



Rainer Willi Bussmann's scholarly impact: a scientometric review

Basharat Ahmad Malik and Zubair A. Malik

Databases and Inventories

Abstract

Background: The article ascertains the intellectual legacy and impact of Rainer Willi Bussmann (RWB), an active ethnobotanist. It is a scientometric review intended to provide a tribute to the intellectual contributions he has made to Ethnobiology, and associated disciplines.

Methods: Bussmann's various IDs were used to collect his publications from Scopus, Web of Science, Google Scholar and ResearchGate. He was also contacted (via email) for information on his life history and the scientific expeditions that he took. Personal experience of one of the authors (ZAM) was also used for describing Bussmann. The tools used for mapping were CRExplorer, VOSviewer and Publish or Perish.

Results: RWB developed scientific curiosity about plants at a very young age. His entire career has been characterized by seeking and creating opportunities in research, conservation and community service. The 1767 publications authored or co-authored by RWB were published in 369 different source titles. But 16.98% of his publications were published in 'Ethnobotany of Mountain Regions – Ethnobotany of the Andes' followed by 13.92% publications in 'Ethnobotany of the Himalayas'. Out of the total publications (1767), 1200 (67.91%) are book chapters followed by Journal articles 274 (15.50%). Out of 1200 book chapters the maximum (966; 80.5%) were published in year 2020. He has collaborated with authors from 55 countries. It was found that titles of his publications are in 18 world languages, the prominent languages being English, Spanish and German.

Conclusion: Documentation and conservation of traditional knowledge is the theme around which RWBs research revolves. He has conducted

numerous such studies in Bolivia, Peru, the Caucasus, and the Himalayas. Examination of keyword co-occurrence (text analysis of titles and abstracts) networks facilitated the identification of clusters, addressing subjects such as ethnobotany and documentation of traditional knowledge of Peru, Bolivia, Pakistan etc.

Correspondence

Basharat Ahmad Malik¹ and Zubair A. Malik^{2*}

¹Department of Library and Information Science, Aligarh Muslim University, Aligarh, Uttar Pradesh, India 202002.

²Department of Botany, Govt. HSS, Hardturoo, Anantnag, J&K, India 192201.

*Corresponding Author: Zubair A. Malik; malikmzubair081@gmail.com

Ethnobotany Research & Applications

21:14 (2021)

Key words: Scientometrics; Systematic Reviews; Reference Publication Year Spectroscopy; Citation analysis

Background

The exploration of plants and their utilization has been a primary human concern for all societies since the rise of humankind, though the practice was not called by any specific name until the term 'ethnobotany' was established (Malik *et al.* 2021a). The American botanist, John W Harshberger, coined the term 'ethnobotany' for the first time in 1895 in a lecture in Philadelphia and defined it as the 'scientific study of the relationships that exist between people and plants.' The 'Introduction to Ethnobotany' by Faulks (1958) was perhaps the first book specifically on the subject, but this author enlarged the scope of the book to cover the entire area of economic botany.

The discipline of ethnobotany is usually considered a relatively new field. But Malik *et al.* (2021a) recently provided a systematic examination of the history of ethnobotanical publications using reference publication year spectroscopy (RPYS). Accordingly, a total of 44 publications (including books and articles) by different authors published between 1555 and 2000 were found to have been especially influential in the development of this discipline (ethnobotany). Andrés Laguna de Segovia, a Spanish humanist physician, pharmacologist and botanist during the first half of the sixteenth century, translated 'Dioscorides' *Materia Medica* into Spanish, adding his own commentaries and additions (Annotations). The book, entitled '*Pedacio Dioscorides Anazarbeo, Acerca, de la materia medicinal y de los venenos mortiferos*' ('Pedacio Dioscorides Anazarbeo on materia medica and deadly poisons') (Laguna 1555), has about 900 chapters grouped into 6 books in which he described medicinal plants, animals and minerals (Malik *et al.* 2021a). The other pioneer ethnobotany researchers include K.W.L. Pappé, Edward Palmer, Andrew Smith, Julius Berendes, Richard Spruce, R.E. Schultes, Brent Berlin, and Levi-Strauss.

Richard Evans Schultes has no doubt been one of the most important ethnobotanists of the 20th century and he is rightly considered as the father of modern ethnobotany. During decades of fieldwork, first in Mexico and then the Colombian Amazon, Schultes amassed a wealth of data later presented to the public in over 400 papers and dozens of books (Ponman & Bussmann 2012). He is known for his studies of the uses of plants by indigenous peoples, especially those of the Americas. He worked on entheogenic or hallucinogenic plants, particularly in Mexico and the Amazon. His book 'The Plants of the Gods: Their Sacred, Healing, and Hallucinogenic Powers' co-authored with chemist Albert Hofmann, the discoverer of LSD, is considered among his popular works. His book 'The healing forest: medicinal and toxic plants of northwest Amazonia' is one of the 44 influential and landmark publications of ethnobotany (Malik *et al.* 2021a).

Brent Berlin, an American anthropologist, has played a noticeable role in the field of ethnobiology. One of the first works Berlin published in relation to the budding field of ethnobiology was also one of his more influential: 'General Principles of Classification and Nomenclature in Folk Biology' (Berlin *et al.* 1973) was co-authored with Dennis Breedlove and Peter Raven. One of Berlin's most well-known contributions to ethnobiology is his book, 'Ethnobiological Classification: Principles of Categorization of Plants and Animals in Traditional Societies' (Berlin 1992). In this comprehensive

synthesis of two decades of deep research, Brent Berlin presents a perspective that has revolutionized what anthropologists take ethnobiology to be. Another significant contributor, Claude Lévi-Strauss was a French anthropologist and ethnologist whose work was key in the development of the theory of 'structuralism'. His book 'The Savage Mind' is a landmark publication in the field of ethnobiology, legitimating 'folk biological classification' as a worthy cross-cultural research endeavour (Ellen 2006). At present many ethnobotanists, including Rainer Willi Bussmann (RWB), are actively contributing to the discipline of ethnobotany.

Methods

Bibliometrics has become a central component of research evaluation. It is used directly or indirectly as a quantitative measure of intellectual merits, scholarly impacts, or other types of indicators. The basic supposition of bibliometrics or scientometrics is that it demonstrates structural and dynamic patterns and inclinations to disclose something convenient (Chen 2018). Many scholars have adopted the supposition or at least the spirit of it and conduct various analyses based on information and insights drawn from such patterns in scholarly publications (Abramo & D'Angelo 2011; Aksnes *et al.* 2019; Ali *et al.* 2018). In this study, we analysed the works of RWB (indexed in Scopus, Web of Science, ResearchGate & Google Scholar) to ascertain his collaborative nature, influence of his works and which studies, theories, and ideas have influenced RWB's own scientific work. His biographical sketch (<https://www.savingknowledge.org/rainer-w-bussmann>) says that he predominantly deals with ethnobotanical research and the preservation of traditional knowledge, in Bolivia, Peru, the Caucasus, and the Himalayas. We use the above-mentioned databases because of their vast coverage. Web of Science (WoS) and Scopus are two world-leading citation databases and researchers from many knowledge domains are involved in the use of these two databases (Zhu & Liu 2020). ResearchGate (RG) is one of the widely used academic social networking site by the academicians of the world and has 19+ million members (<https://www.researchgate.net/about>). Google Scholar (GS) is considered as the world's most comprehensive academic social networking database with 389 million records (Gusenbauer 2019).

Rainer W. Bussmann was contacted (via email), when we asked him about his life and the scientific expeditions that he took. Personal collaboration experience of one of the authors (ZAM) was also used for describing Bussmann. The second part of this study is based on papers authored or co-

authored by RWB. We used his Researcher IDs to access his publications (Table 1) on 1st December 2020 from the mentioned databases. It is evident from the table that there is a huge difference of number of publications authored or co-authored by RWB in all those databases. The prominent reason for such vast difference in indices is because databases like Scopus and WoS index only journals, trade journals, book series and conference materials. These indexing services also require time-consuming support systems (Hauer *et al.* 2020) as compared to academic social networking sites (ANS) such as ResearchGate and Google Scholar. We tried to reflect his overall scholarly output and impact and compared the vastly different indices of RWB on different databases. We clubbed all the document types reflected in all the mentioned databases and then removed the duplicates in MS-Excel 2019. After removing the duplicates, the overall data set contained 1767 documents authored or co-authored by RWB. We divided the analysis into three parts.

Part-I presents an overall picture of the 1767 publications i.e., publication distribution, collaborative nature etc. Part-II deals with the cited references (CRs) of the publications: We used reference publication year spectroscopy (RPYS) method introduced by Marx *et al.* (2014). Thor *et al.* (2016) developed the CRExplorer—a program specifically designed for RPYS (<http://www.crexplorer.net>). This program extracts the CRs. As this tool is specifically designed to use the data of Scopus and WoS, for this analysis we used data extracted from these two databases only. To extract the CRs from the dataset of WoS, we exported the data from the WoS database as 'other

reference software' format. This data set of 127 publications contain 7627 non-distinct CRs. Using export function of the CRExplorer we exported all those CRs as Scopus file. The dataset of Scopus database has been exported from the Scopus database as csv file, and that dataset of 172 publications was introduced to CRExplorer to extract the CRs. This dataset contains 9891 non-distinct CRs. Using export function of the CRExplorer we exported all those CRs as Scopus file. After these two steps we clubbed the exported csv files and then removed the duplicate titles. We then introduced this file (which contains 198 documents with 11304 non-distinct CRs) to CRExplorer. This data set (198 publications) was further introduced to the CRExplorer for processing. The removing, clustering, and merging functionalities of the CRExplorer have been used to clean the CR dataset, especially for variants of the same CR. The clustering and merging of variants (using volume and page number information) lead to a slightly reduced set of CRs ($n = 9080$) (see section cited reference analysis). Part-III deals with the influential publications authored or co-authored by RWB.

The h-index, research items and citations of RWB provided in table 1 reflects on the four most commonly used platforms (Scopus, WoS, GS and RG) results in a variance. This is due to the varying definitions of the underlying databases, and different qualities of the entity recognition problem. The h-index on Scopus and WoS is calculated using citation data from Scopus and Web of Science Core Collection respectively, based on the publications researcher has published in publications indexed in Scopus and WoS respectively.

Table 1: Overall publications reflected in four different databases.

ID	DT	TP	TC	h-Index
Scopus 6603001909 and 57217216611	Article	151	2917	31 including self- citations
	Review	7	101	
	Editorial	5	43	
	Note	5	3	
	Book Chapter	3	3	
	Conference Paper	1	13	
	Total	172	3080	
Web of Science ResearcherID A-6105-2010	Article	109	1949	25 including self- citations
	Review	5	88	
	Editorial Material	8	49	
	Proceedings Paper	2	13	
	Book Review	2	1	
	Book Chapter	1	0	
	Total	127	2100	
Google ScholarID jvsdlkIAAAAJ*	Book chapter	640	332	
	Journal article	260	9404	

	ND	65	782	59 including self-citations
	Conference paper	7	29	
	Book	5	98	
	Total	977	10645	
ResearchGate*	Chapter	1690	1110	64 including self-citations and 36 excluding self-citations
	Article	338	13856	
	Conference Paper	53	45	
	Book	34	910	
	Data	24	19	
	Preprint	3	0	
	Technical Report	2	13	
	Thesis	1	0	
	Patent	1	0	
		Total	2147	

ID= Researchers unique identifier on different databases; DT= Document type; TP= Total number of publications; TC= total number of citations as on 1st December 2020

*To extract data from Google Scholar we used Perish or Publish software (Harzing 2007) and for Research Gate we manually extracted the data.

Results and Discussion

About Rainer W. Bussmann

According to Rainer W. Bussmann, his scientific curiosity started at age 12, when he developed interest in plants. By the age of 14, he was engaged in the floral mapping program of the federal state of Baden-Wurtemberg in Germany, and two years later he began chairing the Natural Science Working Group at the Adult College of his home city (Leutkirch), and to teach classes in botany and ecology, which gave him a profound knowledge on how to convey these topics to lay audiences.

After finishing his doctoral research in Kenya, he met the then President of the Board of the San Diego Museum of Man, who then planned to finance an ethnobotanical expedition to Southern Ecuador. In the course of the conversation, it became clear that the expedition required a plant taxonomist – an opportunity that he decided to take. During the subsequent expedition, he convinced the respective donor that the highly biodiverse mountain forest ecosystems of the region, were scientifically unexplored, and would merit in-depth study. This led to the purchase of about 4000 acres of cloud forest, the construction of 'Estación Científica San Francisco' one of the largest research stations in Latin America, and the foundation of 'Nature and Culture International', an NGO that at present is conserving over 20 million acres in the Americas. He served as its vice-president and scientific director for over a decade. This in turn helped him to create and coordinate the largest and longest running tropical ecology program ever financed by the German Science Foundation (DFG) - DFG research units 402

and 816 - which has been continuously running since 1997. He served this program as Scientific Coordinator, which incorporated up to 27 interdisciplinary projects with up to 100 MSc and PhD students at any one time, and a total funding amount of over 20 million Euro, before moving to other opportunities in the US.

His entire career has been characterized by seeking and creating opportunities in research, conservation and community service. He held many positions in different scientific institutions e.g., In 2003, he was appointed as Associate Professor at University of Hawai'i Manoa and Scientific Director of Harold Lyon Arboretum, with the main purpose to develop the facility into a center for tropical ecology and ethnobotany. In 2006, he took an appointment as Research Fellow at UT Austin, while also engaging in private enterprise, founding 'Ceja Andina Environmental Consulting' and 'Arogya,' a company developing and marketing nutritional supplements. In 2007, he was appointed as Director of William L. Brown Center at Missouri Botanical Garden and held this position for ten years; during his tenure, he develop the Center into a full-fledged program in ethnobotany, ethnopharmacology, preservation of traditional knowledge, climate change and conservation, with solid funding from endowment resources, federal and local grants, and industrial contracts. After leaving the William L. Brown Center at Missouri Botanical Garden in 2017, he co-founded the 'Saving Knowledge,' a combination of NGO and for-profit research entity, as well as the Department of Ethnobotany at Ilia State University in Georgia, Caucasus (<https://www.savingknowledge.org/rainer-w-bussmann>).

RWB has co-authored 5 publications with the second author, Zubair A. Malik (Malik *et al.* 2015; Singh *et al.* 2017; Singh *et al.* 2019; Malik *et al.* 2021a and Malik *et al.* 2021b). As per the personal experience of ZAM, RWB is a polite and humble person who is always ready to help, mentor and/or encourage his colleagues at every step of their research (design, methodology, interpretation, writing or publication) irrespective of the region they are contacting him from. He is a sincere and hardworking researcher

Publications of Rainer W. Bussmann

The 1767 publications authored or co-authored by RWB were published in 369 different source titles, but 16.98% of his publications were published in 'Ethnobotany of Mountain Regions – Ethnobotany of the Andes' followed by 13.92% publications in

'Ethnobotany of the Himalayas'. It is worth mentioning here that out of the total publications (1767), 1200 (67.91%) are book chapters followed by Journal articles 274 (15.50%). Of the 1200 book chapters, the maximum (966; 80.5%) were published in year 2020.

It was found that 274 articles were published in 84 journals. Of those 274 articles, 52 (18.97%) were published in 'Ethnobotany Research and Applications' followed by 38 (13.87%) in 'Journal of Ethnobiology and Ethnomedicine' (IF2020= 2.264). It was found that out of 84 journals, 48 were without Impact Factor (IF) 2020. Table 2 shows the source titles in which RWB has published more than 15 publications. The source titles shown in table contain 72.26% of RWB's publication output.

Table 2: Source Titles with more than 15 Publications published by RWB.

Source Title	TP	IF2020	
		2-Year IF	5-Year IF
Ethnobotany of Mountain Regions – Ethnobotany of the Andes.	300	NA	NA
Ethnobotany of the Himalayas.	246	NA	NA
Ethnobotany of the Mountain Regions of Africa.	175	NA	NA
Ethnobotany of Mountain Regions Central Asia and Altai.	149	NA	NA
Ethnobotany of Mountain Regions Far Eastern Europe.	147	NA	NA
Ethnobotany of the Caucasus.	133	NA	NA
Ethnobotany Research and Applications	52	NA	NA
Journal of Ethnobiology and Ethnomedicine	33	2.264	2.842
Economic Botany	24	1.867	1.775
Lyonia	18	NA	NA

NA= Not Available; TP= total number of publications; IF2020= Impact factor of year 2020

Bussmann has 4 publications in those journals with IF2020 more than six. Two are in 'Nature Plants' (IF2020= 13.256), one each in 'BioScience' (IF2020= 8.282) and 'Science of the Total Environment' (IF2020= 6.551). In all these four publications (Restrepo *et al.* 2009; Zambrana *et al.*, 2018; Rahman *et al.* 2020 and Vandebroek *et al.* 2020), he is not first author and all these publications have more than 10 authors. The important outcomes/contributions of these studies are briefly described here. The article entitled 'Landsliding and its multiscale influence on mountainscapes' by Restrepo *et al.* (2009) was published in BioScience. According to the authors, the severe and long-lasting negative effects of landsliding (a common process of mountainscapes of world) contrast with the less-documented positive effects on ecosystems, raises numerous questions about the dual role of landsliding, the feedbacks between biotic and geomorphic processes, and, ultimately, the ecological and evolutionary responses of organisms. The authors presented a conceptual model in which feedbacks between biotic and geomorphic processes, landslides, and ecosystem attributes are

hypothesized to drive the dynamics of mountain ecosystems at multiple scales. Ecological implications of landslides, as per the model, can be addressed by linking their spatial and temporal patterns to gradients in levels of biodiversity.

In the brief communication entitled 'To list or not to list? The value and detriment of freelisting in ethnobotanical studies', the authors (Zambrana *et al.* 2018) stated that although freelisting and semi-structured interviews are commonly used methods in ethnobotany, very few studies quantitatively examine how these methods may bias results. The authors used a comprehensive ethnobotanical inventory of palm species, uses and names in the Chácobo tribe of Bolivia, to show that interviews elicit more items than freelists, but the effect is sensitive to sample size, item type and data categorization. The study suggested that even subtle methodological choices may greatly affect reported results.

The viewpoint entitled 'Reshaping the future of ethnobiology research after the COVID-19 pandemic' by Vandebroek *et al.* (2020) was

published in Nature Plants. The authors (a geographically diverse group of 29 ethnobiologists) addressed three common themes in response to the COVID-19 global health crisis: impact on local communities, future interactions between researchers and communities, and new/renewed conceptual and/or applied research priorities for ethnobiology. This viewpoint highlights the important role of ethnobiology in a post COVID-19 world in order to ensure the adoption of a new conception of human health interconnected with the sustainability of the biosphere.

The article entitled 'Response of plant physiological attributes to altitudinal gradient: Plant adaptation to temperature variation in the Himalayan region' by Rahman *et al.* (2020) that appeared in the journal 'Science of the Total Environment' determined the impact of cold stress on the physiological attributes of two high altitude plants: *Pedicularis punctata* and *Plantago major*. The authors studied the protein, sugar and proline contents, as well as abscisic acid (ABA) and indoleacetic acid (IAA) in leaves collected from three different altitudinal ranges in Himalayan region of Pakistan. They found that the plant ecophysiology plays an important role in determining the response of plants to climate change. Studying the physiological attributes of plants linked to temperature and elevation gradients provides better understanding of how plant communities have adapted to different environmental pressures like cold stress.

Author Collaboration

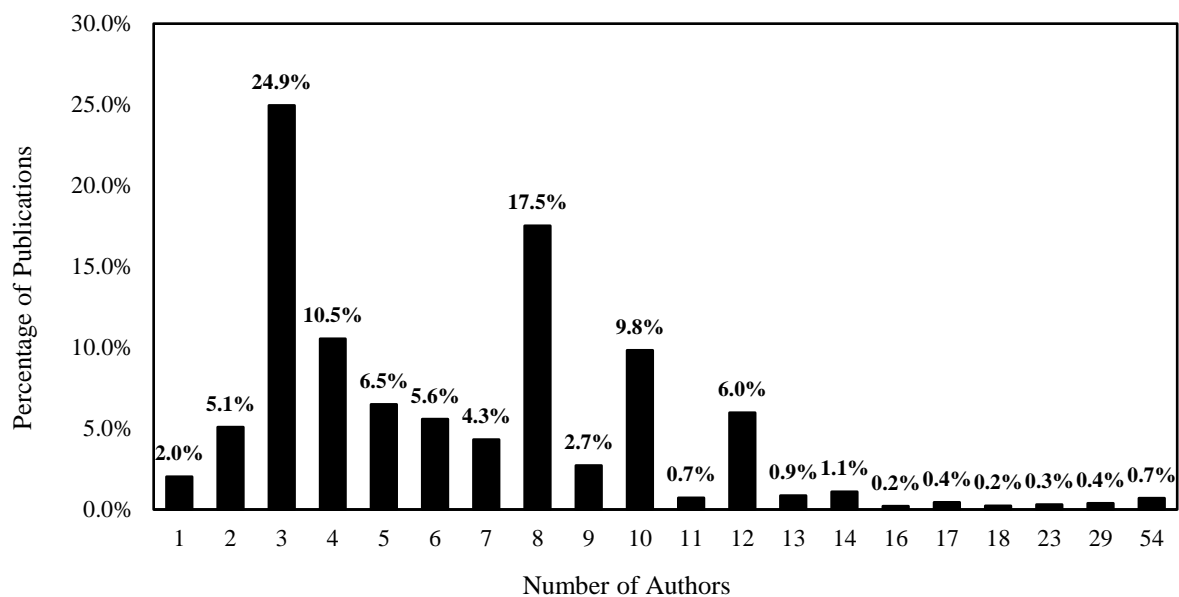


Figure 1: Distribution of publications based on number of author(s)

RWB has collaborated with 945 unique authors. It was found that out of the total, only 154 (8.71%) publications were solo publications, rest 1613 (91.28%) were collaborative publications. It is evident from the fig.1 that three author publications are followed by eight author publications. Out of the total publications, RWB is first author in 703 (39.78%). The data reveals that RWB is tandemly working in collaboration with Paniagua Zambrana N.Y. (1055), Batsatsashvili, K (374) and Kikvidze, Z. (373) (Fig. 2).

The reason behind RWB having 91.28% of collaborative work could be because collaborative work improves the quality of research. This has been proven in a study by Zuckerman (1967) that winners of the Nobel Prize were more likely to collaborate than were other scientists in the same discipline. Birnholtz (2007) in his study finds a positive correlation between higher quality and collaboration, while Katz & Hicks (1997) found in their study that there is a positive relationship between co-authorship and the number of citations. Other reasons why scientists work together include improvement of efficiency, to increase motivation, and help see a project to its conclusion (Fox & Faver 1984). Furthermore, in scientific fields, authors usually take accountability for a specific portion of the research on the basis of the explicit type of knowledge that they bring to the project. Without the help of one or more colleagues, the scope of the study and the expertise needed frequently would make it difficult for a scientist to complete a project.

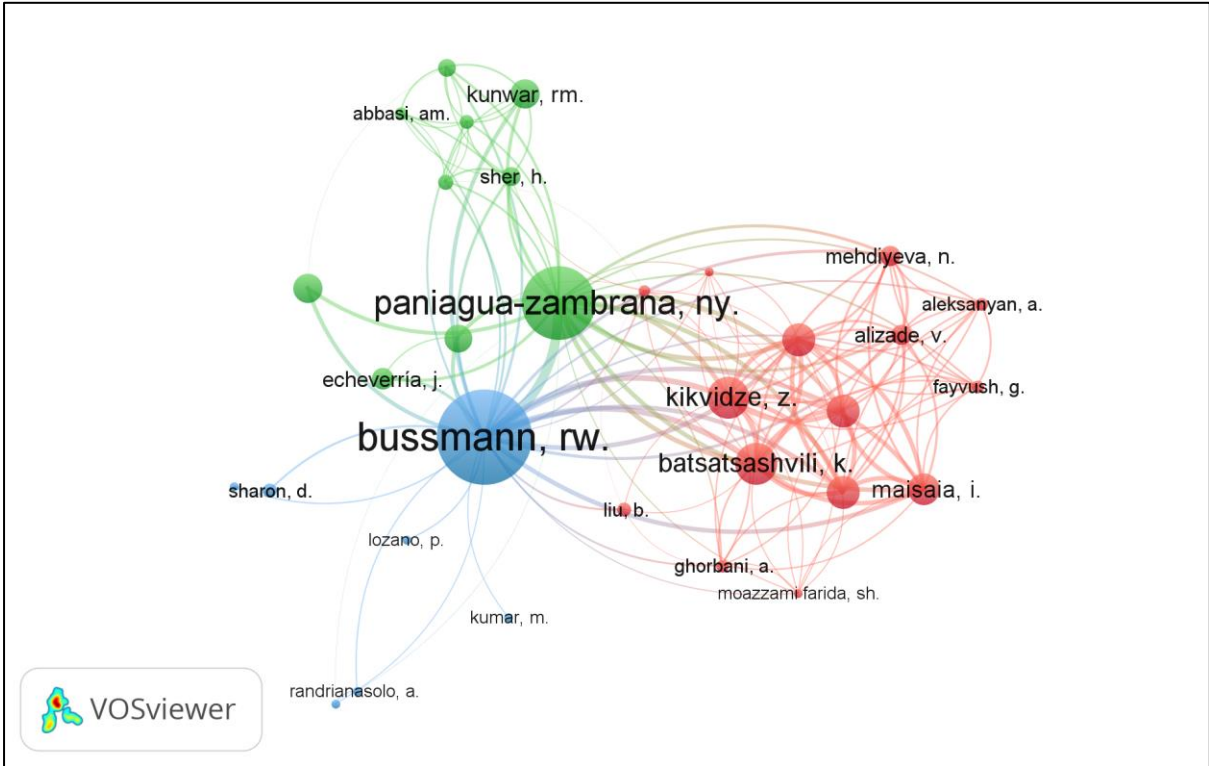


Figure 2: Author collaboration.

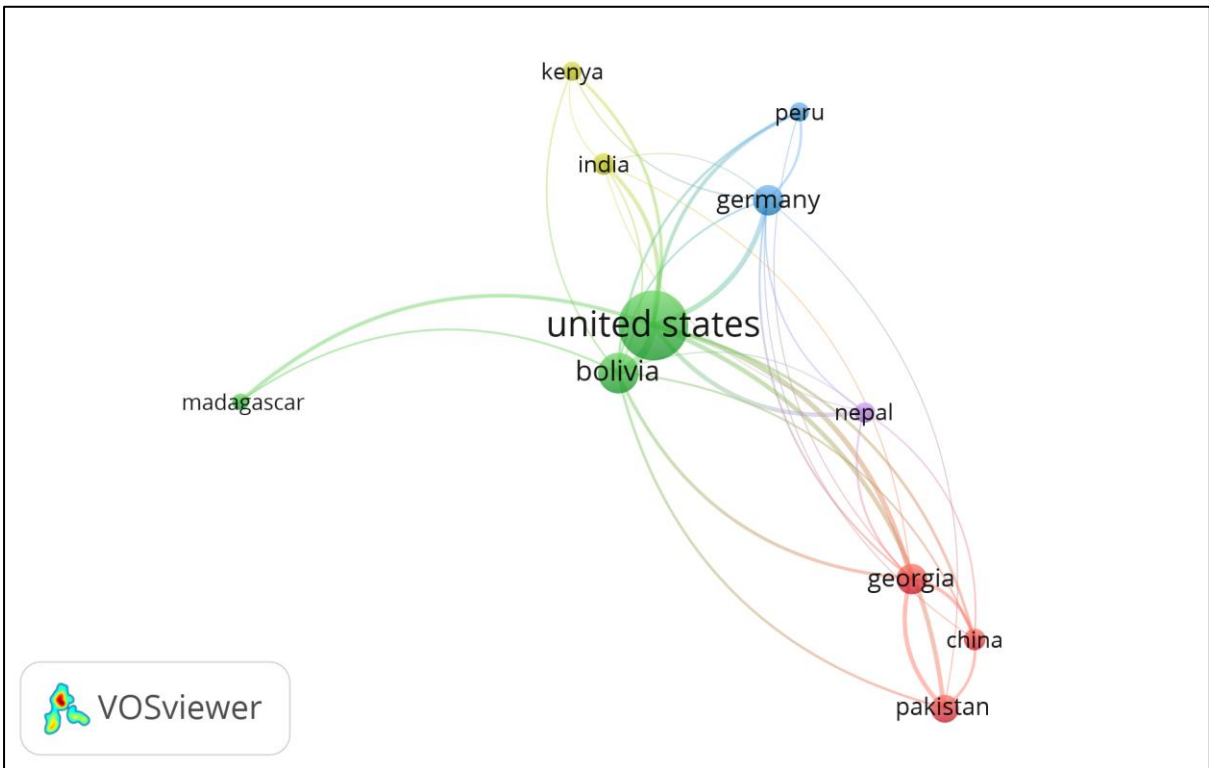


Figure 3: Country-wise analysis of co-authorship.

Country collaboration

To analyse the country collaboration of RWB, we considered Scopus and WoS data alone as these two databases included author affiliation in the bibliographic descriptions of the publications, while as the other two databases (GS and RG) do not include such information. After clubbing the Scopus (172) and WoS (127) data and removing the duplicate titles in excel 2019, 198 unique titles remained. All these unique publications were produced by RWB in collaboration with authors belonging to 55 countries. It was revealed from the country analysis of the authors that he has more collaboration with Bolivian, German, Pakistani and Indian authors (Fig. 3). As per the World Bank country classification on the basis of Gross national income (GNI), out of the total collaborative countries with which RWB is working in collaboration, 24 countries are high-income countries, 18 are upper middle-income countries, 8 are lower middle-income countries and 5 are low-income countries (World Bank Groups 2021). This shows that the author is inclined to work with upper middle-income, lower middle-income and low-income countries, as 31 (56.36%) belongs to these countries. As per the study of Hidayati *et al.* (2015), working with researchers from less developed countries help to enhance local capacity building and mobilisation of external financial resources, and RWB is following the same.

Cited Reference Analysis Results

In this section we will try to ascertain which studies, theories, and ideas have influenced RWB the most. In scientific publications, the researcher(s) refer to previous studies, this relationship between present studies and past studies reflect some basic significance between the citing article and the cited article (Chen 2018; Malik & Ahmadi 2020). Marx *et al.* (2014) introduced reference publication year spectroscopy (RPYS), which can be used to answer this question. The 9080 CRs were used for this analysis, the 'view' option of the software (CRExplorer) was used to view the CRs ranging from 1900 to 2020 (Fig. 4). The spectrogram of the number of CRs and the 5-year median deviations for data set is shown in Fig. 4. It features three large peaks at RPYs 1936, 1948 1993, 2000 and 2006 (Fig. 4, Table 3). Table 3 lists the CRs which are mainly responsible for these four peaks. In addition to the bibliographic information, the table provides the number of occurrences (i.e., how often the publication has been cited by RWB) in absolute terms and other comprehensive information. The brief description of these publications is given below.

The first cited reference corresponds to 'Flora of Peru' (CR1) by Macbride (1936), an American

botanist who devoted most of his professional life to the study of the flora of Peru. The 'Flora of Peru' was initiated in 1936 with the publication of the first number of Volume 13 of 'Field Museum of Natural History', and continued for another 24 years. Bussmann has often consulted this book for the identification of plant species.

The peak of 1948 corresponds to an article titled '*Informe sobre las aplicaciones populares de la cimora en el norte del Perú*' (CR2) by Cruz Sánchez (1948). This paper represents the first major overview on some important hallucinogenic plants in Peru. The peak of 1993 is the result of the four highly cited references, CR3 to CR6. The 1286-page book entitled 'Catalogue of the flowering plants and Gymnosperms of Peru. *Catálogo de las Angiospermas y Gimnospermas del Perú*' (CR3) by Brako & Zarucchi (1993) provides basic data and modern literature references for more than 17,000 species of seed plants known from Peru. Bussmann has followed this book for the nomenclature of plant families, genera, and species. The 264-page book in Spanish entitled '*Árboles y arbustos de los Andes del Ecuador*' (CR4) meaning 'Trees and shrubs of the Andes of Ecuador' by Ulloa & Jørgensen (1993) gives the composition and structure of neotropical montane forest of the Andes of Ecuador. Bussmann has used this book along with the 'Flora of Peru' for the identification of plant species. The article 'The useful plants of Tambopata, Peru: II. Additional hypothesis testing in quantitative ethnobotany' (CR5) by Phillips & Gentry (1993) published in 'Economic Botany' presented the results of applying a simple technique to statistically test several hypotheses in ethnobotany, using plant use data from non-indigenous people in southeast Peru. 'Sorcery and Shamanism' (CR6) by Joralemon *et al.* (1993) is a 306-page book which documents the lives and rituals of twelve curanderos, offering a perspective on their curing role and shared knowledge. Authors Donald Joralemon and Douglas Sharon have presented a broad view of the shamans' work in modern Peruvian society, particularly in connection with gender-based conflicts.

Two cited references are responsible for the peak of 2000. In a 76-page book entitled '*Shamanismo y el Cacto Sagrado-Shamanism and the Sacred Cactus*' (CR7) (Shamanism & the Sacred Cactus: ethnoarchaeological evidence for San Pedro use in northern Perú) in which Douglas Sharon (2000) outlines the almost 4000 years of history of use of the hallucinogenic cactus *Trichocereus pachanoi* is one of the publications cited often by Bussmann. In an 82-page Spanish book entitled '*Estudio costo-efectividad: Programa Nacional de Medicina Complementaria. Seguro Social de EsSALUD*' (CR8) EsSalud (2000) determines the relative

advantages and disadvantages, in relation to the alternative procedures of conventional medicine.

Four cited references are responsible for the peak of 2006. In an article, 'Traditional medicinal plant use in Northern Peru: tracking two thousand years of healing culture' (CR9) published in *Journal of Ethnobiology and Ethnomedicine* in 2006, Bussmann & Sharon (2006) examined the traditional use of medicinal plants in Northern Peru. Being one of the pioneer studies on 'traditional medicine plant use' in Peru, the article has been repeatedly cited by Bussmann in his papers on traditional medicine.

In an article entitled '*Manteniendo el balance de naturaleza y hombre: La diversidad florística andina y su importancia para la diversidad cultural - ejemplos del Norte de Perú y Sur de Ecuador*' (Maintaining the balance between man and nature: Andean floristic diversity and its importance for cultural diversity, examples from Northern Peru and Southern Ecuador) (CR10) published in *Arnaldoa*, Bussmann (2006) stated that the mountain forests and Paramos of the Andes represent some of the most diverse as well as fragile ecosystems of the world but these regions have received little interest from scientific and public sector despite their economic and ecological function as water catchments and erosion barrier. Bussmann has cited

this publication with other similar publications often to show the rapidly increasing traditional knowledge of medicinal use of plants.

In an article entitled 'Ethnobotany of the Samburu of Mt. Nyiru, South Turkana, Kenya' (CR11) published in *Journal of Ethnobiology and Ethnomedicine* in 2006, Bussmann (2006) documented the plant use of the Samburu of the Mt. Nyiru area in Northern Kenya.

The CR12, Sharon & Bussmann (2006): In this volume Sharon and Bussmann identify hundreds of species of useful plants sent to Spain in 1783 by the then bishop Martínez de Compañón, representing the first comprehensive ethnobotanical collection in Perú. It is clearly visible that RWB has been influenced by the above discussed works. These highly cited studies (cited by RWB) include some of his own studies. In fact, out of total highly cited studies, 33.33% are his own (Table 3). He had used these studies to set base for his upcoming research works. The diversity of the cited publications demonstrates the wide-spreading interests of RWB that include taxonomy, and ecology branches of science as a pragmatic operationalization for questions in the ethnobotanical science.

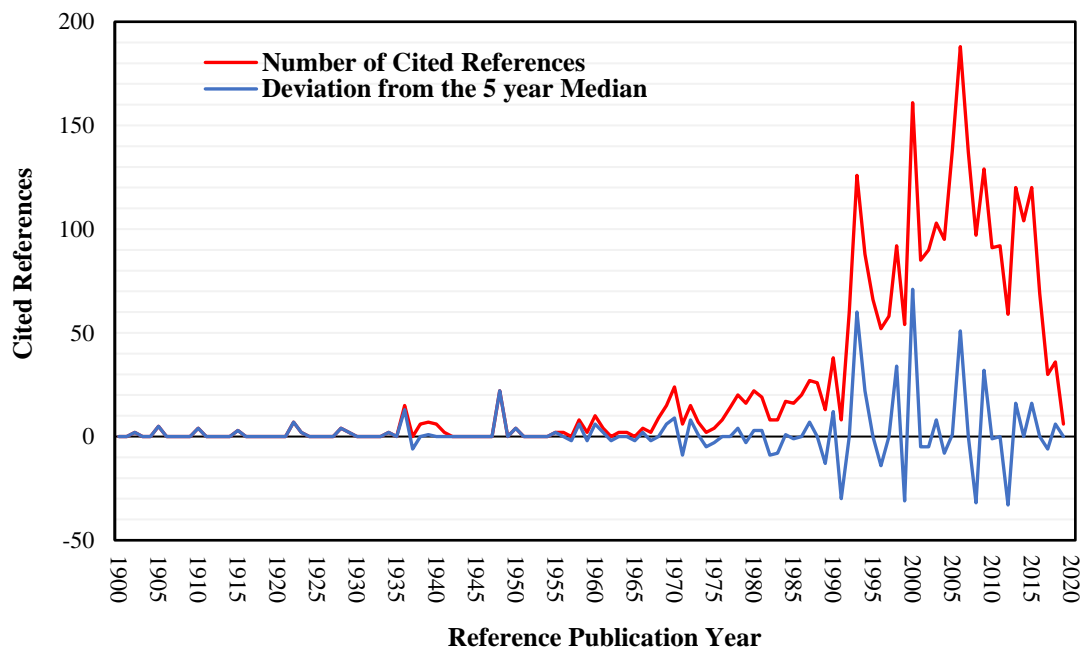


Figure 4: Distribution of the CRs across the reference publication years 1900–2020. Red line represents the number of CRs and blue line represents the five-year median deviation.

Table 3: CRs with the largest number of occurrences.

SN	RPY	CR	NO	No. taxa	Region covered	Botanical name(s)	Common / Vernacular name(s)	Uses	Chemical constituents	Part used	Method of preparation	Brief summary	Document Type	GSC
CR1	1936	(Macbride, 1936)	15	160 families	Peru	Y	Y	N	N	N	N	This book forms the base of description of flora of Peru. RWB has consulted this book for the identification of species.	Book	535
CR2	1948	(Cruz Sánchez, 1948)	9	-	Peru	Y	Y	Y	N	N	N	This article represents the first major overview on some important hallucinogenic plants in Peru.	Article	33
CR3		(Brako & Zarucchi, 1993)	26	17000	Peru	Y	Y	N	N	N	N	Bussmann has followed this book for the nomenclature of plant families, genera, and species	Book	518
CR4		(Ulloa & Jørgensen, 1993)	22	NA	Andes of Ecuador	Y	Y	N	N	N	N	The book in Spanish described composition and structure of neotropical montane forest of the Andes of Ecuador.	Book	206
CR5		(Phillips & Gentry, 1993)	19	-	Southeast Peru	-	-	-	-	-	-	This article presented the results of applying a simple technique to statistically test several hypotheses in ethnobotany.	Article	509
CR6		(Joralemon <i>et al.</i> , 1993)	18	NA	Peru	Y	Y	Medicine	N	Y	Y	The book presented a broad view of the shamans work in modern Peruvian society	Book	118
CR7		(Douglas Sharon, 2000)	19	NA	-	Y	Y	Medicine	N	Y	N	The book outlines the almost 4000 years of history of use of the hallucinogenic cactus <i>Trichocereus pachanoi</i>	Book	33
CR8		(EsSalud, 2000)	16	-	-	Y	Y	Medicine	N	Y	Y	The book determines the relative advantages and disadvantages in relation to the alternative procedures of conventional medicine.	Book	02
CR9	2006	(Bussmann & Sharon, 2006)	35	500	Peru	Y	Y	Medicine	N	Y	Y	The article published in 'Journal of Ethnobiology and Ethnomedicine' examined the traditional use of medicinal plants in Northern Peru.	Article	502

CR10	(Busmann, 2006)	-		Northern Peru and Southern Ecuador	N	N	N	N	N	N	Described the floristic diversity and its importance for cultural diversity, in Northern Peru and Southern Ecuador	Article	26
CR11	(Busmann, 2006)	15	448	Kenya	Y	Y	Food, medicine and others	N	Y	Y	The article documented the ethnobotany of 448 plants of the Samburu of the Mt. Nyiru area in Northern Kenya.	Article	147
CR12	(Sharon & Busmann, 2006)	13	Hundreds	Peru	Y	Y	Food, Medicine and others	N	Y	N	Represents the first comprehensive ethnobotanical collection in Perú	Book Chapter	20

SN= A sequential number for each cited reference; RPY= Reference Publication Year; CR= Cited Reference; NO= Number of Occurrences Y= Yes; N= No; GSC= Google Scholar Citations (as on 1st December 2020)

Table 4 Highly Influential Publications by RWB (ordered according to the ResearchGate rank).

IP	Reference	Scopus R (TC)	WoS R (TC)	GS R (TC)	RG R (TC)	RG Reads	No. taxa	Region covered	Botanical name(s)	Common / Vernacular name(s)	Uses	Chemical constituents	Part used	Method of preparation	Brief summary	DT
IP1	(Busmann & Sharon, 2006)	1 (181)	1 (130)	1 (512)	1 (706)	2892	500	Northern Peru	Y	Y	Y	N	Y	Y	Examined and documented the traditional uses of 500 medicinal plants of Northern Peru.	Article
IP2	(Busmann <i>et al.</i> , 2014)	79 (9)	NA	12 (150)	2 (484)	893	-	Georgian Caucasus	Y	Y	Y	N	Y	N	This article narrates the ethnobotanical travels of authors in the Georgian Caucasus.	Article
IP3	(Busmann <i>et al.</i> , 2016)	NA	NA	14 (148)	3 (432)	241	203	Svaneti & Racha (Georgia)	Y	Y	Y	N	Y	Y	This article documents the traditional use of 203 plant species in a few historical provinces of Georgia.	Article

IP4	(Busmann <i>et al.</i> , 2017)	NA	65 (7)	18 (144)	4 (427)	615	261	Samtskhe-Javakheti, Georgia	Y	Y	Y	N	Y	Y	Documented the ethnobotany of 261 plants of Samtskhe-Javakheti.	Article
IP5	(Busmann & Sharon, 2015)	NA	NA	12 (150)	5 (406)	149942	400	Andes & Amazon, N. Peru	Y	Y	Y	Y	Y	Y	The book (in Spanish) is a pictorial guide of medicinal plants from the Andes and Amazonia of northern Peru along with the common and scientific names and their traditional uses.	Book
IP6	(Busmann & Sharon, 2015)	132 (2)	NA	28 (115)	6 (402)	5940	400	Andes & Amazon, N. Peru	Y	Y	Y	Y	Y	Y	This is the <i>English</i> translation of IP5.	Book
IP7	(Busmann <i>et al.</i> , 2011)	4 (87)	6 (61)	2 (236)	7 (391)	1284	341	Northern Peru	Y	Y	Y	N	Y	Y	Describes the toxicity of 341 medicinal plants of Northern Peru.	Article
IP8	(Busmann, Sharon, Vandebroek, Jones, & Revene, 2007)	20 (50)	17 (41)	8 (166)	8 (366)	682	400	Trujillo & Chichlaya, N. Peru	Y	Y	Y	N	Y	Y	Documents the sources of popular and rare medicinal plants sold in the markets of Trujillo and Chiclayo.	Article
IP9	(Busmann <i>et al.</i> , 2018)	NA	101 (2)	37 (94)	9 (362)	582	338	Guria & Racha, Georgia	Y	Y	Y	N	Y	Y	Documents the traditional plant use in Guria and Racha,	Article
IP10	(Busmann <i>et al.</i> , 2017)	NA	NA	32 (104)	10 (330)	390	17 (plant mixtures)	Borjomi, Georgia	Y	Y	Y	N	Y	Y	Presents an overview of medicinal plant markets in Borjomi Spa	Article

IP = A sequential number for each Highly Influential Papers; IP= Influential Publication; Scopus R (TC) = Scopus rank (Total Citations) ; WoS R (TC) = Web of science rank (total citations) ; GS R (TC) = Google scholar rank (total citations) *; RG R (TC) = ResearchGate rank (total citations) ; DT = Document Type; NA = Not available Y= Yes; N= No
* as on 1st December 2020

Highly influential Publications

The publications with highest citations might be a reliable sign to assist researchers to find the research field's most influential publications. Highly cited publications are especially relevant since a large number of citations for a particular research publication show a positive influence in the research; such publications offer a valuable understanding about the influence of authors and subjects in a field of research over time (Mushtaq *et al.* 2020). Emerging information and communication technologies have enabled new scholarly communication methods of knowledge sharing through institutional repositories (IRs) and scholarly social media (Kim 2018). Academic Social Networks (ASNs) like Google Scholar (<https://scholar.google.com/citations>) and Research Gate (<https://www.researchgate.net>), have become an accepted part of the academic landscape, as these provide a range of metrics for both authors and articles (Marttn-Marttn *et al.* 2016). These interfaces provide: 1. Significantly increasing visibility rate (sharing publications and information) thus contributing to the building of their reputation, 2. Automatically alerting users to the addition of new publications, 3. Allowing connection and collaboration with colleagues and experts in the field, 4. Asking and answering questions, and even finding suitable job opportunities and 5. serving as a source of bibliometric as well as altmetric indicators such as publication counts, reads, number of downloads, citations, and profile views (Boudry & Durand-barthez 2020). The ten influential publications (that are getting much attention from and hence often cited by the ethnobotanists of world) authored or co-authored by RWB are described below and summarized in Table 4.

The article entitled 'Traditional medicinal plant use in Northern Peru: tracking two thousand years of healing culture' (IP1) published in 'Journal of Ethnobiology and Ethnomedicine' by Bussmann & Sharon (2006) examined the traditional use of medicinal plants in Northern Peru. The authors state that the plant knowledge of the population in Northern Peru is much more extensive than in other parts of the Andean region, and the roots of traditional healing practices date back to the Moche period (AC 100–800). But now 50% of the medicinal plants (that were in use during the colonial period) have disappeared from the popular pharmacopoeia. The authors documented the traditional uses and vernacular names of more than 500 medicinal plants, mostly native to Peru.

The article entitled 'Wine, Beer, Snuff, Medicine, and Loss of Diversity – Ethnobotanical travels in the

Georgian Caucasus' (IP2) published in 'Ethnobotany Research and Applications' by Bussmann *et al.* (2014) narrates their ethnobotanical travels in the Georgian Caucasus. Field works and ethnobotanical interviews were conducted in different regions of Georgian Caucasus for documenting the preparation of beer, snuff and wine in these regions. The authors recall the hospitality of their informants and mention that in addition to white wine and bread, hazelnuts walnuts, red currant, tomatoes, and cucumbers were particularly served in all interviews. As per the authors, the main reason for genetic erosion of ancient crop varieties is the demographic decline in mountain regions due to harsh economic conditions and lack of modern infrastructure.

The article 'Medicinal and food plants of Svaneti and Lechkhumi, Sakartvelo (Republic of Georgia), Caucasus' (IP3) published in 'Medicinal & Aromatic Plants' by Bussmann *et al.* (2016) documents the traditional plant use in Svaneti and Racha-Lechkhumi, the historical provinces of Georgia. The authors hypothesized that (1) plant use knowledge in general would be higher in isolated high elevation communities, and that (2) use of home gardens would be much more restricted to lower elevation settings. Interviews using semi-structured questionnaires were conducted with 63 participants. The elevation of the informant community significantly fit the ordination in plant-space and explained a large degree of the variation in plant species reported but not in use-space.

The article of Bussmann *et al.* (2017) entitled 'Ethnobotany of Samtskhe-Javakheti, Sakartvelo (Republic of Georgia), Caucasus' (IP4) published in 'Indian Journal of Traditional Knowledge' documented the traditional plant-use in Samtskhe-Javakheti. About 261 plant species were documented during the fieldwork that was conducted using semi-structured questionnaires.

The 292-pages book (in Spanish) entitled '*Plantas Medicinales De Los Andes Y La Amazonia - La Flora Mágica Y Medicinal Del Norte Del Perú*' (IP5) (meaning Medicinal Plants of the Andes and The Amazon - The Magical and Medicinal Flora of the North of Peru) by Bussmann & Sharon (2015) is a full colour illustrated guide of more than 400 species of medicinal plants from the Andes and Amazonia of northern Peru along with the common and scientific names and their traditional uses.

The 292-paged 'Medicinal Plants of the Andes and The Amazon - The Magical and Medicinal Flora of the North of Peru' (IP6) is the English translation of book '*Plantas Medicinales De Los Andes Y La*

Amazonia - La Flora Mágica Y Medicinal Del Norte Del Perú originally written in Spanish by Bussmann & Sharon (2015). The objective of this book is to provide examples of twenty-five years of global research, describing the change of attitude and methodology during that time, highlighting the increasing role of local actors in ethnobotanical research and contributing ideas for the future development of the discipline. Both the above books (IP5 & IP6) were made available in a special issue of 'Ethnobotany Research and Applications' during 2016 so that the research in Northern Peru reaches to a wider audience.

The seventh influential publication entitled 'Toxicity of medicinal plants used in traditional medicine in Northern Peru' (IP7) published in 'Journal of Ethnopharmacology' by Bussmann *et al.* (2011) describes the toxicity of medicinal plants of Northern Peru. In this publication, the authors reported on brine-shrimp toxicity assays for 341 plant species ingested for a wide range of traditional uses. The aqueous and alcoholic extracts of these plants showed varied levels of toxicity. The authors concluded that the test does not necessarily constitute a direct link to toxicological effects in mammals, and should ideally be subjected to additional laboratory validation. However, it does give a good initial indication for the toxicity of the material tested.

The article entitled 'Health for sale: The medicinal plant markets in Trujillo and Chiclayo, Northern Peru' (IP8) published in 'Journal of Ethnobiology and Ethnomedicine' by Bussmann *et al.* (2007) attempted to document the sources of the most popular and rarest medicinal plants sold in the markets of Trujillo and Chiclayo, as well as to create an inventory of the plants sold in these markets, which would serve as a basis for comparison with future inventories.

The article entitled 'Unequal brothers – Plant and fungal use in Guria and Racha, Sakartvelo (Republic of Georgia), Caucasus' (IP9) published in 'Indian Journal of Traditional Knowledge' by Bussmann *et al.* (2018) documents the traditional plant use in Guria and Racha, the historical provinces of Republic of Georgia. The authors hypothesized that: (i) plant use knowledge in general would be higher in isolated high elevation communities, and that (ii) use of home gardens would be much more restricted to lower elevation settings.

The article entitled 'Plants in the spa – the medicinal plant market of Borjomi, Sakartvelo (Republic of Georgia), Caucasus' (IP10) published in 'Indian Journal of Traditional Knowledge' by Bussmann *et*

al. (2017) presents an overview of medicinal plant markets in Borjomi Spa. The authors reported that all of the vendors in Borjomi featured the same set of medicinal plant mixtures (total 17 in number), and essentially no plants were sold separately. The study underlined that in many cases natural remedies sold in markets can be problematic, and that great care should be taken before using any medicine, whether allopathic or complimentary.

There are studies that has proved that collaboration played an important role in enhancing the impact of articles (Leta & Chaimovich 2002; Narin *et al.* 1991). Aksnes (2003) in his study suggested that highly cited papers typically involve more collaborative research than the general norm. The table 4 of highly cited publications also support this view as all of them are collaborative works.

Keyword co-occurrence analysis

This part of the study deals with the text analysis of the publications (Scopus and WoS only); to extract keywords from the titles and abstracts, the text mining function of the VOSviewer (van Eck & Waltman 2010) Version 1.6.16 was used. This function creates a co-occurrence network of keywords (adjectives and nouns) and displays it on a map. The distance between two keywords (two nodes) is approximately inversely proportional to the similarity (relatedness in terms co-occurrence) of the keywords. Hence, keywords with a higher rate of co-occurrence tend to be found closer to each other. The VOSviewer provides a clustering function, which assigns keywords to clusters based on their co-occurrence (van Eck & Waltman 2017). To generate the map in this study, following settings in the VOSviewer were applied: we used binary counting, a keyword had to occur at least fifteen times, and we included the 60% most relevant keywords in the network. The number of clusters was determined based on interpretability reasons. Words that structure abstracts (e.g. 'practical implications', 'originality value') and names of cited authors in citation contexts were removed.

We generated a network based on RWB's papers (indexed in Scopus and WoS) to get an impression of his papers. From the titles and abstracts of the papers published by RWB, 5087 keywords were extracted, of which 51 occurred fifteen or more times. Based on the criteria mentioned above, 31 keywords were included in the map. The three cluster entities form an important part of RWB's legacy (Fig. 5). Finally, this examination may also assist the recognition of probable themes being studied by RWB. The nodes presented in Figure are, at first, those from which it is possible to infer the themes addressed by the articles in the sample.

- Cluster 1 (C1) consists of keywords such as 'Bolivia', 'case', 'change', 'country', 'ethnobotany', 'forest', 'Kenya', 'market', 'paper', 'plant use', 'population' and 'year'. This group of keywords connote that research has had been concentrated to probably analyse the diversity and ethnobotany of palms of Peru, Bolivia and Kenya.
- Cluster 2 (C2) comprises keywords such as; 'Asteraceae', 'comparison', 'genera', 'leaf', 'northern Peru', 'order', 'Peru', 'remedy', 'treatment' and 'traditional medicine', suggests that this group has concentrated research related to traditional remedy for the treatment of illness by the people of Northern Peru. Families like Asteraceae and plant part like leaf are mostly used during such a treatment.
- In Cluster 3 (C3), it is likely to detect that the most often used keywords are 'data', 'community', 'conservation', 'Pakistan', 'present study', 'questionnaire', 'semi', and 'study area', suggesting that such searches may be related to aspects such as utilization and conservation of community forest resources of Pakistan. Semi-structured questionnaire is used to interview the informants including both men and women.

In relation to clusters, these keywords indicate that research has been gathered addressing the forest resource use pattern and documentation of traditional knowledge in Peru, Bolivia, Ecuador, India and Pakistan. All these keywords of clusters indicate in general that the components of interest include ethnobotanical studies and documentation of traditional plant use and traditional medicine for the treatment of various ailments all of which have been shown to promote health.

To track RWB's research influence in terms of languages, we analysed the titles of 1767 publications. For this, we imported titles of the documents to the spread sheet of the google to detect the language of the titles. In google spread sheet we used this formula '=DETECTLANGUAGE (cell address)' to detect language of the title of the document. It was found that titles of all those publications are in 18 world languages. The prominent languages among them are English, Spanish and German. This part of the study revealed that the RWB research has reached and influenced all over the world.

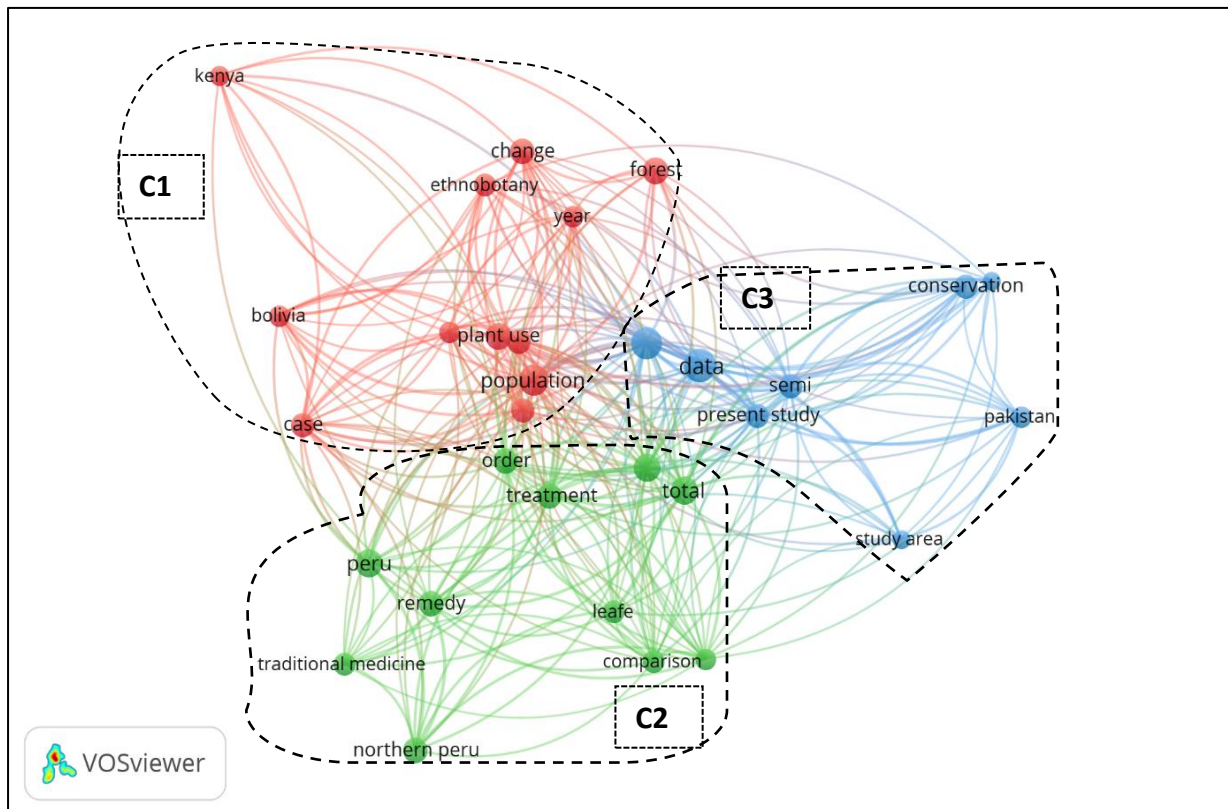


Figure 6: Co-occurrence of keywords in titles and abstracts of publications by Rainer W. Bussmann

Conclusion

Intellectual legacy and impact of Rainer Willi Bussmann, a well-known ethnobotanist, was determined in the present study. It is worth mentioning here that scientific curiosity of RWB about the plants started at a very young age and his entire career has been characterized by seeking, and creating, opportunities in research, conservation and community service. He is a significant contributor to the discipline of ethnobotany and allied disciplines. His work focuses on ethnobotanical research, and the conservation of traditional knowledge, in Bolivia, Peru, the Caucasus, and the Himalayas. He has published ample literature on the ethnobotany of these regions. He has contributed to the conceptual model by which ecological implications of landslides can be addressed by linking their spatial and temporal patterns to gradients in levels of biodiversity. One of his studies on the methodology of ethnobotanical studies suggested that even subtle methodological choices may greatly affect reported results. Recently, his study has highlighted the important role of ethnobiology in a post COVID-19 world in order to ensure the adoption of a new conception of human health interconnected with the sustainability of the biosphere. Published recently in 2020, his publication related to plant physiology suggested that studying the physiological attributes of plants linked to temperature and elevation gradients provides 'better' understanding of how plant communities have adapted to different environmental pressures like cold stress.

Analysis of Cited References (CRs) determined a total 12 publications (including 6 books, 5 articles and 1 book chapter) that influenced RWB and hence are frequently cited/ followed by him in his publications. The examination of keyword co-occurrence (text analysis of titles and abstracts) networks facilitated the identification of clusters, addressing subjects like ethnobotany and documentation of traditional knowledge of Peru, Bolivia, and Pakistan etc. RWB has published his research in many languages, the prominent languages being English, Spanish and German. This reveals his research reach and influence all over the world. He also initiated the repatriation section in ERA- to communicate research findings to local communities with whom the research was conducted. ZAM considers RWB to be a very polite and humble person who is always ready to help, guide and/or encourage his colleagues at every step of their research irrespective of the region they are contacting him from. He is a sincere and hardworking researcher. We wish him long, healthy and peaceful life as he is an invaluable asset to the discipline of ethnobotany.

Declarations

List of abbreviations: RWB: Rainer W. Bussmann; ID: Researchers unique identifier on different databases; DT: Document type; TP: Total number of publications; TC: total number of citations; NA: Not Available; TP: total number of publications; IF: Impact factor; SN: A sequential number for each cited reference; RPY:: Reference Publication Year; CR: Cited Reference; NO: Number of Occurrences Y: Yes; N: No; GSC: Google Scholar Citations; IP: Influential Publication; Scopus R (TC): Scopus rank (Total Citations); WoS R (TC): Web of science rank (total citations); GS R (TC): Google scholar rank (total citations); RG R (TC): ResearchGate rank (total citations); DT: Document Type; NA: Not available Y: Yes; N: No.

Ethical approval and consent to participate: Not applicable.

Consent for publication: Consent to publish this scientometric review including the personal details was obtained (via e-mail) from Dr. Rainer W. Bussmann.

Availability of data and materials: The datasets have not been deposited in public repositories and are available with authors.

Conflict of interests: The authors declare that they have no conflict of interests.

Funding: This research work did not receive any specific grant from any public or private agency.

Authors' contributions: Basharat Ahmad Malik designed the study, analysed/interpreted about 80% of data and wrote the initial draft of manuscript. Zubair A. Malik interpreted the ethnobotanical data and thoroughly revised the manuscript.

Acknowledgements

The authors are highly thankful to the authorities of Aligarh Muslim University for providing the necessary facilities for data retrieval. Authors are also thankful to the anonymous reviewers for their useful comments and suggestions on various aspects of our manuscript.

Literature cited

- Abramo G, D'Angelo CA. 2011. Evaluating research: From informed peer review to bibliometrics. *Scientometrics*, 87(3), 499–514. <https://doi.org/10.1007/s11192-011-0352-7>
- Aksnes DW. 2003. Characteristics of highly cited papers. *Research Evaluation* 12(3): 159–170. <https://doi.org/10.3152/147154403781776645>
- Aksnes DW, Langfeldt L, Wouters P. 2019. Citations, Citation Indicators, and Research Quality: An Overview of Basic Concepts and Theories. *SAGE Open*, 9(1). <https://doi.org/10.1177/2158244019829575>

- Ali PMN, Malik BA, Raza A. 2018. Bibliometric analysis of literature on knowledge sharing. *Annals of Library and Information Studies*, 65(4), 217–227. <http://nopr.niscair.res.in/handle/123456789/45730>
- Berlin B, Breedlove D, Raven P. 1973. General principles of classification and nomenclature in folk biology. *American Anthropologist* 75(1),214-242.
- Berlin B. 1992. *Ethnobiological Classification: Principles of Categorization of Plants and Animals in Traditional Societies*. Princeton: Princeton University Press.
- Birnholtz JP. 2007. When Do Researchers Collaborate? Toward a Model of Collaboration Propensity. *Journal of the American Society for Information Science and Technology* 58(14): 2226–2239. <https://doi.org/10.1002/asi.20684>
- Boudry C, Durand-barthez M. 2020. Use of author identifier services (ORCID, ResearcherID) and academic social networks (Academia.edu, ResearchGate) by the researchers of the University of Caen Normandy (France): A case study. *PLoS ONE* 1–16. <https://doi.org/10.1371/journal.pone.0238583>
- Brako L, Zarucchi JL. 1993. Catalogue of the flowering plants and gymnosperms of Peru: Catálogo de las angiospermas y gimnospermas del Perú. *Monographs in systematic botany from the Missouri Botanical Garden (Vol. 45)*.
- Bussmann RW, Sharon D. 2015. *Medicinal Plants of the Andes and the Amazon-The magic and medicinal flora of Northern Peru (1st ed.)* Peru.
- Bussmann RW, Malca G, Glenn A, Sharon D, Nilsen B, Parris B, Dubose D, Ruiz D, Saleda J, Martinez M, Carillo L, Walker K, Kuhlman A, Townesmith A. 2011. Toxicity of medicinal plants used in traditional medicine in Northern Peru. *Journal of Ethnopharmacology*, 137(1): 121–140. <https://doi.org/10.1016/j.jep.2011.04.071>
- Bussmann R, Zambrana P, Narel Y, Sikharulidze S, Kikvidze Z, Kikodze D, Tcheldize D, Batsatsashvili K, Robbie, E. 2017. Ethnobotany of Samtskhe-Javakheti, Sakartvelo (Republic of Georgia), Caucasus. *Indian Journal of Traditional Knowledge* 16(1): 7–24.
- Bussmann RW. 2006. Manteniendo el balance de naturaleza y hombre, La diversidad florística andina y su importancia por la diversidad cultural—ejemplos del Norte de Perú y Sur de Ecuador. *Arnaldoa*, 13(2): 382–397.
- Bussmann RW. 2006. Ethnobotany of the Samburu of Mt. Nyiru, South Turkana, Kenya. *Journal of Ethnobiology and Ethnomedicine* 2(35): 1–10. <https://doi.org/10.1186/1746-4269-2-35>
- Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Jinjikhadze T, Shanshiashvili T, Chelidze D, Batsatsashvili K, Bakanidze N. 2014. Wine, beer, snuff, medicine, and loss of diversity - Ethnobotanical travels in the Georgian Caucasus. *Ethnobotany Research and Applications* 12(1): 237–313. <https://doi.org/10.17348/era.12.0.237-313>
- Bussmann RW, Sharon D. 2006. Traditional medicinal plant use in Northern Peru: Tracking two thousand years of healing culture. *Journal of Ethnobiology and Ethnomedicine*, 2(47): 60–70. <https://doi.org/10.1186/1746-4269-2-47>
- Bussmann RW, Sharon D, Vandebroek I, Jones A, Revene Z. 2007. Health for sale: The medicinal plant markets in Trujillo and Chiclayo, Northern Peru. *Journal of Ethnobiology and Ethnomedicine*, 3(37): 1–9. <https://doi.org/10.1186/1746-4269-3-37>
- Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Batsatsashvili K, Hart RE. 2016. Medicinal and food plants of Svaneti and Lechkhumi, Sakartvelo (Republic of Georgia), Caucasus. *Medicinal & Aromatic Plants*, 5(5). <https://doi.org/10.4172/2167-0412.1000266>
- Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Batsatsashvili K, Hart RE, Robbie E. 2018. Unequal brothers – Plant and fungal use in Guria and Racha, Sakartvelo (Republic of Georgia), Caucasus. *Indian Journal of Traditional Knowledge* 17(1):7-33.
- Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Batsatsashvili K, Robbie E. 2017. Plants in the spa—the medicinal plant market of Borjomi, Sakartvelo (Republic of Georgia), Caucasus. *Indian Journal of Traditional Knowledge* 16(1): 25–34.
- Bussmann RW, Sharon D. 2015. *Plantas Medicinales De Los Andes Y La Amazonia-La Flora mágica y medicinal del Norte del Perú Medicinal plants and their ecology in Northern Peru and Southern Ecuador View project Ethnobotany and livelihoods in Madagascar and Eastern Africa View project*. Centro William L. Brown – Jardín Botánico de Missouri. <https://doi.org/10.13140/RG.2.1.3485.0962>
- Chen C. 2018. Eugene Garfield's scholarly impact: a scientometric review. *Scientometrics*, 114(2): 489–516. <https://doi.org/10.1007/s11192-017-2594-5>
- Cruz Sánchez G. 1948. Informe sobre las aplicaciones populares de la cimora en el norte del Perú. *Revista de Farmacología y Medicina Experimental Lima*, 1: 253–258.
- Ellen R. 2006. *The cultural relations of classification: an analysis of Nuauulu animal categories from central Seram (No. 91)*. Cambridge University Press.
- Fox MF, Faver CA. 1984. Independence and Cooperation in Research: The Motivations and Costs of Collaboration. *The Journal of Higher Education* 55(3): 347. <https://doi.org/10.2307/1981888>

- Gusenbauer M. 2019. Google Scholar to overshadow them all? Comparing the sizes of 12 academic search engines and bibliographic databases. *Scientometrics* (Vol. 118). Springer International Publishing. <https://doi.org/10.1007/s11192-018-2958-5>
- Harzing AW. 2007. Publish or Perish. Retrieved November 30, 2020, from <https://harzing.com/resources/publish-or-perish>
- Hauer MP, Hofmann XC, Krafft TD, Zweig KA. 2020. Quantitative analysis of automatic performance evaluation systems based on the h-index. *Scientometrics* 123(2): 735–751. <https://doi.org/10.1007/s11192-020-03407-7>.
- Hidayati S, Franco FM, Bussmann RW. 2015. Ready for phase 5 - current status of ethnobiology in Southeast Asia. *Journal of Ethnobiology and Ethnomedicine*, 11(17), 1–8. <https://doi.org/10.1186/s13002-015-0005-7>
- Joralemon D, Sharon D, Giddings JC. 1993. Sorcery and shamanism: Curanderos and clients in northern Peru. University of Utah Press.
- Katz JS, Hicks D. 1997. How much is a collaboration worth? A calibrated bibliometric model. *Scientometrics* 40(3): 541–554. <https://doi.org/10.1007/BF02459299>
- Kim Y. 2018. An empirical study of biological scientists' article sharing through ResearchGate: Examining attitudinal, normative, and control beliefs. *Aslib Journal of Information Management* 70(5): 458–480. <https://doi.org/10.1108/AJIM-05-2018-0126>
- Leta J, Chaimovich H. 2002. Recognition and international collaboration: The Brazilian case. *Scientometrics* 53(3): 325–335. <https://doi.org/10.1023/A:1014868928349>
- Macbride JF. 1936. *Flora of Peru*. (BE Dahlgren, Ed.). Chicago, U.S.A.: Field Museum Press. <https://doi.org/10.5962/bhl.title.2284>
- Malik BA, Ahmadi A. 2020. Investigation into the development and historical roots of collection development by referenced publication year spectroscopy. *Collection and Curation* 39(4): 97–103. <https://doi.org/10.1108/CC-08-2019-0024>
- Malik BA, Malik ZA, Ali PMN, Bussmann RW. 2021a. Detecting seminal research contributions to the development of ethnobotany by Reference Publication Year Spectroscopy (RPYS). *Nordic Journal of Botany* (In Press). doi: 10.1111/njb.03102
- Malik ZA, Bhat JA, Ballabha R, Bussmann RW, Bhatt AB. 2015. Ethnomedicinal plants traditionally used in health care practices by inhabitants of Western Himalaya. *Journal of Ethnopharmacology* 172:133–44. doi: 10.1016/j.jep.2015.06.002
- Malik ZA, Haq SM, Bussmann RW, Bhat JA, Bhatt AB. 2021b. Altitudinal variation in soil properties with reference to forest structure and composition in Western Himalaya. *Indian Forester* 147 (3): 288–301 DOI: 10.36808/iff/2021/v147i3/151484 .
- Marttn-Marttn A, Orduna-Malea E, Delgado López-Cózar E. 2016. The Role of Ego in Academic Profile Services: Comparing Google Scholar, ResearchGate, Mendeley, and ResearcherID. *SSRN Electronic Journal*, 1–3. <https://doi.org/10.2139/ssrn.2745892>
- Marx W, Bornmann L, Barth A, Leydesdorff L. 2014. Detecting the Historical Roots of Research Fields by Reference Publication Year Spectroscopy (RPYS). *Journal of the Association for Information Science and Technology* 65(4): 751–764. <https://doi.org/10.1002/asi.23089>
- Mushtaq M, Malik BA, Raza A, Fazili MA. 2020. Inclinations of Global Research on Saffron as Represented by Science Citation Index-Expanded. *Library Philosophy and Practice*, 1–17. Retrieved from <https://digitalcommons.unl.edu/libphilprac/4070>
- Narin F, Stevens K, Whitlow ES. 1991. Scientific co-operation in Europe and the citation of multinationally authored papers. *Scientometrics* 21(3):313–323. <https://doi.org/10.1007/BF02093973>
- Phillips O, Gentry AH. 1993. The Useful Plants of Tambopata, Peru: II. Additional Hypothesis Testing in Quantitative Ethnobotany. *Economic Botany* 47(1): 33–43. <https://doi.org/10.1007/bf02862204>
- Ponman B, Bussmann RW. 2012. Medicinal plants and the legacy of Richard E. Schultes. *Proceedings of the Botany 2011 Richard E Schultes Symposium*. Graficart, Trujillo.
- Rahman IU, Afzal A, Iqbal Z, Hart R, Abd_Allah EF, Alqarawi AA, Alsubeie MS, Calixto ES, Ijaz F, Ali N, Kausar R. 2020. Response of plant physiological attributes to altitudinal gradient: Plant adaptation to temperature variation in the Himalayan region. *Science of The Total Environment* 706, 135714.
- Restrepo C, Walker LR, Shiels AB, Bussmann R, Claessens L, Fisch S, Lozano P, Negi G, Paolini L, Poveda G, Ramos-Scharrón C. 2009. Landsliding and its multiscale influence on mountainscapes. *BioScience* 59(8), 685–698.
- EsSalud P. 2000. Estudio costo-efectividad: Programa Nacional de Medicina Complementaria. Seguro Social de EsSalud. ESSALUD.
- Sharon D, Bussmann RW. 2006. Plantas Medicinales en la Obra del Obispo Don Baltasar Jaime Martínez Compañón (Siglo XVIII). In *Desde el exterior: El peru y sus estudios*. Edited by LM Y & T. Kato. Tercer Congreso Internacional de Peruanistas. Pp147–165.
- Sharon D. 2000. Shamanismo y el Cacto Sagrado-Shamanism and the Sacred Cactus. San Diego

Museum Papers. San Diego Museum San Diego, CA.

Singh S, Youssef M, Malik ZA, Bussmann RW. 2017. Sacred groves: myths, beliefs, and biodiversity conservation—a case study from Western Himalaya, India. *International Journal of Ecology*. <https://doi.org/10.1155/2017/3828609>

Singh S, Bhat JA, Malik ZA, Youssef M, Bussmann RW, Kunwar RM. 2019. Sacred groves in Western Himalaya, India: community-managed nature refuges for conservation of biodiversity and culture. *Ethnobotany Research and Applications*. 18:1-21.

Thor A, Marx W, Leydesdorff L, Bornmann L. 2016. New features of CitedReferencesExplorer (CREF Explorer). *Scientometrics* 109(3): 2049–2051. <https://doi.org/10.1007/s11192-016-2082-3>

Ulloa CU, Jørgensen PM. 1993. *Arboles y arbustos de los Andes del Ecuador*. Risskov, Denmark: Department of Systematics Botany, Aarhus University.

Vandebroek I, Pieroni A, Stepp JR, Hanazaki N, Ladio A, Alves RRN, Picking D, Delgoda R, Maroyi A, van Andel T, Quave CL *et al.* 2020. Reshaping the future of ethnobiology research after the COVID-19 pandemic. *Nature Plants*, 6(7), 723-730.

van Eck NJ, Waltman L. 2010. Software survey: VOSviewer, a computer program for bibliometric

mapping. *Scientometrics* 84(2): 523–538. <https://doi.org/10.1007/s11192-009-0146-3>

van Eck NJ, Waltman L. 2017. Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics*, 111(2): 1053–1070. <https://doi.org/10.1007/s11192-017-2300-7>

World Bank Groups. (2021). World Bank Country and Lending Groups. <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>

Zambrana NYP, Bussmann RW, Hart RE, Huanca ALM, Soria GO, Vaca MO, Álvarez DO, Morán JS, Morán MS, Chávez S, Moreno BC. *et al.* 2018. To list or not to list? The value and detriment of freelisting in ethnobotanical studies. *Nature plants*, 4(4), 201-204.

Zhu J, Liu W. 2020. A tale of two databases: the use of Web of Science and Scopus in academic papers. *Scientometrics* 123(1): 321–335. <https://doi.org/10.1007/s11192-020-03387-8>

Zuckerman H. 1967. Nobel Laureates in Science: Patterns of Productivity, Collaboration and Authorship. *American Sociological Association* 32(3): 391–403. Retrieved from <https://www.jstor.org/stable/2091086>