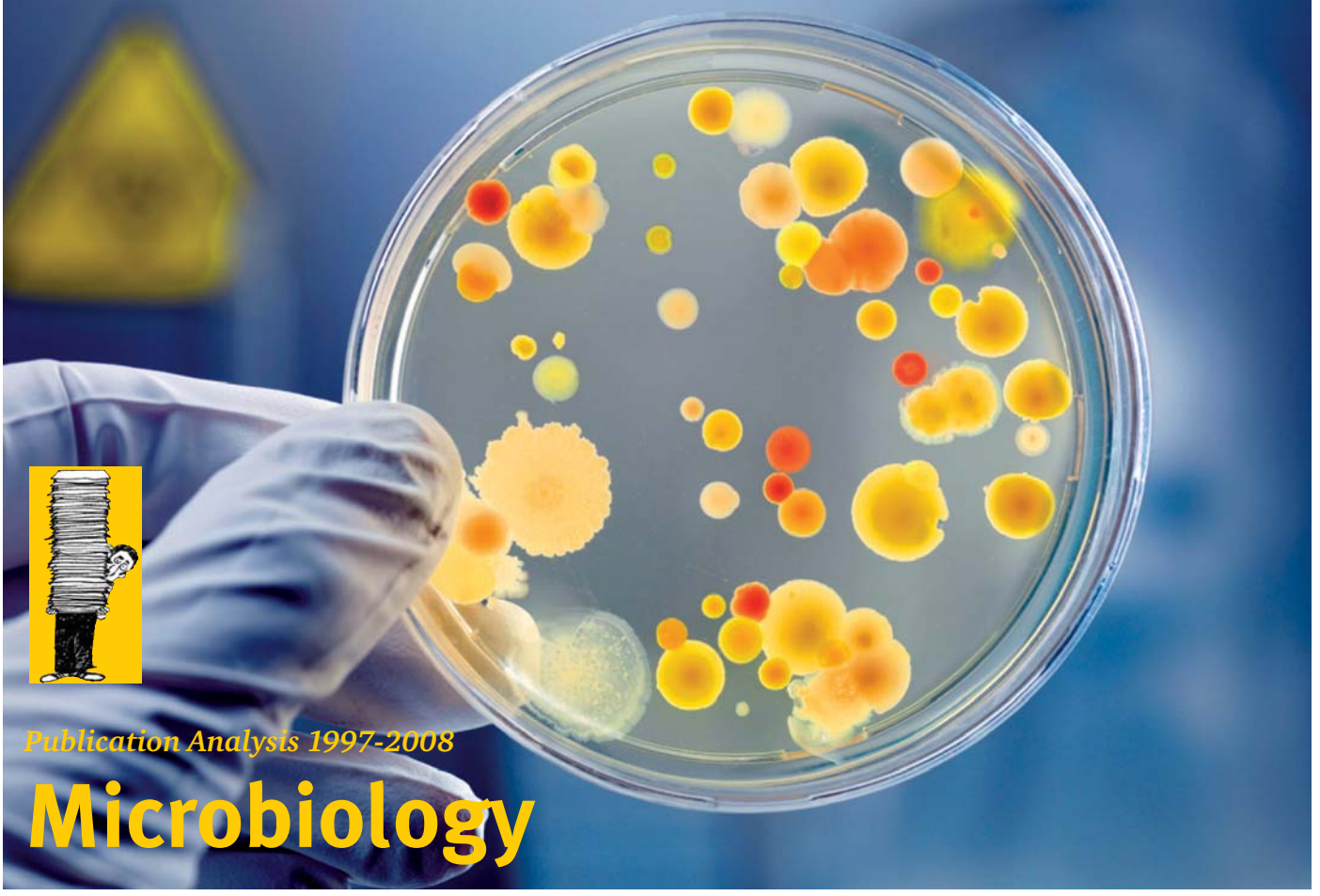

Publication Analysis 1997-2008

Microbiology

European microbiology performs extraordinarily strong when compared to other life science disciplines. Its "hottest topics" are genomics and microbiomics, disease mechanisms and therapy of pathogens, and biofilm formation.

Microbiology has definitely faced a revolution in the last decade. The basis for this has been the rapid advance of powerful high throughput sequencing techniques, which instantly paved the way for massive application of genomics and even metagenomics to the field. Accordingly, in a growing number of studies, it's no longer one or two microbes that count but rather their *totality* present in a given habitat. Just think, in which diverse environments such microbial communities or "microbiomes" have already been described: the human gut and skin, the air over New York, the Sargasso Sea, deep sea vents, honeybee colonies, Antarctic ice....

Nevertheless, this rapid development hasn't automatically cleared the way for "genomicists" to completely dominate the landscape of total microbiology publications. Certainly, there are still enough single "protagonists" left that continue to attract a lot of research activity – and, therefore, also citations. Most of those, of course, belong to the area of human pathogens, such as *Mycobacterium*, *Rickettsia* or *Staphylococcus*. On the other hand, a couple of microorganisms that have proven valuable for certain biotechnological applications or production have also entered this category. Examples are electrochemically active bacteria, like *Shewanella* and *Aeromonas*, or "food-producing" microbes like *Lactobacillus* (yoghurt).

The real "victims" of that recent development – at least in terms of publications and citations – have obviously been the long-standing microbial models for genetic research, headed by *E. coli*, *Bacillus subtillis* or yeast. Publications studying "only" basic genetic problems in one of those former "powerhorses" have definitely lost ground within "total microbiology".

From "individuality" to "totality"

Before discussing the results of our publication analysis on microbiology in more detail, you should also be aware of some inevitable methodological constraints.

In order to compare performance of the individual European countries in microbiology research (as shown in the "blue" table on p. 37), we had to restrict the analysis "merely" to the papers published in the 95 journals listed in *Web of Science*'s category "microbiology". Certainly, many of the "top papers" in microbiology are published in multidisciplinary science journals like *Nature*, *Science* or *Proc. Natl. Acad. Sci.* Regrettably, however, we had to omit them, at least from this part of the analysis. The reason is that the database used, *Web of Science*, doesn't provide any reliable tools to automatically extract relevant "microbiology" articles from those multidisciplinary journals. And before assigning too many "false positives" to the individual countries, we decided to restrict this analysis to the specialist journals only. Nevertheless, we believe that such a "trimmed" survey still provides sufficiently valid indicators for the countries' overall productivity in microbiology research.

However, as for the rankings of the most-cited researchers and papers (see tables, p. 38) there were no such limitations. They could be analysed from publications in all journals.

France, Belgium and Denmark are "strong perfomers"

Applying these directives, we find the "usual three" on top of the nations' list when it comes to total citations. With their articles, published in microbiology journals during the twelve-year period 1997-2008, England, Germany and France have respectively accumulated 302,000, 289,000 and 253,000 citations to-date. "Silver medallist", Germany, however, needed more "mass" than the other two to achieve its almost 290,000 citations. With a total of 15,000 papers, including at least one co-author from a German lab, England (12,800) and France (12,000) were clearly left behind. On the other hand, both these nations achieved considerably higher mean rates of citations per article than Germany, which finally enabled England to pull ahead of Germany and climb to the top of the "total citations" list.

At the same time, England's average of 23.6 citations per microbiology article proved to be the third-highest value of all European countries. Even higher ratios were obtained by their colleagues from Switzerland (25.2) and the Netherlands (24.0).

Another "strong performer" was Belgium, climbing to 8th place by total citations and 4th place by mean citation rate. Also interesting: Sweden wasn't as successful as in most other life science disciplines; however, Denmark instantly stepped in to rescue the Scandinavian honour by performing clearly "better than usual".

Altogether, European microbiology appears to have remained unimpressed by the aforementioned changes of the last decades and, thus, has been successful in maintaining its high status among the European life science disciplines. This becomes even more obvious when comparing European microbiology to the "rest of the world". The USA was considerably outcompeted by Europe's performance, which is not the case in many other life science fields. The same is true for Japan and Canada who this time lagged far behind Europe's number three, France.

The five most-cited microbiology papers to have appeared between 1997 and 2008 with corresponding addresses in Europe clearly demonstrate the trend outlined earlier: all of them exclusively come from the field of microbial (meta-)genomics – three complete genome sequences and two method papers about analysing sequence data from microorganisms.

Where has *E. coli* gone?

This fact, of course, raised a problem on the identification of the most-cited European microbiology researchers. Which of the authors on those highly-cited genomics papers can really be regarded as microbiologists and who "merely" contributed technology expertise in sequencing or bioinformatics? Drawing this boundary, for example, led to including Julian Parkhill (3rd) and Gordon Dougan (7th) in the list, but excluded Bart Barrell and Michael Quail – despite the fact that all four shared authorships on many microbial genomics papers from the Wellcome Trust Sanger Centre in Hinxton.

Apart from microbial genomics, what further "hot topics" in European microbiology are represented by the most-cited authors? *Rickettsia* specialist Didier Raoult from Marseille, in first place, heads the group of medical microbiologists studying certain human pathogens. Further members are, for example, David Denning (5th, *Aspergillus*), Jerome Etienne (13th, *Staphylococcus*) or Peter Vandamme (17th, *Burkholderia*). In contrast, other medical microbiologists like Brian Spratt (14th) and Michael Givskov (25th) have specialised on the role of microbial biofilms in disease formation.

Related to this group are a couple of researchers studying therapy development and microbial mechanisms of drug resistance. Representatives are Rino Rappuoli (4th), Patrice Nordmann (16th) and Peter Andersen (20th).

Completely distinguishable from them are "biotechnological microbiologists" like Willy Verstraete (9th), "microbial ecologists" as represented, for example, by Rudolf Amann (2nd) and Michael Wagner (10th) or the bacterial cell biologists Pascale Cossart (12th) and Jeff Erington (22nd).

Last but not least, good old "taxonomy, systematics and phylogenetics" is also still on the list. See, for example, Jean Swings (23th) and Erko Stackebrandt (24th).

But where has *E. coli* gone? Despite definitely being the most famous bacterium in research, it was simply not present in the "top 30".

RALF NEUMANN

Europe...

Country	Citations	Articles	Cit./Art.
1. England	302,963	12,827	23.6
2. Germany	288,984	14,985	19.3
3. France	253,498	11,947	21.2
4. Spain	136,535	8,915	15.3
5. Netherlands	122,083	5,094	24.0
6. Italy	85,386	6,150	13.9
7. Switzerland	84,000	3,333	25.2
8. Belgium	81,106	3,447	23.5
9. Sweden	71,339	3,573	20.0
10. Denmark	66,940	3,268	20.5
11. Scotland	48,990	2,313	21.2
12. Ireland	32,269	1,519	21.2
13. Finland	31,345	1,622	19.3
14. Israel	31,232	1,594	19.6
15. Austria	29,274	1,650	17.7
16. Norway	25,709	1,319	19.5
17. Russia	23,978	3,718	6.5
18. Portugal	19,253	1,269	15.2
19. Greece	17,165	1,196	14.4
20. Wales	15,833	805	19.7

Articles appearing between 1997 and 2008 in 'Microbiology' journals as listed by Thomson Reuter's *Web of Science*. The citation numbers are accurate as of December 2010. A country's figures are derived from articles where at least one author working in the respective European nation is included in the author's list. Israel is included because it is a member of many European research organisations and programmes (EMBO, FP7 of the EU...).

... and the World

	Citations	Articles	Cit./Art.
Europe	1,442,491	81,003	17.8
USA	1,231,884	49,892	24.7
Japan	166,782	11,933	14.0
Canada	140,888	6,533	21.6
Australia	87,354	4,300	20.3
South Korea	43,950	5,395	8.2
Brazil	41,325	3,762	11.0

Publication Analysis 1997-2008 – **Microbiology**

Most Cited Authors...

		Citations	Articles
1.	**Didier Raoult**, Clin. Microbiol. Fac. Med. Univ. Mediterr. Marseille	19,136	754
2.	**Rudolf Amann**, Max-Planck-Inst. Marine Microbiol. Bremen	13,200	177
3.	**Julian Parkhill**, Wellcome Trust Sanger Ctr. Cambridge	12,928	115
4.	**Rino Rappuoli**, Novartis Vaccines & Diagn. Siena	12,212	260
5.	**David W. Denning**, Med. Mycol. Univ. Hosp. South Manchester	10,236	173
6.	**Philippe J. Sansonetti**, Path. Microb. Mol. Inst. Pasteur Paris	9,878	179
7.	**Gordon Dougan**, Wellcome Trust Sanger Ctr. Cambridge	9,582	209
8.	**Stewart T. Cole**, Microb. Pathogenesis Ecol. Polytech. Fed. Lausanne	9,574	129
9.	**Willy Verstraete**, Microbial Ecol. & Technol. Lab. Univ. Ghent	9,006	347
10.	**Michael Wagner**, Microbial Ecol. Univ. Vienna	8,919	138
11.	**Willem M. de Vos**, Microbiol. Lab. Univ. Wageningen	8,883	243
12.	**Pascale Cossart**, Interact. Bact.-Cell. Inst. Pasteur Paris	8,777	140
13.	**Jerome Etienne**, Ctr. Nat. Ref. Staphylocoques Univ. Lyon	8,608	181
14.	**Brian G. Spratt**, Mol. Microbiol. Sch. Publ. Hlth. Imperial Coll. London	8,483	92
15.	**Stefan H.E. Kaufmann**, Max-Planck-Inst. Infect. Biol. Berlin	8,459	276
16.	**Patrice Nordmann**, Bacteriol.-Virol. Hôp. Bicêtre Univ. Paris Sud	8,165	267
17.	**Peter Vandamme**, Microbiol. Lab. Univ. Ghent	7,924	242
18.	**Gurdyal S. Besra**, Microb. Physiol. & Chem. Univ. Birmingham	7,762	213
19.	**Karl Heinz Schleifer**, Microbiol. Tech Univ. Munich	7,742	93
20.	**Peter Andersen**, Statens Serum Inst. Copenhagen	7,592	148
21.	**C. Anthony Hart**, Med. Microbiol. Univ. Liverpool (*† 2007*)	7,562	351
22.	**Jeff Errington**, Ctr. Bact. Cell Biol. Med. Sch. Univ. Newcastle	7,545	91
23.	**Jean Swings**, Microbiol. Lab. Univ. Ghent	7,472	287
24.	**Erko Stackebrandt**, German Collect. Microorg. & Cell Cult. Braunschweig	7,417	278
25.	**Michael Givskov**, Ctr. Biomed. Microbiol. Tech. Univ. Denmark Lyngby	7,355	115
26.	**Søren Molin**, Syst. Biol. Tech. Univ. Denmark Lyngby	7,193	118
27.	**Fernando Baquero**, Microbiol. Univ. Hosp. Ramón y Cajal Madrid	7,058	198
28.	**David M. Livermore**, Ctr. Infect. Hlth. Protect. Agcy. London	6,946	192
29.	**Michael Hecker**, Microbiol. Univ. Greifswald	6,915	178
30.	**Paul Williams**, Infect. Immun. & Inflammat. Univ. Nottingham	6,809	139

Citations of articles published between 1997 and 2008 were recorded up until Sept. 2010 using the *Web of Science* database from Thomson Reuters. The "most cited papers" had correspondence addresses in Europe or Israel.

... and Papers

	Citations
1. Cole, ST; Brosch, R; Parkhill, J; [...]; Taylor, K; Whitehead, S; Barrell, BG Deciphering the biology of *Mycobacterium tuberculosis* from the complete genome sequence. *NATURE, 393 (6685): 537-+ JUN 11 1998*	3,330
2. Ludwig, W; Strunk, O; Westram, R; [...]; Ludwig, T; Bode, A; Schleifer, KH ARB: a software environment for sequence data. *NUCLEIC ACIDS RESEARCH, 32 (4): 1363-1371 FEB 2004*	1,873
3. Maiden, MCJ; Bygraves, JA; Feil, [...]; Feavers, IM; Achtman, M; Spratt, BG Multilocus sequence typing: A portable approach to the identification of clones within populations of pathogenic microorganisms. *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA, 95 (6): 3140-3145 MAR 17 1998*	1,116
4. Bentley, SD; Chater, KF; Cerdeno-Tarraga, AM; [...]; Barrell, BG; Parkhill, J; Hopwood, DA Complete genome sequence of the model actinomycete *Streptomyces coelicolor* A3(2). *NATURE, 417 (6885): 141-147 MAY 9 2002*	1,026
5. Andersson, SGE; Zomorodipour, A; Andersson, JO; [...]; Eriksson, AS; Winkler, HH; Kurland, CG The genome sequence of *Rickettsia prowazekii* and the origin of mitochondria. *NATURE, 396 (6707): 133-140 NOV 12 1998*	833