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Guest editorial

How well is *Environmental Biosafety Research* supporting the scientific debate on the biosafety of genetically modified organisms (GMOs)?

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One of the most direct routes to informing scientific debates is through the timely publication of relevant research results. By making a comparison of the number and type of articles published by *Environmental Biosafety Research* (*EBR*) with those from other journals active in the arena of GMO biosafety, it is possible to shed light on the answer to the question posed in the title. To do this, we have used a unique open access online tool, the Biosafety Bibliographic Database (BBD) that has been provided by ICGEB since 1990. As of June 2007, the BBD contained 6694 records pertaining to scientific publications (full references and abstracts), and appearing in international and national scientific periodicals and books. Based on the records in the BBD, biosafety research activity over the past 16–17 years can be summarized by analyzing basic statistics. The BBD should prove to be a useful starting point for diverse bibliometric studies of publications in this area.

THE BIOSAFETY BIBLIOGRAPHIC DATABASE (BBD)

Since the inception of the BBD (http://www.icgeb.org/biosafety/bsfdata1.htm) in 1990, ICGEB has been facilitating access to scientific literature relevant to GMO biosafety. The records are provided by CAB International on a contractual basis, and are the result of an automated, keyword-based search of the expansive CAB Abstracts database (http://www.cabi.org/datapage.asp?iDocID=165). This latter database is described by CABI as "*the most comprehensive bibliographic, abstracting and indexing database in the applied life sciences. CAB Abstracts covers more than 9000 sources from over 150 countries in over 50 languages, including all the core peer-reviewed journals and a large number of other titles, including books, conference proceedings and serials from developing countries*" (J. Halsall, CABI, pers. comm.). Prior to uploading to the BBD, the monthly update from CABI is screened and classified by scientists in the ICGEB Biosafety Unit to ensure that each record will contribute to the various scientific debates arising from the commercial release of GMOs. Any record not meeting precise selection criteria is discarded to ensure the validity of the information ultimately provided. The full-text version of each record can be obtained either by following the provided DOI link to the specific article on the periodical website and downloading directly (especially for those users with individual or institutional online access), otherwise contact e-mail and postal address details are supplied for each corresponding author. The BBD is also fully accessible through the Biosafety Clearing House of the Convention on Biological Diversity (http://bch.biodiv.org/default.aspx), and is consistently the most visited section of the entire ICGEB website, currently receiving an average of 17 000 visits per month. In addition, new records to the BBD are distributed by e-mail to freely subscribed users on a monthly basis.

BIOSAFETY RESEARCH PUBLICATION ACTIVITY

A simple plot of the number of records in the BBD published per year shows a relatively low number of records over the first 10 years (Fig. 1A), reflecting the fact that biosafety research *per se* was still in its infancy. These early years are then followed by a sharp increase from 2000 onwards, approximately 18 years after transgenic plants were first being created in the laboratory, and

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four years after significant commercial cultivation of GM crops began. It should be noted that some part, if not all, of the decrease since 2004 is due to the delay in processing by CABI, particularly for journals in foreign languages.

By taking advantage of another feature of the BBD, it is possible to discover which broad biosafety themes are of greatest interest. Every record in the BBD has been categorized into one (or more) main area(s) of biosafety research (see http://www.icgeb.org/biosafety/bsfconc.htm). These include:

- **health impacts**, including toxicity and allergenicity issues in GM food/feed safety;
- **environmental impacts** such as transgene persistency, susceptibility of non-target organisms, changes to ecological fitness and biodiversity;
- **agricultural impacts**, involving resistance development in target organisms, changes in agricultural practices due to pest or weed management requirements;
- **general concerns** associated with GMO regulation, detection and traceability, labeling, risk analysis, monitoring, public attitudes and socio-economic issues;
- **horizontal (trans)gene flow**, primarily through either pollen or seed dispersal and transgene uptake and recombination by various micro-organisms, which is dealt with as a separate case in the BBD, primarily for historical reasons.

When annual data of these categories are plotted (Fig. 1B), the overall shape of the graph is very similar to that of Figure 1A. The sharp increase in the number of publications from 1999 onwards appears mainly to stem from overall increases in publications discussing general concerns, environment and health issues. Publications dealing with 'Transgene flow' have remained fairly stable over the years, whereas 'Agriculture' has declined after an initial increase during the first six years. The predominance of the 'General concerns' category is hardly surprising considering the vast range of topics that fall within it, each of which can be considered a "hot topic" in recent years. This has also coincided with the various on-going international and national discussions regarding the Cartagena Protocol on Biosafety (CPB; http://www.cbd.int/biosafety/default.shtml) which came into force in 2003, for example the development and implementation of national biosafety regulatory frameworks, the consistent anti-GMO activity by particular non-governmental organizations significantly impacting public perceptions and raising specific socio-economic concerns, as well as attempts within the international community to harmonize risk analysis procedures.

Amongst the rise in environmental and health publications are the notable articles by Ewen and Pusztai (1999) and Losey et al. (1999). Although each raised much public outcry at the time, they were both heavily criticized within the scientific community with regard to their experimental procedures, either for poor design or for the lack of sufficient realism, respectively. In their own way, they each played an instrumental role in stimulating ongoing scientific debates, the outcome of which has been a large number of publications dealing with not only possible toxicological effects when GM crops are consumed by animals or humans, but also possible changes to ecological biodiversity from their cultivation.

THE PERFORMANCE OF *ENVIRONMENTAL BIOSAFETY RESEARCH* (*EBR*) AS SEEN THROUGH THE BBD

The top 20 periodicals were tabulated for the period of 1990 to June 2007 and ranked according to the overall number of publications from each that are present in the BBD (Tab. 1). Only periodicals were considered, *i.e.* conference proceedings and individual books were removed as they were generally "one-off" publications, even if they comprised copious chapters/abstracts that constituted numerous individual records. As reflecting the recent interest in biosafety research, nine out of the top 20 periodicals published their first issue after 1990, with the *EBR* obtaining a rank of third overall, a relatively high rank for the newest journal in the table. It is outranked only by two other journals, *Nature Biotechnology* and the *Journal of Economic Entomology*, each of which has been active for at least 10 years.

If the statistics on the average number of publications relevant to biosafety per year are considered instead, *EBR* then increases in rank to first place, followed by the *Journal of Economic Entomology, Nature Biotechnology*, and *Environmental Entomology*, respectively. Also, if the periodicals are re-ranked based on the period of issue for the *EBR* (*i.e.* 2002–2007), then the *EBR* once more comes out on top. Eight periodicals have an improved ranking for 2002 onwards, two even making it into the top five: *Environmental Biosafety Research* (#1) and *Bulletin OILB/SROP* (#5). Six of the overall top 10 journals have lost ground since 2002, most notably *Nature Biotechnology*, *Transgenic Research, Molecular Ecology, Theoretical and Applied Genetics, Proceedings of the National Academy of Sciences of the United States of America*, and *Applied and Environmental Microbiology.* Three of the periodicals that fell out of the top 20 ranking after 2001 include the prestigious journals *Nature* and *Science*. Overall, this may imply that biosafety research has now developed sufficient momentum that specialized journals are being targeted by scientists for publication purposes,

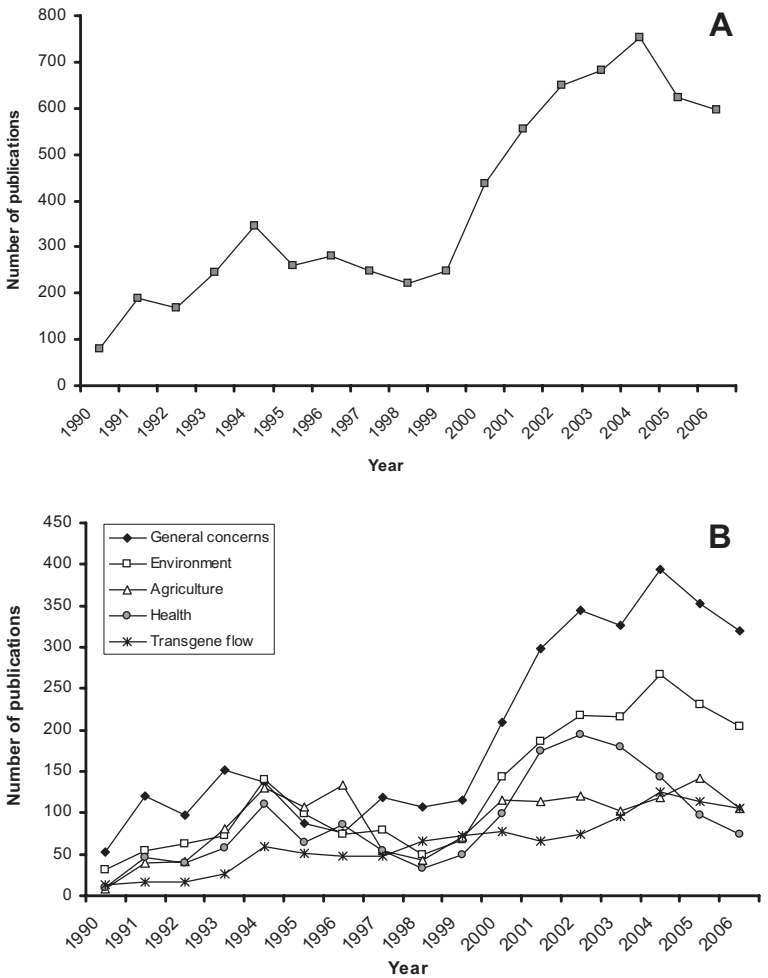

Figure 1. Number of scientific publications per year in the BBD (A). Number of scientific publications per category per year in the BBD (B). Only completed years are represented *i.e.* data is correct as of June 2007, and is presented for the period 1990–2006 only; no data for 2007 given. In addition, due to the time required to index publications, delays are incurred by CABI in forwarding relevant records to ICGEB, and it is therefore expected that the profiles of each year will increase as new records are received. This is particularly notable for years 2005 and 2006.

rather than more "all-encompassing" scientific periodicals. It will be interesting to see if this is reflected in the value of the impact factor to be assigned to *EBR*.

Returning specifically to *EBR*, it is also possible to plot the percentage coverage for each subject category, based on the total number of *EBR* publications present in the BBD, and to compare the coverage with the BBD as a whole (Fig. 2). The scope of *EBR* is to publish articles focusing primarily on studies related to the biosafety of organisms intentionally or accidentally introduced into the environment, with special emphasis on those pertaining to analyzing any environmental impact as well as those less associated with field data (for example, GMO regulations and risk communication) that would usually be categorized in the BBD as 'Environment', 'Transgene flow' and 'General concerns', respectively. This therefore explains why these categories predominate *EBR*'s coverage as compared to the BBD as a whole, and why 'Agriculture' and 'Health' have been given a lesser priority.

CONCLUSION

Since its introduction in 2002, it would appear that *EBR* has quickly taken up a dominant position in disseminating the results of biosafety research to the wider global community. In order to maintain such an elevated position, it may be worth considering the expansion of its

Table 1. The first 20 periodicals, ranked by number of records, in the BBD (data correct as of June 2007).

Overall rank (1990–2007)	Title	# records (average # records/year[1])	First issue (year)	Rank[2] (≥ 2002)
1	*Nature Biotechnology*[3]	154 (8.6)	1983	4
2	*Journal of Economic Entomology*	115 (9.6)	1996	2
3	***Environmental Biosafety Research***	**77 (12.8)**	**2002**	**1**
4	*Transgenic Research*	70 (4.1)	1991	6
5	*Environmental Entomology*	66 (6.0)	1997	3
6	*Molecular Ecology*	60 (3.8)	1992	16
7	*Theoretical and Applied Genetics*	57 (3.2)	1929	=14
8	*PNAS*[4]	55 (3.1)	1915	11
9	*Bulletin IOBC/WPRS*[5] *(Fr. OILB/SROP)*	54 (3.0)	1971	5
10	*Applied and Environmental Microbiology*	49 (2.7)	1953	17
=11	*Journal of Agricultural and Food Chemistry*	46 (2.6)	1953	7
=11	*Trends in Biotechnology*	46 (2.6)	1983	18
=13	*AgBioForum*	43 (4.3)	1998	8
=13	*Nature*	43 (2.4)	1861	–
=15	*Molecular Breeding*	39 (3.0)	1995	10
=15	*OCL - Oleagineux, Corps Gras, Lipides*	39 (2.8)	1994	–
=17	*Acta Horticulturae*[6]	35 (1.9)	1963	20
=17	*AgBiotechNet*[7]	35 (2.2)	1992	13
19	*Science*	34 (1.9)	1880	–
20	*Crop Science*	33 (1.8)	1961	9

[1] The average number of records per year was calculated by dividing the number of records (# records) by the number of years the journal has been present in the database, *e.g.* those issued before 1990 were divided by 18 (1990–2007 inclusive), those issued after 1990 were divided by the number of years that the journal has actually been in print.
[2] Ranks were determined following the first issue of *Environmental Biosafety Research* in 2002. Only periodicals appearing in the overall Top 20 ranking are listed. '–': not present in Top 20 ranking for specified period.
[3] Previously published as *BioTechnology* and renamed *Nature Biotechnology* in 1996. Data collated from both sources.
[4] *Proceedings of the National Academy of Sciences of the United States of America*.
[5] *Bulletin of the International Organisation for Biological & Integrated Control of Noxious Animals & Plants: West Palaearctic Regional Section*.
[6] Each volume issued as a book.
[7] Published as review articles, and not as AgBiotechNet database entries.

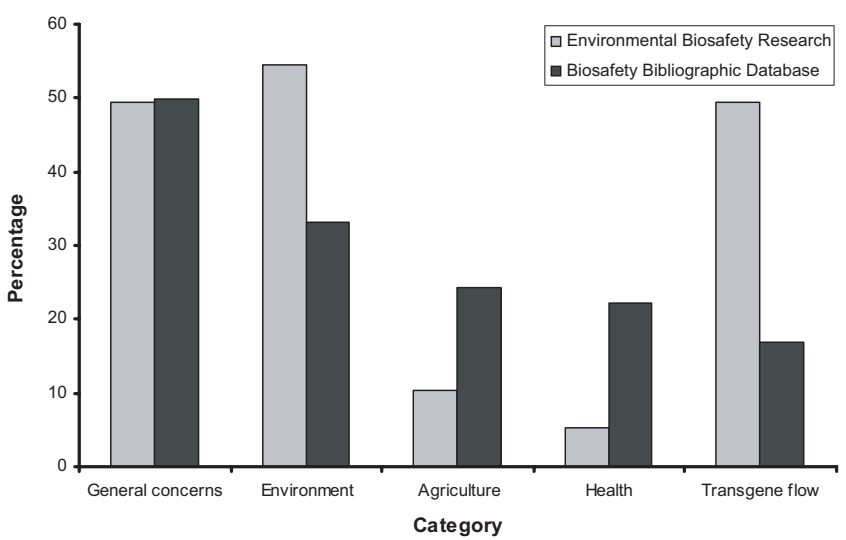

Figure 2. Comparison of the topic coverage between *Environmental Biosafety Research* (*EBR*) and the database as a whole (BBD). Each record can be pertinent to one or more categories, therefore total percentages are greater than 100 for each series.

coverage on health and agricultural issues, thus consolidating its role as a premier supplier of high quality GMO biosafety-related information.

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