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Review

Peter D. Crittenden: meta-analysis of an exceptional two-decade tenure as senior editor of *The Lichenologist*, the flagship journal of lichenology

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Abstract

Peter D. Crittenden served as senior editor of *The Lichenologist*, the flagship journal in the field of lichenological research, for a period of two decades, between 2000 and 2019. A review of the development of the journal and the publication output during this period is provided. The number of papers published during this period (1197) matches that of all papers published under the three previous senior editors, Peter W. James, David L. Hawksworth and Dennis H. Brown, during a much longer period of 42 years from 1958 to 1999. Peter oversaw important editorial changes to the layout and content of the journal: an increased size with a modern cover design, leaving behind the classic mint-coloured cover of more than 40 years; the addition of 'thematic issues' and encouragement of large monographs; implementation of substantial changes to the *Code*, such as effective electronic publication and obligate registration of new fungal names; and more recently a new policy to reject so-called 'single naked species descriptions'. Shortly before Peter took over as senior editor, *The Lichenologist* had received its first impact factor, and Peter managed to continuously increase this measure from around 0.9 to lately up to over 1.5, higher than most other competing journals. The 1197 papers between 2000 and 2019 were published by a total of 1138 different authors, more than half of whom appeared just once as author, whereas a small number participated in numerous (up to 93) papers. There was a continuous increase in the mean number of authors per paper per year, from below 2.5 to around 3.5, the highest numbers ranging between 11 and 30; still, *c.* 75% of all papers between 2000 and 2019 were single-authored or had up to three authors. Based on affiliations at the time of publication, two thirds of author contributions came from Europe (66%), 13% from North America, 9% from Asia and 7% from Latin America. Likewise, almost half of the study areas were located in Europe and around 10% each in North America, South America and Asia. The countries with the highest number of studies included, in descending order, the United States, Spain, the United Kingdom, Norway and Sweden. North America and Europe were over-represented in terms of author contributions, whereas Africa, Latin America, Australia and Oceania were over-represented in terms of study areas. The 1197 papers analyzed encompassed a broad diversity of topics, classified into 32 categories. Taxonomy of lichenized fungi was the most frequent component, representing the focal point in almost half of all studies, followed by phylogeny and evolution, ecology, and the taxonomy of lichenicolous fungi. Around two thirds of the currently accepted genera of lichenized fungi were treated, with a significant correlation between known species richness and the number of papers in which a genus was treated, underlining the taxonomic representativity of papers published in the journal during the past two decades. Examples of genera that were treated more frequently than expected included commonly studied model organisms, such as *Lobaria*, and those frequently featured in ecological or other non-taxonomic studies, such as *Xanthoria*. Species-rich tropical genera, particularly in the *Graphidaceae*, were generally under-represented. Mean number of authors per paper per volume and total number of country origins of authors per volume were the best predictors of impact factor, followed by diversity of study countries per volume, mean number of study countries per paper per volume, mean number of topics per paper per volume, and proportion of studies with phylogenetic components per volume. Individual papers that contributed to high impact factors included broad-scale revisionary treatments and worldwide keys to species-rich taxa, substantial phylogenetic reclassifications of known taxonomic groups, papers dealing with novel methodological approaches of broad interest, and broad-scale studies related to environmental change and lichen biomonitoring.

Key words: *Graphidaceae*, *Hypogymnia physodes*, lichen microbiome, *Lobaria pulmonaria*, multi-authored papers, *Trypetheliaceae*, *Xanthoria parietina*

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Introduction

Founded in 1958 by the British Lichen Society (BLS), *The Lichenologist* soon established itself as the flagship journal of studies related to lichens and has maintained this position until today. Its output is paralleled only by its North American counterpart, *The Bryologist*, the journal of the American Bryological and Lichenological Society (ABLS). Among over 51 000 lichen-related papers recorded in the *Recent Literature on Lichens* database (RLL) (http://nhm2.uio.no/botanisk/lav/RLL/RLL.HTM; Timdal 2010) up to 2019, over 2400 (4.7%) were published in *The Lichenologist* (Fig. 1). These cover a broad range of topics,

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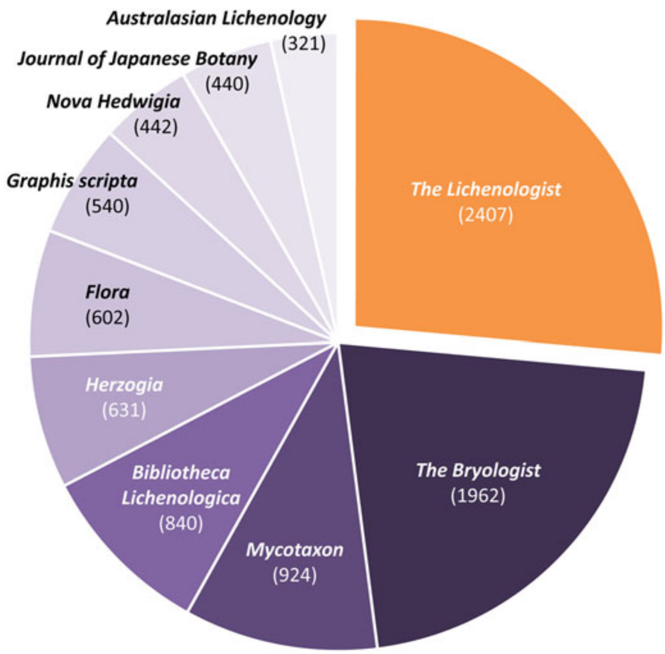

Fig. 1. Comparison of the total output of lichen-related papers of the ten most prolific journals publishing on lichen-related topics up to 2019 (extracted from the Recent Literature on Lichens database; http://nhm2.uio.no/botanisk/lav/RLL/RLL.HTM). In colour online.

from taxonomy, systematics and molecular phylogeny, to ecology and biogeography, to applications in biochemistry and biomonitoring. Almost half of these papers appeared under the senior editorship of Peter D. Crittenden, our esteemed colleague and friend honoured with this issue, who took responsibility for the journal in the year 2000 and only recently, after a 20-year tenure, handed over this role to a new tandem, Christopher J. Ellis and Leena Myllys (Ellis & Myllys 2020).

In this paper, the output of *The Lichenologist* over the past 20 years (2000–2019) is reviewed and analyzed, outlining how the journal has developed over these two decades and paying homage to the extraordinary efforts Peter has put into maintaining and increasing the role of *The Lichenologist* as the world's flagship journal in lichenology.

Material and Methods

All publications recorded in the *Recent Literature on Lichens* database (http://nhm2.uio.no/botanisk/lav/RLL/RLL.HTM; Timdal 2010) up to 2019 were downloaded. The records were first sorted according to journal and, after cleaning up the journal data, the number of publications per journal was computed.

In a second step, all papers published in *The Lichenologist* (2453) were filtered and checked for duplicates, which were removed. The data set was then divided into papers published between 1958 and 1999 (1256) and between 2000 and 2019 (1197). The subset from between 2000 and 2019 was further edited and analyzed as follows (see Supplementary Material S1, available online):

- All authors were checked and standardized.
- For each author and publication, the affiliation country was recorded.
- Titles were checked and corrected where necessary.
- Each publication was screened and scored for topic, using the following designations: Allelopathy, Biodeterioration, Biodiversity and Conservation, Biogeography, Biography, Biology, Biomonitoring, Biotechnology, Book Review, Chemistry, Culturing, Ecology, Ecophysiology, Editorial, Environment, Fossils, History, Interactions, Lichenicolous, Metabolism, Microbiome, Morphology, Nomenclature, Ontogeny, Photobionts, Phylogenomics, Phylogeny and Evolution, Pollution, Population Genetics, Resources, Symbiosis, and Taxonomy; a paper could have more than one designation.
- Each publication was screened and scored for countries covered.
- Each publication was screened and scored for genera covered; where possible, outdated genus assignments were complemented by current generic classifications (e.g. in *Caloplaca* s. lat., *Lobaria* s. lat., *Parmelia* s. lat. etc.).
- Recorded genera were classified to family level based on Lücking *et al.* (2017*a*, *b*).

The 2-year impact factor (IF) of the journal for the period from 1999 to 2018 was obtained from SCImago (https://www.scimagojr.com/journalsearch.php?q=19312&tip=sid&clean=0). To analyze which parameters potentially contribute to the impact factor, the following were assessed:

- Mean number of authors per paper per year (volume).
- Total number of country origins of authors per year (volume).
- Diversity of topics per year (volume).
- Mean number of topics per paper per year (volume).
- Proportion of non-taxonomic topics per year (volume).
- Diversity of study countries per year (volume).
- Mean number of study countries per paper per year (volume).
- Diversity of genera per year (volume).
- Mean number of genera per paper per year (volume).
- Proportion of studies with phylogenetic components per year (volume).
- Inclusion of a thematic issue in volume.

For each IF year, the mean value for the two preceding years for each parameter was computed and then each parameter was plotted against the IF, to calculate the corresponding Spearman rank correlation. To analyze which parameter predominantly contributed to IF in a multiple regression model, three multiple regression models were tested:

- Forward stepwise linear multiple regression.
- Backward stepwise linear multiple regression.
- General non-linear multiple regression with log link function.

To assess the impact of individual publications, citation records of all papers published between 2000 and 2019 were obtained from the *Web of Science* (http://apps.webofknowledge.com; Salisbury 2019) and, for comparison, also from *Google Scholar* (https://scholar.google.com; Falagas *et al.* 2008; Harzing & Alakangas 2016; Martín-Martín *et al.* 2018) for the 30 most cited papers.

Results and Discussion

General development of the journal

The Lichenologist started out in November 1958 with the first issue of Volume 1, with Peter W. James as senior editor and privately published by the British Lichen Society. Volume 1 was

Fig. 2. A selection of cover designs for *The Lichenologist* between 1958 and 2019. Upper row, from left to right: covers of Volume 1, Parts 1 (1958), 2 (1959) and 3 (1959), showing the development of background coloration towards the classic mint green. Middle row, from left to right: first issue in the classic layout (Volume 4, Part 1, 1968), with Peter James as editor; last issue in the classic layout with Dennis Brown as sole editor (Volume 31, Part 6, 1999); first issue, still in the classic layout, with Peter Crittenden as editor in tandem with Brown (Volume 32, Part 1, 2000). Lower row, from left to right: first issue in the new layout (Volume 33, Part 1, 2001); one of the most striking volume layouts, combining *Cladia* (*Pulchrocladia*) *retipora* with a blue-dominated design (Volume 37, Part 1, 2005); last issue in the new design developed by Peter (Volume 51, Part 6, 2019). In colour online.

published with five issues between 1958 and November 1961. All issues maintained a basic cover layout, although the first three issues experimented with colour until arriving at the classic mint green with issue 3 that would be in use until the year 2000 (Fig. 2). The 3-year span for a single volume continued with Volume 4 (1968–1970) and 5 (1971–1973), and it was only with Volume 6 (1974) that consecutively numbered volumes became synchronized with calendar years.

Beginning with the first issue of Volume 4 in 1968, the journal maintained a consistent cover layout for 32 years until the year

2000 (Fig. 2). During this period, Peter James continued as editor until 1977 (Volume 9), in that year in tandem with David L. Hawksworth. Hawksworth then took over in 1978 (Volume 10) and stayed on until 1988 (Volume 20), in that year in tandem with Dennis H. Brown who continued as editor until 2000 (Volume 32). During Brown's tenure, a major change was the switch to six annual issues in 1995 (Volume 27); in previous calendar year-based volumes, the number of issues had oscillated between mostly three and later four, rarely two. In 1997, the journal started to be indexed, resulting in the first 2-year impact factor in 1999.

In 2000, with Volume 32, Peter D. Crittenden started as senior editor of the journal, the first two issues in tandem with Dennis Brown and from issue 3 onwards as sole editor, continuing in this role until 2019 (Volume 51). Lasting 20 years, Peter's tenure as senior editor has substantially surpassed that of all of his predecessors; indeed, the number of papers published under Peter's editorial supervision (1197) almost matches that of all papers published under his three predecessors combined (1256). Peter can look back on a very successful period which has seen substantial developments in scientific research on lichens, but also significant changes in matters of publication. The first task that Peter took on was modernizing the layout and printing of the journal, adopting a larger page size and an entirely new cover layout with Volume 33 in 2001. The new layout combined an elegant design, playing with colour coordination between the graphic layout of the background and a selected lichen photograph, with a changed cover each volume (Fig. 2).

During his tenure, Peter witnessed major changes in the way taxa, and specifically fungi including lichens, are validly described: the new option of effective publication through electronic media and the discontinuation of an obligate Latin diagnosis (with the option to use either English or Latin), both starting on 1 January 2012, and obligate registration of new fungal names, which commenced on 1 January 2013 (McNeill *et al.* 2012). To this, the *Code* added the obligate registration of newly designed types, such as lectotypes, neotypes and epitypes, with a starting point of 1 January 2019 (Turland *et al.* 2018). Peter managed to implement these changes smoothly.

Peter's tenure also saw the rise of molecular phylogeny as the predominant approach to lichenological studies in the past two decades. At the beginning of his editorship, on average less than 10% of the papers per year included molecular methods, and this proportion has grown to sometimes over 50% in the past few years (see below). Witnessing these developments, Peter also actively implemented changes to the scope of manuscripts published by the journal. Individual issues of the journal were dedicated to thematic topics bundling papers on a particular subject and thus generating a higher level of attention by readers. Thus far, this covered *Graphidaceae* (41(4), 2009), *Thelotremataceae* (42(2), 2010), *Parmeliaceae* (43(6), 2011), and *Trypetheliaceae* (48(6), 2016). Other thematic issues not specifically labelled included one on *Physciaceae* (33(1), 2001) and a set of papers from Session II of the 5th Symposium of the International Association for Lichenology in Tartu, Estonia, in 2004, '*Quality and Quantity: maintaining biological diversity in space and time*' (38(4), 2006). Another strategy has been to encourage longer, more comprehensive papers: between 2000 and 2019, the mean number of pages per paper per year increased from mostly under 9 to largely over 11, with three of the four highest paper length averages in the past four years (Fig. 3). The highest page numbers for individual publications during this period were 220 (Aptroot & Lücking 2016), 90 (Lücking

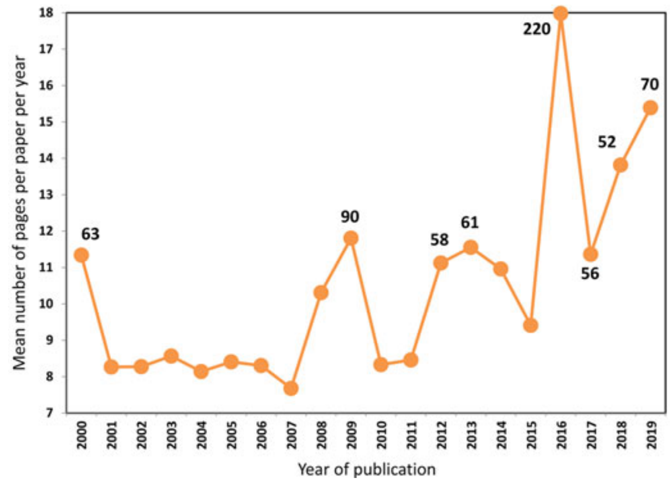

Fig. 3. Development of the mean number of pages per publication per year in *The Lichenologist* from 2000 to 2019. Highest maxima for selected years are indicated. In colour online.

et al. 2009), 70 (Kistenich *et al.* 2019), 63 (Diederich & Etayo 2000) and 61 (Moncada *et al.* 2013). However, lengthy contributions had occasionally also been published prior to 2000, the five highest page numbers of individual papers being comparable to those listed above, namely 115 (Hawksworth *et al.* 1980), 89 (Hawksworth 1969), 81 (Hawksworth 1972) and 71 for two papers (Gilbert 1980; Lücking *et al.* 1998).

From 2016 (Volume 48) onwards, so-called 'single naked species descriptions' (SNSD) were no longer admitted for editorial reasons, a measure also adopted by several other journals specializing in lichen and fungal taxonomy. It forced authors to develop different publication models, enhancing alpha-taxonomy by elements with broader impact, such as incorporating molecular data or improved taxonomic or natural history context, and generating a more inclusive framework especially through the addition of updated identification keys. The latter in particular has been a useful by-product of this policy, although it shows tendencies towards inflation when adding a new key each time a new species is published in the same genus. Following the model by Lumbsch *et al.* (2011), multi-authored papers compiling individual new species descriptions have become a new outlet allowing for rapid cataloguing of unrecognized taxa (Aptroot *et al.* 2016; Lücking *et al.* 2016*a*; Sheard *et al.* 2017).

While the change in editorial policy to no longer accept SNSD might be seen as controversial, it was justified by the notion that a scientific journal is primarily a reading source and not a taxonomic encyclopedia. The attractiveness, and hence impact, of a journal lies in provoking immediate curiosity in a broad readership, whereas SNSD are largely of technical interest to a smaller community of specialists. This does not mean that journals should block the description of new species; on the contrary! After all, new species discoveries are the single most important component of cataloguing our planet's diversity and laborious contributions by taxonomists, in particular non-professionals, are at the core. Nevertheless, blended with other publication models such as those mentioned above, *The Lichenologist* has generated its higher impact and has aimed to receive more immediate attention also from non-specialists. It is worthwhile noting that even before the new measure was implemented, the proportion of species established through SNSD had already declined

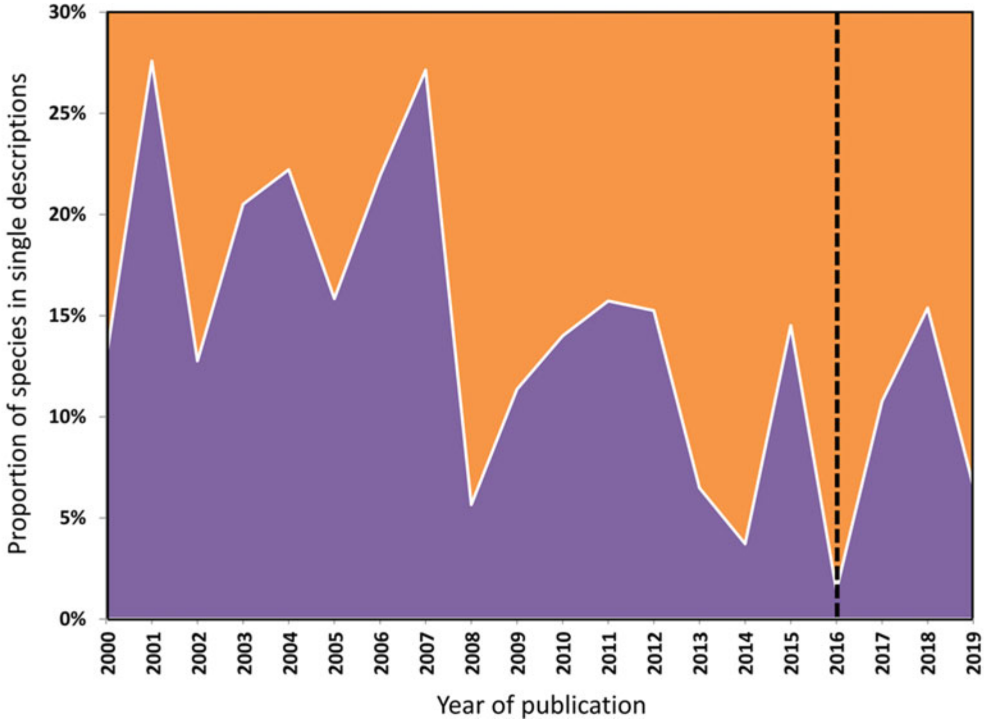

Fig. 4. Development of the proportion of species established in papers with single species descriptions per year in *The Lichenologist* from 2000 to 2019. The dotted line indicates the start of the new policy of editorial rejection of 'single naked species descriptions' (SNSD). In colour online.

(Fig. 4). The main difference is that since 2016, single descriptions require an enhanced component. Indeed, most new species were established as part of broader treatments, even prior to the new policy. Between 2000 and 2019, a total of 2069 new species were described in *The Lichenologist*, out of a total of 2988 since the first issue in 1958, which corresponds to 69% of all newly described species in 32% of the time. Thus, the rate of new species descriptions increased from 22 per year between 1958 and 1999 to 103 per year between 2000 and 2019. Of the 2069 species established in the past two decades under Peter's tenure as senior editor, only 227 (11%) were described in single species descriptions, corresponding to 19% of all papers, whereas 89% were established using other publication models. Notably, between 2000 and 2015, before introducing the new policy of editorial rejection of SNSD, a mean of 96 new species had been published per year in the journal, whereas between 2016 and 2019, this figure increased to 135 new species per year. It thus appears that authors have not only accepted and successfully implemented this new measure, but also had followed its spirit long before the measure was introduced.

In 1999, just before Peter took over as senior editor, *The Lichenologist* started to receive annual 2-year impact factors (IF). During the first ten years until 2009, the IF largely oscillated between 0.8 and 1.0, with a single drop to 0.696 in 2005 and a single peak at 1.315 in 2008. Since then, Peter managed a continuous increase, with values constantly over 1.1 and two times (2014, 2017) up to 1.594 and 1.587 (Fig. 5). These values are distinctly above those of journals with similar specialized scope that frequently publish about lichens, such as *Herzogia*, *Mycotaxon*, *Nova Hedwigia* and *Phytotaxa*, with the exception of *The Bryologist*, which has seen a similarly successful tenure in its senior editorship by James ('Jim') D. Lawrey since 2012 (Lücking *et al.* 2019). The flourishing development of both journals in parallel is not by accident; indeed, Peter and Jim have developed a successful collaboration aimed at increasing the quality of both journals during the past two decades, aided by Jim having served as an associate editor for *The Lichenologist* since 2005 (Lücking *et al.* 2019).

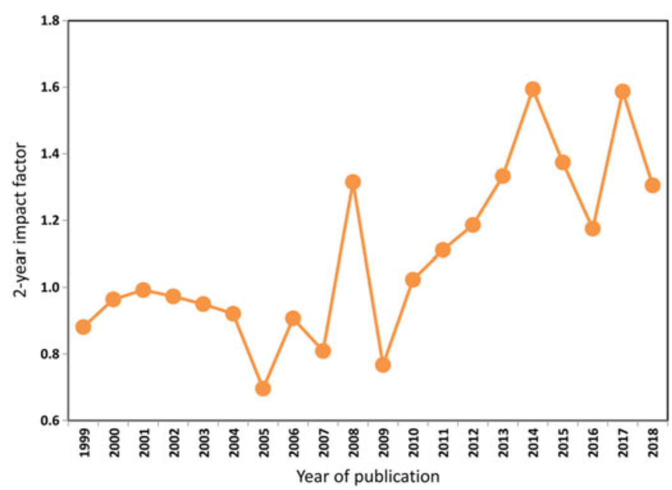

Fig. 5. Development of the 2-year impact factor of *The Lichenologist* from 1999 to 2018 (extracted from SCImago; https://www.scimagojr.com/journalsearch.php?q=19312&tip=sid&clean=0). In colour online.

Authorship of publications between 2000 and 2019

A total of 1138 different authors was recorded for the 1197 papers published in the journal during Peter's tenure as senior editor between 2000 and 2019. Of these, 637 (57%) appeared only once as author, while ten had 33 or more publications and, of these, three had between 65 and 93 (Fig. 6).

The mean number of authors per paper per year has continuously increased during the past two decades, remaining below 2.5

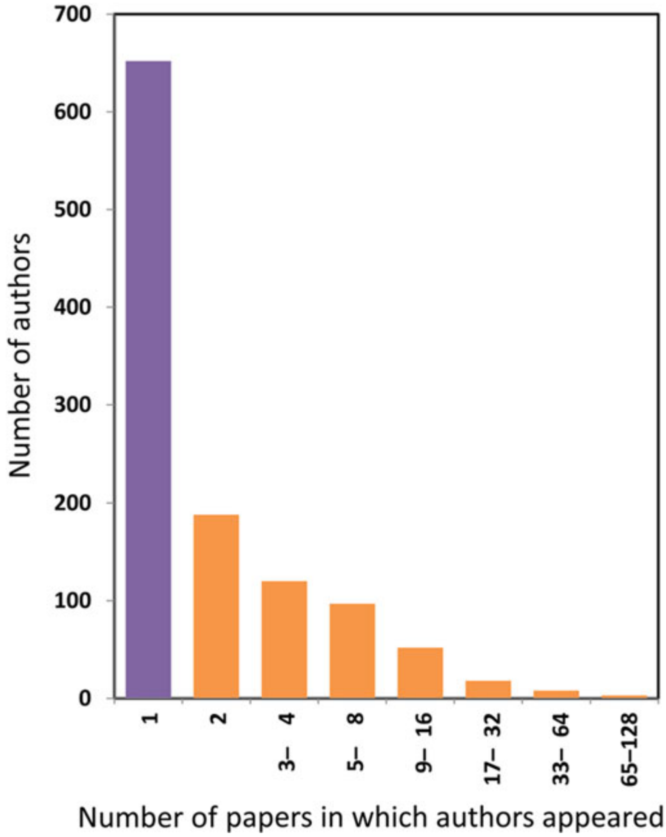

Fig. 6. Frequency distribution of individual authorships and co-authorships in publications in *The Lichenologist* from 2000 to 2019. Authors publishing only once during this time are highlighted in purple. The x-axis was scaled logarithmically, with a possible maximum of up to 128 appearances as (co-)author in the last category, although the realized maximum was 93. Purple and orange are represented by darker and lighter shades, respectively. In colour online.

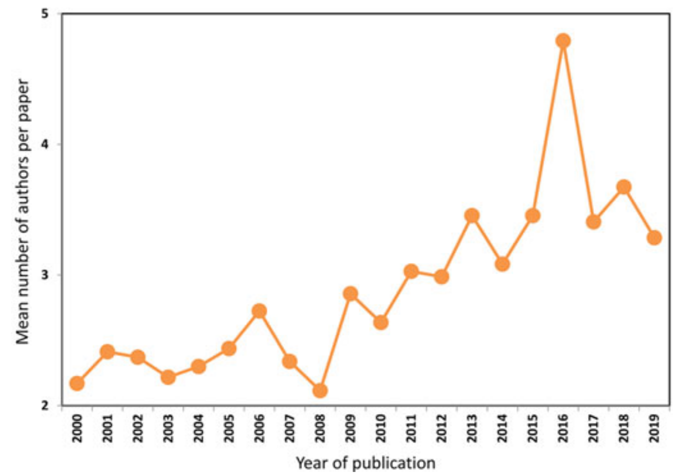

Fig. 7. Mean number of authors per publication per year in *The Lichenologist* from 2000 to 2019. In colour online.

at the beginning of the millennium but then growing to around 3.5 (Fig. 7). For comparison, prior to 2000, the mean number of authors was 1.6. The peak in 2016 was caused by one paper with 30 authors on the phylogeny of *Trypetheliaceae* (Lücking *et al.* 2016*b*), thus far the record for the journal, and this was bolstered by two papers with 15 authors each, one on new species in *Trypetheliaceae* (Lücking *et al.* 2016*a*) and one on lichen diversity and air pollution in the Niagara Escarpment World Biosphere Reserve in North America (McMullin *et al.* 2016). The paper with the second highest number of authors (20) was published by Stofer *et al.* (2006), analyzing the richness of lichen functional groups in relation to land use intensity across Europe.

There have been 264 single-authored papers (22%), 634 papers with two or three authors (53%), 216 papers with four or five authors (19%), 92 papers with six to ten authors (7.5%), and six papers with more than ten authors (0.5%). By far the most frequent number was between one and three authors, representing 75% of all papers (Fig. 8). For comparison, prior to 2000, 59% of all papers were single-authored and 97% of all papers had between one and three authors. Thus, authorship in *The Lichenologist* during the past two decades has followed a general trend towards multi-authored papers (Wuchty *et al.* 2007; Nabout *et al.* 2015; Logan 2016; Teixeira da Silva & Dobránszki 2016), although this development was not as pronounced as it was in scientific journals in general, which as of 2019 showed a mean of 6.0 authors with papers frequently having over 100 authors (Aboukhalil 2014).

The overwhelming majority of author contributions between 2000 and 2019, based on affiliation at the time of publication, came from Europe (66%), particularly Western Europe (57%), followed by North America (13%), Asia (9%), Latin America (7%), in particular South America (6%), and Australia (4%). Few author contributions came from Africa (Fig. 9). This reflects an ongoing issue in mycology in general, although geographical balance is much improved compared to historical times (Lücking 2020).

Peter's tenure as senior editor of *The Lichenologist* during the past two decades saw the passing of some of the greatest lichenologists of the 20th century, with tributes published in the journal (Fig. 10). These included: William Louis Culberson (1929–2003), a pioneer in the chemotaxonomy of lichens (Elix & Nash 2003); Oliver Lathe Gilbert (1936–2005), past president of the British Lichen Society and editor of the British Lichen Society *Bulletin* (Purvis 2005); Natsurang Homchantara (1957–2006), the first trained lichenologist in Thailand, who received her PhD with Brian Coppins in the UK in 1999 and passed away at the young age of 49 (Boonpragob 2010); Antonín Vězda (1920–2008), arguably one of the leading lichen taxonomists of all time (Farkas *et al.* 2010); John Walter Thomson (1913–2009), a pioneer in North American contemporary lichenology (Ahti 2009); Nina Sergeevna Golubkova (1932–2009), leading Russian lichenologist (Biazrov *et al.* 2010); Syo Kurokawa (1926–2010), Japanese lichenologist and world expert in *Parmeliaceae* and *Physciaceae*, who developed the TNS herbarium into a world-class collection (Kashiwadani 2011); Dharani Dhar Awasthi (1922–2011), known as the 'Father of Indian Lichenology' (Singh 2013); Aino (Marjatta) Henssen (1925–2011), who single-handedly redefined the importance of anatomy and ontogeny in lichen fungi for taxonomy and systematics (Lumbsch & Döring 2012); Rolf Santesson (1916–2013), a pioneer in the modern taxonomy of foliicolous lichens and ahead of his time envisioning a phylogenetic classification of lichen fungi (Tibell & Moberg 2014); Peter Wilfrid James (1930–2014), a prominent figure in British lichenology, founding member and past president of the BLS, and first editor of *The Lichenologist* (Wolseley *et al.* 2015); Jack Rodney Laundon (1934–2016), also a founding member and past president

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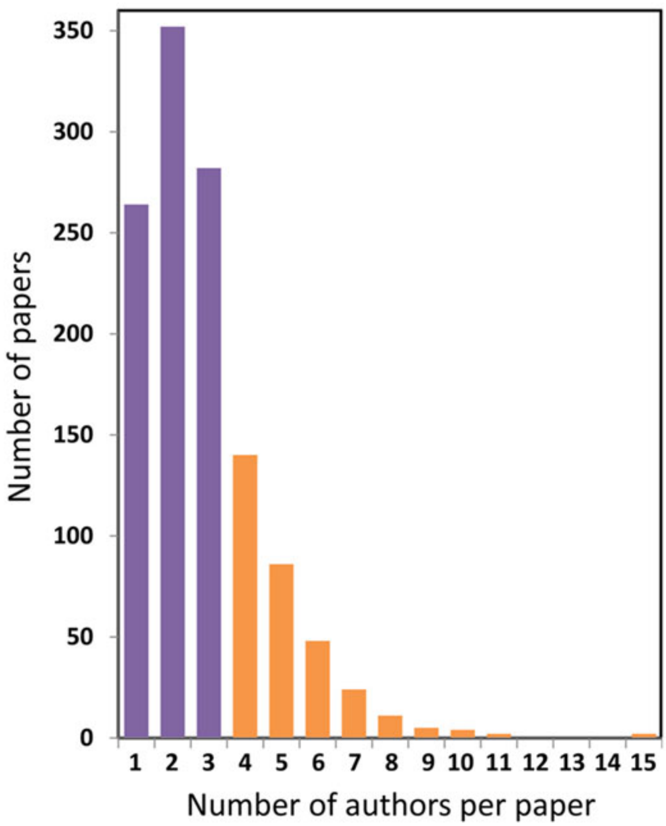

Fig. 8. Frequency distribution of the number of authors per publication in *The Lichenologist* from 2000 to 2019. Two additional papers had 20 and 30 authors, respectively (not included in graph). Papers with up to three authors are highlighted in purple. Purple and orange are represented by darker and lighter shades, respectively. In colour online.

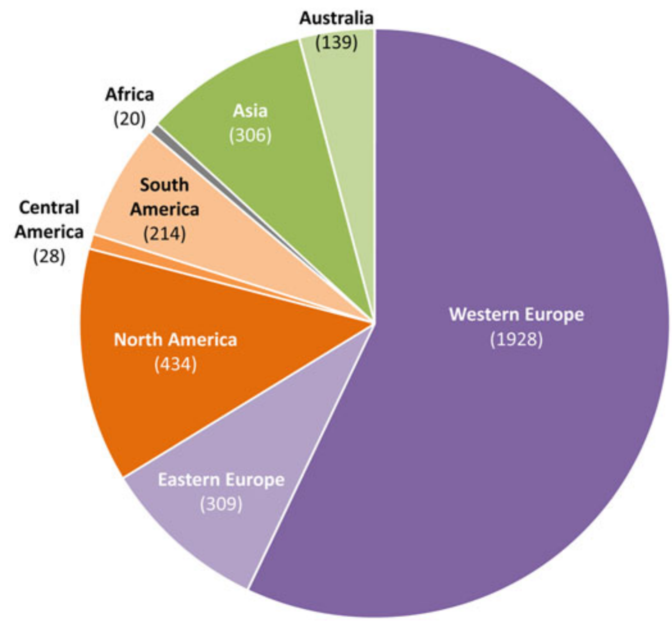

Fig. 9. Geographical author contributions (frequency) based on affiliation at the time of publication in *The Lichenologist* from 2000 to 2019. In colour online.

of the BLS, astute in questions of nomenclature (Seaward & Hawksworth 2017); and Otto Ludwig Lange (1927–2017), one of the foremost authorities on ecophysiological studies in lichens (Green 2019). Some of these well-remembered colleagues published their last or only scientific papers in *The Lichenologist* (Homchantara & Coppins 2002; Gilbert 2004; Vězda in Lücking *et al.* 2005; James 2010; Lange in Bader *et al.* 2010; Laundon 2010).

Several other esteemed colleagues passed away during this period, also recipients of the prestigious IAL Acharius Medal like most of those mentioned above. These included Elisabeth Tschermak-Woess (1917–2001), F. J. Georges A. Clauzade (1914–2002), Siegfried Huneck (1928–2011), Christian Leuckert (1930–2011), Margalith Galun (1927–2012), Erast Parmasto (1928–2012), Vernon Ahmadjian (1930–2012), Hildur Krog (1922–2014), David John Galloway (1942–2014), and Hans-Voldemar Trass (1928–2017). While some of these were prolific contributors to the journal, others rarely, if ever, authored papers in *The Lichenologist*. Both Huneck and Galloway published among their last papers in the journal (Hauck & Huneck 2007; Galloway 2014). David Galloway was especially close to the journal, being author of a total of 44 papers, owing to his tenure in various positions, including Head of the Lichen/Bryophyte Division at the British Museum (Natural History) in London between 1973 and 1994, being an associate editor of *The Lichenologist* between 1987 and 1996, and vice president of the British Lichen Society between 1993 and 1994. It was Peter Crittenden who took over David's slot as associate editor in 1997, before becoming senior editor three years later.

Geographical focus of publications between 2000 and 2019

At a regional scale, the overwhelming majority of studies published in *The Lichenologist* between 2000 and 2019 were performed in Europe (49%), particularly in Western Europe (38%). Notably, the geographical region with the second highest number of studies was South America (11%), followed by North America and Asia (9% each). In the latter case, a higher proportion of studies related to South-East Asia (6%) compared to mostly temperate Asia (3%). The eastern austral region (Papua New Guinea, Solomon Islands, Australia, New Zealand) and Africa contributed 6.5% and 4.5% of the studies, respectively (Fig. 11). Other regions had a share of between 0.6% and 2.2%.

In terms of individual countries, most studies between 2000 and 2019 were performed in the continental United States, followed by Spain, the United Kingdom, Norway, Sweden, Australia, Canada, Germany, Russia and France (Table 1). Largely tropical, Asian or Southern Hemisphere countries with a comparatively high number of contributions included Brazil, Chile, India, China, Costa Rica, Japan and Mexico. This reflects a trend that commenced in the second half of the 20th century in the geographical diversification of mycological and lichenological expertise (Lücking 2020).

Geographical origin of author contributions correlated rather well with geographical focus of the individual study areas (Fig. 12). However, a slight shift could be observed for North American and Western European authors showing more frequent involvement in studies outside these regions, whereas for most other geographical regions, corresponding authorships were underrepresented. This was particularly obvious for Africa but to a certain extent also for Central and South America, and Australia (Fig. 12). Some studied regions had no contributing authors, which by default applied to the Artic and Antarctica, but was also notable for the Caribbean and Oceania. In particular cases, these gaps were caused by authors having their origin in a particular region but at the time of publication were affiliated elsewhere,

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Fig. 10. Renowned lichenologists who passed away during the past two decades, with tributes published in *The Lichenologist*. Upper row, from left to right: William L. Culberson (1929–2003), Oliver L. Gilbert (1936–2005), Natsurang Homchantara (1957–2006), Antonín Vězda (1920–2008). Middle row, from left to right: John W. Thomson (1913–2009), Nina S. Golubkova (1932–2009), Syo Kurokawa (1926–2010), Dharani Dhar Awasthi (1922–2011), Aino Henssen (1925–2011). Lower row, from left to right: Rolf Santesson (1916–2013), Peter W. James (1930–2014), Jack R. Laundon (1934–2016), Otto L. Lange (1927–2017). Pictures taken from the original tributes (see text) and adjusted for greyscale and contrast. Photograph credits: see references cited in the text, with specific credits to J. Kocourková, T. Ahti, O. Blum, R. Honegger and H. Hertel. Reprinted with permission.

for instance by doing a Ph.D. abroad, such as the Puerto Rican lichenologist Joel A. Mercado-Díaz who is currently affiliated with the University of Chicago and The Field Museum (Aptroot *et al*. 2016, 2018; Lücking *et al*. 2016*b*; Moncada *et al*. 2018).

Topic orientation of publications between 2000 and 2019

By far the most frequently covered topic in the 1197 papers published in *The Lichenologist* between 2000 and 2019 was taxonomy (44%), mostly alpha taxonomy but also new higher taxa and systematic rearrangements. Around 17% of the topics referred to a molecular phylogenetic component, mostly tree-based phylogenetics (15.5%), often accompanying taxonomic studies. The other two most frequent topics were lichenicolous fungi (4.7%) and ecology (8%). Overall, 32 topics could be distinguished, with many papers encompassing more than one (1.37 on average). Even with a dominance in taxonomy and systematics, the topics covered by the journal during the past two decades have been quite diverse (Fig. 13).

Over the past two decades, individual papers have highlighted advances in molecular approaches. A study of *Parmeliopsis ambigua* and *P. hyperopta* was among the first to employ the fungal ITS for species delimitation and to demonstrate the applicability of chemotaxonomy (Tehler & Källersjö 2001). Orock *et al*. (2012) tested the performance of blast-based identifications on lichens from Cameroon, while Redchenko *et al*. (2012) obtained

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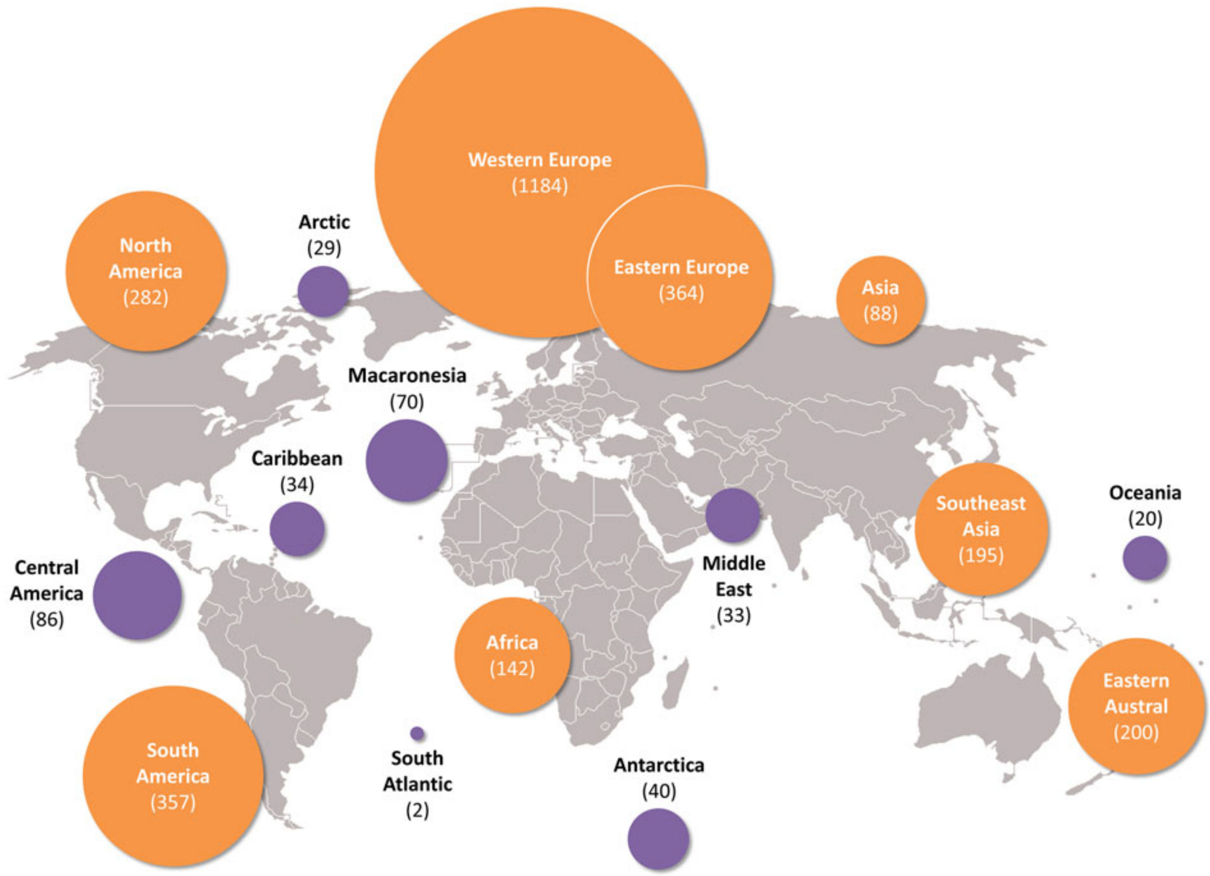

Fig. 11. Geographical focus of studies published in *The Lichenologist* from 2000 to 2019. Regions with a higher number of contributions are in orange, others in purple. The total is substantially higher than the total number of papers, since many papers encompass more than one geographical region. Purple and orange are represented by darker and lighter shades, respectively. In colour online.

Table 1. The 30 countries where the highest number of publications in *The Lichenologist* were focused, from 2000 to 2019.

Country	Number	Country	Number
USA	191	India	59
Spain	175	New Zealand	58
United Kingdom	138	Finland	57
Norway	123	Argentina	51
Sweden	115	China	51
Australia	107	Czech Republic	47
Canada	90	Switzerland	47
Germany	87	Poland	37
Russia	83	Turkey	36
France	76	Costa Rica	34
Brazil	69	Japan	34
Italy	69	Antarctica	33
Austria	68	Greece	32
Portugal	65	Mexico	30
Chile	63	Netherlands	30

ITS data from a 151-year-old herbarium specimen. In the same year, Bates *et al.* (2012) published the first study on the eukaryote lichen microbiome using 454 pyrosequencing. More recently, Ludwig *et al.* (2017) presented one of the few studies on mating-type loci in lichen fungi, in the enigmatic species *Knightiella* (*Icmadophila*) *splachnirima*, a temperate eastern austral endemic (Ludwig 2016), and Dal Grande *et al.* (2018) sequenced the genome of *Lasallia hispanica*. Evidence for the formation of genetically identical, yet phenotypically discrete morphs was reported for the South American genus *Endocena* (Fryday *et al.* 2017).

A still largely neglected, yet apparently growing, field of study is integrative taxonomy, in which phenotypic features are analyzed using quantitative, often multivariate methods, ideally within a phylogenetic framework. During Peter Crittenden's tenure as senior editor, *The Lichenologist* published quite a number of papers using this approach, covering taxa in *Parmeliaceae*, *Physciaceae* and *Teloschistaceae* (Arup & Åkelius 2009; Truong *et al.* 2009; Lendemer & Hodkinson 2010; Arup & Berlin 2011; Resl *et al.* 2016). Among the many monographic revisions appearing during this period, one on the genus *Dirina* (Tehler *et al.* 2013) stands out. One of many highlights regarding lichenicolous fungi was a paper on the new species *Tremella cetrariellae* (Millanes *et al.* 2015). The only two papers on fossil lichens, encompassing lobarioid and

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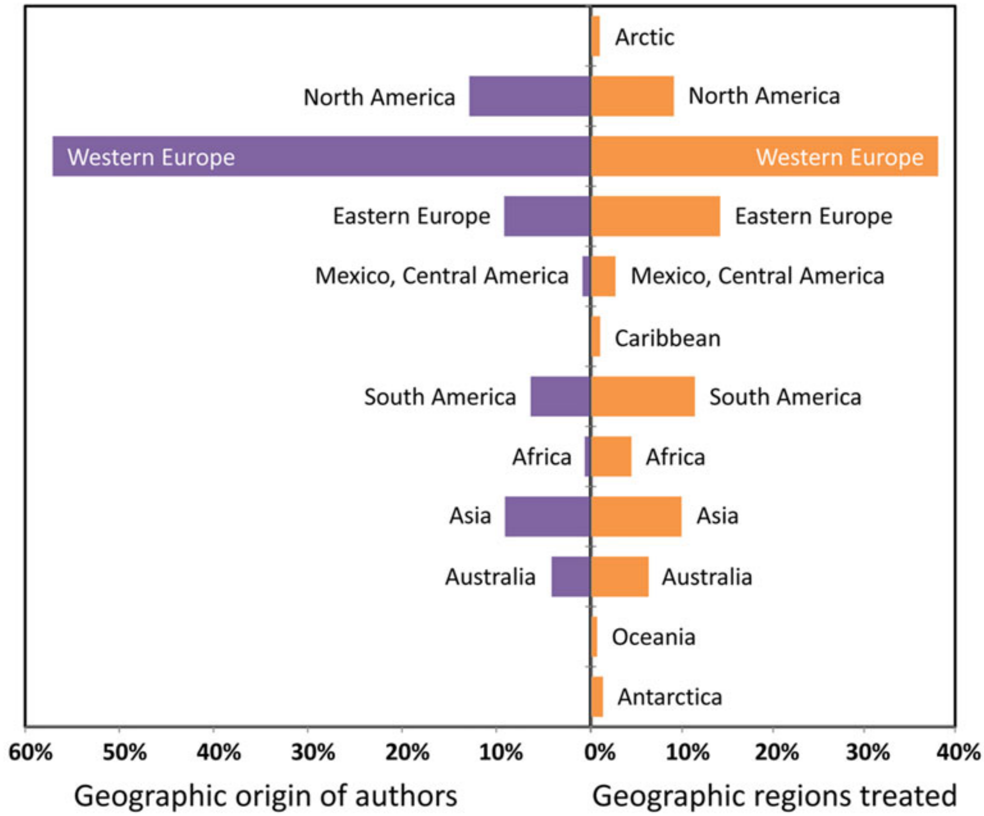

Fig. 12. Comparison of the geographical origin of author contributions based on affiliation at the time of publication with the geographical focus of studies published in *The Lichenologist* from 2000 to 2019, expressed as percentage of the total. The total is substantially higher than the total number of papers, since many papers encompass more than one geographical region, in terms of both authors and study areas. In colour online.

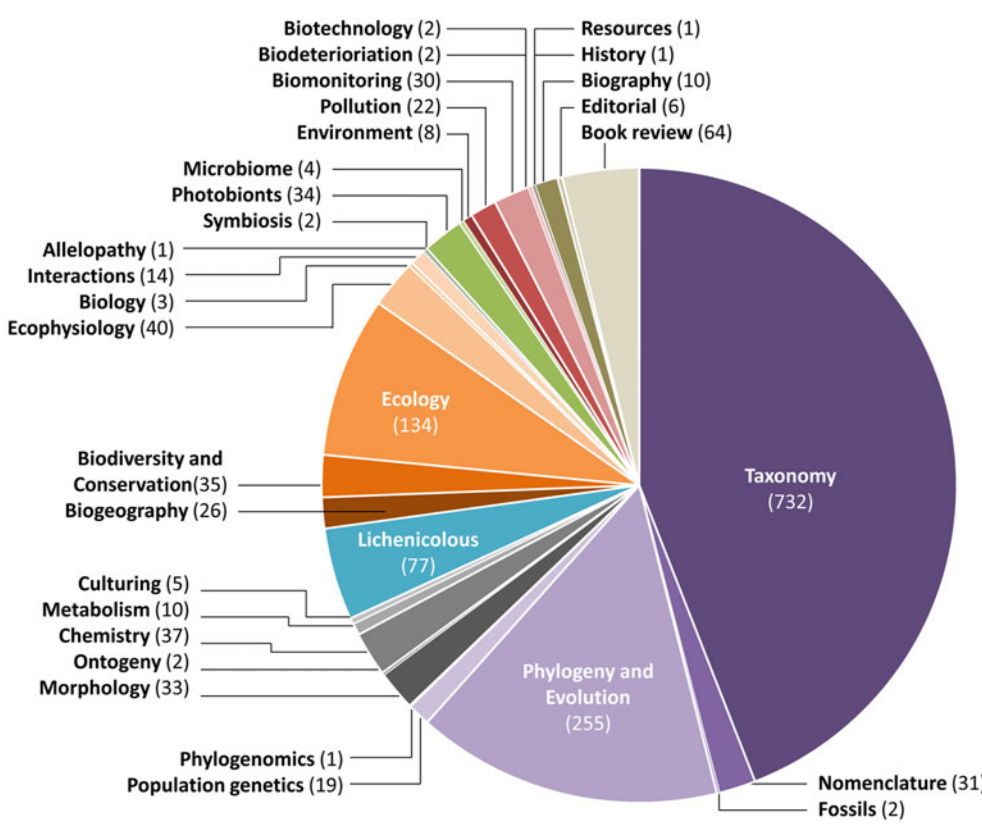

Fig. 13. Diversity and relative proportion of topics covered by studies published in *The Lichenologist* between 2000 and 2019. The total is higher than the total number of papers, since many papers encompass more than one topic. In colour online.

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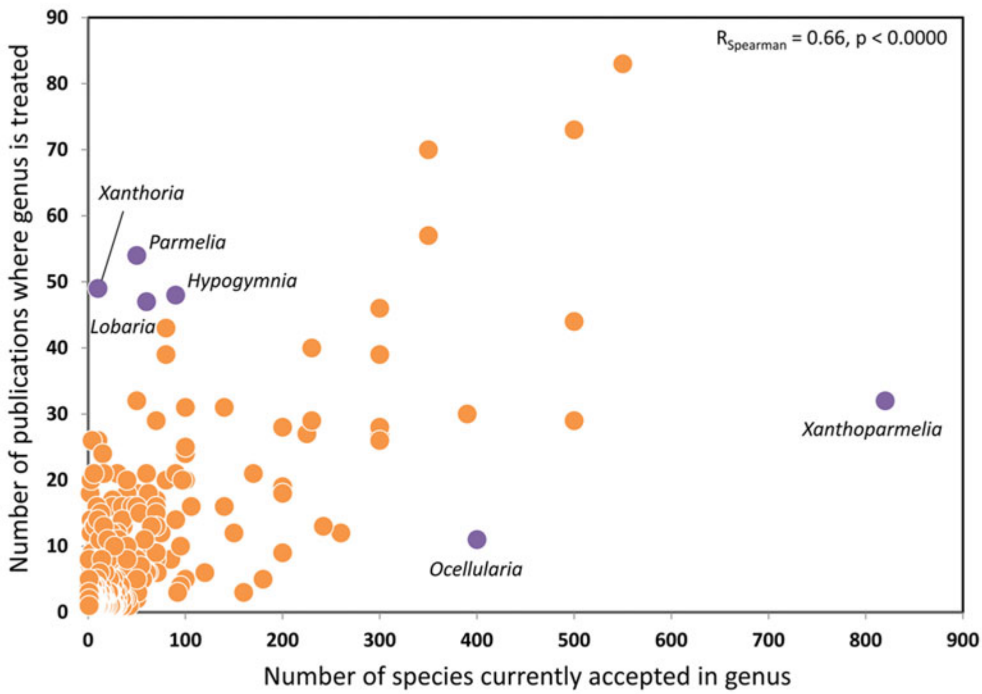

Fig. 14. Correlation between the number of species currently accepted in a genus and the number of publications where the genus was treated in *The Lichenologist* from 2000 to 2019. Selected genera more or less frequently treated than expected based on species richness are highlighted in purple. Purple and orange are represented by darker and lighter shades, respectively. In colour online.

Table 2. Genera treated in *The Lichenologist* between 2000 and 2019 occurring in 15 or more papers with a non-taxonomic focus, indicating the proportion relative to all publications treating the genus, as well as the corresponding predominant species if applicable.

Genus	Proportion of non-taxonomic vs all papers	Predominant species treated
Evernia	96%	*prunastri*
Phaeophyscia	95%	
Platismatia	94%	*glauca*
Xanthoria	90%	*parietina*
Lecidella	90%	
Physcia	89%	
Pseudevernia	88%	*furfuracea*
Lobaria	85%	*pulmonaria*
Ramalina	85%	
Hypogymnia	83%	*physodes*

parmeloid lichens, were published during the first year of Peter's tenure (Peterson 2000; Poinar *et al.* 2000); these fossils play an important role in time-calibrating phylogenetic trees.

Among the numerous and diverse papers on biological aspects of lichens, notable contributions included a study on the discrimination of lichen taxa using element concentrations (Bennett 2008) and an essay on the evolutionary implications of asexual reproduction in lichens (Tripp 2016). Perhaps the most understated contribution was a laborious analysis of lichen microbionts in *Lobaria retigera*, *Parmelia omphalodes* and *Umbilicaria esculenta* (Jiang *et al.* 2017), published as a Short Communication but easily amounting to a standard paper. In an extensive review on the ecology of soil crust lichens, Green *et al.* (2018) pointed out the remarkable convergence in so-called 'window lichens', beautifully elaborated in an earlier paper by Vogel (1955).

A curious occurrence was the publication of two subsequent papers, with taxonomically different content but inadvertently exactly the same title, '*New species and records of* Lepraria (Stereocaulaceae, *lichenized Ascomycota*) *from South America*' (Flakus & Kukwa 2007; Flakus *et al.* 2011).

Taxonomic diversity recorded in publications between 2000 and 2019

Retroactively applying revised genus concepts, a total of 835 genera were treated in the 1197 papers published in *The Lichenologist* between 2000 and 2019. Of these, 749 corresponded to lichenized taxa and the remainder to lichenicolous (78) or non-lichenized taxa (8). Among the lichenized genera, 642 matched genera accepted in the most recent classification of lichenized fungi (Lücking *et al.* 2017*a*, *b*). Another 107 names represented either outdated genus names (97) or genera newly established since 2017 (10). Among the 78 lichenicolous genera, 69 corresponded to genera accepted in the most recent classification (Diederich *et al.* 2018), whereas seven genus names were outdated and two have been newly established since that classification was published.

Therefore, the 1197 papers published under Peter's tenure as senior editor of the journal can be considered broadly representative of the diversity of lichen fungi, with over 60% of the currently accepted genera treated, whereas only 17% of the currently accepted genera of lichenicolous fungi were covered. The hypothesis that the known species richness per genus, with reference to Lücking *et al.* (2017*a*, *b*), was a good predictor of the number of times a given genus was treated in a study was supported by the data (Fig. 14), giving a good and statistically highly significant non-parametric correlation ($R_{Spearman}$ = 0.66, P < 0.0000). However, a number of genera were treated more often than expected based on their species richness, including *Xanthoria*, *Pseudevernia*, *Parmelia*, *Parmeliopsis*, *Platismatia*, *Evernia*,

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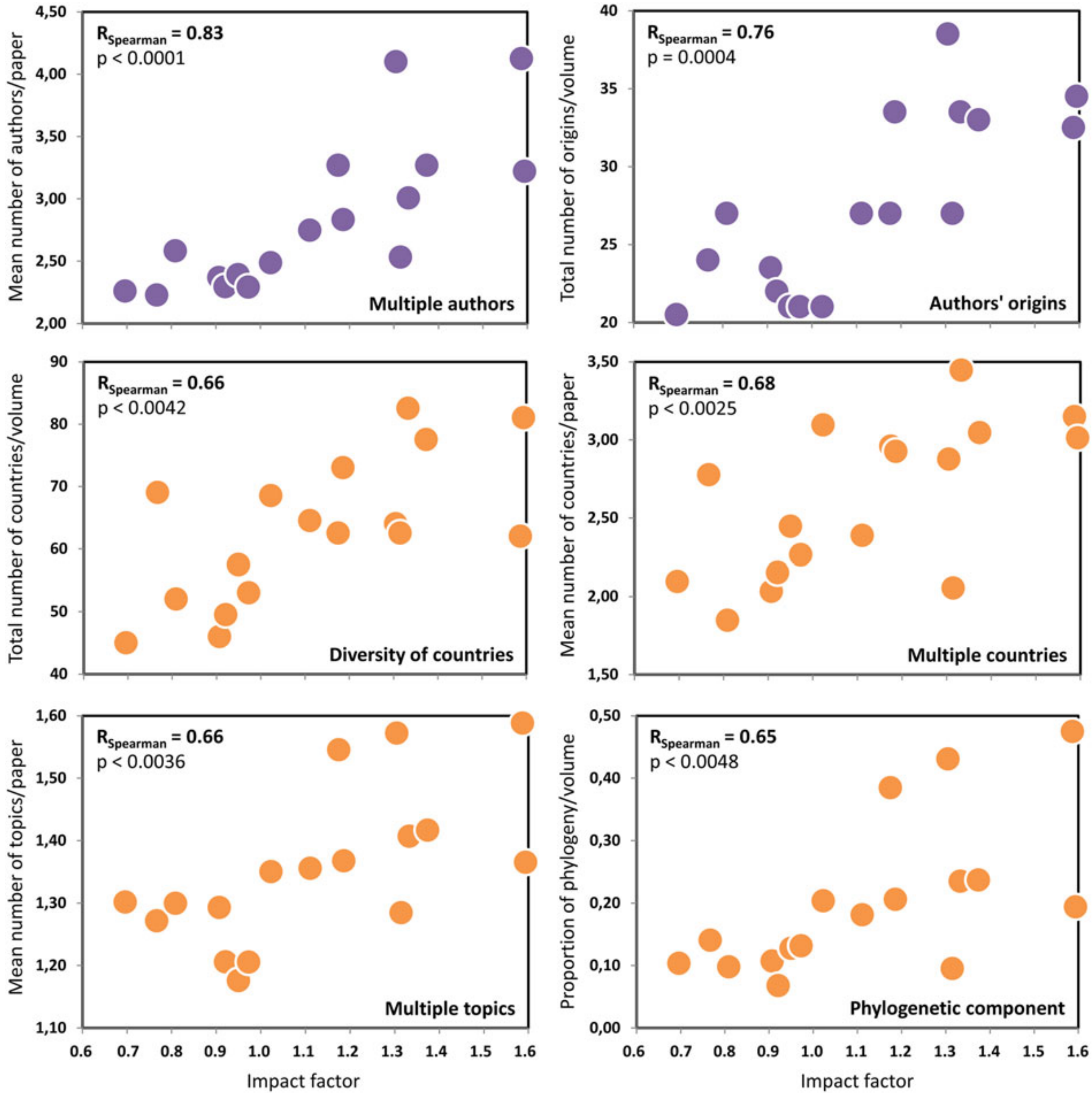

Fig. 15. Correlation between the impact factor (IF) of *The Lichenologist* from 2000 to 2019 and six selected publication parameters (means of two years prior). Spearman rank correlations and corresponding *P*-values are indicated and parameters with highly significant correlations ae highlighted in purple. Purple and orange are represented by darker and lighter shades, respectively. In colour online.

Melanelia, *Lobaria*, *Cetraria* and *Hypogymnia*. Other genera appeared less often than expected: *Ocellularia*, *Xanthoparmelia*, *Fissurina*, *Phaeographis*, *Cora*, *Polyblastia*, *Hypotrachyna*, *Phyllopsora*, *Rhabdodiscus* and *Thelidium*. The latter includes predominantly tropical genera that are generally under-represented in publications.

Papers with a taxonomic or systematic focus on lichenized fungi encompassed 647 genera, whereas studies with an emphasis on non-taxonomic topics, such as ecology, biogeography, and biomonitoring, included 428. Some genera appeared frequently and predominantly in non-taxonomic works based on single, common and widespread species (Table 2), which explains the over-representation of these genera in the published papers, even if some are not notably rich in species.

Contribution of parameters to Impact Factor

Six of the 11 tested parameters showed a statistically significant rank correlation with IF (Fig. 15). The strongest correlation was observed for mean number of authors per paper per volume, followed by total number of country origins of authors per volume, both highly significant ($P < 0.001$). Four further parameters exhibited a significant correlation ($P < 0.05$), namely diversity of study countries per volume, mean number of study countries per paper per volume, mean number of topics per paper per volume, and proportion of studies with phylogenetic components per volume (Fig. 15). The five remaining parameters, viz. diversity of topics per volume, proportion of non-taxonomic topics per volume, diversity of genera per volume, mean number of genera

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Table 3. The 30 papers published in *The Lichenologist* from 2000 and 2019 with the highest individual impact factors (IFs) derived from citation counts in the *Web of Science*. *Google Scholar* citation counts and derived impact factors are added for comparison. Papers published between 2012 and 2013, and between 2015 and 2016, contributing to high IFs in 2014 and 2017, respectively, are marked with an asterisk. WoS = *Web of Science*; GS = *Google Scholar*.

Author(s)	Year	Number of authors	Topic(s)	Citations WoS	Citations GS	IF WoS	IF GS
Gauslaa 2014	2014	1	Ecology/Ecophysiology	62	91	15.50	22.75
Lücking *et al*. 2009	2009	3	Taxonomy (global key)	107	176	14.59	24.00
*Aptroot & Lücking 2016	2016	2	Taxonomy (global key)	33	47	12.38	17.63
Rivas Plata *et al*. 2010	2010	6	Taxonomy (global key)	73	104	10.95	15.60
van Herk *et al*. 2002	2002	3	Biomonitoring	128	297	10.67	24.75
*Moncada *et al*. 2013	2013	3	Taxonomy/Phylogeny and Evolution	49	86	10.50	18.43
Helms *et al*. 2001	2001	4	Photobionts/Phylogeny and Evolution	126	169	9.95	13.34
Meyer & Printzen 2000	2000	2	Chemistry	124	171	9.30	12.83
Vondrák *et al*. 2009	2009	4	Taxonomy/Phylogeny and Evolution	67	104	9.14	14.18
van Herk 2001	2001	1	Biomonitoring/Pollution	115	210	9.08	16.58
Ekman *et al*. 2014	2014	4	Taxonomy/Phylogeny and Evolution	34	48	8.50	12.00
*Aptroot 2012	2012	1	Taxonomy (global key)	45	79	8.44	14.81
van Herk *et al*. 2003	2003	3	Biomonitoring/Pollution	89	165	7.85	14.56
Wolseley *et al*. 2006	2006	4	Biomonitoring/Pollution	68	125	7.29	13.39
*Lücking *et al*. 2016*b*	2016	30	Taxonomy/Phylogeny and Evolution	19	19	7.13	7.13
Molina *et al*. 2004	2004	5	Taxonomy/Phylogeny and Evolution	75	102	7.03	9.56
Dal Grande *et al*. 2018	2018	6	Phylogenomics	9	10	6.75	7.50
Ertz *et al*. 2018	2018	4	Taxonomy/Phylogeny and Evolution	9	9	6.75	6.75
*Bates *et al*. 2012	2012	6	Microbiome	35	56	6.56	10.50
Stofer *et al*. 2006	2006	20	Ecology/Environment	60	81	6.43	8.68
Gauslaa & Solhaug 2000	2000	2	Ecology	81	115	6.08	8.63
Arup 2006	2006	1	Taxonomy/Phylogeny and Evolution	56	89	6.00	9.54
Saag *et al*. 2009	2009	3	Taxonomy	44	88	6.00	12.00
Molina *et al*. 2011	2011	7	Taxonomy/Phylogeny and Evolution	36	49	6.00	8.17
Malíček *et al*. 2017	2017	4	Taxonomy/Phylogeny and Evolution	12	18	6.00	9.00
Molins *et al*. 2018	2018	5	Photobionts/Phylogeny and Evolution	8	6	6.00	4.50
Launis *et al*. 2019	2019	5	Taxonomy/Phylogeny and Evolution	4	6	6.00	9.00
Baniya *et al*. 2010	2010	4	Ecology	39	87	5.85	13.05
Crespo *et al*. 2011	2011	3	Taxonomy/Phylogeny and Evolution	35	50	5.83	8.33
Myllys *et al*. 2011	2011	6	Taxonomy/Phylogeny and Evolution	35	51	5.83	8.50

per paper per volume, inclusion of a thematic issue in volume, did not show statistically significant correlations with IF. In particular, taxonomic diversity did not affect the IF.

Both forward stepwise and backward stepwise multiple regression revealed mean number of authors per paper per volume as the single, statistically significant component contributing to IF, with R = 0.93, beta = 2.43, $P = 0.0072$ for forward stepwise and R = 0.79, beta = 0.79, $P = 0.0002$ for backward stepwise multiple regression. Generalized non-linear multiple regression also resulted in mean number of authors per paper per volume being the most significant component (Wald statistic = 12.79, $P = 0.0003$), but further identified two additional parameters as statistically significant components: total number of country origins of authors per volume (Wald statistic = 7.42, $P = 0.0064$) and diversity of topics per volume (Wald statistic = 4.08, $P = 0.0434$).

Thus, mean number of authors per paper per volume and total number of country origins of authors per volume appear to be the most important parameters influencing the IF, suggesting that papers with multiple authors of diverse geographical origin have higher short-term citation rates, an observation also found in other studies (Tahamtan *et al*. 2016). The multiple regression approach indicates that it is indeed authorship and not the underlying content that causes this effect. International teamwork has been shown to positively affect the IF (Didegah & Thelwall 2013), probably also because a diverse composition of authors

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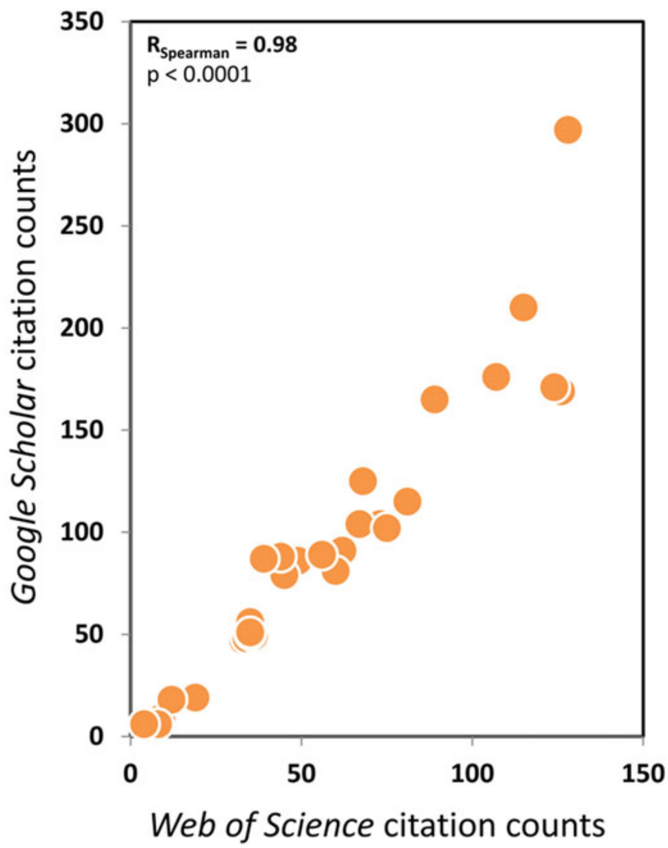

Fig. 16. Correlation between *Web of Science* and *Google Scholar* citation counts for the 30 most frequently cited papers published in *The Lichenologist* between 2000 and 2019 (see also Table 3). In colour online.

increases immediate distribution of a paper through multiple networking.

The contribution of individual papers to the highest achieved impact factors in 2014 and 2017 was further investigated by recording the citation numbers for all papers between 2012 and 2013 and between 2015 and 2016 in *Web of Science* and *Google Scholar*. Among these, five papers were identified with high citation counts, translating into individual impact factors between 6.56 and 12.38 (Table 3). These included broad-scale revisions and global keys to species-rich groups (Aptroot 2012; Aptroot & Lücking 2016), phylogenetic reclassifications of higher taxa including commonly studied genera and species, such as the former family *Lobariaceae* and the *Trypetheliaceae* (Moncada *et al.* 2013; Lücking *et al.* 2016*b*), and implementation of novel methods (Bates *et al.* 2012).

A survey of citation counts and corresponding individual impact factors among all papers published in *The Lichenologist* between 2000 and 2019 revealed a concentration on certain topics largely matching the above (i.e. large-scale revisionary works with keys, phylogenetic reclassifications, and novel methods including next-generation sequencing and phylogenomics), but also including papers on ecology and ecophysiology, photobionts, secondary chemistry, and particularly on environmental change and using lichens as biomonitors (Table 3). The paper with the highest individual impact factor based on *Web of Science* citation counts was an innovative study on the influence of different forms of precipitation on the ecomorphology and niche preferences of epiphytic lichens (Gauslaa 2014). Among the most frequently cited papers from Peter's early days as senior editor of the journal are three on air pollution and lichen biomonitoring focusing on Europe and the Netherlands, spearheaded by Kok van Herk (van Herk 2001; van Herk *et al.* 2002, 2003), and one performed in the United Kingdom (Wolseley *et al.* 2006). These included the work with the highest individual impact factor based on *Google Scholar* citation counts (van Herk *et al.* 2002). In a classic study, Helms *et al.* (2001) surveyed the phylogenetic diversity of photobionts in *Physciaceae* (including the subsequently separated *Caliciaceae*) using the ITS marker. Reference papers directed at a broad audience, such as the '*Proposal for a standardized nomenclature and characterization of insoluble lichen pigments*' by Meyer & Printzen (2000) also received much attention, as did another ecological study on the elevation gradient of species richness of lichenized fungi in Nepal, and its variation depending on growth form, photobiont and substratum (Baniya *et al.* 2010).

The mean number of authors of the 30 most frequently cited papers was 5.1, significantly above the overall average for the publication period, thus supporting the correlation between journal impact factor and mean number of authors per paper per year outlined above. The data also showed a strong and highly significant correlation between citation counts derived from *Web of Science* and *Google Scholar*, with the latter being consistently higher (Fig. 16). While *Web of Science* only counts indexed journals and hence underestimates real citations, *Google Scholar* probably overestimates citations due to inaccuracies in the algorithms that catalogue scientific publications and the references listed therein (Falagas *et al.* 2008; Fagan 2017). Thus, the true citation count is somewhere in between.

Conclusions

The present meta-analysis is the first of its kind in terms of scope and detail performed for any scientific journal for a prolonged period of time, in this case documenting the scientific output and impact of lichenological research published in *The Lichenologist* during the past two decades. The data illustrate why *The Lichenologist* has become the flagship journal of lichenology, with this status reinforced under Peter D. Crittenden's tenure as senior editor. Peter has not only modernized the journal in both layout and content, but has also successfully implemented adjustments necessary in a changing publication landscape, with a shifted focus towards broader-impact papers, discouraging so-called 'least publishable units', in particular 'single naked species descriptions' (SNSD), in favour of publication models that incorporate individual findings into more inclusive studies. While Peter has paid attention to impact factor as one important measure to increase the prominence of the journal, he has never lost sight of the fact that *The Lichenologist* is first and foremost an outlet to publish high quality research in all fields of lichenology and that taxonomy remains the core of lichenological research. It is therefore no surprise that lichenologists across the world continue to consider *The Lichenologist* as their first choice for publishing.

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