Ecology and environmental sciences in Brazilian Higher Education – Graduate Programs, Research and Intellectual Identity

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Introduction

Ecology has become a first rank scientific discipline or at least a primary source of problems, theoretical frameworks or orientation in recent years. From a minor and institutionally restricted discipline until the second World War, Ecology has achieved remarkable prominence from the sixties on (McIntosh, 1985). Much of this has to do with the environmental issue having become an all encompassing mandatory problem, a set of general questions integrating an unavoidable agenda, now not only for science, but for a great number of other professional practices and symbolic fields and, above all, for politics. Ecologists have, undoubtedly, played a role in this process and in the sites where Ecology has been a traditional well established discipline, it has gained priority in the establishment of environmental studies. The range of expression of the environmental issue as a top problem and its outcomes is worldwide. Nevertheless, Ecology as a scientific discipline is certainly an Anglo-American tradition (Citadino, 1980; Hagen, 1992; Coutinho, 1994). Therefore, the rapid and irreversible spread of the environment biased set of orders triggered in the seventies could in some sites lack the disciplinary/institutional Ecology base to found it. How did the process of institutionalization of research themes and specialities derived from it proceed in these cases? Did it require the previous establishment of Ecology as a scientific practice, with a definite community of practitioners sharing basic theoretical and procedural assumptions? Did it run over latecomer ecologists and rooted its basis in other disciplines? Did it disregard disciplinary boundaries and flourish through alternative knowledge production schemes? To answer such fundamental sociology of science questions we need local cases to study. Brazil is one of these cases, where Ecology is not traditional and where the establishment of the environmental theme as a high priority subject has been quite successful. Therefore, the study of this case can provide important contributions to the understanding of alternative processes of science institutionalization, of knowledge production, and of the negotiation of the relevance of science and of the scientific role in society. This paper will present the first outcomes of a research about the institutionalization of Ecology and of the environmental theme in Brazilian higher education[1] and some preliminary considerations on the subject. I will try to show that the emergence of Ecology as a distinct scientific practice in Brazil has followed major international trends as well as a favorable local environment, but that it has been largely short-circuited by the trans-disciplinary, context-driven environmental research trends.

[1] *A institucionalização de diferentes perspectivas da Ecologia e da temática ambiental no ensino superior brasileiro*, supported by FAPESP, Project 1995/0449-8.

To understand what these trans-disciplinary context-driven alternative forms of technoscience[2] look like, the recent history of Ecology and of the emergence of the environmental issue are very illustrative. Ecology is one of the disciplines of the "new Renascence" in science, the boom of new specialities that marked the turn of the century . But even among such new intellectual practices, by their own youth less stable, and certainly compared to other more traditional sciences, Ecology has always been peculiar (Simberloff, 1980; McIntosh, 1980; Hagen, 1989 and McIntosh, 1995). The stages of development observed along the history of Ecology are plotted in Table 1. Ecology has evolved from a theoretically heterogeneous discipline, more or less committed with the generation of socially prescriptive discourses in the first half of this century to an even more theoretically heterogeneous, socially committed discipline in post-war years (contradicting general expectations as to theoretical unification taking place along the maturation of science[3]). Early twentieth century Ecology with its dominant community Ecology tradition and respective adversaries (namely, individualistic population Ecology) was not a well behaved science. Not only it wasn't theoretically or even conceptually unified (not only many theories, but a profusion of concepts emerging in a myriad of specific discourses), but it had a clear tendency of generating socially prescriptive discourses, with its holistic superorganismic community basis (Worster, 1977; Coutinho 1992). One clear situation, marked in the scheme, where such propositions came to public and ecologists actually played an important role in agricultural policy armed with their holistic community perspective was the one involving the episodes of the dust bowl, the great aeolic erosion catastrophe that took place in central United States in the thirties, causing extremely serious social problems (Worster, 1977). Eventually, the operating research perspectives lost hold of their domination - "went into crisis", with many signals of dissatisfaction among practitioners in the academic media. Then, during a turbulent period for Ecology, for science in general, and for the world - for it all happened around and during the war years -, Ecology changed. From this transition period, a "New Ecology" emerged - that is how it was called by observers and practitioners. The new Ecology was dominated by two new theoretical perspectives: ecosystem Ecology and population Ecology (McIntosh, 1980; Simberloff, 1980). Their basic features are plotted in Table 2. We could grossly state that while ecosystem Ecology is devoted to the (structural and functional) study of these functionally defined units of nature, the ecosystem, population or evolutionary/population Ecology focuses in historically defined individual populations.

[2] This conception of an alternative form of science or of knowledge production in general relies heavily on the works of Gibbons et al. (1994) and S. Schwartzman (1992). They will be detailed later, when the new trends in science will be explored.

[3] Most models of scientific development assume theoretical unification to be an outcome of maturation and the elimination of one or more contenders in theoretical dispute to be necessary. A classical example is T. Kuhn's *The Structure of Scientific Revolutions* (1970), whose work is often remembered by commenters of Ecology's theoretical structure.

Table I - Stages in the history of Ecology

Periods	**First period: 1893-1939**		**Transition 1940-1952**	**Second period: 1953 - today**	
Phases	Phase 1 1893-1915	Phase 2 1916-1939	Phase 3 1940-1952	Phase 4 1953-1968	Phase 5 1969- today
Features	Field formation	Field consolidation	Changes in the legitimacy orders	Consolidation of the new approaches	Institutional expansion and thematic re-organization
Markers	1893 - AAAS meeting 1915 - the Ecological Soc. America is founded	1916 - *Plant Ecology* (Clements) 1939 -conference on communities (38) - proceedings published	1940 1952	1953 - first textbook on a new perspective 1968 - IBP starts	1969
Important facts	Warming's controversy with floristic biogeograph; first world war	Between wars period dust bowl; anti-nazi biological discourse	New ecosystemic and populational perspectives are born; systems theory and cybernetics are developed; molecular biology is developed; second world war; Macy Conferences	Ecologists produce catastrophist discourse; cold war fully developed; Vietnam war; first significant expressions of social contestation with environmentalist discourse	Systems Ecology is developed; IBP establishes new procedural standards and greatly influences the practice of Ecology Stockholm conference; green parties are formed and take part in elections; end of Vietnam war; Glasnost and Perestroika

Table II - Differences between theoretical perspectives in Ecology

	Early community Ecology	**Population Ecology - individualistic concept**	**Ecosystem Ecology**
Study unit	Community	Population	Ecosystem
Discrete character of units of nature	yes	no - nature is a continuum of environmental conditions and populations of living beings; these items are subject to independent and random distribution	yes
Cohesion criteria	structure and composition of community is determined by the environment that orchestrates population dynamics	no cohesion, just circumstantial arrangements arbitrarily set by the observer	ecosystem structure is determined by functional relations between its components (energy flow and matter cycling, determining trophic structure)
Development	community evolves like a living organism, undergoing well determined developmental phases towards an environmentally determined climax stage	as random and individual as species distribution; a combination of component species independent dynamics	functional relation tend to evolve according to a pattern that favors trophic complexity, species diversity and other features; functional relations themselves are determinant
Dominance	increases with development		decreases with development
Stability	increases with community development	does not increase according to community features	increases with ecosystem development
Relations with the environment	"environmentist": environment determines structure and dynamics	environment is the stage for population centered processes	environment is a compartment of a cybernetic system
Competition	cooperation is more important than competition	competition is central in population dynamics	"positive" interactions tend to substitute "negative" ones (among which is competition) along the successional process
Evolution	evolution is not so important to interpret nature's patterns	populations favor the analysis of evolutionary processes	group selectionist conceptions are favored

In 1953, the transition cycle was apparently over. Ecosystem Ecology, for example, was sufficiently "cold" (to use a Latourian expression[4]) to produce an important textbook for undergraduate students. Thence, all the new perspectives grew in internal articulation (intensifying mathematization trends) "disciplinary" consolidation and institutionalization. Like other life sciences disciplines, Ecology, and specially ecosystem Ecology, was rapidly moving towards new research styles and scales, moving closer to "big science", to the large grants and to the large and multidisciplinary teams (McIntosh, 1985, pp. 213-221). That is why I fixed the limit for this stage in the year of 1968, when the International Biological Program (IBP) started.

The next stage is still on and comprises the so called "decade of Ecology" - the seventies. This is when Ecology actually started playing new social roles. It is when new discourses about society appear within Ecology and its agents take part in the transformation of the environmental issue into something of great importance in the

[4] B. Latour distinguishes basically two aspects of science: "cold", "consolidated" science, where all is consensus and where scientists no longer argue, and "hot", "soft" science - or science in action - where scientists are still negotiating its features. See Latour (1987).

political agenda of the world (Coutinho, 1994). "Systems Ecology", a very formalized perspective in ecosystems Ecology, is developed from 1968 to 1978 (McIntosh, 1985, p. 209). This is when its first contributions appear and strongly influence the study of ecosystems.

By then, trends on the approximation, interaction or rearrangement of discourses involving the new Ecology perspectives that were emerging in the post-war period evolved into two distinct paths: while population Ecology moved into greater approximation with genetics and evolutionary biology, forming a sort of "super-area" some people called "population studies" (McIntosh, 1985, p. 147; Collins, Beatty & Maienschein, 1986; Collins 1986), ecosystem Ecology developed a strong interaction with non-scientific, socially prescriptive discourses (Coutinho, 1994).

The emergence and development of such socially prescriptive discourses on environment and their intense interaction with ecosystem Ecology is the core of a most outstanding phenomenon of the end of this century: the promotion of the environmental issue to an unavoidable item in the political and scientific agenda of the world - an *obligatory problem*. The details of how exactly this condition has been brought about are yet to be shown, but it seems evident that scientists (specially those related to the production of catastrophist, ecosystemist based discourses) as well as (then) marginal social actors of the political field played together a determinant role.

In the political field the scene was dominated by the polarization of two alternative perspectives on how to interpret and therefore to react to what was already generally known as the "environmental crisis". One of them, somewhat popular in the late sixties and early seventies and supported at the time by a loud segment of scientists, understood the "crisis" as a huge historical and cultural impasse and our dominant attitude towards nature would be at its core. It would be a crisis of *modernity* at large or of *industrial society* and its solution would require a thorough substitution in current production and consumption patterns. Social relations standing today would be absolutely inadequate and would have to be substituted too, as well as administrative and political structure and values that go with it. Moreover, society would have to develop a completely different approach to science and technology, objects of harsh criticism by this perspective. This is a perspective that tends to harbor ethical and even religious attitudes towards nature and the environment and I call it *ecocentrist discourse*. We could consider *Blueprint for Survival* (1972) and most of the contents of the journal *The Ecologist* as its illustrative examples. Its emergence is a mark of the amalgamation of scientific and political discourses that characterized this period. The other perspective rose immediately against it and holds a more conservative position as to social structure and economy. It understands the "environmental crisis" as very typical of industrial societies, where it would be a result of the irrational and unplanned aspects of development. Its solution would require administrative measures in the "system", managing its parts from the vantage point of the external analyst. I call this optimistic perspective *technocratic sustainabilist discourse*[5]. The best known example of it is "Our Common Future" (World Comission on Environment and Development, 1987).

[5] On the optimism of its Ecology interlocutor and counterpart, see P. J. Taylor (1988) and about the scientific roots of its managerial attitude see Taylor and A.S. Blum (1991).

In this polarized political setting, a great variety of institutional and legal outcomes of the new "unavoidable" condition of the environmental issue were suddenly observed: legal tools and action on the protection of environment had unseen increase, governmental and international inter-governmental organs were created and meetings and conferences were held, the most outstanding of all being the Stockholm meeting of 1972. The United Nations Conference on the Human Environment held at Stockholm was the first UN conference on this theme and is the most powerful illustration of its successful rise in political importance. Green political parties began to form and grow in visibility from 1972 on and in 1974 they presented a presidential candidate in France (McCormick, 1989). But real social novelties were the new relevant social actors involved in all these transformations: the non governamental organizations activists (actively present in great numbers already at the Stockholm meeting) and the "new professionals" of very versatile nature - environmental consultants, environmental management technicians and bureaucrats, etc. -, frequently mingled.

Ecology was very rapidly promoted to a high position in the hierarchy of the sciences, with evident results in terms of institutional insertion and funding (McIntosh, 1985). But more to the point here is the fact that concepts and ideas from its theoretical perspectives became an endless source of building blocks for a great variety of new discourses: first and of chief importance are the political discourses on environment that polarized the discussion on this issue. But many other types of discourses were also generated on this basis, discourses that don't easily fit into one or another category: religious-political, philosophical-managerial, and a very interesting variety that claimed and partially gained scientific legitimacy (Gaia hypothesis and some types of global Ecology products) without departing from its extra-scientific footing.

Ecology also spread its influence over a large range of other constituted scientific specialities which developed its "environmental" variety as a result: it actually exported its theoretical frameworks, its questions and its concepts to other scientific practices (Coutinho 1994, p. 154). As a consequence, we observe a sharp increase in the creation of new journals in Ecology and in the environmental studies (Figures 1 and 2).

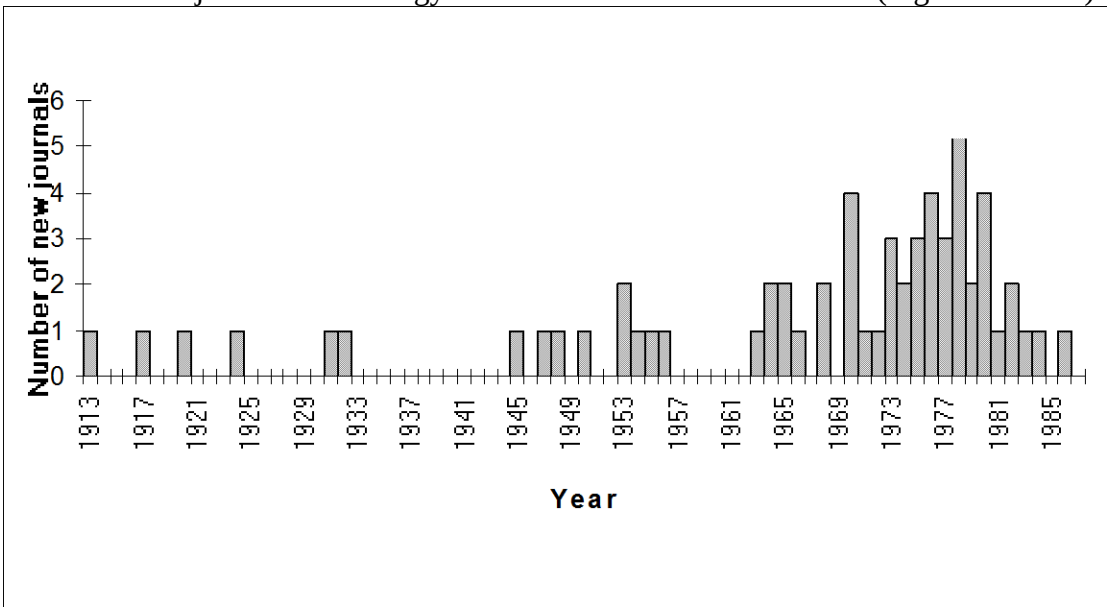

Figure 1- Growth of the number of Ecology journals between 1913 and 1978.
Data obtained from *Ulrich's International Periodicals Directory* (1988-89), pp. 1444-1468.

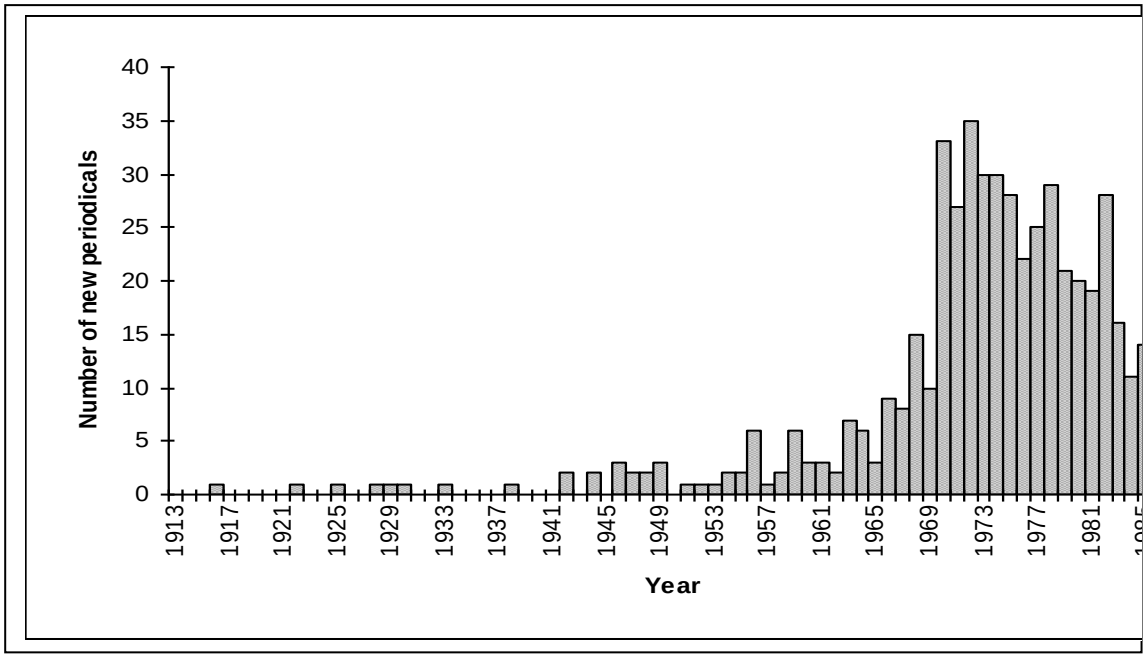

Figure 2 - Growth of the number of Environmental Studies journals between 1913 and 1973.

Data obtained from *Ulrich's International Periodicals Directory* (1988-89), pp. 1444-1468. The definition of "environmental studies" is the one adopted by the Directory in its classification of periodicals.

The combination of all these trends had a dramatic consequence on the evolution of Ecology. If Ecology has never been a structurally well behaved discipline, what happened from the late sixties on was an incredible explosion of disciplinary boundaries. Several trends are illustrative of that:

1. If we observe the titles and contents of many of the new periodicals bearing "Ecology" or the prefix "eco" in their names we can grossly grasp the extent of the disciplinary diversification that took place: *Annual Review of Ecology and Systematics* (founded in 1970), *Journal of Chemical Ecology* (founded in 1975), *Ecotoxicology and Environmental Safety* (founded in 1977), are some examples.

2. If we do the same with the journals classified as "environmental studies" publications the result is even more remarkable, since it doesn't even display the subtle tendency to concentrate or to be led by the natural sciences: *Journal of Environmental Pathology, Toxicology and Oncology* (founded in 1981), *Environmental Law* (founded in 1970), *Environmental Geochemistry and Health* (founded in 1979), *Environmental Education and Information* (founded in 1981), and *Environmental Ethics* are examples.

3. If we examine the institutional origins of the authors who publish their works in these journals, we will find they come from public and private institutions; from higher education institutions, from research institutes, from governmental organs and from private corporations; from the life sciences, from the exact sciences and also from the humanities and social sciences; they come from the applied management and

planning areas and also from the basic research and experimental areas (Coutinho, 1994, p. 150).

If Ecology completely lost hold of the environmental studies it inspired many years ago, the original link was never erased: up to now, many of such endeavors are classified as "Ecology" in directories and indexes and it is not clear whether such a classification doesn't find a counterpart in academic legitimation mechanisms. The same permanence of the original link can be ascertained for the political discourses on environment that made (and make) extensive use of ecological concepts and ideas. Their producers are frequently called "ecologists" and they defend an ecological "cause" and "programs".

Ecology became an intellectual tradition that exerts extremely liberal requirements for legitimate belonging and practicing as a consequence of that, and a typical career pattern is impossible to identify (both as to background and institutional trajectory). Considering scientific disciplines as well circumscribed, self relied practices and discourses, carried out by scientific collectives faithful to group consensus and its orders of legitimacy, Ecology can hardly be regarded as one.

2. The new forms of knowledge production and Brazilian higher education and research

But maybe Ecology is just expressing what is to become a general trend in the behavior of science and technology. It has always been biology's poor cousin who never succeeded in conforming to the traditional models for science and its revenge might be precisely to be the forerunner of new forms of knowledge production, what Gibbons, Limoges, Nowotny, Schwartzman, Scott & Trow (1994) are calling "mode II". While in "mode I", hegemonic until at least a few decades ago, knowledge is produced in an academic context (with relevant questions being established and dealt with in a context governed by the interests of a specific scientific collective), in mode II it is produced in a "context of application". That means problems are established and processed along negotiations involving a great variety of social agents and their immediate interests. That also means that while in mode I production is concentrated in traditional academic institutional sites, in mode II it involves agents placed in very different professional settings. Disciplinary fidelity, which means that problems established as relevant by a certain discipline will preferentially be solved within the boundaries of its domain, so typical of mode I, is completely subverted in mode II. While mode I is disciplinary, mode II production is trans-disciplinary: problems configured in a context of application generally do not coincide with object definition and methods of a single discipline and, as we saw, their solution involves professionals with diverse origins and trajectories. These new knowledge producers circulate rapidly among the centers of production and carry with them new procedures and criteria for the judgment and validation of

products[6], which, in their turn, circulate much more rapidly due to new communication technology available and intensely used.

Such a new form of knowledge production would be, for the authors, a result of the conditions established in post-war years, when the great expansion and massification of higher education would have created a surplus of trained research professionals (Gibbons et al., 1994; S. Schwartzman, 1992). Such a surplus would have met a growing demand for specialist knowledge and a considerable diversification of institutional sites for knowledge production would have taken place as a consequence. The rapid development of information and communication technologies in the same period is a last determinant for the emergence of mode II. The authors stress that although these features seem to describe many of the transformations observed in contemporary techno-science, mode II would not substitute, but complement mode I.

But if the trends leading to the expression of mode II involve institutional diversification coupled to expansion with the displacement of research sites from previously exclusive academic environments, we have nothing of that in Brazil. We do have expansion, following the world trend, but its features led to the opposite tendency of concentrating research sites even more. After the Higher Education reform that tried to re-structure the higher education system according to the North American research university model, there was in fact expansion. Applications for higher education institutions increased more than fivefold between 1970 and 1980 (S. Schwartzman, 1991, p. 220), but government authorities responded to this pressure by allowing an uncontrolled proliferation of private institutions. Together with the great majority of federal higher education institutions which up to now have a very low quality, they form the large bulk of higher education institutions with no research environments and which certainly are not delivering trained researchers into an overcrowded market[7]. Despite all the attempts from the sixties on to foster scientific and technological research as a means to counteract technological dependency, inducing scientific and technological activity in industries and research institutions, research became even more concentrated in universities and, among them in a select group of public institutions of the Southeastern region: the University of São Paulo, the State University of Campinas, the University of the State of São Paulo (the three of them make up the powerful "São Paulo state system") plus São Paulo Federal University (previously São Paulo School of Medicine, the EPM) and the Federal University of Rio de Janeiro (Schwartzman 1991, p. 240). The very select groups of researchers from these sites found themselves in a new and favorable situation in the seventies, when money was available in large amounts and when incentive programs and agencies responded to their aspirations and followed their value system for quality assessment (Schwartzman, 1991, p. 222). Money was available and the graduate education system was being put up according to the same ideals that motivated the rest of the higher education reform. In this context and over the earlier stratification that distinguished the elite universities from the rest of the potential research sites, an additional stratification level was established separating the high level research and graduate education committed groups and departments from the lower level undergraduate education committed sites in the same institution (Schwartzman, 1991, p. 222). Guimarães (1995) defines the Brazilian process of institutionalization of

[6] See also J.D. Certaines (1976).

[7] About the reality and trajectory of Brazilian federal universities, see J. Schwartzman (1993).

research as one centered in the university and having as privileged sites the graduate programs established according to the North American model.

According to S. Schwartzman (1991), the construction of this graduate education system was undoubtedly a successful part of the higher education reform and he seems to relate this success to the building of a significant scientific community[8]. Programs were rapidly being organized in many areas. In 1970 there were 57 doctoral programs offered and in 1985 there were more than 300. The financing agencies, already committed to peer review evaluation procedures, supported the programs they judged deserving and wouldn't consider the accreditation mechanisms adopted by the Federal Counsel for Education until CAPES took over the task (S. Schwartzman 1991, p. 222). CAPES was created much earlier, along with the CNPq in 1951 (Guimarães 1995, p. 257). Nevertheless, it seems to have really met its calling when it assumed the activities of accreditation of graduate programs from 1976 on (Guimarães 1995, p. 280). CAPES seems to have satisfied both the funding agencies and the (research) groups building programs and applying for grants.

This role was analyzed by Castro and Soares (1986). According to their report, CAPES behavior changed over time from evaluations that privileged structural indicators such as the number of students and graduates to procedures focused in quality and production features. Such a shift was statistically analyzed by Castro & Soares, although his work does not contemplate differences in assessment behavior among the different areas. In his report, Castro & Soares also point out that there are such differences, like the higher rating of international publication by the hard sciences or the emphasis of the social and human sciences in national publication. His report and, it seems, CAPES too, is neutral with respect to these differences, considering them as given differences between fields with no judgment value.

From the evidences presented by the previous authors, it seems that CAPES does play a key role in the institutionalization of research in Brazil. From 1976 on and in the middle of the boom of graduate program formation in this country it became the only legitimate interpreter of the aspirations and value systems of the scientists. And from all that has been said up to now, it must be clear it ranks not only graduate programs, but research groups. It does so by the following evaluation procedures: programs are required to submit their implantation project to be able to apply for grants in the available agencies. An implantation project is forwarded to a number of referees for appraisal and suggestions for improvement are produced. After the program has met minimum standards, it will be under scrutiny for a certain time, during which it will work normally, reports will be analyzed and visits to the program facilities will be made by referees. Depending on the contents of referees' reports, the program might be accredited and attributed a qualification mark (from A to E). Such qualification marks comprise the most reliable ranking system in Brazilian higher education (and, consequently, of research too; Castro & Soares, 1986).

Now considering all contextual information on Brazilian higher education and research system that distinguish it so sharply from the North American setting where

[8] Guimarães (1995) goes a step further and states the best results of the science and technology policies of the 70's are related to the construction of the Brazilian graduate education system.

Ecology was allowed to illustrate the new trends in techno-scientific knowledge production, the concentration of ecological research in higher education institutions won't seem unexpected. There are 249 research groups in Ecology and 73% of them are placed in higher education institutions. Of the 732 Environmental Sciences research groups, 75% are at higher education institutions[9]. Not surprising too is the concentration of research groups in the Southeastern region: of the 165 research groups in Ecology, 90 are at the Southeastern region. Other 35 are at the Southern region, leaving the North, the Northeast and the Western Central regions with only 40 groups (CNPq 1994, p. 24). As to the Environmental Sciences, of the 732 groups, 455 are at the Southeastern region and 132 at the Southern region (CNPq, 1994, p. 65).

With a previous knowledge of their concentration in higher education institutions and of the nature of the institutionalization of research in Brazil, the best way to investigate the emergence of Ecology is by examining the graduate programs in the area, around which, presumably, research is organized.

3. Graduate programs on Ecology and Environmental Science

There were 30 initiatives on the implantation of graduate courses on Ecology and Environmental Sciences from 1976 up to now (Table III). It must be stressed that the implantation of a doctoral degree program even after the institution has successfully established a masters degree graduate program is a hard task and involves as many steps as the first effort. Therefore, it is advisable to consider it a second, different (although not independent), initiative. Also, it is quite representative for our purposes to do so, since it signals the success of the first initiative or important instances of negotiation with CAPES or among dominant practitioners, as will be described bellow. There is often a lag of many years between the implantation of a M.Sc. and a Ph.D. program.

Up to the early nineties, there were only four programs offering doctoral degrees: the two programs established by INPA, the UFSCar program and the one offered by UNICAMP. Other programs offering doctoral degrees would only appear much later (Figure 3).

[9] Data obtained from CNPq (1994) *Diretório dos Grupos de Pesquisa no Brasil*. Brasília: CNPq.

Table III - Graduate Programs on Ecology and Environmental Sciences

Program		Level	Start	Accreditation
Ecologia e Recursos Naturais	UFSCar	MSc	1976	1980
Ecologia e Recursos Naturais	UFSCar	PhD	1980	1985
Biologia de Água Doce e Pesca Interior (Programa de Pós-Graduação em Biologia Tropical e Recursos Naturais)	INPA/FUAM	MSc	1976	1978
Biologia de Água Doce e Pesca Interior (Programa de Pós-Graduação em Biologia Tropical e Recursos Naturais)	INPA/FUAM	PhD	1976	0
Ecologia	INPA/FUAM	MSc	1976	0
Ecologia	INPA/FUAM	PhD	1976	0
Ecologia	UnB	MSc	1976	1982
Ecologia	UnB	PhD	1992	1993
Ecologia	UNICAMP	MSc	1976	1981
Ecologia	UNICAMP	PhD	1980	0
Ecologia de Ambientes Aquáticos Continentais	UEM	MSc	1991	0
Ecologia de Ambientes Aquáticos Continentais	UEM	PhD	1992	0
Ecologia e Conservação da Biodiversidade	UFMT	MSc	1993	0
Ecologia e Conservação da Biodiversidade	UFMT	PhD	1995	0
Programa de Pós-Graduação em Ecologia - Curso de Mestrado em "Ecologia e Conservação"	UFMS	MSc	1996	0
Programa de Pós-Graduação em Ecologia, Conservação e Manejo da Vida Silvestre	UFMG	MSc	1989	0
Ecologia	UFRJ	MSc	1990	0
Ecologia	UFRJ	PhD	1995	0
Ciências da Engenharia Ambiental	USP - São Carlos	MSc	1989	0
Ciências da Engenharia Ambiental	USP - São Carlos	PhD	1989	0
Ecologia	USP	MSc	1982	1987
Ecologia	USP	PhD	1993	1995
Ecologia	UFRGS	MSc	1977	0
Agroecossistemas	UFSC	MSc	1995	0
Desenvolvimento e Meio Ambiente	UFS	MSc	1995	0
Engenharia Ambiental	UFSC	MSc	1994	0
Sociedade e Meio Ambiente (Doutorado Interdisciplinar em Ciências Humanas - Sociedade e Meio Ambiente)	UFSC	PhD	1995	0
Ciências Ambientais	USP	MSc	1989	0
Produção Aquática	UFBA	MSc	1983	
Biologia Aquática	UFRN	MSc	1995	

UFSCar, Universidade Federal de São Carlos; INPA, Instituto Nacional de Pesquisas Amazônicas; FUAM, Fundação Universidade do Amazonas; UnB, Universidade de Brasília; UNICAMP, Universidade Estadual de Campinas; UEM, Universidade Estadual de Maringá; UFMT, Universidade Federal do Mato Grosso; UFMS, Universidade Federal do Mato Grosso do Sul; UFMG, Universidade Federal de Minas Gerais; UFRJ, Universidade Federal do Rio de Janeiro; USP, Universidade de São Paulo, campus São Paulo; USP - São Carlos, Universidade de São Paulo - campus São Carlos; UFRGS, Universidade Federal do Rio Grande do Sul; UFSC, Universidade Federal de Santa Catarina; UFS, Universidade Federal do Sergipe; UFBA, Universidade Federal da Bahia; UFRN, Universidade Federal do Rio Grande do Norte.

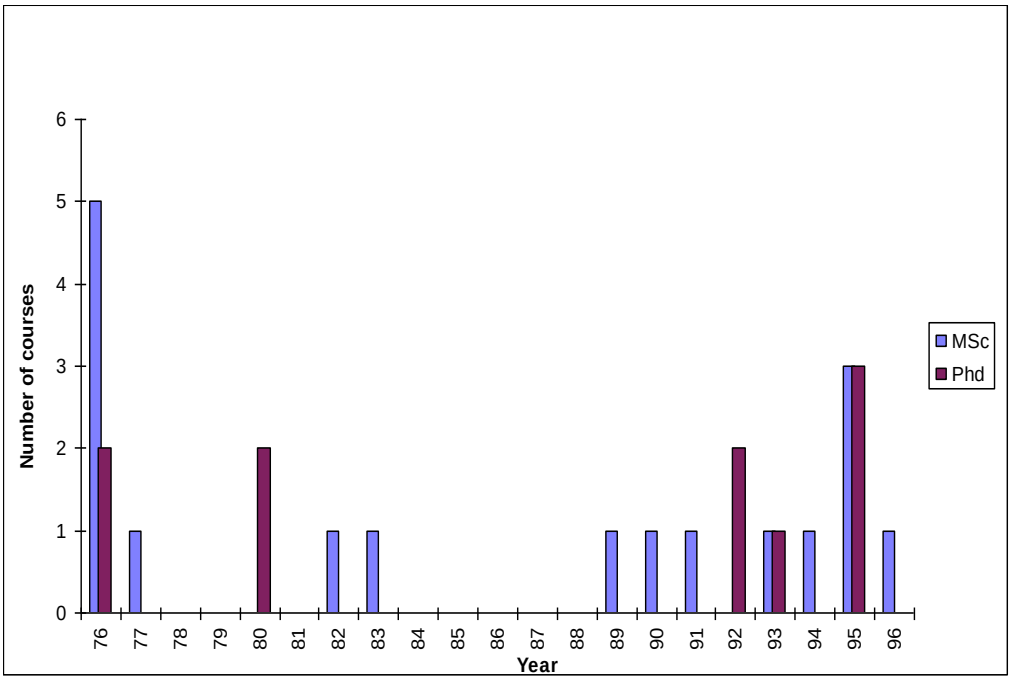

Figure 3 - Year of beginning of graduate courses on Ecology and Environmental Science.

Data obtained from the files of CAPES or from material sent by the involved institutions.

Accreditation records offer important supplementary information concerning the nature and status of these Ecology and Environmental Sciences programs: in Table IV, three programs are outstanding in having been credited good marks during all their history: UFSCar, UNICAMP and UnB.

Table IV - Evolution of concepts attributed by CAPES to graduate programs

Insti-tution	Program	Begin-ning		Year/level/concept													
		M	D	1981		1982		1983		84/85		86/87		88/89		90/91	
				M	D	M	D	M	D	M	D	M	D	M	D	M	D
INPA/UA	Biologia de Água doce e Pesca Interior	76	84	C	-	C	-	C+		D	D	C	C	B	C	B	C+
INPA/UA	Biologia (Ecologia)	76	76	C	C	C	C	C+	C+	D	D	C	C	C	C+	C+	C+
UFSCAR	Ecologia e Recursos Naturais	76	76	A	B	A	A	A	A	A	A	A	A	A	A	A	A
UnB	Ecologia	76	-	B	-	B+	-	A	-	A	-	A	-	A	-	A	-
UNICAMP	Ecologia	76	80	A	nc *	A	A	A	A	A	A	A	A	A	A	A	A
UFRGS	Ecologia	78	-	D	-	D	-	D	-	C+	-	C+	-	B+	-	B	-
USP	Ecologia	82	-	-	-	nc	-	D	-	C	-	C+	-	B	-	B+	-
UFBA	Produção Aquática	83	-	-	-	nc	-	E	-	E	-	C	-	C	-	C	-
UFMG	Ecologia (Conservação e Manejo da Vida Silvestre)	89	-	-	-	-	-	-	-	-	-	-	-	nc	-	B	-
UFRJ	Ecologia	90	-	-	-	-	-	-	-	-	-	-	-	-	-	nc	-
FUEM	Ecologia de Ambientes Aquáticos Continentais	91	-	-	-	-	-	-	-	-	-	-	-	-	-	nc	-

* nc - “no concept”

Table adapted from CAPES (1994), *Cursos por Área do Conhecimento*. p. 6.

Programs are thus stratified according to many criteria: time of beginning, the permission to offer doctoral degrees and accreditation records. Bearing in mind all these features, we could group the programs in a sociologically significant system. Consider the bars representing the number of courses in each four year interval in Figure 4. In this figure, each “program” was counted only by the date of beginning of the first degree offered: if one institution opened a graduate program offering a masters degree and years later started offering a doctoral degree (under the same structure), only the first date was counted. The groups resulting from this procedure can be observed in Table V.

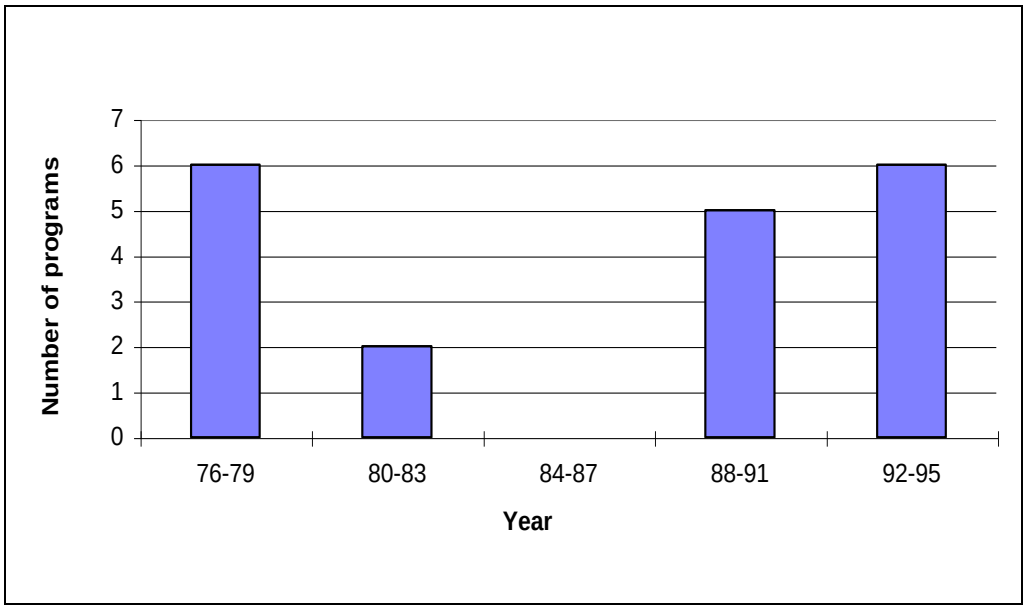

Figure 4 - Ecology and Environmental Sciences programs introduced for the first time in institutions.

Dates for the beginning of M.Sc. programs were counted, except when the first program in that institution was a PhD program. PhD programs introduced with the same name and same departmental structure in an institution were not counted.

Table V - Ecology and Environmental Sciences programs according to their groups

Group 1	1976	Ecologia e Recursos Naturais - UFSCar
	1976	Biologia de Água Doce e Pesca Interior (Programa de Pós-Graduação em Biologia Tropical e Recursos Naturais) - INPA/FUAM
	1976	Ecologia - INPA/UFAM
	1976	Ecologia - UnB
	1976	Ecologia - UNICAMP
	1977	Ecologia - UFRGS
Group 2	1982	Ecologia - USP
	1983	Produção Aquática - UFBA
	1989	Ciências da Engenharia Ambiental - USP - campus São Carlos
	1989	Ecologia, Conservação e Manejo da Vida Silvestre - UFMG
Group 3	1989	Ciência Ambiental - USP
	1990	Ecologia - UFRJ
	1991	Ecologia de Ambientes Aquáticos Continentais - UEM
	1993	Ecologia e Conservação da Biodiversidade - UFMT
	1994	Engenharia Ambiental - UFSC
	1995	Agroecossistemas - UFSC
Group 4	1995	Desenvolvimento e Meio Ambiente - UFS
	1995	Sociedade e Meio Ambiente (Doutorado Interdisciplinar em Ciências Humanas - Sociedade e Meio Ambiente) - UFSC
	1995	Biologia Aquática - UFRN
	1996	Ecologia e Conservação (Programa de Pós-Graduação em Ecologia) - UFMS

Ecology and Environmental Sciences programs were grouped according to the date of their emergence.

Group 1 is constituted by the pioneer and dominant courses. The ones established first, the ones that monopolized the doctoral degree market for more than a decade and the ones more quickly achieving the best qualification marks attributed by CAPES, therefore, the highest positions in the hierarchy of programs. They can be considered pioneer programs (by pioneer groups) not only because they were the first, but also in the ecological sense: like pioneer biological communities, they have colonized many new environments. For example: among the 14 teachers of the Programa de Pós-Graduação em Ecologia - Curso de Mestrado em "Ecologia e Conservação" of the Universidade Federal do Mato Grosso do Sul, seven obtained their degrees at UNICAMP[10]. Although they are all considered "top" programs up to now, the group itself exhibits an internal hierarchy: of the six programs there comprised, only four of them were able to offer doctoral degrees before the nineties; of these four, only two of them were attributed high qualification marks by CAPES ("straight A's") on a stable and long lasting basis and of these two, UNICAMP was the one who started off with the highest productivity (Figures 5 and 6). These indexes coincide with informal judgment by practicing ecologists.

[10] Which is analogous to what has taken place with these pioneer programs themselves: among the 21 teachers bearing a doctoral degree at the beginning of the UFSCar program, 17 were from the University of São Paulo (from programs other than Ecology, naturally). USP, which is exceptionally unsuccessful in the Ecology and Environmental Sciences business, is the highest ranked university in Brazil according to any criteria. See J. Schwartzman (1995).

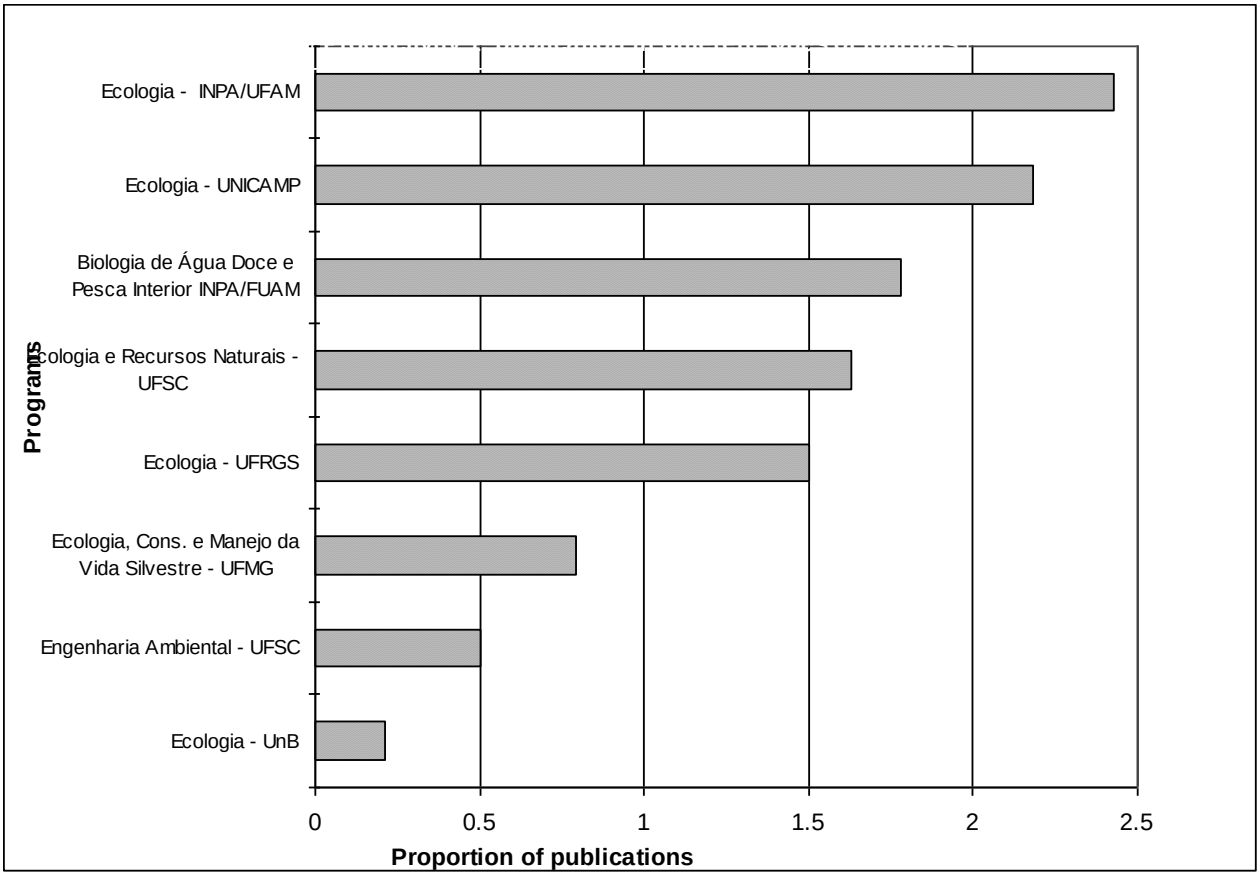

Figure 5 - Productivity 1: Publication in different types of journals.

Data were obtained either from the files of CAPES or from implantation projects provided by the involved institutions. Proportion of publications is the total number of articles published in scientific journals divided by the number of teachers in each institution.

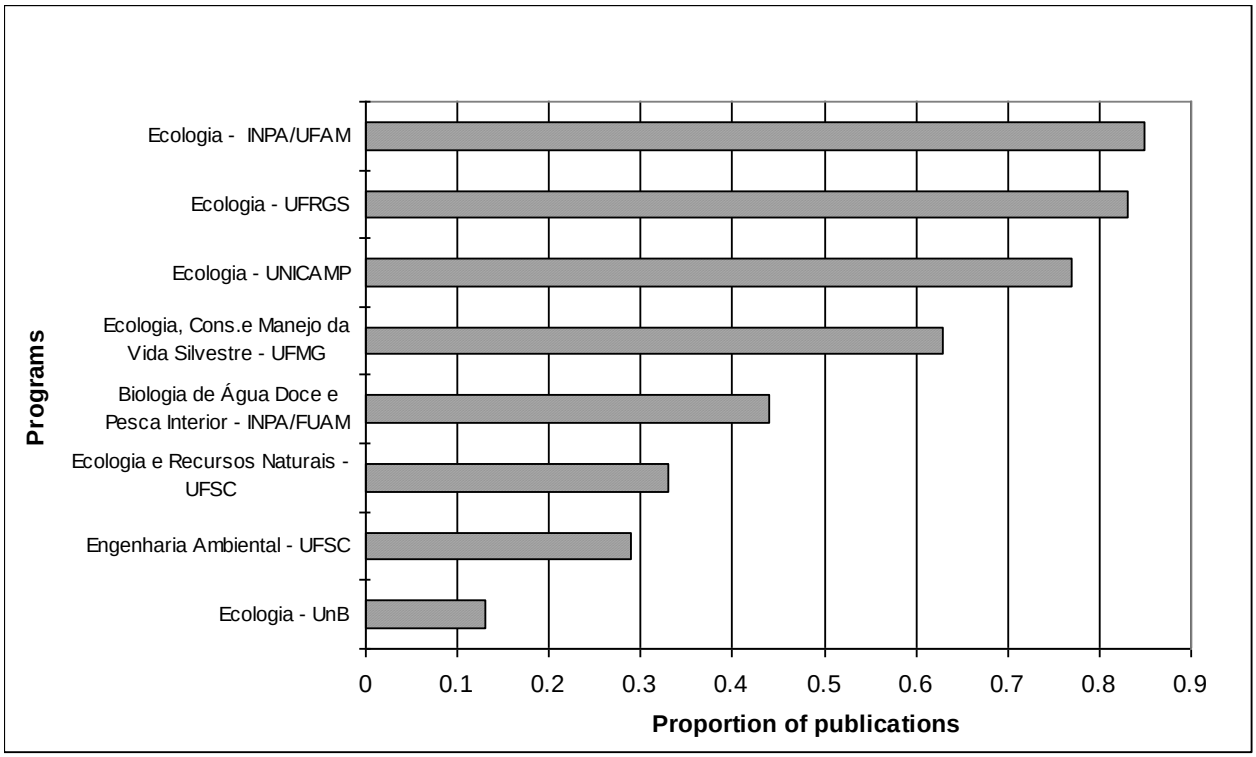

Figure 6 - Productivity 2: Publication in international journals.

Data on publication records and number of teachers in the beginning of courses were obtained either from the files of CAPES or from the involved institutions. Proportions correspond to total number of international publications divided by the number of teachers in the institution (visiting teachers not counted).

Nevertheless, despite differences, the members of this first group share important common features. First of all, they all aim to set the basis for a practice they understand to be an expression of the discipline *Ecology*. Consider the apparently secondary issue of the name given to the program: except for one of the INPA programs and the UFSCar program, all of the other programs are named just "Ecology". Programs bearing this dry title would only be seen twice again in the following initiatives: among the latecomers USP and UFRJ, commented later on. The common choice of the name and the ripe time to begin their programs matches the concern of these pioneers about the necessary contents for a graduate program apt to deliver individuals with the recognizable profile of the ecologist into the academic market. The UFSCar displays a very clear commitment to ecosystem Ecology propositions: they claim the "systemic" approach is the appropriate one for the understanding, prevision, simulation and management of ecosystems (UFSCar-CCBS-PPGERN 1991, "Introdução"). This claim also serves the important function of providing a distinction mark for the group[11], quite significant in the ever operative process of struggling to exert domination in a field. As we have already seen, UFSCar's only match was UNICAMP, not by chance the only other program to exhibit clear claims as to theoretical and methodological affiliation. In its reports, UNICAMP emphasizes the early and permanent commitment to

[11] Distinction marks are believed to be significant in the struggle of groups of practitioners for legitimacy and/or dominance in a field. See, for example, P. Bourdieu (1987).

"evolutionary Ecology, especially population and community Ecology" (CPGE/UNICAMP, 1994). In a referee report of 1980, produced by a UnB professor, it is stressed that UNICAMP offers many elective courses, "all of them reflecting the most recent directions in modern Ecology, that is, the emphasis in quantitative and behavioral aspects, always according to a genetically based and evolutionary approach" (Almeida Jr., 1980).

In the also pioneer UFRGS and INPA programs, a clear statement as to their role in providing a solid theoretical basis in Ecology is always present in implantation projects and reports (UFRGS 1986, PPG INPA/FUA 1992). CAPES referees seem very sensitive to course contents related to such a "solid" base, but they seem to have different understandings about it. One anonymous referee made serious remarks on what he saw as the weaknesses of the Implantation project for the UnB Ecology program and he concluded his report by not recommending the program. One of the deficiencies he pointed out was the lack of "fundamental courses for the formation of ecologists, such as Population Genetics, Evolution and Principles of Animal and Plant Taxonomy" (Parecer 1977, p.3). It is clear by this choice that the referee had a definite commitment to evolutionary-population perspectives in Ecology and he was judging the program from this point of view.

But the same Ecology whose rightful domain of competence the pioneers struggled to defend is sprinkled with stains of the new forms of knowledge production: for the UFSCar ecologists, Ecology is:

> a. the practice from which to expect the generation of "endogenous knowledge" for the solution of management problems derived from lack of technology to deal with tropical regions;
>
> b. a tool for re-structuring ecosystems and ecological processes with the objective of improving life quality and environmental planning (UFSCar-CCBS-PPGERN, 1991, "Considerações Científicas").

For UNICAMP's referee Ameida Jr (1980), the program reflects the "most recent international trends in the ecological field, that is, a conception of Ecology as a science of integration, with multidisciplinary approach".

Moreover all the programs are problem focused and display a strong regional concern: UNICAMP and UFSCar are concerned with tropical Ecology and the inadequateness of the approaches developed in and for temperate regions (Almeida Jr., 1980 and UFSCar-CCBS-PPGERN, 1991). They justify the need for a program such as theirs based on these assumptions and the demands created by the "environmental crisis". INPA justifies both its programs not by a general concern with the environment or even a general insufficiency of approaches, but by the extreme national and international importance of Amazonia which is poorly understood by any previous academic attempt (PPG do INPA/FUA, 1992). Bearing unique ecosystems, unique human relations with the environment and unique development challenges, it calls for a heavy academic effort to understand it and devise solutions for its problems. The choice of Ecology as concentration area for such a course is only a consequence of those premises. It couldn't be more problem focused. The UnB program is concentrated on the

study of the Cerrado formation and the region covered by it. It is committed to finding managerial solutions to environmental problems of this region. The UnB is located at the city of Brasília, which lies in the middle of an extensive Cerrado region (Travassos, 1977).

If these programs are characteristically problem focused, social concern and, moreover, its fundamental role in the configuration of the problems in which programs are focused is another important feature - although not distinctive: most of the other programs examined here share and advance this feature, except, again for USP and UFRJ. To many, sustainable development is the core of social perspective: the program is to provide ecosystemic view because of its managerial as well as analytical advantages (UFSCar) and thus promote sustainable development, or it is seen as a way of overcoming development problems, whose chief limiting factor would be the lack of qualified researchers (INPA). They all recognize the urgent nature of environmental problems and their specificity in Brazil as a tropical country with important development challenges.

As to the institutional structure of the pioneer programs, we have as extreme conditions the UNICAMP multi-departmental structure, providing the least discipline commitment by institutional ties (ironically the one most concerned with disciplinary definitions), and the UnB program, harbored at an Ecology department (Table VI). Except for UnB, a pioneer, high ranked program, the only other graduate courses to be based at Ecology departments are the ones offered by USP and UFRJ - traditional, prestiged and conservative institutions.

Table VI - Institutional placement of Ecology and Environmental Sciences programs

Program	Institution	Type	Department or comment	Unit or comment
Ecologia e Recursos Naturais (Ecology and Natural Resources)	UFSCar	federal	Departamento de Ciências Biológicas (CCB - Dept. of Biological Sciences)	Centro de Ciências Biológicas e da Saúde (Center for Biological and Health Sciences)
Biologia de Água Doce e Pesca Interior (Fresh water biology and fishing)	INPA/FUAM	federal	Departamento de Biologia Aquática e Limnologia (dept. of water biology and limnology)	
Ecologia (Ecology)	INPA/FUAM	federal		linked to the Coordenação de Pesquisas em Ecologia (Coordination of research in Ecology)
Ecologia (Ecology)	UnB	federal	Departamento de Ecologia (dept. of Ecology)	Instituto de Ciências Biológicas (Inst. of Biological Sciences)
Ecologia (Ecology)	UNICAMP	state	interdepartmental (teachers from five different departments: 1.Zoology; 2.morphology and plant systematics; 3.plant physiology; 4. genetics and evolution; 5. parasitology	Instituto de Biologia (Institute of biology)
Ecologia de Ambientes Aquáticos Continentais (Ecology of the continental waters environments)	UEM	state		
Ecologia e Conservação da Biodiversidade (Ecology and biodiversity conservation)	UFMT	federal		Instituto de Biociências (institute of biosciences)
Ecologia e Conservação (Ecology and conservation)	UFMS	federal	Departamento de Biologia (dept. of biology)	Centro de Ciências Biológicas e da Saúde (center for biological and health sciences)
Ecologia, Conservação e Manejo da Vida Silvestre (Ecology, conservation and wildlife management)	UFMG	federal	Interdepartamental: dept. of general biology; Botany and Zoology.	Instituto de Ciências Biológicas (institute of biological sciences)
Ecologia (Ecology)	UFRJ	federal	Departamento de Ecologia (dept. of Ecology)	Instituto de Biologia (institute of biology, which is a part of the center for the health sciences)
Ciências da Engenharia Ambiental (environmental scienes engineering)	USP - São Carlos	state	Centro de Recursos Hídricos e Ecologia Aplicada, dept. de hidráulica e saneamento (center for water resources and applied Ecology, dept. of hydraulics and sanitation)	Escola de Engenharia de São Carlos (São Carlos engineering school)
Ecologia (Ecology)	USP	state	Departamento de Ecologia (dept. of Ecology)	Instituto de Biociências (institute of biosciences)
Ecologia (Ecology)	UFRGS	federal	interdepartamental - related to the NIDECO (Núcleo Interdepartamental de Estudos Ecológicos - interdepartmental center for ecological studies), formed by the departments.	Instituto de Biociências (institute of biosciences)
Agroecossistemas (agroecosystems)	UFSC	federal		Centro de Ciências Agrárias (Center for Agricultural Sciences)
Desenvolvimento e Meio Ambiente (Development and Environment)	UFS and other six Northeastern universities	federal		Chiefly related to one center: Núcleo de Estudos do Semi-Árido (center for the study of the Semi-arid region), but also to Núcleo de Estuários e Manguezais (center for the study of stuaries and mangue);
Engenharia Ambiental (environmental engineering)	UFSC	federal		Centro Tecnológico (technology center)
Sociedade e Meio Ambiente (Doutorado Interdisciplinar em Ciências Humanas - Sociedade e Meio Ambiente) (interdisciplinary PhD program in human sciences - society and environment)	UFSC	federal		Centro de Filosofia e Ciências Humanas (philosophy and human sciences center)
Ciência Ambiental (environmental science)	USP	state	no dept.	linked to many "units" (Institutes) at USP. Doesn't belong to any of them. Supervised by the "Pró-reitoria de pós-graduação".
Produção Aquática (water production)	UFBA	federal	Departamento de Zoologia (dept. of Zoology)	Instituto de Biologia (institute of biology)
BioEcologia Aquática (water bioEcology)	UFRGN	federal	Depto. de Oceanografia e Limnologia (dept. of oceanography and limnology)	Centro de Biociências (biosciences center)

There doesn't seem to be any distinctive feature in any of the groups as to initial number of teachers, or proportion of faculty with doctoral degrees obtained abroad (Table VII, Figure 7). It is possible that intellectual production trends will also draw important distinctions among the groups (productivity rates, choices of journals and themes, etc.), but they weren't available yet.

Table VII: Number of teachers at the beginning of the program

Program name	Number of institution teachers
Biologia Aquática - Universidade Federal do Rio Grande do Norte	5
Curso de Ecologia - Convênio INPA/UFAM	7
Biologia de Água Doce e Pesca Interior (Programa de Pós-Graduação em Biologia Tropical e Recursos Naturais)	9
Curso de Pós-Graduação em "Ciências da Engenharia Ambiental" - *campus* São Carlos - Universidade de São Paulo	10
Curso de Pós-Graduação em Ecologia - Universidade Federal do Rio Grande do Sul	12
Programa de Pós-Graduação em Ecologia - Curso de Mestrado em "Ecologia e Conservação" - Universidade Federal do Mato Grosso do Sul	14
Engenharia Ambiental - Universidade Federal de Santa Catarina	14
Ecologia e Conservação da Biodiversidade - Universidade Federal do Mato Grosso	17
Desenvolvimento e Meio Ambiente - Universidade Federal do Sergipe	17
Programa de Pós-Graduação em Ecologia, Conservação e Manejo da Vida Silvestre - Universidade Federal de Minas Gerais	19
Programa de Pós-Graduação em Ecologia - Universidade Estadual de Campinas	22
Produção Aquática - Universidade Federal da Bahia	22
Ecologia - Universidade de Brasília	24
Curso de Pós-Graduação em Agroecossistemas - Universidade Federal de Santa Catarina	25
Ecologia e Recursos Naturais - Universidade Federal de Santa Catarina	27
Programa de Pós-Graduação em Ecologia - Universidade Federal do Rio de Janeiro	31
Curso de Pós-Graduação em "Ecologia de Ambientes Aquáticos Continentais" - Universidade Estadual de Maringá	37
Sociedade e Meio Ambiente (Doutorado Interdisciplinar em Ciências Humanas - Sociedade e Meio Ambiente) - Universidade Federal de Santa Catarina	39
Programa de Pós-Graduação em Ecologia - Universidade de São Paulo	unavailable
Ciência Ambiental - Universidade de São Paulo	unavailable

Data were obtained either from first years reports (reports from the second or third year of program) or from implantation project.

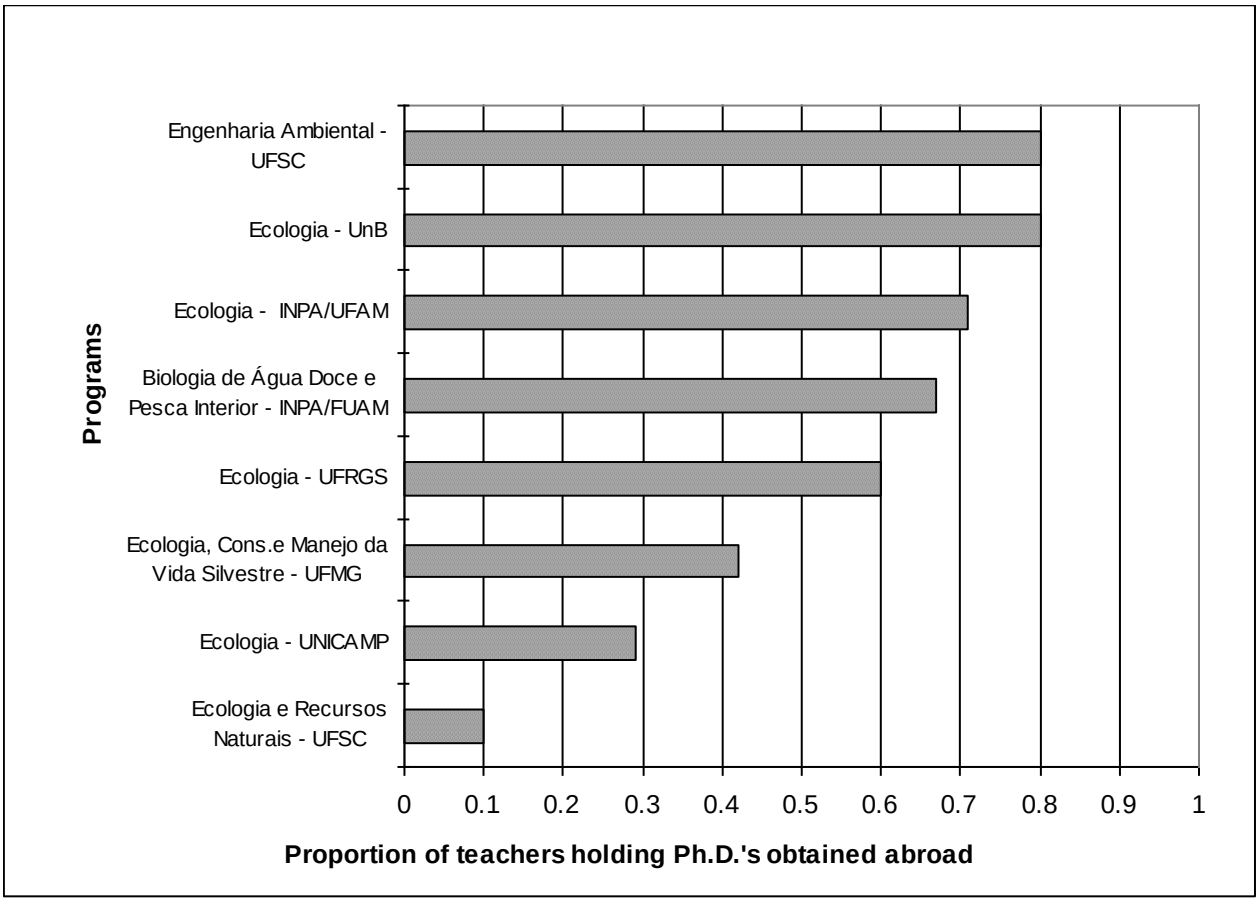

Figure 7 - Faculty doctoral degrees obtained in other countries.

Data obtained from the files of CAPES or from the implantation projects of the programs, provided by the involved institutions. The proportion presented is the number of teachers that hold a doctoral degree obtained in a foreign country divided by the total number of teachers in the institution.

It may be too soon to state it, but, considering the methodological claims and the "colonization" evidence, it seems the establishment of certain "schools" or school like structures in under way. Anyway, they do seem at least to be rehearsing this role: the research groups involved in the implantation of certain programs, specially UNICAMP and UFSCar, claim previous approaches to be insufficient or inadequate and they are problem focused in some extent. They also display strong theoretical commitment and reproduce in Brazil the polarization of perspectives standing in Ecology in general[12].

Group 2 is a small group of weak and unstable programs. In a way, their constitution is a consequence of the operation of factors similar to those at play in the first group: a wide ranged and diffuse awareness as to the environmental issue and as to

[12] Recognizing a "school" or "research school" involves many aspects of the practice involved and an appropriate definition of school. Transmission of tacit knowledge from practitioner to practitioner, the differentiation of the shared assumptions and procedures of its members from those of practitioners not belonging to it (previous or contemporary), stylistic identity elements shared by practitioners spread around different institutions are important issues. See for example M.J. Nye (1993), K.M. Olesko (1993) and J.W. Servos (1993).

the importance of Ecology and ecological approaches. Nevertheless, except for their feebleness and difficulty in achieving higher qualification marks by CAPES, they have little in common: the USP program is a strictly "Ecology" course, set in an Ecology department of the highest ranked institution of Brazil[13]. It is extremely "endogamic", as it is said here, which means faculty obtained their doctoral degrees at the same institution they are employed. It places great emphasis in the general theoretical foundations of Ecology and shows little concern for application and social issues. It certainly lacks the basic problem-focused nature of other programs. It is interesting to note that its document (Departamento de Ecologia Geral - Univesidade de São Paulo, 1978) claims USP to be the major pioneer in the area, illustrating this statement with a list of early professors of the Botany, Zoology and Biology departments who would have been ecologists or precursors of ecological research in Brazil. Amazingly, Dobzhansky himself is among this group, as well as Andre Dreyfus, acknowledged pioneer of genetics in Brazil (Glick, 1994). There is no evidence that such claims were ever taken seriously by anyone outside their department.

The UFBA program is completely different: it is an applied Ecology program, it has no ambition to occupy an important position among the strictly Ecology courses, it is completely problem focused in water resources research in the Northeastern littoral of Brazil and it is set in a very weak federal university struggling against basic infra-structural difficulties (Schaden, 1984; Coutinho, 1984; Alunos, 1987). A long sequence of letters from the students show that this program has stood on the verge of closing many times and that it never did show any sign of being able to become an alternative for Northeastern demands for graduate education in the area (Alunos, 1987; Seeliger 1992).

I would like to describe with a little more detail three of the initiatives belonging to these last two groups to illustrate the nature of the innovations I claim to be characteristic of a new mode of institutionalization of Ecology and environmental themes in Brazil and also to show the operational disparity among them: the UFMG program, the USP-São Carlos program and the UFS program.

The UFMG program is certainly the most remarkable phenomenon in the history of the institutionalization of Ecology and Environmental Sciences in Brazil since it expresses simultaneously:

- unquestionable socialization in international scientific traditions coupled with relatively high productivity (important indexes of scientific success),

- planned collective efforts in academic organization (the rather rapid assembling of the program with a great number of contributors and different participating departments) and research (important indexes of successful interest negotiation and consensus achievement between scientists),

- organized (and, as far as it is reported, successful) efforts in job finding for graduates and students (one of the important functions of group leaders,

[13] See J. Schwartzman (1995)

reflecting an advanced process of social organization among the agents involved in this endeavor);

- remarkable success in fund raising exploring traditional as well as completely innovative alternatives (one of the most important elements of institutionalization of initiatives),

- combination of efforts and actual organization of initiatives with different social actors in the environmental action arena (fully reflecting the new socially diffuse processes of knowledge production),

- evidences of important impact on the wider society, attracting the offices of international environmental organization and agencies and inducing the transformation of an economically and politically secondary city into the country's most important center for environmental research and action.

The M. Sc. program in Ecologia, Conservação e Manejo da Vida Silvestre (Ecology, Conservation and Wildlife Management) started in 1989 after a long and careful preparation involving three departments of the Institute of Biosciences of the Federal University of Minas Gerais. As soon as the initial proposal was ready, the UFMG required two eminent ecologists from other universities to prepare a report on it. The choice was also a careful one, with one referee from UFSCar and the other from UNICAMP. It took a little more than three years to complete the necessary bureaucratic steps (Instituto de Ciências Biológicas, 1991).

At the same time and with a large overlap of involved agents, the Fundação Biodiversitas was created in Belo Horizonte, Minas Gerais. This NGO became the national partner of many international organizations on nature conservancy and developed the role of attracting funding for the ECMVS program and its projects (Fonseca & Aguiar, 1995, p. 68). It seems that its most important partner has been the World Wildlife Fund (WWF): Lacher, Jr. Fonseca, Valle, Fonseca (1991) report the WWF to have been awarded a large fellowship fund which is being used to finance an ambitious project called "U.S. Environmental Education Goes South" aimed at international environmental and conservation education. This project includes a college component and one of its aspects is a plan to create a number of excellence centers in conservation in Latin American universities, which would offer graduate education in wildlife biology and conservation. The first of such programs was established at the Escuela de Ciencias Ambientales, Universidad Nacional, in Costa Rica and started in 1987. The second one is our ECMVS program at UFMG. WWF also established its first Brazilian office in Belo Horizonte in that period and soon *Conservation International* would do the same. Belo Horizonte became the most important center for conservation studies and activities in Brazil in detriment of Brasília, São Paulo or Rio de Janeiro, politically, economically and traditionally more attractive, respectively. Fonseca & Aguiar (1995) report that these agencies as well as Biodiversitas itself became a source of job positions for the ECMVS program graduates. They also state that Belo Horizonte shows high levels of absorption of conservation specialists.

It seems there has been a general strengthening and intensification of activities involving conservation and environmental management in Minas Gerais. Available

financial resources increased during the evolution of the program. As money poured in, the number of involved institutions in projects also increased: the ECMVS program has developed partnership with the Ibama (Instituto Brasileiro para o Meio Ambiente e Recursos Naturais Renováveis - Brazilian Institute for the Environment and Renewable Natural Resources) the IEF (Instituto Estadual de Florestas - State Forestry Institute) and the FEAM in Minas Gerais. These are governmental environmental organization frequently weak and bureaucratic. Such partnerships seem to have transformed the nature of their activity: Fonseca and Aguiar (1995) report that IEF was originally a simple inspection organ and that it has now diversified its efforts. Besides these institutions, the ECMVS program interacts with different NGOs and private organizations and Fonseca & Aguiar (1995, p. 67) are positive in stating that it now exerts undeniable influence on the environmental action and attitude of all these social actors.

It is interesting to check if such an academic-fuge tendency corresponds to equally disciplinary-fuge behavior. The objectives put forward in the accreditation proposal is to form "specialists in an area that could be broadly defined as 'Conservation of Biological Diversity'" (Instituto de Ciências Biológicas, 1991, p. 8). But the program also wants to "provide students with a solid base in theoretical and applied Ecology" (1991, p. 9) besides other technical and procedural instruction necessary for the "specialized exercise of conservation biology". They realize they represent the implantation of a new speciality in Brazil (conservation biology), they have a clear understanding of its current status, of the emphasis given to this or that perspective by dominant international research groups and they reproduce the ambiguous disciplinary relations with Ecology all such practices display: for the proper exercise of conservation biology (or for biodiversity conservation biology) one must have a solid base in... Ecology! It is easy to derive from there that, yes, they keep their disciplinary boundaries relatively well swept and that their program is Ecology, but qualified as conservation biology. But they don't. If a privileged emphasis in Ecology as such is still visible in statements and evidenced in the curricular structure (where mandatory courses are: "systems and community Ecology"; "population Ecology"; Ecology and wildlife management"; "biogeography" and "biostatistics"), it would be difficult to argue for disciplinary subordination. They believe that evolutionary Ecology - dominant in Brazilian graduate programs, as they see it - is insufficient to provide background for the specialists they aim to produce. They would need other material developed by "conservation biology" and derived from population and community Ecology, genetics and faunae management. So we meet again our "population studies" in which one of Ecology's perspectives was supposed to be dissolving its borders. And now we see it does it to respond to certain application situation, much as Gibbons et al. (1994) have proposed.

In the early 90's two other initiatives involving the ECMVS have intensified the interdisciplinary trends the ECMVS featured: an interdisciplinary graduate program focusing the interfaces of biodiversity conservation, human demography and economy was established in an agreement with the University of Florida in 1990. It involves the ECMVS program and also the Demography and Economy programs at UFMG. In 1991, these three programs presented a research and manpower qualification improvement project to the Programa de Apoio ao Desenvolvimento Científico e Tecnológico (PADCT) - Program for Support of Scientific and Technological Development), under the Environmental Sciences sub-program. It was called "Environmental Studies

Methodology in an Interdisciplinary Perspective" and was selected, together with three other projects, among 50 applications by Brazilian institutions.

In the same year that the ECMVS program started at Belo Horizonte, another innovative graduate course was beginning: the Curso de Pós-Graduação em Ciências da Engenharia Ambiental, *Graduate Program in Environmental Engineering Sciences*, at the São Carlos campus of the University of São Paulo. If Belo Horizonte is the most important center for environmental studies, conservation training and environmental action in Brazil, São Carlos is the only city to harbor two important environmental studies graduate courses offering doctoral degrees in two different and prestiged universities. This is no incidental coincidence since both programs were founded by the same character: José Galizia Tundisi. Tundisi is probably the most eminent ecologist in Brazil. Not only has he founded two graduate courses in (or around) Ecology, but he has a very definite methodological commitment, remarkable international collaboration and he has imprinted his mark on both academic endeavors. Tundisi occupies today probably the highest position in science and technology management in Brazil: he is the president of the CNPq. Comments on his intellectual trajectory will be left to a forthcoming paper.

The CEA program at USP/São Carlos follows the line of initiatives in environmental research undertaken by the Department of Hydraulics and Sanitation since the early 70's. The department received a large area around the Represa da Usina do Lobo (Lobo power plant reservoir, belonging to the Electric Energy Company of the State of São Paulo). There they established the Centro de Recursos Hídricos e Ecologia Aplicada (CRHEA) - Center for Water Resources and Applied Ecology. Agreements with several governmental and international organizations from 1973 up to the 1979 permitted the construction of facilities and funded research in the CRHEA. These organizations included the FINEP (Financiadora de Estudos e Projetos - Research and Projects Funding Agency), the OAS, the INPE (National Institute of Space Research), the DAEE (Department of Water and Electric Energy of the State of São Paulo) and the DNAEE (National Department of Water and Electric Energy). The CRHEA, thus equipped, started offering in 1980 courses to engineers and technicians working in water resources, specially in governmental organizations (USP/São Carlos, 1995/1996, pp. 5-7).

These activities seem to have resulted in a new emphasis in water resources management and research in limnology and in 1987 the CRHEA organized an International Symposium in Limnology and Reservoir management (USP/EESCar, 1995/1996, p.7). The CEA graduate program started two years later with an emphasis in environmental management and regional planning and with this program it has succeeded in attracting international funds for the training of specialized personnel from other countries with similar problems, specially those from Latin America and Africa (USP/São Carlos, 1995/1996, pp. 8-9).

The CEA program shares with the other São Carlos course (ERN-UFSCar) not only the emphasis in the systemic approach but also the chief research object, the Lobo Reservoir where limnological and environmental impact research is carried out. The bio-fuge and eco-fuge tendencies observed in environmental studies are again only partially expressed and do so specially in the institutional placement. Although there is

an explicit statement in their catalogue as to the importance of demography, social and cultural change, law, management and economic studies in the Environmental Sciences, the composition of their curriculum bears a strong biological bias and offers only two courses in non-biological disciplines ("environmental economy" and "environmental analysis and administration"). The two mandatory courses are "ecological models" and "theoretical Ecology", the latter suggesting a strong ecosystemic commitment.

The last program I would like to comment on is the Programa Regional de Pós-Graduação em Desenvolvimento e Meio Ambiente (DMA) - Regional Graduate Program on Development and Environment. It is an inter-university program, where seven universities of the Northeastern region of Brazil will cooperate with their specific sub-programs. From 1995 up to now, five of the seven institutions already started their sub-programs. The Brazilian Northeastern region is not only extremely poor but it also concentrates some of the most serious socio-environmental and development problems dealt with by governmental organizations. Draught, extreme land and income concentration and a feeble economy make this one of the most explosive regions in the country. Northeastern universities are generally among the most unproductive of the federal system and their state counterparts don't do much better.

I have received a letter from Dr. Vania Fonseca, coordinator of the Center for the Studies of the Semi-Arid Region (NESA) at the Universidade Federal de Sergipe (UFS) where she describes the process that led to the constitution of the DMA regional program (Fonseca, pers. com., 1996). The efforts that resulted in the setting up of the program began at the UFS in 1986 and involved faculty from geography and biology areas. They set up an interdisciplinary research program to study the Semi-arid region. She describes the enormous efforts to raise funds from federal agencies, to involve governmental organs (they actually had some level of articulation with 52 organizations) and their general failure in both. Despite great frustration, they managed to develop some activity with very few organizations and this interaction led them to devise specialization courses to the technicians involved - much like the CEA São Carlos program predecessors did. They wanted to organize: they even founded a Sociedade Nordestina de Ecologia (Northeastern Ecology Society) in 1987 and, according to Fonseca, they already had in mind something "much wider" than Ecology. In the early nineties they expanded their contacts to two other Northeastern universities: the Universidade Federal do Alagoas (UFAL) and the Universidade Regional do Rio Grande do Norte (URRN). From this articulation was born the idea of graduate programs in institutional nets as a form of overcoming the local weaknesses of each university. They managed to join 18 Northeastern universities in 1992. Along the process of organization and actual building of the structure of the DMA regional program most of them dropped out and in march 1995 the first sub-program started in the UFS. There was much difficulty in convincing CAPES to allow the net to work. There was also much difficulty in raising funds from any sources and the few international agreements they attempted to establish seem to have either failed or not to have evolved as expected. Fonseca states they have no other source of support and just as she was writing me she had no office material to send me the rest of the papers she wanted me to have and even envelopes for properly mailing them. As one observes the bibliographic references suggested in the course syllabi, most of the indicated books and articles are in Portuguese and there is no updated material. Access to relevant bibliography seems to be critical.

There are two groups of courses in their curriculum: the "common stalk" courses and the courses offered in different concentration areas. The "common stalk" is composed of "logic and criticism of scientific investigation", "society, nature and development: foundations", "society, nature and development: the Brazilian experience", "integrating seminar I' and "integrating seminar II". A diffuse and unclear ecosystemic rhetoric is sometimes suggested, together with what is felt as a Marxist perspective. It is difficult to infer any specific commitment in research methodology or perspective.

The diffusion of the new orders of legitimacy where the environmental issue occupies an important position inspired yet this last initiative[14]. Nevertheless, in many aspects, it seems to be the anti-image of the ECMVS Belo Horizonte program: both had action in establishing a wide net of institutional links involving different organizations and social interests. ECMVS was astonishingly successful, DMA failed. Both are based in problem-focused, trans-disciplinary research: ECMVS made the relevance of the problem a national and international wide consensus, DMA still has difficulty in convincing close interlocutors. ECMVS evolves towards greater internationalization while DMA failed its early efforts and shows extreme difficulty in even circulating their production in the local national scientific media[15].

I would like then to address an issue that is of foremost concern for those who study the institutionalization of science and technology in countries like Brazil (which I prefer to call a "non-traditional context" rather than a peripheral country): the internationalization challenge. It seems that the pioneer courses have been able to establish research endeavors that reflected varying (but always observable) degrees of socialization in international scientific traditions. That is the case of UFSCar, lead by Tundisi, who has a long history of collaboration and participation in international enterprises in ecosystem Ecology. It is also the case of UNICAMP, INPA and UFRGS, with productive foreign (and well socialized) founders. Still, the acquisition of a doctoral degree abroad and the incorporation of researchers who did so by the institution does not seem to be a guarantee either of proper socialization in international practices or of higher productivity (Figures 8 and 9). I believe this issue has yet to be analyzed with more data and also in a comparative perspective[16].

[14] This is not only contextual inference, but one based on documents produced by the agents involved. The historical relation of their initiative and the events that led to the UN Conference on Environment and Development is stated in UFS/PRPGP (1995) *Programa Regional de Pós-Graduação em Desenvolviemnto e Meio Ambiente* (p. 3).

[15] This is evidenced by the scientific production records of faculty, UFS/PRPGP (1995) *Programa Regional de Pós-Graduação em Desenvolviemnto e Meio Ambiente* (Aracajú).

[16] About the relationship between academic choices of study/research periods abroad and chances of scientific success in Brazil in the carreers of chemists and physicists, see Meneghini (1991 and 1995).

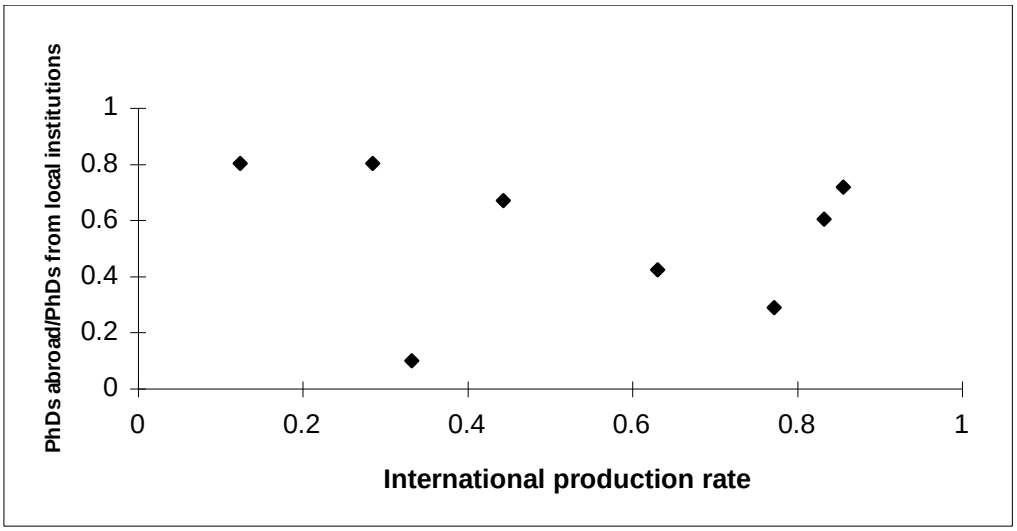

Figure 8 - Faculty foreign doctoral degrees and international publication.

Data on publication records and number of teachers in the beginning of courses were obtained either from the files of CAPES or from the involved institutions. Foreign doctoral degrees rate was plotted against international publication rate (abciss), which corresponds to the number of international publications in the period (two years) divided by the number of teachers.

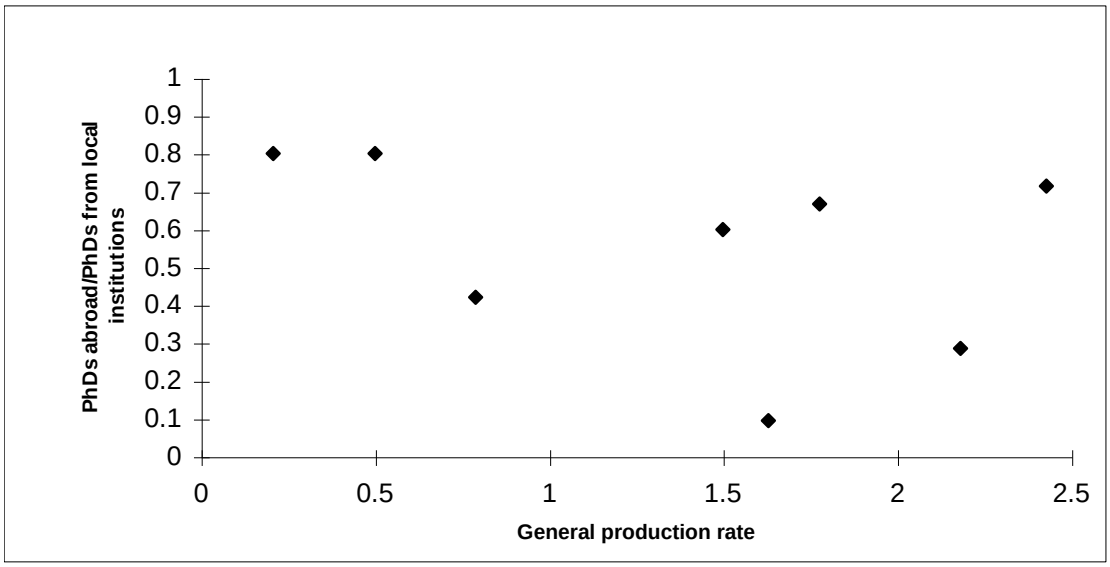

Figure 9 - Faculty foreign doctoral degrees and general productivity.

Data on publication records and number of teachers in the beginning of courses were obtained either from the files of CAPES or from the involved institutions. Foreign doctoral degrees rate was plotted against international publication rate (abciss), which corresponds to the total number of publications (national and international journals) in the period (two years) divided by the number of teachers.

The most successful situation of internationalization is the ECMVS program at Belo Horizonte, detailed above, where international relations go much beyond intellectual production. It is difficult to accept the argument according to which WWF chose Belo Horizonte for its ecological features, as Lacher et al. (1991) state. Quite on

the opposite, it seems that the process went the other way round: the presence of pioneers who are properly socialized in international traditions appears to have been in this case and others quite decisive for the ability to persuade national and international interlocutors (from scientific collectives or not) as to the relevance of their problem-focused research. From this original ability derive the most decisive competence to fund research, to circulate products in the wider possible public at each specific level and to have them quickly legitimized.

4. Research groups in Ecology and Environmental Sciences

If the features we have just analyzed relative to graduate programs in Ecology and environment seem to show a somewhat centrifuge tendency as to the basic ecological disciplinary commitment, a closer look at research groups in Environmental Sciences might offer interesting elements in this line. Figure 10 is a comparison between the "areas of knowledge" recognized by CNPq as to the relative weight of research lines in "Environmental Sciences". The rates obtained are a result of the division of the number of research lines classified as "environmental science" (each research line might be classified in more than one category) by the total number of research lines in Brazil for that area (which is also subject to double counting, since research groups might be classified in more than one area). The rates give us a rough idea of the order of magnitude of that weight. Surprisingly, Ecology is the eighth area in this sequence, trailing behind Botany and Zoology. We could argue that this is to be expected, that Botany and Zoology have both gone through a long history of institutionalization in Brazil and that they have occupied the "niche" of the Environmental Studies provided by the diffusion of international orders. After all, much of this seems to have been responsible for the first wave of ecological research.

But then we should be able to find evidence for the present feebleness of Ecology according to certain indexes as, for example, the number of researchers catalogued under this area (which should be substantially smaller) or their relative immaturity, reflected, for example, in their academic degrees. Figures 10 and 11 show that none of this is consistent: Ecology has in fact a considerable number of practitioners according to these data. Actually, except for agronomy with its huge crowd of practitioners, the "basic" areas rank close to each other. As to the proportion of doctoral degrees, Ecology, Botany and Zoology are almost identical in their numbers and they constitute a sort of "middle" class: there are the very weakly academic (with small proportions of doctoral degrees among practitioners) professional areas, the highly academic, competitive and productive molecular research basic areas and, between them, those areas for one reason or another not having achieved high proportions of doctoral degrees (being either too young, or too backward, or not competitive enough, or having its practitioners precociously absorbed by other professional markets where the doctoral degree is not an important requirement).

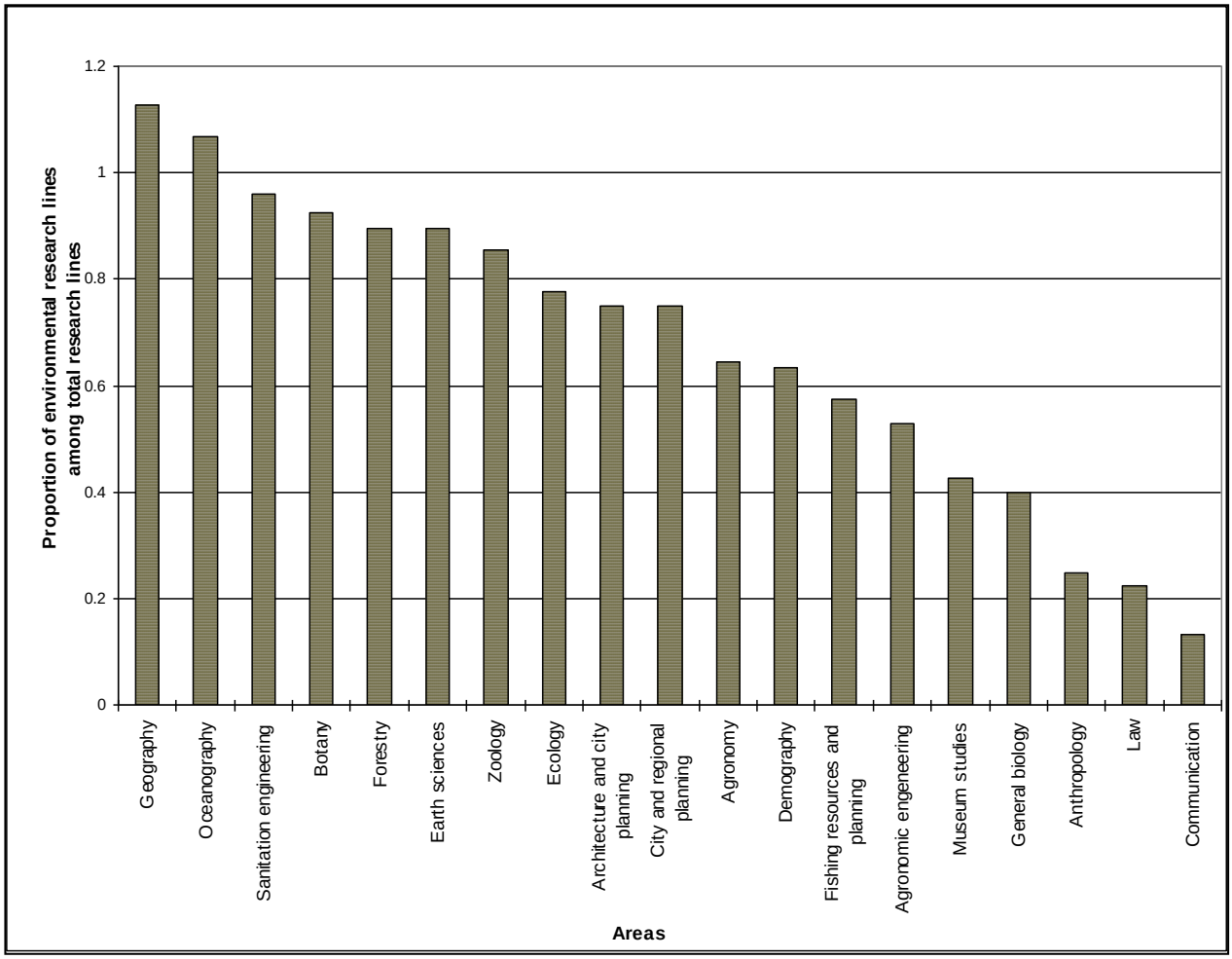

Figure 10 - Ratio of Environmental Science research lines.

Data were obtained from CNPq (1994, p. 383 e pp. 2-62). Values in the ordinate correspond to the order of magnitude of the proportion of environmental research lines among total research lines accounted for in Brazil in each area: the number of research lines in Environmental Sciences (groups are classified according to self-definition) in the area was divided by the total number of research lines in the area in the country. Both values were subject to double counting when original data from the groups was processed by the CNPq: each research line might claim more than one "activity sector" (environmental science, education, etc.) and each research group might be classified in more than one "knowledge area" (geography, Botany, Ecology, etc.). Thus, the ratio here produced represents only an estimation of magnitude of the proportions of Environmental Sciences research lines in the "areas".

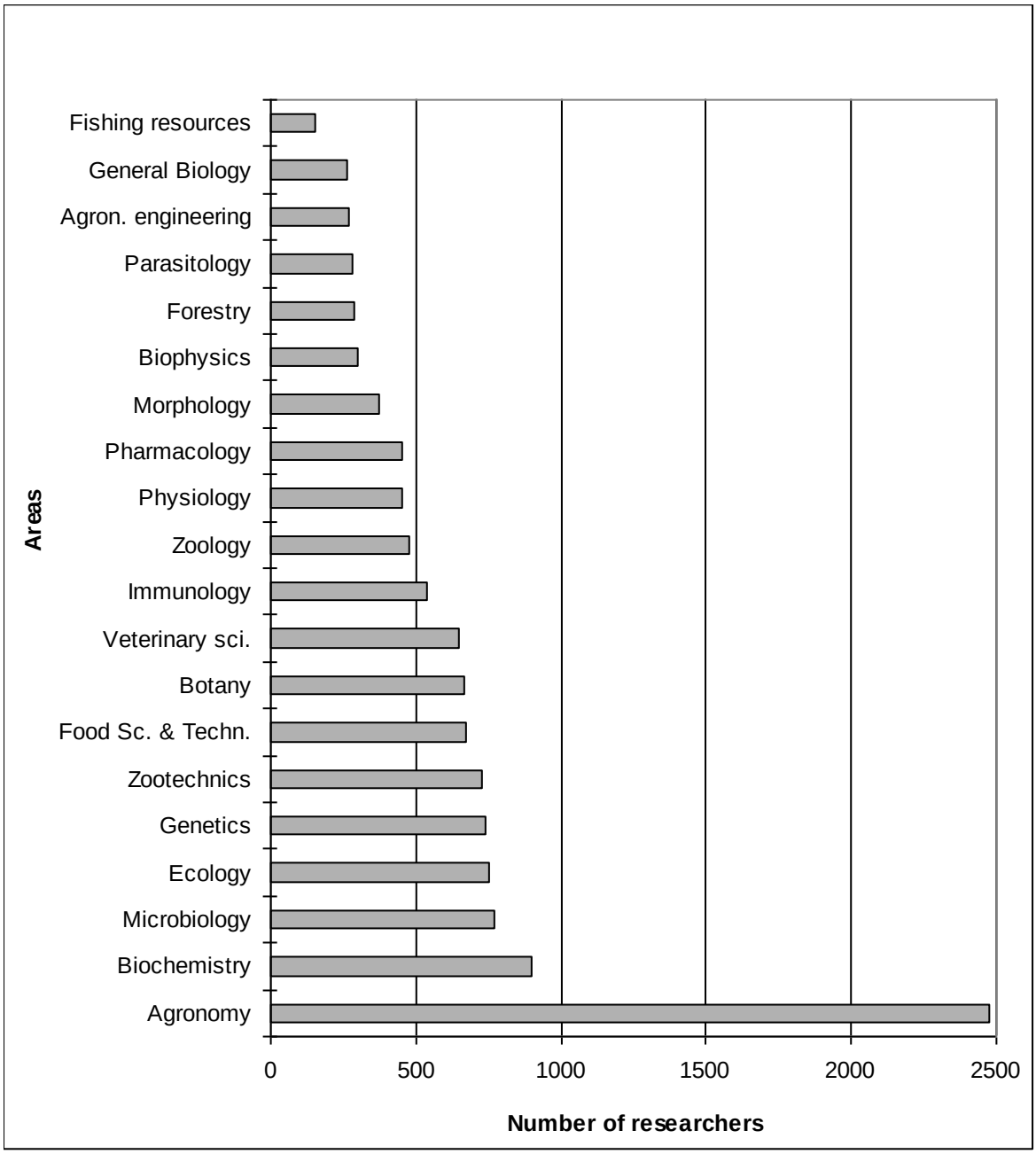

Figure 11 - Number of researchers in each area.

Data were obtained from CNPq (1994, pp. 375-382).

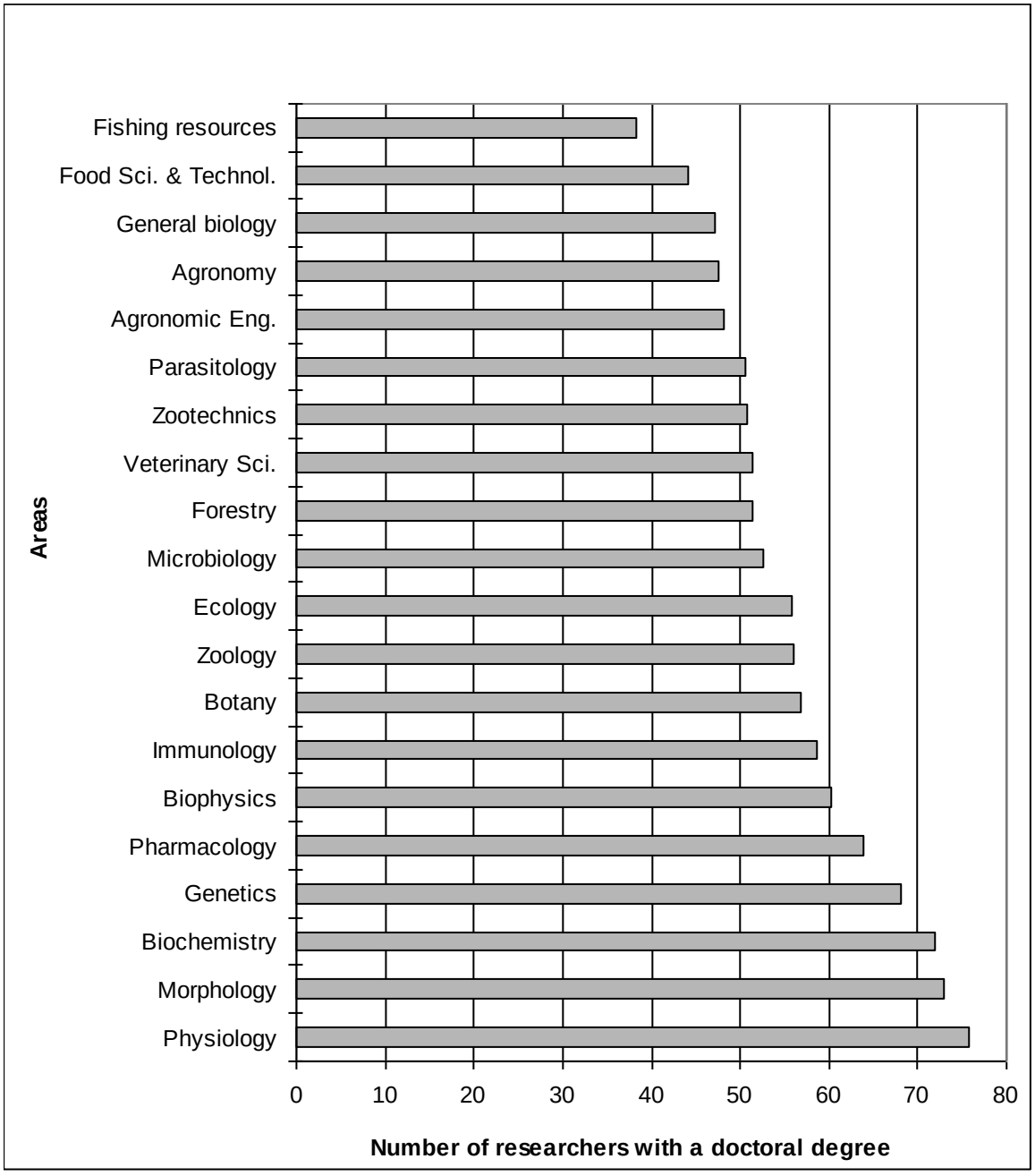

Figure 12. Percentage of researchers holding a doctoral degree.

Data were obtained from CNPq (1994, pp. 375-382).

5 - Alternative tendencies in the institutionalization of science

During the last twenty years we seem to have watched the transformation of the pattern which guides the institutionalization of Ecology in Brazil. In the first years of this process, in the late seventies, we had what could be qualified as a more academic, biologically and ecologically centered mode. The context was a favorable one in this direction. There was a generalized nationalist and optimistic perspective as to the role of science and technology in society. The correspondent "recapitulationist" outlook ("let's protect our science and technology endeavors from international competition so that we can develop them from scratch here")[17] tends to favor traditional conservative perspectives as to science. There was a lot of money available and many governmental incentive programs for science and technology and it was the middle of the boom of graduate education. 1976, the key year for Ecology programs, was also the year CAPES took over the accreditation procedures for graduate courses, inaugurating a new era in the relationship between scientists and funding agencies. The country believed in science, the higher education reform was quite fresh and the efforts that led to the opening of the pioneer courses in 1976 must have been undertaken when departments were very young. It is not likely that they would be seen as inadequate or insufficient for harboring a graduate program.

The period was also one when many development projects from the early 70's were being developed: the nuclear program, large hydroelectric power plants, ambitious road and railroad construction projects and the expansion of the frontier into the Amazon. At the same time, the first environmentalist and conservation NGO's in Brazil were being created and fears about the implications of the development model adopted by the military government were being expressed by some people.

It is not surprising thus to see the pioneer Ecology groups setting up their graduate courses bring forward their concern with development and, naturally apply for the role of scientific authorities to legislate on the matter.

Among important features in the pioneer group are the department-based institutional structure, the emphasis in disciplinary knowledge, with a strong focus on theoretical foundations of Ecology and the academic internationalization led by senior researchers. Discipline-fuge tendencies, innovative institutional structures could already be glimpsed, although they were never developed until many years later. Similarly, interaction between these institutions was sought but failed: Tundisi reports unsuccessful attempts to organize the graduate programs in a very early stage (personal communication) and there is a record of a subsequent effort, in 1984, to organize an Integrated Program in Ecology (Heads of graduate programs in Ecology 1984).

All this could only be effectively accomplished in the next institutionalization wave which started in 1988. The context as to science funding was completely different: there was a general shortage of resources and the few remaining lines of incentive were aimed at technological, hard sciences projects (Guimarães 1995, Stemmer 1995). It was

[17] About import substitution policies, see S. Schwartzman (1991) and J. Meyer-Stamer (1992).

a time to develop funding and institutional alternatives and these are important features of successful endeavors in the new wave. Besides being institutionally innovative, they were also cognitively original: they displayed a clear centrifuge tendency as to the life sciences core (with social sciences and engineering emphasis in some cases) and, in the life sciences, as to the Ecology core (with agricultural sciences cores, for example). They express deeply trans-disciplinary tendencies as well as intense inter-institutional dynamics. Institutional relationships are here fully developed: we have colonization relationships (pioneer programs colonizing new wave programs), inter-institutional projects, programs and collaboration (like the Northeastern initiative, the interaction between the two São Carlos programs and between the CEA USP/São Carlos program and UNESP and UNICAMP) and, finally, the Integrated Project in Ecology (Fórum Nacional de Coordenadores de Pós-graduação em Ecologia - FNCPGE, 1994; FNCPGE, 1995(a); FNCPGE, 1995(b)).

6 - Concluding remarks

The institutionalization of Ecology and Environmental Sciences still takes place basically in higher education institutions due to the particular distribution of scientific activity in Brazil. Nevertheless, it already displays in full range the new contemporary trends in science and technology production, with trans-disciplinary problem-focused initiatives leading the field.

In spite of that, it should be pointed out that Brazilian science still follows a university-based centralizing pattern and that the diffusion of research activity and diversification of institutional sites for research has not taken place and shows no tendency to do so in a short time. Moves like those of the ECMVS program at UFMG go against this structure and should not be expected to be smoothly multiplied. There are other factors concurring to obstruct the evolution of the institutionalization of Ecology according to the successful UFMG model: it seems very likely that conservative traditional sites are hostile to many requirements for its development. That is a possible factor in determining that the pioneer ecological programs themselves could not be successful in places like USP or UFRJ and had to be otherwise harbored by newer and less traditional prestiged and productive higher education institutions. On the other hand, in most federal universities the environment is extremely research hostile - for all possible reasons (infra-structure, corporate attitudes of faculty who managed to establish promotion uncoupled from academic or scientific production records[18], etc.). Given the continuance of current scientific production distribution patterns and current higher education and science & technology policies, the availability of potential sites for the development of these innovative initiatives is, thus, very limited.

[18] For a detailed study of the academic profession, its requirements and sub-cultures and its relations with the institutionalization of research, see E. Balbachevsky (1995).

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