# ASSESSMENT OF INTERNATIONAL SCIENTIFIC COLLABORATION IN BRAZILIAN AMAZONIA

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## Introduction

Amazonia represents a crucial region of the globe from the point of view of biological research and its technological and economic applications. Awareness of this fact has been growing steadily in recent years for different reasons. On the one hand pollution, soil degradation and population pressure combined to cause so many extinctions of species that some people started to become frightened (1). These people, who see life as intrinsically worth sustaining, put forward moral and ethical reasons for biodiversity conservation. On the other hand molecular biology and genetic engineering, which allow the combination of genes across all taxa, opened up potentially new technological applications and transformed genes in rare commodities. Since genes come packaged in species, most of them unknown to science (2) and possibly containing useful information, biodiversity became, at least temporarily, worth protecting for economic reasons.

It is biotechnology which establishes the articulation between environmental and economic value of biodiversity, opening up a new action field for global capitalism. In this context, Amazonia – which contains a considerable proportion of the world's living species (3) – stands out as a particularly important biodiversity region. Some argue that it is through the biodiversity located in its territory that Brazil can expect to play a role in the globalization process which is shaping new international relations (Santos, 1994). From this perspective it seems that biodiversity may mean for Brazil both an opportunity and a problem. Whether the former or the latter will prevail depends on several factors, one of which is the knowledge of its biological resources that the country will be able to obtain and apply.

However, assessment studies and systematic observation of biodiversity which can lead to its conservation and sustainable use is not a task that can be accomplished by just the countries containing the biological resources. In fact, this has been considered by many to represent an area in which all scientists and all nations have a major stake. It is agreed that there must be a quantum leap in scientific and collaborative activity in this field so that all nations will benefit from the increased knowledge deriving from studies of tropical biology and scientifically based conservation of biological diversity (4).

Thus, considering that averting the biological diversity crisis is seen as a respon-

sibility of all nations, and that Amazonia is a crucial region for biodiversity, it is not surprising that scientists, particularly of the advanced countries, have focused their interest in carrying out investigations in that part of Brazil. So it is that a number of collaboration projects involving different advanced countries – UK, USA, France, Germany, Japan and others – have either been carried out, or are currently under development, or are being thought of or negotiated with the Brazilian government in order to investigate different biological aspects of the Amazon Region.

From the Brazilian perspective there is broad agreement to the extent to which the country lacks the scientific expertise and the number of scientists required to tackle the volume and complexity of the scientific questions waiting to be studied in the region. Also, there is awareness that such an enterprise requires considerable amounts of money, a rare resource in these days of serious fiscal crisis of the Brazilian state. Add to this the current globalization of the economy, the trend towards internationalization of science and technology, the growing competition between countries and regional blocks and it becomes evident that international collaboration in science is not only desirable, but essential for the country. This fact notwithstanding, when it comes to the implementation of scientific collaboration projects there is considerable conflict of opinion not only between different social segments but also between local scientists (5).

On the one hand some believe in the «neutrality» of science, in the advancement of scientific knowledge as a common heritage flowing freely across political and geographical barriers. For those, Brazil should stimulate the scientific collaboration with advanced countries, avoid all restrictions to access of foreign scientists – even in strategic areas like Amazonia – because the nationality of the scientist is not important, since science is international (6).

On the other hand a considerable number of local scientists and other segments of the population are very reluctant to unreservedly open up the frontiers of the Amazon for foreign scientific exploration. The reasons for such reluctance are many but may be summarized under two categories:

1) "economic imperialism": the biological resources of Amazonia have an impressive potential for economic application which can occur by different means: domestication of wild species; use of natural biochemical compounds for the synthesis of pharmaceuticals, fibers and foodstuff; the scaling up of biological processes to industrial applications; and most importantly, use of genetic information contained in plants, animals and microorganisms to obtain new engineered organisms (7). In view of that, there are fears that foreign research activities in the region would revert in economic benefit to the advanced countries (because they are scientifically, technologically and financially better qualified to explore such resources) at the expense of Brazil. This argument does not imply the closing down of Amazonia to foreign scientific activity but means that access must be negotiated so that the country may actually benefit, scientifically and economically, from such exploration. It puts forward the need to discuss, beforehand, questions such as the Brazilian access to international germplasm banks controlled by the North, intellectual property rights to native and modified germplasm, foreign access to Brazilian native germplams in exchange for new technologies, and so on (8).

2) "scientific imperialism": 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-wide (9). It is argued that foreign scientists are only, or mainly, interested in benefit from access to such biological resources in order to further their own careers and scientific interests, and have very little concern for developing the biological sciences within Brazil, or for training local young scientists (unless such scientists pay for the high fees charged by advanced country universities), or for helping in institution-building (10). There is also a belief that foreign scientists may introduce concepts, methods and techniques of research developed in their countries to the study of the Amazon, which may not be the most appropriate approach to investigate the region.

It is clear from the above that North/South scientific collaboration in general, and in the biological aspects of Amazonia, in particular, involves not only scientific and technical aspects, but also political ones (11). Collaboration projects must be thought of and designed with great care, negotiated with scientists and other segments of society and must be systematically evaluated so that corrections of course of action may be taken, lessons can be learned for future initiatives, and benefits (or the lack of them) can be identified. Most collaboration projects in Amazonia share a common problem: they have not been subject to any kind of evaluation from the Brazilian side, therefore what is said about them are impressionistic views painted by political and ideological colours.

While it is easy to say that scientific collaboration projects must be evaluated, carrying out the evaluation is a difficult thing to do, since there is no agreed methodology to perform such a task. It is generally perceived that international research collaborations are intrinsically beneficial: that they contribute financial resources not available internally; that they enhance the prestige of local scientists; that they expand training opportunities; that they help to consolidate internally some scientific fields; that they improve international relations. There are, however, few measures – either quantitative or qualitative – of any of these benefits, although most Brazilian policy experts do not dispute them. Without accurate measures, however, we cannot really test the equations used to demonstrate that the presumed benefits outweigh potential losses in every circumstance.

In view of what was said above, this paper reports the first attempt to develop and apply a methodology for evaluating international collaboration projects in the Brazilian Amazonia. The focus of the study is on such projects being carried out at the Amazonia National Research Institute (henceforth INPA). The choice of this institution is justified on many grounds. Firstly, INPA is the federal institution responsible for biodiversity research and the use of biological resources 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 partnerships – institutional, bilateral, multilateral – which makes it a relevant subject for an evaluation exercise. In addition, presently INPA has been struggling to elaborate its strategic planning for the next ten years, which includes designation of the role to be played by international

collaboration. For this reason, the institution had great interest in participating in the study and supported its development.

Finally, at present, the advanced countries as well as the international organizations are reviewing their international cooperation policies. Among other things there is now a clear preference for funding environmental related research (12). In view of that, a significant increase in the number of international collaboration projects to be negotiated with INPA is expected. Learning from past experiences is essential if the country is to benefit from the new international collaboration opportunities.

In what follows the methodology used in the study is presented, as well as the main findings and conclusions.

## Conceptualization and methodology

The basic assumption underlying this study is that the evaluation of a collaborative scientific effort must look at the whole process -from its negotiation phase to the final results- trying to identify the role played by each side as well as the potential and real benefits which accrued to each partner. This methodological procedure derives from the obvious recognition that collaboration among knowledge producers represents essentially a pragmatic attitude. In other words, no one gets involved in a partnership without believing they will get something out of it. Particularly, to Brazilian scientists working in Amazonia collaborative research projects may hold the promise of access to financial and qualified human resources, to international scientific publication channels and to recognition from the international scientific community. To the advanced countries such collaboration means access to biological resources and ecosystems which are only available in Brazil.

The concept of an "ideal" research collaboration used in this study includes such characteristics as: (1) equally divided tasks; (2) common sources of support (or shared assets) and shared equipment; (3) pooled intellectual effort. Shared input naturally implies (4) shared output – from co-authored publications and reports, to co-ownership of patents and copyrights and hence equally divided royalties. As a consequence of (4) both parties should be able to equally share the credit and professional reward for the work done. Having in mind these characteristics the methodology attempted to find out the extent to which they could be found in the international collaboration projects being carried out at INPA.

As for the sources of information, the general assumption is that both parties involved in the project must be investigated. Sources were of two kinds: archival and personal. The former refers basically to written documents -project agreements, correspondence, scientific papers, reports and the like. The latter involved personal semi-structured interviews with participants – both scientists and non-scientists – in the international projects under development at INPA. In total around forty people were interviewed including Brazilian and foreign scientists as well as government officials.

The information collected and analyzed allows answers to many important questions and clarifies the circumstances in which the projects were negotiated and implemented. It also provides grounds for a number of preliminary and tentative conclusions about

international scientific collaboration activity in Amazonia in general, not only at INPA. Such aspects will now be taken in turn.

## Main findings

In 1951 the Brazilian Ambassador to UNESCO presented a bill to the National Congress to create an international research institute in Amazonia – the Hileia Amazonica International Research Institute – which would be under the auspices of UNESCO. Scientists from all UN member countries would have access to carry out investigation in the institute which would be managed by an international board. The bill was attacked from various fronts and was eventually rejected by large majority after political leaders in both the House of Representatives and Senate delivered forceful speeches against it and the powerful and nationalist Armed Forces Ministry issued a very negative review of the project.

Feeling that it owed a response to international public opinion, the Brazilian government decided to create the Amazonia National Research Institute to carry out the investigations other countries were calling for. Collaborations with other countries were welcome, but political, administrative and managerial control would be exclusively Brazilian. Thus, INPA was created in 1952 but installed in 1954 and up to the end of the 60s was slowly building up its physical infrastructure which today contains around 40 buildings, more than a hundred laboratories, collections, libraries, biological reservations, experimental stations, ships, large boats and so on.

The most difficult part of the enterprise was perhaps to gather a critical mass of qualified researchers to do the work. The Northern Region of the country is the least developed and it was very difficult to find people from other regions who wanted to move to Manaus, Amazonas State capital city. It was necessary, then, to invest in the scientific training of locals and to rely on researchers from other parts of Brazil and from other countries who were willing to spend some time in Amazonia. This problem has persisted until the present and is responsible, in great part, for the situation which will be discussed below. This fact notwithstanding, INPA has managed to have today a permanent body of researchers of around 300 – 80 PhDs, 120 MScs and 100 graduates (Brasil, 1993). There is also a temporary mass of people doing research at INPA which varies from 200 to 300 and is made up of graduate students (locals, from other parts of Brazil and from other countries) and foreign researchers. Adding these numbers it is possible to realize that there is quite a lot of research activity going on at INPA. This, added to the challenges and scientific opportunities presented by the natural laboratory of Amazonia, would suggest a fostering research environment. There are problems, though, which will be presented later on.

Since its beginnings INPA has hosted a significant number of foreign researchers. Some have been incorporated into its permanent research staff, but the majority have carried out collaborative work with Brazilians, staying at INPA for short or long terms. Today INPA is the Brazilian institution which has the greatest number of international collaboration projects – 20 under execution and 24 being negotiated.

This study has looked at all the 20 international collaboration projects (13) being carried out as well as at one which was developed in recent years and has already

finished (the Maracá Rain forest Project, with the Royal Geographical Society of the UK). Table 1 lists such projects and identifies the participant countries and institutions.

The projects in Table 1 were in varying phases of development. Some of them have been going on for many years -such as those with Max Planck Institute of Limnology, with ORSTOM, with the University of Washington, with the Smithsonian Institution. Others have just started -with UK institutions, with CSIRO, with the University of Tokyo. Still others, as mentioned, have already finished -with the Royal Geographical Society. This, of course, raised problems for the application of the methodology since not all the characteristics could be examined for all projects. In spite of this the analysis of the projects evidenced so many similarities in their dynamics and functioning that the different stages of development did not invalidate the comparison. Thus the presentation and discussion of the findings will be restricted to the general and recurrent problems and features of all projects. Specific projects will only be identified when a relevant point needs to be made and illustrated.

**Table 1. Ongoing International Collaboration Projects at INPA**

| Country | Institution | # Projects | Starting |
|---|---|---|---|
| Germany | Max Planck (Institute of Limnology) | 4 | 1969 |
| France | CIRAD | 1 | 1985 |
| France | ORSTOM | 2 | 1979 |
| USA | Washington Un. | 2 | 1982(CAMREX)<br>1991(EOSRAM) |
| USA | Smithsonian Inst. | 1 | 1978 |
| USA | NY Bot. Garden | 2 | 1980 |
| Canada | IDRC (Int. Devpt. Res. Centre) | 1 | 1987 |
| Japan | ITTO | 1 | 1992 |
| Japan | Un. of Tokyo | 1 | 1992 |
| Australia | CSIRO (Common. Scient. & Ind. Res. Org.) | 1 | 1991 |
| UK | NRI (Nat. Research Inst.) | 1 | 1992 |
| UK | Hydrology Res. Inst. | 1 | 1990 |
| UK | Kew Bot. Garden | 1 | 1992 |
| UK | Sea Mammal Res.Inst. | 1 | 1993 |

## Negotiation and Management of the International Collaboration Projects

Negotiation for the establishment of international scientific cooperation agreements may take different forms, from the most simple researcher-to-researcher agreement up to multilateral ones involving international organisms. However, by far the most common form ruling the international collaboration projects at INPA is the bilateral agreement. This is part of a more general and broad cooperation treaty signed by Brazil and another specific country through the Brazilian Cooperation Agency of the Ministry of International Relations (ABC/MRE). When a scientific project appears to be developed under these agreements, the Brazilian National Research Council (CNPq) then becomes

involved. CNPq is in charge of the negotiation, management and funding of the Brazilian side of the international collaboration projects. The negotiator of the foreign side, on the other hand, is generally the institution which will execute the project, often accompanied by the funding organism.

A number of problems may be listed which are created as early on as the negotiation of projects starts which have consequences throughout their development. The two most important are worth mentioning here. The first is that some of the agreements are very old indeed and were signed when the context was completely different, being thus anachronistic. For example, some agreements establish the cooperation to be restricted to exchange of information and researchers and do not set rules for long-term stays of foreign researchers at INPA. Yet researchers under such agreements do stay at INPA for years and nobody knows very well what should be expected from them, what should be given to them, how to control and evaluate the work done. It is a typical case in which, in practice, the project is an institutional collaboration but the mechanisms to manage, control and evaluate it are those of a simple exchange.

Some of the foreign institutions have been so long at INPA that they have built their own buildings (inside INPA's campus), established laboratories and equipped them, installed administrative offices and representations inside INPA's buildings. How can such a situation be controlled by INPA without pertinent provision under the agreement? This is not a simple bureaucratic concern. The absence of clear rules and procedures which can be relied upon poses serious problems for INPA's directors in the everyday routine but, much more seriously, when specific situations come up. For example: who is to pay for the "per diem" of the field workers who will accompany Brazilian and foreign researchers on a field excursion? Should the equipment brought in by the foreign researchers be incorporated into INPA's assets? In which circumstances? Whose are the property rights for the scientific results and for technological applications they might generate? A considerable amount of conflict not only between foreign scientists and administrators, but also between researchers (foreign and locals but also between locals involved and not involved in the international collaborations) could be avoided if rules and procedures, duties and rights, cans and cannots were clearly set out at the negotiation table. For this, the negotiation of projects which is done by CNPq and the foreign institution would have to be not the final step as it is today, but the stage that gives the go-ahead to a new negotiation round between INPA and the foreign participants. Only after that should the projects be allowed to begin.

The second problem, however, is even more serious. It has to do with the lack of expertise in negotiation from the Brazilian side. The reading of the agreements reveals clauses which are clearly against Brazilian interests. For example, a recent agreement signed by the Ministry of Science and Technology (on behalf of INPA) and the Max Planck Institute of Limnology establishes in its clause 2, first paragraph that "it is the attribution of the chief of the work group of the Max Planck Institute to elaborate the basic program for the research projects in limnology and ecology for the Brazilian Amazonia".

In summary it seems that the negotiation of international collaboration projects under execution at INPA is flawed in many ways. The Brazilian side apparently do not know what it wants from the collaboration while the foreign partners are very targeted. The

only thing that the Brazilian officials in charge of negotiation seem to have very clear in mind is that international collaboration projects mean external funds for research and, consequently, saving domestic money. This point will be discussed now.

### Funding for the International Collaboration Projects

When the foreign researchers decide to carry out a project at INPA they can get the necessary funds by different means. Some spend a long time in fund-raising activities by exchanging correspondence and making contact with prospective donors (14).

More commonly, however, foreign researchers succeed in getting money from their own institutions or to receive grants from their country's or international funding agencies. To start the process they need to have a research proposal which will be submitted to the various organisms. Thus, a project which will be carried out in Brazil by ORSTOM, for example, may count on a certain amount of money from this institution but may also be partly funded by EEC. Such a procedure has consequences for the Brazilian side: (1) the project which arrives in Brazil has already been designed and submitted to foreign agencies, frequently without the participation of the Brazilian partners. The latter are then invited to participate, often just to fulfill the Brazilian requirement that all projects need a local "counterpart"; (2) the Brazilian participants frequently have no idea of the real project budget or of the institutions which are funding it; (3) part of the money is often spent in "overheads" to the home institution of the foreign researcher (15).

In fact foreign researchers at INPA seem not to have serious money problems (of course, money is never enough, as some pointed out). The Brazilians, however, 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. CNPq, which is the funding agency for Brazilians in some of the projects – e.g. ORSTOM, CIRAD, Max Planck – traditionally has not done its part due to financial constraints. This situation (the foreign side has and the local side has not) can be very conflicting. It is true that not infrequently the foreign partner ends up funding all the project's current expenses, but this also has its price: the Brazilians must *ask* the foreigners for money and the latter *decide* whether they will give it or not. Brazilians are then excluded from control and decision over financial resources for the projects.

What is many times forgotten is that, despite its financial difficulties, INPA contributes significantly to the various projects: paying salaries for the researchers, technicians, field and administrative personnel; maintenance expenses such as electric power, water, telephone; making cars and boats available at no cost. Some even argue that what INPA gives foreign researchers has no price: access to the greatest natural laboratory of the planet. Despite the appeal of this argument, INPA cannot negotiate with foreign partners based on it. It is essential that the institution be able to negotiate from a strong position and this means, among other things, having research funds which can be used the way judged most appropriate.

In order to have this financial flexibility, INPA's board of directors decided last year to pass an administrative directive charging 15 % of each project's budget as overhead to INPA. This has provoked a rebellion of the foreign researchers who promptly exhibited the terms of agreement containing no provision for this measure. So far, none of

the 20 on-going projects have paid anything to INPA. The institution is struggling to include this clause in the negotiation of the 24 new projects.

Without proper negotiation and having very little control over financial resources, it is not surprising that the Brazilian position is also weak both in the execution of the projects and in the scientific outcomes.

### Choice of Research Problems and Division of Tasks

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 was pointed out that when foreign researchers approach INPA most of the time they already know clearly what they want to do. They are more in search of a place in Amazonia where to develop the project than of a Brazilian partner to collaborate in the planning and design. The second reason is that INPA does not have enough qualified researchers in all fields and problems proposed by foreign scientists (16). Thus, because Brazilian legislation requires a local scientist to participate in all collaboration projects, often the assigned "counterpart" is not familiar with the research field or problem and plays a bureaucratic role. Also foreign researchers are frequently better qualified, have greater international experience and prestige and, due to a certain "colonial mentality", are generally perceived by Brazilians to be wiser and better prepared to make such decisions. In addition, INPA did not have, until very recently, an internal research agenda which would identify priorities and serve as a guide to define research projects. Finally, because foreign scientists have control over research funds they are in a favorable position to lead the research toward their own interests.

Important scientific decisions are made then by foreign scientists, while the Brazilians 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.

### Scientific Outcomes of the International Collaboration Projects

A significant number of publications has come out of the various international collaboration projects at INPA. However, as said before, not all projects have already reached a stage in which publications were produced. Some have not published anything yet; others have just started to. Thus, the analysis of the scientific output was performed for only those projects which have either finished or have been going on for some time and whose coordinators felt comfortable enough to hand out the publication lists for the purposes of this study. The output for such projects 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, a number of general trends can be identified. Firstly, co-authorship publication between Brazilian and foreign scientists seems not to be the rule. If it is assumed that "international collaboration in science is the

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

| Projects | Brazilian* | Foreign* | B+F* | Total** |
|---|---|---|---|---|
| Max Planck | 7 [35] | 67 [90] | 26 [70] | 227 |
| Orstom (Hyd) | 9 [40] | 28 [92] | 63 [98] | 58 |
| Orstom (Eco) | 10 [40] | 63 [72] | 27 [65] | 121 |
| Cirad | 70 [0] | – – | 30 [67] | 10 |
| Smithsonian | 20 [28] | 66 [78] | 14 [50] | 90 |
| Camrex (W.Un.) | 15 [85] | 18 [100] | 62 [82] | 70 |
| Maracá (RGS) | 23 [0] | 62 [92] | 16 [25] | 121 |

[ ] Numbers in brackets mean percentage of publications in the nationality categories which were published in international [non-Brazilian] outlets.
(*) Figures are percentages of the total output of each project.
(**) Figures are absolute number of journal articles, books and book chapters produced by each project since its official starting date.

result of works developed between two or more countries and identified by means of co-signed articles" (Leclerc *et al.*, 1992, p. 16), 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 co-authored publications (63% of the total output) (17). Moreover, 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 these, only one had a Brazilian researcher as the first author. Similarly, CAMREX project with the University of Washington presents only 38% of co-authored articles with a Brazilian as the first author. 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.

Reasons for this state of affairs were discussed with the interviewees and many factors are at play. For one thing there was wide agreement that the lack of a qualified INPA scientist working in the specific field or topic of the project is largely to blame (18). Also, often the foreign researcher is better qualified, more experienced and truly has the scientific leadership. Evidence of this is that 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. This means that as the Brazilians become more qualified and experienced they start to have more initiative to lead the research (19).

It is also a general feature of the projects that foreign researchers alone are responsible for the greatest proportion of the total output (with the exceptions, already commented on, of Hydrology/ORSTOM and CAMREX). 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. Seen from this perspective it seems that the projects have served more to enhance the international visibility of the foreign scientists than that of their Brazilian counterparts. The Brazilians, however, seem to be «pushed» to publish internationally when they co-sign the publications together with a foreign researcher.

Some 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 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.

An important outcome of the international collaboration projects is the training of new researchers. Many foreign researchers participate actively in the graduate programs offered by INPA. All the projects are open to Master and Doctoral students from Brazilian and foreign institutions who want to develop research leading to their dissertations in topics related to the projects' objectives. Table 3 shows the number of graduate students who have been trained by the various international projects.

It can be argued that the figures shown in Table 3 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 the researchers argue, 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. It goes without saying that the foreign researchers teach on the graduate programs at their own initiative since there is no provision in the agreements that require them to do so. Given the difficulties of finding 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 for all international project participants.

**Table 3. Nationality of Graduate Students Who Were Trained on the International Collaboration Projects at INPA**

| | MSc | | Ph.D. | | Total |
|---|---|---|---|---|---|
| **Projects** | **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 |
| Camrex (W.Un.) | 6 | 2 | 5 | 5 | 18 |

[ ] Numbers in brackets stand for Troisième Cycle.

## 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 earth. 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 side.

In such circumstances, the partnership established between INPA and foreign research institutions is, by definition, asymmetrical. Recognition of this from the very beginning would be important for taking measures to counteract the effects. As this is not done, from the negotiation of the projects to the final results, the asymmetry is reinforced: negotiation is inadequately conducted and project management is poor from the Brazilian side; Brazilian interests are not clear and thus cannot be spelled out; local researchers lack qualification and an internally established research agenda; budget is severely cut and committed research grants either arrive later and smaller or never do; salaries are declining, there is no institutional motivation to be productive; human resources turnover is very high (Amazonia is fascinating but Manaus is a very difficult place to live for long periods) and the institution cannot hire new researchers who occasionally appear (20).

Into this scene comes the international collaboration projects promising: ready-to-start research projects; qualified researchers; research funds; sophisticated equipment; occasional international travel to congresses or short-term training in foreign (advanced) countries; scientific leadership; an occasional co-authored paper in a prestigious international journal. All this added to the political and diplomatic pressures pushing INPA to host international partners can only result in the situation this paper has described (21).

The difficulties of a developing country to negotiate and implement effective scientific collaboration projects with an advanced one are enormous. The obstacles are derived from the "weaker" position of the developing country not only with respect to scientific qualification and insufficient research funds, but also from a political perspective. Of course this is not a justification for not establishing international collaboration efforts, much to the contrary: the collaboration of foreign scientists is essential to the scientific development of these countries. The argument is that it is up to the developing countries to get themselves internally organized concerning this issue by establishing a protocol of procedures and a blueprint for collaboration which attends their scientific and development objectives. Of course, this would mean that these countries need first to know what such objectives are and how they can proceed to achieve them. And that is the most difficult part: to build a wide social agreement around a truly «national project» able to provide all public policy with a concerted direction.

## NOTES

**Acknowledgements**: *Thanks are due 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. My gratitude also goes to INPA for granting me access to all archives and documents as well as for making my stay there both pleasant and productive. I am also strongly indebted to all researchers who shared their precious time, reflections and experiences with me in endless interviews and conversations. Finally, this research would not have been possible without the financial assistance provided by FAPESP, FAEP and CNPq.*

1) Christensen (1987) argues that the rate of species extinction is accelerating to the point that by the end of the century from 5 to 10 million species may have disappeared -approximately half of all species existing today. Another estimate points to the extinction of 25% of today living species by the year 2000 (Shen, 1988). Despite the different calculations for species extinction rates, there is wide agreement that the loss of species (biodiversity erosion) is the most serious environmental problem facing humanity today.

2) Only 5,000 of the estimated 250,000 existing species of superior plants have been systematically classified and examined. Of these, only 1% have been analysed in detail by scientists in order to identify those of potential economic importance (Myers, 1988).

3) 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, 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, 1987).

4) Agenda 21, for example, in chapter 15 on Conservation of Biological Diversity, when designing the basis for action explicitly calls for effective international cooperation as a requirement "for the *in situ* protection of ecosystems, for the *ex situ* conservation of biological and genetic resources and for the enhancement of ecosystem functions" (p. 131).

5) A recent public opinion survey in Brazil indicated that 45% of the sample believe that external cooperation is necessary to protect our environment, while 47% think Brazil should do it alone (Leitão, 1993).

6) There are known cases of Brazilian scientists who, aware of the lack of scientific capability within the country to perform some kinds of analysis with native germplasm and "in the name of science", have helped foreign scientists to leave the country with living organisms without conforming to legal requirements.

7) The germplasm of native species has strategic importance for the obtention of new species with specific and desirable characteristics. Different authors have pointed out that the germplasm reservoir of the Amazonia has an unlimited potential for economic application (see, for example, Adler, 1985).

8) The proponents of this argument want the access of the North to the germplasm of the South to be linked to technology transfer in the reverse direction or, at least, to a more favorable participation of the South in technological development.

9) Departments of systematics, for example, in the developed world have been closing down for some decades because it was felt that the gene was the unit of life, the organism being a mere package (Dawkins, 1986). With the recognition of the biodiversity crisis there is now talk of infusing new life into systematics and consequently there is significant interest on the part of botanists in Amazonia as a means, among other things, to justify their institutional existence (Janzen, 1993).

10) It is constantly argued that despite the great number of foreign scientists who have spent significant time at INPA the institution has not suceeded in consolidating an international reputation in the biological sciences. Moreover it still lacks expertise to perform relatively unsophisticated tasks such as plant taxonomy. This is, at least partially, attributed to the lack of interest of foreign scientists in contributing to the strengthening of the institution and to the qualification of its human resources.

11) Science and technology, given their assumed artificial neutrality, have many times been placed at the center of diplomatic relations as a means to achieve political and commercial objectives. Such a foreign policy mechanism makes possible the inclusion of scientific cooperation packages in the negotiation process of more "sensitive" matters such as commercial treaties and intellectual property questions (Dickson, 1988).

12) During the last two decades foreign interest in collaborating with Brazil has clearly been declining for a number of reasons. In the beginning of the 90s the picture was suddenly reversed given the importance of the biodiversity crisis. The case of the UK is a good example. According to officials of the Brazilian Ministry for International Relations, by the mid 80s the UK was "phasing-out", waiting for projects with Brazil to finish and with no interest in renewing them. Then the word sustainability came into being and the British government decided it was politically important to show public opinion that it was aware of the problem and contributing to its solution. Thus M. Thatcher decided to give ODA – the British Agency for Overseas Development – the amount of £ 100,000,000 to be applied in projects related to sustainable development of tropical forests. For this reason the British have since then been offering funds to cooperation projects in the Brazilian Amazonia.

13) 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 subprojects related to a broad and general objective.

14) That was the procedure adopted, for example, by the Royal Geographical Society of the UK to fund the famous Maracá Project in Amazonia. The exercise resulted in a list of more than 100 donors, including many pharmaceutical companies.

15) This is the case, for example, of the CAMREX Project between INPA and the University of Washington, USA funded by the National Science Foundation. The University of Washington keeps 25% of the funds for the project as "overhead" payment. Ironically, INPA, which provides all infrastructure for the project, receives nothing.

16) There are many examples of this situation at INPA. One is the project between INPA and the New York Botanical Garden which has been going on for around 12 years. Because INPA lacked, and still does, qualified plant taxonomists the foreign partners were completely free to do whatever they wanted. The result was that the New York Botanical Garden has today the most complete collection of plants from Brazilian Amazonia, far better than the collection owned by INPA.

17) CAMREX, the collaboration project with the University of Washington, also has a significant proportion of co-signed articles. This figure, however, must be looked at with care. The reason is that one of the researchers, of American origin, started to work at the project as the foreign partner. In recent years he was incorporated into INPA's staff and since then his name in a publication has been counted as Brazilian participaton. His name is the only "Brazilian" appearing in 25% of all papers which were classified as co-authored.

18) 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 subproject in soils had the participation of Brazilians from other institution (CENA/USP) and not from INPA. For a detail analysis of this point see Toni, 1994.

19) 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.

20) It was a common complaint of the interviewees that when local graduate students finish their work and are willing to stay as researchers at INPA, there is no way to hire them. According to the institution's director INPA has not hired a single researcher in the last 6 years.

21) The Maracá Rainforest Project with the UK is a typical example of INPA's being politically and diplomatically forced to enter a partnership against its will. For a detailed analysis see Velho & Velho (1992).

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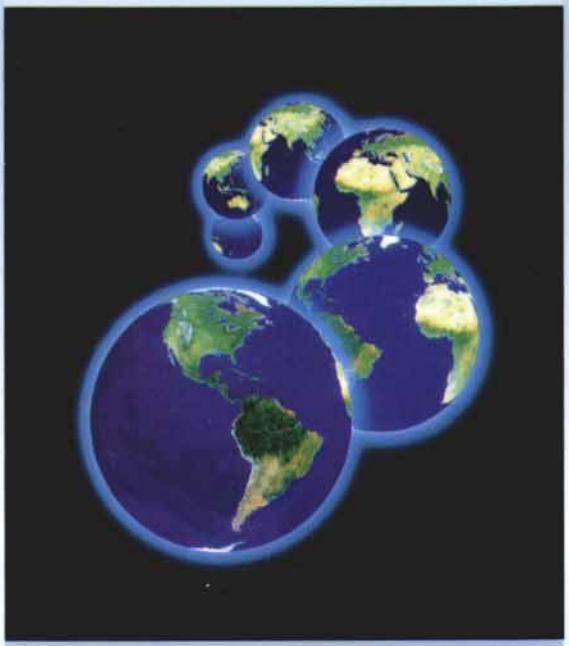

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L'INSTITUT FRANÇAIS DE RECHERCHE SCIENTIFIQUE POUR LE DÉVELOPPEMENT EN COOPÉRATION
PARIS 1996