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General Report of the Colombia - U.S. Study Group on
THE POTENTIAL FOR GRADUATE EDUCATION AND RESEARCH
IN THE BIOLOGICAL SCIENCES IN
COLOMBIAN UNIVERSITIES

Bogotá, Colombia

29 May - 13 June 1972

Jointly Sponsored by the
Colombian Fund for Scientific Research and Special Projects
"Francisco José de Caldas"
and
The National Academy of Sciences
United States of America

NOTICE

The study reported herein was undertaken under the aegis of the National Academy of Sciences with the express approval of the Governing Board of the National Academy of Sciences - National Research Council. Such approval indicated that the Board considered that the problem is of national significance; that elucidation and/or solution of the problem required scientific or technical competence and that the resources of NAS were particularly suitable to the conduct of the project. The institutional responsibilities of the Academy were then discharged in the following manner:

The members of the study committee were selected for their individual scholarly competence and judgment with due consideration for the balance and breadth of disciplines. Responsibility for all aspects of this report rests with the study committee, to whom sincere appreciation is expressed.

Although the reports of our study committees are not submitted for approval to the Academy membership nor to the Council, each report is reviewed by a second group of appropriately qualified individuals according to procedures established and monitored by the Academy's Report Review Committee. Such reviews are intended to determine, inter alia, whether the major questions and relevant points of view have been addressed and whether the reported findings, conclusions, and recommendations arose from the available data and information. Distribution of the report is approved by the President only after satisfactory completion of this review process.

PREFACE

This report is based on a translation of an original Spanish document prepared by a Colombia - U.S. Joint Study Group on the Biological Sciences appointed by the Colombian Fund for Scientific Research and Special Projects "Francisco José de Caldas" (COLCIENCIAS) and the United States National Academy of Sciences (NAS). The joint study group was formed to determine the potential for graduate education and research at the master of science level in Colombian universities. The report is submitted to the Agency for International Development under contract AID/csd-2584, Task Order 5.

The original Spanish-language report is somewhat more detailed in that it provides further information for each university visited. The information includes course outlines for undergraduate biology majors, lists of teaching and research equipment available in the laboratories, lists of journals and specialized references in the biological sciences in the central libraries of each university, etc. The English-language report restricts itself to general materials, policy questions, and the study group's conclusions and recommendations.

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I. INTRODUCTION

The Colombia - U.S. Study Group on the Potential for Graduate Education and Research in the Biological Sciences is a part of a continuing collaborative effort of the U.S. National Academy of Sciences (NAS) and three Colombian institutions--the Colombian Fund for Scientific Research and Special Projects "Francisco José de Caldas" (COLCIENCIAS), the Colombian Institute for the Development of Higher Education (ICFES), and the National Department of Planning (DNP). This collaboration formally began in 1968 when a Colombia - U.S. Workshop on Science and Technology in Development was held. The workshop led to the strengthening of Colombian national support for science and technology and the creation of COLCIENCIAS within the Ministry of Education as the agency to plan and administer programs.

One recommendation of the workshop referred to the need for increased numbers of highly skilled persons and the necessity of strengthening graduate education and research in Colombian universities. Within the context of this recommendation, COLCIENCIAS, ICFES, and NAS agreed to study the potential for graduate education and research in biology, chemistry, geology, engineering, mathematics, and physics. NAS participation in the studies was funded by the Agency for International Development (AID) Mission in Colombia; local Colombian expenses were provided by COLCIENCIAS and ICFES.

The methodology for the studies and an executive committee to oversee them were established by officials of the four co-sponsoring organizations

during a meeting in Washington, D.C., in March, 1970. The studies in chemistry and mathematics were carried out in February and March, 1971, respectively. Because Colombian universities were closed for a long period, it was not possible to maintain the original schedule. In October, 1971, a joint decision was reached to combine the engineering, geology, and physics studies into one effort designated by the title "Engineering and Applied Sciences." This study was made in February, 1972. The last of the joint studies, in the biological sciences, was then scheduled for the period 30 May through 13 June 1972 and is the subject of this report.

Universities Visited

In the time available, the study group was not able to consider the potential for programs in the biological sciences in the detail that would be desired. The report includes, however, a short discussion for each of the programs, as follows:

1. Javeriana - Los Andes (including observations concerning Punta Betín)
2. University of Bogotá "Jorge Tadeo Lozano" (including the Laboratory of Marine Biology, Naval School, Cartagena, and the INDERENA Laboratory, Cartagena)
3. University of Antioquia, Medellín
4. University of the Valley, Cali
5. National University of Colombia, Bogotá
6. University of Nariño, Pasto. (Note: The study group did not visit Pasto, but received a representative from the University of Nariño while visiting Cali.)

7. National Pedagogical University, Bogotá

For each university the report includes background materials, information about postgraduate education and research programs that are either in progress or proposed, comments by the study group, and specific recommendations. The following pages include some general observations and conclusions thought to be applicable to teaching and research in the biological sciences in several Colombian institutions visited.

Joint COLCIENCIAS-ICFES-NAS Biology Study Group

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II. NEED FOR GRADUATE EDUCATION AND RESEARCH IN THE BIOLOGICAL SCIENCES

No quantitative data were available to the study group on the demand for graduates in the biological sciences in the academic sector (universities), the government sector, or the private industrial sector. A detailed justification in this report for highly trained human resources in the biological sciences, however, is not necessary. Development planners recognize that economic and social advancement depend on the availability, and continuous training of skilled human resources. Training in basic biological sciences is essential to advances in applied medicine and agriculture as well as preservation of environmental quality as natural resources are exploited. Current Colombian development plans aim to improve the health, nutrition, and general economic level of all citizens; however, although the plans recognize the fundamental character of medicine and agriculture, there is less recognition that the quality of the human environment is also a biological problem. Thus environmental management is one aspect of development planning that should be of increasing concern to Colombian officials. Use of both renewable and nonrenewable natural resources requires careful study lest actions that contribute to short-run economic gain result in degradation or destruction of resources (air, water, and soil) thought to be renewable or infinite. Biological scientists must form part of the interdisciplinary teams that plan and manage environmental programs.

Recognition should also be given to the fact that Colombian industrial development, like industrial development everywhere, is becoming increasingly

complex; simultaneously, as it should, it is being brought under national control. This situation also calls for persons with higher education than the traditional baccalaureate or licentiate degree. Biologists with modern, advanced training are needed in many industries: food and fiber processing, pharmaceuticals, heavy construction, pollution abatement, mineral extraction, marine and fresh water resources, etc. If these trained biologists are Colombian citizens, they are likely to give higher priority to the wise use of Colombia's resources than to the interests of international investors.

Finally, the improvement of university education, both graduate and undergraduate, depends on strong research programs. The continual process of renewing university education, even at the undergraduate level, requires that Colombia produce within her universities persons who can do independent research meeting international standards, on both basic and applied problems.

Teaching and Research

The study group noted that, without exception, professors in the biology departments in all Colombian universities have excessive teaching loads. In each university the departments not only serve biology majors but also offer basic biology courses to students of medicine, agronomy, education, dentistry, nursing, chemistry, physics, social sciences, engineering, the humanities, etc. Training in the fundamentals of biology should be the responsibility of the trained biological scientists; however, teaching loads are so heavy in Colombian universities that almost no time remains for research or for development of new postgraduate programs.

The study group strongly recommends that in all Colombian universities

it visited means be found to release time for qualified staff members to do research, and that increased support for research be made available. In some universities this will require substantial staff increases to lighten teaching loads. In other cases it may be possible to concentrate teaching responsibilities in one portion of a semester or academic year and thereby release time for exclusive dedication to research.

The importance of this recommendation, in the opinion of the study group, cannot be overemphasized. Research experience is essential to good teaching at all levels in the university. Research, furthermore, is the means to problem-solving capability to accelerate Colombian economic development. Importing ready-made solutions to problems that are specific to Colombian conditions has not been successful. Experience throughout the world has shown that the ability to produce indigenous researchers of high quality, ingenuity, and productivity depends on good university environments; i.e., proper recognition of scholars and scientists, adequate remuneration, good facilities, and a reasonable balance between teaching and research.

Research Facilities

Facilities for Graduate Research at the M.Sc. Level. Use of research facilities outside the universities offers an excellent means to extend research opportunities for Colombian students. Examples of facilities which the study group visited, are (1) Punta Betín Laboratory of the University of the Andes and University Justus Liebig of Giessen-Santa Marta: marine studies; (2) INDERENA Laboratory - Cartagena: food

processing and chemical analysis; (3) Naval School - Cartagena: oceanographic training; (4) Empresa Vikingos - Cartagena: fishing methods and food processing; (5) Other departments and faculties within Colombian universities. Collaboration between Colombian universities offering graduate programs should be encouraged; an example is the one existing between Javeriana University and the University of the Andes. Collaboration may involve exchange of both students and faculty so as to offer wider possibilities for research.

Facilities for Graduate Research at the Ph.D. Level. At present postgraduate training in Colombia is largely focused on M.Sc. level graduate programs. However, more advanced programs should be developed in the near future. Research programs offering training at the Ph.D. level, both within and outside universities, should be encouraged by the continuing development of strong centers of research. One way to accomplish this would be to establish scientific collaboration between a Colombian institution and a sister institution abroad, or between two Colombian institutions. This collaboration could involve research programs of mutual interest and the exchange of researchers and advanced students carrying out doctoral research.

Library Resources

As in the previous studies (mathematics, chemistry, engineering and applied sciences), the study group noted that most universities have deficient collections of the books and journals so essential for teaching and research. Serious enough at the undergraduate level, this deficiency is particularly significant in postgraduate studies. Throughout the

country, and especially in Bogotá, some sharing of library facilities takes place. COLCIENCIAS and ICFES have a commendable plan for an information network which should be implemented. Nevertheless, more books, journals, reference collections, bibliographies, and other materials are required, and a greater level of support for acquisitions is needed.

Equipment

One of many encouraging factors noted by the study group is that COLCIENCIAS, ICFES, and university authorities recognize the importance of equipment in the biological sciences, as in other experimental sciences. The sections of the report dealing with individual universities visited comment on equipment needs. A general observation, however, is that better equipment maintenance is also required. The study group did not have time for a detailed review of equipment maintenance problems. Ultimately, each university must have its skilled, full-time equipment technicians, just as it requires shops for more general maintenance and repair. As a general recommendation, the study group feels that COLCIENCIAS should consider making a special study of the situation in Colombia to determine alternate solutions (such as regional centers throughout the country) for maintenance of equipment (particularly electronic and optical) in universities and national laboratories.

Fellowships

The subject of fellowships was constantly raised during the individual visits. The other study groups (mathematics, chemistry, engineering) have

commented in some detail on fellowship needs and levels of support. Particular attention, in this group's view, needs to be given to fellowships for graduate study within Colombia by both in-service professors and recently graduated young scientists who are not yet on university staffs.

Because of the universal concern about fellowships, COLCIENCIAS may want to recommend a broadly based, national study of present Colombian fellowship programs. A group representing the universities, ICETEX, ICFES, COLCIENCIAS, DNP -- and including students -- might carry out the study.

Scientific Communication

Active scientists badly need communication with colleagues in their own and allied fields. The limited opportunities in Colombia for foreign travel to scientific meetings should be expanded and given more support. Younger scientists, particularly those who have recently received their degrees and are incorporated in Colombian universities should be given opportunities for travel to foreign training-and-research centers in South America, Europe, and North America.

Research journals, national and local, exist in Colombia, but most are published irregularly. The study group warmly endorses a plan by COLCIENCIAS to establish a new, broadly scientific national research journal. As the number of articles increases, COLCIENCIAS should consider a special national journal for the biological sciences.

In Colombia, as in other countries, scientists communicate more easily with each other than with the public that supports their research and benefits from it, often without knowing why or how. Colombian scientists should present less technical, less specialized articles on their research

in newspapers and national magazines aimed at a wide audience, both urban and rural.

Colombian scientists also should be encouraged to submit articles for publication in international journals, thereby providing a wider audience for Colombian research and greater contact with researchers throughout the scientific world.

The study group learned that the Association of Colombian Biological Scientists has recently been formed. It believes that COLCIENCIAS should support national organizations of this kind so that scientists may have a forum for national meetings within Colombia.

The study group believes that Colombian authorities should also encourage the meeting of international scientific congresses and similar groups in Colombia in order to promote a wider awareness of Colombian research. An international symposium on "Genetics in Agriculture" is scheduled for late 1972 at the University of the Valley, and the study group learned that other such meetings are planned.

Another need, of particular importance to the improvement of postgraduate education and research in the biological sciences, is for information on graduate programs, existing and planned, to be widely and periodically disseminated throughout all Colombian universities.

Relationship between the Professional Degree (Biólogo) and the Licentiate

The study group noted that at some Colombian universities the initial degree in biological sciences requires 5 years, and at others only 4 years. As postgraduate programs become more common, such a lack of uniformity may cause difficulties for students who do their undergraduate work at

one place and wish to do advanced work at another. Colombian authorities need to resolve this potential problem.

Student Research

Undergraduate student research is required at all universities visited by the study group. This requirement is commended, but it places an added responsibility on university and other authorities to provide facilities and financial support as more students apply for degree work in the biological sciences; it also reinforces the need to lighten professors' teaching loads. Moreover, as noted in the report on mathematics, non-trivial problems accessible to undergraduate research are not easily found. Therefore, several universities should perhaps modify the research requirement, especially for the 4-year licenciatura. Experience in some U.S. universities indicates that not all "senior essays" need involve original research to be of high quality and to be useful learning experiences; some are better done in libraries where breadth of reading and thinking can sometimes substitute for premature depth of specialization, and where the possibility of lost time through false starts is not so great. As it becomes more generally accepted that the M.Sc. degree and not the licenciatura or biólogo is the nationwide requirement for research and university teaching, it may be easier to waive the thesis requirement for undergraduates and intensify it for graduates.

Industrial Research and the Universities

The study group visited one seafood-processing company that offers its facilities, its fleet and modest financial support for student research on applied problems related to its interests. This industrial interest in

biological scientists and their education in Colombia is highly commendable and should be expanded to include other industries wherever appropriate and possible, for example, pharmaceutical companies, tanneries, processors of forest and agricultural products, and all industries requiring remote sensing and aerial photo-interpretation.

In general, however, it has never been easy to harmonize the narrow requirements of industry for "development" research with the broad requirements of students and faculties, and of science itself for "basic" research. (Here we chose to recognize ecology, atmospheric science, and geochemistry as "basic" sciences, though in another sense they are "applied".)

Rapid development of all necessary forms of biological engineering is probably no more likely in Colombia than elsewhere, and certainly the initiative for these new professional modes cannot safely be entrusted to profit-making industries. The universities must take this initiative in partnership with government agencies charged with development and regulation of economic growth.

Colombian authorities should consider the model for national resource-management represented by the cooperative, but separable, components of Environment Canada, a ministry that includes the Fisheries Research Board (FRB) and the Department of Fisheries. In Canada, basic and applied research, including much ecology, are entrusted to the FRB's national laboratories, which are quasi-autonomous and have strong relations with university science. Development, law enforcement, and international agreements are the functions of the Department of Fisheries. The governing board of FRB is composed one third of industrial representatives, one third of university scientists, and one third of officials of the department.

Canada leads the world in the high quality of its fisheries science and management, largely because of this separation of functions. For the scientist, its major advantage is the partial insulation of the ablest researchers from the insistent and worthy, but scientifically trivial, demands of industry for various improvements in technology. These demands are met (by the Department of Fisheries), but not at the cost of interrupting basic research programs that have greater long-run benefits. Industry equally respects scientists (in the FRB laboratories) and engineers and economists (in the Department of Fisheries), but for different reasons.

The study group visited the government marine laboratory of INDERENA (National Institute for the Development of Renewable Natural Resources) at Cartagena; the unfinished university laboratory of the University "Jorge Tadeo Lozano" at the Naval School, Cartagena; and the laboratory at Punta Betín, Santa Marta, jointly operated by the Universities of the Andes and Giessen (Germany). Interactions among these laboratories, and between the laboratories and industry, are healthy and growing. However, the universities need more research personnel. Postgraduate educational and research projects are already well established at Punta Betín and have great potential for further expansion. The University of the Andes took the initiative for the establishment of cooperative activities with the University of Giessen and for training programs at Punta Betín for Colombian students. To continue and strengthen these activities the help of other Colombian universities is needed.

Ecology and Environmental Biology in Colombia

Suggestions from COLCIENCIAS, and from all the universities and laboratories visited, point to a widespread belief that biological science, to

meet Colombia's needs adequately, must be more concerned with ecological matters in the future. The need is real, and in the sections describing graduate programs we note their ecological content with approval. Nevertheless, problems of resource-management and environmental quality cannot be solved by biological scientists alone. Throughout the world, as the general public becomes aware of the concept of ecology, it mistakes the part for the whole, and demands more from those who call themselves ecologists than can possibly be expected of scientists, or of any single profession. Fear of public misunderstanding, and the resulting disillusion with all science, leads the study group to prefer other terms for several graduate programs that are ecological in orientation but purely biological in content.

The practice of ecology is essentially a new and little-developed form of social and political engineering, not science. Beyond this, it is a high and difficult art in which social, political, and economic understanding, as well as deep moral conviction, often outweigh the scientific evidence. Better ecological education for decision-making positions is urgently needed in Colombia, as in all countries. Trained biological scientists in universities, government agencies, and industry can provide much of that education. But no conceivable expansion of environmental biology as a science, or of the research training typified by the Ph.D. degree, will significantly improve the training of decision-makers in areas that are more political than scientific.

What might be appropriate is an Institute of Advanced Studies in Ecology, made up of experienced ecologists. Though the initiative for such a new Colombian organization might come from pure and applied environmental

biologists, the Institute should also have sanitary and civil engineers, anthropologists, geologists, atmospheric scientists, oceanographers, geophysicists, economists, architects, and lawyers. A respected but private group, in a position to advise government on all environmental matters, would provide some immediate answers to the more elementary questions; it would sponsor and coordinate research directed at more difficult questions for which no answers are yet possible. Though the group would conduct regular seminars for exchange of information and ideas, it probably should not begin as a degree-granting or formal educational institution. Later, a degree like certificado en ecología might result from a planned curriculum involving full-time participation for a year or more. Public participation and support might be rapidly encouraged by publication of a nontechnical monthly journal, perhaps a Revista Colombiana de Recursos Naturales, with both writers and readers drawn from all of Latin America.

In summary, ecology is so broad a subject that no advanced degree is yet possible, and no university biology department can deal effectively with more than a fraction of it. Colombia's university biologists in their various ways are dealing effectively with that fraction, at the level of the M.Sc., and their efforts deserve maximum encouragement.

III. SUMMARY REPORTS OF UNIVERSITIES VISITED

Javeriana University and the University of the Andes (Bogotá)

1. Program Summary

The departments of biology of Javeriana University and the University of the Andes have united their teaching and laboratory resources in a graduate program leading to the masters degree, thereby increasing opportunities to strengthen the academic preparation of Colombians who engage in research in the biological sciences and coordinating local and international resources for studying Colombia's natural resources and utilizing those resources for the greater benefit of the country.

2. Resources of the Departments of Biology

Staff. Both institutions have highly qualified professors in various fields of biology. Currently, at least 15 professors with the M.D. or Ph.D. are doing research, but all professors have heavy teaching responsibilities at the undergraduate level.

Physical Facilities. The minimum basic research equipment already exists in both institutions, but more equipment is needed to strengthen the programs as larger numbers of students are admitted for postgraduate study. At present, the physical facilities of the university are adequate; however, strengthened library resources are necessary.

3. Conclusions and Recommendations

The collaboration between Javeriana University and the University of the Andes to promote graduate studies is highly commended.

It is necessary that research equipment and library resources be strengthened at each institution.

The availability of qualified professors to offer graduate courses depends directly upon reducing undergraduate teaching requirements of the staff.

University of Bogotá "Jorge Tadeo Lozano" (Bogotá)

1. Program Summary

The marine sciences program has been designed to include a 3-year basic cycle in Bogotá, followed by a "professionalization cycle" of 2 more years at the Naval School in Cartagena. The goal is to prepare scientific personnel at the licentiate level for industrial exploration of Colombian marine resources, with specialization in food technology and fishing. There is no plan for a graduate program before 1980.

2. Resources of the Department of Biology

The university has laboratories and equipment in Bogotá and in Cartagena for its undergraduate courses. The library is divided into two sections; in both Bogotá and Cartagena are journals and more than 1,500 volumes. The teaching staff consists of 23 professionals of whom four have M.Sc. degrees.

3. Conclusions and Recommendations

Because at present the University of Bogotá "Jorge Tadeo Lozano" is the only university in Colombia with experience and interest in marine sciences, the study group recommends that the program be strengthened to build a base for future graduate studies.

University of the Valley (Cali)

1. Program Summary

The Biology Department of the University of the Valley has proposed

three graduate programs leading to the M.Sc. degree: genetics, ecology, and the teaching of biology.

2. Resources of the Department of Biology

Staff. The department has thirteen full time professors: three (all foreigners) have Ph.D.'s and three M.Sc.'s; two, with no graduate degree, have extensive research experience; and three others have research in progress. There are six professors of the department doing additional graduate research and study abroad.

Physical Facilities. Present laboratories are not sufficient for graduate programs, but the new laboratories under construction in the University City should be satisfactory. The department has a museum with 4,000 specimens of Pacific birds and an herbarium. Also, a biological field station at Buenaventura can be utilized.

The central library is comparatively good in medicine and in the biological sciences, but more books and journals are needed for the proposed programs.

3. Conclusions and Recommendations

The proposed program can begin in 1974 only if the personnel studying abroad for advanced degrees return and if the collaboration of the Faculty of Medicine is guaranteed. The department ought to give an M.Sc. in biology and not in the specific fields proposed (i.e., genetics, ecology and teaching of biology).

University of Nariño (Pasto)

1. Program Summary

The University of Nariño presented a graduate program in biology which

would require COLCIENCIAS grants to bring to the university full time visiting staff and who would remain for several years.

2. Resources of the Department of Biology

The department staff is principally made up of professors having their degree in agronomy (ingenieros agrónomos). Two have the M.Sc. degree.

3. Conclusions and Recommendations

Because of the academic level of the staff, the joint study group could not recommend that the University of Nariño offer a master's degree program at this time. Nevertheless, COLCIENCIAS should examine carefully the research projects proposed by the University because of their promise.

University of Antioquia (Medellín)

1. Program Summary

The University of Antioquia plans to begin a masters degree program in biology in 1974. The program would offer specialization in genetics, zoology, and botany, because the present staff are best prepared in these specialties and are doing research. At present (June 1972), the details of the program and courses to be offered are not determined. It appears that botany, now the strongest area in the department, would be the first to be offered at the M.Sc. level.

2. Resources of the Department of Biology

Staff. The department has ten professors who could assist in a masters program; one has a Ph.D., and the rest have M.Sc.s from Colombian or foreign universities.

Physical Facilities. The physical plant of the university is new and spacious. The library is basically good, but for a research program at the masters level, it will require considerable additions of books and, especially, scientific journals.

3. Conclusions and Recommendations

The degree offered should be Master of Biology, within which the student could specialize in one of the three fields (botany, zoology, or genetics). The M.Sc. ought not to be in zoology, botany, or genetics.

In the opinion of the joint study group, the Department of Biology of the University of Antioquia ought not to offer the Master of Biology in 1974 unless the persons doing advanced work return and the six Ph.D.'s requested have been secured.

National Pedegogical University (Bogotá)

1. Program Summary

The Department of Biology proposes to establish in 1974 three types of programs: two are nondegree projects for improving and standardizing in-service secondary school teachers (of biology), and the third leads to a masters degree with emphasis in general biology or health education. Each emphasizes biology teaching.

2. Resources of the Department of Biology

Staff. There are enough professors for the nondegree projects for improvement and standardization, but not for an M.Sc. program in biology.

Physical Facilities. Similarly, the physical resources (laboratories, library, and classrooms) are adequate only for the nondegree projects.

3. Conclusions and Recommendations

The joint study group feels that with the professors and physical resources currently existing it would not be possible to consider a program leading to the Master of Biology degree. However, the projects for improvement and standardization ought to be supported by the groups directly concerned with improving of secondary education within the Ministry of Education, Pedagogical Institute (INCOLPE), and the Institute of Sciences.

National University of Colombia (Bogotá)

1. Program Summary

The Institute of Natural Sciences and particularly its staff of 13 botanists proposes to intensify research on the Flora of Colombia by accepting graduate students for an M.Sc. program in botanical taxonomy requiring approximately 2 years. The Ecology Section of the Department of Biology, with 12 full-time professors, also proposes a masters program. Although their program is described as "Ecology," the interest of the staff is concentrated in the special ecology of various groups of animals, and in reality is as focused upon biosystematics and biogeographics as that of the botanists.

2. Resources of the Department of Biology

The National Herbarium is a magnificent research tool. There are also important animal collections, particularly of vertebrates. The library is strong in systematic botany, weaker but adequate in systematic zoology, and rather inadequate for systematic ecology. Research equipment is exceptionally complete for studies in systematics, but is not adequate for graduate teaching in general biology and therefore inadequate

for modern ecology investigations. The large new building is designed for graduate teaching and research. The staff is generally well trained and scientifically productive.

3. Conclusions and Recommendations

The two programs are quite similar in their orientation toward classical and modern systematics, giving emphasis to the distribution and population ecology of various taxonomical groups. There is not enough equipment for, nor notable interest in, comprehensive studies of ecological models.

The department is not prepared to offer graduate training in ecology. In reality, what they have proposed is an excellent program in ecosystematics, similar to that proposed by the botanists of the Institute of Natural Sciences. Assuming the two groups work together in one graduate program that would receive 5 to 10 students per year beginning in 1972, the program should be highly recommended. However, assistance would be necessary for (1) field research, (2) fellowships for graduate students, and (3) research projects in animal ecology.