Environmental Microbiology: A Database Coverage Study

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The purpose of this study was to compare database coverage in the area of environmental microbiology. Journal titles important in the subject were identified and checked for coverage in relevant databases. A random sample of journal citations from *Environmental Microbiology*, a key journal in the area, was checked for coverage in eight databases. *Web of Science* found the highest number of references in the sample whereas *Scopus* found the second highest number of references. Subject-specific databases covered a large portion of the references in the sample but were not as comprehensive as the interdisciplinary databases.

Environmental microbiology, database coverage, overlap studies, Indexes and abstracts

INTRODUCTION

One of the duties of an academic reference librarian is to provide advice to students and faculty on which databases to search for a particular subject. While key databases for some topics can be easily identified, it can be more difficult to identify databases for interdisciplinary topics. The problem of identifying appropriate databases is not new. Carol Tenopir's (1982b) statement in her 1982 article is as valid today as when it was written over 20 years ago:

"As the number of publicly available bibliographic databases continues to grow, it becomes increasingly difficult for a searcher to select the most appropriate databases for any given search topic. The searcher faces the task not only of deciding which databases are of the most potential relevance, but also of deciding how many databases should be searched to get adequate recall of citations".

Tenopir's statement was made at a time when librarians acted as search intermediaries using database systems such as DIALOG. With the proliferation of more user-friendly web databases the librarian's role as a search intermediary has disappeared in most academic libraries but the ability to refer users to an appropriate database is still just as important. In some instances good coverage of a topic necessitates searching more than one database. Hood and Wilson's (2001) study found that references were scattered across many databases for some topics while in other instances a smaller number of databases was needed to provide good coverage of the topic.

Criteria that are used to decide on the appropriate database may include several different factors such as years of coverage, unique features like citation searching, inclusion of formats in addition to journal articles such as book chapters or patents, journal coverage, indexing features such as subject headings and/or the ability to explode thesaurus terms, and search features unique to a search interface. Some of the criteria are fairly easy to identify from database descriptions or database help files. Comparison of database journal coverage can be more difficult however as it requires knowledge of the journals important in the field, which may not be known to the librarian or student.

The purpose of this study was to determine the database coverage for the core journal literature of environmental microbiology. Environmental microbiology as defined in the *Dictionary of Environmental Microbiology* is "the study of microorganisms that grow in or contaminate the environment" (Stetzenbach and Yates 2003). Environmental microbiology, like other environmental topics, is quite interdisciplinary and covers subject areas such as aeromicrobiology, agriculture and soil microbiology, biogeochemistry, bioremediation, biotechnology, food quality, microbial production of proteins, microbial mediated recovery of oil and metals, wastewater treatment, and water quality (Maier, Pepper and Gerba 2000).

The field of environmental microbiology began in the early 1970's with the primary focus being in the area of water quality (Maier, Pepper and Gerba 2000). Since that time the subject area has expanded and in the 1990's more researchers from a variety of disciplines started to be attracted to the subject area (Timmis and Stahl 1999).

In 1999 a journal devoted specifically to environmental microbiology was started, signaling an increased interest in this multidisciplinary area.

LITERATURE REVIEW

Journal coverage studies have been conducted long before electronic databases existed. Gluck (1990) includes a useful review of some of the earliest attempts at determining overlap of journals in abstracting and indexing sources.

Several different approaches have been used to examine database coverage for a large variety of topics. One method is to compare the number of results based on a subject/keyword search. Due to the large amount of work involved most of the studies only examine the numbers of citations retrieved but do not look at the number of duplicates that exist between the databases. Brettle and Long (2001) however, recorded the database source for each citation in their study of databases on the topic of rehabilitation of people with severe mental illness. They also identified unique papers retrieved by each database and expressed the overlap between pairs of databases.

Another method of evaluating database coverage is to compare lists of journals indexed by each database. Kawasaki (2004) compared a core list of journals in agriculture with lists of journals indexed for each database. Hass, Lee and Battiste (1999) compared the indexing coverage of journals identified as core on the serials list of *Ecology Abstracts*. The journal name and year of publication were searched and the number of articles from each year and journal were compared in each database.

Other researchers have compared the references cited in a bibliography or references selected in journals representative of the field. Walters and Wilder (2003) created their own bibliography for their study by first searching for the later-life migration literature on several databases and then evaluating each article based on six criteria. When the bibliography was finished, 12 databases were searched for all of the articles identified.

Lascar and Mendelsohn (2002) also used a variation on the bibliography approach by looking at the publications of scientists working in the area of structural biology at the New York Structural Biology Center from 1995 to 2000 and then determined which database covered the largest number of publications. Chapman and Brothers (2006) identified references in selected journals representative of the field to use for their bibliography.

Other studies have made use of database systems such as DIALOG to conduct database comparisons. DIALOG has a duplicate detection feature that is useful to determine database overlap. Hood (1998) used a subject term search and developed his own duplicate detection algorithms to improve on the DIALOG duplicate detection feature but found that this method was very time consuming. In Hood and Wilson's 2001 study they made use of DIALOG's DIALINDEX and Duplicate Detection feature to study database overlap for fourteen different search statements. Jacso (1998) also searched DIALOG and used DIALOG's advanced commands including the Journal Name Finder feature, DIALINDEX, OneSearch, Rank, IDO (Identify Duplicates Only) and RD (Remove Duplicates Only) to compare coverage of library and information science serials in six databases.

Tenopir (1982b) compared the bibliography method vs. the subject profile method of comparing database coverage by searching two databases in DIALOG. She found that both methods gave the same general conclusions but that the bibliography method was much more costly because of the time required to search a random sample of citations on DIALOG. Tenopir also stated that the two methodologies do not test the same thing. The bibliography method, which makes use of cited references, may reflect certain biases of the author such as biases against foreign language material. In the bibliography method the references included have been judged as to quality whereas the subject-based approach does not take quality into account.

One of the problems with a subject-based approach is that the databases chosen may cover different time spans, different types of publications and may have different indexing policies such as subject headings or keywords that may affect retrieval unless only title words are searched. If actual article duplicates are not examined it is not known how many articles are unique. Another problem identified by Jacso (1998) is that some databases may even have duplicate records in a single database. He found that a test sample of the ISA database had a 6 % average duplication rate. While problems identified in this particular database may not present themselves in other databases, it is a factor to consider when looking at the number of articles retrieved.

If only lists of journals indexed by each database are compared, selective versus complete indexing of each journal may not be identified. Jacso (1998) also discovered that some journal titles identified as core in the *ISA* database were not fully covered due to late start of coverage, early coverage, shallow coverage or uneven coverage.

A useful summary of previous studies that compare database content by subject was included in Walters and Wilders' (2003) study. Several different subjects have been studied but environmental microbiology or any microbiology topic has not been examined. Some studies of overlap in environmental databases have been conducted. Miller (1981) used DIALOG to search three environmental databases for different keywords/concepts and results were checked for duplicates to get an indication of the amount of overlap between the databases but none of the concepts represented topics related to microbiology. Yska and Martyn's (1976) environmental databases study looked at databases and abstracts available during 1976. They used a broad subject-based search for several different environmental topics. Topics were searched in 46 different environmental databases. The number of postings for each of the topic areas was noted for each database. The actual amount of overlapping articles was not examined.

METHODOLOGY

A subject-based methodology was not considered for this project due to the wide variety of potential terms that would be needed to provide an adequate representation of the topic. Instead, it was decided to base the database comparison on coverage of core journals and searching a random sample of citations from a key journal in the field.

The core journals were identified using the methodology developed by Schloman (1997) with some modifications. Schloman's methodology is being used in the Mapping the Literature of Allied Health project which is designed to identify the core journals of various allied health fields and to assess the coverage given these titles by the major indexing and abstracting services. Allen, Jacobs and Vieira (2003) have also adapted this methodology for the nursing literature.

Schloman (1997) identifies key journals in the field to be studied either by using a standard bibliography or an official journal of an association representing the field. Three journals representative of the field are selected and all cited references in each source article are recorded for a three-year period. The cited reference data is sorted by journal title so that the articles are sorted from the highest number of citations to the lowest. The cited references are then divided into three zones. Three zones are marked off so that each zone equals approximately the same number of references. The division of the cited references into three zones is based on Bradford's (1948) work in which he found that a small number of journals yielded a large percentage of the citations in the field (zone one). The second zone contains a larger number of journals of moderate productivity and the third zone has even more journals that are less important to the field.

For this study, references from only one journal, *Environmental Microbiology,* were used to identify core journals in environmental microbiology. *Environmental Microbiology* is selected from a list because it focused on the subject of the studybecause it focused on the subject of the study. Rather than manually entering the references, all the references were downloaded from *Web of Science* and sorted using Microsoft Excel. Schloman (1997) also recommends using citations for a three-year period. For this study references from a longer time frame, 1999 (the first volume) to March 2006, were used since only one journal was included as a source journal.

After the cited references were downloaded into Excel, references to journal articles only were selected by looking at only those citations with volume numbers. Since some multi-volume monographs were included, some verification was done to distinguish the monograph citations from journal citations. In-press journal articles were not included as complete volume and page number information were not available. The journals were then sorted by title and examined to find variations in the abbreviated journal titles. The Data Subtotal function in Excel was used to subtotal each journal title and then the titles were sorted by decreasing frequency. A total of 31,473 citations to journal articles were examined and divided into three zones, representing approximately the same number of references. The journals located in Zones 1 and Zone 2 were examined to see if there were any title changes and the citation counts were applied to the most recent title. The journals were then resorted according to citation frequency with the most recent title including counts of the previous title changes.

Journals in Zones 1 and 2 were considered to represent the core journals in the field. Five journals in Zone 1 and 31 journals in Zone 2 were identified using the above methodology (see Table 1 and 2). These 36 journals contained two-thirds of the articles cited.

[Insert Table 1 and 2 here]

The core journals were then checked in twelve databases which were chosen based on the subject coverage of the databases, indexing sources for the journal *Environmental Microbiology* that were listed in *Ulrich's Periodical Directory*, and databases identified in Yska and Martyn's (1976) environmental databases study. The method used to determine the journal coverage varied depending upon the type of information available. Lists of journals indexed were examined on publishers' web sites. Many of the lists indicated journals that were indexed cover-to-cover. If the lists did not indicate if a journal was indexed cover-to-cover the number of articles available in the database for 2004 was compared to the number of articles listed in 2004 *Journal Citation Reports*.

A random sample of citations was also drawn from the citation lists from *Environmental Microbiology* that were downloaded from *Web of Science* to develop the core journal list. Citations to journal articles only from 1985 to the present were selected as all the databases included references from that time period. A total of 28,318 references to journal articles from 1985 to 2005 were obtained. A random sample of 379 citations was selected from the Excel file of citations. This sample size represents a confidence level of 95 percent and a confidence interval of plus or minus 5 percent. Random numbers were generated by using the Research Randomizer (www.randomizer.org) and these numbers were used to select citations from the matching line number in the Excel file. Any duplicate citations were replaced by the next citation in the reference list (6 duplicates were in the total random sample). Citations from the random sample were checked in the eight databases that indexed the highest number of core journals.

RESULTS

Core Journal Coverage

The number of core journals indexed and number of journals indexed completely were determined for twelve databases (See Table 3).

[Insert Table 3 here]

Table 4 summarizes the number of journals indexed and the number of journals indexed completely for each database. Based on the number of journals indexed completely, *Web of Science* indexes the highest number of core journals. *Scopus* offers the next best coverage for journal articles as 35/36 journal titles are indexed and according to SCOPUS's *Content Coverage* (2006) document, all research articles from 1996 to the present are indexed completely. Indexing coverage of journal articles before 1996 may not be as complete. The other databases indexed a large percentage of the titles in question but the number of journals indexed completely was not a high.

[Insert Table 4 here]

Random Sample

A random sample of citations from the journal, *Environmental Microbiology,* was selected and checked in eight databases that had the greatest potential based on the number of journals indexed and number of titles indexed completely. Since some of the more multidisciplinary journals were selectively indexed by some of the databases, it was not possible to determine how well these databases selected environmental microbiology articles. This approach is similar to the methodology developed by Chapman and Brothers (2006) in their database overlap study of management information systems. They compared journals indexed in various databases combined with checking a random sample of citations selected from three journals.

The citations from the random sample were searched in those databases covering the highest number of journals in the subject: *Biological Abstracts*, *BIOSIS Previews*, *CAB Abstracts*, *CAplus*, *Environmental Sciences and Pollution Management Abstracts*, *MEDLINE*, *Scopus* and *Web of Science*.

Table 5 summarizes the results of checking the random sample in the eight databases included in this portion of the study.

[Insert Table 5 here]

The *Web of Science* database provided the highest coverage of the random sample of citations with 99% of the citations being covered by the database. Since *Web of Science* covered all of the journals identified in the first part of this study and all of the journals were indexed cover-to-cover, it was expected that this database would include a large percentage of the articles. However, the sample also included several journals not listed in the first part of the study. Eighty-three unique journal titles and a total of 133 articles from Zone 3 were included in the random sample. Since *Web of Science* does not aim to be all inclusive, it is surprising that so many of the Zone 3 titles were also indexed and were not included in some of the other databases.[31]

Scopus, another inter-disciplinary index, had the second highest number of citations found (95%). This result is somewhat surprising as several articles published before 1996 were included in the study and the indexing coverage of articles prior to 1996 in *Scopus* is not as complete as after 1996.

BIOSIS Previews database covered 90% of the random sample. *BIOSIS Previews* includes the information from *Biological Abstracts* as well as reports, meetings and review articles. One of the reasons for the lower coverage of journal citations is that articles from *Environmental Microbiology* were not indexed by *BIOSIS Previews*. If these articles were indexed, coverage would have increased to 93%, still lower than *Web of Science*.

CAplus had the fourth-highest count of citations found at 84%. The high percentage of available citations from *CAplus* might seem unusual to people who are unaware of the broad coverage of this database but *CAplus*'s policy of indexing almost anything related in some way to chemistry appears to be the reason for the high retrieval rate.

Eighty-three percent of the citations in the random sample were indexed by *Biological Abstracts*. Since *Biological Abstracts* has a policy of not covering review articles some of the citations not covered by this database would be in this category. In addition, twelve citations in the sample were to articles in the journal *Environmental Microbiology* which is not indexed by *Biological Abstracts*.

Seventy-eight percent of the citations in the sample were found in *Environmental Science and Pollution Management Abstracts* (ESPM). The poorer coverage by *Environmental Science and Pollution Management Abstracts* (ESPM) was surprising. The lower percentage can be explained partially by the fact that the random sample included several citations to the journal *Environmental Microbiology* which although it is now covered by *ESPM Abstracts* and is considered to be a core title, coverage appears to have started only in 2003 and retrospective articles have not been indexed. The random sample also included several citations to multidisciplinary journals such as *Nature*, *Science* and *Proceedings of the National Academy of Sciences of the USA* (PNAS) which are only indexed selectively in *ESPM Abstracts*. While it is understandable that articles from these journals would not need to be indexed cover-to-cover, it appears that articles of potential interest to environmental microbiology are being missed. Two of the thirteen articles from *Science* and 5 out of 11 articles in *Nature* were not indexed. Coverage of articles from *PNAS* was better with 10 of the 11 articles available in the database. Another journal title that appeared in the random sample but was not indexed by *ESPM Abstracts* was *Nucleic Acids Research*. Thirteen articles in the sample were from this journal but they were not indexed by *ESPM Abstracts*.

MEDLINE covered 69% of the citations in the sample which was higher than expected since some areas of environmental microbiology are not necessarily health related. One of the reasons that *MEDLINE* covered such a high percentage of articles was likely due to the fact that some of the highly-cited journals including *Applied and Environmental Microbiology*, *Journal of Bacteriology*, *FEMS Microbiology Ecology* and *Environmental Microbiology* are fully indexed by the database.

CAB Abstracts only covered 29% of the articles in the sample. While the coverage of the sample was not high, this database covered more citations than the author expected, since only two journals in the Zone 1 and 2 list were completed indexed. While all areas of environmental microbiology would not be covered by this database, this database could be used to find articles more related to agricultural aspects of environmental microbiology.

Three references out of 379 checked were not found in *Web of Science*. One of these references could be found in either *CAplus*, *Biological Abstracts, BIOSIS Previews* or *Scopus*. *Environmental Science and Pollution Management (ESPM) Abstracts* and *MEDLINE* found one other citation not included in *Web of Science*. One citation was not indexed by any of the databases in the study.

Since the indexing data for each citation was entered into Microsoft Access, it was possible to generate results based on combinations of databases. Table 6 indicates the number of references found in pairs of databases (excluding Web of Science) that located at least 90% of the citations. *Scopus* combined with *BIOSIS*, *Biological Abstracts* or *ESPM Abstracts* found between 97 and 98 percent of the articles in the sample. If *Scopus* or *Web of Science* was not available, a combination of *CAplus* with *BIOSIS*, *ESPM Abstracts* or *Biological Abstracts* would find more than 95% of the articles. Similarly, if both *MEDLINE* and *BIOSIS Previews* were searched, 96 percent of the articles would be found. *ESPM Abstracts* combined with either *Medline* or *Biological*

Abstracts increased the coverage from 78% in *ESPM Abstracts* to over 91%. *CAplus* combined with *CAB Abstracts* increased the percentage of articles found from 84% in *CAplus* to 91%. Ninety-one percent of the articles would be also be located if *SciFinder Scholar*, which includes *CAplus* and *Medline*, was searched.

[Insert Table 6 here]

Forty-three percent (162/379) of the random sample were listed in all the databases included in the second portion of this study with the exception of *CAB Abstracts.* A large overlap existed between *Web of Science*, *Biological Abstracts, BIOSIS*, *Scopus* and *CAplus* with 262/379 (69%) of the citations in the random sample being covered by any of these five databases. Seventy-one percent of the articles found in *CAplus* were also indexed in *Biological Abstracts*. Since the *BIOSIS* database covered a few more articles than *Biological Abstracts*, the percentage of overlapping articles was also greater at 77 percent.

DISCUSSION

The results of the study were unexpected as *Web of Science* is selective in adding journals to their database. *Web of Science* indexes 8,830 journals, of which approximately 5,900 come from *Science Citation Index Expanded*. Since *Science Citation Index* covers all fields of science, only the highest-cited journals are included in the database. In contrast, *Biological Abstracts* covers over 5,000 journals and *Environmental Sciences and Pollution Management Abstracts* indexes over 6,000 journals. Since these subject-specific databases cover more journals in life sciences and environmental sciences respectively it was assumed that they would have better coverage of environmental microbiology. In addition, Bradford's law of scattering has been shown to apply to databases as well as to journal articles so it was expected that more unique references would be scattered throughout the databases in the study (Tenopir, 1982a).

Most database overlap studies in the literature, albeit with a different methodology, have found that more than one database is needed to get good coverage of a topic. Some of these studies searched a subject term to find the number of postings in different databases and did not exclude non-journal material. Useful summaries of previous database overlap studies can be found in Gluck (1990) and Hood and Wilson (2003). A subject approach would usually find unique material if the comparison database included other source material in addition to journal articles.

Some other researchers have looked at a random sample of journal citations or have prepared a bibliography of citations to be checked in several databases. For instance, Walters and Wilder (2003) created their own bibliography of later-life migration by searching several databases and then refining the list of citations according to six criteria in order to find the most relevant studies. A total of 155 citations to journal articles were then searched in 12 databases. They found that the multidisciplinary databases included in their study of this interdisciplinary area provided better coverage than single-subject databases. The highest proportion of literature on later-life migration was indexed by *Social Sciences Citation Index* (part of *Web of Science*) at 73%. While the *Web of Science* in Walters and Wilder's study covered the highest proportion of citations, the percentage found was not as high as in this study. Chapman and Brothers (2006) also looked at a random sample of citations in a different subject area, management information systems. They found that *Web of Science* retrieved 58.8% of the random sample. The highest coverage of citations was a combination of *Business Source Premier* with *Web of Science* which provided 82.4 percent of the sample citations.

In contrast, Robert Poyer's (1984) comparison of journal article overlap among *Index Medicus*, *Science Citation Index*, *Biological Abstracts* and *Chemical Abstracts* did however, find a much higher percentage of his sample in *Science Citation Index*. He searched references from a total of 70 dissertations from seven preclinical science disciplines affiliated with medical schools. References from ten dissertations for each subject area were examined and searched in the indexes included in his study. A total of 7,969 references were included in the study with 1,436 from microbiology dissertations. Although the microbiology dissertations would not necessarily focus on the same areas as environmental microbiology, it is interesting to note that *Science Citation Index* provided the highest coverage by indexing 96.7% of the cited references. Lascar and Mendelsohn (2002) also found that *Web of Science* provided the highest number of journals published by researchers working in the area of structural biology in comparison to *PubMed* and *Biological Abstracts.*

Different results might become apparent if Zone 3 journals were looked at in more detail. Although the random sample did include Zone 3 titles, it would be interesting to see if a random sample consisting only of Zone 3 journal citations would get a similar result. Zone 3 journal citations are characterized by a large number of different journal titles with a small number of citations to each journal. While the journals listed in the third zone for environmental microbiology might include highly-cited journals from another field, it is also possible that the journals in this zone would tend to have fewer citations overall. Therefore Zone 3 articles might not be indexed by *Web of Science* as this database focuses on journals with the highest citation counts.

CONCLUSION

This study compared the coverage of journal articles in environmental microbiology for various databases. The two interdisciplinary databases, *Web of Science* and *Scopus*, indexed the highest number of journal articles in this study. Although *Web of Science* indexed the highest number of journal articles, this database does not index other material such as book chapters, patents or conference proceedings which are included in some of the other databases in the study. These factors would have to be taken into account when recommending a database to search. Additional features that would make retrieval easier such as the presence of controlled subject headings, which again are not present in *Web of Science,* would also have to be considered.

It appears that *Web of Science*'s policy of indexing journals cover-to-cover provides an advantage for the area of environmental microbiology and presumably other interdisciplinary topics. Some of the journals included in the random sample and identified as core journals were multidisciplinary titles such as *Nature*, *Proceedings of the National Academy of Sciences of the United States of America* and *Science* which publish articles on a wide variety of topics. The subject-specific databases were more selective in their coverage of articles from these journals which affected the percentage of articles found. Databases that index selected articles that fit their selection profile may not always cover all of the articles that might be of interest for some interdisciplinary subjects.

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