SCIENCE, SOCIETY AND THE INTERNATIONAL SCIENTIFIC COMMUNITY: AN EXPLORATORY STUDY

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By

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ABSTRACT

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By Sal P. Restivo

Given the lack of a comparative perspective in the sociology of science, and the lack of an adequate theoretical foundation for comparative research, this exploratory study attempts to identify significant factors affecting the relationships between science and society. Doctoral candidates in mathematics, physics, biology, and psychology are interviewed using an open-ended interview schedule. We explore their perceptions of 1)the relationships between scientists and intellectuals in American society, 2)the university as an institutional setting for science, and 3)the nature of the international scientific community. We conclude that the institutional setting of science (e.g., the university, government, industry), stratification systems in science, and types of disciplines are factors affecting the relationships between science and society. The type of society in which science functions is also a determinant of the structure of science and the kinds of relationships it develops with other institutions.

INTRODUCTION

Historical background. The sociology of science, developing out of the sociology of knowledge and the philosophy and history of science, has had four major theorists: Robert K. Merton, Talcott Parsons, Bernard Barber, and Norman W. Storer. In his pioneering effort, "Science, Technology, and Society in Seventeenth Century England"[1] and in his classic essay, "Science and the Social Order"[2], Merton emphasized that science is a social institution which is related to other institutions in society and which is characterized by four institutional imperatives: universalism, "communism", disinterestedness, and organized scepticism. Parsons, working from the theoretical base established by Merton, divided the structure of science into two sets of norms governing 1) the pursuit of scientific knowledge (empirical validity, logical clarity, logical consistency, and generality of the "principle" involved), and 2) the occupational role of the scientist (universalism, affective neutrality, specificity, achievement orientation, and institutionalization of the scientist with reference to the collectivity).[3] Bernard Barber attempted to synthesize the works of Merton and Parsons by providing empirical referents for their generalizations while contributing to theory in the sociology of science by examining the social functions of science.[4] Norman W. Storer, in the most recent contribution to the sociology of science, has analyzed the internal structure of science as an "autonomous" system of exchange governed by rewards and sanctions.[5]

Problems in the Sociology of Science: Toward a Comparative Perspective. At the institutional level of analysis the sociology of science focuses on the relationships between science and other institutions in societies in which science is a "visible", more or less differentiated component of the social structure. Substantively, studies in the sociology of science illuminate the nature of these relationships and their consequences for science and society. Theoretically, they contribute to our understanding of the process of institutionalization, institutional structure and function, and the dynamics of total societies in terms of the relationships between and among institutions. However, theory in the sociology of science has focused on the internal structure of the scientific community and has neglected the relationships between science and society. The "autonomous" structure of science has been rigorously defined and elaborated. The norms of the scientific community have been classified. But the precise delimitation of the system-boundaries of science, the systemic linkages between science and other institutions, and the consequences for science and society of these relationships have not been adequately dealt with.[6]

Sociologists of science have relied on the Western experience for substantive data under the implicit assumption that the nature of science is not substantially affected by societal context. Comparative studies are necessary not only for purposes of illuminating the nature of science in different types of societies, but also for determining the range of societies in which science is present.

In the historical context, we have comparative cases for the study of the relationships between science and other institutions such as Needham's classic work on the development of science in China.[7] We can study the international character of science which has been fundamental to it throughout its history: Alexandria, Baghdad, and Azerbaiijan were centers of international "communities" of scientists before the Middle Ages.[8] Some of the historical background for understanding the institutionalization of science in Europe is provided by events such as 1) the establishment of the "scientific role" in Europe[9], 2) the development of communication and transportation networks by French and English scientists in the eighteenth century while their nations were at war with each other[10], and 3) the "liquidation of the entire structure of French science" by the Jacobin convention in 1793 and the erection of a new set of scientific institutions - les écoles centrales, l'Ecole normale, and l'Ecole polytechnique.[11]

Contemporary Western societies provide another context for research in the sociology of science. We can study the relationships between science and the polity and the impact of political control over the allocation of resources for basic and applied scientific research. The growing inter-relatedness between science and other institutions offers the sociologist an opportunity to study the emergence of new structures.

The developing nations provide still another, and neglected, context for the study of science and society. How is science institutionalized? What kinds of relationships will develop between science and other institutions in these nations? What is the relationship between science in the developing nations and science in the advanced nations? Is the level of economic and political development of a nation reflected in its relationships with the international scientific community?

Finally, we might inquire into the nature of the scientific community. We might study, for example, differentiating factors within the scientific community, and the formal and informal structures that link scientists from different societies.

Given the lack of a comparative perspective in the sociology of science, and the lack of an adequate theoretical foundation for comparative research, we designed an exploratory study 1)to aid us in identifying significant factors affecting the relationships between science and society, and 2)to help us formulate working hypotheses to guide future research in the comparative study of science and society. In this study, we investigate scientists' perceptions of science as a form of inquiry, their perceptions of the international scientific community, and their views on the function of science in American society.

METHODOLOGY

Population. We selected as our population doctoral candidates in the physical, biological, and social sciences for theoretical as well as practical reasons. Theoretically, graduate students are being socialized to the norms of science that will govern their search for knowledge and their relationships within and outside of the scientific community. As participants in a particular culture, they should reflect, cognitively and behaviorally, American culture, the norms of science, and the relationships between science and American society. Practically, the population was selected because of status-equality and ease, of establishing rapport between interviewer and interviewee./ The pretest verified our feeling that status differences between senior scientists and Master's level students would affect not only the rapport between interviewer and interviewee, but also the type and quality of data obtained.

Stratified sample. The pre-test revealed that there appears to be a "continuum" of disciplines in science based on "degree of involvement" in society in terms of the dependency of each discipline on resources allocated by other institutions, and in terms of the function of each discipline in society. The continuum ranges from mathematics to the social sciences. Mathematicians dealing with a highly abstract subject-matter felt they did not depend on society for resources: all they need, as one respondent phrased it, is "a cigar and a rocking chair" to pursue a problem. Physical and biological scientists said they depend heavily on outside sources for facilities, equipment, and financial support to conduct their research. Biological and social scientists, because they must experimentally and clinically manipulate human beings and animals, are restricted in their pursuit of knowledge by the laws, moral codes, and ethical precepts of our society. Social scientists and biological scientists are particularly subject to the influence of personal and cultural value systems on the most technical aspects of their research. Mathematicians and physical scientists can conduct their research by manipulating symbols and physical objects. The differential influence of value systems on methodology, and the differential need for resources in different disciplines may result in the development of different types of relationships between scientists and society.

To explore the significance of "degree of involvement" in society for science, we sampled from four disciplines: mathematics, physics, biology, and psychology. Our sample of psychologists was divided into two sub-samples, clinicians and experimentalists. This division was made on the basis of the continuum revealed in the pre-test. The psychologists interviewed in the pre-test viewed clinicians as closer in orientation to the social science and more involved in society than experimentalists.

The research design called for a non-brobability sample of forty-eight respondents, twelve from each of the four disciplines. To draw our sample, we obtained lists from the departments of mathematics, physics, biology, and psychology at a large Midwestern university of all doctoral candidates registered for the 1966 summer session. Except in mathematics, we randomly selected twelve names from each list - only six doctoral candidates were registered in the department of mathematics. We secured interviews with twelve biologists, twelve psychologists, eleven physicists, and five mathematicians. This gave us an N of 40.

Technique and coding. On the basis of the exploratory nature of our research, we chose the open-ended interview as the most appropriate data-gathering technique for sensitizing us to the important sociological variables that need to be considered in a comparative sociology of science. Given the lack of an adequate theoretical foundation for formulating questions and hypotheses, and the lack of similar empirical studies, the open-ended interview schedule seemed the most feasible instrument for achieving our research objectives.

The coding schema in this study was established by using the empirical categories generated in the responses to the first series of interviews. Some changes were made in the course of our research until a fairly stable set of categories was developed which allowed us to code directly during the interviews.

Standardizing the interview process. Since the data for this study were collected by two researchers working independently, certain standardizing procedures were necessary to insure data-comparability. During the pre-test period we interviewed respondents together, independently, and with our colleague present but not participating in the interview. These sessions sensitized each of us to the interview style of the other. An open-ended interview schedule was then constructed, and several interviews were conducted by each interviewer. These interviews were taped and compared. The final interview schedule was constructed with each question typed out in full, with words to be emphasized underlined, and probes specified. Tests of the comparability of our interview techniques, our use of probes, and date collected were made during the pre-test period as well as at the research site. By the time we began our research, the interview procedures were sufficiently comparable to insure data comparability.

The interview schedule. The interview schedule was divided into three sections: 1) "World View" - conceptions of science, views of the relationships between science and society, and conceptions of the future; 2) reference and membership groups; and 3) science and the university. The original interview schedule contained seventy-seven questions. During the course of our research fifteen questions were eliminated because they did not yield usable data. No questions were added.

Scope of the paper. The first section of the paper deals with scientists and intellectuals in American society. Their functions in our society, as perceived by our respondents, are compared, and their function as referance and/or membership groups for these graduate students is explored. In the second section, we examine their perceptions of the university as an institutional setting for science; specifically, we inquire into the relationships between their graduate departments and graduate departments at other universities, and we explore the nature of science in the university vis à vis science in government and in industry. The third section deals with the nature of the international scientific community as these graduate students experience it. We conclude with a discussion of our findings with reference to the significant variables and ideas that emerged from the study and suggest guides for future research in a comparative sociology of science.

Scientists and Intellectuals in American Society. In popular as well as scholarly usage, the terms "scientist" and "intellectual" are continually linked, and sometimes used synonymously. This suggests certain sociological questions. Is the scientific community one part of the intellectual community? Are intellectuals a reference and/or membership group for scientists?

Our respondents distinguish scientists and intellectuals in terms of "degree of involvement" in society. They are unable to say in any rigorous sense what an intellectual is. Their responses to the question, "What is an intellectual?" are vague and difficult to elicit. But they are able to locate intellectuals in the social structure of American society. Sixty-five percent characterize intellectuals as central participants in our society: they view critics, educators, opinion-leaders, and government decision-makers as intellectuals. Sixty-eight percent, by contrast, view scientists as peripheral participants in our society. The function of science in our society derives from the application of the knowledge which scientists pursue for its own sake.

The view that scientists are peripheral participants in American society is reflected consistently in the responses of these young scientists. Ninety percent say that scientists should popularize their findings for the general public, but they are pessimistic about the possibility of communicating scientific findings to the layman. They say that basic research often cannot be popularized without the type of simplification that can lead the layman to draw false inferences. The general public appreciates scientists, according to ninety percent of these graduate students, but for the wrong reasons. "They may not appreciate basic research, but the results", says one respondent. Scientists are appreciated, says another, but people are still "a bit mystified by them".

Science, according to Norman W. Storer, is a "non-service" profession.[12] The graduate students in our sample perceive science similarly, and consider themselves non-service scientists, i.e., scientists interested in the pursuit of knowledge for its own sake. Their reference and membership group is the non-service collectivity of scientists.

Intellectuals, by contrast, are a reference group but not a membership group for these young scientists. Sixty-eight percent feel "a sense of commonality" with intellectuals, but have neither the time nor the status to be critics, educators, opinion-leaders, or government decision-makers. The scientific community is not viewed as one part of the intellectual community. Scientists are not perceived as intellectuals by virtue of being scientists.

<u>Science and the University</u>. Scientists function in different institutional settings - the university, government, industry - and these settings are differentiating factors in the scientific community. Ninety-three percent of our respondents say there is a distinction among university scientists, government

scientists, and scientists in industry. University scientists are perceived as most highly thought of by members of the scientific community. Typical descriptions by our respondents of the university scientist are: "University scientists are the cream of the crop"; "University scientists have the greatest freedom to pursue pure science"; "They can be honest about their research"; "They are best acquainted with what is happening in their field". The scientist in industry is accorded the lowest status and portrayed as a "money grubber", an "engineer", someone who does not have the orientation he ought to have as a scientist. Scientists in industry have, say our respondents, limited freedom of inquiry, they are out of contact with the mainstream, and they do not publish in the journals or attend professional meetings. Six of the seven respondents who explicitly ranked scientists in the three settings ranked university scientists first, government scientists second, and scientists in industry third. Government scientists at laboratories such as Argonne and Brookhaven are as competent as university scientists, according to most of our respondents, and work under similar conditions. University scientists are viewed as engaged in pure research under conditions such that they can select their own problems and present their findings honestly. The only source of influence is "the group of colleagues" in the profession. This is perceived to be less true in government, and less true still in industry.

Our respondents characterize the faculty and graduate students in their respective departments as research-oriented. Teaching, especially at the undergraduate level, is subordinate to university research. Research for government or industry, and service outside the university in an advisory or consultant capacity is rarely engaged in by faculty members, according to our respondents.

Inter-university relationships are maintained by the four departments through personal communications among faculty, and through seminar and collocuia programs. Within the university there are few inter-departmental programs. Scientific communication among members of different departments is minimal. The Division of Biological Sciences, composed of four divisions, has inter-divisional links. And the mathematics, physics, and astronomy departments, located on the same part of campus and sharing in good part a common subject-matter, maintain inter-departmental seminars, colloquia, and personal communications between and among faculty and graduate students.

The graduate department, say our respondents, is the focal point for communication with fellow students, faculty, and other scientists. They are made aware of new developments in their fields through personal communications, and through the journals. Among the physicists, pre-prints of research in progress or ready for publication are distributed to interested faculty who pass them on to their students. The physics department also has a fournal club which gives graduate students an opportunity to present talks on, hear about, and discuss new developments in their fields based on recent publications. Thirty-nine of our forty respondents say that these communication links keep them abreast of the major developments in their fields.

<u>The International Scientific Community: Its Extent and Homogeneity.</u> Following Hagstrom, Ben-David, Kornhauser and others we have used the term "the scientific community".[13] Our data suggest that more research is necessary to establish the empirical referents for this term: for example, does "scientific community" refer to scientists in all disciplines in all countries?

By "community" we refer, in part, to a group with shared values and patterns of interpersonal relationships. The responses to our questions indicate that our respondents are a homogeneous collectivity sharing the values of scientists tapped by our questions. But the interaction among scientists from different disciplines which is a necessary element of a community of scientists is not present.

We selected "felt sense of commonality" and journals read in allied and other disciplines as indexes of the presence of links among the scientific disciplines. If scientists are participants in a community we would expect that these young scientists would feel a sense of commonality with all scientists based on the use of the same logic of inquiry and orientation to the same set of norms. But the basis for a sense of commonality with scientists within and outside of one's

Table 1. Number of respondents ranking divisions of science on the basis of "felt sense of commonality", by discipline.

		Discipline				
Division	Rank	Math.	Physics*	Biology*	Exp. psych.	Clin. psych.*
Physical	1	4	9		3	
	2	1		8	2	
	3				1	4
Biological	1			8	2	
	2	4	8		4	4
	3	1	1			
Social	1	1			1	4
	2	4	1		5	
	3		8	8		

*N = 40 - Two physicists, four biologists, and one clinical psychologist did not rank the divisions of science.

discipline or specialty is, for our respondents, the ability to understand what other scientists are going. For any group of scientists, the likelihood that they will have any other group of scientists as a reference and/or membership group is a function of 1) the extent to which the subject-matter of the two groups coincides, and 2) the extent to which a given subject-matter is of interest and comprehensible. Table 1 shows how respondents ranked the three broad divisions of science - physical, biological, social - with respect to "felt sense of commonality". All but seven graduate students ranked these divisions in terms of the degree to which they felt a sense of commonality with scientists in each division. Table 2 shows the extent to which members of pairs of disciplines agreed in ranking the divisions of science on the basis of "felt sense of commonality". Physicists feel more of a sense of commonality with physical scientists than with social scientists. Clinicians feel more of a sense of commonality with social scientists than with biological or physical scientists. The directions of the correlations in Table 2 indicate that, in general, 1)physical scientists feel a greater sense of commonality with biological scientists than with social scientists, 2)social scientists feel a greater sense of commonality with biological scientists than with physical scientists, and 3) biological scientists than with social scientists.[14]

Table 2. Rho correlations between disciplines based on respondents' rankings of the divisions of science on the basis of "felt sense of commonality".

Discipline	Physics	Exp. psych.	Math.	Biology	Clin. psych.
Physics		1.00	0.875	0.500	-1.00
Exp. psych.	0.875		1.00	0.125	-0.63
Math.	0.875	1.00		0.125	-0.63
Biology	0.500	0.125	0.125		-0.500
Clin. psych.	-1.00	-0.63	-0.63	-0.500	

We selected journals read in allied and other disciplines as another index of the presence of links among the scientific disciplines. Table 3 shows the number of respondents, by discipline, who read journals in disciplines which are allied with their science (e.g., allied disciplines for physicists would be other physical sciences). Table 4 (page 18) shows the number of respondents, by discipline, who read journals in "other" disciplines (e.g., "other" disciplines for physicists would be biological or social sciences). These data, and the data on "felt sense of commonality", indicate that with increasing distance between disciplines measured by the degree to which

Table 3. Number of respondents reading professional journals in allied disciplines, by discipline.

	Discipline				
Response	Math.	Physics	Biology	Exp. psych.	Clin. psych.
Yes					
Regularly		1	1	1	1
Often			1	1	1
Seldom	3	2	3	2	2
No	2	8	7	2	2

N = 40

Table 4. Number of respondents reading professional journals in "other" disciplines, by discipline.

Response	Discipline: Math.	Physics	Biology	Exp. psych.	Clin. psych.
Yes					
Regularly				2	1
Often				1	
Seldom	1	2	2	1	
No	4	9	10	2	5

N = 40

subject-matters coincide, communication links are fewer. We infer fewer interpersonal links between disciplines which have less shared subject-matter, and to the extent that this is true the concept of "the scientific community" takes on a more restricted meaning than it has been given in the literature.

That there is an "international scientific community" of some type is not disputed by sociologists of science, or by scientists. Ninety-five percent of our respondents say that there is an international scientific community. But one of the criteria of "community" as we conceive it is "patterns of interpersonal relationships". If there is an international scientific community, we would expect that structures would exist for the communication of scientific ideas, research findings, data and so on across national boundaries. We would also expect structures for bringing scientists from different countries together, e.g., international conferences, exchange lectureships, visiting professorships, and the like. If these structures exist, if there is a viable international community of scientists, we would expect actual and anticipated participation by graduate students in this community.

We selected the following indexes of actual participation in and anticipated participation in the international scientific community: 1) reading journals in foreign languages, 2) membership in international organizations, 3) knowledge of international organizations, 4) intention to join international organizations, and 5) attendance at international conferences. While sixty-eight percent of the graduate students we interviewed read one or more professional journals in their discipline regularly, only 7.5% read foreign language journals regularly. Fifty-eight percent are members of one or more national professional organizations, and 88.2% of those who are not members intend to join; but only 12.5% are members of international organizations and 22.8% of those who are not members intend to join. Only 5% have attended international scientific conferences, compared with 40% who have attended regional meetings, and 32.5% who have attended national meetings. Approximately one-third of those who are not members of an international organization can name at least one such organization in their discipline.

To determine the geographical locus of the international scientific community perceived by these graduate students, we asked them, "What areas of the world are strong in your discipline?" Their responses indicate that for them science is a Western phenomenon, with the United States as the center. Of thirty-eight graduate students who explicitly ranked countries in response to our question, thirty-seven ranked the United States first. The United States, Russia, England and Japan, Germany, and France were most often named, in that order. The pattern of responses - the number of times a particular country was mentioned, and the number of times it was assigned a given rank - was similar in each of the disciplines for these six countries with one exception, Russia. Only one-third of the biologists mentioned Russia, compared with 60% of the mathematicians, 83.3% of the psychologists, and all of the physicists. Russia was never ranked lower than fourth by students in mathematics, psychology, and physics: among the four respondents in biology who mentioned Russia, two ranked her third, one ranked her sixth, and one ranked her seventh. This deviation from the pattern of responses probably reflects the curtailment of the progress of the biological sciences in Russia due to Lysenko-ism.[15]

DISCUSSION

This exploratory study was undertaken to identify significant factors affecting the relationships between science and society. Our study suggests that these relationships are affected by a structural complexity of the scientific community that has been ignored by sociologists of science. This complexity derives from at least three factors:

1) Institutional setting. Our respondents differentiate among university, government, and industrial scientists with respect to a)orientation to the norms of science, b)status and role in the scientific community, and c)role in American society. This differentiation is due to the fact that science is structurally interlocked with the university, government, or industry. The institutional setting in which science functions is one determining factor of the kinds of relationships that develop between science and society.

2) Stratification. The fact that we interviewed graduate students in the sciences raises the question of whether they can be considered members of the scientific community. The graduate students we interviewed consider themselves scientists. They are, in general, members of professional scientific organizations, and are engaged in supervised or independent research. If this is true for graduate students in general, it seems appropriate to consider them members of the scientific community. This implies a stratification system in science based on level of education. It also suggests the problem of stratification systems in science

based on other criteria: The general concern here is with the extent to which different strata in science develop different relationships with society.

3) Type of discipline. In our section on methodology we introduce the idea of a continuum of scientific disciplines based on "degree of involvement" in society. We did not pursue this idea with reference to the relationships between science and society in our study. But the working hypothesis that the physical, biological, and social sciences develop relationships with society independent of each other should be pursued in future research.

There is a fourth factor affecting the relationships between science and society:

4) Type of society. To the extent that we can classify societies (e.g., in terms of diminant institutions, or according to type of political, religious, or economic system) we should be concerned with how the type of society in which science functions affects the relationships between science and society.

Speculation on the results of our study can suggest the significance of these factors. For example, the graduate students we interviewed perceive scientists as peripheral participants in American society. This view might be explained in terms of a)their definition of science as the pursuit of knowledge for its own sake (basic science), b)the structure of American society, and c)the structure of their departments.

These young scientists define science as the pursuit of knowledge without regard to its practical utility (e.g., increasing economic productivity, strengthening military capabilities, raising the standard of living). The product of science is the cumulation of knowledge through basic research. Historically, the American people have been indifferent to such research.[16] In our society, the pursuit of knowledge for its own sake has not been defined as a societal function: basic knowledge has not been defined as a product in the conomic sense.[17] It is difficult for most Americans, it seems, to understand the pre-occupation of scientists with problems which have no tangible solutions. The results of basic research become tangible only when the knowledge gained is applied in technology or engineering. The general public in our society appreciates basic research only in terms of the tangible results of such research, according to our respondents.

Our sample is biased in favor of students in basic research. The departments we sampled from are all apparently oriented to pure science. The structure of these departments seems to preclude the exposure of graduate students to applied science or to scientists who are "involved" in society (e.g., involved as intellectuals - critics, educators, etc., or as applied scientists). They are being socialized to a work-role that subordinates practical science, teaching, and non-university activities such as research for government or industry to basic research under university auspices. Thus, their perception of pure scientists as peripheral participants in American society is in part a function of the historical indifference of the American people to basic research, and in part a function of the institutional setting in which they are being socialized to the norms of science.

It is possible to argue that our respondents perceptions of pure scientists as peripheral participants in our society is a function of their role-status-position in the scientific community: they are students, and have neither the time nor the status to participate in society as intellectuals, or applied scientists. But this is not relevant to their work-role as basic researchers. Senior scientists pursuing basic knowledge who do engage in intellectual activities, or are active in applied science, would still be peripheral participants in American society in their work-role as basic researchers.

Our respondents view science as international in concept and spirit. But their cognitive map of the international scientific community excludes South and Central America, Africa, and most of Asia. They perceive science as a Western phenomenon, and the United States as the center of the international scientific community. If the United States is in fact such a center, this would help to explain these young scientists' low scores on our indexes of actual and anticipated participation in the international community of scientists. As a center, the United States should be capable of mobilizing resources for research and teaching in science to a greater extent and more efficiently than other nations. It should also have advanced systems of communication to make foreign publications readily available in translation to American scientists. And its national scientific organizations should be international organization, i.e., the proceedings of our national organizations should be of primary interest to scientists from all nations.

This is, in fact, the perception our respondents have of the place of the United States in the international scientific community. They feel that the most important research in their respective fields is being done in America; that America has the best training facilities for scientists; that they need not master foreign languages since all of the important foreign publications are available in translation; and one respondent states explicitly that our national scientific organizations are international organizations.

Additional research is necessary to validate the notion of the United States as a center for science. If America is a center for science, then American scientists would not, as a rule, have to travel to other societies for advanced training, or to use technical equipment not available in this country. In general, we would contend, scientists in a center would not have to be as mobile as scientists outside that center. Such a situation would help to explain our respondents low scores on actual and anticipated participation in the international scientific community.

It may be true, though, that scientists from all nations, and not only American scientists, exhibit a "practical nationalism".[18] But further speculation along these lines is fruitless without comparative data on the cross-cultural mobility of scientists, the types of scientists who travel across cultures, and the extent to which interpersonal relationship structures have developed among scientists from different nations.

CONCLUSION

In describing and explaining the relationships between science and society, variations in 1) the institutional setting of science, 2) stratification systems in science, 3) types of disciplines, and 4) types of societies must be taken into account. Research in an historical and contemporary context should be aimed at specifying the variations in these factors singly and in combination and the resulting consequences 1) for the structure of science and its relationships with other institutions in particular societies, and 2) for the structure of the international scientific community.

Future research in the sociology of science should be concerned with the following kinds of questions:

1) What are the consequences of differential resource requirements for scientific disciplines in terms of the relationships they develop, or do not develop with other insitutions? Do mathematicians, for example, require fewer resources (technical equipment, materials, funds) than physicists or chemists? Does dependence on other institutions for resources affect autonomy of inquiry in a discipline?

2) Do the relationships of scientists to the norms of science vary with the institutional setting of science? What is the nature of the relationships among university, government, and industrial scientists? What is their relationship to other segments of society? Are these relationships stable over time, and in different societies?

3) What ties, if any, exist between the scientific community and the intellectual community? Are a scientist's role-status-position, and the institutional setting in which he works determinants of whether he is an intellectual? Are the roles of "scientist" and "intellectual" separate in American society, as our respondents contend they are; are they separate for certain types of scientists; and are these roles separated in other societies?[19]

4) What are the effects on science in those underdeveloped nations where government is the principal user of scientific manpower; and what are the consequences for science when political leaders "ration [their] precious stock of university-educated personnel?[20] Are scientists in the developing nations less likely to receive government support for basic research because of the need for manpower in the applied sciences?

5) Will the institutionalization of science in the new nations be accompanied by the emergence of a set of scientific norms different from those which accompanied the institutionalization of science in Europe? Is it likely that the international scientific community, which our respondents perceive as a Western phenomenon, will be bifurcated by the emergence of a scientific community in the developing areas?

In general, the task of the sociology of science is the development of

> concepts sufficiently abstract to permit different cultures to be compared in the analysis of their scientific institutions, while at the same time remaining sufficiently concrete so that the historical growth and interconnections within a specific society will not be lost.[21]

This task should be pursued within the framework of general sociological theory. Sociologists of science should provide us with a better understanding of problems in social organization, institutionalization and social change, and the relationships between collectivities, as well as a substantive understanding of the relationships between science and society.

FOOTNOTES

1. Robert K. Merton, "Science, Technology, and Society in Seventeenth Century England". _OSIRIS_, IV, Part 2, Bruges (Belgium), 1938, pp. 360-632.

2. This paper is reprinted in Robert K. Merton, _Social Theory and Social Structure_ (Rev. and enlarged edition); The Free Press of Glencoe, 1957, pp. 537-549.

3. Talcott Parsons, "Belief Systems and the Social System...", Chapter VIII in _The Social System_; The Free Press of Glencoe, 1951.

4. Bernard Barber, _Science and the Social Order_; Glencoe, Illinois: The Free Press, 1952.

5. Norman W. Storer, _The Social System of Science_; Chicago: Holt, Rinehart and Winston, 1966.

6. Research and theory-building in the sociology of science and in general sociology will be facilitated if we can specify, however arbitrarily and tentatively, a general frame of reference for the study of institutions and total societies. At one level of analysis, the social structure of a society can be conceptualized as composed of more or less differentiated institutions - every society has the same analytical components of social structure, manifested in a variety of concrete institutions. Science is an institution - it is not universal, but is present in the range of cases which represent our universe of study. The sociology of science, as a substantive area, illuminates the nature of the relationships between science and the other institutions of society, their effects on science in particular, and the social structure in general. The purposes of comparative studies is to help us identify recurring processes, relationships, and so on. The meaningfulness of this particular way of viewing one part of the social world is an empirical question - it is not a question of whether or not the world is "really like that", but a question of the utility of such a model for organizing one part of the human experience and providing meaningful explanations.

7. Joseph Needham, _Science and Civilization in China_ (4 vols.); Cambridge: Cambridge University Press, 1954.

8. ____________, _Science and International Relations_, Oxford: Blackwell Scientific Publications, 1949.

9. Joseph Ben-David, "The Scientific-Role: The Conditions of Its Establishment in Europe", _Minerva_, Vol. IV, Autumn, 1965.

10. Gavin DeBeer, The Sciences Were Never at War, London: Thomas Nelson and Sons Ltd., 1960.

11. C.C. Gilispie, "Science in the French Revolution", Behavioral Science, Vol. IV, No. 1, January 1959, pp. 67-101.

12. Storer, op. cit., p. 16.

13. Walter Hagstrom, The Scientific Community, New York: Basic Books, 1965; Thomas Kuhn, The Structure of Scientific Revolutions, Chicago: University of Chicago Press, 1962; William Kornhauser, Scientists in Industry: Conflict and Accommodation, Berkeley: University of California Press, 1962; Joseph Ben-David, op. cit.

14. The rank (1, 2 or 3) which at least 50% of the respondents in a discipline assigned to a division (see Table 1) was selected for calculating the correlation in Table 2. For example, in experimental psychology, three respondents ranked the physical sciences first, two ranked them second, and one ranked them third. We assigned the rank "1" to the physical sciences for experimental psychology. Thus the divisions of science were ranked as follows for experimental psychology: physical (1), biological (2), and social (3). In calculating correlations in Table 2, no assumptions were made regarding the relation of our sample to a normal bivariate universe in which regression is linear. The correlations were used merely to indicate the direction of association between rankings by pairs of disciplines. See Solomon Diamond, Information and Error; New York: Basic Books, Inc., 1959, pp. 241-244.

15. For a discussion of the Lysenko movement, and why it has made Soviet biology "different from standard world biology" (Joravsky), see David Joravsky, "Lysenko's Maize", in The State of Soviet Science (edited by the editors of Survey: A Journal of Soviet and East European Studies), Cambridge: MIT Press.

16. Richard H. Shryock, "American Indifference to Basic Science During the Nineteenth Century", Archives Internationales d'Histoire des Sciences, No. 28 (1948-1949), pp. 3-18: reprinted in Bernard Barber and Walter Hirsch, (eds.), The Sociology of Science, The Free Press of Glencoe, 1962, pp. 98-110.

17. Dael Wolfle (ed.), Symposium on Basic Research, Publication No. 56, Washington, D.C.: American Association for the Advancement of Science, 1959. Of particular interest is the article by Alan T. Waterman, "Basic Research in the United States", pp. 17-40.

18. Alexander King, "Science International", in Maurice Goldsmith and Alan Mackay (eds.), The Science of Science, London: Souvenir Press, 1964, p. 114.

19. The kinds of problems that need attention in this area are illustrated by the intellectual roles scientists have played in America and Russia. For example, Shils, commenting on the "scientists movement" in America following World War II, says it was "a product of freedom and was rendered possible by the fundamental confidence of those who participated in it that their actions [had] some chance of success". Soviet scientists, during the same period, could not have played an intellectual role in Russia; see Edward Shils, "Freedom and Influence: Observations on the Scientists' Movement in the United States", Bulletin of the Atomic Scientists, Vol. XIII (Jan. 1957), No. 1, pp. 13-18. Under different social structural conditions than existed in post-World War II Russia, scientists did play an intellectual role in Russia: Vucinich notes that scientists in 18th century Russia destroyed the intellectual supremacy of the Church, and gave strength to the emergent national consciousness of the Russian people. As teachers, they "supplied the necessary intellectual stimulus for those moved by the Enlightenment"; see Alexander Vucinich, Science in Russian Culture (a history to 1860), Stanford: Stanford University Press, 1963, pp. 182-183.

20. Harbison and Myers make this policy recommendation to political leaders of the underdeveloped nations; see Frederick Harbison and Charles A. Myers, Education, Manpower and Economic Growth, New York: McGraw Hill Book Co., 1964, p. 69.

21. Gerard DeGré, Science as a Social Institution: An Introduction to the Sociology of Science, New York: Random House, 1955, p. 6.

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