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BETWEEN CENTERS AND PERIPHERIES

THE RISE OF A NEW SCIENTIFIC COMMUNITY

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This article analyzes the production and diffusion of the scientific products of sixty-one researchers in soil sciences belonging to ORSTOM. In a period corresponding to two scientific generations we have observed important changes in writing and publishing habits. Non-published reports have lost importance while article production has grown. Also there is a noteworthy growth of the number of presentations at meetings, most of them international scientific congresses. The article shows the result of a factor analysis of their production that allows us to identify seven different types of behavior. We have stressed a series of elements explaining these different types. The possible predominance of a nationally oriented production behavior can be mainly explained by easy access to publication, sufficient appropriateness to the kind of data studied, and correct recognition by scientific peers. Finally we suggest that this typology can be used for analytical purposes in order to study the growth and publication patterns of Third World science.

Introduction

The main interest of the social studies of science has focused on well developed and highly structured disciplines, as well as sophisticated technologies. Moreover it has been implicitly asserted that these disciplines and technologies should serve as a model for the underdeveloped countries. Both these views have been increasingly challenged recently, with scholars urging the study of less conventional disciplines, or of research little recognized by the international establishment. At the same time, traditional views of development have been reexamined and challenged.[1]

Our own research participates in these new trends. In former works, we attempted to analyse the underlying paradigms used in tropical natural sciences. We have shown that these paradigms are essentially shaped in temperate regions and are severely inadequate for the tropical zone.[2] In short, there is a fundamental tension between international and national achievements. This conflict seems so general and implicitly accepted that there is an urgent need to clarify it.[3] One can apply the traditional opposition between Center and Periphery in order to describe the world

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scientific situation and to assess the scientific production of these two global entities. However if one wants a better appraisal of the degree of domination of the Periphery by the Center at the theoretical and disciplinary level (internal analysis) and the sociological level (external analysis), one has also to proceed through an historical analysis.[4] In doing so, one can clearly assert that there was not only an historical main *shift of the Center* (from the Europe of the 17th and 18th centuries to present day North America) but also that there is emergence of new Centers, or in other words, of *Peripheral Centers* (in Asia today, for example). As such, there does not seem to be an unsurpassable gap between *one* Center and *one* Periphery but rather a complex and changing scientific situation.

We have conducted[3] a bibliometric study of world production in tropical soil and agricultural science that further delineates this more complex image: First, in the main present Center (Europe, North America) there exist large influential countries with no production on tropical zones. Other powerful countries are essentially oriented towards theoretical or general studies while others work more at the local level in developing countries themselves. Second, secondary or Peripherical Centers also emerge clearly, such as Australia or New Zealand. Finally, Third World countries constitute the true present Periphery. However their strategies vary greatly. They are able to adopt either an international orientation (they publish in English in "mainstream" journals, mainly general studies), or to work and publish more at their own national level.

In addition, nationally oriented strategies seem to coexist with internationally oriented ones.[3] What had appeared to be a contradiction between these two tendencies can best be depicted by the use of an alternative image, that of *a growing network of diversified research Centers.*

Still, one might wonder how national strategies are shaped. Working and publishing are mainly individual decisions, so that the analysis of *individual behavior* is relevant in order to understand the positioning in the wider world network. Our interest lies in looking at the behavior of researchers who are neither in the most central parts of the network, nor in the most peripherical positions. We intended to analyse the emergence of an intermediate new scientific community, small but visible through time.

Principles and methods

We have chosen to study the community of soil scientists in our institute, the "Institut Français de Recherche Scientifique pour le Développement en Coopération", better known by its former acronym: ORSTOM. It is one of the major research institutes in the world specialized on tropical areas. One of the first scientific disciplines to be part of ORSTOM was soil science. Practically all of soil science

dedicated to tropical soils has been developed within this Institute.[5] This situation where the discipline (within one country) and the institution overlap is quite rare in developed countries, but is a common feature of developing countries.[6]

ORSTOM research is *neither fully at the Center nor in the remote Periphery.* Agricultural sciences are strongly developed by French researchers, in France and overseas as well. Despite this, these disciplines stand largely apart from the "mainstream". According to the Institute for Scientific Information from Philadelphia, the scientific "mainstream" is circumscribed by a few prestigious international scientific journals.[7] Moreover, the work done in soil sciences is neither totally fundamental nor uniquely applied. At a more social level in the French scientific community, the group of tropical soil scientists had considerable difficulty in obtaining recognition, so that it can be said that its position is very much like that confronting Third World scientists.[8] Eventually, the ORSTOM group rose and became more important and influential. However, as it is the case for French research teams, it has a tendency to look somewhat "provincial" or "home-bred"[7] (publishing in French in French journals mainly). It had to struggle to get closer to the so-called international "mainstream". In the following pages we will briefly depict this dynamic.

We confronted *the problem of confidentiality* that is present when dealing with a small scientific group. We present no data that can identify specific researchers and cause either prejudice or advantage to them. Moreover, we selected among the total number of researchers in soil science of the Institute a random set of sixty one, so that for each year we had two thirds of the total soil scientist staff in our sample.

We identified the total printed production of these randomly selected 61 researchers in tropical soil science. Most of these researchers have achieved or are achieving a complete career at ORSTOM. In fact, we studied all publications for these scientists in a 36 years period. We present this lapse of time without mentioning the calendar years, as a supplementary means to insure confidentiality. For the last year of the period only, we could not locate all the produced documents. We also had access to information on the professional curriculum vitae of the researchers. However, no one was interviewed.

The profile of this particular – and small – community can now be examined. Since we had access to their vitae, we counted for each year *the number of productive scientists,* i.e., the number of scientists that occupy a scientific post and produce at least one scientific report a year. In doing so we excluded all full-time administrative positions. The number of productive scientists in one single year was never over 54. Adding up the career years of each scientist we get a total of 1,055 years, so that *the mean professional age* in our community is 17 years.[9]

Twenty out of 61 authors had a doctorate. We should add that the doctorate, until the 1982 reform of ORSTOM, was not a career prerequisite in this research institution.

We gathered 2,884 documents, all extracted from the vitae of the scientists and checked in the library of the Institute. As far as individual production is concerned, we found the usual dispersion of publications. Eight researchers never published a a journal article, 32 published less than three, and 21 published at least four, at most 12 articles.[10] Sixteen authors published a "Compte-Rendu à l'Académie des Sciences", considered to be a high prestige document.

All documents were classified according to the following seven categories:

(1) *Unpublished reports* are those materials written in close connection with field and laboratory work. They are mainly institutional papers, circulating internally. As expected, they are quite diverse, some being large documents from which articles are further extracted for journals, others being field notes, soil identifications, and site reconnaissance. Most are not published and are the basis of literary inscriptions, as *Latour* and *Woolgar*[11] call the paperwork produced by scientists.

(2) Next come real *working papers.* These are mainly of a theoretical or prospective nature. They circulate inside and outside the institution by non-formal channels.

(3) *Technical bulletins* are generally short published documents. The majority are map commentaries. For soil science – and especially so for French tropical soil science which emerged in large part through the mapping of Africa – this was a basic activity.

(4) *Books* were very often found to be, in our case, the publication of a Doctoral Thesis. It should be remembered that "Doctorat d'Etat" has no equivalent in any other academic system, and can cover a lifelong scientific activity.

(5) *Journal articles* are published articles in scientific periodicals.

(6) We distinguished papers published as *chapters of edited books* from journal articles, because of their very distinct function. These papers are gathered in books generally edited by highly prestigious scientists in the field, and are considered by us as good clues of greater recognition.

(7) Finaly, we counted the number of *presentations at scientific meetings,* either published or not. We avoided double counts between oral presentations and further written publications.

We will now examine the overall change of total production, as well as each item separately. Then we will focus on the type of documents in order to draw a *typology of authors* according to the type of documents they write and publish.

General features

Figure 1 shows the number of authors by year. As can bee seen, there are three different periods: first a period of slow growth then one of rapid growth, followed by a slower growth in the last years of our sample.

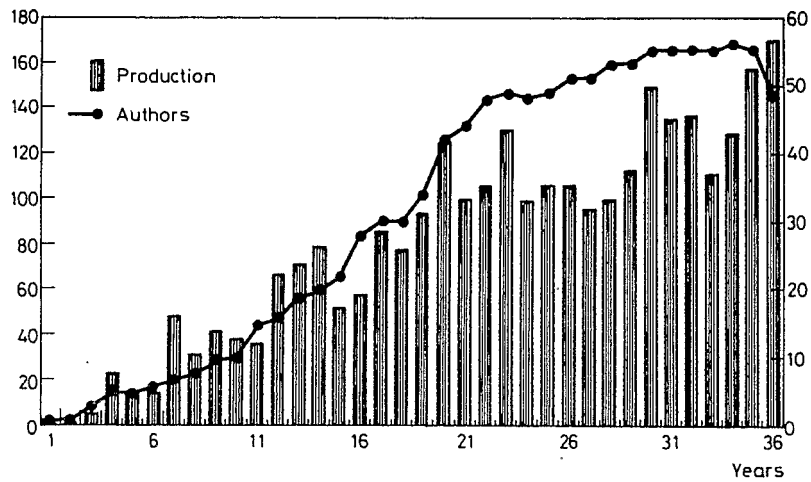

Fig. 1. Authors and total production

In the same Fig. 1 we report the total number of written documents for the same period. As can be seen, there are two clear tendencies: regular growth for 23 years, then followed by a slower trend. Also, it appears that there is a change in the writing habits of the scientists in the last 13 years.

Table 1 shows the distribution of total production by type of document.

Table 1
Types of documents in the ORSTOM sample

	Number of references	% of the total	Number of authors
Mimeographed documents (reports, etc.)	1,653	57.3	1.6
Journal Articles	493	17.0	1.9
Congress	278	9.6	1.8
Books	47	1.6	1.7
Chapters of Edited Books	65	2.2	1.9
Technical Bulletins	84	2.9	1.6
Working Papers	264	9.1	1.4

One particular aspect is interesting: the number of co-authors, a criteria that gives *a measure of associativity* between researchers. There are less co-authored articles in the ORSTOM production than in the usual production of tropical soil scientists. In particular, in a recent study[12] of this sub-discipline, we found that Third World scientific communities (a) have a very high number of authors per article: around 2.5 authors per article for India and Egypt and nearly 2.8 for Brazil. In the same sample of the above mentioned study, 4 European countries (b) show a lower number of authors per article: from 1.48 to 1.63. The USA, Australia, New Zealand, Israel, and South Africa (c) are in a middle position with a number of authors per article between 2.1. and 2.2.

One can note *an historical pattern.* The oldest scientific countries (Europe) have the lowest rate of associativity. They are followed by the historically younger scientific countries (like the USA, Australia), and then by the latest to emerge (which all belong to the Third World) where the associativity is high. France definitively belongs to the "old countries," i.e. the first historical scientific Center. In the ORSTOM sample the number of co-authors ranges from 1.6 (for technical bulletins and map commentaries) to 1.9 (for articles).[13] These figures show that the associativity of the ORSTOM group is slightly higher than in other European countries or France as a whole, but significantly lower than in the US, the Peripheral countries and the Third World.[14]

As noted above, chapters of edited books are a good indicator of *international prestige.* In our sample, 40% of these books are of an international nature.

Books, articles in edited books and technical bulletins are production borne out of a *long term effort.* They contain information that takes a long time to gather or theoretical elaborations of experienced scientists. These three items (196 references) can then be analyzed together in order to have an idea of the long term research effort. Figure 2 compares these publications (196 total items) and working papers (264 total items). It is interesting to note that growth in working paper production precedes growth within a 5 year interval. This supports the hypothesis that working papers are good indicators of theoretical advances and that they announce further important achievements. Moreover, it appears that working on such long term scientific objectives does not fit with an active participation in the competition for international visibility.

Unpublished reports are mimeographed documents lacking a copyright. They are the most numerous part of the total production. We find in this category field reports, soil maps and their legends, laboratory reports, and the like. Practically all of these documents are quite large in size. They circulate in the scientific community and among a narrow range of users (agronomists, development agents, etc.). Comparing the publications and the unpublished production (grey literature) in such

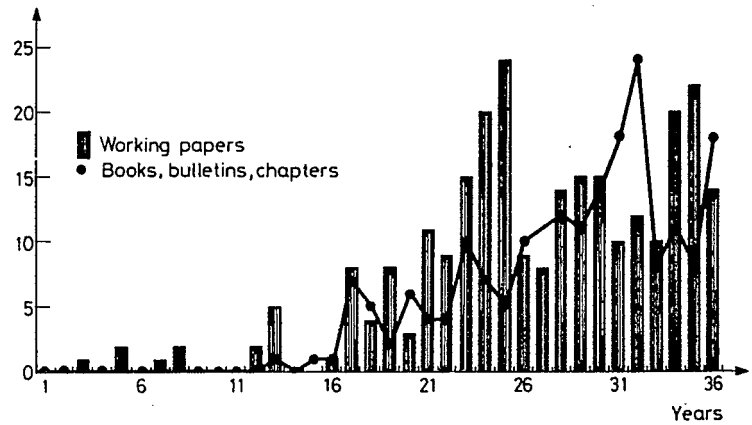

Fig. 2. Long term publications and working papers

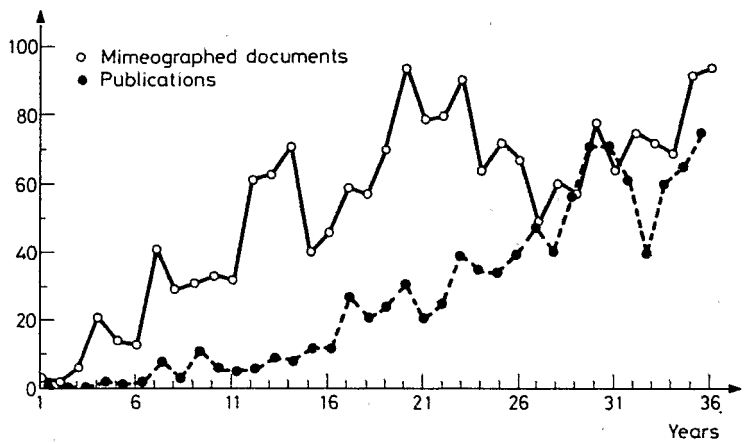

Fig. 3. Grey literature and publications

a long period is quite interesting (Fig. 3). Around the 16 th year, publications (articles, congresses, books) take off. A *first threshold* is then passed.

A *second threshold* is passed the 29 th year when each active author produces more than one publication per year (Fig. 4). In the last year under study, 6 books, 11 chapters of books and 5 technical bulletins documents were published. Mimeographed reports seem to have lost their initial value as a mean of communicating information. Not only did publishing increase in quantity and quality, but at the same time, unpublished reports lost their role as normal production. They

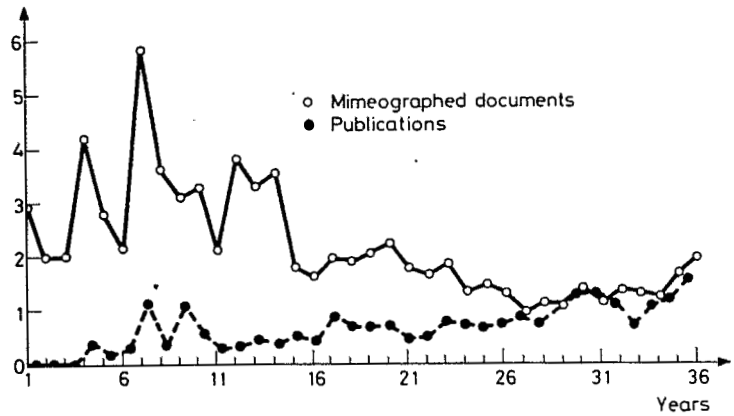

Fig. 4. Grey literature and publications per author

are still used for recording data, quick diffusion of practical information among scientists and users, and institutional use.

Looking at the detail of the published documents, we find that articles became an important item around the 12th or 13th year, and increased continuously.. Communications to congresses became important later. During the 15 first years these communications are rare and independent from article production. Later they clearly precede publication in journals (Fig. 5 and 6).

As shown in Table 2, *the soil scientists in our sample write mainly in French* (92.6% of the articles) in French-language journals, practically all of them being French (31 journals) or being produced by French-speaking African countries (20

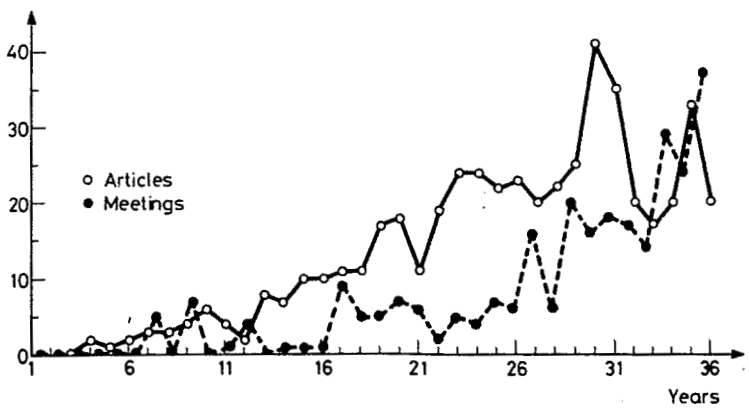

Fig. 5. Publications and meetings

journals). The 3.4% of articles in 10 different Latin American journals are written by scientists who have worked on the American continent, mainly in Brazil. One interesting figure is that although French soil scientists specialized in tropical areas publish very little in English-language international journals (only 8 journals), they do participate in *international meetings* outside France.

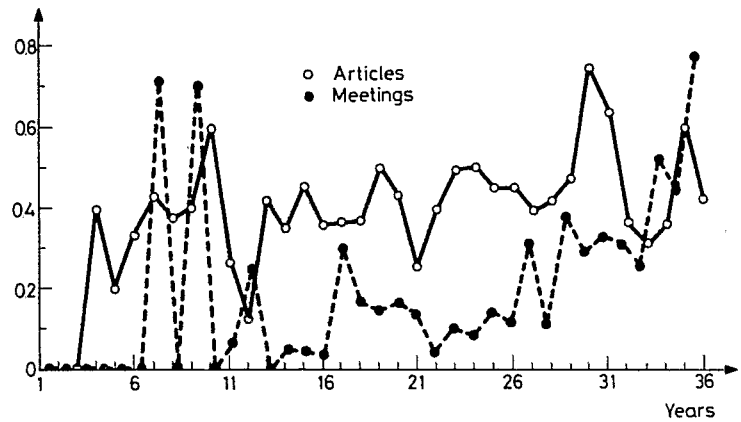

Fig. 6. Articles and meetings (number of references per author)

Table 2
Distribution of articles and communications to congresses by area

	French-speaking	Latin-America	International
% of Articles	92.6	3.4	3.8
% of Communications to Congresses	23.3	15.1	61.5

A Typology of the authors

On the basis of the type of documents, we tried to depict the publication behavior of the scientists in our sample. That is we consider that the type of documents produced by the scientists are a valuable indicator of their strategy and of their visibility. Publishing more books than articles is choosing a long term strategy, where one can afford not to enter in the "publish or perish" race. Producing mimeographed reports confers a weak visibility outside the institution. Articles in edited books have a high prestige value in the community, as also communications to congresses; generally, both these kinds of documents belong to highly "inter-

nationalized" strategies. However, none of these kinds of publications is a good way of disseminating scientific information by itself. Rather, a whole set of documents should be regarded as indicators of a coherent individual strategy. We will try *to figure out the distinct behaviours in our sample using a factor analysis.*[15] It will allow us to provide a typology of authors by their publications.

The variables retained correspond to the headings coded C1 to C10 in Table 3. The first headings of the Table, that are not coded, were not included in the computation. They were used as an additional help in the interpretation of the factor analysis. Since publication is mainly influenced by the duration of each author's career, the total individual production was divided by the professional age of each author. Taking into account the mean number of documents by year of professional activity erases the age effect: it does not appear in any of the first four factors drawn by the factor analysis (although these four factors account for 75% of the variance explained). The average professional age is nearly the same in Types 1 to 5 described below. Only very young researchers are excluded from these Types and grouped in the lower right quadrant of the graph.

Table 3
Coding of variables used in Factor Analysis

Code	Headings	Range	
	Thesis (French Doctorate-Es-Sciences)	0	1
	Number of papers submitted to the French National Academy of Sciences	0	5
	Number of scientific journal having published one or several papers of the authors	0	12
C-1:	Research career (number of years)	2	34
C-2:	Multicopied Reports (number)	2	98
C-3:	Books (number)	0	5
C-4:	Articles in Scientific Journals (number)	0	30
C-5:	Presentation to Congresses (number)	0	22
C-6:	Working Papers (number)	0	21
C-7:	Chapters in Edited Books (number)	0	5
C-8:	Technical Bulletins (cartography, laboratory technique) (number)	0	5
C-9:	Among the preceding, documents with international character (number)	0	22
C-10:	Total number of written pages	100	3,373

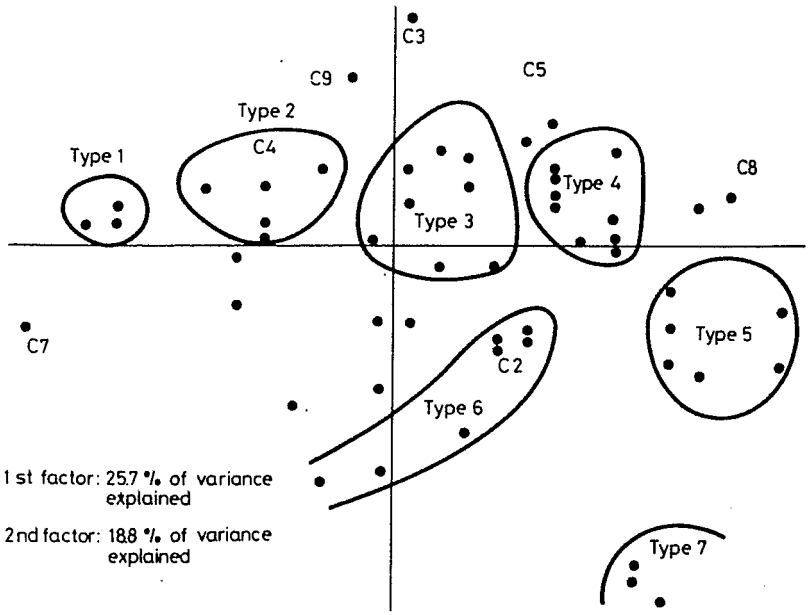

Fig. 7. Fractional analysis of Orstom Soil Scientists sample production

The number of pages (C 10) is not a discriminant factor, since every author writes a nearly equivalent number of pages a year. On the contrary, books (C 3) are strongly weighted. Only some of our authors have published a book in their curricula; having written two books or more is outstanding. This high weight given to heading (C 3) is understandable, since a book represents a major work, often being the publication of a higher level thesis (the French "Doctorat d'Etat"). Following books, we find articles in edited books, and technical bulletins. These two types of document do not play the same role. An opposition appears between chapters of edited books (C 7) that have frequently an international character, and technical bulletins (C 8) that are mainly accounts of fieldwork. Headings (C 7) and (C 8) appear on the two sides of Factor 1.

Figure 7 reproduces the graph of the first two factors drawn by the factor analysis. These two factors account respectively for 25.7% and 18.8% of the variance explained. Each author is represented by a point on the graph, except a few of them which appeared extremely deviant and were rejected by the automatic computation. The interpretation was made point by point, with the aid of additional clues given by the factor analysis (hierarchical classification, factor loadings).

In Table 3, we have calculated the range of the differents variables. Non-coded

headings of Table 3 were helpful for interpretation, as was close examination of confidential information concerning the vita. The factor analysis confirms that the authors' behavior vary greatly and without any clear cut boundary. This reason added to the technical constraints noted in the preceding paragraph led us *to define some Types of behavior,* and to avoid a comprehensive classification giving each author a place in a specific category. Each Type is personified by a few individuals; others individuals are more or less equated to these Types, or better characterized as intermediates.

Therefore, we will describe *7 Types of scientific workers.*

– *Type 1* are researchers who resemble very closely the ideal of "mainstream science",[16] They publish in a large array of journals. In this group we find authors of "Compte-Rendus de l'Académie des Sciences", of articles in international journals, and frequent participation in meetings. All the scientists of the group are "Docteur d'Etat." They clearly have an internationally oriented strategy.

– Researchers of *Type 2* publish many articles in journals and are eager to conduct long-term studies. Some of them have published 3, 4 or 5 books. All of them are "Docteur d'Etat" or are close to obtaining the title. They travel less than their counterpart of Type 1. This fact clearly confirms the initial hypothesis that an international orientation through articles is opposite to publishing long-term work.

Both Types 1 and 2 are high prestige scientists, who could be considered the elite. As we have seen, however, this "elite" is divided by two types of behavior.

– *Type 3* is a compromise between the two same opposing trends: long-term, locally based and published research *vs.* "mainstream" internationally published research. All the authors have abundant and high quality scientific production. Many of them have a Doctorate. But they do not make a clear choice between the mainstream and the more "locally" oriented goals. These scientists show that "locally" oriented strategies and "internationally" oriented ones can coexist even at an individual level.[17]

– *Type 4* may be legitimately chosen as an example of high quality in-breeding. The authors do not seem anxious to be recognized and do not worry about mainstream prestige. They choose specific targets and work efficiently. They publish fieldwork or technical bulletins. Many of them have the Doctorate. It seems that these researchers simply lacked the incentive to enter the international competition. Moreover, they are highly skilled and nearly totally oriented to the regional level, which they consider to be congruent with the mission of the Institute.

– *Type 5* appears as an opposite of the first Type. The authors publish rarely

and produce mainly mimeographed reports. Many times they are involved only in the cartography of soils.

– *Type 6* are grouped marginal researchers. One can perhaps explain their low scientific performance by external or accidental factors. Some belong to this Type of behavior because of an interruption in their scientific career.

– *Type 7* is representative of young researchers who have not worked long enough to have a defined scientific personality.

Discussion

In a period corresponding to two scientific generations we have observed a very important change in writing and publishing habits within the same institutional setting. Grey literature has lost importance while article production has grown. In this trade-off between grey and published literature, many factors are playing a role. First of all, in the international scene there exists now a wider sample of periodicals where a soil scientist specialized on tropical areas can publish. The new generation is more "article-producer" than their older colleagues. The reporting requirements in the institution also have changed: reports, once basic instruments in the evaluation process of the institute, are now replaced by the total scientific production. Also, the soil scientists in our sample are producing more books and chapters in edited books. But *the single most important change* is the rapid growth of presentations at meetings, most of them international congresses. This change has still not produced all of its impacts and one needs 5 to 10 years to evaluate such a long-term variation.

French soil scientists publish in "local" journals in their own language. However, at the same time, they are very mobile, attending congresses and meetings, living and working in Africa, America, Asia. This seems to be a paradoxical behavior.

As we have noted elsewhere (see references in notes 3 and 5), two factors seem to determine publication behavior: availability and access to *specifically targeted journals* (and readers), on one hand; *langage* on the other. In the case of our sample comprised of French soil scientists the situation is as follows. An agronomic study will benefit rom many publication outlets while a pedological study (on tropical soils) will be restricted to scarce jorurnals (and even more so in French). Moreover international journals are selective, not only on quality grounds, but also regarding their scientific interest, so that authors dealing with specific subjects, such as regional studies in developing countries, or unconventional methods, may not be able to publish in such journals. Of course, one has to take into account the fact that

French researchers are less pressed by international competition than their local – African or Asian – counterparts.

Another important clue to explaining the behavior of authors is the recognition of their value by their peers. In our case, publishing in international journals implies additional work that does not bring sufficient advantages to be worth the effort. This seems to apply to the researchers in our sample. It is this same feature – the evaluation through peer recognition – that explains why report production fell while overallpublished production rose.

In short, for the community under study, French journals offer (a) easy access to publication, (b) sufficient appropriateness to the kinds of data studied, and (c) clear recognition by scientific peers.

Looking now at individual publishing behavior, our typology raises some important issues. First of all, *the diversity of behaviors* should be stressed. It would be a mistake to consider that a given scientific community has two kinds of members: good ones and bad ones. Differences in the results are explained to a greater extent by personal choices and/or external circumstances.

Second, researchers show a great ability *to adapt their behavior* to changing contexts. Not only did the scientific community evolve as a whole, but so did individual behavior. Close examination of careers show that some researchers have totally changed their behaviors and strategies. Some researchers shifted from Type 1 to Type 4 behavior. Moreover, the inclusion in one or another Type depends on the actual position of each researcher. This is so with researchers who appear as home-grown researchers when living in a first country and later as international scientists when living in second country. In this case, the researcher would first belong to Type 4 and later to Type 1.

A third comment refers to *the similitude between individual behavior and national strategies.* In some developing countries, the scientific community as a whole tries to participate in the international mainstream. Such countries would be classified in Type 1 or Type 2. Other national scientific communities work more on specific national problems, and therefore would be equated with Type 3 or 4. But whatever the overall orientation of a country, it is quite clear that both tendencies – the international and the local – can be found in a same country, within a common discipline, and inside one single research institution.[18] Nevertheless, it appears that the dilemma between regional and international orientations is a very fundamental one, at the individual, disciplinary and national levels.

References

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2. See two papers from Y. CHATELIN, G. RIOU, in: *Pratiques et Politiques Scientifiques*, Y. CHATELIN, R. ARVANITIS (Eds.), Editions de L'ORSTOM, Paris, 1984; 149–156, 171–181.
3. Bibliometric studies are generally conducted assuming that the domination of Northern countries versus Southern countries is the "normal" situation. In order to reassess this statement, see Y. CHATELIN, R. ARVANITIS, *Stratégies scientifiques et Développment. Sols et Agriculture des Régions Chaudes*, Editions de l'ORSTOM, Paris, 1988. See also M. ROCHE, Y. FREITES, Producción y flujo de informacion científica en un pais periférico americano (Venezuela), *Interciencia*, 7 (No 5) (1982) 279–290.
4. Y. CHATELIN, La Science et le Développement. L'Histoire peut-elle recommencer? , *Revue Tiers-Monde*, 27 (No 105) (1986) 5–24.
5. France is also one of the biggest producers on these topics. Australia, New Zealand, Israel, and South Africa produce 26% of the literature on tropical soils and agriculture and the Southern countries 51%. It is probable that France's position would be even higher if sole "pedology" was taken into account in this statistic. See R. ARVANITIS, Y. CHATELIN, National Scientific Strategies in Tropical Soil Sciences, *Social Studies of Science*, 18 (1988) 113–148.
6. On The theme of scientific institutions in the Third World, see H. VESSURI (Ed.), *Ciencia Académica en la Venezuela Moderna*, Caracas: Fondo Editorial Acta Científica Venezolana, 1984, and H. VESSURI (Ed.), *Las instituciones científicas en la historia de la ciencia en Venezuela*, Caracas: Fondo Editorial Acta Científica Venezolana, 1987; also SCHARTZMAN (Ed.), *Universidades e Instituçoes científicas no Rio de Janeiro*, CNPq, Brasilia, 1982.
7. We extensively analyze the notion of "mainstream" research in: R. ARVANITIS, Y. CHATELIN, (1988), op. cit. note 5.
8. Moreover, among Central countries, ORSTOM is unique in its functioning since its researchers live in the developing countries where they do the fildwork, so that they share partly the conditions of Peripheral scientists.
9. This corresponds to the mean age of the entire soil science community of the Institute as revealed by an internal study of a task force on the state of soil sciences in ORSTOM.
10. Co-authored articles were counted as one unit for each of the authors.
11. B. LATOUR, S. WOOLGAR, *Laboratory Life*, Sage Publications, Beverly Hills, 1979.
12. Reference in note 3: Y. CHATELIN, R. ARVANITIS, (1988), specially Chapter 4.
13. Excluding all non-conventional literature (1.6. for unpublished reports and 1.4 for working papers). As expected – since they represent mostly ideas developed in the long run by individual scientists – working papers show the lowest number of co-authors.
14. It is those countries that invented the modern "ethic" of science that follow it least. The most probable explanation lies in the fact that, in most of the Third World countries, scientists are encouraged to publish at an international level through the evalutaion systems they adopt; this is also the conclusion of L. VELHO, *Science on the periphery: a study of the agricultural scientific community in brazilian universities*, PhD Thesis, SPRU, Sussex (G. B.), 1985, and of other studies on the institutionalization of research in Third World countries (see references in note 6).
15. For general principles of factor analysis, see J. P. BENZÈCRI, *L'analyse des données*, Dunod, Paris, 1973, Vol. 2, 616 and 620 pp. Our computations were made in CIRCE, the main computer center of "Centre National de la Recherche Scientifique" (CNRS) in Paris, applying programs from *Yagolnitzer* and *Tabet*. For interpretation of this analysis, we used J. P. FENELON, *Qu'est-ce que l'analyse des données?* , Lefonen, Paris, 1981, 312 p. We received also personal help from *J. P. Courtial*, "Ecole Nationale des Mines", Paris.

16. See notes 5 and 7. One has to understand that, relating to French scientists, the "mainstream" cannot be exactly what is defined by the Institute for Scientific Information..
16. *Eisemon* and *Davis* recently showed that this is a common contradiction in the behavior of most scientists. T. O. EISEMON, CH. DAVIS, *Publication Strategies of Scientists in Four Peripheral Scientific Communities: Some Issues in the Measurement and Interpretation of Non-Mainstream Science,* to be published in a book on academic research environments, P. ALTBACH (Ed.).
18. This challenges the view that growing scientific communities tend necessarily to be integrated in the international "mainstream". For such a recent statement, see LOMNITZ, REES, CAMEO, Publication and Referencing Patterns in a Mexican Research Institute, *Social Studies of Science,* 17 (1987) 115.