
GENETICS
infectious diseases
cardiac surgery
Neuroscience

EVALUATION

What are we good at?

Studies indicate 11 areas of knowledge in which Brazilian research shines throughout the world

FABRÍCIO MARQUES | ILLUSTRATIONS CLAUDIUS CECCON

Published in February 2007

Two studies published in the journal *Annals of the Brazilian Academy of Sciences* have sketched an unprecedented portrait of what Brazil has been producing of most relevance in the international scientific scene. Researchers Rogerio Meneghini and Abel Packer, from the Latin American and Caribbean Center on Health Sciences Information (Bireme), pored over the cream of the national academic production between 1994 and 2003: the set of 248 scientific articles cited over a hundred times in other publications connected to the Thomson-ISI (Institute for Scientific Information) database. This sample represents 0.23% of the 109,916 articles by Brazilians published in magazines indexed in the ISI in that period. The significance of a paper is usually measured by the number of mentions that it gets in other articles.

The next step was to try to group the 248 articles into areas of knowledge. It was possible to find common denominators in 114 of them, leading the authors to conclude that 25 Brazilian centers of excellence achieved special prominence in 11 different fields:

■ Amongst the 12 articles on the Amazon Forest, the majority about the consequences of the exploitation of the forest, eight were connected to the National Institute of Amazon Research (INPA), based in Manaus. "It is a positive fact, because it shows the viability of producing high level research outside the big centers", Meneghini says. Its closeness to the object of study does not explain the impact. "Many institutions from other countries also sponsor research in the Amazon", he says.

■ Cardiovascular surgeries are the theme of 18 of the most cited articles. The majority of them are linked to large international research networks, and many have to do with the same subject: the effectiveness of techniques like angioplasty and the implantation of stents to unblock arteries, carried out at institutions in São Paulo like the Heart Institute (InCor) and the Dante Pazzanese Cardiology Institute. An innovative technique for reducing dilated left ventricles invented by surgeon Randas Batista, from Pará, was also significant.

■ Twenty Brazilian groups that are studying the oxidative mechanism of cells produced ten articles that received over a hundred citations. Amongst the highlights were the five articles by the team of Aníbal Vercesi, a professor from the School of Medical Sciences of the State University of Campinas (Unicamp). Their papers helped to understand the relationship between the activities of the mitochondria and cell death. Another three papers are from the group of Ohara Augusto, at the Chemistry Institute, the University of São Paulo (USP), in partnership with Rafael Radi, a Uruguayan. The articles resulted from a research that reported the formation of a carbonate radical, a compound hitherto unknown in living organisms.

■ Seven articles about chemical catalysis evidence the success of the research coordinated by Jairton Dupont and Roberto F. de Souza, professors from the Federal University of Rio Grande do Sul (UFRGS). In 1992, they developed new molten salts, liquid at room temperature and highly stable, which have found a wide application in the chemical industry. The group managed to produce various ionic liquids, ensuring applications in various fields of science. The work was done in partnership with Petrobras.

■ Genetic sequencing was responsible for three Brazilian articles of great significance. The main one was the sequencing of the *Xylella fastidiosa* phytopathogen, which merited the cover of the *Nature* journal on July 13, 2000. *Xylella* is responsible for the agricultural "yellowing" scourge. The sequencing was fostered by a program coordinated by FAPESP, which organized the network connecting institutions in São Paulo. "It's too early to conclude whether that is the best way to attain excellence in molecular biology", says Meneghini. "But there was a fundamental gain in our capacity to organize research networks at a national level."

■ Brazilian research in neurosciences produced 16 high impact articles. One of the groups that stood out, in the field of experimental pharmacology, is led by Frederico Graeff, from the School of Philosophy, Sciences and Literature of USP in Ribeirão Preto, and it seeks to understand the effect of drugs that relieve or produce anxiety in rats. The team with the most articles is led by Iván Izquierdo, then of the Federal University of Rio Grande do Sul, which investigates the mechanisms of the memory. Pharmacologist Xavier Albuquerque, from the Federal University of Rio de Janeiro (UFRJ) and the University of Maryland, in the United States, is researching the biophysical aspects of synaptic transmission in neurons. One of the articles in neurosciences has a Brazilian author, Luiz Antônio Baccalá, from USP, but the work was conducted in a laboratory at Duke University, in the United States, commanded by Brazilian Miguel Nicolelis, known for his work with sensomotor connections. Meneghini and Packer observe that both Xavier Albuquerque and Miguel Nicolelis were students of César Timo-Iaria, a researcher

from USP and a pioneer in neurosciences in Brazil, who died in 2005.

■ Particle physics was responsible for 13 articles, thanks, in good measure, to collections of data carried out by two research networks, one linked to USP's Physics Institute, and another connected to the Brazilian Center for Research in Physics. The laurels are diluted: each one of the articles has an average of 154 authors from a dozen different countries.

■ Quantum physics is the theme of seven articles, divided into two categories. One of them, more inclined to the theoretical field, is captained by Constantino Tsallis, of the Brazilian Center for Research in Physics – responsible for concepts that took his name, such as the Tsallis entropy. The other, in experimental physics, is led by Luiz Davidovich, from UFRJ.

■ Fourteen articles deal with human genetics, the highlights being the studies by Mayana Zatz and Maria Rita Passos Bueno, from USP, who identified the genes involved in human muscular dystrophy. The Genetic Endocrinology Unit of USP's School of Medicine also contributed with two articles about a genetic disease, a type of pseudohermaphroditism.

■ Research into infectious diseases, such as toxoplasmosis, Aids and Chagas's disease, accounted for 14 articles highlighting three institutions: the Federal University of Minas Gerais, the Oswaldo Cruz Foundation, and USP's School of Medicine in Ribeirão Preto.

■ Finally, three articles on the use of oral contraceptives and their effects on vascular ailments revealed the participation of the Federal University of São Paulo (Unifesp) in studies with major international research networks.

The survey is useful for showing the international face of Brazilian research, but the authors warn that the data has to be contextualized. The predominance of articles in the area of medicine and biomedicine (108 of the 248 articles) is not explained just by the performance of the scientists, but also by the fact that, all over the world, this field is particularly productive. Meneghini and Packer did another study, not yet published, in which they looked at articles that had received at least 50 citations. In this universe, there emerged groups of excellence in areas like mathematics, computing sciences, anthropology, engineering, veterinary medicine and biophysics. In some of these areas, the world academic production is lower, which explains the lower number of citations. Brazilian research in humanities is less significant due to the fact that they deal with regional subjects, which do not arouse international interest.

The survey brings various findings that inspire reflection. One of them is the considerable prevalence of studies done by large international networks, in the areas of medicine, particle physics and astronomy. They are articles about the incidence of diseases or the effectiveness of drugs, or that depend on the collection of data by means of accelerators or telescopes. Amongst the 37 articles most cited, each of which received as many as 250 citations, 18 are of this kind. On average, each one of these articles has 21 authors from 9.4 different countries, against an average of 3.8 countries per article from the set of papers studied. "They are important researches, but some have an almost bureaucratic scope, in which the participation of the researchers is limited to supplying large quantities of data", Meneghini says.

What also called attention was the fact that only four of the 37 articles are the exclusive responsibility of Brazilian authors, a demonstration of the importance of international cooperation, which inspired the researchers to write a second article, specific to the theme.

Could it be a symptom of dependence or of weakness? The president of the Brazilian Academy of Sciences (ABC), Eduardo Krieger, does not see this as a problem. "Of the research published by Brazilians, between 30% and 35% have international cooperation, which is a healthy number", says Krieger. "This distortion occurs in the ranking of the most quoted articles because there is a tendency of American authors to cite their fellow countrymen more", he claims.

Planning the future – The idea of doing a survey arose in 2004, when Britain's David King, scientific advisor to the government of the United Kingdom, did a study about the 1% most quoted articles in the world between 1993 and 2001 and published an article in Nature magazine, showing the ranking of the 31 countries that produce the most significant research on the planet. In it, Brazil appears in an honorable 23rd place. The study showed that the country published 27,874 articles in the Thomson ISI database, between 1993 and 1997 (0.84% of the total), and 43,971 articles from 1997 to 2001 (1.21% of the total). But what Brazilian studies were these? The ranking did not set out to answer this, the reason Meneghini and Packer decided to investigate the data.

Knowing the weak points and the strong points is essential for planning the future and stepping up the performance of research. In the opinion of Eduardo Krieger, the 11 areas of greatest impact can help the government to target investments, but it would be a mistake to bet exaggeratedly on areas with practical applications, leaving aside basic research. "The areas of excellence have to be expanded, but it cannot be forgotten that each one of them was constructed on a solid base of uncommitted science", he says.

Science, let it be said, is not produced by spontaneous generation. Jairton Dupont, a professor from UFRGS and the leader of the group that became prominent in chemical catalysis, reminds us that the advances in their field of knowledge result from investments made from 1980 onwards, by force of the first Scientific and Technological Development Support Program (PADCT), of the federal government. "Chemistry was a sort of poor cousin of the science and technology system, but it has managed to make a lot of headway in the last 20 years", Dupont says. For him, his group was successful because it was always ready for the unexpected – the innovative process of chemical catalysis was driven by the difficulty of importing reagents.

Aníbal Vercesi, who is responsible for prominence in the area of oxidative stress, notes that the recognition of his field of research comes from the great popularity that it won abroad in the last few years. "There are no secrets. Everything depends on a lot of work and on having the backing of good students and good collaborators, besides seeking interaction with other researchers. I visit various foreign laboratories and I always leave the doors open for those who want to get to know our work", says Vercesi, although foreigners only contributed to one of his five articles , with over a hundred citations.

For Eduardo Krieger, the challenge is to set aside resources capable of guaranteeing an annual growth of 8% in the articles published, as has been happening in the last 20 years, although the economy is advancing at a far slower pace. "Our research system is young and has evolved a lot. We have to help the country to develop and root for the growth of the economy to allow Brazilian science to take further leaps forward." ■

Who produces most in health and biology

The University of São Paulo (USP) is the leader in the production of articles on health and biology. Between 2001 and 2003, it published 5,696 articles indexed in the database of the ISI (Institute for Scientific Information) and 6,368 on the Medline database. This leadership is recorded in a study published in the *Brazilian Journal of Medical and Biological Research*, which presented a ranking of the 20 most productive Brazilian universities in this field, responsible for 78.7% of the some 25 thousand papers published between 2001 and 2003. The main author of the study is journalist Ricardo Zorzetto, the science editor of *Pesquisa FAPESP* and a researcher in Jair Mari´s group, a professor from the Psychiatry Department of the Federal University of São Paulo (Unifesp). Production is concentrated in institutions from the Southeast of the country. The second place went to the Federal University of Rio de Janeiro, with 2,476 articles in the ISI and 2,318 in Medline, followed by Unifesp, USP in Ribeirão Preto and the State University of Campinas (Unicamp). Also featuring in the ranking are the Oswaldo Cruz Foundation, the Federal Universities of Minas Gerais, Rio Grande do Sul, Paraná, Pernambuco, Santa Catarina, Bahia, Ceará and Pará, three units of the São Paulo State University (Unesp), the Rio de Janeiro State University, the campus of Unicamp in Piracicaba, and the University of Brasilia (UnB).