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Bulletin of Mathematical Biology—Facts, Figures and Comparisons*

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The Society for Mathematical Biology (SMB) owns the *Bulletin of Mathematical Biology* (BMB). This is an international journal devoted to the interface of mathematics and biology. At the 2003 SMB annual meeting in Dundee the Society asked the editor of the BMB to produce an analysis of impact factor, subject matter of papers, submission rates etc. Other members of the society were interested in the handling times of articles and wanted comparisons with other (appropriate) journals. In this article we present a brief history of the journal and report on how the journal impact factor has grown substantially in the last few years. We also present an analysis of subject areas of published papers over the past two years. We finally present data on times from receipt of paper to acceptance, acceptance to print (and to online publication) and compare these data with some other journals.

HISTORY OF THE BULLETIN

The BMB was first published in March 1939 with the title *Bulletin of Mathematical Biophysics* as a supplement to the journal Psychometrika. The Bulletin was published in March, June, September and December and was devoted to publications of research in mathematical biophysics, as contributing to the physico-mathematical foundations of biology. The papers covered physico-mathematical theories as well as any other mathematical treatments of biological phenomena, with the exception of purely statistical studies or papers dealing with empirical

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equations. Description of experimental work also fell within the scope of the Bulletin provided that it made close comparison with the mathematical formulations developed in the same paper (Rashevsky, 1939). The Bulletin was sent free to all members of the Psychometric Society.

The *Bulletin of Mathematical Biophysics* was founded by Dr Nicolas Rashevsky, who is generally recognised as the founder of the first organised group in Mathematical Biology in the world. This group had been formed at the University of Chicago in 1947 as the interdisciplinary Committee on Mathematical Biology from the previous one on Mathematical Biophysics. The latter had been founded by Rashevsky in 1934 after obtaining a Rockefeller Fellowship on the basis of his many investigations of the mathematics of biological phenomena, in particular the effects of surface tension and diffusion drag forces during cell division, and nerve excitation (Bartholomay *et al*., 1972; Rosen, 1972).

The *Bulletin of Mathematical Biophysics* quickly became the classical journal in general mathematical biology and served as the principal natural publication outlet for the majority of mathematical biologists. Many classical papers have appeared in the Bulletin and several of these are familiar to biologists. It has become an important avenue for the exchange and transmission of new ideas and approaches to biological problems and incorporates both the quantitative and qualitative aspects of mathematical models and characterisations of biological processes and systems.

Dr Rashevsky remained the editor of the *Bulletin of Mathematical Biophysics* until his death on January 16th, 1972. During the last year of his life he founded *Mathematical Biology, Inc.* which became the publisher of the Bulletin. Dr Rashevsky owned *Mathematical Biology, Inc.* and acquired the ownership of the Bulletin as well. In June 1972, Volume 34, Number 2, he was succeeded by Herbert D. Landahl from University of California at San Francisco (Chief Editor), and George Karreman from University of Pennsylvania and Anthony F. Bartholomay from the Medical College of Ohio at Toledo working as co-editors.

In February–April 1973, Volume 35, Numbers 1–2, the *Bulletin of Mathematical Biophysics* was re-titled the *Bulletin of Mathematical Biology* and became the official journal of the recently incorporated Society for Mathematical Biology of which Dr Landahl was a co-founder [see, Conrad (1996), for a History of the Society]. The BMB continued to be published bi-monthly and the editorial policy remained the same as that of its predecessor, the *Bulletin of Mathematical Biophysics*. The annual dues for membership of the Society for Mathematical Biology were $25 which included a subscription to the Bulletin. Herbert D. Landahl continued as Chief Editor with Hugo M. Martinez as Assistant Editor until Volume 43, Number 6, 1981. Hugo Martinez took over as Chief Editor in Volume 44, Number 1, 1982 with Julie S. Ransom (The University of California, San Francisco) as Editorial Assistant. They retired in 1986, Volume 48, No. 3/4. Lee A. Segel from the Weizmann Institute of Science, Israel, became the first non-American editor of the Bulletin in Volume 48, No. 5/6, 1986. Lee Segel in his Editorial Announcement of Volume 49, No. 1, pp. i–iv, 1987 changed the scope of the journal to offer

the publication of research at or near the interface of theoretical and experimental biology. An ideal article for the Bulletin would be a symbiotic combination of theory and experiment. Lee Segel also welcomed papers providing documentation of a purely theoretical advance together with a clear exposition of how this advance furthers biological understanding. Philip K. Maini became the present editor in 2002, Volume 64, Number 1. As he mentioned in his Editorial (Volume 64, No. 1, p. 1), he took over as editor of the Bulletin at a very exciting time for mathematical biology. The advances made in molecular biology over the past three decades have resulted in the generation of a vast amount of experimental data. The need to understand this data requires the development and analysis of mathematical and computational models; this is increasingly recognised as a number of interdisciplinary centres have recently been set up for modelling in life sciences and more faculty positions are being advertised. This also confirms the great insight shown by those who set up and worked as editors for this particular journal, and it is reflected in the present position of the BMB in the Journal Citation Reports.

JOURNAL CITATION REPORTS

The Journal Citation Reports (JCR) is a comprehensive resource for journal evaluation from the Institute of Scientific Information (ISI)*. It is used by scientists, universities, research institutes, publishers and government to evaluate the impact of journals in the scientific community, and also to select preferred journals in which to publish. The JCR lists the highest impact journals, most frequently used journals, 'hottest' journals and largest journals. It uses citation data drawn from over 8400 scholarly and technical journals worldwide and the citations are collected from 1981. Coverage is both multidisciplinary and international, and incorporates journals from over 3000 publishers in 60 countries.

The most widely used index from JCR is the journal impact factor, which is a measure of the frequency with which the 'average article' in a journal has been cited in a particular year. The impact factor is calculated by dividing the number of current citations to articles published in the two previous years by the total number of articles published in the two previous years. This index helps to evaluate a journal's relative importance, especially when compared to others in the same field. In this report we show the JCR results for the BMB in the year 2002.

The trends in the impact factor show that the BMB has increased its impact from 0.980 in the year 1997 to 1.408 in 2002. In fact, the impact has been increasing from 2000 when it was 1.002 and 1.316 in 2001. The JCR gathers journals into subject categories for comparison with journals in the same field. The Bulletin

*ISI Journal Citation Report® is a product of the Thomson Corporation (http://www.isinet.com). It is delivered via Journal Citation Reports® on the Web (http://jcrweb.com) or via CD-ROM. The Web service for UK Education is http://wok.mimas.ac.uk.

Table 1. 2002 JCR statistics for mathematical journals with interdisciplinary applications to biology and medicine.

Rank	Abbreviated journal title	2002 total cites	Impact factor	Immediacy index	2002 articles	Cited half life
1	Bull. Math. Biol.	974	1.408	0.178	45	8.3
2	Math. Biosci.	1609	1.080	0.141	71	>10.0
3	Biometrics	7469	1.077	0.115	96	>10.0
4	J. Math. Biol.	1219	0.980	0.283	53	>10.0
5	Biometrika	6742	0.970	0.117	77	>10.0
6	IMA J. Math. Appl. Med. Biol.	215	0.658	0.333	3	7.5
7	Biometrical J.	287	0.250	0.071	70	8.0

is in two subject categories: 'Mathematics (Interdisciplinary Applications)' and 'Biology (General)'.

In the subject category 'Mathematics (Interdisciplinary Applications)', the BMB is ranked 7th in a list containing 30 journals, if the list is sorted by the impact factor. The top journals are *Econometrica* (2.737), *Journal of Computational Neuroscience* (1.855), *Educational and Psychological Measurement* (1.661), *Journal of Mathematical Psychology* (1.641), *Archive for Rational Mechanics and Analysis* (1.585). However, these journals are not strictly mathematical biology journals. The BMB is the top mathematical journal with interdisciplinary applications to biology and medicine. We show this in Table 1.

In the subject category 'Biology (General)', the BMB is ranked by impact factor in 21st position out of 62 general biology journals. The top journal on this category is *Bioessays* (7.888), followed by *FASEB Journal* (7.252), *Biological Reviews* (5.730), *Quarterly Review of Biology* (5.200), *Philosophical Transactions of the Royal Society of London Series B—Biological Sciences* (3.410). There are only two journals above the BMB which accept mathematical biology papers (see Table 2), these are the *Proceedings of the Royal Society of London Series B—Biological Sciences* (3.396), now known as *Proceedings: Biological Sciences*, and the *Journal of Theoretical Biology* (1.552).

Note that in Tables 1 and 2 we show other indices. Citation and article counts are important indicators of how frequently current researchers are using individual journals. By tabulating and aggregating citation and article counts, we can gain another perspective for journal evaluation and comparison. Citation counts acknowledge previously published research, publicly recorded in the references listed by contemporary authors. This is measured by the **2002 total cites** column in the ranking tables. It indicates the total number of times that each journal has been cited by all journals included in the ISI database during the period 1981–2002.

The **2002 articles** column shows the number of articles published in each journal in 2002. In this index, editorials, letters and meeting abstracts are not included. The journal **immediacy index** is a measure of how quickly the 'average article' in

Table 2. 2002 JCR Statistics for general biology journals publishing mathematical biology papers.

Rank	Abbreviated journal title	2002 total cites	Impact factor	Immediacy index	2002 articles	Cited half life
1	Proc. R. Soc. Lond. B Biol.	12798	3.396	0.478	347	6.0
2	J. Theor. Biol.	7501	1.552	0.273	238	>10.0
3	Bull. Math. Biol.	974	1.408	0.178	45	8.3
4	Math. Biosci.	1609	1.080	0.141	71	>10.0
5	Biometrics	7469	1.077	0.115	96	>10.0
6	J. Math. Biol.	1219	0.980	0.283	53	>10.0
7	Biometrika	6742	0.970	0.117	77	>10.0
8	Biosystems	806	0.846	0.112	80	6.5
9	Comput. Biol. Med.	430	0.814	0.125	40	7.7
10	Theor. Biosci.	78	0.705	0.167	12	
11	IMA J. Math. Appl. Med. Biol.	215	0.658	0.333	3	7.5
12	C. R. Acad. Sci. III—Vie.[a]	1842	0.528		0	9.4
13	Acta Biotheor.	264	0.522	0.000	13	>10.0
14	J. Biol. Syst.	98	0.282	0.000	26	
15	Riv. Biol.–Biol. Forum	72	0.220	0.083	12	

[a] Statistics are incomplete because the journal was re-titled *Comptes Rendus Biologies* in 2002.

a journal is cited. The immediacy index indicates how often articles published in a journal are cited within the same year. It is calculated by dividing the number of citations to articles published in a given year by the number of articles published in that year. The immediacy index is useful for comparing how quickly journals are cited. This index tends to discount the advantage of large journals over small ones, because it uses a per-article average. However, frequently issued journals have an advantage, because an article published early in the year has a better chance of being cited than one published later in the year. For comparing journals specialising in cutting-edge research, the Immediacy Index can provide a useful perspective.

The **cited half-life** is the number of publication years from the current year which accounts for 50% of current citations received. This index evaluates the age of the majority of cited articles published in a journal. Only those journals cited 100 or more times have a cited half-life in the database. A higher or lower cited half-life does not imply any particular value for a journal. For instance, a primary research journal might have a longer cited half-life than a journal that provides rapid communication of current information.

JOURNALS CITING ARTICLES PUBLISHED IN BMB

The JCR also identifies those publications that most frequently cited a particular journal. These citation links can reveal a journal's subject orientation, point to its

Table 3. Number of citations to articles published in the Bulletin between 1981 and 2002. The table shows the citing journals and their rank.

Rank	Citing journal(s)	Number of articles cited
1	J. Theor. Biol.	41
2	Phys. Rev. E	32
3	Bull. Math. Biol.; Math. Comput. Model	24
4	J. Math. Biol.	22
5	Biosystems	18
6	Proc. Natl. Acad. Sci. USA	16
7	Bioinformatics; IMA V. Math.	15
9	Ecol. Model.	14
10	J. Comput. Biol.	12
11	Biophys. J.	11
12	Int. J. Bifurcat. Chaos; Network-Comp. Neural; SIAM Rev.; Z. Phys. Chem.	10
13	Am. Nat. Indian J. Pure. Appl. Math.; Lect. Notes. Comput. Sci.; Physica A	9
14	Ecology	8
15	Appl. Math. Comput.; Chaos, Solitons Fract.; Math. Biosci.; Math. Model Meth. Appl. Sci.; Nature; Neurocomputing; Proc. R. Soc. Lond. B Biol.; Physica D; Theor. Comput. Sci.	7
16	Bioessays, Int. J. Eng. Sci.; J. Comput. Syst. Sci.; Theor. Popul. Biol.	6
17	All others (351 journals)	5 or less
	Total	974

closest peer or competitor publications, and describe speciality-specific networks of journals. The BMB has received 974 citations between 1981 and 2002. The journal citing most articles in the BMB is the *Journal of Theoretical Biology* with 41 references to the Bulletin. It is followed by *Physical Review E* citing articles 32 times in the BMB. These two journals are followed by *Bulletin of Mathematical Biology and Mathematical and Computer Models* (24 citations each), *Journal of Mathematical Biology* (22 citations), *Biosystems* (18 citations) and *Proceedings of the Natural Academy of Sciences of USA* (16 citations). We summarise number of citations to articles published in the Bulletin between 1981 and 2002 in Table 3.

In Table 3, we show the ranking of 33 journals. The other 351 journals cite the Bulletin five or less times, among these we can find *Trends in Ecology and Evolution, Nucleic Acid Research, Physical Review Letters, Annual Review of Genomics and Human Genetics, Behavioural and Brain Science, Journal of Biological Chemistry, Journal of Molecular Biology, AIDS, Diabetes, Genome Research, Journal of Neuroscience, Journal of Virology, Neuroimage and Systematic Biology*.

This shows that the BMB is making an impact in the experimental community as well as in the theoretical community. However, it is vital that we do not become complacent. We must continue to increase the awareness among our experimental colleagues of articles in the BMB.

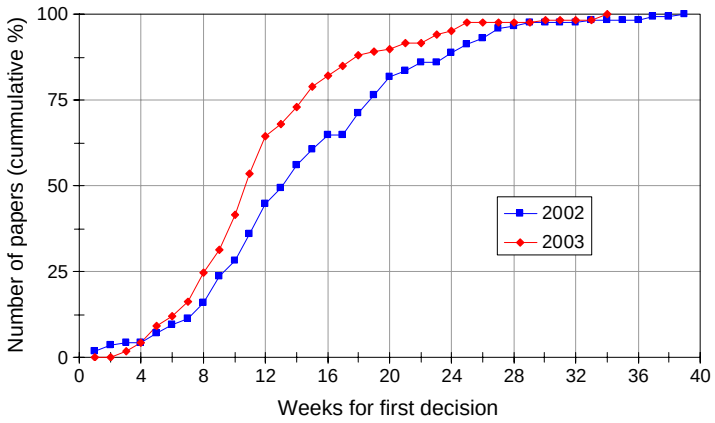

Figure 1. Cumulative percentage of submitted papers versus weeks taken to made the first editorial decision.

2002–2003 Statistics for the Bulletin of Mathematical Biology

We have carried out an analysis for the data available in the editorial office up to January 31st, 2004. For the year 2002, the total number of papers submitted was 114. From those, 66 were accepted, 45 rejected and 3 are outstanding. The median time in weeks for the first decision from the editorial office is 14 weeks (mean time is 14.8 weeks) for the papers submitted in 2002.

For the year 2003, the total papers submitted were 143. The Bulletin accepted 47 papers, rejected 46 and 50 are outstanding. We analyse the time in weeks for the first decision from the editorial office for 118 papers. The median is 11 weeks (mean time is 12.4 weeks). In 2003 there was an improvement in the median response time which is due to new measures taken by the editorial office to improve the processing of the papers. This is clearly illustrated in Fig. 1.

The subject of published papers in 2002 and 2003 remained almost homogeneous with the exception of the 'Physiology' and 'Computational Biology and Bioinformatics' categories. The number of 'Physiology' papers decreased in 2003 and the number of 'Computational Biology and Bioinformatics' papers increased (see Fig. 2).

2003 Publication Backlog of Mathematical Biology Journals

We have estimated the publication backlog in a number of journals of choice for mathematical biologists, focusing on: *Journal of theoretical Biology, Bulletin of Mathematical Biology, Mathematical Biosciences, Journal of Mathematical Biology* and *Mathematical Medicine and Biology—A Journal of the IMA*, formerly known as *IMA Journal of Mathematics Applied in Medicine and Biology*.

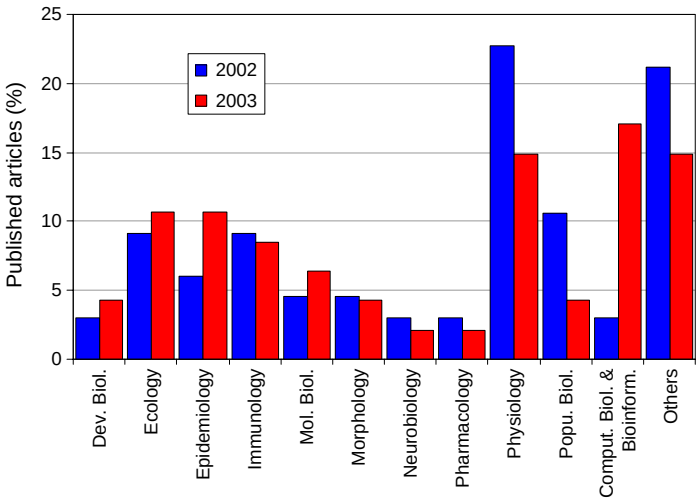

Figure 2. Percentage published articles for the years 2002 and 2003 in subject categories.

The source of our data is the relevant journal Website with the exception of *Journal of Mathematical Biology*. We have calculated for papers published in 2003 the number of days between received and acceptance dates, acceptance to print and acceptance to online publication, based on a 360-day year (twelve 30-day months). The data for the *Journal of Mathematical Biology* were obtained from 'Backlog of Mathematics Research Journals' published in the *Notices of the AMS*, Volume 50, Number 8—September 2003, pp. 961–964.

From Table 4, we observe that the *Bulletin of Mathematical Biology* is the periodical which was quickest to publish a paper. The median time from received to print is 11.2 months (336.5 days). The Bulletin is followed very closely by the *Journal of Theoretical Biology* with a median time from received to print of 12.2 months (366 days). They are followed by *Mathematical Biosciences*, which has a median (printed) publication time of 13.7 months (411 days). We calculated the received to print times for *Medicine and Biology—A Journal of the IMA* from the 2003 printed version of the journal. We obtained a median time of 11.3 months (340 days), which is very similar to that for the Bulletin.

CONCLUSIONS

It is important to view the above data in context. For example, there has been a 25% increase in the number of papers submitted to the Bulletin from 2002 to 2003. It remains to be seen whether this is a statistical blip, or whether it reflects the increase in research in the field. The most striking feature of Fig. 2 is the increase in the number of papers in computational biology and bioinformatics, as a percentage of the total accepted papers.

Table 4. Publication backlog for mathematical biology journals for papers published in 2003.

Journal	Issues per year	Approximate pages per year	2003 Median time (in months) from:			
			Received acceptance	Acceptance to print	Acceptance to online publication	Received print
Bull. Math. Biol.	6	1174	6.9	4.4	2.9	11.2
J. Theor. Biol.	24	3389	6.5	5.5	3.3	12.2
Math. Biosci.	12	1324	9.2	4.6	2.4	13.7
J. Math. Biol.	12	1152	10.8	6.8	4.7	15.1[a]
Math. Med. Biol.[b]	4	378	*NA*	*NA*	*NA*	11.3

NA: not available from Website or printed journal.

[a] Editor's estimate for papers to be published in 2003 obtained from 'Backlog of Mathematics Research Journals' published in the *Notices of the AMS*, Volume 50, Number 8—September 2003, pp. 961–964.

[b] Formerly known as *IMA J. Math. Appl. Med. and Biol*.

The data on processing times presented in Table 4 must also be taken in context. For example, many biological journals have substantially quicker turn-round times, mainly because reviewers are not expected to redo the experiments presented in the paper. One would expect that the more mathematical a journal is, the longer it will take to review because the reviewer is expected to work through at least some of the mathematics (see 'Backlog of Mathematics Research Journals' published in the *Notices of the AMS*, Vol. 50, Number 8—September 2003, pp. 961–964, which shows that some mathematics journals can take up to 28.2 months from received to print). The 'Received to accepted' data only partly reflect the journal's efficiency, as they depend also on the time taken for the authors to revise their manuscript.

One thing that is clear is the steady increase in impact factor of the journal. This is very exciting and bodes well for the future of the journal.

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