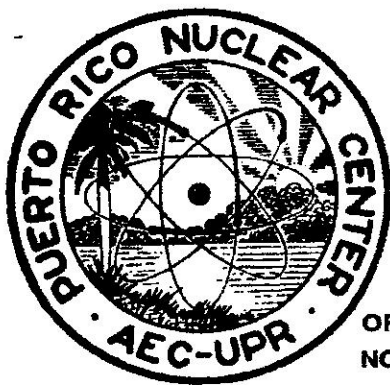


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**THE LABORATORY ABROAD,
Proceedings of the First Symposium
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on Administration of Research,
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FIRST SYMPOSIUM: THE LABORATORY ABROAD

INTRODUCTORY REMARKS

John C. Bugher, *Presiding
Director
Puerto Rico Nuclear Center*

The Symposium for this morning is entitled "The Laboratory Abroad." That is a very big title and I think the words which follow it serve to explain something of what is meant. We will discuss the problems of the conduct of scientific work in laboratories in various countries, presumably outside of the United States. Although the term "abroad" becomes a little confusing at times, I presume that our panel could very reasonably speak of laboratories and their problems in the United States under this title of "The Laboratory Abroad." But the intent is to discuss scientific problems and the problems of scientific investigation in various countries and under various circumstances. In the printed program there appears the name of Dr. Oliviero Phillips of Bogota, Colombia, who, unfortunately, is ill and cannot be with us. So our panel is a little unbalanced at present, with three of us from Puerto Rico who, naturally, tend to speak from the point of view of science in Puerto Rico. For that reason, I will try to direct my own remarks a little later to activities which are outside Puerto Rico and outside the United States. I will mention particularly the activities in South America and, notably, in Colombia itself, since Dr. Phillips is not with us.

The emphasis here is on administration, I suppose; yet, administration without a concept of substance, of objectives, is largely meaningless. I think we all know of instances of good research being done under conditions of bad administration. The presence of good administration does not in itself insure good research. But there we back up and say, "Well, what do you mean by good administration? If the situation is such that good research does not result, then is it true that, *ipso facto*, the administration is bad?" So very much of our problem, from the administrative standpoint, is to avoid permitting the machinery of administration—which after all should be the servant of the intellectual pursuits—to so oppress, to so hem in the freedom of investigation and thought as to prevent a profitable outcome of the project itself. As administrators we are really speaking from the standpoint of the scientists, I

trust. We are not speaking so much from the standpoint of the accountant as from the standpoint of a joint effort or a group concerned in a joint effort to advance knowledge, to serve the purposes of intellectual pursuit and, ultimately, to benefit the lives of people in this and future generations.

I think it was an unfortunate and, I hope, a chance remark by the famous scientist quoted a little earlier by Dr. Beall. Thirty years have passed and I think the answer to the comment can be found very easily. You have only to look about you. Stop any man on the street in San Juan or any town on this island and ask him whether he thinks the scientific work, particularly in the fields of engineering, of public health, of medicine, of the basic sciences, has resulted in any benefit to his family, to his friends and to himself in the last 30 years.

The answer is dramatic; it is pointed; and I think it is complete. A little reflection would reveal that if it were not for the fact that our modern society has developed largely through the scientific efforts of people who have gone before us, less than half of this audience would be alive to attend a conference of this kind. We oftentimes are brought to realize that the great mind is, after all, a human mind and subject to the weaknesses and vagaries of human minds in general. It is so difficult as to become practically impossible for a specialist in one rather restricted field to comprehend fully the content of all. We frequently find that the pontifications of mathematicians, or theoretical physicists or abstract chemists, have little relationship to the facts of life in social development as they are indeed experienced. So the answers to such questions lie in the lives of those about us and in the societies, imperfect as they are, with which we are affiliated and of which we form a part. Oftentimes, answers to what appear to be colossal questions turn out to be ridiculously simple and almost self-evident.

I recall that during these years there has been a lot of discussion about the effect on man of small amounts of added radioactivity in the environment. On one occasion, a very distinguished and very hon-

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est and honorable biologist ventured to predict that in all likelihood the human race would disappear as the result of the biological effects of radioactive materials from weapons-testing that had already been conducted at that time. That was relatively early in the fifties, along about 1953. Despite the fact that although the total amount up to then and later amounted to something on the order of one per cent of normal background radiation, and despite the further fact that in some areas of the world, as in India, populations have lived in background 10 to

50 times so-called normal for at least 2,000 years, this prediction was made and published. The answer is self-evident. One only has to look about him and observe, oftentimes the simple things, to get the answer to what may appear to be a very difficult question.

I trust that difficult questions will continue to arise during this Symposium and if we can't find the answers, at least it is some accomplishment to point up what the important questions are.

THE RESEARCH SCIENTIST IN LATIN AMERICA

Alejandro Zaffaroni
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Syntex, S. A.
Mexico D. F., Mexico

I want to express my appreciation for this invitation that permits me to attend this National Conference on the Administration of Research. I want to extend my thanks particularly to Dr. Beall and Mr. Thompson, Chairman of the Program Committee, who so kindly extended the invitation.

I would like to bring to you some of the experiences that I have had as Director of Research in Mexico, a Latin-American country. My field of experience is chemistry, biochemistry. My activities have been associated with the research laboratories of the Syntex Company in Mexico City where I was given the opportunity to develop—in collaboration with two outstanding scientists, Drs. George Rosenzanz and Carl Jerrasi—the scientific organization devoted to research in the steroid field. To clarify, steroids are natural substances from which the sex hormones, cortisone and similar products are derived. During a period of 10 years our organization developed to a size of about 220 people, of which more than 100 are chemists with different degrees of training. I must say that 10 years ago in Mexico, as in many other Latin American countries, the career of chemistry ended with the Bachelor of Science degree; that only more recently at the Institute of Chemistry of the University of Mexico has it become possible to pursue advanced studies leading to a doctor's degree; and that it was only when the new Institute opened in the University City of Mexico that research laboratories were available for the training of chemists on this higher technical level. In most Latin American countries the teaching of chemistry has been done mainly in the areas of theory; very little practical experience was available for the undergraduate student, since there were not well-appointed research laboratories or training laboratories to carry out what we would call research work. So, in undertaking this task of developing a research laboratory in the field of chemistry, we were faced with the problem of training personnel.

Concerning research, my first part of the discussion will be devoted to explaining the double task that we had in our institution of carrying out research and at the same time extending teaching and training to the junior chemist. We organized our group into "group leaders," with each having three to four junior chemists with the Bachelor of Science degree. We allocated sufficient time for the programs to be developed, so that in carrying out specific chemical reactions leading to the sequence of steps in a

specific chemical program the group leaders were able to teach and to assign reading material, not only preparative but in theoretical organic chemistry. This made it possible for the junior chemist to obtain knowledge of the processes that he was handling at the same time that he was actually performing the chemical operations. We accomplished, in other words, the transformation of junior chemists from plain technicians being utilized simply for carrying out instructions given by the group leaders to young men to whom was conveyed the basic knowledge involved in every one of the chemical operations being carried out. So with these intensive instructions, similar to what you have in college in advanced courses in chemistry, with a ratio of three to four chemists to one group leader, it was possible to convey in a course of two to three years an amount of technical knowledge and theoretical knowledge to these chemists sufficient to bring them to a much higher level of education. We have as collaborators in this program a small number of group leaders—chemists with the Ph.D. degree obtained in foreign or Latin American universities. We have endeavored, from the beginning of our work in the organization, to create an international atmosphere and to bring trained Ph.D. degrees in chemistry from many countries of the world to Mexico. (Later, I would like to elaborate on the problems of foreign personnel in Mexico.)

In addition to this methodic training by the group leaders, the research director had also a hand in the education of the junior chemists not only by talking to them as much as possible on a daily basis, but also by actually conveying to the entire group, through lectures from time to time, a much broader prospectus of the field in which they were working at present. In addition, a weekly seminar was instituted in which first the group leaders and later some of the more qualified junior chemists were taking part in presenting a selected copy in the field of organic chemistry. These seminars always ended with round table discussions, in which free periods of questions and answers were encouraged; many times, these periods lasted for one or two hours and they were very constructive. We also had the privilege of receiving the visits of many distinguished scientists in the fields of chemistry and biology who had accepted our invitations to visit with us in Mexico and have given series of lectures in their respective fields, sometimes three or four lectures within a week or

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two; and the lectures served as a basis for extending the basic knowledge of the understanding of the chemical sciences as a whole.

Later on, when the Institute of Chemistry began its operations in the new laboratories in the University city, and advanced courses in chemistry were set up, the junior chemists were encouraged to actually participate and engage in courses of this type, particularly in the summer sessions when many guest lecturers and guest professors were coming to Mexico for periods of two to three months to give special courses on selected subjects. It was possible for the research director to select, at the end of two or three years of training, some of the more qualified candidates among the junior chemists to be sent to foreign universities—in the States, mainly, and in Europe—to obtain advanced degrees, master's and doctorates. Today we can report that more than 15 men in our organization have already received either a Ph.D. degree or a master's out of this training program and that of the entire force of 100 chemists in the research organization, only 19 are of foreign extraction.

They also organized, in addition to a number of the group leaders, important projects in other areas of the country. The Assistant Directors of developing the direction or control of these were all trained 10 years ago as junior chemists under the program by which the company started looking for new chemists at that time. To further the relationship of Mexico to science in other parts of the world, to keep alive the interest of this group of young people and to create an even better understanding of the prospectus of chemistry and biology in this area, we have been encouraged to send out at least once a year each one of the senior chemists or group leaders to participate in research meetings in the United States or in Europe. After participation in a research conference or congress of this nature, they bring back to Mexico their impressions and points of view of what they have seen and the material they have absorbed. Such reports are generally good subjects for informal meetings; they create interest in the younger group, not only about the new developments in science but also about the countries these people have visited. We have had the occasion also to obtain through the United Nations some scholarships that permitted some of our people, particularly in the engineering group, to participate in group visits, industrial visits, in Europe and in the United States, which have also been very constructive.

Now we have from the beginning set up a very special policy regarding publications. Here we come to a central point in research administration, which is, how to keep alive the interest of the research workers in an organization. We have two problems: (1) if they are working in industrial laboratories, there is the question that the work must be patented;

and (2) we don't want to give advantage to competitors by releasing information ahead of time. We have taken only one step in this direction—that has been to make sure that whenever a chemist has material ready for publication, the patented formula is satisfied, the material is covered by appropriate documentations and, automatically, the material is released for publication. This has had two results: (1) it has created a very high morale among the entire group of research people in our organization; and (2) it has put Syntex ahead of the entire group of companies working in this field of research. For comparison, consider all the pharmaceutical companies of the United States working in the sterostic field; if you add up all the publications in this area for the last 10 years, all of them together will not have published the number of papers that Syntex Laboratories alone has published in this field. It has created an image for the company of a research institution, quasi-academic, that has solved certainly any problem that we may have had in hiring additional trained personnel from the United States or foreign countries. We have always in our files a very large list of applications of highly qualified scientists who would be interested in joining the forces in our laboratories. This today is a rare occurrence, particularly if you consider that our laboratories are not located in the United States, but in Mexico City, with all the difficulties associated with moving personnel to foreign countries.

In addition, we have shown and given the opportunity to the junior chemists to see at the very earliest stages of their careers their names associated with publications, because obviously work which is carried out by the group leader with a junior chemist will involve, in the publication, the name of the two persons; and if the team is larger—if three or more chemists have participated—then obviously all the names go in the appropriate folder in the publications. This has been a tremendous incentive to their development of their work; it creates in them a great deal of interest in their careers, and there is something to say about this that certainly goes beyond any possible economic compensation. A young man in the earliest stages of development of his scientific career looks forward to this recognition, to the fact that he belongs *now* to the scientific community, that the acceptance of a paper with his name in one of the recognized and outstanding scientific journals of a community today is something much more important than anything else that you would consider as reward for his efforts. I believe that these are all very important things to keep in mind in developing a new organization.

The problems that I am bringing to you and the things that we have done ourselves are quite different from the problems you are facing yourself in the areas of responsibilities that you have, since

the training of research personnel in the United States is a job that is allocated to the universities and to institutions of higher learning. Unfortunately, we have to keep in mind that in many Latin-American countries, in certain areas of science, developments have not reached the stage where this training can be given by the universities. If we actually look to the development of scientific research in Latin America we will see that the research institutions that exist have all been more or less an accident of nature—the fact that a man of outstanding qualities, many times a self-made scientist, has had the courage to dedicate himself to this activity and, fighting impossible odds, has obtained either Government support or the support of private institutions and has started out a very small research laboratory which then grew only on the basis of the number of poor workers which he himself was able to train. I think one of the outstanding examples of this nature is the case of Professor Bernardo Houssay, the Nobel Prize winner in medicine, professor of physiology and director of one of the most important laboratories in physiology in the world in Buenos Aires. He had to do everything with his own hands; he trained him-

self as a researcher and he built the research institution by training his poor workers first. The same things have happened in those areas of Latin America where spots in development of science have appeared, and even our own institution in Mexico is an accident of nature, because the reason our company was established in Mexico is the fact that a certain raw material, a yam from which we extract the chemical substance which is the mother of all the steroid formulas that we make, exists in the tropical jungle of Mexico.

I submit that this is not enough; that the social and economic development of Latin America has to be firmly based on the development of science in the territories. What we are doing today is not enough; support must be expanded and the responsibility of the administrators of funds for research in foreign countries should look into this problem very seriously. The United Nations, in planning for this area of the world, should consider basic support of the pure science in the territories, for this is the basis of development of the human power upon which rests any development of Latin America.

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THE PROBLEM OF ADMINISTERING AGRICULTURAL RESEARCH IN PUERTO RICO AND ITS IMPLICATONS FOR LATIN AMERICA

Harry E. Warmke
Director
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I do not believe I will be divulging any confidential information if I say that Puerto Rico still has agricultural problems. Those of you who have the opportunity during this short visit to get out into the island will see these problems firsthand. In spite of the fact that Puerto Rico has a dense population, many areas, especially in the mountainous regions, are not being used productively. You will note that advances are needed, including those in mechanization, in the development of crop varieties which will be better adapted to local conditions, in higher farm salaries and incomes, and in more adequate farm credit. You may also observe that agricultural production in the Tropics is difficult—principally because of hilly terrain, heavy soils, and high rainfall and humidity. Yet with all these problems, the effort that has gone into agricultural research in the Tropics is almost infinitesimal in comparison with that in the Temperate Zones.

This morning I am not going to talk about details of agronomy or horticulture or plant breeding, but I should like to dwell in the same general area that Dr. Zaffaroni has—the matter of personnel. This is a universal problem in research administration, whether it be agriculture, electronics, or other fields. Research accomplishment is directly equated to the trained, experienced, and creative individual worker. Puerto Rico has a shortage of such workers. At present in Puerto Rico, there is no graduate-level training which leads to the doctorate degree in any of the sciences. Training in science for the master's degree is just getting underway. In short, we have many problems, and a scarcity of highly trained, skilled research workers to cope with these problems.

This also is a general condition throughout Latin America—serious agricultural problems and too few well-trained scientists. And in many areas of Latin America this problem is a good deal more serious than in Puerto Rico.

What are the possible solutions? One of these is an adequate system of graduate scholarships. This has been used most effectively by the University of Puerto Rico in training men to fill research positions. I suspect our next speaker, Director Arturo Roque of the Agricultural Experiment Station of the University of Puerto Rico at Rio Piedras, will have more to say about this program. It is also of interest to

note from Dr. Zaffaroni's presentation that scholarships and in-service training are being used successfully by his organization in Mexico.

Another method of carrying out research abroad is to recruit and bring in highly trained scientists as project leaders. This has been the method largely used by our station in Mayaguez over the years. It is in this latter area, therefore, that I should like to use the balance of my time this morning, discussing the problem of administering research in a Federal agency outside the continental United States with project leaders that have been recruited from colleges and universities within the United States.

This is not our only problem, of course, but it is a major problem; nor can I promise very many of the answers. I can simply say that our station has had 60 years of experience in Puerto Rico, essentially in maintaining a research establishment abroad. I shall speak frankly in an attitude of scientific inquiry—not intending to be critical in any way but simply to try to explore this one area—and I would ask you to take my remarks in that same attitude of inquiry.

What are some of the problems a North American family encounters in coming to Puerto Rico on a research assignment?

In the first place, there is a language barrier. This is minimal in Puerto Rico, because Puerto Rico is largely bilingual. There are various degrees of failure of communications, however—from a complete block to perhaps only an accent. One may be able to get across what he means, but does he get it across effectively? Is he able to feel "at home" in civic and community participation? Most of our men come to Puerto Rico with little or no knowledge of Spanish, and most of them experience problems in trying to communicate effectively.

There also are cultural differences: differences in traditions and backgrounds and senses of values that cause problems. There is the separation of the man and his family from their home environment. There is a sense of isolation and homesickness; in many cases being away from friends and relatives is more serious for the wife than the husband. There are different climates and different crop conditions requiring adjustment and learning, and there are physical inconveniences. We Americans—and I speak now as a continental American with many

years of experience in Puerto Rico—are accustomed to the many conveniences and luxuries of modern civilization.

When a new family comes to Puerto Rico there are problems—real problems—in securing housing and in finding adequate schools. This may be especially true in some of the outlying areas. There are minor irritations, including those in telephone service, in securing automobile license plates and drivers' licenses, and in shopping, all problems which in themselves are not great, but which may add up to create a problem situation.

Now something about the reaction of the scientist to this new environment: This depends to a large extent on the individual. Some men take it in stride. They begin to learn the language; they make friends outside their own national group; they put down roots and become productive in a short period of time. Other men fail to make this adjustment. They may not make an effort to learn the language; they may build up antagonisms and resentments; they may consciously or unconsciously begin to make emotional preparations to return home. Unfortunately, the latter group is not small.

Although I am sure one cannot consider Puerto Rico as a hardship post (there are some 400,000 American tourists who come to Puerto Rico each year for vacations)—certainly not in comparison with some of the posts that are filled elsewhere in this hemisphere—he must understand that this problem of the North American's adjustment is extremely important. I suspect that a large part of our staff suffers from maladjustments of one degree or another, especially in the early days after their arrival. These little frustrations and depressions, the feeling of helplessness, griping about things that in the continental United States would be understood and taken for granted, all add up to what has been most aptly called by Schaffner, Oberg, and others as "culture shock." It is something that has a real psychological basis. I am sure there are highly trained individuals who are not emotionally able to take up a research position in many Latin American locations and live there for a period of two years and maintain sound mental health, let alone be productive research workers.

There is also a high rate of turnover; most continental families that come to Puerto Rico do not remain long. I was talking with the local FBI director recently, and he said it is a rare case that a family asks to be held over for an additional two-year tour of duty. Other Federal agencies on the island have had similar experiences.

I took occasion this year to get some figures on the comparative lengths of service of continental and Puerto Rican members of our station staff. Our station normally has a technical and clerical staff of

30 to 40, of whom some eight or 10 are continental project leaders. The average tour of duty for members of our continental staff over the past 15 years has been 5.9 years. This is good—considerably longer than the average North Americans employed in Federal agencies in Puerto Rico as a whole, I believe. The total length of duty of our locally recruited staff over this same period has been 13.6 years. Moreover, two out of three members of Puerto Rican staff at our station who were employed during the past 15 years are still with us. Only one out of five continental members who were employed during this period remains in service.

Now a word about the effect of adjustment on research productivity. Scientific research is a creative process. It requires something more than good training and working in an office or laboratory for 8 hours a day. It requires another dimension—an enjoyment of one's work and environment. Frustrations and dissatisfaction in a man or his family can cause a block to creativity. A man can become listless, unproductive, or a trouble maker, and, moreover, the relative importance of his work and his personal problems can become badly distorted.

What is the reaction of the community to the individual who does not adjust well? In Puerto Rico this reaction has been most generous. There is no antagonistic or "Yankee Go Home" attitude. The Puerto Rican is most generous in his attitude; he expects a North American to be a little queer, somewhat abrupt, and wanting to get things done right now. Nevertheless, he trusts and honors the North American for his sincerity and technical ability.

The significance of the reaction of the community to the individual depends largely on the nature of the individual's contact with the community. If he is required to work closely with local groups, maladjustment can almost destroy the effectiveness of his work. This is most likely to occur when national pride is worn conspicuously and where language is a real barrier. I remember a case that came to my attention several years ago when I was making a trip through Central America. I visited an agricultural mission in a country the name of which I shall not mention, and found the director of the institution to be very worried. His group had not had contact with the local Department of Agriculture for 6 months. He told me: "If I telephone, the Minister is busy. If I write, he doesn't answer. If I send a messenger, I get no response. What is the matter; don't they want help?" I found the answer that evening when I joined the members of his staff in a party at his home. The principal occupation of these men and their wives was complaining about the climate, about the people, about the schools, about the food. They had closed the door to effective cooperation by this attitude and unfortunately, I

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suspect, they did this completely without consciousness.

I am not a psychologist, but I would like to spend a few minutes discussing some reasons for maladjustments during overseas assignments. Any change requires adjustment; when a family moves from the South to the North, or from the West to the East in the continental United States, stresses are set up and adjustments are required. Children have to find new schools; parents leave one set of friends, perhaps relatives, and have to make new friends. I think the point is that when this change is to an overseas post, with a new climate, a new culture, a new language, the problems are greater . . . and significantly greater. Perhaps other reasons for our maladjustment are our high standard of living and the importance that all of us place on comfort and conveniences and things we have come to consider as part of the "American way of life." These are not always available in the same amounts and the same degree in an overseas post. I am afraid, also, that we tend to take democracy and "the American way of life" for granted. We feel all too little personal responsibility to defend these or to disseminate the technology necessary to make them functional elsewhere in the hemisphere.

Perhaps another reason is that we are no longer the pioneer type like our forefathers, who crossed the plains and withstood dangers and hardships to carve out a new home and a new livelihood. Another point may be that emotional, personality, and family problems are becoming more important in American homes. We have more divorces, juvenile delinquency and family tensions and, certainly, under the stresses of an overseas assignment, these tensions and problems are accentuated. Also, some families may bring with them race prejudices and segregation customs that have been a part of their continental environment.

What can we do about these problems? I am convinced that they cannot be avoided and that they cannot be forgotten. Probably the most important first step is to recognize that these problems do exist. Let's not put the blame on the host country, or on the scientist who is brought into the new situation. Let's try to recognize that these problems are inherent—that they are real—and try to understand them.

The first suggestion I should like to make is that we attempt to make a better selection of personnel. Our scientists to be stationed abroad, and their wives, should be given careful interviews by men with experience in character analysis. We should make careful pre-employment physical examinations and checks of references of past employers, in which specific questions are asked regarding eccentricities, adaptability, etc. It is essential to recognize that some men adjust better than others—some are naturally more adventurous and more adaptable. Recognize also

that the early environment of the man may be important. It has been our experience that a man who has had hardships in his youth, who may have had to help support his family or work his way through college, is a better risk than a man who has not had these experiences.

We also should recognize that personality characteristics are of equal importance to technical competence. A man stationed abroad must be technically competent because he often is "on his own;" however, it is equally important that he be able to adjust and be happy under the stresses of an overseas post.

We try to select men who place strong importance on an opportunity for service. We also try to avoid those who have had difficulty holding jobs in the States, for personality reasons or otherwise, and we try to avoid those who may come chiefly for financial betterment. These individuals tend to place strong emphasis on what this additional money will buy. As in many cases they are not able to spend that money at the assigned post to buy the luxuries desired, they usually are a poor risk. All of this, you will realize, is a far cry from selecting one of the three top men on a U. S. Federal Civil Service register. We can only hope that the Civil Service Commission and other agencies of the Federal government can be made aware that the selection of men for positions abroad requires special characteristics and special investigations, which usually are not recorded in any way on Standard Form 57 or in the official personnel folder.

We can also try to provide better orientation for a man and his family before sending them overseas. This might well include special language instruction and perhaps some in-service training in an area like Puerto Rico, which is tropical in climate and crops and is a cultural midpoint in the hemisphere. We can also try to provide a more favorable environment for this man and his family at the overseas site. We can encourage them to use the language and to make social contacts outside of their own national group. We can encourage them to participate in outdoor recreational and hobby activities. (Outside of the large cities, a family generally has to make its own recreation.) We can also try to get a man involved as quickly as possible in his work assignment, as the man who is deeply interested in his own work never presents an adjustment problem for very long.

Now, one final point: What are the implications, if any, for Latin America? I realize the dangers of extrapolating from limited experiences in Puerto Rico to a wider area, but I believe certain similarities are obvious. Latin America, even more than Puerto Rico, has tremendous technological problems to solve, and it has a shortage of trained and experienced research personnel. Some of this will be made up by the countries sending their superior students to the

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United States or elsewhere for graduate training. Some of it, however, will certainly have to be met by supplying highly trained technicians from the outside. Most of our foreign aid programs are based on this principal of technical assistance—and I am very sure that if the United States is to maintain a position of world leadership it will have to do more than make charity cases out of underdeveloped areas by sending in dollars and surplus food materials.

It will have to provide highly trained men who can go into these countries and make good; who can teach people how to produce more food and more goods and, at the same time, make friends. These men and their families will need enthusiasm, energy, and desire for service equal to that of members of the Peace Corps. But at the same time, they will need the technical competence that only advanced

graduate training and technical experience can give. And these individuals—in our modern TV-, prepackaged-, air-conditioned culture—are hard to come by!

I am sure the problem will require more careful attention than it has received in the past—that it will require fuller recognition of the importance of those individuals who are both adaptable and technically competent. Finally, perhaps we as a nation should give careful thought to developing more individuals of this type in our social and educational systems.

I notice from the printed program that we are advised by our genial chairman that speakers are expected to be constructively critical and that they may pose questions for which no ready answers are apparent. I hope my presentation this morning has not overstepped the bound of that gracious invitation.

RECRUITING AND RETAINING RESEARCHERS FOR LESS-DEVELOPED COUNTRIES

Arturo Roque
Director
Agriculture Experiment Station
University of Puerto Rico
Rio Piedras, Puerto Rico

The difficulties of recruiting a qualified research staff for less scientifically developed countries, or for areas culturally and socially different from the areas from which research workers are drawn, should not be underestimated. It is at best a slow and painstaking process and because of the constant turnover, stability and permanence are never achieved.

I shall dwell briefly on some of the most common obstacles encountered in recruiting and retaining a body of research workers for less-developed countries.

The most common and difficult hurdle is the language barrier. Unless quickly overcome, it interferes with the needed communication between the scientist and his fellow workers, his assistants and, eventually, the public. This leads to isolation which, in turn, breeds distrust, which works against the best interests of research.

Lack of first-class secular educational facilities compels many a scientist to return to his homeland. This is even truer of the scientist whose children have reached college age, as the cost of providing a college education away from home for one or more children is high.

Another factor of importance to most scientists is the availability of facilities for worship and for teaching their children their own religion.

The social and cultural activities and the mode of life of a community are of paramount importance to a scientist weighing an assignment that will keep him and his family away for a long period of time. This is especially so when his children are of marriageable age.

These major considerations, plus others less obvious but no less important, such as climate, housing, substandard medical and hospital facilities and lack of employment opportunities for other members of the family, lessen the possibility of organizing and maintaining with a reasonable degree of stability a large research staff drawn from foreign countries.

In assembling and developing a body of highly trained scientists for agricultural research in countries with little or no previous research tradition, the experience of Puerto Rico, specifically of the Agricultural Experiment Station of the University, might be useful. (These observations should be objectively assessed, however, within the frame of circumstances

in which they have proved to be sound, so that their application in other areas may be successfully accomplished. It would be injudicious to transplant them without due consideration to the political, economic and intellectual climate under which a program will operate.)

Our experience dates back to the period when the end of the Second World War was in sight and when, with the explosion of the first nuclear device, the impact of research dawned on the minds of all the peoples of the world. At that time, research was already underway at the Experiment Station with a small nucleus of select agricultural workers. Puerto Rico enjoyed, besides, certain positive advantages towards the development of a research staff from native talent; it had a democratic government, a sound public school system, a state university belonging to the land-grant college system although lacking a graduate school, a planned government program for economic development aimed at increased productivity and improved living standards, and nearly half a century of close association with the United States.

In spite of these favorable circumstances, however, the decision to train and develop our own staff was made with the realization that although such a long-range program of training in the disciplines necessary to forge a strong and balanced staff would take time and expense, the benefits would outweigh the cost in the end.

The essential features of our program for the development of a permanent research staff are as follows:

1. The selection of college graduates of high academic performance in the life sciences, agronomy, chemistry and engineering, and with a genuine research vocation. It is not easy to correctly identify true research inclinations in young graduates. Their acquaintance with research is unsubstantial and they are ignorant of the additional training required and the economic sacrifices that a research career often involves. Therefore, they must discover their vocation while working as research assistants, the initial appointment given them by the University.

2. The research assistants work under close supervision but with enough freedom of action to be able to display their initiative and resourcefulness. As part

of their in-training they are given regular courses in biometry and experimental design by senior members of the staff and are required to attend staff seminars and lectures. This gives the administration opportunities to evaluate their integrity, initiative, dedication, vocation and other professional and personal characteristics.

3. From this group of young research assistants an average of 12 are chosen each year to pursue graduate work. They are given from one to one and one-half years of leave with full pay to complete the master's degree. The discipline and the field of studies the candidate will pursue according to his vocation, as well as the university he will attend, are jointly selected by the administration and the candidate. This induces students to enroll at a broad selection of good universities. The course work is jointly planned in light of the needs of the current research program and the future plans of the institution. During this first study cycle, emphasis is placed on basic courses and training in research techniques, rather than on applied courses. In many instances, a candidate completes all major course requirements for a doctor's degree in the first one and one-half years of residence.

4. After the trainees get their master's degree, they return to the institution. By now they have developed a deeper concept of research and of their particular discipline. But what is more significant, they have discovered their limitations. A great deal of time and money is saved and discouragement avoided when junior researchers find out for themselves the limitations of their technical capabilities.

At this stage they are now able to contribute to the research program while at the same time selecting from the many research projects underway within their discipline, a problem on which to work for their doctoral dissertation. This is advantageous both for the trainees and for the institution. A junior scientist is able to complete the major portion of his thesis before returning to graduate school, thus accelerating the completion of his graduate studies requirements. Also, with his thesis problem practically worked out while in service, he can devote more time to strengthening his course work in the minor subjects, to attending more seminars and to doing more library research when he resumes graduate studies.

5. After two or three years the candidate who has proved his worth is again granted leave of absence with full pay to complete his doctor's degree. This research assistant may complete his postgraduate studies within five to eight years.

This is in essence the basic program of training which we have followed at the Experiment Station during the last 15 years. Under this program, over 180 workers have completed graduate work for the

master's or doctor's degree. Less than 22 per cent of the staff trained under the program has left the institution and in every case of resignation the main reason has been the desire for economic advancement.

But to keep abreast of scientific progress and maintain the vitality indispensable to productive research and a climate of unremitting inquiry, the training of a staff by the conventional program outlined above is not enough. If we limit our efforts to the training activity only, productivity will constantly diminish and quality will be impaired. Our program at the Station is being continuously refreshed by the following activities:

1. Distinguished scientists and teachers are being invited to the Station, preferably during the period of their sabbatic leaves. The ideal situation, when funds are available, is to have one visiting scientist for each department per year. The presence and availability of a good scholar or specialist for ready consultation and guidance inspires confidence in the staff, particularly among the junior scientists, stimulates publication of papers and improves working techniques. Through such scholars, the staff enlarges its contacts with other scientists in other countries.

2. A medium is being provided for the rapid publication of scientific papers. This is of utmost importance in view of the difficulties encountered by young or new researchers in having their papers published in current scientific journals. At best, the waiting period is so long that it dampens interest in writing and publishing results. I may say that in this respect our Station has been fortunate. For 44 years it has regularly published its quarterly review, *The Journal of Agriculture of the University of Puerto Rico*, in which our staff primarily publishes its papers.

Incidentally, some impact of our training program is evidenced in the fact that 15 years ago many of the papers appearing in the *Journal* were outside contributions. Today, most of the papers are authored by our own staff and in many instances, due to the accumulation of manuscripts, short delays in publication are unavoidable.

3. Efforts are being made toward development of a first-class library, one which grows in quality and size with the growth of the staff and the quality of the work performed. Our Station has now 15,000 volumes and nearly 170,000 classified bulletins and scientific papers. More than 600 scientific journals and periodicals are received monthly at the library, most of them in exchange for our *Journal*. Thus, the cost of publishing the *Journal* is partially borne by savings in subscription costs.

4. To keep the research staff up-to-date, opportunities for postgraduate training are being offered, principally to those with Ph.D. degrees and to the senior members of the staff. These are usually short

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periods of training at a laboratory under a scientist of renown mainly to learn or become familiar with new concepts or specialized techniques. This may be accomplished either by inviting qualified scientists in a particular field or by sending abroad members of the staff. The former procedure is generally more desirable since it allows many more members of the staff to benefit from the training and since the visiting scientist may help select and set up necessary equipment under the conditions prevailing at the institution.

5. Finally, I wish to mention the importance of staff members attending scientific meetings, and I mean scientific meetings, not scientific conventions. This is of utmost importance in relatively isolated communities. The scientist should be asked, as we do, to present a paper at the meeting and to actively participate in the discussions of the group. We have found this policy most fruitful for the institution and stimulating for the workers. If nothing else, it stimulates the individual to move ahead with his research, so as to show progress and achievement when he appears again before his peers.

As you may surmise, our program to train and assemble a competent research staff for the past 15 years has given excellent results.

During this same period, a peaceful, democratic, social and economic revolution has taken place in Puerto Rico. The family income has trebled, over 21,000 students attend our State University alone, and the income from manufacturing, spearheaded by a dynamic industrial development program, has already surpassed the income from agriculture. Yet, last year the net income from agriculture increased 3.4 per cent, and that of the whole economy was up 9.4 per cent.

This rapid pace of growth, among the fastest in the world, has created a demand for scientists, technicians and skilled personnel. Many of the men

trained under our program have been drafted to key positions in government and private industries, and our training program has thus proved its worth beyond the institution; it now permeates and is felt throughout the entire economy.

Most underdeveloped countries have primarily agrarian economies and, consequently, the first goal of any development program should be the efficient increase of agricultural production, mainly through research and technological advancement. This is a desirable and wise course to follow. As far as possible, industrial development should be tied up with the basic agricultural resources. Otherwise, industrial development, being easier and more rapidly achieved, will always outpace agricultural development.

At first, agricultural research is generally accepted as an indispensable tool essential for development and basic to intelligent planning. But as the country develops, the need to provide direct services to the people becomes all but overwhelming. Education, public works and health services, to mention a few, must be given the highest priority and, in a democratic society, competition for the research dollar derived from public sources becomes intense.

Yet, in underdeveloped countries research needs greater government support because, on the one hand, it lacks the wealth of accumulated knowledge available in countries with long research traditions and, on the other hand, the country is not sufficiently developed for local industries to contribute to its support with grants and endowments.

The great task is how, then, to get across to the government and the people at large the inescapable fact that the accomplishments of good research generate the resources necessary to provide for the direct services and development needs of a country; and that research is the first and last recourse with which to escape from hunger, sickness and want.

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J. C. BUGHER: Thank you very much, Dr. Roque. These have been very illuminating discussions by Drs. Roque and Warmke.

Dr. Roque spoiled a point that I was going to make. I was just going to say that one of the remarkable characteristics of this discussion this morning was that three speakers had treated the problem of administration of research and not one of them had mentioned money. At the last moment, Dr. Roque made me cross out that remark. But I think it is significant that the very omission of attention to budgets reflects the fact that in these days, difficult as budgets and finance may be, the deeper problems are the ones that preoccupy us. These are the problems of human development, of the motivations of scientists, of the interrelationships of people; these are the things that give the working scientist and the administrator of organized research his greatest worries. I think it is not a sign of neglect at all, but an indicator of relative values, that the mention of budgets and finances comes almost as a postscript to the discussions we have been having.

Now, in the framework of our discussion this morning, it is clear that we are concerned with the organized approach to scientific problems, the systematization of the search for new knowledge. There is no doubt that in these days of our history we are very much dependent upon such major attacks on great problems, upon the development of teamwork, and upon the accumulation of institutes and their equipment. Oftentimes, particularly in the physical sciences, one thinks he cannot do anything without a large capital investment in machines of various kinds which, in themselves, require a large force of people even to keep operating.

I would like to say a word in favor of rugged individualism in science, if you wish to call it that, and to go back in particular in my own history. I will not be talking about the Nuclear Center of Puerto Rico, which is a young institution in the scientific field, but I would like to refer to a period in Colombia in which I was concerned with work in yellow fever, both in research and in control. This was a combined operation of the Colombian government and the Rockefeller Foundation. Both participated and the Foundation individual was responsible not only to his own organization but to the government of Colombia. He had to measure up to standards of that system and to accomplish whatever he could within that framework, which oftentimes is a matter of some difficulty. It is usually enough of a problem for a young man to meet the standards of a single system, but when he has to meet the standards of two systems simultaneously it really puts a bit of stress on him. But that's the way one develops people and to a

certain extent develops the fiber of independent work.

In recalling the history of the yellow fever investigations in Colombia I always go back mentally to the experiences of Dr. Roberto Franco, who may be known to some of you, although perhaps not unless you have been concerned with the medical field. Roberto Franco was professor of medicine at the National University School of Medicine at Bogota. In 1908 he investigated in the Departamento de Boyacá in the region of Muzo, a febrile outbreak which was killing quite a large number of people. With a small laboratory and facilities, with one assistant, the whole equipment and personnel of this operation being transported by pack mules over three days of travel upon the trails, Dr. Franco did a study which in accuracy and insight is almost a classic.

He recognized that there were three sources of infection in that community: yellow fever, malaria, and relapsing fever. He distinguished each one on its clinical basis. He properly identified the epidemiological mechanism of each and with respect to yellow fever particularly. The remarkable thing was that his conclusion as to the manner of the spread of yellow fever in that community was completely contrary to everything accepted up to that time. He concluded that the individuals who developed the disease which he recognized as yellow fever acquired their infection not in the village, not in the town, but in the forest. It was a distinctly forest-related infection. He went so far as to identify this mechanism with a particularly gaily decorated mosquito to be found only in the forest and not in the community, and very clearly established a forest mechanism for yellow fever.

He published this work in 1911 and it was completely disregarded because it was contrary to the accepted norms of the time. General Gorgas, with all the reputation and distinction which followed him, visited the place. "No, no," he said, "this can't be yellow fever because the mosquito which carries yellow fever doesn't exist in this place." He referred to the mosquito which is known today as the *Aedes aegyptis* but was at that time known by a different name. The whole clean-up of yellow fever in the Caribbean area, in Central America, and the development of the Panama Canal, had all been accomplished on the thesis that yellow fever is a disease of communities, transmitted by the mosquito *Aedes aegyptis*, which is essentially a domestic mosquito. Here was a man who said: "Here we have yellow fever in the absence of such mosquitos and it is contracted in the forests." What do you do when you meet a person like that? What is done usually is to forget him and go on and do something else. But he was absolutely right. The only mistake that Roberto

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Franco made was that he was 25 years ahead of everyone else. That was the degree of lag that existed before jungle yellow fever as the real background of yellow fever in South America became recognized. Then it became a popular thing. Everyone was interested in it, and some of us were put in to work on this problem jointly with Colombian scientists. All we did, in a certain sense, was to confirm what Dr. Franco had demonstrated very conclusively 25 years before. We might have said, "Well, isn't it nice that Dr. Franco confirmed our findings?" and regarded it as evidence of negative time.

That experience and knowing that man was one of the most impressive things in my own life. Oftentimes, when I have gotten rather discouraged with the pace of things, I go back to Roberto Franco and his dedication to the pursuit of the truth and the characteristics which he exemplified all his life in his teaching as well as in his research. It is the emergence of individuals of this character—this quality—that really carries our scientific frontier forward by great leaps. They frequently are not appreciated in their own lifetimes. I had the pleasure, in Doctor Franco's old age and shortly before he died, of expressing to him the personal inspiration which I had found in his life.

Then there is the case of Carlos Chagas, in Brazil, again a remarkable individual, who was the discoverer of the trypanosoma which is the cause of Chagas disease. Now over 50 years have passed since what was at that time an incidental and not very interesting discovery, but which turned out to be very fundamental to the recognition of a disease widely distributed in South America.

One can add to this list the names of other individuals who went against the current of the moment, who followed a line of investigation wherever it might lead and who served as a guiding light to the younger people who came after them. So I wish to add to our discussion a note of appreciation for the individual qualities—the individual, almost lonely qualities—of scientific research, and the necessity for our organization to permit the emergence and the free operation of these remarkable people who in great leaps have carried forward our understanding of the world about us.

In a more practical vein in regard to organization, I think that experience has shown that it is unwise, generally speaking, in any country, to depend too much upon foreign nationals for the advancement of science. One has to build on what exists and if, in the rush to get ahead, the rush to emulate, the struggle for prestige, one tries to take a shortcut by bringing in a large group of foreign scientists, the result is usually disappointing because we get into these problems of "cultural shock" that Dr. Warmke mentions so eloquently. There is nonassimilation of such a

large group of individuals who are strange to the land and to the culture, but more important is the lack of continuity that comes about. I think the policy which has been followed most successfully in this regard is to maintain a very small minority of foreign nationals—that minority to be carefully selected with regard to the qualities which Dr. Roque and Dr. Warmke have been stressing—to fit into the scene, to lead, principally by example. I do not feel very much impressed by exhortations. There is no stimulus to hard work so effective as having to follow a man who is working hard and going fast.

A second principle is that generally a foreign national in any research program needs to have his counterpart from the local scientific group. This is the man who works with him constantly so that if the foreigner doesn't stay (and oftentimes he comes with the intention of a short stay) he leaves behind a going concern and not something that collapses when he leaves.

So a minority representation of selected individuals who can fit into the community and who find in their new association a great scientific opportunity is desirable, until some arrangement can be made for continuity in personnel.

Above all is the need for a system of values. Part of our difficulty, particularly in the United States, arises from what I feel is a devotion to a set of values which are not worth following—which are not worth achieving. These take various forms, such as chromium plate on automobiles. (Automobiles are a good example, in that 50 years of development and evolution have culminated in a vehicle which is poorly adapted, usually, to the transport of human beings in a modern environment.) The emphasis on gadgets—even on comfort—can be a source of degeneration to society and a danger to its own survival. One of the important things is to maintain, particularly in the mind of the young scientist, a real appreciation of what is worth living for, what is worth fighting for, so that he does not come to his mature and older years a disillusioned and embittered individual who is vaguely conscious of somehow having missed the main reason for things.

I think the discussions of three speakers and that of Dr. Zaffaroni in particular brought up the great importance of continued education and training within the group. Wherever the scientific work is being conducted—whether it is in a commercial or an industrial area, or in a university—the constant stimulus to intellectual advancement must be always there. If it isn't, the whole system will begin to decline until finally we have an organization already dead but not buried. This we all know.

On the importance of turnover, Dr. Roque stressed this as did Dr. Zaffaroni and Dr. Warmke. I think turnover of personnel is necessary. An or-

ganization that is too stable and too rigid tends to grow old all at once. We see it in some of our laboratories in the States. They began with a group of young men full of steam; they stayed together; they are growing old together. They have suffered somewhat from the absence of the stimulation of a mal-adjusted individual; just as a man needs an enemy at times to keep him going and to goad his progress. The introduction of new brains, of new ideas, of new concepts into a scientific system is one of the best ways to delay old age on the part of those who have been with the organization for a long time.

It is part of the duties of the scientific research institution or team to add the sum total of manpower available in the country or in the region so that the educational importance of these major and oftentimes very large scientific research organizations is very great indeed. I think the point raised in regard to the organization in Mexico City is a very important one. Here in an industrial relationship there is also essentially a university academic approach. The distinction becomes rather vague and the blurring of the boundaries becomes, I think, an important part of a vigorous scientific research system that is highly productive.

Now at this time I believe we are open to the questions and the comments of the audience directed to any member of the panel or to the panel as a whole. I can assure you that if the question cannot be answered by the individual to whom it is directed he will adroitly shift it to somebody else.

J. D. PERKINSON: Mr. Chairman, I am sure we all greatly appreciated the very illuminating remarks made by all the members of the panel, but due to the limitation of time I would like to limit my remarks to those points raised by Dr. Zaffaroni.

I think that with those who are not very familiar with the situations as they exist in many of our Latin-American countries, Dr. Zaffaroni's remarks have not been perhaps fully appreciated. If you realize the handicap under which such training and education takes place today in many of our countries and how different this situation is from the situation in the United States, then this becomes more apparent. I think it is really remarkable that a company in one of the Latin-American countries has taken this initiative in insuring the continuation of personnel to carry on and increase the scientific life of the country in which the company is located. I wonder, Dr. Zaffaroni, whether you care to comment on any particular problems that you have encountered in the development of your training and education programs?

A. ZAFFARONI: Thank you very much for your

comments, Dr. Perkinson. The primary problems are connected with making available the training procedures to widen the education of these junior chemists into areas beyond those which are under current consideration in the laboratories. The education can be in a way polarized too much in one direction only. We have tried to avoid this polarization of the training of the chemist which, after all and in spite of all of our interests, is concerned with a certain area—organic chemistry—and we have tried to avoid this by extending the curriculum, by guest lectures, by the seminars and by the education which is given later on to selected candidates who go to the foreign universities in the States or abroad. More recently, we have had a panel of an Advisory Committee in which about six very distinguished scientists from America and foreign universities take trips to Mexico three to four times a year; in addition to reviewing the total research program in meeting with the staff, they undertake to give lectures on various subjects. We have available Professor Birch from the University of Rochester, Dr. Spork from the University of Columbia, Professor Lefherberg, who is Nobel prize winner in genetics, Professor Dorfman of the Worcester Institute, and Dr. Sondheimer of Weizmann Institute in Israel. These men have wide experience in different areas of chemistry and biology and they are a continuous source of renewal of experience and intellect for the group and in their own laboratories; as a matter of fact, some of our men obtain additional training from time to time. They have chances to go there for periods of six months to a year.

We are also working now in exchange programs, through the University of Mexico, with other universities in foreign territories. I would say that this is the only type of problem we find and this is the way we try to solve it. It is interesting to point out that outside of the United States and of the few countries of Europe that have developed very high chemical technology, it is the only area of the world and the only institution that is working in research and chemical manufacturing of perhaps the most complicated chemical substances which are today made anywhere; it is a great source of pride for all the members of the organization that this achievement could have been actually developed in a Latin-American country and working with local resources.

K. S. COLMEN: To what extent do you lose people who go to the United States and other countries to study? How many and what per cent of them intend to stay where they are? We have a large number of very fine scientists and engineers in the United States who have come to the United States and

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studied and then decided not to go back home. How much of a problem is that to you? I direct these questions to the panel generally.

J. C. BUGHER: Yes, I think that is a question that these three gentlemen each must answer in regard to his own organization. Dr. Zaffaroni?

A. ZAFFARONI: Our experience has been that we don't lose them to the foreign countries to which people go for training. But of course we do have and we are very proud to have contributed to the general chemical industrial development of Mexico, because more than 100 people that have received training in our laboratories are working today in chemical industries in Mexico; we recognize that this is actually part of the system, part of the program, that we have undertaken. So to us this is not a problem; it's actually a way in which we feel we have contributed to the community.

A. ROQUE: Our experience is very similar. These young graduates who go to graduate training in the States sign a contract with the University, and at the end of their study period must give back to the institution the same amount of time which they were allowed to study. So when a man goes for his master's degree and stays a year-and-a-half, he has to come back and give us a year-and-a-half of service. This gives us time to raise his salary and to induce him to stay in many other ways.

There are many aspects of finesse that we have to work out. Also, our salary scale includes provision for a technician at an assistant level to receive a salary if he has a master's degree and a much higher salary if he has a Ph.D. This also is an inducement.

H. E. WARMKE: We have had very little problem and I attribute it to the fact that the locally recruited man is at home here. This is his culture; he is adapted here. He hesitates to migrate into another culture—to another environment—and if he does, almost without exception, within two years this man is back and says, "May I have my job back?" I think it is the reverse of the same process that I discussed regarding the problem of the North American adjusting here. These matters of cultural differences, of environment, of friends, of relatives, play a very important role in the matter of a man's work.

A. ROQUE: I don't think we have that problem. During the last 10 years, of course, many recent graduates have gone to work for American industry, notably for the Martin Company and North American Aviation in the case of engineering graduates. If the Army doesn't call them, there is a fifty-fifty chance that they might come back. In the case of engineer-

ing graduates with B.S. degrees, our experience has been that they returned to Puerto Rico after four, five or six years of work in the States. We feel that is very good for us, for these graduates bring back the accumulated experience of professional practice in big industry and big research laboratories. We almost welcome such a situation.

J. C. BUGHER: I would like to ask Dr. Zaffaroni for further comment.

A. ZAFFARONI: I know many Latin-American scientists who are working in the United States principally because of the lack of suitable laboratory facilities in their native country which would enable them to continue their chosen career. Let's say that a man comes to the United States to study genetics or to get a degree in biochemistry. He would have a very difficult time finding in his home country a well-equipped laboratory at which he could carry out the research to which he became accustomed in the United States. This individual is lost to the community because no adequate centers are provided for research in Latin America. He would be much happier working in his home country and could make much more important contributions there, not only in his special area of science but also in missionary work. I think this is a fact that must be recognized and must be solved because these countries do require today the financial help to set up appropriate laboratories for the people that are being trained in certain scientific specialties for which the countries have not found it possible to provide.

J. C. BUGHER: I would like to stress that point that Dr. Zaffaroni has made, because it is a vital one in any reasonable development of science in any country. Unless the Fellowship Program, which has been mentioned, is supported by a planned development of laboratories, the man who has special training not only will be lost in the sense of working somewhere else, but he may be lost permanently. We've had many examples in which the scientist has become so completely discouraged that he has finally given up science entirely and gone into something else. It is an extremely important aspect of this whole problem which one can hardly stress too much. Are there any further questions on this?

V. L. PARSESIAN: Mention has been made of the need for rugged individualism, of the difficulty of providing places where people can work productively and also of how there has to be within the community or country, the internal drive to get things done with less dependence on foreign scientists. I just wonder whether the panel would care to comment on what are the obstacles toward doing just this? The Good Lord does help those who help themselves. In the

environment, for example—right here in Puerto Rico, a country that tolerates the rugged individual—does it tolerate an individual effort to do something different? And I think this is a problem that probably has broader dimensions than its application to the Puerto Rican scene. What are the handicaps that a person, the rugged individual, has to face in trying to help from within, which is really the only way to develop a country?

H. E. WARMKE: I believe that in Puerto Rico we have the ideal example of an area trying to do something for itself, as exemplified by "Operation Bootstrap" in the industrial field. Bringing down know-how, bringing down capital, encouraging that to become productive, even though facilities may not always be available, Puerto Rico, with honest government, with intelligent government, and with generous help from the United States, I believe, can set an example for much of the underdeveloped areas of the world in this matter of self-government.

J. C. BUGHER: As a postscript to this very significant question, I think that Dr. Parsegian was fishing for a comment on the matter of communication among scientists, particularly among those who may not be so intimately a part of a governmental system.

It is one of the most important problems we have. I believe there is growing up in Latin America at present and especially for, say, 10 years ahead, a tradition of consultation among scientists outside of their formal government representation. There is quite a lot of that in Europe, where scientists meet simply as scientists, either at scientific meetings or under other auspices, without the representation of their governments, pooling their information and their problems as well. Out of that, I think, comes a lot of informal guidance of scientific programs; the concept being, if there is a concept here, that each scientific center should do its best possible job in its own environment with its own problems and then share those results and problems with scientists from other areas. That is, I think, beginning quite widely in Latin America and it's a kind of informal communication that should supplement and buttress the communication that we have under more formal auspices, such as the International Congresses.

I wish to thank the members of the panel for their contributions and the audience for its kindness and its exhibition of the tolerance for which Puerto Rico is so famous. Thank you.

P. R. BEALL: My thanks, too, gentlemen; and thanks also to the panel.