 8. Location of Protected Areas in examined papers.

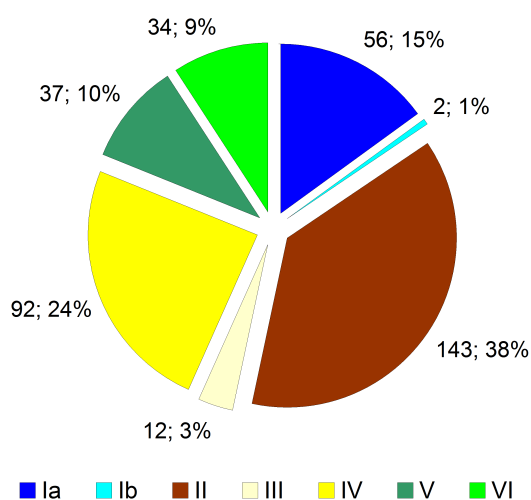


Fig. 9. Proportion of different IUCN categories of Protected Areas in included papers. Designations: Ia – Strict Nature Reserve; Ib – Wilderness Area; II – National Park; III – Natural Monument or Feature; IV – Habitat/Species Management Area; V – Protected Landscape/ Seascape; VI – Protected area with sustainable use of natural resources.

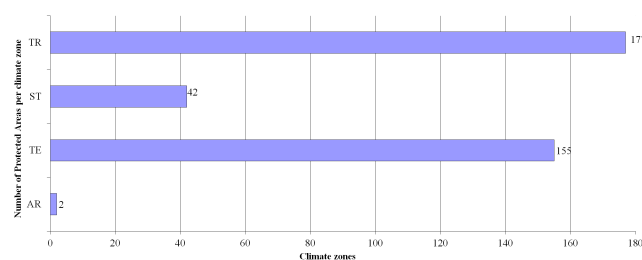


Fig. 10. Number of Protected Areas per climate zone (Plots include studies from Web of Science Core Collection, Scopus, and RSCI). Climate zone designations: AR – arctic zone, TE – temperate zone, ST – subtropics, TR – tropics.

Research on orchids in PAs increased since 2000s in all analysed databases (Fig. 4). This is not caused by an increase in data on Orchidaceae in PAs since this time. The main reason is the beginning of database processing – 1997 (WoS CC), 1998 (RSCI), 2004 (Scopus). Similar results from different published global systematic reviews

(e.g. Lowry et al., 2013; Davis et al., 2016; Galvin et al., 2018; Jones & Daehler, 2018; Chichorro et al., 2019) based on international and regional bibliographic databases confirm this assumption.

A large proportion of studies included in this systematic review for orchids in PAs was conducted in areas located mainly in Southeast Asia and Central America, followed by Central and Eastern Europe (Fig. 5). At the same time, several regions were identified with a lack (Northern and Middle Asia, Africa, northern and central parts of North America, Australia) or absence (West Asia) of data. In these regions can be noted botanists working on orchids. For instance, Reiter et al. (2013) and Indsto et al. (2006) in Australia, there are two scientific teams in Africa, including Bulafu et al. (2007), Mucunguzi (2007) in the first team, and Descourvières et al. (2013), Droissart et al. (2014), Ječmenica et al. (2016, 2017), Simo-Droissart et al. (2018) in the second one. The North American authors' group is represented by publication of Dutra et al. (2009), Gutting et al. (2015), Mújica et al. (2018). Only one study (Beshko et al., 2017) was found in Central Asia. Taking into account the high vulnerability of orchids around the world, it is assumed that studies of orchids are obviously being conducted in a wider range, but their results have not been published in the databases WoS CC, Scopus and RSCI. For example, such studies are represented by unpublished manuscripts, reports, etc. or they are published in journals (e.g. Dey et al., 2007; Khapugin & Korochkina, 2017), at a conference proceedings (e.g. Gale et al., 2013; Hervouet & Misandeau, 2018), numerous «grey» literature, and books (e.g. Vakhrameeva et al., 2014; Tsiftsis & Tsiripidis, 2015; Kreutz et al., 2018) which were not indexed neither in international, nor in regional bibliographic databases. It makes the search and generalisation of data on orchid biology, ecology and conservation incomplete. Hence, even involvement of all known bibliographic databases cannot provide complete data on orchids in PAs. The handle search of literature apart from bibliographic databases could yield the most comprehensive results, but that is rather time consuming.

In the selected databases, a large number of studies on orchids in PAs has been conducted in forests and grasslands with considerable dominance of the first habitat type. Other authors have demonstrated a higher confinement of orchids to forest habitats, too (e.g. Wraith & Pickering,

2017). Noteworthy, studies of orchids in PAs in different forest types have demonstrated the highest orchid abundance in tropical forests with a declining from equator to the poles. This picture is similar to the distribution of PAs, which have the highest abundance in the tropics (Fig. 10). Previous studies have demonstrated that orchid diversity hotspots occur in areas of high diversity of plants (Myers et al., 2000; Cribb et al., 2003; Zhang et al., 2015). However, noticeable is a high abundance of analysed PAs in Europe (Fig. 8). This could be explained by a more comprehensive character of investigations in this region. For instance, some publications in this review are devoted to three and more PAs (e.g. Stefaniak et al., 2013; Koval et al., 2018).

Concerning the study focus, papers indexed in different bibliographic databases have not been analysed separately. Overall, the study has focused first of all on the diversity and distribution of orchid species in PAs. This was expected as the Orchidaceae is one of the richest and diverse plant families. Noteworthy, studies conducted in temperate regions have concerned only orchid diversity and distribution, i.e. they represented statements or confirmations of the orchid species presence in PAs (e.g. Stefaniak et al., 2013; Serra Laliga et al., 2015; Koval et al., 2018). At the same time, in tropics and subtropics, studies on Orchidaceae included also additional data on the plant taxonomy (e.g. Averyanov, 2012; Averyanov et al., 2016a,b), economic value (e.g. Cerda et al., 2013; Liu H. et al., 2014), and conservation threats (e.g. Sinu et al., 2011; Raventós et al., 2015). The studies on orchid taxonomy ranked a second place among study focuses due to permanently newly described taxa of this plant family (e.g. Averyanov, 2012; Descourvières et al., 2013; Ječmenica et al., 2017; Zhou et al., 2018). The results expectedly demonstrated that these studies concerned orchid diversity hotspots – tropics and subtropics. Although there is a lower number of studies devoted to orchid populations and conservation threats, these results are the most important for the knowledge on Orchidaceae species due to the global increase in habitat degradation and destruction, climate change, livestock grazing (e.g. see Soto Arenas et al., 2007; Liu H. et al., 2010; Liu Q. et al., 2015; Kull et al., 2016; Le Roux et al., 2019). The highest number of population-based studies has been concerned investigations of 1–2 orchid species (e.g. Raventós et al., 2015; Khapugin et al., 2016, 2017a; Br-

zosko et al., 2017; Puchnina, 2017; Kirillova & Kirillov, 2020). However, there are a few studies (Pierce et al., 2006; Stefaniak et al., 2013; Talalaj et al., 2017) concerning a higher number of orchid species which are more valuable for further comparison. Finally, the lowest number of studies on orchids in PAs was devoted to economic importance and use of orchids. They predominantly concerned South Asian (Samant et al., 1998) and East Asian (Liu H. et al., 2014) PAs, where orchids are mostly considered as medicinal plants. Other studies have confirmed the wide economic use of orchids in Asia, too (Bulpitt, 2005; Chauhan & Chauhan, 2014; Kreziou et al., 2016).

On the basis of the review of quality of journals, no considerable differences in the number of journals with different quartiles in both Scopus and WoS CC databases could be found. This is an evidence for the wide diversity of studies on orchids in PAs with almost an equal number of journals per quartile. Among the 159 journals included in the review, there was only one title (Lankesteriana indexed in Scopus) focusing on the study of Orchidaceae. Noteworthy, of the total number of identified journals, Lankesteriana published almost the highest number of articles included in this review (Table). Despite its presence in the 3rd quartile of Scopus and its high value for orchid taxonomy and conservation, this title is still not included in WoS CC (Karremans, 2016). Among the 17 distinguished leading journals, six of them (Phytotaxa, Lankesteriana, Turczaninowia, PhytoKeys, Plant Systematics and Evolution, Taiwan) predominantly publish taxonomic studies, two journals (Biodiversity and Conservation, Biological Conservation) focus on nature conservation studies. Other journals publish studies on botany, ecology and distribution of plants, including orchids. Thus, the whole list of journals includes titles predominantly dealing with taxonomy and conservation of orchids.

In this systematic review the utility of systematic reviews in both indicating and filling gaps in the literature on orchids in PAs has been shown. However, even if a review is based on national and international databases, it is not always possible to identify a range of the most important and comprehensive studies, particularly related to Orchidaceae species in PAs. Obviously, there is a need to include a higher number of related studies in some regions (e.g. Northern Asia, Africa, northern part of North America). It is urgent to fill large gaps in the knowledge on Orchida-

ceae in PAs. To obtain a full picture of studies on orchids in PAs, we suggest taking into account studies of orchids in temperate PAs in a higher number of non-English-language literature and a wider range of scientific regional and national databases. These actions will potentially broaden the knowledge and understanding of orchid biodiversity and conservation worldwide.

Conclusions

Despite the undoubted significance of international (Web of Science Core Collection and Scopus) and national (Russian Science Citation Index) databases to search and accumulate the most important data, the use of only these sources is not sufficient to generalise full comprehensive data about Orchidaceae worldwide. It especially concerns the regions outside the tropics and subtropics where there are numerous taxonomic, distributional, and populations-based studies. A large portion of valuable data on distribution, population status, and economic importance of orchids in PAs is obviously stored in national, non-English, databases. Proposed is the necessity to use additionally other, in English or non-English-language, national and regional databases to conduct the most comprehensive systematic reviews on Orchidaceae within and outside PAs.

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Supporting Information

Bibliography of included publications on orchids in Protected Areas (Electronic Supplement 1: Bibliography of included papers on orchids in Protected Areas on the basis of data from Web of Science Core Collection, Scopus, and Russian Science Citation Index), and data on the analysed Protected Areas (Electronic Supplement 2: Characteristics of Protected Areas analysed in the present study) may be found in the Supporting Information [here](#).

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ГЛОБАЛЬНЫЙ ЛИТЕРАТУРНЫЙ ОБЗОР ДАННЫХ ОБ ОРХИДЕЯХ НА ОСОБО ОХРАНЯЕМЫХ ПРИРОДНЫХ ТЕРРИТОРИЯХ

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Данная статья представляет собой обзор мировой литературы, посвященный изучению видов семейства Orchidaceae на особо охраняемых природных территориях (ООПТ). Работа направлена на понимание направлений исследований орхидей на ООПТ по всему миру. Мы использовали методологию, хорошо зарекомендовавшую себя в биологических и медицинских науках, с акцентом на две международные и одну национальную базы данных (Scopus, Web of Science Core Collection, РИНЦ). Нами были изучены данные о местонахождении каждой ООПТ, исследованного биотопа и обсуждаемой тематике исследования с учетом категории ООПТ по классификации МСОП. Мы предположили, что орхидеи преимущественно исследуются на ООПТ, и поэтому опубликованные результаты этих исследований должным образом проиндексированы библиографическими базами данных во всем мире. Мы проверили, будут ли такие наиболее угрожаемые и одни из самых изучаемых растений, как орхидеи, детально и интенсивно исследованы на законодательно охраняемых территориях (природные заповедники, национальные парки, памятники природы, заказники дикой природы и т.д.)? А также охватывают ли базы данных Scopus, Web of Science Core Collection, РИНЦ большинство публикаций, посвященных орхидеям на ООПТ в глобальном масштабе. Нами выявлена 331 публикация, посвященная орхидным на ООПТ, в том числе 72 публикации из базы данных РИНЦ, 96 – из базы данных Scopus, 163 – из базы данных Web of Science Core Collection. Большая часть исследований была проведена в тропиках, в то время как крупные регионы умеренной и субтропической зон (Северная Евразия, Центральная и Западная Азия, Северная и Центральная части Северной Америки, внетропическая Африка, большая часть Австралии) были слабо представлены публикациями в анализируемых базах данных. Большинство исследований было проведено в лесах (по убыванию числа публикаций – тропических, умеренной зоны, таежных). Они были посвящены преимущественно распространению и разнообразию орхидных на ООПТ. Меньшее количество исследований было посвящено таксономии, структуре и динамике популяций, угрозе исчезновения орхидных, а также взаимодействиям орхидных с другими организмами (насекомыми-опылителями, деревьями-форофитами, грибами-симбионтами). Мы также пришли к выводу, что использование только баз данных Scopus, Web of Science Core Collection, РИНЦ не может предоставить достаточного количества данных для всестороннего обобщения данных об исследованиях орхидей на ООПТ в глобальном масштабе. Для будущих систематических обзоров предлагается использовать другие, не только англоязычные, международные и национальные базы данных, насколько это возможно.

Ключевые слова: Orchidaceae библиографическая база данных, биоразнообразие, заповедник, местообитание, национальный парк, сохранение природы, угрожаемые таксоны, фокус исследования