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Basic research in Chagas disease: laboratory cultures in Brazil[1]

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Abstract - A group of Brazilian medically trained biochemists has managed to establish, in the early seventies, a very successful molecular parasitology community in their country. Pioneer members were already engaged in Chagas disease research and they attracted younger biochemically trained researchers coming from their post-docs in United States or Europe with a bold funding program negotiated with Brazilian and international agencies. Taking advantage of the good tides in science funding prevalent in the seventies, the group grew in number, production, cohesion and internationalization. The analysis of the works presented each year in the main activity of this community, the meeting they hold at Caxambú, Brazil, it is possible to observe the growing proportion of foreign participants. A closer examination of these participants has produced preliminary evidence for the exportation of science from the Brazilian molecular parasitology community to American and European institutions.

Introduction

In February 1995, *Science* published a large report on Latin-American science where one could read that "when hundreds of biologists from Brazil and elsewhere gathered here for a recent meeting, the work they discussed would not have been out of place at Cold Spring Harbor or Heidelberg" (E. Marshall 1995, p. 811). This magic place where national frontiers seemed to be unexpectedly suspended is Caxambú, a small bathing resort town in the State of Minas Gerais, Brazil. This is where the *Annual Meeting of Basic Research in Chagas Disease* (AMBRCD) takes place every year since 1974. The meeting is the work of a certain *ghost committee*[2], the closest we can get to a formalized expression of one of the most outstanding and powerful research communities in Brazil: the basic research in Chagas disease group (BRCDG), or, more up to date with current trends of object diversification among practitioners, the molecular parasitology Brazilian community.

We will briefly try to show that this group has managed to occupy a very special place not only in Brazilian science but also in international public health efforts and that this can be explained both by the persistence of former medical research traditions with their own agenda and the "entrism" of new social agents committed to molecular

[1] This paper has been presented at the *II Jornadas Latinoamericanas de Estudios Sociales de la Ciencia* (ESOCITE) (Caracas, September 9 - 11, 1996).

[2] The ghost committee is the group constituted by all previous meeting organizers. Once a person organizes a meeting, he becomes a new member of the ghost committee.

biology research styles acquired in United States and Europe: the group has been set up by a combination of efforts from traditional "chagologists", holders of a heritage that goes back to early century medical research, and very modern biochemically trained doctors previously unconnected to *T. cruzi.* Until very recently this group has been able to set its own program and approaches. Based on preliminary evidence, we will also suggest this program has been partly exported to foreign institutions during the eighties and that this group is then probably to some extent responsible for the rise of *T. cruzi* and Chagas disease research in United States and Europe. Although it cannot be argued that this phenomenon represents the formation of a research specialty or even school, there is evidence that the commitment to the object (*T. cruzi*) is fairly strong. Consequently, it seems we are facing a curious situation of inverted diffusion of science. What exactly is being diffused poses another difficult question: is there real diffusion of stylistic elements (tacit knowledge, methodological and object choices, etc.[3]) or are Brazilian laboratories just providing raw material and importing tacit knowledge? We will try to argue that evidence suggest that it is the first case and that it feeds a necessary discussion around peripherality and marginality in science.

The establishment of the molecular parasitology community in Brazil

Brazil built its current research establishment around the early seventies, when enough money and incentives derived from the first decisive science and technology policies adopted by the Brazilian government were available[4]. This is also the period when the higher education reform was being implemented, partly reorganizing institutions and procedures according to the American system of higher education. The combined action of these measures resulted in a very concentrated research system, centralized in a small number of high ranked public universities and closely related to graduate education (Schwartzman 1991, Stemmer 1995, Guimarães 1995). This is the context of the beginning of our story. A group of researchers devoted to studying *T. cruzi* organized a meeting in June 1974, in Rio de Janeiro, claiming the need for discussing nutrition and metabolism of the parasite. The title of the meeting was: *Workshop about Trypanosoma cruzi: nutrition, growth and strain variation*[5]. Under that call, what really focused everybody's attention was the normalization of a very important growth media preparation developed by Erney Pleissman Camargo - the LIT medium. Without that, results could hardly be compared and there were a lot difficulties on reproducibility of procedures. Such an imperative for consensus and unproblematic

[3] About the significance of these elements, see for example Nye (1993) and Olesko (1993).

[4] Important episodes were, for example the creation of the FNDCT (National Fund for Scientific and Technological Development). It was formed in 1969, but only started working effectively in 1971(R. Guimarães 1995, p. 257). Also, in 1975, the old Conselho Nacional de Pesquisas (National Counsil for Research) was transformed into a new and much larger Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Counsil for Scientific and Technological Development), under the Ministry of Planning (Schwartzman 1991, p. 216).

[5] *Workshop sobre Trypanosoma cruzi: Nutrição, crescimento e variações de cepas*, June 20-21, 1974, Rio de Janeiro, RJ, Brazil. Organizer: José Ferreira Fernandes.

research tools was the expression of a group already committed to early elements of a common strategy. The evidence for this is that at this point, they had already succeeded in attracting funding: the year before, a special program for the incentive of research in endemic diseases was formed at the CNPq (National Counsel for Scientific Research). This program was called PIDE (Integrated Program for Endemic Diseases) and all indicators on scientific productivity have shown it to have been extremely successful[6], although success is specially concentrated in the sub-specialty of Chagas disease research, in detriment of the other tropical diseases. We have interviewed not only the organizer of the first meeting, José Ferreira Fernandes, but also Erney P. Camargo, Zigman Brenner and Walter Colli, important early participants of the group, but we weren't able to determine the actual basis of the general assumption according to which the first meeting had to do with organizing the PIDE. It seems very clear that both were closely related and involved the same agents.

Also crucial to the development of basic research in Chagas disease was the *Special Programme for Research and Training in Tropical Diseases*, the TDR. This program is co-sponsored by the United Nations Development Programme (UNDP), the World Bank and the World Health Organization (WHO) and is supported by voluntary contributions from governments, international organizations, foundations and other non-governmental bodies. It was established in 1975, when six diseases were chosen as "target" for foment: malaria, schistosomiasis, filariasis, African trypanosomiasis, Chagas disease, leishmaniasis and leprosy (*Twelfth Programme Report of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases* 1995). Although most of them are actually important health problems in Brazil[7], again Chagas disease absorbed proportionally more grants and delivered more products. The TDR's Scientific Working Group on Chagas disease began to work in 1979. From 1977 to 1994, the TDR funded 402 projects in Brazil, summing a total of US$ 20,290,611 of investment and resulting in 957 publications. Of the "Research and Development" projects, 41,25% had to do directly with Chagas disease (Fig. 1). The total budget of projects in Brazil begin to rise steeply in 1988 and reached its peak around 1990 with more than US$ 2,000,000 annually (UNDP/World Bank/WHO, *Special Programme for Research and Training in Tropical Diseases (TDR) - Country Profile for Brazil* 1995) (Fig. 2). Its aims included the development of new drugs, control, diagnosis to epidemiology, with a strong bias towards actions on the disease, but the distribution of funds by section from 1978-1993 shows a higher absorption from the "biochemistry and molecular biology" projects (TDR, "Steering Committee Minutes 1978-1993").

In the TDR's 12th report, the organizers pointed out that the success of the enterprise in the case of countries like Argentina and Brazil is related to the presence of

[6] E. Camargo analyses the parallel enrollment of researchers in the program and scientific production in parasitology between 1973 and 1981 and observes the increase in absolute numbers of researchers involved in the PIDE corresponds to a dramatic rise in publication. See Camargo (1983, p. 334). It is noteworthy that the increase in publication is restricted to international journals.

[7] Tropical Disease Research, *Twelfth Programme Report* (1995) Brazil has the second largest number of cases of leprosy (pp. 102-3), of the "new world leishmaniasis", Brazil and Peru have the largest number of cases (p. 137), and, although Africa is still the epicenter for malaria, Brazil is also seriously affected.

a research structure around Chagas disease studies which preceded the program and supported it. Given such a favorable environment, it would have resulted in a strong network of national institutions, a loser Latin American one and connections to scientifically more advanced countries (*Twelfth Programme Report of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases* 1995).

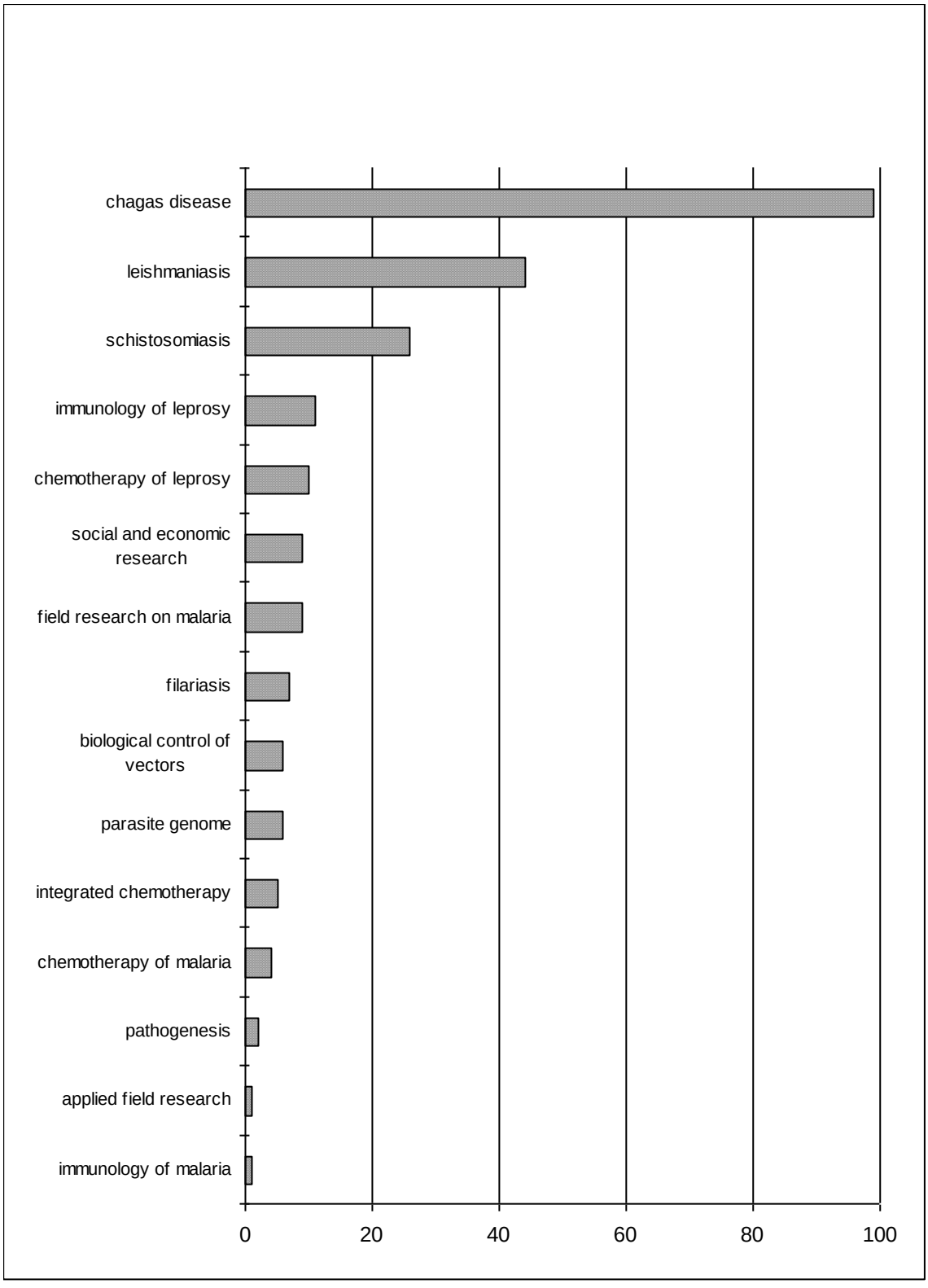

Figure 1 - Number of projects in each component. Data obtained from UNDP/WORLD BANK/WHO - *Special Programme for Research and Training in Tropical Diseases* (TDR): *Country Profile for Brazil, 1994.*

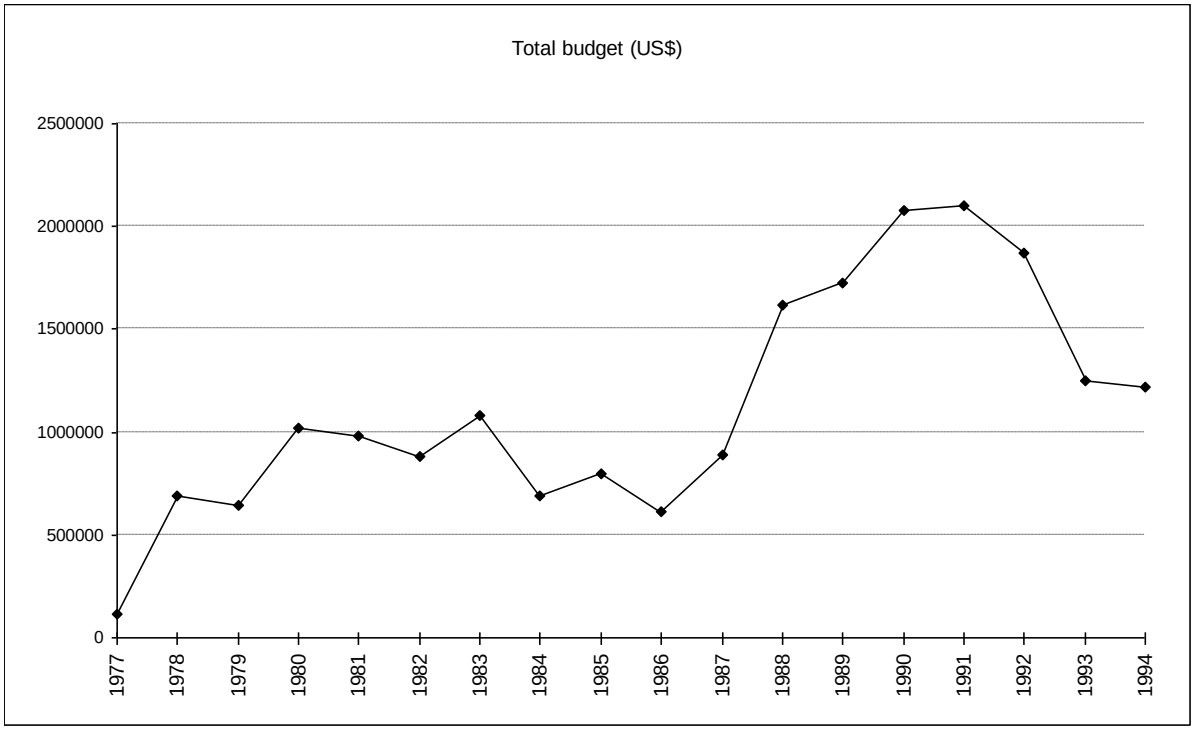

Figure 2 - Total TDR budget for Brazil, per year. Data obtained from UNDP/WORLD BANK/WHO - *Special Programme for Research and Training in Tropical Diseases* (TDR): *Country Profile for Brazil*, 1994.

Also, figures from the TDR country profile of Brazil show a stable tendency in the emergence of new projects and renewed projects. Considering that most of these projects are either Chagas disease of leishmaniasis research (and, curiously, leishmaniasis researchers meet at the Annual Meeting for Basic Research in Chagas Disease and actually form one sole community), this tendency seems to show a certain stability in the group (Fig. 3).

Figure 3 - TDR action in Brazil: projects by year. Data obtained from UNDP/WORLD BANK/WHO - *Special Programme for Research and Training in Tropical Diseases* (TDR): *Country Profile for Brazil*, 1994.

Unlike research on other parasites, Chagas disease research seems to be greatly concentrated in Brazil. Camargo points that in his 1981 study, 30% of all published works about *Trypanosoma cruzi* in the world were published by Brazilian institutions[8]. Considering the dramatic growth in the number of researchers in the area from then on, this tendency has probably been intensified. Considering this and the fact that the Annual meeting at Caxambu is an inescapable activity for the molecular parasitology community in Brazil, we have studied the evolution of this meeting in terms of the number of participants, percentage of presented papers authored or co-authored by researchers from foreign institutions and co-authorship trends. From the 24 participants in the first meeting they reached the astonishing number of 1114 participants in the 20th meeting, in 1993. The group grew very quickly for the first ten years and then seemed to reach a slower increase rate (Fig. 4). These tendencies are more visible if we check the numbers of presented papers, where the stabilization trend is clearer (Fig. 5). It also reveals another interesting feature: while the average number of co-authors ranged around 1,8 for the first decade, it reached 2,5 in 1986 and 3,2 in 1993. Parallel to that, the proportion of papers where at least one of the authors belongs to a foreign institution increases from around 10% in the early years, to around 20% in mid and late eighties to almost 40% in 1993 (Fig. 6). The number of papers on parasites other than *T. cruzi* grew substantially along the years (Fig. 7). The Caxambú meeting seems to have become an international one. We have tried to investigate the nature of this foreign participation. We have analyzed the last meeting that took place in November 1995 where 319 abstracts were presented on *T. cruzi* or Chagas disease, among which 92 were authored or co-authored by participants from foreign institutions. We have excluded second

[8] See Camargo (1983, p. 320).

papers presented by the same team and we have analyzed the 58 remaining works presented where at least one of the authors belonged to a foreign institution.

Nearly half of these works were co-authored by researchers from Brazilian institutions and precisely half had at least one Latin-American author (Fig. 8).

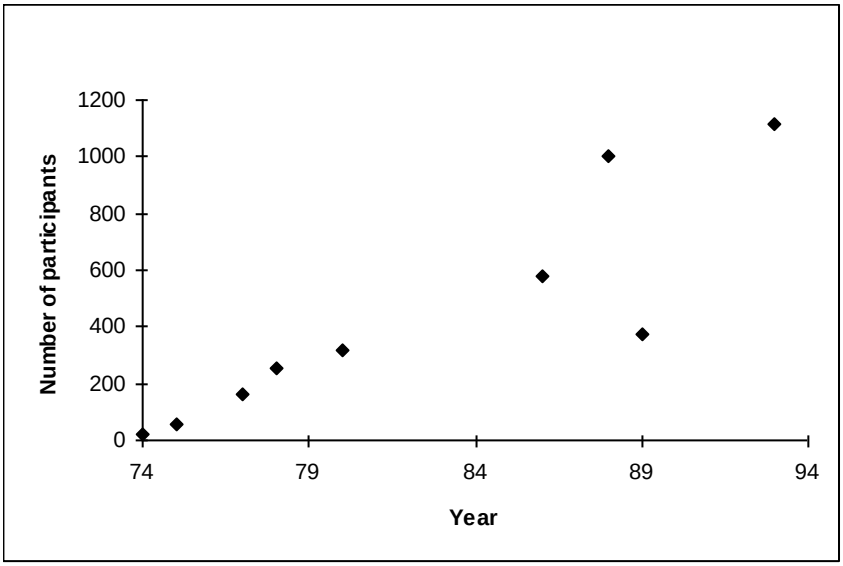

Figure 4 - Number of participants in the Annual Meeting of Basic Research in Chagas Disease in each year.

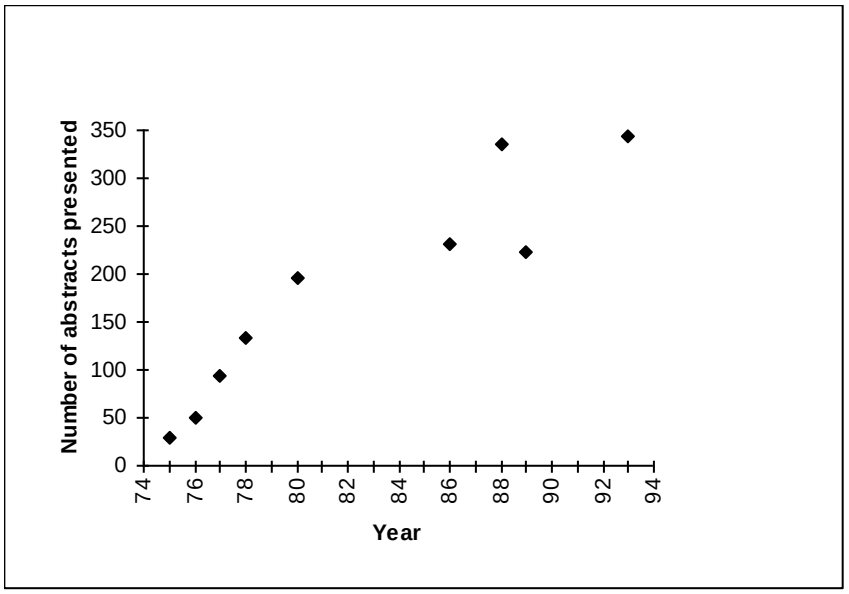

Figure 5 - Number of abstracts presented each year at the Annual Meeting of Basic Research in Chagas Disease.

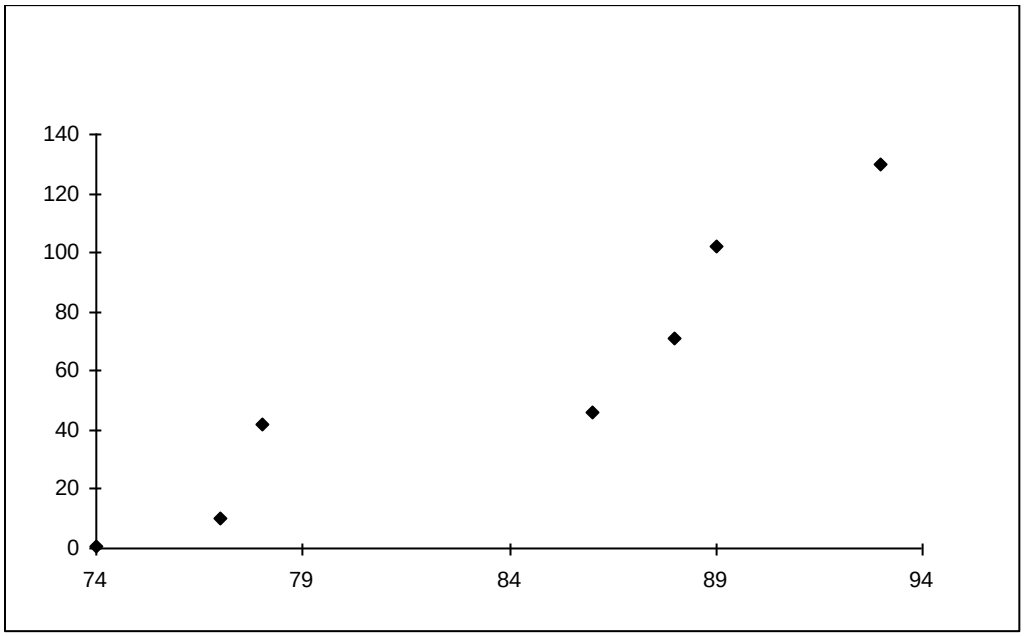

Figure 6 - Number of papers presented at the Annual Meeting of Basic Research in Chagas Disease in each year having at least one co-author from a foreign institution.

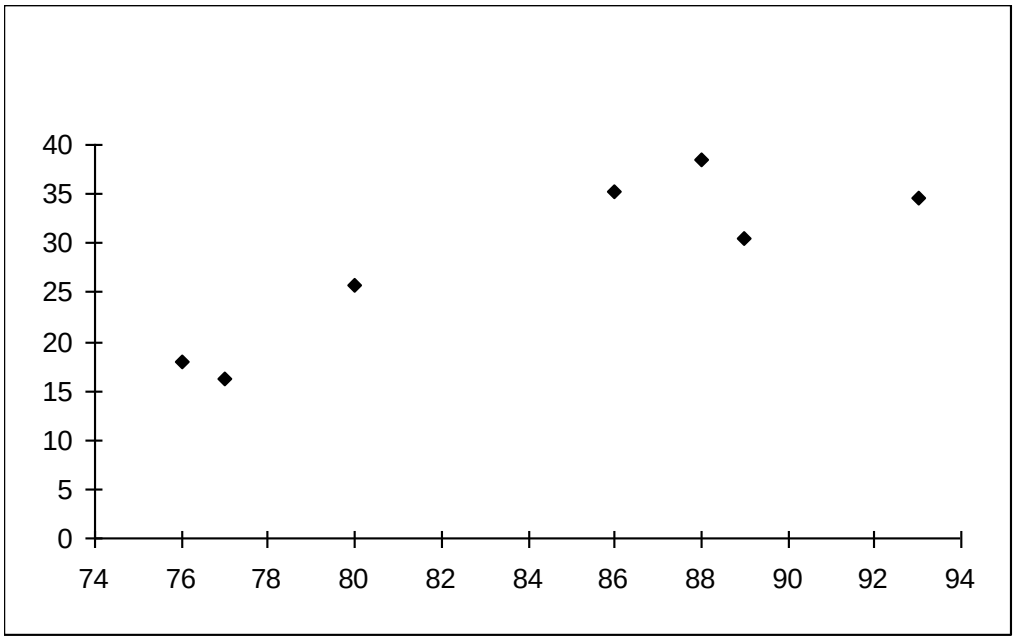

Figure 7 - Percentage of papers presented about parasites other than *T. cruzi* at the Annual Meeting of Basic Research in Chagas Disease in each year.

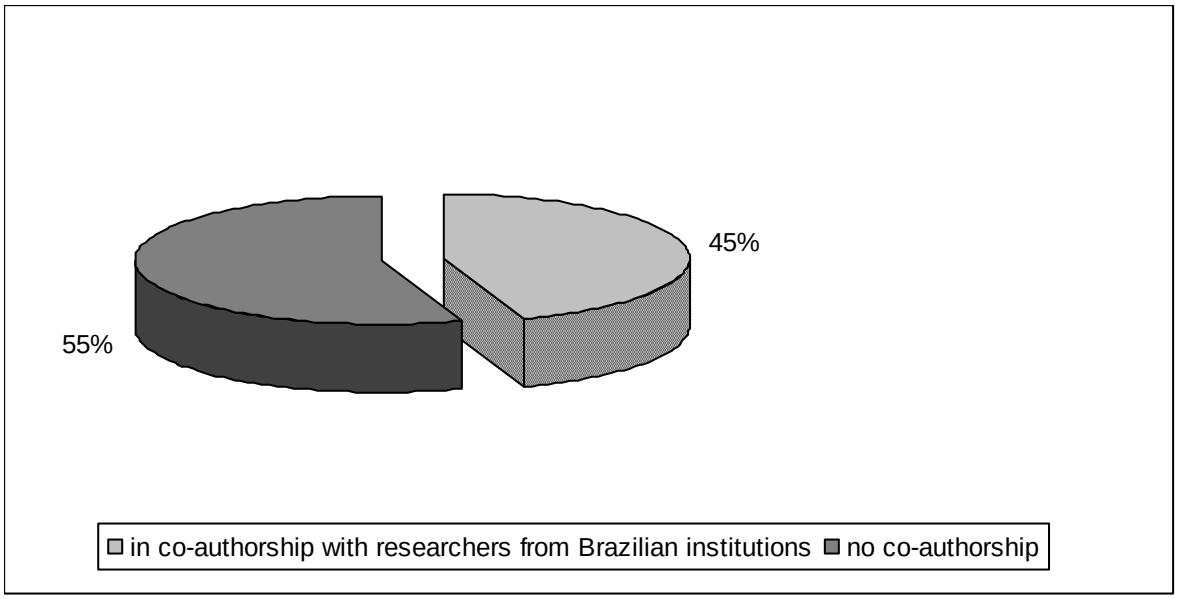

Figure 8 - Papers presented at the 1995 Annual Meeting of Basic Research in Chagas Disease by different teams where at least one participant comes from a foreign institution.

Most papers presented by Latin-American authors had no co-authorship with researchers from Brazilian institutions, whereas most papers presented by American or European authors were co-authored by someone from a Brazilian institution (Fig. 9).

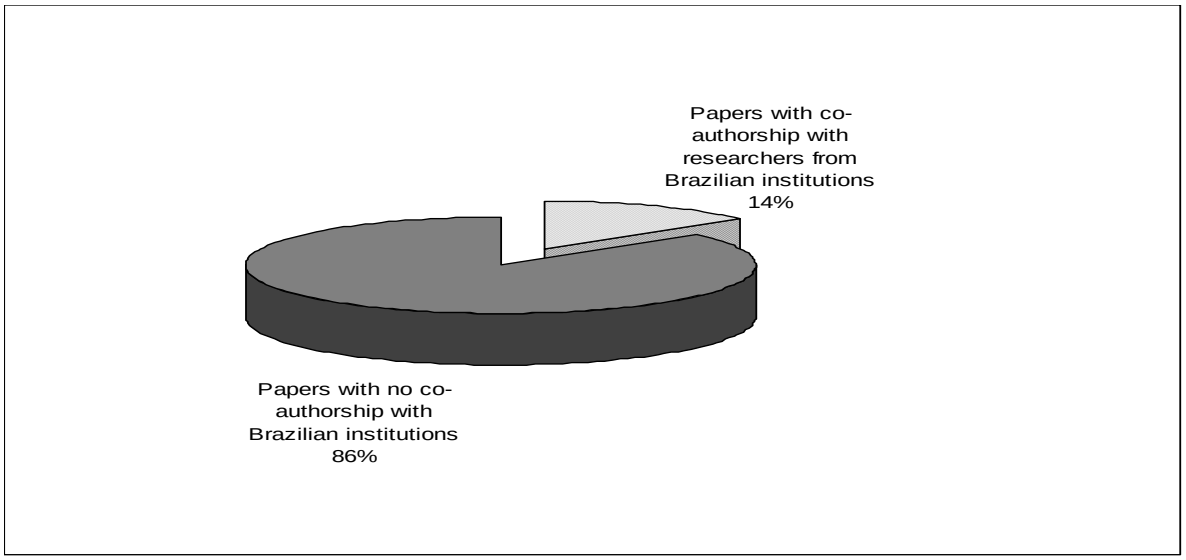

Figure 9 - Papers presented at the 1995 Annual Meeting of Basic Research in Chagas Disease by different teams where at least one participant comes from a foreign institution. Number of papers with authors from Latin-American coutries.

We have also written to these researchers asking them about the origins of the *T. cruzi*/ Chagas disease research in their institution, its funding, their eventual relationship with Brazilian laboratories, and the nature of their research. Results presented here are quite preliminary and correspond to a three week answer period: 10 answers from researchers from England (4), France (2), Scotland, Germany, Argentine and Chile. Most of them work at public higher education institutions (7) and are funded by private foundations (5), local public funding agencies (4) or other international funding agencies (3). Only two of them received grants from the TDR. Except for the Latin-American groups where research started by the late seventies and early eighties, most of the research on *T. cruzi* developed by respondents started in the late eighties and early nineties. Teams are generally small, ranging from one to five people (with one 8 people team exception). Most of them work in institutions where there are other laboratories involved with research with *T. cruzi*, but they report curious stories about how research was started in their own lab: in one case, the person (from U.K.) had family in Brazil and in one of his visits he established collaboration with a local institution. In other cases, visiting post-docs from Brazil brought the parasites and started the research line on *T. cruzi*. It is also interesting to observe that most of them do not attend the AMBRCD on a regular basis and they list many other meetings as more appropriate for communicating their results: Keystone Meeting, New York Academy of Sciences, FEBS (Federation of European Biochemical Societies) conferences, British Society for Parasitology meetings, Gordon Conferences, etc. None of them attended more than four AMBRCD. Most of our respondents have collaboration relationship with Brazilian groups (7) and Ph.D students and researchers visit each other's labs. The division of labor is fair, with a lot of sophisticated work being carried out in Brazilian labs.

This is a very small sample but it suggests participation in AMBRCD underestimates the real influence Brazilian laboratories exert over international research in Chagas disease: foreign groups, once established through this influence and even keeping the original link will go on favoring the traditional meetings of their own specialties. Chagas disease research is not a specialty and can only have the cohesive force it has in Brazil in environments where disciplinary traditions are very weak. Considering this, the disproportionate concentration of publishing activity in Brazil and the outstanding visibility of the Brazilian molecular parasitology community, it seems reasonable to conjecture that Brazilian influence is larger than expected. Most of the partnerships described and many reported by interviewed researchers were established between a Brazilian Chagas disease research laboratory and a "virgin" foreign lab. The Brazilian partner brought not only the parasites but in vitro culture techniques, approaches and "questions". Tacit knowledge, in brief.

Much more work should be done to explore this hypothesis. Nevertheless, in the case of Chagas disease research, we can straightforwardly rule out the "paper collaboration" described by John Cohen in the volume of *Science* devoted to Latin-American science (Cohen 1995) where the Latin-American partner is a passive provider of raw material, or even more dynamic collaborations where the Latin-American partner depends on foreign money for their own research. Much on the contrary, at least in some of the cases described and others reported by interviewed researchers (Colli 1995a, Camargo 1995), research on Chagas disease was exported by practitioners from strong,

well established and productive Brazilian laboratories. Let us now discuss the origins of these research centers.

The molecular parasitology collective in Brazil and its laboratories

The basic research group was actually founded by "real" parasitologists: researchers who, although in basic research departments or institutions, were mostly doctors with parasitological training[9]. Nevertheless, it immediately attracted a very special strain of Brazilian scientists: those young researchers recently trained in molecular research specialties in eminent centers in US or Europe. They wanted a good study object toward which interesting questions could be posed, they needed money and safe funding perspectives and they wished for the stimulating intellectual environment they had learned to cherish during their socialization in the dynamics and competitive molecular research collectives abroad. They found all that in the BRCDG. The early growth of the group is related to this attraction and to the increasing number of students who engaged in molecular parasitology research around the early members in the newly institutionalized national graduate education system[10].

As we mentioned before, the first meeting was held in Rio de Janeiro in June 20 to 21, 1974 and was organized by José Ferreira Fernandes, who soon retired and didn't actually play a decisive role in this community. The second meeting took place already at Caxambú in 1975, a site selection guided by a previous choice made by the Brazilian Biochemical Society, which met there since 1972. Its organizer was Zigman Brenner, from the René Rachou Institute (affiliated to FIOCRUZ) who also organized the third meeting, held in October 1976. But the 1977 meeting already had two new organizers: Walter Colli, from the Department of Biochemistry of USP, and Erney P. Camargo, from the Escola Paulista de Medicina. The following year the small ghost committee would welcome the fourth powerful member of the early (pre-eighties) group: Carlos Médicis Morel, from FIOCRUZ. These four medically educated biochemists that embraced trypanosome research form the basic structure of the group and through them it is possible to understand the laboratory network underlying it. Brenner represents the connection between the early history of research in Chagas disease and the new molecular parasitology tradition. He has inherited a heavy legacy from the Minas Gerais group that resisted the obscure years when Chagas disease was discredited and wasn't even diagnosed at hospitals. He was actually trained by important members of this group in field epidemiology work and he was very early committed to research in Chagas disease. Erney P. Camargo, as well as Walter Colli, was educated at the most important center for higher education and research in Brazil: the University of São Paulo. Both studied medicine and had very similar experiences and influences, except for the fact that Erney devoted his life to the study of parasites very early in his career, attracted to

[9] That is the case of Erney P. Camargo, Zigman Brenner and J. F. Fernandes, for example.

[10] See E. P. Camargo, "Entrevista com Erney P. Camargo", *BLM Oral History Program* (São Paulo, SP, Brazil, March 1995). In In http://www.usp.br/nupes/blm.html (*forthcoming*).

the parasitology department much as a consequence of political affinity with senior and young members, all of them faithful to the ideals of social transformation and fight against injustice. Eventually, Erney had to leave the country because of harsh political persecution following the 1964 coup d'etat and its toughening in 1968. He went to the University of Wisconsin in 1965, where he wasn't allowed to take his pathogenic parasites, only to return in 1969. He reports a very intense academic life in Wisconsin, where he got in touch with important cell biology characters and ideas. Colli also left the country in 66 and returned in 69 for the specific purpose of developing postdoctoral research[11]. Nevertheless, his scientific trajectory was quite different from Erney's: he was attracted to the biochemistry department as an undergraduate, he was trained by a researcher who had himself been trained in United States and he had no scientific contact with *T. cruzi* until he returned from his post-doc abroad and was invited to the first meeting of what would become the Brazilian molecular parasitology collective, in 1974. Colli actually engaged in molecular biology research in New York, published four high impact papers and returned to a University of São Paulo drowned in a gloomy mood. Erney couldn't even be re-integrated there until more than a decade had passed. He went to the Escola Paulista de Medicina, which, along with the USP and the UNICAMP comprise the top productivity pole in Brazilian science. Nevertheless, despite political difficulties, money poured in generously and actually permitted equipping the departments of both scientists in the early seventies.

Morel, the youngest of the four, has also spent training years abroad, in Switzerland. He returned to the University of Brasília to be absorbed in 1978 by the FIOCRUZ. This historically respected institution had lost its brightness during years of political attack and academic paralysis. Morel then devoted his efforts to set up an impressive apparatus of what would become one of the most productive molecular biology centers in Brazil.

The laboratories of these four researchers were built up during the early years of the molecular parasitology community. Not by chance, they are also leading characters in the large biochemistry community in Brazil. They have regular collaboration with American or French laboratories and for that matter it seems that Morel has been the most successful. His collaborations render many different products, among which a rich literary production.

A competitive solidarity marks the relationship between these groups: their summed efforts and their normative agreement are responsible for the astonishing success they actually achieved. Students visit each other's laboratories and there is limited collaboration between them. Nevertheless, as in any vigorous community, they are always struggling for leadership. It cannot be denied that due to his engagement in the parasite genome project, which is attracting the largest resources in the area, Morel has achieved the highest visibility and impact among them. An evidence of this condition is the treatment he received by *Science* journalist E. Marshall (Marshall 1995).

[11] Although Colli was politically active in the sixties, his period abroad was not related to politics (Colli 1995a).

Erney and Colli represent an interesting couple in this story. They are institutionally representative of the most important centers for higher education and science in Brazil and they reflect one of the major trends of this group: the ability to set its own agenda. Erney has dedicated early efforts in solving technical problems for cultivating the epimastigote form of *T. cruzi* and thus being able to perform biochemical experiments. Later on, Colli's laboratory also devoted much time and effort for establishing cell cultures of trypomastigote forms. The trypomastigote form is infective, whereas the epimastigote is not. Having established and designed the experimental system, Brazilian researchers could now devote their efforts to studying the main event related to this life form: the infection itself. This is how Colli's laboratory then focused on membrane components and their role in the interaction with mammalian cells.

Erney's early work on the LIT medium is the single most quoted paper in the area. Colli is until today the member of the Brazilian molecular parasitology group with the highest impact index[12]. They have recently disputed the presidency of the University of São Paulo against each other - they both lost to another independent candidate. Other illustrations of the group's prominence include Morel's nomination to the presidency of the FIOCRUZ in 1993 and Colli's designation as director of the Chemistry Institute at USP soon after. Erney also occupied a high administrative position at the University of São Paulo. Their action is quite similar and not a bit representative of the large and unproductive category of Brazilian scientists: they favor the internationalization of science both in production trends (ranking high papers published in international journals) and collaboration, they defend and strengthen the legitimacy of peer review evaluation, they struggle against Science and Technology bureaucracies and corporate groups in their own institutions and they are highly collaborative and competitive. One example of such collaboration-competition balance is the foment program known as Bioq-FAPESP, instated in the early seventies. Incorporating certain innovative procedures of peer evaluation with foreign participation, the agreement made large financial resources available to biochemists from São Paulo. Nevertheless, the purchase of equipment would only be allowed provided their shared use: the acquiring lab would be obliged to make it available to members of other labs from the department who needed it. The department of Biochemistry of the USP, which has been formally and informally headed by Colli more than once and is considered the "best department" in Brazil, played an important role in the negotiation of the Bioq-FAPESP[13].

Another example of actions guided by these principles is the re-incorporation of Erney to USP. He was brought back as head of a very weak department - the parasitology department at the Institute of Biomedical Sciences. It was weak, poor and displayed trace productivity. In one year he persuaded 18 people to leave the department and he filled their positions with younger and more productive researchers. Although not having reached the level of the Biochemistry department, it is now considered a respectful department (Camargo 1995).

[12] See "A lista dos produtivos" (1995, p.5).

[13] About the department of Biochemistry and its history, see Colli (1995b).

Concluding remarks

Science in Brazil is concentrated in higher education institutions, particularly public universities. Among the enormous number of public universities, most scientific production is concentrated in five Southeastern universities: USP, UNESP, UNICAMP, UFP (previously EPM) and UFRJ[14]. Four of them are in São Paulo and among these four, three of them comprise what is known as "São Paulo State system" - the three respected state universities of São Paulo. Actually, in these top hierarchy universities there are strong, research committed departments and groups, focused on graduate education and harboring well internationalized groups. But they too represent a small "center" compared to the large "periphery" comprised by most other departments and groups, much less productive and poorly internationalized.

The impression reported by *Science* journalist Marshall is very precise: he was getting in touch with the most outstanding excellence core in Brazilian science, where except for the language used in chatting and other subtle details, there is very little difference to distinguish local research groups from their kin abroad. They manipulate central questions in their own areas, they manage to publish and be quoted and they are independent from their international partners to raise funds for their research.

Naturally, they are not representative of the Brazilian scientific establishment. The great majority of those who formally would be classified as researchers or members of academia are unproductive and poorly internationalized (Balbachevsky 1995). In fact, a large part doesn't practice science at all. Among those who are able to exhibit evidence of scientific practice of any kind, there is very little normative agreement, very little collective action and very little combined negotiation of their role in society. If we consider these to be constitutive elements of the "community" condition in science, then, actually, there is no national scientific community - in Brazil, at least.

Considering all this and the preliminary evidence for science "exportation" to American and European institutions by Brazilian molecular parasitology labs, we believe it is time to review our concept about "peripheral science". It seems that besides national borders, scientific knowledge production has its own boundaries and its own "frontier politics". If we consider the current situation, we see top hierarchy scientific enterprises whose performance and financing are geographically and institutionally dispersed[15], but hardly counting with participants from underdeveloped or developing countries. Surrounding this center and sharing different degrees of marginality, there are layers and layers of "periphery"- also geographically and institutionally dispersed. So, what should be the standpoint for the analysis of scientific achievements considering the regional "materiality" of its practice? Should we consider national belonging hard enough so as to permit retrieve from it local normative systems for accomplishment

[14] USP: University of São Paulo; UNESP: University of the State of São Paulo; UNICAMP: University of Campinas; UFP: Federal University of São Paulo; EPM: São Paulo medical college; UFRJ: Federal University of Rio de Janeiro.

15 About institutional transformations in science, see Gibbons et al. (1994).

assessment? Are there national scientific communities constituting their own set of norms and values against which performance can be measured? Should we deal with intellectual belonging (to discipline or specialty) as prevalent in the cases where international socialization is successful and national academic sub-cultures - with its own achievement parameters - where it isn't?

We believe not. There are economically central countries and there are economically peripheral countries. There is marginal scientific research activity and there is well socialized science (and although some have attributed an imperialistic outlook to one of us about this, we insist: well socialized science is internationalized science, specially now). Globalization trends are favoring standardization in science and intensifying that basic polarization, although there is a wide gradient between the two extremes: groups might display different degrees of "centrality" in the collectives they are socialized in, measurable by different approaches (citation indexes, international collaboration activity, etc.). Due to exclusion barriers and cultural features, where national policies and the historical development of science play a determinant role, there is much more socialized science in absolute numbers in central countries[16]. There is no peripheral science.

That is why protective measures adopted by Brazilian authorities as the core of science and technology policies have resulted in failure. That is why recapitulationist assumptions[17] embedded in these policies are outright wrong, disregarding inescapable standardization trends[18]. Nationality, gender, ethnic origin and political commitment all leave indelible marks in scientific practice and products and science studies is rightly recognizing and revealing these features. Nevertheless, science is irreversibly international and integrated in production, communication and legitimation. There is no "de novo" synthesis.

[16] This refers to the well known fact that most of the publications come from scientifically central and traditional countries and they attract most of the correspondent citations. However, there is a huge number of marginal works in these countries as well. See Leta & de Meis (forthcoming).

[17] Recapitualationist assumptions are those involved in the idea that if enough protective measures are taken to avoid international competition, then science will develop from scratch and eventually mature to a robust condition. Also known as the "re-invention of the wheel" strategy. This conception was and is shared by significant segments of Brazilian academia.

[18] The protective policies mentioned here are described by Schwartzman (1991) and commented in Meyer (1992).

References

"A lista dos produtivos", *Folha de São Paulo*, Domingo, May 21, 1995, "caderno 5": p.5.

BALBACHEVSKY, E. , 1995. *Atores e estratégias institucionais: a profissão acadêmica no Brasil*. Ph.D thesis presented at the Dept. of Politica Science at the Universidade de São Paulo. São Paulo: Universidade de São Paulo.

CAMARGO, E.P., 1983. 18. Parasitologia. In: *Avaliação & Perspectiva - Ciências Biológicas 1982*. Brasília: SEPLAN/CNPq, pp.: 315-334.

-- 1995. Entrevista com Erney P. Camargo, *BLM Oral History Program.* São Paulo: Brazil, March 1995. In In http://www.usp.br/nupes/blm.html (*forthcoming*).

COHEN, J. 1995. Latin America's Elite Looks North for Scientific Partners. *Science* **267**: 809-810.

COLLI, W. 1995. Entrevista com Walter Colli, *BLM Oral History Program.* São Paulo: Brazil, March 1995. In In http://www.usp.br/nupes/blm.html (*forthcoming*).

-- 1995. O Instituto de Química da Universidade de São Paulo: 25 anos de Ensino e Pesquisa. *Química Nova* **18**: 584-591.

GIBBONS, M. et al., 1994 *The new production of knowledge; The dynamics of science and research in contemporary societies*. London: Sage.

GUIMARÃES, R., 1995. FNDCT: uma nova missão. In: Schwartzman (Org.). *Ciência e Tecnologia no Brasil: Política Industrial, Mercado de Trabalho e Instituições de Apoio*. Rio de Janeiro: Editora da Fundação Getúlio Vargas, pp 257-287.

LETA, J. & de MEIS, L. *A profile of science in Brazil* (forthcoming).

MARSHALL, E. 1995. A Deadly Parasite Spurs Up-To-the-Minute Biology. *Science* **267**: 811-813.

MEYER-STAMER, J., 1992. The end of Brazil's informatics policy. *Science and Public Policy* **19**(2): 99-110.

NYE, M.J., 1993. National Styles? French and English Chemistry in the Ninteenth and Early Twentieth Centuries. *Osiris* **8**: 30-49.

OLESKO, K.M., 1993. Tacit Knowledge and School Formation. *Osiris* **8**: 16-29.

SCHWARTZMAN, S., 1991. *Space for Science: The Development of the Scientific Community in Brazil.* University Park: Pennsylvania University Press.

STEMMER, C.E., 1995. Programa de Apoio ao Desenvolvimento Científico e Tecnológico (PADCT). In: Schwartzman, Coord. *Ciência e Tecnologia no Brasil: Política Industrial, Mercado de Trabalho e Instituições de Apoio*. Rio de Janeiro: Editora da Fundação Getúlio Vargas, pp 288-332.

TDR, "Steering Committee Minutes 1978-1993".

Twelfth Programme Report of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR). 1995. Geneva: World Health Organization.

UNDP/World Bank/WHO, *Special Programme for Research and Training in Tropical Diseases (TDR) - Country Profile for Brazil.* 1995. Geneva: World Health Organization.

Workshop sobre Trypanosoma cruzi: Nutrição, crescimento e variações de cepas, June 20-21, 1974, Rio de Janeiro, RJ, Brazil. Organizer: José Ferreira Fernandes.