

INTERNATIONAL SCIENTIFIC COLLABORATION IN BRAZIL, THE CASE OF THE AMAZONIA NATIONAL RESEARCH INSTITUTE

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Abstract: Results are presented of a study aimed at investigating the degree of cooperation which actually exists between Brazilian researchers working at the Amazonia National Research Institute and their colleagues from various advanced countries. A detailed analysis of the scientific output produced by such collaboration projects is performed. This is complemented by a number of face-to-face interviews in an attempt to clarify the motives driving researchers to carry out joint research projects and the circumstances under which the partnerships develop. These circumstances, it is claimed, have important consequences for the outcomes of the collaborations.

1. INTRODUCTION

Collaboration in science is a phenomenon said to be as old as modern science itself¹, and collaborative efforts involving scientists of more than one country have been noted as early as the nineteenth century². Although international collaboration has been increasing since then, its recent annual growth rate of 7-8 per cent has no precedent³. A number of factors have been pointed out as contributing to the increase in international partnerships in science⁴. Particularly noteworthy for its novelty is the fact that international collaboration has been fostered and stimulated by governmental initiatives⁵. This is greatly due to the importance that science and technology have acquired for economic competitiveness and to the globalization of the economy⁶⁻⁷.

This new world order with its consequent greater degree of internationalization of science is affecting differently the countries of the North and those of the South. The former are collaborating more in scientific activities likely to lead to technological innovation⁸, while the latter tend to be involved in scientific partnerships either for geo-political reasons⁹ or because they contain certain specific environments or facilities -fundamental for scientific advances- which can not be found elsewhere¹⁰.

Location specificity for science is exactly what is found in Brazilian Amazonia. It contains a considerable proportion of the world's living species¹¹, standing out as a particularly important biodiversity region. There is wide agreement to the extent that the survey, classification and study of biological diversity and the understanding of biological systems of Amazonia can contribute substantially to the advancement of the biological sciences world-wide¹².

For this reason, there has been great interest, particularly from advanced country scientists, to carry out investigations in such part of Brazil. Evidence of this is the number of collaboration projects involving different advanced countries -UK, USA, France, Germany, Japan and others- which have either been carried out or are currently under development there.

This paper reports the first attempt to identify the degree of cooperation which actually exists among the Brazilian and foreign scientists working at the Amazonia National Research Institute

(henceforth INPA)¹³. More ambitiously it aims at clarifying the motives leading scientists -both from INPA and from foreign countries- to engage in joint research projects and the circumstances under which the partnership develops. These, I will claim, have important consequences for the outcomes of the collaborations.

2. METHODOLOGICAL PROCEDURES

Since its beginnings INPA has hosted a significant number of foreign researchers¹⁴. Today INPA is the Brazilian institution which has the greatest number of international collaboration projects -20 under execution and 24 being negotiated.

Not all of the ongoing collaboration projects¹⁵, however, have already reached a stage in which publications were produced -some have not published anything yet; others have just started to. Thus, the analysis was performed for only those projects which have either finished or are going on for some time and whose coordinators felt comfortable enough to hand out the publication lists for the purposes of this study. Table 1 below lists such projects with their starting dates and identifies the participant countries and institutions¹⁶.

After having the publication lists for the period of existence of each project, a classification of such output was performed in order to identify a number of features: a) the proportion of papers which were coauthored by Brazilian and foreign researchers and of those which had Brazilians only or foreigners only as authors¹⁷; b) the proportion of coauthored papers which had a Brazilian as first author; c) the place of publication of coauthored, Brazilians-only and foreigners-only articles¹⁸.

Although this paper uses -as is the rule for studies of international collaboration- coauthored research publications as measure of collaboration, in many aspects it departs significantly from related studies in the field. It is a micro-level analysis, concentrated in one Brazilian institution and using local collection of information instead of international databases such as SCI. Most importantly, however, this paper innovates in the sense that it assumes that in order to understand collaborative scientific efforts it is not enough to look at quantitative data alone. These must be interpreted in the light of qualitative information about the whole process of collaboration -negotiation, implementation and outcomes. Thus, personal semi-structured interviews were performed with 41 Brazilian and foreign scientists involved in the projects analysed.

3. SCIENTIFIC OUTCOMES OF THE COLLABORATION PROJECTS

A significant number of publications has come out of the international collaboration projects analysed at INPA. The output for such projects, classified according to the national origin of authors, is presented in Table 2.

A look at Table 2 reveals that the participation of Brazilian researchers in the scientific output of the projects varies. However, generally speaking, coauthored publications between Brazilian and foreign scientists seem not to be the rule. If it is assumed that "international collaboration in science is the result of works developed between two or more countries and identified by means of co-signed articles"¹⁹, then it could be said that very little cooperation takes place at INPA. Of all projects analyzed, only the Hydrobiology with ORSTOM presents a significant proportion of coauthored publications (63% of the total output).

The collaboration project with the University of Washington has also produced more than 50% of co-signed articles, but this is a case which must be looked at with care for two reasons. Firstly, one of the researchers, of American nationality, started to work at the project as one of the foreign partners. In recent years he has been incorporated into INPA's staff and since then his name in a publication has been counted as Brazilian participation. His name is the only "Brazilian" appearing in 25% of all papers which were classified as coauthored²⁰. Moreover, the other Brazilians appearing as coauthors are not from INPA, but from the University of São Paulo. Thus, although

a real collaboration was established between Brazilian and American scientists in this project, INPA as an institution participates marginally, except by offering physical facilities.

A detailed analysis of the position of the names in the co-signed publications showed that there is a tendency for the foreign scientists to appear as first authors. Thus the collaboration with the Smithsonian Institution, for example, produced 12 co-signed publications (14% of the total), of which only one had a Brazilian researcher as the first author. Similarly, the project with the University of Washington presents only 38% of co-authored articles with a Brazilian as the first author. Even the Hydrobiology project with ORSTOM, which produced a significant proportion of co-signed publications, has French researchers as first authors in more than half of them. Considering that scientific leadership is reflected in the order of appearance of authors (most important coming first) then it seems clear that such leadership is on the foreign researchers.

A thorough content analysis of the papers was not performed. However, a close look at the titles of the papers seemed to indicate that articles authored by Brazilians only tend to report results of restricted experiments, while those published by foreigners are more likely to deal with broader topics, once more implying foreign scientific leadership. This point needs further investigation but the hypothesis met with accordance from a number of interviewees.

The noted asymmetry in the collaboration between INPA and foreign researchers is a consequence of the way the projects were negotiated and implemented. It was a recurrent statement in the interviews that the major part of the important scientific decisions -specific research problems, methodology, framework of analysis, publication outlets and the like- was made by the foreign partner. Reasons for this were volunteered by the informants and widely discussed. Firstly it became clear that the initiative of the collaborations was invariably the foreigners'. When foreign researchers approach INPA they most of the times already know clearly what they want to do. They are more in search of a place in Amazonia where to develop a project than of a Brazilian partner to collaborate in its planning and design. Brazilians are then invited to participate, many times just to fulfill the Brazilian legal requirement that all international projects must have a local "counterpart". Because INPA lacks qualified researchers in all fields and problems proposed by the foreigners, it happens that the Brazilian scientist is often only nominally a participant in the project and, consequently, does not qualify as coauthor²¹.

Other times Brazilian researchers do participate in the projects, although not in an equal footing with the foreigners. While the latter make the important decisions, the former in general take care of the execution of the projects, mainly in the field. Some of the laboratory analyses are performed at INPA by the Brazilians but the most sophisticated are many times done abroad. In any case the discussion and the writing up of the results are closely pursued by foreign scientists and not so closely by the Brazilian ones. Such division of tasks clearly manifests itself in the scientific outcomes of the projects by granting first authorship to the foreign researchers.

An interesting question seems to derive from the above considerations: why are INPA researchers and INPA itself as an institution willing to host international collaboration projects while not getting themselves truly involved with them? It is a complex issue where many different factors are at play. For one thing, the needs for research funds stand out as particularly important. Brazilian researchers face grave financial difficulties. INPA itself, in recent years, received much less than its National Congress approved budget. As a consequence, the little it gets goes to payroll. The National Research Council -CNPq- which is the funding agency for Brazilians in some of the projects, traditionally has not done its part due to financial constraints. Thus, foreign money is all that is left for Brazilian researchers to carry out their work. If accepting this money means giving up control of their own research interests and engaging in someone else's research, this is better than not being able to do research at all. The gravity of the situation was expressed by INPA's director: "Impoverished in the last ten years, INPA has been working more with international than with national financial resources. This resulted in projects of little national interest and increased the participation of foreign scientists to the expense of the Brazilian ones".

There are Brazilian researchers who are happy to serve as nominal counterparts or to perform marginal roles in the projects "in the name of science". As the argument goes, science is neutral and scientific knowledge is a common heritage flowing freely across political and geographical barriers. Thus, the nationality of the scientist is not important, since science is international. The following statement illustrates the point made by some: "It is not fair to say 'no' to an international project only because we do not have a local counterpart working in the same problem. There is space in Amazonia for many more scientists than those who are willing to come here. It is science which matters and we all have to gain from the results produced by foreign scientists. I would hate to see science hindered by bureaucratic requirements".

Another reason for Brazilians' accepting to participate in international projects has to do with enhancing their personal capability and prestige. This is not necessarily an egotistical motive like having the opportunity to travel abroad and appearing as coauthor of an international publication (although some interviewees charged others of being driven by such motives only). What seems to be more often the case is that those Brazilians believe that by establishing partnerships with foreign scientists -who are perceived as being better qualified and more experienced- they will, broadly speaking, "learn". Actually, there is evidence that they might be right. When one looks at the scientific output year by year and not just at the aggregate figures, it is possible to see that the proportion of co-authored papers is increasing. For example, the collaboration with the Max Plank Institute produced almost 40% of co-authored articles in 1993 as compared to only 20% a decade ago. In addition, the proportion of papers having a Brazilian as first author also tends to increase with the duration of the projects²². This indicates that as the Brazilians get more qualified and experienced -possibly as a result of their partnership with foreign researchers- they start to have more initiative to lead the research.

Last, but not least, it must be said that INPA many times is "forced" to engage in international collaboration projects by political and diplomatic pressures. These can, sometimes, be difficult to be discerned but are quite evident and well-known in specific cases such as the Maracá Rainforest Project with the Royal Geographical Society of the UK²³.

It is also a general feature of the projects that foreign researchers alone are responsible for the greatest proportion of the total output²⁴. Thus, according to information in Table 2, four of the projects studied had over 60% of their scientific publications authored by foreigners only. Besides the reasons already given above -which certainly have a bearing in this finding- some interviewees have argued that the foreigners publish more because they work harder than the Brazilians. Of course this is too simple an explanation. What does happen is that INPA, as is common in Brazil, has no mechanisms to punish or reward the researchers according to their publication performance. They all have tenure, the majority has been promoted to the highest level of their careers as a mean to counteract declining salaries and keep them at the institution. The foreigners, on the other hand, are closely watched and evaluated: to some (such as the Germans) low publication rates can cost their jobs; to others (such as the French) bad research performance means stagnation in the career and less chance to choose a country or project in which they have interest; to all of them, scientific productivity is essential to obtain research grants without which they are out of business. As one of the foreign scientists puts it: "Our project is financed by the National Science Foundation of the US and is evaluated and renewed every five years. If the scientific production is considered to be poor -quantitative and/or qualitatively- we will not be granted the money any more. This will not only affect this specific project, but will have consequences in our future lives as researchers".

Not only are the foreign researchers more productive but also they tend to publish in international periodicals of high prestige, while Brazilian scientists tend to publish at home. This tendency is clearly revealed by the figures in Table 3.

The data in Table 3 seem to indicate that each side of the partnership has a distinctive audience. While Brazilians have their country fellows as main reference group, foreigners look for recognition in the international scientific community. The Brazilians, however, seem to be "pushed" to publish internationally when they co-sign the publications together with a foreign

researcher²⁵. According to some Brazilian interviewees, the association with a foreign partner solves one of the serious problems they have for submitting papers to international periodicals -language. For the foreigners, however, language barrier is not what they remove for the Brazilians. As one researcher explained: "We are more important in helping them to remove 'cultural barriers'. We value the reward and recognition that stems from the international scientific community and we have socially built-in mechanisms to take criticism from them as academic and not personal. Brazilians have serious difficulties to face rejection, for example, from an international periodical. For us, this is the rule of the game and we know how to play it. It is part of the culture I guess".

Some Brazilians also referred to a kind of "cultural barrier" to publication. This, however, was not of the kind mentioned above, but had more to do with the lack of internalization of this practice in the exercise of their profession as scientists. In their words: "The Brazilian researcher works hard but is not very inclined to published his results. For the foreign researcher publication is part of the profession, but it is not so much for us. So, when we associate with them, we provide a knowledge of the region which they do not have. They, in turn, give us access to publication outlets for which they know the workings much better than we do. Because they do the writing, they are the first authors and they choose the periodicals".

An important outcome of the international collaboration projects -and one which is seldom analysed- is the training of new researchers. Foreign researchers many times participate in the graduate programs offered by INPA besides opening up their projects to Master and Doctoral students from Brazilian and foreign institutions. Table 4 below shows the number of graduate students who have been trained by the various international projects.

Some have argued that the figures shown in Table 4 are very modest, considering that most the projects have been going on for years. The Hydrology/ORSTOM project, for instance, has produced only 5 Masters in its more than 10 years of existence. However, as many have pointed out, qualified human resources are a rare commodity in Amazonia, so prospective students do not appear every day. That is the reason put forward to explain that the large majority of trained PhDs are foreigners.

This fact notwithstanding it can be said that the contribution of the projects to the training of qualified human resources is still very positive. The collaboration with the Max Plank Institute, for example, has produced 16 Brazilian Masters, and 3 Brazilian PhDs. These are today INPA's researchers who are collaborating with Max Plank and slowly building up a Brazilian leadership in the project. It goes without saying that the foreign researchers teach at the graduate programs at their own initiative since there is no provision in the formal agreements between the institutions that require them to do so. Given the difficulties to find qualified local teachers and to get Brazilians from other parts of Brazil to go to Manaus for longer terms, there is no doubt that the participation of the foreigners in graduate programs should be a part of INPA's internal policy and a requirement to all international projects participants.

4. CONCLUSIONS

The biodiversity of Amazonia greatly attracts researchers from various parts of the world. This is reflected in the large number of international collaboration projects being carried out at INPA. The intensity of such activity is atypical *viz. a viz.* other Brazilian institutions, particularly considering that the Northern region is the least developed, not only economically, but also scientifically. Thus, it seems clear that INPA is chosen by foreign scientists not for its expertise in biological research but for the access it grants to the most important and unexplored natural laboratory on earth²⁶. This is qualitatively different from what happens in international collaborations involving only advanced countries where researchers from each side have interest in the scientific capability embodied in the other side²⁷.

If foreign researchers are motivated by the scientific opportunities and challenges posed by Amazonia, the driving forces behind Brazilian researchers are of quite different natures. They engage in international partnerships out of the recognition that by doing so they will have funds for research, will have professional benefits, will help the advancement of science even if their participation in the process is sometimes marginal.

The collaborations developed from such considerably different perspectives are, by definition, asymmetrical. Reinforcing the asymmetry is the fact that foreign scientists are in general better qualified and more experienced, have control over financial resources, have much stronger personal and institutional motivations to be scientifically productive than their Brazilian counterparts.

Having been conceived from the start as international cooperation projects, the partnerships analysed here failed to produce the expected coauthored output of initiatives traditionally deserving this name. In spite of this, they have contributed significantly to the training of new researchers and to bringing into INPA habits of work typical of international science.

Although the quantitative and qualitative data provided are restricted to the case of INPA, I want to argue that they have a broader explanatory power. Similar instances involving other advanced and developing countries scientific collaboration efforts may as well present many of the traits found here.

The paper has also gone some way to demonstrate the importance of investigating and understanding the circumstances under which international partnerships are developed and implemented. This provides arguably the most significant vindication of the research design, that is, the need to gather qualitative information in order to interpret quantitative data on international research collaboration studies.

5. TABLES

Country	Institution	# Projects	Starting Y.
Germany	Max Planck (Institute of Limnology)	4	1969
France	CIRAD ²⁸	1	1985
France	ORSTOM ²⁹	2	1979
USA	Washington Un.	1	1982
USA	Smithsonian Inst.	1	1978
UK	Royal Geographical Soc. (Maracá Rainforest Project)	1	1986

Table 1. International Collaboration Projects Analysed

Projects	Brazilian*	Foreign*	Co-signed*	Total**
Max Planck	7	67	26 [21]	227
ORSTOM (Hyd)	9	28	63 [43]	58
ORSTOM (Eco)	10	63	27 [32]	121
CIRAD	70	—	30 [98]	10
Smithsonian	20	66	14 [7]	90
Un. Washington	15	18	62 [38]	70
Maracá (RGS)	23	62	16 [22]	121

* figures are percentages of the total output of each project

** figures are absolute numbers of journal articles, books and book chapters produced by each project since its official starting date.

[] figures are percentage of coauthored publications which have a Brazilian as first author

Table 2. Participation in Scientific Output of the International Collaboration Projects at INPA - Percentage of Brazilian, Foreign and Co-signed Publications

Projects	Brazilian*	Foreign*	Co-signed*	Total**
Max Planck	35	90	70	227
ORSTOM (Hyd)	40	92	98	58
ORSTOM (Eco)	40	72	65	121
CIRAD	0	—	67	10
Smithsonian	28	78	50	90
Un. Washington	85	100	82	70
Maracá (RGS)	0	92	25	121

* figures are percentages of the number of Brazilian, foreign and co-signed publications which appeared in non-Brazilian outlets

** figures are absolute number of journal articles, books and book chapters produced by each project since its official starting date

Table 3. Percentage of Publications in Each Nationality Category Published in International (non-Brazilian) Outlets

Projects	MSc		Ph.D.		Total
	Bras.	For.	Bras.	For.	
Max Planck	16	-	3	16	35
Orstom (Hyd)	4	1	-	-	5
Orstom (Eco)	6	-	3[2]	1[4]	16
Smithsonian	19	8	2	13	42
Un. Washington	6	2	5	5	18

[] Numbers in brackets stand for Troisième Cycle

The projects with the Royal Geographical Society and with CIRAD have not trained any graduate students

Table 4. Nationality of Graduate Students Trained at the International Collaboration Projects at INPA

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I am grateful to Fabiano Toni and Paulo Velho not only for the information they produced and kindly made available to me, but mainly for the many hours we spent together talking about the topic. Of course, the opinions expressed here are not necessarily theirs and I remain the sole responsible for any mistakes. I also want to express my gratitude to INPA for granting me access to its archives and to all researchers who shared their time, feelings and opinions with me. I also acknowledge the financial support of FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo, Brasil) and FAEP/UNICAMP.

6. REFERENCES AND NOTES

- 1 Beaver, B. de B. & R. Rosen, "Studies in scientific collaboration: Part I. The professional origins of scientific co-authorship", *Scientometrics*, 1 (1978) 65-84. In this paper the authors point out that the first collaborative research paper was published in 1665.
- 2 Beaver, B. de B. & R. Rosen, "Studies in scientific collaboration: Part II. Scientific co-authorship research productivity and visibility in the French scientific elite, 1799-1830", *Scientometrics*, 1 (1979) 33-49.
- 3 *Measuring Internationalization of Science*, Laboratoire d'Evaluation et des Prospective Internationales (CNRS), Paris, 1993, p. 69.
- 4 For an extensive list of the factors promoting collaboration in science see J. S. Katz, J.S., "Geographical proximity and scientific collaboration", *Scientometrics*, 31 (1994) 31-43. It has been argued that such factors -which can be grouped under the categories of economic, cognitive and social- have varying relative importance to explain either field-to field or country-to country differences in the rates of collaboration (Luukkonen, T.; O. Persson & G. Sivertsen, "Understanding patterns of scientific collaboration", *Science, Technology and Human Values*, 17 (1992) 101-126).
- 5 The novelty lies in the fact that until very recently international collaborative projects were nearly always born out of direct, spontaneous initiatives between researchers (Miquel, J. F. "Evaluation of international collaboration, *Science and Technology Policy Evaluation*, SPRU, London, 1991, p.1). Also international collaboration was granted only a marginal position in the science and technology policies of most countries (*Measuring Internationalization of Science, op.cit.*, Ref. 3). Today, however, different intergovernmental science programs have been established (e.g., the ESPRIT and the FAST Programs of the EEC).
- 6 Chesnais, F. *Some notes on technological cumulativeness, the appropriation of technology and technological progressiveness in concentrated market structures*, Vienna, 1986, mimeo.
- 7 Ohmae, K. *Triad Power: the Coming Shape of Global Competition*, New York, Free, 1985, 205 p.
- 8 For a list and discussion of international projects aimed at increasing industrial competitiveness of advanced countries see Mytelka, L. K. *Strategic partnering: some lessons for Latin America*, 1992, mimeo. Also, Miquel, J. F. *op.cit.*, Ref. 5, has shown that for OECD countries, collaboration in engineering and technology increased more than in any other field from 1986 to 1990.
- 9 Scientific collaboration involving advanced and developing countries tend to follow the pattern of economic and political influence. Thus, Japan has very strong scientific links with its neighbouring countries (see Okubo, Y. & J. F. Miquel, "International scientific collaboration of Japan, co-authorship analysis", *Journal of Science Policy and Research Management*, 6 (1992) 1-16), while the US is the main research partner of Latin America (see Narvaez-Berthelemy, N. et al, "International scientific collaboration in Latin America", *Scientometrics*, 24 (1992) 373-392).

10 This is the case, for example, of tropical forests; geological, oceanographic and atmospheric special conditions; astronomic observation. For this point see Ailes, C.P. et al, *New Directions for US-Latin American Cooperation in Science and Technology*, final report prepared for National Aeronautics and Space Administration, Arlington, VA, 1988, SRI project 3164.

11 For example, Brazil is said to have more species of flowering plants (approximately 55,000) than any other country on earth (G. Prance quoted in Plotkin, M. J. *Biological Diversity and Modern Medicine*, Statement before the Subcommittee on Natural Resources, Agriculture Research and Environment of the Committee on Science, Space and Technology of the US House of Representatives, 1987). Also, the Rio Negro in Central Amazonia contains more species of fish than are found in all of the rivers of the US combined (M. Goulding quoted in Plotkin, M. J. *ibid.*).

12 Ailes, C.P. et al, *op.cit.*, Ref.10.

13 The choice of this institution is justified on many grounds. Firstly, INPA is the federal institution responsible for biodiversity research in Amazonia. It is also the strongest and most respected scientific institution in the region with a significant number of qualified researchers (for regional standards)- around 80 PhDs. Also INPA has for many years been involved in various types of international scientific partnership -institutional, bilateral, multilateral- which makes it a relevant subject for analysis.

14 INPA was created in 1952 but installed in 1954 and up to the end of the 60's was slowly building up its physical infrastructure and human resources capacity.

15 The word "project" has been used here in the way it is done at INPA. It does not stand for a single research work but includes many different sub projects related to a broad and general objective.

16 With the exception of the Maracá Rainforest Project with the Royal Geographical Society of the UK, which lasted for 18 months and of the one with CIRAD which lasted 3 years, all other projects have been going on from their starting date up to now.

17 Although not all collaborative efforts end up in coauthorships, nor all coauthored publications necessarily imply cooperation between the authors, it is assumed that in most cases coauthorship indicates a fairly active cooperation between partners (Luukkonen, T.; O. Persson, G. Sivertsen, *op.cit.*, Ref. 4).

18 This analysis was performed because it was expected that collaboration with foreign colleagues could be an important prerequisite for submission to SCI-covered journals from Brazilian scientists (see Luukkonen, T.; O. Persson, G. Sivertsen, *op.cit.*, Ref.4, p.104).

19 Leclerc, M.; Y. Okubo; L. Frigoletto & J. Miquel, "Scientific cooperation between Canada and the European Community", *Science and Public Policy*, 19 (1992) 15-24.

20 This is an important methodological point -are scientists to be classified according to their nationality or to their institutional affiliation? The procedure adopted here was, as is the rule in studies of this kind, to classify the authors according to their institutional affiliation. There were cases, however, when authors had no institutional affiliation, that is, they were graduate students doing their research under the collaboration projects. The methodological decision was to classify such authors by their nationality, irrespective of the institution where they were registered for their courses.

- 21 This was typically the case of the Ecology project with ORSTOM. Because INPA did not have soil scientists who could work together with the French pedologist, the latter was forced to work by himself. It is worth mentioning that the co-signed publications that eventually came out of the sub project in soils had the participation of Brazilians from other institution -the University of São Paulo- and not from INPA. For a detailed analysis of this point see Toni, F., *Avaliação da Cooperação Científica Internacional em Pesquisa Biológica na Amazônia: o Caso Brasil e França*. MSc Dissertation, DPCT/IG/UNICAMP, 1994.
- 22 The project with the University of Washington, for example, in the period 80-81 had only 20% of the publications with a Brazilian as first author, a figure which increased to almost 50% in 1993.
- 23 For a detailed analysis of this case see Velho, L. & P. Velho, "Advanced/Developing Countries Collaboration in the Biological Sciences: the Case of the Maracá Rainforest Project", paper presented at the Meeting of the Society for Social Studies of Science, Gothenburg, Sweden, 23-27 august, 1992.
- 24 There are three exceptions: the Hydrobiology project with ORSTOM, which seems to be the one where Brazilians and foreigners are collaborating the most; the project with the University of Washington which has already been commented; and the collaboration with CIRAD which was an atypical case because it involved only one foreign participant who was not a scientist, but a technician, and went to INPA to work on an already existing local investigation (for details of this collaboration with CIRAD see Toni, F., *op. cit.*, Ref. 21).
- 25 These figures provide further evidence for the argument of Luukkonen, T.; O. Persson, G. Sivertsen, *op. cit.*, Ref. 4, p.104, that "collaboration with foreign colleagues could be an important prerequisite for submission to SCI-covered journals from scientists of the smaller countries".
- 26 As said one of the foreign researchers: "As an ecologist, tropical rain forests are the most fascinating places to work because there is the diversity and so much to see, besides being badly threatened areas".
- 27 Leclerc, M.; Y. Okubo; L. Frigoletto & J. Miquel, *op.cit.*, Ref. 19, p. 17, argue that "International co-operation exists because scientists need each other's competence". The authors point out that even this kind of collaboration may lead to new forms of dominance or of asymmetrical equilibrium between the participants.
- 28 CIRAD is Centre de Coopération Internationale en Recherche Agronomique pour le Développement.
- 29 ORSTOM is Institut Français de Recherche Scientifique pour le Développement en Coopération.