RESEARCH PRODUCTIVITY

London, Cambridge Lead Europe in Output

When it comes to total output of scientific papers, London is Europe's most prolific city. But in terms of number of research papers published per capita, nearby Cambridge can claim bragging rights, according to a new study that attempts to rank the scientific productivity of major cities throughout Europe.

The findings—to be presented this week at a meeting of the International Geographical Union's Urban Systems Commission in Bucharest, Romania, and submitted to the journal *Urban Studies*— are likely to be used by local governments seeking to attract high-tech industry. "Such figures could be very helpful for city politicians to see how important their research base is," says urban geographer Christian Matthiessen of the University of Copenhagen, one of the authors of the study. And they point to continuing disparities between Eastern and Western Europe. "Western investors in Eastern Europe may be wary if knowledge there is low," says Matthiessen.

Matthiessen and Annette Schwarz of the Technical Knowledge Center of Denmark carried out the study as part of their ongoing research into competition between urban centers. Their first problem was the lack in Europe of a standard definition of a city. Rather than relying on densities of buildings or people, they developed a "functional" definition based on daily flows of people, goods, information, and money. Cities within 45 minutes of one another were grouped together, and the final delimitation was marked out on topographical maps. The researchers then added in publication data from the Institute of Scientific Information (ISI) in Philadelphia to create a geographic portrait of European science.

London comes out as the preeminent science center in Europe. Its total output of papers—nearly 65,000 in 1994 to 1996—topped Paris, which ranked second, by some 19,000 papers. It also dominated many individual fields: Of the 162 fields analyzed by ISI, London produced the most papers in more than half. The study identified two other "megacities" of research: Moscow and the Dutch conglomerate of Amsterdam, The Hague, Rotterdam, and Utrecht. A different pecking order emerges, however, if one takes population into account. The small city of Cambridge, dominated by its large and ancient university, heads a per capita ranking by a wide margin, followed distantly by Oxford-Reading and Geneva-Lausanne. The megacities are scattered well down this list, with London ranked 16th and Paris in 22nd place.

A breakdown by specific field also shows some interesting trends. Three of the four megacities, not surprisingly, rate near the top of the publication league in a wide range of disciplines, while Moscow is strong in physics and the traditional natural sciences but noticeably weak in medicine and modern biology. That regional difference in diversity can be seen in the statistics from other cities. Although high output generally leads to all-around strength —14 of the 17 top-producing centers can be considered genuine all-arounders—all cities with broad strengths are situated in Western Europe. Several Eastern European cities show biases similar to Moscow's toward the natural sciences.

The study proves the fairly obvious point that "big cities have big universities," says geographer John Goddard of the University of Newcastle upon Tyne, and reflects the centralized political systems of the United Kingdom and France. Although the results may please the citizens of London or Paris, a more decentralized research landscape, as exists in the United States, might bolster industry in outlying regions. Says Goddard: "A more even distribution might provide bigger benefits to the economy as a whole."

–DANIEL CLERY

SOURCE FOR TABLES: MATTHIESSEN AND SCHWARZ

EUROPE'S TOP RESEARCH CITIES

City	Total papers	Per capita	City	Total papers	Per capita
London	64,742	7	Geneva, Lausanne	13,405	29
Paris	45,752	5	Mannheim, Heidelberg	12,289	8
Moscow	39,903	3	Zürich	11,951	13
Amsterdam, The Hague, Rotterdam, Utrecht	36,158	10	Brussels, Antwerp	11,786	5
			St. Petersburg	11,506	3
Copenhagen, Lund	21,631	11	Barcelona	11,467	5
Stockholm, Uppsala	20,195	12	Vienna	10,882	5
Berlin	19,872	5	Bristol, Cardiff	10,633	15
Oxford, Reading	18,876	41	Helsinki	10,287	12
Edinburgh, Glasgow	18,688	10	Birmingham	9,882	5
Manchester, Liverpool	18,653	5	Aachen, Maastricht, Liege	9,705	5
Cambridge	17,764	81			
Madrid	16,230	4	Lyon	9,175	7
Munich	15,947	10	Warsaw	7,966	4
Dortmund, Düsseldorf, Cologne	15,716	1	Prague	7,516	6
			Hamburg	7,425	3
Milan	15,120	6	Gothenburg	7,378	10
Rome	15,088	5	Budapest	6,697	3
Frankfurt, Mainz	14,512	6	Oslo	6,466	8
Basel, Mulhouse, Freiburg	13,918	20	Dublin	5,043	6
			Stuttgart	5,043	4
Sheffield, Leeds	13,484	5			

CITY LEADERS IN SELECTED FIELDS

BIOCHEMISTRY & MOLECULAR BIOLOGY (44,368)	London Paris Amsterdam* Stockholm† Cambridge	CONDENSED MATTER PHYSICS (18,461)	Moscow St. Petersburg Paris Berlin Stuttgart
GENERAL & INTERNAL MEDICINE (27,981)	London Paris Edinburgh‡ Manchester Amsterdam*	CHEMISTRY (17,102)	Moscow Paris London Frankfurt Prague
NEUROSCIENCES (24,127)	London Paris Amsterdam* Stockholm Rome	ENVIRONMENTAL SCIENCES (7,159)	London Copenhagen§ Amsterdam* Stockholm† Helsinki
PHYSICS (21,691)	Moscow Paris Geneva St. Petersburg Warsaw	BIOTECHNOLOGY & APPLIED MICROBIOLOGY (6,479)	London Paris Amsterdam* Copenhagen§ Edinburgh‡
IMMUNOLOGY (19,003)	London Paris Amsterdam* Copenhagen§ Stockholm†	METEOROLOGY & ATMOSPHERIC SCIENCES (3,675)	Moscow London Oxford Paris Copenhagen§

* Includes The Hague, Rotterdam, and Utrecht † Includes Uppsala ‡ Includes Glasgow § Includes Lund